

DEP SPECIFICATION

**INSTALLATION OF ROTATING EQUIPMENT
(AMENDMENTS/SUPPLEMENTS TO API RP 686)**

DEP 31.29.00.10-Gen.

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DESIGN AND ENGINEERING PRACTICE



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TABLE OF CONTENTS

PART I	INTRODUCTION	4
1.1	SCOPE.....	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	5
1.5	SUMMARY OF MAIN CHANGES.....	5
1.6	COMMENTS ON THIS DEP	7
1.7	DUAL UNITS.....	7
1.8	NON NORMATIVE TEXT (COMMENTARY).....	8
PART II	GENERAL.....	9
PART III	AMENDMENTS/SUPPLEMENTS TO API RP 686	10
Chapter 1 - Introduction.....		10
1	Scope	10
2	Definitions.....	12
Chapter 2 - Rigging and Lifting.....		12
2	Preplanning	12
3	Lifting the Machinery.....	12
Chapter 3 - Jobsite Receiving and Protection.....		14
2	Responsibility	14
Chapter 4 - Foundations		16
4	General Design Requirements	16
7	Vertically Suspended Pump Foundation Design.....	16
11	Anchor Bolt and Reinforcing Steel Design	17
12	Drawing Design Information	17
14	General Installation Requirements	17
Chapter 5 - Mounting Plate Grouting.....		18
2	Machinery Grouting Installation Design Requirements.....	18
3	Machinery Grouting Installation Requirements.....	19
Chapter 6 - Piping.....		22
2	Machinery Piping Installation Design	22
3	Machinery Specific Piping Installation Design	24
4	Machinery Piping Installation	26
Chapter 7 - Shaft Alignment		28
4	Alignment Types	28
5	Field Alignment Requirements	29
Chapter 8 - Lubrication Systems		32
3	System Design Requirements	32
4	Lubrication System Installation	32
Chapter 9 - Machinery Installation: Commissioning		35
4	Field Commissioning.....	35
6	Gas Turbines	37
PART IV	REFERENCES	40

APPENDICES

APPENDIX A	INSTALLATION OF ROTATING EQUIPMENT ON FLOATING AND FIXED OFFSHORE PLATFORMS.....	41
APPENDIX B	INSTALLATION REQUIREMENTS FOR BELT DRIVEN FIN FANS.....	48

PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the mechanical installation of rotating equipment.

This DEP is based on API RP 686, 2nd Edition, December 2009; Part III of this DEP amends, supplements and deletes various clauses of API RP 686 2nd Edition, December 2009. Part III follows the clause numbering of API RP 686 for easy reference.

All clauses of API RP 686 not modified by this DEP remain valid as written.

This is a revision of the DEP of the same number dated September 2011; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

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

1.3 DEFINITIONS

1.3.1 General definitions

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

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

NOTE: In API RP 686, the term **Vendor** is used. In this DEP, the term **Vendor** shall be understood to mean the Manufacturer/Supplier.

The **Principal** is the party that initiates the project and ultimately pays for it. 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.

1.3.2 Abbreviations

Term	Definition
DBSE	Distance Between Shaft Ends
E-SPIR	Electronic Spare Parts and Interchangeability Record
FS	Factor of Safety for sizing
OEM	Original Equipment Manufacturer

1.4 CROSS-REFERENCES

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

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated September 2011. The following are the main, non-editorial changes.

Paragraph	Change	Reason
Chapter 1		
1.1	Added	Clarification to follow this RP
1.3.1	Updated	Current Project Practice
1.3.2	Added	Lessons Learned from Projects
1.3.3 1.3.4	Added	Lessons Learned from Projects
1.6	Added	Lessons Learned from Projects
Chapter 2		
2.7	Deleted	Not Required
3.1	Added	Lessons Learned from Projects
3.7	Modified Text	Clarified Requirement
Chapter 3		
2.3.2.c	Added	Lessons Learned from Projects
2.3.19	Modified Text	Clarified Requirement
2.4.1	Amended	Deleted unnecessary text
2.6.1 (1)	Deleted	Not Required
2.6.4 (1)	Updated Text	Clarified Requirement
2.18	Deleted	Covered in API RP 686
2.18.5	Added	Relocated from 2.18.12
Chapter 4		
4.1	Deleted	Removed unnecessary items
4.5	Added	Lessons Learned from Projects
12.1	Updated	Clarified
14.5	Added	Lessons Learned from Projects

