Design and Analysis of Stationkeeping Systems for Floating Offshore Structures

API RECOMMENDED PRACTICE 2SK
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Introduction

API standards for the analysis and design of moored vessels have evolved since the first editions of API 2P, API 2FP1, and API 2SK (published in 1984, 1993, and 1995, respectively), and these codes continue to be applicable to the analysis and design of stationkeeping systems that are normally manned and may be occasionally evacuated. The design of mooring systems described herein assumes redundancy, intact and one-line broken cases satisfying the acceptance criteria are required, and therefore it is not applicable to moorings that cannot keep station in one-line broken conditions (such as single-line tethers for buoys or mooring systems with less than five mooring lines in the intact case). For permanent production systems, operating procedures for stationkeeping systems are intended, as a minimum, to include the ability to shut in wells and the facility in an emergency (e.g. emergency shut-down valves on the seabed); otherwise, the consequence of mooring failure could be very different than inherently assumed.

This edition includes several additions and changes. The most significant changes include the following:

— mandatory minimum design requirements are collected in the body of the standard, and informative guidance is included in Annex A;

— Gulf of Mexico hurricane season mobile offshore drilling unit mooring requirements are included in Annex B;

— guidance based on recent technical advances in the offshore industry is also included throughout.

The Fourth Edition of API 2SK also represents an umbrella document for stationkeeping system design, which is supported by additional guidance or specifications of stationkeeping system components, such as environmental criteria, anchor design, inspection, and integrity management. These supporting documents include (to address the described interest):

— API 2MET (environmental conditions a moored stationkeeping system is exposed to);

— API 2SM (determination of fiber rope properties for design analysis);

— API 2I (inspection of moored stationkeeping systems and components);

— ISO 19901-4 (geotechnical aspects of anchor designs for stationkeeping systems);

— API 2MIM (integrity management of moored stationkeeping systems);

— API 2F (chain specification for moored stationkeeping systems);

— API 9A (wire rope elements of a moored stationkeeping system);

— API 2S (mooring fairleads or windlasses for a moored stationkeeping system).

The technology of moored floating units continues to develop. In those areas where adequate data are available, specific and detailed recommendations are given. In other areas, general statements are used to indicate where it is intended for consideration to be given to those particular design aspects. Designers are encouraged to utilize research advances available to them.

Design and Analysis of Stationkeeping Systems for Floating Offshore Structures

1 Scope

This standard addresses the design and analysis of stationkeeping systems (mooring systems with or without thruster assistance) in conditions from survival to operational. Different design requirements for mobile and permanent moorings are provided.

The procedures for the design of permanent or site assessment of mobile mooring systems specified in this document are based on a deterministic approach where mooring system responses, such as line tensions, vessel offsets, and anchor loads, are evaluated for a design environment defined by an annual probability of occurrence or return period. Mooring system responses are then checked against acceptance criteria for mooring strength, offsets and orientation, clearances, anchor capacity, fatigue resistance, and so forth. The minimum acceptance criteria are either defined in this standard or are to be specified by the owner or the operator.

For moored vessels, system responses are calculated and compared to acceptance criteria for limit states describing acceptable extreme loads (line tensions), vessel offsets (translation and rotation), clearances (vessel, risers, water surface, seabed, anchors, field infrastructure, etc.), and fatigue (cumulative mooring component fatigue damage). Limit states associated with the extremes of the vessel's first order wave-frequency motions (surge, sway, heave, roll, pitch, and yaw at a particular point on the vessel), such as serviceability of machinery, heave compensators, separators, tank sloshing, motion-sickness, etc., exist; however, they are not addressed by this standard.

The requirements of this standard mainly address spread and single-point mooring systems with mooring lines composed of chain, wire rope, fiber rope, or a combination of these. This standard is applicable to the following types of stationkeeping systems:

— spread moorings;

— single-point moorings, anchored by spread mooring arrangements;

— thruster-assisted moorings (TAMs).

NOTE Guidance on the design and operation of dynamically positioned vessels is contained in IMCA M103.

This standard is not applicable to the vertical tendons found on tension-leg platforms (TLPs), which are covered by API 2T. Parts of this standard may not be appropriate for stationkeeping systems that are normally unmanned and occasionally manned (such as wind farms) or normally unmanned floating facilities. API 2SM, API 2I, and API 2MIM provide more detailed guidance on fiber ropes, mooring inspection, and integrity management.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document (including any addenda or errata) applies.

API Recommended Practice 2A-WSD, *Planning, Designing, and Constructing Fixed Offshore Platforms—Working Stress Design*

API Recommended Practice 2I, *In-Service Inspection of Mooring Hardware for Floating Structures*

API Recommended Practice 2MET, *Derivation of Metocean Design and Operating Conditions*