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ALLEGATO 12 – Estratto "OCIMF – Guidelines for the design, operation and maintenance of multi buoy moorings"

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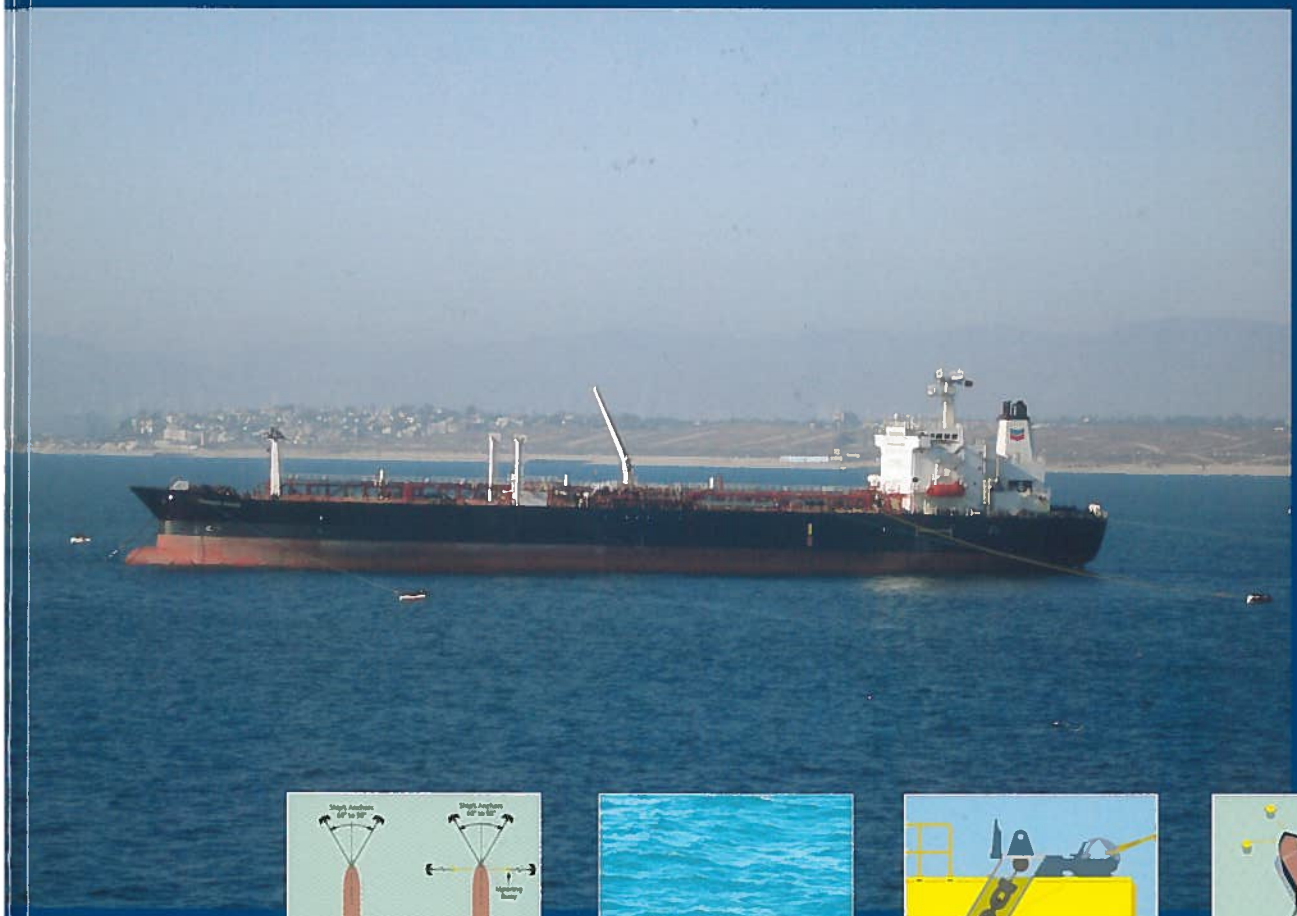
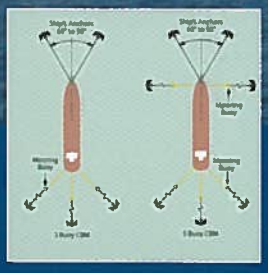
Guidelines for the Design, Operation and Maintenance of Multi Buoy Moorings





