Rules for Building and Classing

Single Point Moorings

January 2024

RULES FOR BUILDING AND CLASSING

SINGLE POINT MOORINGS
JANUARY 2024

American Bureau of Shipping
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Foreword *(2024)*

This edition of the ABS *Rules for Building and Classing Single Point Moorings* (SPMs) primarily reflects changes in format and references to ABS and other standards that have occurred since the previous edition was issued.

Changes to the technical criteria include revisions made to other pertinent ABS Rules that are the basis of SPM criteria; such as, the introduction of an adjustment factor (Q) to account for higher strength steels in the determination of buoy scantlings. Also the section on Moorings and Anchoring Section (3-4-1, herein) has been updated to reflect industry practice and to specifically allow the option to use the criteria found in the ABS *Rules for Building and Classing Floating Production Installations* for this topic.

The January 2023 edition includes updates to add a new Chapter 5 to Part 4 and a new Chapter 3 to Part 5, to provide the requirements for charging station installation onboard SPMs. In addition, a new optional notation OCC is introduced.

PART 1

For the 2008 edition, Part 1, "Conditions of Classification" was consolidated into a generic booklet, entitled *Rules for Conditions of Classification – Offshore Units and Structures (Part 1)* for all vessels other than those in offshore service. The purpose of this consolidation was to emphasize the common applicability of the classification requirements in "Part 1" to ABS-classed vessels, other marine structures and their associated machinery, and thereby make "Conditions of Classification" more readily a common Rule of the various ABS Rules and Guides, as appropriate.

For the 2024 edition, *Rules for Conditions of Classification – Offshore Units and Structures (Part 1)* is renumbered as "Part 1B".

Part 1 of these Rules specifies only the unique requirements applicable to single point moorings. This supplement is always to be used with the aforementioned *Rules for Conditions of Classification – Offshore Units and Structures (Part 1B)*.

RULES FOR BUILDING AND CLASSING

SINGLE POINT MOORINGS

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CHAPTER 1
Scope and Conditions of Classification

SECTION 1
Classification *(1 January 2008)*

The requirements for conditions of classification are contained in the separate, generic ABS *Rules for Conditions of Classification – Offshore Units and Structures (Part 1B)*.

Additional requirements specific to single point moorings are contained in the following portions Sections of this Chapter.

PART 1

CHAPTER 1

Scope and Conditions of Classification

SECTION 2

Classification Symbols and Notations

A listing of Classification Symbols and Notations available to the Owners of vessels, offshore drilling and production units and other marine structures and systems, "List of ABS Notations and Symbols" is available from the ABS website "http://www.eagle.org".

1 Single Point Moorings Built Under Survey *(2014)*

1.1 General *(2021)*

SPM's which have been built under the supervision of the ABS Surveyors to the requirements of these Rules or to their equivalent, where approved by the Classification Committee, will be classed and distinguished in the *Record* by the symbols ✠ **A1Single Point Mooring**. This document is mainly applicable to SPM systems which are designed for temporarily moored vessels. For vessels which will be permanently moored to a SPM, the ABS *Rules for Building and Classing Floating Production Installations (FPI Rules)* applies. Data as described in 1-1-2/7 will be indicated in the *Record*.

Where design fatigue life values are specified by the applicant for the position mooring system and the design complies with the fatigue requirements of the ABS *Requirements for Position Mooring Systems*, the notation **FLM (number of years)**, **Year**, where **(number of years)** refers to the target value of the fatigue life for a new position mooring system and **Year** refers to the year of maturation associated with the new position mooring system will be applied. Where an existing mooring system is to be reused, the notation **RFLM (number of years)**, **Year** referring to the remaining fatigue life of the existing position mooring system will apply.

1.3 Modified Scope to Exclude PLEM

When requested by the Owner and agreed to by ABS; the Pipeline End Manifold, PLEM, (or similar equipment) associated with the SPM may be exempted from the scope of Classification. The manner used to control the flow of fluid between a subsea pipeline and the visiting vessel is to be fully described in documentation provided to ABS when requesting this exemption. As appropriate, the Classification Designation used when the PLEM is excluded from the scope of classification is **Single Point Mooring (excl. PLEM)**. The following portions of these Rules will not apply when the PLEM is excluded from the scope of classification: 3-2-2/17, 4-1-4/9 and items pertinent to the PLEM in 5-1-1/11.3 TABLE 2. It is the Owner's responsibility to verify that the exclusion of the PLEM from ABS design review and survey is acceptable to the governmental authority having jurisdiction over the SPM.

1.5 Unconventional Designs

These Rules apply to conventional SPM designs. A conventional SPM provides temporary offshore mooring to a variety of visiting vessels by means of a hawser or yoke from the buoy or fixed tower. Fluid transfer between the visiting vessel and a sea floor pipeline is performed by an underbuoy hose or riser, and a hose between the buoy or tower and the visiting vessel.

An example of a mooring system design that differs from the above concept is one characterized as a *detachable turret-type* system. In this case the visiting vessel has a unique mating assembly used to join the buoy and the vessel. The mating assembly may be located inside the hull of the visiting vessel, or the assembly may be mounted externally at an end of the vessel. Fluid flow may occur through jumper hoses or piping between the buoy and vessel. The applicability of these Rules to an unconventional design will be decided by ABS on a case-by-case basis. In such a case, the criteria in these Rules may need to be supplemented or replaced by criteria in the *FPI Rules*.

3 Single Point Moorings Not Built Under Survey

SPM's which have not been built under the supervision of the ABS Surveyors, but which are submitted for classification, will be subject to a special classification survey. Where found satisfactory, and thereafter approved by the Classification Committee, they will be classed and distinguished in the *Record* in the manner as described as in 1-1-2/1 but the mark "✠" signifying the survey during construction will be omitted.

5 Single Point Mooring as a Part of a Floating Production System *(2011)*

SPM's built under survey for use as part of the mooring system for a classed floating production system do not require a separate classification under these Rules. Requirements for mooring systems of floating production systems are found in the *FPI Rules*.

6 Single Point Mooring Fitted with Charging Stations *(2023)*

Where requested by Owner, SPM fitted with charging stations which are found to comply with the requirements in Part 4, Chapter 5 and Part 5, Chapter 3, will be eligible for an optional notation **OCC**, e.g. **Single Point Mooring (OCC)**.

Where the optional notation **OCC** is not requested, but the SPM is fitted with a charging facility, then the charging facility is to comply with minimum requirements prescribed in 4-5-1/Table 2.

7 Classification Data

Data on single point moorings will be published in the *Record* as to the latitude and longitude of the location of the mooring, the length overall and displacement of the ship it is designed to moor, the depth of water at the site, maximum hawser tension where applicable, and general types of cargo and other fluids which the mooring is designed to handle..

PART 1

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SECTION 3
Rules for Classification *(1 January 2008)*

1 Application of Rules

These Rules are applicable to unmanned SPM's as defined in Section 3-1-1 and are generally intended for temporary moored vessels.

These Rules are applicable to those features of the system that are permanent in nature and can be verified by plan review, calculation, physical survey or other appropriate means. Any statement in the Rules regarding other features is to be considered as a guidance to the designer, builder, owner, et al.

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SECTION 4

Plans and Design Data to be Submitted

1 Plans

Plans showing the scantlings, arrangements, and details of the principal parts of the structure, associated piping and equipment of each SPM to be built under survey are to be submitted for review and approved before construction is commenced. These plans are to clearly indicate the scantlings, joint details and welding, or other methods of connection. The number of copies to be submitted is to be in accordance with 1-1-4/11 and 1-1-4/13. In general, plans are to include the following where applicable.

- General arrangement
- An arrangement plan of watertight compartmentation, including the location, type and disposition of watertight and weathertight closures
- Structural arrangement showing shell plating, framing, bulkheads, flats, main and bracing members, joint details, as applicable
- Details of watertight doors and hatches
- Welding details and procedures
- Corrosion control arrangements
- Type, location and amount of permanent ballast, if any
- Bilge, sounding and venting arrangements
- Hazardous areas
- Electrical system one line diagrams
- Location of fire safety equipment
- Mooring arrangement
- Mooring components including anchor legs, associated hardware, hawser(s), and hawser load-deflection characteristics
- Foundations for mooring components, industrial equipment, etc. showing attachments to hull structure
- Anchoring system showing the size of anchor, holding capacity of piles, pile sizes, and capacity, etc.
- Pipe Line End Manifold (PLEM) as applicable
- SPM main bearing

- Cargo or product swivel including swivel driving mechanism, swivel bearings, and electrical swivel details
- Product or cargo system piping schematic drawing with bill of materials
- Design data of equipment, piping and related components including minimum and maximum design pressure and temperature
- Ancillary piping systems schematic drawings with bills of material
- Floating and underbuoy hoses/flexible risers
- Telemetry/Control system
- Navigation aids
- Methods and locations for nondestructive testing (NDT)
- Plans for conducting underwater inspections in lieu of drydocking
- Test and inspection plan for all major load carrying or pressure retaining components including cargo or product swivel, electrical swivel, bearings.
- Test Procedures

3 Site Chart

To demonstrate that navigational considerations have been taken into account in establishing the mooring location, a site chart of the mooring area is to be submitted in accordance with Section 3-1-2 which shows the location of the mooring, potential navigation hazards and existing and planned navigation aids, bottom contour elevations, maneuvering area and swing circle.