Paragraph	Change	Reason
Chapter 5		
2.4	Updated	Project experience
2.4.2.1	Deleted	Not necessary
2.6.5	Added	
2.6.6	Added	Lessons Learned from Projects
3.9.1.1	Deleted	Not Required
3.9.4.8	Modified	Previous wording was not clear. API RP 686 tolerances are adequate.
3.9.4.9	Modified	Clarified
3.10.4	Deleted	Covered in API RP 686
3.12.6; 3.15.7; 3.15.9	Modified Text	Clarified
Chapter 6		
2.1.3 and 3.2.5.9	Added	Lessons Learned from Projects
2.4.6	Added	Lessons Learned from Projects
2.5.3	Modified	Based on DEP Feedback
2.8.1.9	Modified	Lessons Learned from Projects.
2.15	Added	Lessons Learned from Projects
3.2.	Added	Lessons Learned from Projects
4.4.1	Updated Text	Clarified
4.6.1	Deleted	Covered in API RP 686
Chapter 7		
4.1	Added	Lessons Learned from Projects
4.1.2	Added	Based on DEP Feedback
4.2.2	Modified	Not required
5.1.3	Updated Text	Clarified
5.1.4	Added Text	Clarified
5.3.1	Added	Lessons Learned from Projects
5.4.1.1; 5.4.2.1; 5.4.2.2	Modified Text	Clarified
5.4.4.1; 5.4.10	Modified	API RP 686 tolerances are adequate.
Chapter 8		
3.14	Added	Based on DEP Feedback
4.6	Added	Lessons Learned from Projects
4.6.2	Modified	Clarified

Paragraph	Change	Reason
4.6.7	Modified	Based on DEP Feedback
4.6.8	Added	Lessons Learned from Projects
4.6.12	Modified	Based on DEP Feedback
Chapter 9		
4.2.3; 4.4.6	Added	Lessons Learned from Projects
4.10; 4.10.8; 4.10.9; 4.20.10; 4.20.11; 4.21.10	Modified	Clarified
Appendix(1A,1B,1C)	Deleted	Not Required
New Appendix A	Added	Requirements for offshore
New Appendix B	Added	Requirements for belt driven fin fans

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

PART II GENERAL

Part III of this DEP is written as amendments and supplements to API RP 686, 2nd Edition, December 2009. Wherever reference is made to API RP 686, it shall be understood to mean API RP 686, 2nd Edition, December 2009 as amended/supplemented by this DEP.

For ease of reference, the clause numbering of API RP 686 has been used throughout Part III of this DEP.

Clauses in API RP 686, which are not mentioned in this DEP, shall remain valid as written.

PART III AMENDMENTS/SUPPLEMENTS TO API RP 686**Chapter 1 - Introduction****1 Scope****1.1 Purpose**

Add the following to this clause:

1. This API recommended practice (RP) shall be followed.

This DEP makes API RP 686 required instead of recommended.

2. If there is a conflict with this RP and instructions provided by the original equipment Manufacturer, then the Contractor shall inform the Principal.

The Contractor, Principal, and OEM will consult together and resolve the conflict.

1.3 Contractual Requirements

Add the following new clauses:

1.3.1 Quality Plan

1. Well in advance of equipment installation, the Contractor shall propose for the approval of the Principal a quality and certification plan detailing all aspects of site reception, preservation, installation, inspection, statutory approvals and pre-commissioning of rotating equipment.
2. Each item of equipment shall have its own checklist covering preservation, installation, inspection and pre-commissioning.
3. Such checklists shall be approved by the rotating equipment Technical Authority of the Principal or its representative.
4. The completed and signed-off checklists shall be the key documents in the hand-over procedure.
5. A copy of the completed checklists shall be added to the Permanent Equipment file (including installation records, level and alignment data, run-in record, vibration data).
6. These documents shall be in the electronic format agreed with the Principal.
7. Refer to DEP 61.10.08.11-Gen.

1.3.2 Construction Tools/Special Tools

1. The Contractor shall ensure that the correct tools are available and are used for the installation of rotating equipment.

Examples include 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, chipping tools for foundation preparation.

2. The Contractor shall review with the Principal the tools proposed to be used.
3. Self-made wrenches or adjustable wrenches shall not be used on rotating equipment.

1.3.3 Installation and Operating Manuals

1. The Manufacturer's installation and operating manuals shall be made available at the site two weeks prior to equipment shipment from the Manufacturer's facility.
2. The instructions contained therein shall be followed, unless superseded by more stringent requirements in this DEP.
3. Specific installation and commissioning instructions from these manuals shall be incorporated in the individual equipment checklists, as referenced in (Chapter 1, 1.3.1).

