TECHNICAL REPORT

ISO/TR 13637

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Petroleum and natural gas industries — Mooring of mobile offshore drilling units (MODUS) — Design and analysis

Industries du pétrole et du gaz naturel — Amarrage d'unités mobiles de forage en mer — Conception et analyse

Reference number
ISO/TR 13637:1997(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 13637, which is a Technical Report of type 2, was prepared by the American Petroleum Institute (API) (as API Recommended Practice 2SK, 2nd edition) and was adopted by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 7, *Offshore structures*.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

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This document is being issued in the Technical Report (type 2) series of publications (according to subclause G.3.2.2 of part 1 of the ISO/IEC Directives, 1995) as a "prospective standard for provisional application" in the field of offshore structures for the petroleum and natural gas industries because there is an urgent need for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an "International Standard". It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

A review of this Technical Report (type 2) will be carried out not later than three years after its publication with the options of: extension for another three years; conversion into an International Standard; or withdrawal.

Introduction

For the purposes of providing interim guidance on mooring/stationkeeping design, ISO TC 67/SC 7 has adopted API RP 2SK in recognition that it constitutes one of the most complete documents on the subject. API RP 2SK contains design guidelines which are based on experience in the offshore industry, results of several joint industry projects and many technical publications.

There are several issues that require further consideration and harmonization prior to this Technical Report being progressed further as part of ISO 13819-4. These include:

- environmental criteria in terms of return periods for temporary and permanent moorings;
- factors of safety for tensions, anchor load and fatigue;
- improving the definition and the methodology of the mooring analysis;
- improving the guidelines for thruster-assisted mooring systems;
- providing specific guidance in relation to corrosion protection of mooring lines;
- including IMO DP Guidelines (MSC Circ 645 "Guidance for vessel with dynamic positioning systems") and relevant industry standards.

Technical Report ISO/TR 13637 reproduces the content of API Recommended Practice 2SK, 2nd edition, 1996. ISO, in endorsing this API document, recognizes that in certain respects the latter does not comply with all current ISO rules on the presentation and content of a Technical Report. Therefore, the relevant technical body, within ISO/TC 67, will review ISO/TR 13637:1997 and reissue it, when practicable, in a form complying with these rules.

This Technical Report is not intended to obviate the need for sound engineering judgement as to when and where this Technical Report should be utilized and users of this document should be aware that additional or differing requirements may be needed to meet the needs for the particular service intended.

Standards referenced herein may be replaced by other international or national standards that can be shown to meet or exceed the requirements of the referenced standards.

Appendices A, B, C and D to this document should not be considered as requirements. They are included only as guidelines or information.

Petroleum and natural gas industries — Mooring of mobile offshore drilling units (MODUS) — Design and analysis

1 Scope

This Technical Report presents a rational method for analysing, designing or evaluating mooring systems used with offshore floating units for the petroleum and natural gas industries.

2 Requirements

Requirements are specified in:

"API Recommended Practice 2SK, 2nd edition, December 1996 — *Recommended Practice for Design and Analysis of Stationkeeping Systems for Floating Structures*"

adopted as ISO/TR 13637.

For the purposes of international standardization, however, modifications shall apply to publication API RP 2SK as outlined below.

a) Information given in the SPECIAL NOTES and FOREWORD is relevant to the API publication only.

b) Throughout publication API RP 2SK, the conversion of English units shall be made in accordance with ISO 31. The content shall be replaced by the following.

LENGTH	1 inch (in) 1 foot (ft)	= 25,4 mm (exactly) = 304,8 mm
PRESSURE	1 pound-force per square inch (lbf/in^2) or psi NOTE 1 bar = 10^5 Pa	= 6 894,757 Pa
STRENGTH OR STRESS	1 pound-force per square inch (lbf/in^2)	= 6 894,757 Pa
IMPACT ENERGY	1 foot-pound force (ft·lbf)	= 1,355 818 J
TORQUE	1 foot-pound force (ft·lbf)	= 1,355 818 N·m
TEMPERATURE	The following formula was used to convert degrees Fahrenheit (°F) to degrees Celsius (°C): °C = 5/9 (°F – 32)	
VOLUME	1 cubic foot	= 0,028 316 8 m^3 or 28,316 8 dm^3
MASS	1 pound (lb)	= 0,453 592 37 kg (exactly)
FORCE	1 pound-force (lbf)	= 4,448 222 N

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Recommended Practice for Design and Analysis of Stationkeeping Systems for Floating Structures

Exploration and Production Department

API RECOMMENDED PRACTICE 2SK
SECOND EDITION, DECEMBER 1996

EFFECTIVE DATE: MARCH 1, 1997

American Petroleum Institute

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FOREWORD

The bar notations identify parts of this recommended practice that have been changed from the previous API edition. Note that all sections, paragraphs, figures, and tables have been renumbered.