Oil Companies International Marine Forum

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Oil Companies International Marine Forum

Guidelines for the Design, Operation and Maintenance of Multi Buoy Moorings

First Edition - 2010

The OCIMF mission is to be the foremost authority on the safe and environmentally responsible operation of oil tankers and terminals, promoting continuous improvement in standards of design and operation

Introduction

Multi Buoy Moorings (MBM) are common in the oil industry and are generally used in areas where the environmental conditions are moderate.

This publication provides information and guidance to assist with the planning, design, operations, maintenance and inspection of multi buoy moorings. While the information provided is primarily geared towards the initial planning, design and operation of new facilities, it may also be useful for reference when upgrading or evaluating existing berths or when replacing individual components.

The scope of this publication embraces mooring and oil transfer equipment within the multi buoy berth, up to and including the Pipeline End Manifold (PLEM). Information regarding the subsea pipelines serving the PLEM is considered to be outside the scope and may be readily found in other publications.

The objective of this publication is to provide information and recommendations on good practice to assist with the development of site-specific requirements. Terminal operators and designers are encouraged to provide feedback to OCIMF on the content, and on any aspects that are not addressed, for proposed inclusion in subsequent editions of this publication.

Contents

Bibliography

Reference 1	*International Safety Guide for Oil Tankers and Terminals - ISGOTT (ICS, OCIMF, IAPH)*
Reference 2	*Mooring Equipment Guidelines (OCIMF)*
Reference 3	*Guide to Manufacturing and Purchasing Hoses for Offshore Moorings (OCIMF)*
Reference 4	*Single Point Mooring Maintenance and Operations Guide (OCIMF)*
Reference 5	*Guidelines for the Handling, Storage, Inspection and Testing of Hoses in the Field (OCIMF)*
Reference 6	*Recommendations for Oil Tanker Manifolds and Associated Equipment (OCIMF)*
Reference 7	*Marine Terminal Baseline Criteria and Assessment Questionnaire (OCIMF)*
Reference 8	*International Safety Management (ISM) Code (IMO)*
Reference 9	*International Ship and Port Facility Security Code - ISPS Code (IMO)*
Reference 10	*BS/EN 6349 Part 1: Maritime Structures. Code of Practice for General Criteria*
Reference 11	*BS/EN 6349 Part 6: Maritime Structures. Design of Inshore Moorings and Floating Structures*
Reference 12	*BS PD 8010-2: Code of Practice for Pipelines. Subsea Pipelines*
Reference 13	*API RP 2SK: Design and Analysis of Station-keeping Systems for Floating Structures*
Reference 14	*API SPEC 2F: Specification for Mooring Chain*
Reference 15	*API RP2I: In-service Inspection of Mooring Hardware for Floating Structures*
Reference 16	*API 1111: Design, Construction, Operation and Maintenance of Offshore Hydrocarbon Pipelines*

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Guidelines for the Design, Operation and Maintenance of Multi Buoy Moorings

Description of Multi Buoy Moorings

Section 1

1.1 General

The two main configurations of Multiple Buoy Moorings (MBMs) commonly found throughout the industry are described below:

1.1.1 *Conventional Buoy Moorings (CBMs)*

Conventional Buoy Moorings (CBMs) are offshore marine berths in which the ship's bow is held in position by its own anchors. A number of mooring buoys, typically 3 to 7, are installed to secure the stern, as shown in Figure 1. CBMs are the most common type of MBM installed worldwide.