5 Site Condition Reports

To demonstrate that site conditions have been ascertained and taken into consideration in establishing design criteria, reports on subjects including the following are to be submitted in accordance with Section 3-1-2.

i) Environmental conditions of wind, waves, current, seiche, tide, visibility, temperature, and ice.

ii) Water depth, at berth and throughout the maneuvering area, bottom soil conditions, and subsurface hazards.

7 Model Tests

When model tests are used to determine the design loads or to demonstrate that the established design loads have been based on the results of physical dynamic model tests, a report is to be submitted describing the design loads, calculations, description of model test facilities and procedures, and a summary of the results. It is recommended that the designer consult with ABS concerning model testing, procedures, methods and data analysis to ensure the investigation is adequate.

9 Calculations

In general, where applicable, the following calculations are to be submitted:

i) Structural design in accordance with Section 3-2-2

ii) Stability calculations in accordance with Section 3-2-2

iii) Mooring and anchorage in accordance with Section 3-4-1

iv) Piping in accordance with Part 4, Chapters 1 and 2

v) Calculations for all pressure retaining and load bearing components in accordance with Part 4

vi) Swivel stack static and dynamic analysis in accordance with Part 4

Calculations when submitted are to be footnoted indicating references.

11 Additional Plans

Where certification under the other regulations described in Section 1B-1-5 of the ABS *Rules for Conditions of Classification – Offshore Units and Structures (Part 1B)* is requested, submission of additional plans and calculations may be required.

13 Submissions *(2011)*

Plans should generally be submitted electronically to ABS. However, hard copies will also be accepted.

Additional copies may be required when the required attendance of the Surveyor is anticipated at multiple locations.

All plan submissions originating from manufacturers are understood to have been made with the cognizance of the builder.

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SECTION 5
Information Booklet and Maintenance Manual

For each SPM, a document is to be submitted. This document is to include recommendations regarding operation and maintenance of the SPM facility, the design criteria for the SPM, information regarding the mooring area, and the components of the SPM.

1 Items Included in Information Booklet and Maintenance Manual *(2023)*

The document is to include the following information.

i) Site chart as described in 1-1-4/3

ii) Design vessel data, including deadweight, length, draft and distance from bow to manifold.

iii) Environmental design criteria with various sizes of vessels, including the operating wind, wave, current and tides.

iv) Design cargo transfer criteria, including type of cargo and design maximum. working pressure, temperature, flow rate, and minimum valve closing times including the vessel's manifold valves.

v) Plans showing the general arrangement of the single point mooring components and details of those components required to be handled during operation or inspected during maintenance, including details of access to these components.

vi) Description of navigation aids and safety features.

vii) Recommended procedure for the mooring and disconnecting a vessel at the SPM.

viii) Recommended procedure for connecting and disconnecting floating hose to a tanker's manifold.

ix) Recommended maintenance schedule and procedures for the SPM facilities, including a check list of items recommended for periodic inspection. Where applicable, procedures for adjusting anchor leg tension, removal and reinstallation of hoses, inspection of flexible risers, adjustment of buoyancy tanks, and replacement of seals in the cargo swivel are to be included.

x) Recommended cargo system pressure testing.

xi) When the SPM is fitted with a charging station as detailed in Part 4, Chapter 5, procedures for mooring and charging a vessel at the SPM are to be included.

The Information Booklet and Maintenance Manual is to be submitted for review by ABS solely to ensure the presence of the above information which is to be consistent with the design information and limitations considered in the SPM's classification. ABS is not responsible for the operation of the SPM.

The Information Booklet and Maintenance Manual required by these Rules may contain information required by flag and coastal Administrations. These Administrations may require that additional information be included in the Operation and Maintenance Manual.

PART 2

Materials and Welding

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Materials and Welding

The independent booklet, ABS *Rules for Materials and Welding (Part 2)* for steels, irons, bronzes, etc. is to be referred to. This booklet consists of the following Chapters:

1 General *(2014)*

Rules for Testing and Certification of Materials

CHAPTER 1	Materials for Hull Construction
CHAPTER 2	Equipment
CHAPTER 3	Materials for Machinery, Boilers, Pressure Vessels, and Piping
APPENDIX 1	List of Destructive and Nondestructive Tests Required for Materisls and Responsibility for Verifying
APPENDIX 4	Procedure for the Approval of Manufacturers of Hull Structural Steel
APPENDIX 5	Procedure for the Approval of Manufacturers of Hull Structural Steels Intended for Welding with High Heat Input
APPENDIX 6	Nondestructive Examination of Marine Steel Castings
APPENDIX 7	Nondestructive Examination of Hull and Machinery Steel Forgings
APPENDIX 8	Additional Approval Procedure for Steel with Enhanced Corrosion Resistance Properties

Rules for Welding and Fabrication

CHAPTER 4	Welding and Fabrication
APPENDIX 2	Requirements for the Approval of Filler Metals
APPENDIX 3	Application of Filler Metals to ABS Steels
APPENDIX 9	Welding Procedure Qualification Tests of Steels for Hull Construction and Marine Structures

3 Offshore Structures *(2014)*

For structure and connections that are typical of offshore structures (e.g., towers, jackets, and similar steel non-buoyant structures); instead of Part 2, Chapter 1 above, reference should be made to Part 2, “Materials and Welding” of the ABS *Rules for Building and Classing Offshore Installations.*

PART 3

Mooring System Design

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General

SECTION 1
Definitions and Abbreviations

1 Definitions *(2014)*

Anchor Leg. Mooring element connecting the single point mooring structure to the seabed at the anchor point, and is essential for station keeping of the system.

Buoyancy Element. A buoyancy member provided to support the weight of mooring equipment or risers, and designed to resist differential pressure from submergence and internal pressure.

Hawser. Mooring line between SPM structure and moored vessel.

Hose. Conduit designed to convey fluids between supply and delivery points with significant relative movement and able to tolerate large deflections. Typically, a hose is comprised of a string or series of short hose segments joined together at flanged ends.

Hose, Floating. Hose or hose string located between the SPM structure and the moored vessel for the purpose of conveying fluid. When not connected to a moored vessel, it remains connected to the SPM structure and floats on the sea water surface.

Hose, Underbuoy. Hose or hose string located between the SPM structure and the pipeline end manifold (PLEM) for the purpose of conveying fluids.

Main Bearing. The bearing which supports the load from the mooring and hawser and provides a mechanism for the moored vessel to rotate or weathervane about the mooring structure

Product. Any fluid transferred between the moored vessel and the pipeline end manifold (PLEM) such as crude oil, petroleum product, petroleum gas, slurry, and bunkers.

Product Swivel. A mechanism which provides for passage of cargo or product while allowing the main structure to weathervane freely with respect to the fixed or anchored structure without significant leakage at the rated design pressure.

Recognized Consultant. A person or organization recognized by ABS as being capable of providing specialized knowledge or assistance.

Riser, Flexible. Conduit designed to convey fluids between supply and delivery points with or without significant relative movement and able to tolerate large deflections. A flexible riser usually comprises one continuous length, used for relatively greater water depths and constructed to be used totally submerged.

Single Point Mooring (SPM). A system which permits a vessel to weathervane while the vessel is moored to a fixed or floating structure anchored to the seabed by a rigid or an articulated structural system or by catenary spread mooring. Examples of such system are CALM, SALM, tower mooring, etc.

SPM, Fixed. A tower mooring and a Single Anchor Leg Mooring (SALM) which are gravity based (fixed or pinned) system are defined here as fixed SPMs.

SPM, Floating. A Catenary Anchored Leg Mooring (CALM) is an example of a floating SPM.

Swing Circle. The swing circle is the area swept by the moored vessel as it revolves about the mooring point.