This recommended practice is under the jurisdiction of the API Subcommittee on Offshore Structures.

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Suggested revisions are invited and should be submitted to the director of the Exploration and Production Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

This standard shall become effective on the date printed on the cover but may be used voluntarily from the date of distribution.

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Recommended Practice for Design and Analysis of Stationkeeping Systems for Floating Structures

1 Scope

The purpose of this document is to present a rational method for analyzing, designing or evaluating mooring systems used with floating units. This method provides a uniform analysis tool which, when combined with an understanding of the environment at a particular location, the characteristics of the unit being moored, and other factors, can be used to determine the adequacy and safety of the mooring system. Some design guidelines for dynamic positioning systems are also included.

The technology of mooring floating units is growing rapidly. In those areas where the committee felt that adequate data were available, specific and detailed recommendations are given. In other areas general statements are used to indicate that consideration should be given to those particular points. Designers are encouraged to utilize all research advances available to them. As offshore knowledge continues to grow, this recommended practice will be revised. It is hoped that the general statements contained herein will gradually be replaced by detailed recommendations.

2 Basic Considerations

2.1 INTRODUCTION TO STATIONKEEPING SYSTEMS

The stationkeeping system for a floating structure can be either a single point mooring or a spread mooring. Single point moorings tend to be used more frequently for ship shaped vessels, while spread moorings are used mostly for semisubmersibles. A third type of stationkeeping system is dynamic positioning (DP). Dynamic positioning can be used as the sole source of stationkeeping or used to assist a catenary mooring. Dynamic positioning can be used with either tanker or semisubmersible based systems.

2.1.1 Spread Mooring

Figure 1 is an illustration of a catenary spread moored semisubmersible. This is a conventional mooring technique used in floating drilling operations. For floating production applications, spread moorings are used primarily with semisubmersibles. Since the environmental force on a semisubmersible is relatively insensitive to direction, a spread mooring system can be designed to hold the vessel on location regardless of the direction of the environment. However, this system can also be applied to ship-shaded vessels which are more sensitive to environmental directions. The mooring can be chain, wire rope, fiber rope, or a combination of the three. Either conventional drag anchors or anchor piles can be used to terminate the mooring lines.

A spread mooring offers some advantages to the semisubmersible based floating production system. Since it fixes the position of the vessel, drilling and completion operations can be carried out on subsea wells located immediately below the vessel. The same is true for workover operations. On the other hand, a spread mooring system has a fairly large mooring spread (on the order of several thousand feet). Anchors and suspended mooring lines are present within this spread. These must be considered in the installation or maintenance of pipelines, risers, or any other subsea equipment.

The combination of a spread mooring with vertical mooring tendons to restrain a tension leg platform (TLP) on location, as shown in Figure 2 enhances both the operability and reliability of the basic TLP concept. The spread mooring allows for adjustment of the surface vessel in a controlled manner and provides an independent parallel load path to react against the lateral environmental forces. With this concept it is possible to horizontally position drilling tools and production equipment packages to be landed and attached to seafloor structures. Otherwise, these equipment packages would have to be positioned by other means such as guidelines, thrusters, or skidding the derrick on the surface vessel. The configuration and design of this spread mooring will be very similar to a spread mooring system used to moor semisubmersible based floating production systems.

2.1.2 Single Point Mooring

Single point moorings are used primarily for tankers. They allow the vessel to weather vane. This is necessary to minimize environmental loads on the tanker by heading into the prevailing weather. There is wide variety in the design of single point moorings, but they all perform essentially the same function. Single point moorings interface with the production riser and the vessel. An introduction to typical single point mooring systems is as follows:

a. Turret mooring. A turret mooring system is defined as any mooring system where a number of catenary mooring legs are attached to a turret that is essentially part of the vessel to be moored. The turret includes bearings to allow the vessel to rotate around the anchor legs.