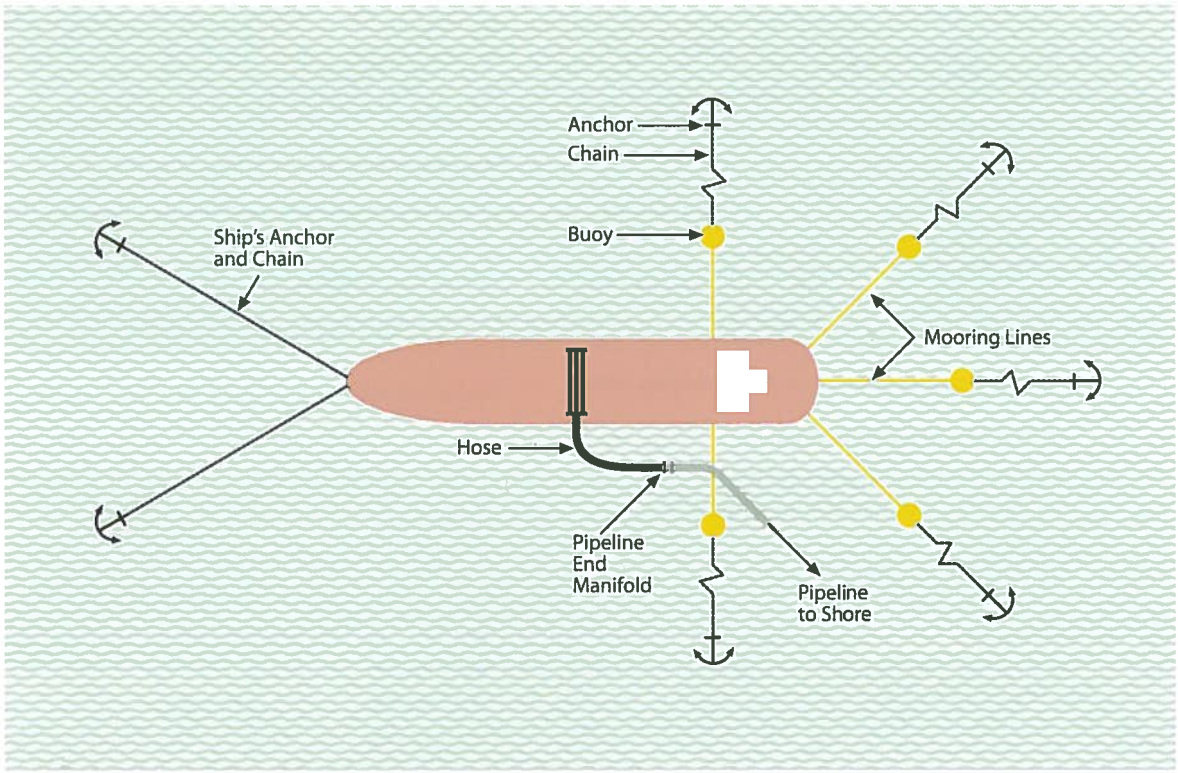

Figure 1: Simplified Layout of a Conventional Buoy Mooring (CBM)
(Note: typically may have 3, 5 or 7 buoys)

The advantages of a CBM are that it provides the least amount of obstruction during berthing and unberthing and that is the most cost effective in terms of fabrication and installation.

The disadvantage of a CBM is that it relies on the ship's anchors to provide the bow restraint. The ship's anchors provide limited mooring capacity compared to permanent mooring legs, so this type of arrangement may be limited to sites with relatively mild environmental conditions.

1.1.2 *All Buoy Moorings (ABMs)*

All Buoy Moorings (ABMs) are offshore marine berths in which both the ship's bow and stern are held in position by mooring buoys, as shown in Figure 2.

ABMs are generally located where bottom conditions prevent the use of the ship's anchors or where additional mooring restraint is needed for the maximum expected environmental conditions. The ship's anchors may be used for manoeuvring, but are not considered part of the required mooring restraint.