3 Abbreviations *(2014)*

AFBMA: Anti Friction Bearing Manufacturers Association

AISC: American Institute of Steel Construction

ANSI: American National Standards Institute

API: American Petroleum Institute

ASME: American Society of Mechanical Engineers

ASTM: American Society for Testing and Materials

DWT: Dead Weight

EJMA: Expansion Joint Manufacturer's Association

IALA: International Association of Marine Aids to Navigation and Lighthouse Authorities

NACE: National Association of Corrosion Engineers

NIIT: Non-Destructive Testing

OCIMF: Oil Companies International Marine Forum

PLEM: Pipe Line End Manifold

ROV: Remotely Operated Vehicle

RTU/MTU: Remote Terminal Unit/Mobile Test Unit

UWILD: Underwater Inspection In Lieu of Drydocking

5 Systems of Measurement

These Rules are written in three systems of units, i.e., SI units, MKS units and US customary units. Each system is to be used independently of any other system.

Unless indicated otherwise, the format of presentation in the Rules of the three systems of units is as follows:

SI units (MKS units, US customary units)

PART 3

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General

SECTION 2
Site and Environmental Conditions

1 General

The provisions of this Section are intended to establish the method of defining the location of the SPM, the environmental conditions which will affect operations at the SPM and which are to be considered in establishing design criteria, and the bottom soil conditions which affect the anchorage of the SPM.

3 Mooring Location

3.1 Site Chart *(2014)*

A complete chart of the mooring area is to be submitted. This chart is to show depth soundings and obstructions within the swing circle, the maneuvering area, and where applicable, the approach channel from deep water or an established navigation channel. The chart may be based on local charts published by government agencies or on hydrographic surveys conducted by a recognized consultant. In the case of charts based on hydrographic surveys, a survey report is to be submitted describing the surveying method, equipment, and personnel employed to conduct the survey.

The exact location and water depth of the mooring base or pipeline end manifold (PLEM), and each anchor point, is to be indicated on the chart. The route of the submarine pipeline and of all other pipelines and cables is to be indicated on the chart. If the mooring is associated with other SPMs in the area, or with a pumping or control platform, these features are to be indicated on the chart. All other features and water use areas which may present potential navigational hazards are to be identified. All existing and planned navigation aids such as lights, buoys, and shore markers which will be used in conjunction with the mooring are to be indicated and identified on the chart.

3.3 Bottom Topography

All depths on the chart are to be referenced to the datum of the local navigational chart. The chart is to be based on depth soundings taken at 15 m (50 ft) horizontal intervals or less.

The chart is to show bottom contours at a vertical interval of 1.5 m (5 ft). Where the bottom is irregular, the spacing of soundings is to be reduced. Where side scan sonar or wire drag is employed, the spacing of soundings may be increased.

All obstacles, such as sunken wrecks, rocks, and pinnacles are to be identified and their clear depths indicated. Where such obstacles are encountered, wire drag at a depth beneath the required water depth or a side scan sonar survey is to be conducted throughout.

Where it is shown that water depth is far in excess of the required water depth, the survey may be appropriately modified.

3.5 Maneuvering Area *(2023)*

The maneuvering area is to be indicated and captioned on the site chart. The maneuvering area is defined as the area through which a vessel is to maneuver in making an approach to, or a departure from, the SPM. The shape and size of the maneuvering area are to be established based on pertinent local conditions. The radius of the maneuvering area about the mooring is to be at least three (3) times the length of the largest vessel for which the SPM is designed, plus the hawser length and maximum buoy offset in the *Design Operating Condition* defined in 3-1-2/7.1.1.

Where it can be shown that the prevailing environment (wind, waves, current, and tides) favorably influences the mooring maneuver, and that the vessel can always maneuver to and from the SPM without danger, the maneuvering area may be appropriately modified. Where tugs will always be used to assist in mooring, the maneuvering area may be appropriately modified. Where mooring maneuvers are to be made in extreme environments, including offshore exposed waters where the prevailing environment (wind, waves, current, squalls, microbursts, rotary currents, and shallow water effect) unfavorably influences the mooring maneuver, the minimum radius is to be increased substantially to account for an additional safety allowance necessary for safe vessel maneuvering under those conditions. Fixed obstacles such as platforms or buoys, other than the mooring, are not to be anywhere within the maneuvering area. The route of the submarine pipelines may be marked by a buoy at the edge of the maneuvering area. It is suggested that no other pipelines exist in the SPM maneuvering area.

3.7 Swing Circle

The swing circle as defined in 3-1-1/1 is to be indicated and captioned on the site chart. The radius of the swing circle is the sum of the horizontal excursion of the SPM from its center position under operating hawser load and minimum tide, the horizontal projection of the length of the hawser under operating hawser load, the length overall of the largest vessel for which the SPM is designed, and a safety allowance of 30 m (100 ft).

3.9 Water Depth *(2014)*

The water depth at any place within the maneuvering area is to be such that no vessel which may use the SPM system will touch the sea bottom or any protrusion therefrom in any sea condition under which such a vessel is expected to be present as outlined in the design premises within the maneuvering area.

The designer may elect to specify limiting drafts for various vessel sizes when the proposed water depth is not sufficient to allow a vessel of the maximum size to be moored in the maneuvering area under the design operating environmental condition.

The determination of the required water depth is to be based upon calculations, data from ship model tests or full scale trials, designers' experience or other available sources of information.

The designer is to submit evidence to demonstrate to the satisfaction of ABS that in determining the required water depth, the following effects have been considered:

i) Vessel's dimensions and other relevant characteristics

ii) Wave height, wave period, and compass direction with respect to the vessel

iii) The prevailing wind and astronomical tides

iv) The expected vessel's heaving, rolling and pitching and vessel under keel clearance of at least 1 meter (3.3 feet)

v) The consistency of the sea bottom material or the character of any protrusion from the sea bottom

vi) The level of accuracy of the depth survey data *vii)* Predicted variation of seabed profile due to sediment transport during the design life

5 Soils Data

5.1 Bottom Soil Condition

The general character of the soil on the sea floor throughout the maneuvering area is to be indicated on the site chart. The presence of a rock bottom or of rock outcroppings is to be clearly indicated. Where soil movements such as soil slides, excessive erosion or deposition of soil, or an active fault are suspected, an analysis by a soils consultant of the nature and degree of this hazard is to be submitted.

5.3 Sub-Bottom Soil Conditions *(2014)*

Soil data should be taken in the vicinity of the mooring site. An interpretation of such data is to be submitted by a soils consultant.

In the case of a mooring having a piled or gravity base, a boring or probing is to be taken at the location of the base to the depth of any piles or to a depth sufficient to establish the soil characteristics of the site.

Site investigation in general should be in accordance with Section 3-2-5 of the ABS *Rules for Building and Classing Offshore Installations (Offshore Installation Rules)*. For mooring systems with anchor piles, gravity boxes, or drag anchors, borings or probings are to be taken at all anchor locations to the depth of any piles or to a depth sufficient to establish the soil characteristics of the site. As an alternative, sub-bottom profile runs may be taken and correlated with at least two (2) borings or probings in the SPM vicinity and an interpretation may be made by a soils consultant to adequately establish the soil profile at all anchor pile locations.

7 Environmental Conditions and Data

7.1 Environmental Conditions *(2014)*

The design of an SPM system is to consider the following two environmental conditions:

7.1.1 Design Operating Condition (DOC)

The operating environmental condition for an SPM is defined as the maximum sea state in which a vessel is permitted to remain moored to the SPM without exceeding the allowable loads and stresses required in Parts 3 and 4 of these Rules. Wind, waves, and the associated currents used in the design shall be based on site specific data, as determined by recognized meteorological and oceanographic consultants.

7.1.2 Design Environmental Condition (DEC)

The Design Environmental Condition for an SPM design is defined as the environmental condition with maximum wind, waves, and associated currents based on a 100-year recurrence interval. At this condition, no vessel is moored to the SPM system, unless the SPM system is specifically designed for this situation. The wind, waves, and the associated currents are to be established by recognized meteorological and oceanographic consultants.

7.3 Waves *(2014)*

7.3.1 Design Operating Wave

The characteristics of the wave for the Design Operating Condition described in 3-1-2/7.1 are to be established. The wave characteristics are to include wave height in terms of significant wave height (the average of the highest one third wave heights), associated wave spectrum and associated mean spectral period.