4. Shop test and inspection records and records of all as-built clearances shall be collected and made available at the site when the installation commences.
5. At the time installation starts, permanent equipment files for all equipment supplied should be available at the site.
6. The project specifications shall specify whether permanent equipment files are required in electronic form or as hard copies.
7. Prior to installation and commissioning, the Contractor shall agree with the Principal on which API RP 686 checklists to use for each equipment item on the project.
8. The Contractor shall maintain these checklists throughout the installation and commissioning process.
9. The final copies signed by the Principal shall be added to the permanent equipment file.

1.3.4 Lubricants

1. The Contractor shall furnish lubricant recommendations for all rotating equipment of the project in the form of a lubrication manual (schedule).
2. The lubrication manual (schedule) shall contain the required grade and quantity of lubricant, as well as the lubrication intervals for each rotating equipment item.
 - a. This information shall be available six months prior to the initial start-up of the installed equipment.
3. The Contractor shall ensure that lubricants comply with the latest Shell grade designation or equivalent, as approved by the Principal.
4. The Contractor should minimise the number of grades by a grade rationalisation exercise, in consultation with the Principal and the equipment Manufacturer.
5. The Contractor shall ensure that the lubricants required for preservation are at the jobsite prior to the equipment arriving.

1.3.5 Spare Parts

1. The Contractor shall ensure that initial and insurance spare parts are available during the construction and commissioning period.
2. Normal operating spare parts (finalized based on E-SPIR analysis and agreed with the Principal) shall be ordered to arrive at the site prior to handover of the equipment to the Principal.
3. Refer to DEP 70.10.90.11-Gen.

Add the following new clauses:

1.7 Machinery Layout

1. As a minimum, a machine stop button and speed indicator for steam turbines shall be provided on the deck.
 - a. The speed indicator should be easily visible to personnel operating the trip and throttle valve.
2. Additional machine stop buttons shall be positioned at the lower level (near the base of stairs for example) and a trip function provided remotely from the DCS.
3. The Contractor shall provide rigging points as part of the table top compressor foundations for the installation of vertical segments of machinery piping to the equipment nozzles.
 - a. The rigging points should be welded to steel that is provided as fabricated attachments that are bolted to the concrete foundation after the concrete cure.

- 4 Platform decking around the compressor train should be non-slip painted or galvanized metal grating.
 - a. Grating under and around coupling guards shall be provided.
- 5 All grating shall be provided with grating clips to secure the grating to the support structure.
6. The compressor non-drive end shall have a minimum of 2 m (6.6 ft) of decking on both ends and both sides of the train, subject to the following.
 - a. Offshore installations that are not able to meet this requirement shall review and mutually agree on the layout requirements with the Principal.
 - b. For barrel type machines, the compressor non-drive end shall have sufficient clear space to remove the rotor.
7. Reciprocating compressor access platforms shall provide adequate access for maintenance including the following:
 - a. of the discharge valves on the largest cylinder.
 - i. If lifting jacks are required for maintenance of the discharge valves, there shall be adequate space between the platform decking and the discharge valves to use the lifting jacks.
 - b. of the lube oil heater
 - c. for removal of pistons and rod assemblies.
8. The main start/stop station shall be located near the compressor.
9. A remote stop button shall be provided at ground level, if the main start/stop station is located on the access platform.
10. The skid or rack of any auxiliary system (e.g., dry gas seal, lube system.) shall be located at grade or on the concrete table, but on a lower grade than the machine.

2 Definitions

Add the following new clause:

2.61

1. Soft foot is a condition where the machine support does not have solid flat contact with the mating surface of the mounting plate, when the feet are not with coplanar tolerances or when a rocking motion occurs between diagonal feet once the equipment has been put in place and the fastening or hold-down bolts are in a non-tightened or relaxed condition.

Chapter 2 - Rigging and Lifting

2 Preplanning

Add new clause:

2.7

1. All fluids shall be removed from the skid prior to lifting or checked to confirm that sloshing will have no effect on the package centre of gravity (CG).

3 Lifting the Machinery

3.1

Add the following to this clause:

1. The sizing and selection of all lifting gear shall have a selection criteria based on 1.5 times the bearing load.

2. All lifting eyes designs and lift points shall have a design FS of 5.

This includes canister fabrication, baseplates, lifting lugs on machinery, spreader bars.

3.3

Add the following to this clause:

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

3.5

Add the following to this clause:

1. All rotors with sleeve bearings shall be suitably blocked.
2. Coupling spacers shall be removed prior to the lift.

Add the following new clauses:

3.6

1. Rollers may be used when necessary to move equipment into position, subject to approval by the Principal.
2. The rollers shall be rated for the reactions at each point and be provided with guides such as a channel to maintain a straight path.
 - a. Roller and guide sizing and selection shall have a FS of 1.5.
3. Calculations shall be provided to ensure that an appropriate number of rollers have been used
4. Calculations shall be provided to ensure the foundation bearing surface will withstand the reaction forces.
5. Contractor shall ensure that control measures are in place to both start and stop the movement of the package.

