

GENERAL SPECIFICATION

ROTATING MACHINERY

GS EP MEC 300

Noise and Vibration of Rotating Machine Packages

07	10/2016	Update
06	05/2015	Organization change - January 2015
05	09/2014	Update
04	10/2012	Extension to noise consideration and measurement
00	10/2005	First issue
Rev.	Date	Purpose of the revision

Owning entity: DSO/TEC	Managing entity: DSO/TEC/MTH
Other Approving entity(ies):	

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1. Scope

This specification covers the requirements for the noise and the vibrations of rotating machine packages, here-after called packages, including the whole equipment assembly (driver, driven equipment, gear box, coupling, lube oil system, base plate, intermediate base plate with low frequency insulation system if any, auxiliary equipment, enclosure...). The specification applies to packages installed on rigid concrete foundations, on fixed off-shore platforms, or on floaters such as FPSOs or FPU's.

The purpose of this document is to specify:

- The type of supporting system for each package according to the application and the installation (On-Shore versus Off-Shore including fixed platform or floater)
- The classification of the packages requiring a dynamics study
- The details of the dynamics study, when required
- The measurement, when required, of the dynamics behavior during the factory tests of the packages
- The noise measurement methods for determining the sound pressure and the sound power levels of the packages during factory tests.

Those requirements are issued to assess that the noise and the vibrations of packages remain within specified limits.

Package base plate design shall conform to **GS EP STR 103** to maintain alignment of the shaft line under all operating conditions: normal, transient and abnormal. Static stresses and deflections shall also comply with **GS EP STR 103** requirements.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
API STD 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
API STD 614	Lubrication, Shaft-sealing, and Oil-control Systems and Auxiliaries
API STD 616	Gas Turbines for the Petroleum, Chemical, and Gas Industry Services
API STD 617	Axial and Centrifugal Compressors and Expander-compressors for Petroleum, Chemical and Gas Industry Services

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Reference	Title
API STD 618	Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services
API STD 619	Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical Natural Gas Industries
API STD 674	Positive Displacement Pumps - Reciprocating
API STD 676	Positive Displacement Pumps - Rotary
EEMUA Publication 140	Noise Procedure Specification
ISO 10816 (All parts)	Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts - All parts
ISO 1940 (All parts)	Mechanical vibration - Balance quality requirements for rotors in a constant (rigid) state - All parts
ISO 3744	Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plan
ISO 8528-9	Reciprocating internal combustion engine driven alternating current generating sets - Part 9 Measurement and evaluation of mechanical vibrations
ISO 9614 (All parts)	Acoustics - Determination of sound power levels of noise sources using sound intensity - All parts

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Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP STR 103	Design and fabrication of skids and equipment supporting structures

3. General requirements

In order to comply with the noise and the vibration requirements, the noise and vibration control shall be performed throughout all phases of the project, including preliminary study, basic engineering, Front End Engineering Design (FEED) and detailed engineering phases.

As a first step, a "Vibrating rotating equipment list" shall be issued at the FEED stage. This list contains the packages for which a vibration study is required and for which vibration measurements are also required.

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The vibration control shall be based on the following main requirements:

- a) Vibration of the rotating machine packages considered as being within the limits specified in approved standards and indicated in the Rotating Machine Package Project Specifications:
 - API standards: [API STD 610](#), [API STD 614](#), [API STD 616](#), [API STD 617](#), [API STD 618](#), [API STD 619](#), [API STD 674](#), [API STD 676](#)
 - [ISO 1940](#) related to balancing for rotating equipment
 - [ISO 10816](#) (All parts).
- b) The dynamic forces generated by the rotating equipment are taken into account in the design of the base plate and supporting deck. Coincidences between natural frequencies of the packages and excitation frequencies shall be avoided.
- c) Implementing, when necessary, the appropriate low frequency vibration insulation system.
- d) Measurement of the vibration and comparison to the acceptance criteria that apply to the selected vibrating rotating equipment

As a second step, a “Noise rotating equipment list” shall be issued at the FEED stage. This list contains the sole packages, for which noise limitation is specified and for which the surface time-average sound pressure level (see [ISO 3744](#) definition) will be measured during factory test and at site. Noise monitoring and survey, either at the factory or at site, shall be restricted to those packages exclusively.

As a third step, the Vibration and Noise rotating equipment lists shall be merged into a common and single list.

If required, the vibration study as well as the noise study shall be conducted by the Rotating Equipment Supplier or subcontracted to a third party under the Rotating Equipment Supplier responsibility.

If required, the measurement of the noise and vibrations during factory test shall be performed by the Rotating Equipment Supplier or subcontracted to a third party under the Rotating Equipment Supplier responsibility.

4. Vibrating Rotating Equipment List

The scope of this paragraph is to assess a package as “vibrating rotating equipment or not”. For packages identified and classified as “vibrating rotating equipment” a dedicated vibration study shall be conducted as per paragraph 5.

This paragraph also defines if vibration measurement shall be performed during factory test of the rotating machine packages.

The Vibrating rotating equipment list is a key issue and thus shall be handled in the early phase of the Project. The list will be issued by the Company rotating equipment leader.

The parameters that shall be considered for the establishment of the Vibrating rotating equipment list are the following:

- Location of the package: on-shore, off-shore fixed platform, off-shore floaters such as FPSOs, FPU's
- Type of rotating machine: centrifugal, reciprocating, screw type, etc.

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- Type of mounting: multipoint rigid support, 3 points support, low frequency suspension
- Rotating speed and Power
- Size and weight of the package
- Excitations frequencies
- Dynamics forces.

4.1 Type of mountings

Three different types of mountings shall be used depending of the type of package, application and location:

- **Multipoint rigid support:** Mainly for on-shore applications on concrete and for small off-shore packages (roughly lower than 6 meters in length) installed on rigid enough offshore structure or deck.
- **Low frequency suspension** also called **resilient mounting system:** Mainly for diesel and gas reciprocating engines to avoid vibration transmission from package to the supporting structure or deck for onshore and offshore applications. [ISO 8528-9](#) gives typical mountings for reciprocating internal combustion engines. To avoid the vibration transmission from the package to the supporting structure or deck, the equipment or part of the equipment shall be suspended at low frequency. The suspension system shall be based on flexible elements (flexible pads). The three translatory suspension rigid body modes of the considered equipment shall be lower than 0.5 times the first main excitation frequency of the vibrating equipment. The three tilting suspension rigid body modes of the considered equipment shall be lower than 0.7 times the first main excitation frequency of the vibrating equipment.
- **Three points support:** Mainly for large off-shore packages either on fixed platform or floaters to accommodate the potential deflections of the supporting structure or deck. Two different types of “three point supports” can be used: “**gimbals**” (with some degrees of freedom in rotation) or “**sliding insulation pads**” (with internal stiffness and damping properties and some degrees of freedom in translation). Due to the size of the packages the three point support shall not be considered as a resilient mounting system which always required a larger number of flexible elements (not only three).

For off-shore applications and three points support mounting systems, the choice between gimbals and sliding insulation pads is made by the Rotating Equipment Supplier and shall be subject to Company approval.

4.2 Requirements for vibration study

During the detailed engineering, a vibration study shall be conducted under Rotating Equipment Supplier responsibility for all packages and equipment classified as “vibrating rotating equipment”, as per paragraph 4.4.

As a minimum, all reciprocating internal combustion engine packages whatever the driven machine and all reciprocating compressors shall be part of the vibrating rotating equipment list.

Electrical driven centrifugal pumps and compressors on 3 points support and floaters shall also require a vibration study.