The turret can be mounted externally from the vessel bow or stern with appropriate reinforcements (see Figure 3—External Turret Mooring System) or internally within the vessel (see Figure 4—Internal Turret Mooring). The chain table can be above or below the waterline. The turret also could be integrated into a vertical riser system that is attached to the bow or stern of the vessel (or internally) through some kind of mechanism that allows articulation (gimballed table, "U" joint or chain connections). The base of the riser is often weighted through additional weight within the riser or suspended beneath the riser (counterweight). These items affect

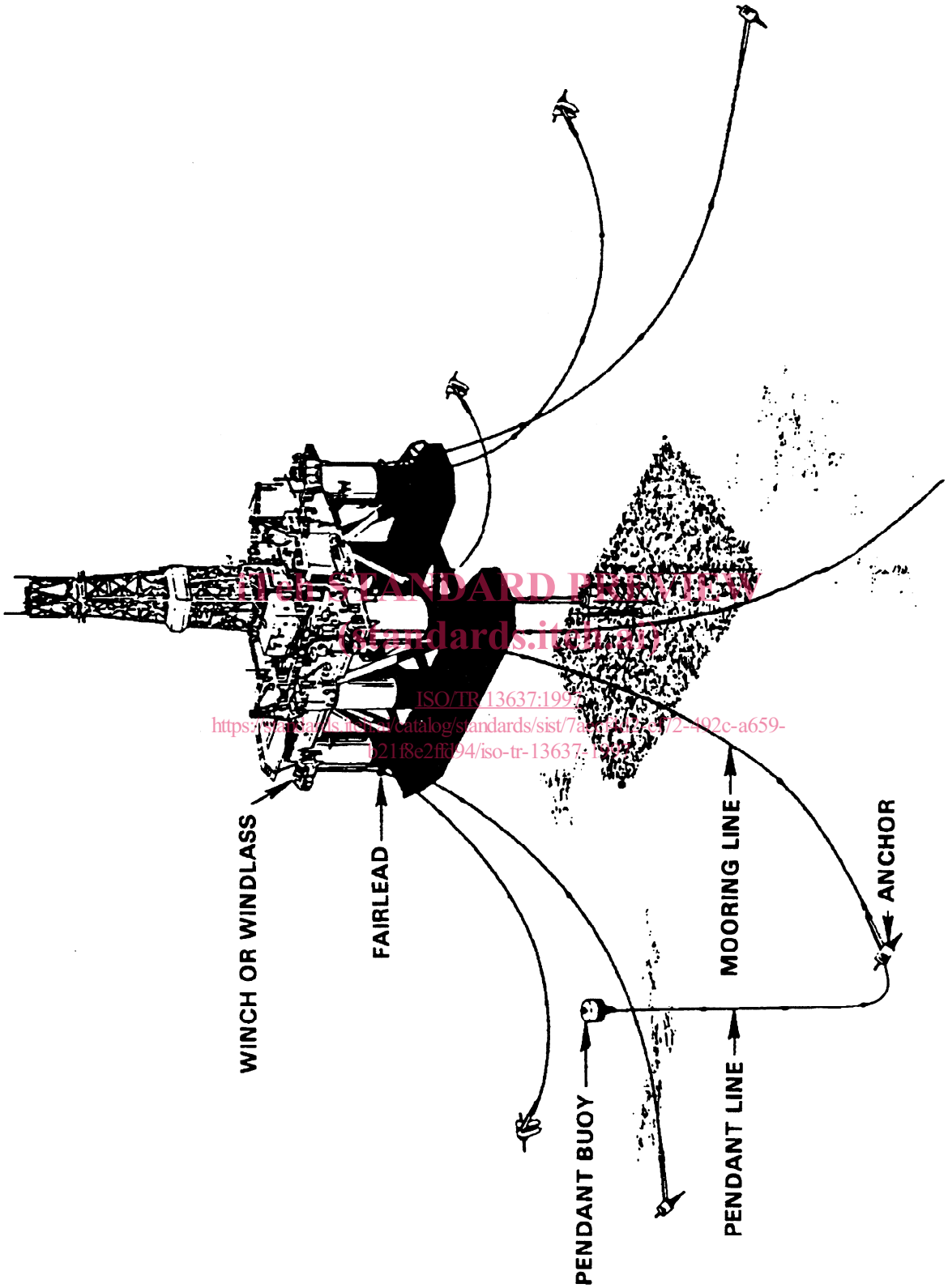

Figure 1—Spread Mooring