7.3.2 Design Environmental Wave

The wave characteristics representing the Design Environmental Condition as described in 3-1-2/7.1 for the design of an SPM and its anchorage are to be established based on not less than a 100-year recurrence interval. The characteristics to describe the storm wave are to include:

- The significant wave height and the maximum wave height
- The maximum wave in terms of maximum crest elevation above mean low water
- An indication if the wave is expected to be a breaking wave
- The wave spectrum
- Associated mean spectral period corresponding to the maximum wave
- The tide surge associated with the maximum wave

When component parts are designed for a wave representing lesser recurrence interval, they are to be noted in the design document.

7.3.3 Wave Statistics

A report is to be submitted presenting wave statistics for the mooring area. The statistics are to be based on wave data analyzed and interpreted by a recognized consultant. The statistics are to include a table showing the frequency distribution of wave height, period, and direction, and a table or graph showing the recurrence period of waves.

It is recommended that data be obtained from a wave recorder operated in the general vicinity of the SPM for a period of time sufficiently long to establish the reliability of the wave statistics. If the site of the wave recorder is in a different water depth or different exposure from the mooring site, an interpretation to transfer the data to the mooring site is to be performed by a recognized consultant. Alternatively, data may be based on wave observation records for a period of time sufficiently long to establish the reliability of the wave statistics from a local shore station or from published references. The bias of such observations against design storms and therefore against extreme wave heights is to be accounted for.Hindcast studies calibrated to measurements for a location nearby the SPM's installation site can also be used to supplement measured data.

The statistics for the maximum wave are to be based on wave records for a period of time sufficiently long to establish the reliability of the wave statistics performed by a recognized consultant.

7.5 Wind *(2014)*

7.5.1 Design Operating Wind

The wind characteristics for the Design Operating Condition described in 3-1-2/7.1 are to be established. The wind velocity is to be specified at a height of 10 m (33 ft) above the ocean surface, and averaged over a one minute period. A one-hour wind with appropriate wind spectrum may be used as an alternative approach.

7.5.2 Design Environmental Wind

The wind characteristics for the Design Environmental Condition described in 3-1-2/7.1 for design of SPM are to be established based on not less than a 100 year recurrence interval. The wind velocity is to be specified at a height of 10 m (33 ft) above the ocean surface and averaged over a one minute period. A one-hour wind with appropriate wind spectrum may be used as an alternative approach.

7.5.3 Wind Statistics

A report is to be submitted presenting wind statistics for the mooring area. The statistics are to be based on wind data analyzed and interpreted by a recognized consultant. The statistics are to include a wind rose or table showing the frequency distribution of wind velocity and direction, a table or graph showing the recurrence period of extreme winds, and the percentage of time which the operating wind velocity is expected to be exceeded during a year and during the worst month or season.

Where possible, statistics are preferably to be based on data from an anemometer operated in the general vicinity of the mooring for a period of time sufficiently long to establish the reliability of the wind statistics. If the site of the anemometer is influenced by terrain or is inland or if the mooring site is far offshore, an interpretation to transfer the data to the mooring site, performed by a recognized consultant, is to be submitted.

Alternatively, the statistics may be based on wind velocity determined from synoptic weather chart pressure gradients for a period of time sufficiently long to establish the reliability of the wind statistics performed by a recognized consultant. If synoptic weather charts are not available, the statistics may be based on observations from published references. These records are to be reviewed and interpreted for the site by a recognized consultant. The bias of such observations against extreme storms and therefore against extreme wind speeds is to be accounted for.

7.7 Current *(2014)*

7.7.1 Design Operating Current

The current characteristics for the Design Operating Condition described in 3-1-2/7.1 are to be established. The Design Operating Current is defined as the maximum current associated with the maximum wind and waves in which a vessel will remain moored. The current velocities at the sea surface and seabed are to be included. If the current profile is not linear, the velocities at a sufficient number of intermediate depths are also to be included.

7.7.2 Design Environmental Current

The current characteristics for the Design Environmental Condition described in 3-1-2/7.1 are to be established. The current velocities at the sea surface and seabed are to be included. If the current profile is not linear, the velocities at a sufficient number of intermediate depths are to be included.

7.9 Seiche *(2014)*

The location of the mooring site in relation to seiche nodal points is to be investigated by a recognized consultant if the site is in a basin or other area known for seiche action. Seiche is defined as long period oscillation of the water in a basin as excited by a disturbance such as wind, waves, atmospheric pressure, or earthquake. Mooring sites located at or near seiche nodal points may be influenced by currents not otherwise predicted. If the mooring site is at or near a seiche nodal point, currents induced by seiche are to be reflected in the operating current and maximum current, and the influence of the period of the current on the dynamic response of the moored vessel is to be considered.

7.11 Tidal Data *(2014)*

Tidal data is to be based on astronomical tides and storm surge. The astronomical tidal extremes and tidal means for the mooring site are to be established. Sufficient data is to be submitted to establish the validity of the tide data. Tide levels may preferably be determined from records of a tide gauge in the vicinity of the site or from published tide tables for a location in the vicinity of the site. If the location from which the tide data is obtained is from a remote mooring site, a transformation of the tide data to the mooring site is to be performed by a recognized consultant. The seasonality of extreme tidal variations can be considered when considering the combination of astronomical tide and storm surge.

The maximum storm surge for the mooring site is to be established if the mooring is in a coastal or estuary location. Sufficient data is to be submitted to establish the validity of this storm surge.

Maximum storm surge may preferably be determined from tide records taken near the location. If the location from which the tide data is obtained is remote from the mooring site, a transformation of the tide data to the mooring site is to be performed by a recognized consultant Storm surge hindcasts for design (extreme) storms performed by a recognized consultant may be submitted.

7.13 Temperatures and Ice

Where drift ice may be a hazard to a mooring or to a vessel navigating to or moored at a mooring or to floating hoses at a mooring, an analysis of the nature and degree of this hazard is to be submitted.

When air temperature and precipitation, spray, or tidal action may combine to cause substantial ice formation on the mooring, an analysis of the degree to which ice may form and how this ice may affect the performance of the mooring is to be submitted.

The structure, equipment, hoses/flexible risers, component parts and their respective material which may be affected by low temperatures are to be examined.

PART 3

CHAPTER 1

General

SECTION 3

Material Selection

1 General *(2014)*

These Rules are intended for single point moorings (SPM) to be constructed of materials manufactured and tested in accordance with the requirements referred to in Part 2 of these Rules. Where it is intended to use materials of different process, manufacture or of different properties, the use of such materials and corresponding scantlings will be specially considered.

3 Structure

For most applications, ordinary strength steel, such as, ABS Grade A or ASTM A36, is considered acceptable. Critical load carrying components in the mooring load path, such as hawser connection, padeyes, are to be considered as primary application structure. Materials used in the construction of the SPM buoy structure are to comply with Chapter 1 of the ABS *Rules for Materials and Welding (Part 2)*. Materials used in the construction of the tower mooring structure are to be in accordance with the *Offshore Installation Rules*.

The use of other commercial material specifications for SPM applications will be specially considered.

5 Mooring System *(1 July 2022)*

Materials used in the construction of anchors, anchor legs, associated hardware, etc., are to comply with ABS requirements. In instances where ABS does not have published requirements, the material selection of mooring system equipment will be reviewed for compliance with applicable recognized industry standards. The applicable references to ABS publications and industry standards are listed below:

- Buoyancy Tanks: ASME *Boiler and Pressure Vessel Code*
- Chain: ABS *Requirements for the Certification of Offshore Mooring Chain*
- Fiber Rope: ABS *Guidance Notes on the Application of Fiber Rope for Offshore Mooring*
- Wire Ropes: API Spec 9A and RP 9B

7 Cargo or Product Transfer Systems *(2022)*

Materials used in the construction of cargo or product transfer systems are to comply with appropriate material specifications as may be approved in connection with a particular design. The material specifications are to comply with recognized standards and are to specify a suitable range of established values for tensile strength, yield strength and ductility at design temperature. Materials tests for cargo or product swivels are to be witnessed by the Surveyor and are to be produced by ABS approved manufacturers. In all other cases, materials need not be tested in the presence of the Surveyor and may be accepted on the basis of a review of mill certificates by the Surveyor.

Materials used in cargo or product transfer systems that will be exposed to hydrogen sulfide are to be selected within appropriate limits of chemical composition, heat treatment and hardness to resist sulfide stress cracking. Material selection is to comply with the requirements of NACE MR 01 75/ ISO 15156. Material selection is to consider the possibility of chloride stress cracking if chlorides are present in the cargo or product fluid.

Refer to 4-1-2/7 for further requirements regarding underbuoy hoses/flexible risers and floating hoses.

