



**GUIDANCE NOTES ON**

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## **MOORING INTEGRITY MANAGEMENT**

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**American Bureau of Shipping  
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## Foreword

These Guidance Notes provide technical recommendations and guidance on the integrity management of mooring systems used on floating production installations (FPIs) that produce and/or store hydrocarbons. Mooring integrity management actively evaluates and manages the mooring system and thus reduces the risk of failure, and maintains the mooring system's fitness-for-service throughout the life of the FPI. These Guidance Notes are relevant to mooring systems for FPIs of varying shapes, ranging from semi-submersibles to ship-type FPIs. They are applicable to both new and existing installations.

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## GUIDANCE NOTES ON

# MOORING INTEGRITY MANAGEMENT

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## SECTION 1 Introduction

### 1 Background

The mooring systems for floating production installations (FPIs) remain in service for years without retrieval from the water. Deterioration of the lines due to corrosion, wear and other unfavorable conditions can increase the likelihood of single or multiple line failures which could result in loss of position of the FPI, possibly causing damage and hydrocarbon release if the riser is pressurized.

HSE JIP FPS Mooring Integrity <sup>[1]</sup> and Deepstar mooring integrity management (MIM) Guidelines <sup>[2]</sup> summarized serious mooring system incidents and failures of FPIs <sup>[3]</sup>. These documents show that even for modern designs, deterioration of some parts of the mooring systems may be more rapid than expected. The data collected demonstrates that mooring system failures tend to occur in regions of highly dynamic behavior (i.e., at or near the fairlead) at the interfaces with other components (mooring support buoys, subsea connectors), and in the touch down area <sup>[4]</sup>. Most incidents reported are related to chain, connectors and wire rope. This highlights the importance of a proper MIM system for FPIs.

### 2 Objectives

These Guidance Notes provide recommended integrity management procedures of mooring systems for FPIs. The mooring integrity management is to actively evaluate and manage the mooring system, and hence reduce the risk of failure and maintain the mooring system's fitness-for-service throughout the life of the FPI.

They should be used in conjunction with the following ABS Rules, Guides and Guidance Notes.

- *ABS Rules for Building and Classing Floating Production Installations (FPI Rules)*
- *ABS Guide for the Certification of Offshore Mooring Chain*
- *ABS Guidance Notes on the Application of Fiber Ropes for Offshore Mooring*
- *ABS Guidance Notes on Life Extension Methodology for Floating Production Installations*

### 3 Scope and Application

These Guidance Notes are relevant to mooring systems for FPIs of varying shapes, ranging from semi-submersibles to ship-type FPIs. They are applicable to new and existing installations. The mooring system extends from the anchor to the connection to the FPI, including mooring line, winching equipment and anchoring system. These Guidance Notes are not intended for:

- Mooring systems of Mobile Offshore Drilling Units (MODUs)
- TLP tendons

## SECTION 2 Mooring Integrity Management (MIM)

### 1 General

#### 1.1 MIM Philosophy

MIM philosophy should be defined before commencing the design a mooring system. The MIM philosophy should include the following:

- i) Corrosion protection approach
- ii) Degree of redundancy to single and multi-line failure
- iii) Availability of back up station keeping systems (e.g., thrusters, main engines, etc.)
- iv) Inspection philosophy
- v) Design for replacement philosophy
- vi) Approach to safety factors/ margins
- vii) Approach to the management of uncertainty,
- viii) Approach to the management of technology risk
- ix) Approach to sparing and redundancy

The MIM philosophy affects the design of the mooring, and usually forms part of the design basis for the mooring system.

#### 1.2 Design Basis

Mooring design basis contains the baseline requirements for the design of a mooring system. It usually includes the following functional specifications and performance standards <sup>[2]</sup>:

- i) Whether the mooring is dis-connectable
- ii) Watch circle requirements
- iii) Design service life
- iv) Geotechnical conditions
- v) Location as it pertains to availability/cost of mooring installation vessels
- vi) Mooring design standard or Recommended Practice
- vii) Owner specified design guidelines and philosophies

This section introduces the MIM process and its role in the lifecycle of a new mooring design.