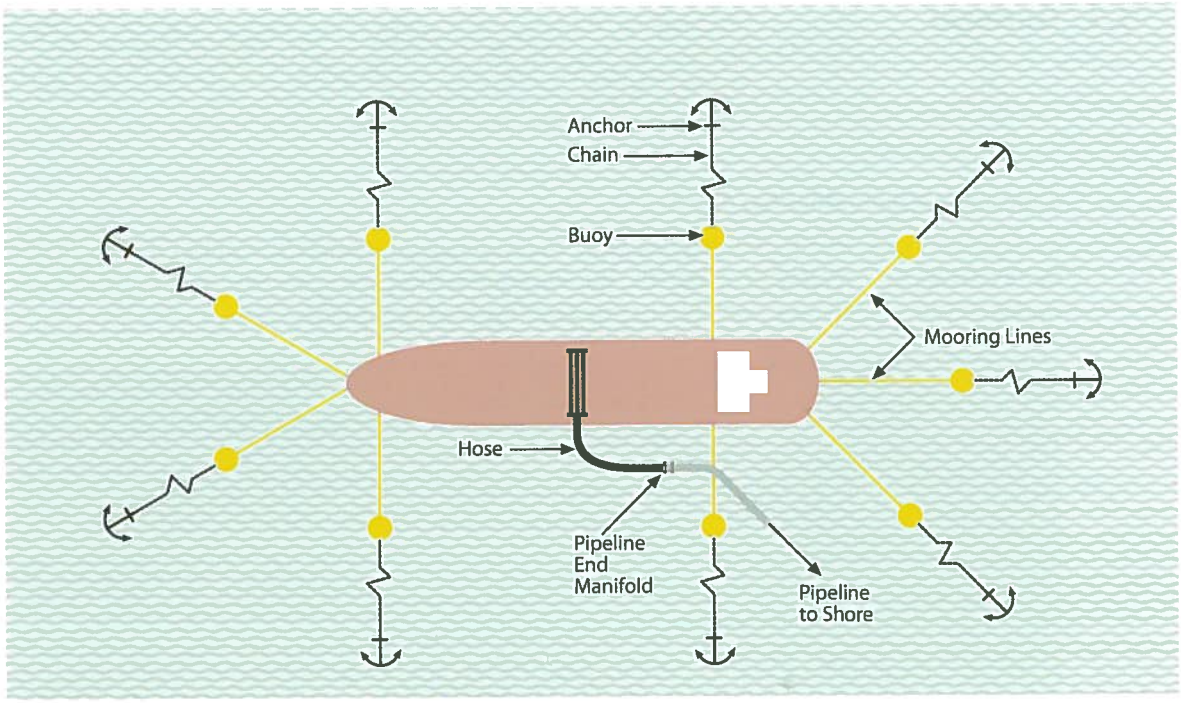

Figure 2: Simplified Layout of an All Buoy Mooring (ABM)

1.1.3 Mooring Leg Components

Mooring legs for both CBMs and ABMs consist of anchoring point(s), chain ground leg(s), chain in thrash zone, a pendant section incorporating a swivel, and a mooring buoy to which the ship's mooring line can be attached.

Figure 3 shows the components of a typical mooring leg for both the no-load case and the maximum loaded case.

1.1.4 Cargo Transfer System

For either a CBM or ABM arrangement, the cargo transfer system in most cases consists of one or more subsea pipelines that run between the shoreline and the MBM. Tanker loading and unloading operations are carried out using flexible hose strings that are connected between the Pipeline End Manifold (PLEM) and the ship's manifold.