9 Bearings *(2014)*

Materials used in the construction of bearings and bearing retainers are to comply with appropriate material specifications as may be approved in connection with a particular design. The material specifications are to comply with recognized standards and are to specify a suitable range of required material properties. Materials need not be tested in the presence of the Surveyor. In general they may be accepted on the basis of a review of mill certificates by the Surveyor.

PART 3

CHAPTER 2
Design

CONTENTS

PART 3

CHAPTER 2
Design

SECTION 1
Design Loads

1 Design Loads

The design conditions are to be established by varying vessel size and loading conditions to determine the critical loading conditions under the environmental conditions described in 3-1-2/7. The designer is to submit calculations for the design condition. The following loads are to be considered in the design:

- Dead Loads and Buoyancy
- Environmental Loads
- Mooring Loads
- Fatigue Loads

3 Dead Loads and Buoyancy

Dead loads are the weight of the SPM structure and associated structural appendages, and equipment which are permanently attached to the structure.

The buoyancy of the SPM structure results in upward forces, the distribution of which depends on the distribution of the submergence of the structure.

5 Environmental Loads

The environmental loads due to the following environmental parameters are to be considered in the design:

- Waves
- Wind
- Currents
- Tides and storm surges
- Ice and snow
- Marine growth
- Air and sea temperatures

Other phenomena, such as tsunamis, submarine slides, seiche, abnormal composition of air and water, air humidity, salinity, ice drift, icebergs, etc. may require special consideration.

5.1 Wave Loadings

The wave loads on the SPM structure and the moored vessel are to be determined by suitable methods such as strip theory, diffraction theory, Morison's equation, etc. The wave loading on a tower mooring is to be in accordance with the *Offshore Installation Rules*.

The wave induced responses of a vessel consist of three categories of response (e.g., first order (wave frequency) motions, low frequency or slowly varying motions, and steady drift) are to be taken into account for designing the SPM structure including the mooring line, anchors, piles, etc., as applicable.

5.3 Wind Forces *(2014)*

For a moored vessel, wind forces on the vessel may be calculated using the coefficients presented in the document *Prediction of Wind and Current Loads on VLCCs*, Oil Companies International Marine Forum (2nd Edition, OCIMF), 1994. For equipment onboard with unusual shape and arrangement, wind forces on such equipment may be calculated as drag forces and are to be added as necessary. Wind tunnel tests may be required in some design to determine the wind loads.

The wind force on the SPM structure and the moored vessel is considered as a constant (steady) force due to the one-minute wind. Alternatively, the designer may use a one-hour wind with appropriate wind spectrum.

The wind force on the SPM structure and wind exposed appendages and unusual items onboard the vessel may be calculated as drag force. The wind pressure P_{wind} on any particular windage may be calculated using the following equations:

$$P_{wind} = 0.6100 \times C_s \times C_h \times V^2{}_{wind} \quad \text{N/m}^2$$

$$= 0.0623 \times C_s \times C_h \times V^2{}_{wind} \quad \text{kgf/m}^2$$

$$= 0.00338 \times C_s \times C_h \times V^2{}_{wind} \quad \text{lbf/ft}^2$$

V_{wind} is in m/s for the first two of the above three equations, while it is in knots for the third equation.

C_s = shape coefficient (dimensionless)

C_h = height coefficient (dimensionless)

The height coefficient C_h is used in the formulation above to take into account of the effect of wind velocity (V_{wind}) profile in the vertical plane. The height coefficient C_h is given by the following equation:

$$C_h = (V_z/V_{ref})^2$$

where, the velocity of windV_z at a height$z$ above waterline is to be calculated as follows:

$$V_z = V_{ref} \times (z/Z_{ref})^{\beta}$$

V_z is to be taken as equal toV_{ref} at elevations below the reference elevation Z_{ref}.

where

V_{ref} = velocity of wind at n reference elevation Z_{ref} of 10 m (33 feet)

β = 0.10 typically for one-minute average wind, other values supported by site specific data will be specially considered.

The corresponding wind force F_{wind} on the windage is:

$$F_{wind} = p_{wind} \times A_{wind} \qquad \text{N (kgf, lbf)}$$

where

A_{wind} = projected area of windage on a plane normal to the direction of the wind, in m^2 (ft^2)

The total wind force is then obtained by summing up the wind forces on each windage.

The shape coefficients for typical structural shapes are presented (for reference only) in 3-2-1/9 TABLE 1. The height coefficients to represent the wind velocity profile (corresponding to β value of 0.10) are presented in 3-2-1/9 TABLE 2 for height intervals of 15.25 meters (50 feet).

5.5 Current Forces

For a moored vessel, current forces on the vessel alone may be calculated by using coefficients based on model test data as presented in *Prediction of Wind and Current Loads on VLCCs*, published by OCIMF (2nd Edition, 1994). For underwater bodies of unusual shape and arrangement, model tests may be required to determine the current forces.

The current forces on the submerged buoy and/or mooring structure, hull of the moored vessel, mooring lines, risers or any other submerged objects associated with the system are to be calculated using the appropriate current profile. The basis of the current profile depends on the environmental conditions described in 3-1-2/7.1.

Current force F_c on the submerged part of the mooring structure, mooring lines, risers, etc., is to be calculated as the drag force as shown below:

$$F_c = 1/2\rho \times C_D \times A_c \times u_c \times |u_c| \qquad \text{kN (Tf, lbf)}$$

where:

ρ = mass density of water

= 1.025 (0.1045, 1.99)

C_D = drag coefficient, in steady flow (dimensionless).

u_c = current velocity vector normal to the plane of projected area, in m/s (ft/s)

A_c = projected area exposed to current, in m^2 (ft^2)

7 Mooring Loads

(2014) The design loads of mooring legs and mooring elements (flexible hawsers or rigid mooring elements such as arm and yoke) between the vessel and SPM may be calculated based on physical model testing of the system, or by analytical methods verified by physical model testing of a similar system. The calculation to determine the mooring load is to include high frequency, low frequency, and mooring line dynamics. The most probable extreme values are to be obtained by time domain analysis for the design environmental conditions described in 3-1-2/7.1 using a storm duration of three hours, unless specific site data supports other durations.

7.1 Operating Mooring Loads

Operating mooring loads are the loads on the SPM structure and foundation with the vessel moored to it. The loads are to be determined in the operating environment for the established design condition as indicated in Section 3-1-2. Operating mooring loads are to be established and submitted for the hawser, rigid connection between the vessel and the SPM as applicable, and the SPM anchor leg loads.

7.1.1 Operating Mooring Load between Vessel and SPM *(2014)*

The operating mooring load between vessel and SPM is to be established for the SPM system, The operating mooring load is defined as the maximum load imposed on the mooring element (e.g., hawser or rigid arm and yoke) for the maximum size vessel for the operating environmental condition described in 3-1-2/7.1, unless a smaller moored vessel is apt to impose higher loads under the influence of the operating wind, wave, current, and tides as established in Section 3-1-2. Data and calculations are to be submitted to establish the validity of this operating mooring load.

The operating mooring load may be statistically determined from model testing and/or analysis. The model testing and analysis on which the operating mooring load is based is to reflect the combined effects of wind, waves, current and tides on the loaded and unloaded vessel. If model testing is performed, the model testing is to model the mooring system appropriately in regard to load-displacement characteristics, and pretensioning of mooring legs as applicable.

7.1.2 Operating Anchor Leg Loads *(2014)*

The anchor leg loads in the Design Operating Condition are to be established for the anchor leg or legs with the vessel at the mooring. The operating anchor leg load is defined as the maximum load in the most highly loaded anchor leg for the maximum size vessel for which the SPM is designed, or other vessel of a smaller size if the smaller vessel is apt to impose higher loads. For a mooring system with several anchor legs of different size or construction, an operating anchor load is to be established for each anchor leg. Model test data and/or calculations are to be submitted to establish the validity of the operating anchor load.

7.3 Loads from the Design Environmental Condition *(2014)*

Design loads are to be established for the SPM structure, each anchor leg, and the foundation as applicable for the design environmental condition as described in 3-1-2/7.1. Model test data and/or calculations are to be submitted to establish the validity of these loads.

9 Fatigue Loading *(2014)*

For tower mooring system, fatigue analysis of the structure is to be performed in accordance with the *Offshore Installation Rules*. For SPMs with novel designs or buoys with permanently moored vessels, fatigue analysis of the structure is to be performed in accordance with *Offshore Installation Rules* or *FPI Rules*, as appropriate.