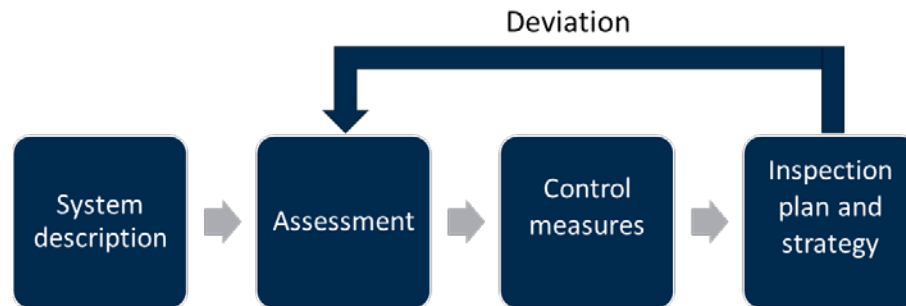
### 2 MIM Process

As shown in Section 2, Figure 1, the MIM process includes:

- *System Description.* The collection of mooring data at installation and during its lifetime.
- *System Assessment.* The assessment of the impact of new data on the fitness-for-service or MIM strategy of a mooring system, and the risk associated with one or more causes of failure.

- *Control Measures.* The development of risk control measures and verification that the intended risk mitigation measures have been successfully implemented.
- *Inspection Plan and Strategy.* Capture of suitable records to facilitate ongoing management by means of inspection and monitoring, and future re-assessment if there is deviation from the as designed mooring design basis.

**FIGURE 1  
MIM Process**



### 3 Implementation of MIM in New Design

For a typical mooring design, the MIM process is applied across the entire lifecycle of the mooring system. A number of key activities continue through the project lifecycle, as shown in Section 2, Table 1.

Section 2, Figure 2 shows a recommended practice for applying the MIM process to a new FPI from design phase to installation and commissioning, and finally the operation phase.

#### 3.1 System Description

A description of the mooring system should be developed to include the following elements:

- i) Mooring line
  - Chain, wire rope, synthetic rope, or a combination
  - Clump weight
  - Spring buoy
  - Connecting hardware (shackle, swivel, other connectors)
  - Chain jewelry
- ii) Winching equipment
  - Windlass
  - Chain jack
  - Winch
  - Fairlead and stopper
- iii) Anchoring system
  - Drag Embedment Anchor
  - Pile Anchor (driven, jetted, drilled and grouted)
  - Dynamically Installed Pile

- Suction Pile and Suction Caisson
  - Gravity Anchor
  - Plate Anchor (drag embedded and direct embedded)
- iv) Monitoring system
- Tension and position monitoring

Up to date mooring information should be kept and maintained for the MIM process throughout the life of a FPI with the goal of capturing data about the mooring's characteristics, including design data, installation data and fabrication data. It also includes the in-service monitoring data (e.g. vessel position, heading, metocean data, and mooring line tension), in-service inspection data, modification/repair data, corrosion data, and operational incident report etc. In developing a description of the mooring system, the typical states and conditions should be considered such as connected/disconnected, intact, transient and damage states.

MIM data should be collected and maintained in a data management system such that the state of the mooring system is always readily available. The monitoring/inspection data should be stored so as to facilitate the quantification of the degradation rate of the system.

**TABLE 1**  
**MIM Implementation Activities**

| Activity                                                     | Ref.  | Design              |      |        | Fabrication | Installation | Commissioning | Operations | Operation-State Change | Life Extension | Decommissioning |
|--------------------------------------------------------------|-------|---------------------|------|--------|-------------|--------------|---------------|------------|------------------------|----------------|-----------------|
|                                                              |       | Feasibility Concept | FEED | Detail |             |              |               |            |                        |                |                 |
| Develop/Update MIM Philosophy                                | 2/1.1 | X                   | X    |        |             |              |               |            |                        | X              |                 |
| Develop/Update Design Basis                                  | 2/1.2 | X                   | X    | X      |             |              |               |            | X                      | X              |                 |
| Develop/Update Mooring Risk Assessments                      | 5/5   | X                   | X    | X      | X           | X            | X             |            | X                      | X              |                 |
| Develop/Update Numerical Models                              | 2/3.4 | X                   | X    | X      |             | X            |               | X          | X                      | X              |                 |
| Develop/Update System Controls and Control Verification Plan | 2/3.5 |                     | X    | X      |             |              |               |            |                        |                |                 |
| Develop/Update Control Test & Verification Records           | 2/3.5 |                     |      | X      | X           | X            | X             |            |                        | X              |                 |
| Develop/Update Emergency Response Plan                       | 5/6   |                     | X    | X      | X           | X            |               | X          | X                      | X              |                 |
| Develop/Update Mooring Inspection Plan                       | 2/3.6 |                     | X    | X      |             |              | X             | X          | X                      | X              |                 |
| Compile Mooring Inspection Records                           | 4/2.3 |                     |      |        |             |              | X             | X          | X                      | X              | X               |