3.7

1. Tie-downs on barges shall consist of a minimum of four clips located in the mid-section of the machine base.
 - a. These clips shall be constructed of steel and designed for the maximum transport accelerations that can be experienced.
2. The clips shall be designed such that coating damage will be minimized.
3. The equipment should straddle bulkheads on the barge.
4. Prior to initiating the lift or any welding, the barge shall be inspected with all ballast hatches pulled and a "Gas Free Certification" issued by a qualified person.
5. Prior to any welding to the barge (e.g., of clips), the Contractor shall confirm the electrical grounding is suitable to prevent stray current arcing across the machinery.

Stray current can cause damage to the rotor or bearings in the machines.

Chapter 3 - Jobsite Receiving and Protection

2 Responsibility

2.3 General Instructions - Jobsite Protection

2.3.2

Add the following item c) to the end of this clause:

- c) A log of all equipment preservative measures shall be maintained and available for the Principal to audit.

2.3.6

Add the following to this clause:

1. If transport containers are stored outdoors, securely attached tarpaulin covers shall be used to prevent ingress of water and dust.

2.3.12

Add the following to this clause:

1. Gas turbine air intake and exhaust systems shall be kept blanked until erection of the air intake and exhaust ducting is completed.
2. Aero-derivative gas generators shall not be removed from their protective cover and transportation frame until immediately prior to installation in the package.
3. Removal, handling and installation of gas generators shall be performed under the direct supervision of the Supplier's representative.

Add the following new clause:

2.3.19

Spare rotors for major rotating equipment are usually furnished with watertight metal transport/storage containers suitable for vertical storage and designed per API RP 687 Chapter 1 section 11.2.3.

1. Containers for spare rotors shall be checked on arrival at the site for any signs of damage and for absence of moisture.
2. Containers for spare rotors shall be stored according to the Manufacturer's instructions.
3. An inert environment shall be maintained in such a container, e.g., by providing it with purge and pressurization fittings and a safety (over pressurization) valve.
4. If the storage canister seal is opened at any time, the o-ring seal located on the horizontal splitline of the canister shall be replaced with a new o-ring before the canister is re-sealed.

2.4 Lubricants and Preservatives

2.4.1

Add the following to this clause:

1. Prior to equipment arrival at the site, the Contractor shall ensure that sufficient quantities are available of:
 - a. rust preventatives;
 - d. desiccant in bags;
 - e. bottles of nitrogen.
2. Shell lubricants should be proposed. Other equivalent protective fluids may be used, if approved by the Principal.

2.6 Spare Parts, Special Tools and Miscellaneous Loose Items**2.6.1**

Add the following to this clause:

1. The Contractor shall not use capital spare parts and other parts ordered on behalf of Principal, without prior written consent of Principal.

2.6.4

Replace this clause with the following:

1. Prior to installation of the equipment during construction, a check should be made on the availability, usability and condition of special tools supplied by the equipment Manufacturer.
2. These special tools, when required, should be used by the Contractor, but the Contractor remains responsible for the proper use and care of these tools and their handover to the Principal in an as-new condition.
3. All special tools will be required to have a unique identification number so that they can be tracked and accounted for handover after commissioning of the equipment.

2.18 Rotary Screw Compressors**2.18.5**

Add the following to this clause:

1. Rotate the shaft using a strap wrench or other non-marking device.

Add new clauses:

2.18.10

1. For wet screw compressor applications, open the inlet and discharge ports to verify that the Vendor has applied a protective coating inside the compressor as follows:
 - a. Rotors should be coated with a preservative by spraying in through the inlet and discharge ports.
 - b. Preservative should be applied (pumped/poured) into the bearing oil supply lines/ports on both the compressor suction and discharge.
 - c. The drain piping should be detached and, when the preservative starts to leak, the rotors turned five times.

2.18.11

1. For wet screw compressor applications, confirm on a monthly basis that preservative exists on the rotors and on the bearings.

2.18.12

1. Only preservatives which are compatible with the lube oil (particularly for the bearings) shall be used.

2.18.13

1. Compressors expected to be outdoors in excess of three months shall be protected by one of the following:
 - a. Preferably by purging with nitrogen.
 - b. If nitrogen is not available, by sealing case openings using a composite sheet gasket material and applying vapour phase inhibitor per the Manufacturer's recommendations to protect the internals from rusting.
2. Where vapour phase inhibitor is used, the equipment should be tagged or labelled with the type and quantity of inhibitor applied.