TABLE 1
Shape Coefficients C_s for Windages

Cylindrical shapes	*0.50-1.00*
Hull above waterline	1.00
Deckhouse	1.00
Isolated structural shapes (cranes, channels, beams, angles, etc.)	1.50
Under deck areas (smooth)	1.00
Under deck areas (exposed beams and girders)	1.30
Truss structure (each face)*	1.25

* *Note:* 30% of projected block areas for both front and back sides.

TABLE 2
Height Coefficients C_h (for β = 0.10)

Height Above Waterline		C_h *1-min*
meters	*feet*	
0.0 –15.3	0 – 50	1.00
15.3 – 30.5	50 – 100	1.18
30.5 – 46.0	100 – 150	1.31
46.0 – 61.0	150 – 200	1.40
61.0 – 76.0	200 – 250	1.47
76.0 – 91.5	250 – 300	1.53
91.5 – 106.5	300 – 350	1.68

PART 3

CHAPTER 2
Design

SECTION 2
Structural Design

1 General

An SPM structure is generally characterized as a floating or fixed type.

1.1 Floating SPM Structure

A floating SPM structure consists of a buoyant hull held in position by anchor leg(s) that transmit mooring forces to the seabed, the equipment and piping used to carry fluid cargo or products, and provides a platform for hawser mooring attachment points.

1.3 Fixed SPM Structure

Fixed SPM structures, such as a SALM or a tower mooring, are typically supported at the seabed by piles or a gravity based foundation. A SALM is often designed as buoyant structure, while a tower mooring may be designed with tubular members. The structure supports the equipment and piping used to carry fluid cargo or products, and provides a platform for hawser (or rigid) mooring attachment points.

3 General Design Criteria

3.1 Strength of Structure *(2014)*

The structure and framing members are to be of adequate size and strength to withstand the mooring, environmentally induced, and other loads established in Section 3-2-1. Each mooring attachment point between vessel and the SPM is to be designed to withstand an appropriate portion of the total operating mooring load on the connecting structure (hawser or rigid yoke). Each anchor attachment point or pile foundation is to be designed to withstand the loads from the Design Operating Condition and the Design Environmental Condition. Stress levels due to loads as determined from Section 3-2-1 are to be within the requirements given in 3-2-2/5 and 3-2-2/7.

3.3 Pile Foundation *(2014)*

For an SPM structure intended to be anchored by piles, the pile design is to be in accordance with the appropriate sections of API RP 2A-WSD, *Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms*.

3.5 Corrosion Control

Where deemed necessary to suit the particular type and service of the structure, a reduction in scantlings in association with protective coatings with or without sacrificial anodes may be considered from those determined by the requirements in 3-2-2/9.1, 3-2-2/9.3, and 3-2-2/9.5. The maximum reduction that will be allowed is 10% of the shell plating, but not more than 3 mm (0.125 in.), provided that the section modulus reduction is no more than 10%. In such instances, the justification for the reduction is to be submitted for review together with the particulars of the coatings with or without sacrificial anodes including the program for maintenance. The plans are to show the required and proposed scantlings, both suitably identified. Where any of the proposed reductions are approved, a notation will be made in the *Record* that such reductions have been taken.

Where scantlings and structural design are determined by the requirements of 3-2-2/5 and 3-2-2/7, or by alternative structural design methods other than the requirements in 3-2-2/9, the following apply:

i) Where effective methods of corrosion control are provided, additional scantlings may not be needed. The particulars of the coatings with or without sacrificial anodes including the program for maintenance are to be submitted.

ii) Where effective methods of corrosion control are not provided, the scantlings and structural thicknesses are to be suitably increased by a margin based on expected rates of corrosion particular to the SPM's location and the type of corrosive environment in contact with the structure. The scantling increases are to be submitted to ABS for review.

5 Stresses

5.1 Structural Analysis

The overall structure of the SPM buoy is to be analyzed using appropriate methods, such as frame analysis or finite element methods to determine the resultant stresses for each member, under the loadings stipulated herein. A complete analysis is to be submitted for each of the structural frames for review. Full consideration is to be taken of secondary stresses, carryover moments, etc., and of three dimensional aspects such as direction of applied forces or reactions. Consideration is to be given to the need for analysis for each loading condition, including the following:

i) Transmission of the operating hawser (or yoke) load from the hawser (or yoke) attachment point(s) to the anchor leg attachment point(s) or to the foundation

ii) Application of the maximum anchor load to the anchor leg attachment point including application of appropriate wave and hydrostatic loads, in the case of a floating structure

iii) Application of the maximum wave, maximum wind, and maximum current loads in the case of a fixed structure

5.3 Bending Stresses

5.3.1 Provisions Against Local Buckling

When computing bending stresses, the effective flange areas are to be reduced in accordance with accepted "shear lag" and local buckling theories. Local stiffeners are to be of sufficient size to prevent local buckling or the allowable stress is to be reduced proportionately.

5.3.2 Consideration of Eccentric Axial Loading

In the consideration of bending stresses, elastic deflections are to be taken into account when determining the effects of eccentricity of axial loading and the resulting bending moments superimposed on the bending moments computed for other types of loadings.

5.5 Buckling Stresses *(2014)*

The possibility of buckling of structural elements is to be specially considered in accordance with 3-2-2/7.5. For a fixed SPM structure, the buckling of tubular members is to be evaluated in accordance with the ABS *Requirements for Buckling and Ultimate Strength Assessment for Offshore Structures*.

5.7 Shear Stresses

When computing shear stresses in bulkheads, plate girder webs, or shell plating, only the area of the web is to be considered effective. The total depth of the girder may be considered as the web depth.

7 Allowable Stresses

7.1 General *(2014)*

The structural elements of the SPM structure are to be analyzed using the loading cases stipulated below. The resultant stresses are to be determined for each loading case,and the stresses are not to exceed the allowable stresses in 3-2-2/7.3.

The load cases to be considered are as follows:

i) *Design Operating Load Case.* The combined gravity, environmental, and mooring loads for the operating environmental condition, as described in 3-1-2/7.1.1

ii) *Design Environmental Load Case.* The combined gravity and environmental loads for the storm condition, as described in 3-1-2/7.1.2. If mooring loads are present in the design environmental condition they are to be combined with the gravity and environmental loads.

7.3 Member Stresses *(2014)*

Individual stress components and, as applicable, direct combinations of such stresses, are not to exceed the allowable stress *F,* as obtained from the following equation.

$$F = F_y / F.S.$$

where

F_y = specified minimum yield point or yield strength as defined in the ABS *Rules for Material and Welding (Part 2)*.

$F.S.$ = factor of safety

for the loading as defined in 3-2-2/7.1.i:

= 1.67 for axial or bending stress

= 2.50 for shear stress

for the loading as defined in 3-2-2/7.1.ii:

= 1.25 for axial or bending stress

= 1.88 for shear stress

7.5 Buckling Considerations *(2014)*

Where buckling of a structural element due to compressive or shear stresses, or both, is a consideration, the compressive or shear stress is not to exceed the corresponding allowable stress F as obtained from the following equation:

$$F = F_{cr} / F.S.$$

where

F_{cr} = critical compressive or shear buckling stress of the structural element, appropriate to its dimensional configuration, boundary conditions, loading pattern, material, etc.

$F.S.$ = factor of safety

= 1.67 for the loading as defined in 3-2-2/7.1.i

= 1.25 for the loading as defined in 3-2-2/7.1.ii

7.7 Members Subjected to Combined Axial Load and Bending *(2014)*

7.7.1 Axial Compression in Combination with Compression due to Bending

When structural members are subjected to axial compression in combination with compression due to bending, the computed stresses are to comply with the following requirements:

When $f_a/F_a \le 0.15$ $\quad (f_a/F_a) + (f_b/F_b) \le 1.0$

When $f_a/F_a > 0.15$ $\quad (f_a/F_a) + \dfrac{C_m f_b}{(1 - f_a/F_e')F_b} \le 1.0$

and in addition, at ends of members:

$1.67(f_a/F_y) + (f_b/F_b) \le 1.0$ for the loading as defined in 3-2-2/7.1.i

$1.25(f_a/F_y) + (f_b/F_b) \le 1.0$ for the loading as defined in 3-2-2/7.1.ii

7.7.2 Axial Tension in Combination with Tension due to Bending

When structural members are subjected to axial tension in combination with tension due to bending, the computed stresses are to comply with the following requirements:

$f_a + f_b \le F_y/1.67$ for the loading as defined in 3-2-2/7.1.i

$f_a + f_b \le F_y/1.25$ for the loading as defined in 3-2-2/7.1.ii

However, the computed bending compressive stress, f_b taken alone shall not exceed F_b

where

f_a = computed axial compressive or tensile stress

f_b = computed compressive or tensile stress due to bending

F_a = allowable axial compressive stress, which is to be the least of the following:

1) Yield stress divided by factor of safety for axial stress specified in 3-2-2/7.3

2) Overall buckling stress divided by factor of safety specified in 3-2-2/7.9.1

3) Local buckling stress divided by factor of safety for axial stress specified in 3-2-2/7.9.2

F_b = allowable axial compressive stress due to bending, determined by dividing the yield stress or local buckling stress, whichever is less, by the factor of safety specified in 3-2-2/7.3

F_e' = Euler buckling stress, may be increased $^1/_3$ for combined loadings as defined in 3-2-2/7.3

= $\dfrac{5.15E}{(K\ell/r)^2}$

E = Modulus of Elasticity

ℓ = unsupported length of column

K = effective length factor which accounts for support conditions at ends of length ℓ. For cases where lateral defections of end supports may exist K is not be considered less than 1.0.

r = radius of gyration

C_m = coefficient as follows:

1) For compression members in frames subject to joint translation (sideways):

$C_m = 0.85$

2) For restrained compression members in frames braced against joint translation and not subject to transverse loading between their supports, in the plane of bending.

$C_m = 0.6 - 0.4(M_1/M_2)$

but not less than 0.4, where .$M1/M2$ is the ratio of the smaller to larger moments at the ends of that portion of the member un-braced in the plane of bending under consideration. The ratio $M1/M2$ is positive when the member is bent in reverse curvature and negative when it is bent is single curvature.

3) For compressive members in frames braced against joint translation in the plane of loading and subject to transverse loading between their supports, the value of $C_m$may be determined by rational analysis. However, in lieu of such analysis the following values may be used:

a) For members whose ends are restrained, $C_m = 0.85$

b) For members whose ends are unrestrained, $C_m = 1.0$

7.9 Column Buckling Stresses

7.9.1 Overall Buckling *(2014)*

For compression members which are subject to overall column buckling, the critical buckling stress is to be obtained from the following equations.

$$F_{cr} = F_y - \frac{F_y^2}{4\pi^2 E}(K\ell/r)^2 \quad \text{when } K\ell/r < \sqrt{(2\pi^2 E/F_y)}$$

$$F_{cr} = \frac{\pi^2 E}{(K\ell/r)^2} \quad \text{when } K\ell/r \geq \sqrt{(2\pi^2 E/F_y)}$$

where

F_{cr} = critical overall buckling stress

F_y = as defined in 3-2-2/7.3

E , K, ℓ, and r are defined in 3-2-2/7.7.2.

The factor of safety for overall column buckling is to be as follows.

i) For the loading as defined in 3-2-2/7.1.i:

$$F.S. = 1.67\left(1 + 0.15\frac{K\ell/r}{\sqrt{(2\pi^2 E/F_y)}}\right) \quad \text{when } K\ell/r < \sqrt{(2\pi^2 E/F_y)}$$

$$F.S. = 1.92 \quad \text{when } K\ell/r \geq \sqrt{(2\pi^2 E/F_y)}$$

ii) For the loading as defined in 3-2-2/7.1ii):

$$F.S. = 1.35\left(1 + 0.15\frac{K\ell/r}{\sqrt{(2\pi^2 E/F_y)}}\right) \quad \text{when } K\ell/r < \sqrt{(2\pi^2 E/F_y)}$$

$$F.S. = 1.44 \quad \text{when } K\ell/r \geq \sqrt{(2\pi^2 E/F_y)}$$

7.9.2 Local Buckling

Members which are subjected to axial compression or compression due to bending are to be investigated for local buckling, as appropriate, in addition to overall buckling as specified in 3-2-2/7.9.1.

In the case of unstiffened or ring-stiffened cylindrical shells, local buckling is to be investigated if the proportions of the shell conform to the following relationship.

$$D/t \quad > \quad E/9F_y$$

where

D	=	mean diameter of cylindrical shell
t	=	thickness of cylindrical shell (expressed in the same units as D)

E and F are as defined in 3-2-2/7.9.1.

7.11 Equivalent Stress Criteria for Plated Structures *(2014)*

For plated structures, members may be designed according to the von Mises equivalent stress criterion, where the equivalent stress σ_{eq}, defined as follows, is not to exceed $F_y/F.S.$

$$\sigma_{eq'} = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x\sigma_y + 3\tau_{xy}^2}$$

where

σ_x	=	calculated in-plane stress in the *x*direction	
σ_y	=	calculated in-plane stress in the *y*direction	
τ_{xy}	=	calculated in-plane shear stress	
F_y	=	as defined in 3-2-2/7.3	
$F.S.$	=	1.43	for the loading as defined in 3-2-2/7.1.i
	=	1.11	for the loading as defined in 3-2-2/7.1.ii

Note:

The Factor of Safety will be specially considered when the stress components account for surface stresses due to lateral pressures.

The buckling strength of plated structures is to be designed according to the latest version of the ABS *Requirements for Buckling and Ultimate Strength Assessment for Offshore Structures* or other recognized standard acceptable to ABS.

9 Structural Design

The hull and frame(s) which are part of the floating structure are to be designed in accordance with the requirements of 3-2-2/5 and 3-2-2/7. In addition to those requirements, the scantlings of plating, stiffeners, and beams are to meet the requirements of 3-2-2/9.1, 3-2-2/9.3, and 3-2-2/9.5. Alternatively the hull and frame design is to be based on a systematic analysis based on sound engineering principles and accounting for the external static and dynamic pressures imposed by the marine environment and the internal pressure of the contents of tanks and floodable compartments.

9.1 Plating

9.1.1 Hull and Watertight Bulkhead Plating *(2014)*

Hull plating is to be of the thickness derived from the following equation.

$$t = \left(sk\sqrt{(qh)}/254\right) + 2.5 \quad \text{mm}$$
$$t = \left(sk\sqrt{(qh)}/460\right) + 0.10 \quad \text{in.}$$

but not less than 6.5 mm (0.25 in.) or $s/150 + 2.5$ mm ($s/150 + 0.10$ in.), whichever is greater

where

t = thickness, in mm (in.)

s = stiffener spacing, in mm (in.)

k = $(3.075\sqrt{\alpha} - 2.077)/(\alpha + 0.272)$ $(1 \le \alpha \le 2)$

= 1 $(\alpha > 2)$

α = aspect ratio of the panel (longer edge/shorter edge)

q = $235/Y$ N/mm^2 ($24/Y$ kgf/mm^2, $34{,}000/Y$ psi)

Y = specified minimum yield point or yield strength, in N/mm^2 (kgf/mm^2, psi), or 72% of the specified minimum tensile strength, whichever is the lesser

h = for plating, the greatest distance, in m (ft), from the lower edge of the plate to a point defined as the following:

i) *Void Compartment Space.* Where the internal space is a void compartment, the head is to be taken to the maximum permissible draft of the SPM in service.

ii) *Areas Subject to Wave Immersion.* The highest wave crest level during the most unfavorable design situation, or 1.0 m (3.28 ft), whichever is greater.

9.1.2 Tank Plating

Where the internal space is a tank, the design head h, in association with the equation given in 3-2-2/9.1.1, is to be taken from the lower edge of the plate to a point located at two thirds of the distance from the top of the tank to the top of the overflow or 1.0 m (3.28 ft), whichever is greater. Where the specific gravity of the liquid exceeds 1.05, the design head, h, in this section is to be increased by the ratio of the specific gravity to 1.05.