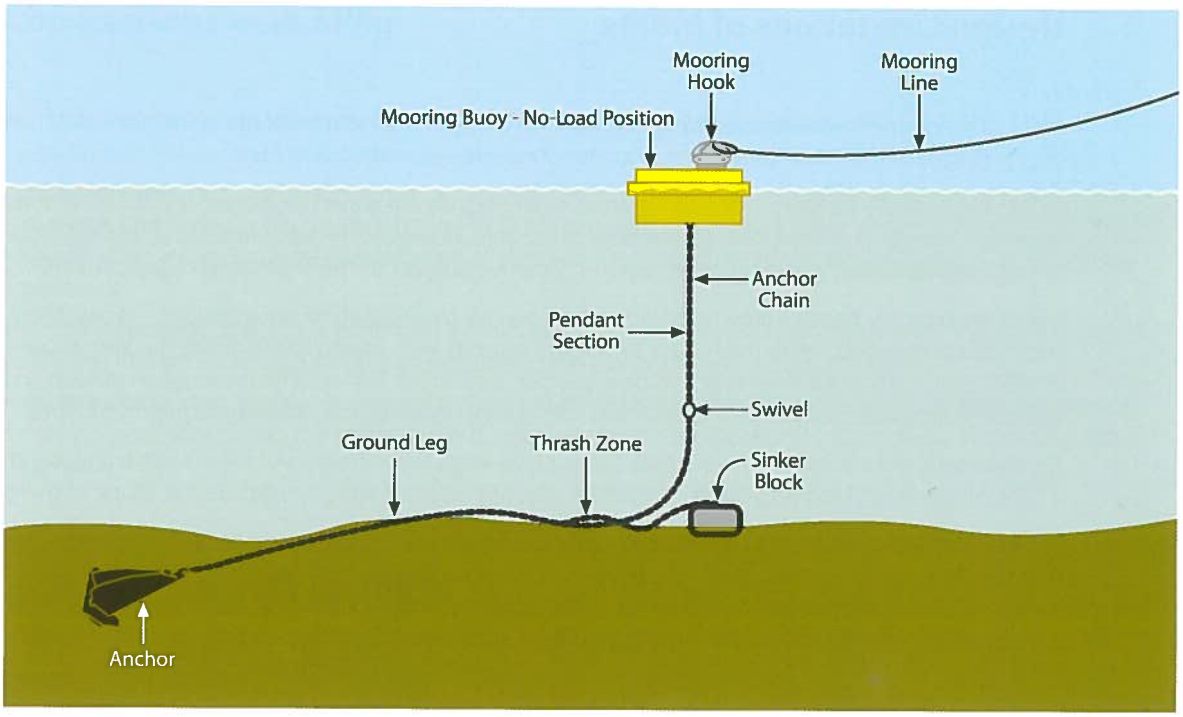

Figure 3a: Typical Mooring Leg Components under No-Load

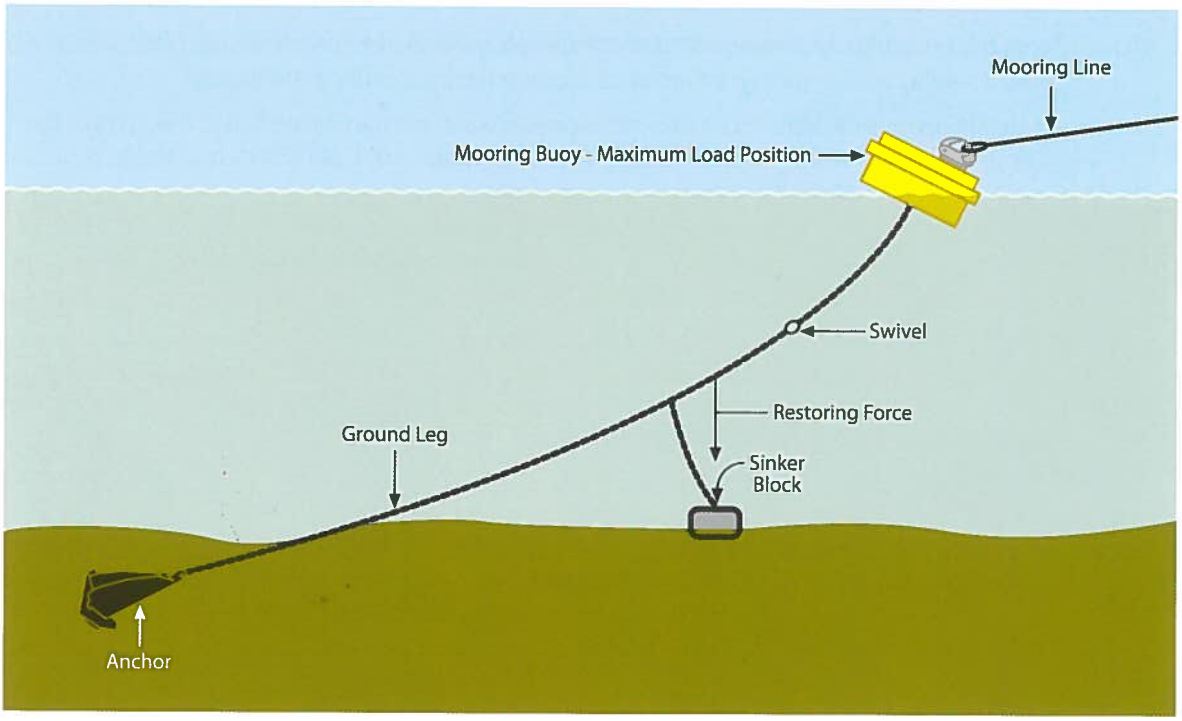

Figure 3b: Typical Mooring Leg Components under Maximum Load
[Note: Restoring Force = weight of chain lifted off seabed + (if fitted) sinker block resistance]

1.2 Design Limitations of MBMs

MBMs provide the flexibility to operate a terminal in areas where environmental conditions may make it impracticable or too costly to operate a conventional pier, sea island or SPM.

MBMs can typically be safely operated in areas where significant wave heights are less than 2.0 metres and are directed towards, or at least near to, the bow of the ship. However, the berthing and unberthing operations are typically restricted to wave heights up to 1.5 metres, subject to the limitations of support craft.

MBMs are typically better suited to environments having small duration wave periods, e.g. less than 10 seconds. Long period swells may cause significant hazards with regard to the ability to safely moor ships at MBM berths. Formal assessments, as described in Section 2.1.2, should be undertaken of each proposed location during the design stage to establish safe operating limits and optimum equipment types.

Facilities with more aggressive wave regimes, such as larger wave heights or longer wave periods, may require a SPM (Single Point Mooring) berth, the design and operation of which is outside the scope of this publication.

While MBMs are considered an economical solution for a marine loading or unloading facility, it is important that the designer fully understands the limitations of this type of berth. Wave heights higher than those indicated above could result in high forces in the ship's mooring lines and berth mooring components with a consequential risk of failure of the mooring system and the hose connection between the ship and the PLEM.

1.3 Comparisons with Fixed Berths (Piers and Sea Islands)

There are a number of advantages and disadvantages associated with installing an MBM facility rather than constructing a new conventional fixed berth. Considerations include the following:

- An MBM permits the berth to be situated in deeper water without necessitating dredging or the construction of over-the-water structures, such as approach ways, sea islands and piping trestles
- berthing and unberthing at an MBM may require less tug assistance than operations at a conventional pier or sea island. Where tugs are used, their operations may be restricted due to the close proximity of the buoys
- MBMs normally have less redundancy in the design when compared to other berth configurations. A failure of a single mooring leg could lead to failures of adjacent mooring legs as the ship's orientation shifts and the loads are redistributed
- deteriorating weather conditions, in particular increasing wave or swell conditions, at an MBM may require the shutdown of cargo operations and, in some cases, the ship vacating the berth, more often than at fixed berth facilities in protected locations
- the MBM terminal has to provide a water-borne mooring crew to assist with mooring and unmooring, hose connection and disconnection. It is normally more difficult to unmoor the ship at an MBM in deteriorating environmental conditions compared to unmooring at fixed berths
- fixed berths provide the option to utilise loading arms or shore equipment to handle hoses. At MBMs, ships should be capable of safely lifting and handling offshore hoses and this issue is of importance, particularly at those MBMs that handle a large range of different vessel sizes where smaller nominated vessels may not have adequate lifting gear. It is necessary to check the adequacy of lifting gear on all nominated vessels prior to their acceptance
- the MBM will require diving support, together with vessels capable of carrying out hose, PLEM and buoy maintenance and inspection
- water craft are required at an MBM to provide access to and from the ship for personnel. Additional supply craft may be required to provide bunkers and fresh water.