9.3 Stiffeners and Beams *(2014)*

The section modulus, SM, of each bulkhead stiffener or beam in association with the plating to which it is attached, is not to be less than obtained from the following equation.

$$SM = Qfchs\ell^2 \qquad \text{cm}^3 \ (\text{in}^3)$$

where

f	=	7.8 (0.0041)	
c	=	0.9	for stiffeners having clip attachments to decks or flats at the ends or having such attachments at one end with the other end supported by girders
	=	1.00	for stiffeners supported at both ends by girders
h	=	vertical distance, in m (ft), from the middle of length ℓ to the same heights to which h for plating is measured (see 3-2-2/9.1)	
s	=	spacing of stiffeners, in m (ft)	
ℓ	=	length, in m (ft), between supports. Where brackets are fitted at shell, deck, or bulkhead supports, and the brackets are in accordance with 3-2-2/17 TABLE 1 and have a slope of approximately 45 degrees, the length ℓ may be measured to a point on the bracket located at a distance from the toe equal to 25% of the length of the bracket.	
Q	=	material strength factor	
	=	1.0	for mild steel
	=	0.78	for H32
	=	0.72	for H36
	=	0.69	for H40

9.5 Girders and Webs

9.5.1 Strength Requirements *(2014)*

Each girder or web which supports a frame, beam, or stiffener is to have a section modulus, SM, not less than obtained from the following equation.

$$SM = Qfchs\ell^2 \qquad \text{cm}^3 \ (\text{in}^3)$$

where

f	=	4.74 (0.0025)
c	=	1.5
h	=	vertical distance, in m (ft), from the middle of s in the case of girders or from the middle of ℓ in the case of webs, to the same heights to which h for plating is measured (see 3-2-2/9.1.1)
s	=	sum of half lengths, in m (ft) (on each side of girder or web) of the stiffeners or beams supported
ℓ	=	length, in m (ft), between supports; where brackets are fitted at shell, deck or bulkhead supports, and the brackets are in accordance with 3-2-2/17 TABLE 1 and have a slope of approximately 45 degrees, the length ℓ may be measured to a point on the bracket located at a distance from the toe equal to 25% of the length of the bracket
Q	=	factor defined in 3-2-2/9.3

Where efficient struts are fitted connecting girders or webs on each side of the tanks and spaced not more than four (4) times the depth of the girder or web, the section modulus, SM, for each girder or web may be one-half that obtained from the above.

9.5.2 Proportions

Girders and webs are to have a depth not less than 0.125ℓ where no struts or ties are fitted, and 0.0833ℓ where struts are fitted. The thickness is not to be less than 1% of depth plus 3 mm (0.12 in.), but need not exceed 11 mm (0.44 in.). In general, the depth is not to be less than 2.5 times the depth of cutouts.

9.5.3 Tripping Brackets

Girders and webs are to be supported by tripping brackets at intervals of about 3 in (10 ft) near the change of the section. Where the width of the unsupported face plate exceeds 200 mm (8 in.), tripping brackets are to support the face plate.

11 Fixed Mooring Structure *(2014)*

The fixed mooring structure is to be analyzed as a space frame taking into account the gravity, functional, environmental, and mooring loads. The analysis is to take into account operating and maximum conditions. For SALM type of mooring structure, the analysis is to be in accordance with the requirements of 3-2-2/5 and 3-2-2/7. The connections between vessel and fixed mooring platform other than those stated in 3-4-1/9 should be adequately designed. The design of the fixed mooring platform is to withstand the operating and design environmental conditions as described in 3-1-2/7.1. A structure with buoyant structural elements is to meet requirements of 3-2-2/5 and 3-2-2/7, while a tower mooring structure designed as a gravity-based fixed structure with tubular members is to be in accordance with the requirements of the *Offshore Installation Rules*.

13 Additional Structural Requirements

An appropriate system is to be designed to prevent damage to the cargo transfer system due to impact from attendant vessels.

15 Buoyancy Tanks for Hoses/Flexible Risers

The buoyancy tank provides buoyancy to support the weight of hoses and flexible risers belonging to the single point mooring system.

The average shell membrane stress at the test pressure is to be limited to 90% of the minimum specified yield strength when subject to hydrostatic testing, and to 80% of the yield strength under pneumatic testing. The combination of average shell membrane stress and bending stress at design operating pressure is to be limited to 50% of the ultimate strength, or the minimum specified yield strength, whichever is less. When the external pressure is not compensated by internal pressure the stress values are also to be checked against critical buckling.

17 Pipeline End Manifold (PLEM) *(2014)*

The PLEM is required to sustain the maximum anticipated loads from the underbuoy hose/ flexible riser under conditions defined in 3-2-2/7.1. Loads on the PLEM and the buoy from the underbuoy hoses/ flexible riser are to be calculated from an appropriate analysis. The structural design of the PLEM and its foundation are to be in accordance with the *Offshore Installation Rules*. Refer to Section 4-1-4 of these Rules for the design of the PLEM piping, valves flanges and fittings.

TABLE 1
Thickness and Flanges of Brackets and Knees

Millimeters				*Inches*			
Depth of Longer Arm	*Thickness*		*Width of Flange*	*Depth of Longer Arm*	*Thickness*		*Width of Flange*
	Plain	*Flanged*			*Plain*	*Flanged*	
150	6.5			6.0	0.26		
175	7.0			7.5	0.28		
200	7.0	6.5	30	9.0	0.30	0.26	1 ¼
225	7.5	6.5	30	10.5	0.32	0.26	1 ¼
250	8.0	6.5	30	12.0	0.34	0.28	1 ½

Millimeters				*Inches*			
Depth of Longer Arm	*Thickness*		*Width of Flange*	*Depth of Longer Arm*	*Thickness*		*Width of Flange*
	Plain	*Flanged*			*Plain*	*Flanged*	
275	8.0	7.0	35	13.5	0.36	0.28	1 ½
300	8.5	7.0	35	15.0	0.38	0.30	1 ¾
325	9.0	7.0	40	16.5	0.40	0.30	1 ¾
350	9.0	7.5	40	18.0	0.42	0.32	2
375	9.5	7.5	45	19.5	0.44	0.32	2
400	10.0	7.5	45	21.0	0.46	0.34	2 ¼
425	10.0	8.0	45	22.5	0.48	0.34	2 ¼
450	10.5	8.0	50	24.0	0.50	0.36	2 ½
475	11.0	8.0	50	25.5	0.52	0.36	2 ½
500	11.0	8.5	55	27.0	0.54	0.38	2 ¾
525	11.5	8.5	55	28.5	0.56	0.38	2 ¾
550	12.0	8.5	55	30.0	0.58	0.40	3
600	12.5	9.0	60	33.0		0.42	3 ¼
650	13.0	9.5	65	36.0		0.44	3 ½
700	14.0	9.5	70	39.0		0.46	3 ¾
750	14.5	10.0	75	42.0		0.48	4
800		10.5	80	45.0		0.50	4 ¼
850		10.5	85				
900		11.0	90				
950		11.5	90				
1000		11.5	95				
1050		12.0	100				
1100		12.5	105				
1150		12.5	110				
1200		13.0	110				

Note: The thickness of brackets is to be suitably increased in cases where the depth at throat is less than two-thirds that of the knee.

PART 3

CHAPTER 2

Design

SECTION 3

Weld Design

1 Fillet Welds

1.1 General

1.1.1 Plans and Specifications

The actual sizes of fillet welds are to be indicated on detail drawings or on a separate welding schedule and submitted for approval in each individual case.

1.1.2 Workmanship

Completed welds are to be to the satisfaction of the attending Surveyor. The gaps between the faying surfaces of members being joined should be kept to a minimum. Where the opening between members being joined exceeds 2.0 mm ($^1/_{16}$ in.) and is not greater than 5 mm ($^3/_{16}$ in.), the weld leg size is to be increased by the amount of the opening in excess of 2.0 mm ($^1/_{16}$ in.). Where the opening between members is greater than 5 mm ($^3/_{16}$ in.), corrective procedures are to be specially approved by the Surveyor.

1.1.3 Special Precautions

Special precaution such as the use of preheat or low-hydrogen electrodes or low-hydrogen welding processes may be required where small fillets are used to attach heavy plates or sections. When heavy sections are attached to relatively light plating, the weld size may be required to be modified.

3 Tee Connections

3.1 Size of Fillet Welds *(2014)*

Tee connections are generally to be formed by continuous or intermittent fillet welds on each side, as required by 3-2-3/19 TABLE 1. The leg size, w, of fillet welds (see figure in 3-2-3/19 TABLE 1) is obtained from the following equations:

$$w = t_{p\ell} \times C \times \frac{s}{\ell} + 2.0 \quad \text{mm}$$

or

$$w = t_{p\ell} \times C \times \frac{s}{\ell} + 0.08 \quad \text{in.}$$

$w_{min} = 0.3 t_{p\ell}$ [4.0 mm (0.16 in.) where 3-2-3/9 is applicable], whichever is greater.

where

ℓ = the actual length of weld fillet, clear of crater, in mm (in.)

s = the distance between successive weld fillets, from center to center, in mm (in.)

s/ℓ = 1.0 for continuous fillet welding

$t_{p\ell}$ = thickness of the thinner of the two members being joined, in mm (in.)

C = weld factors given in 3-2-3/19 TABLE 1

In selecting the leg size and spacing of matched fillet welds, the leg size for the intermittent welds is to be taken as not greater than the designed leg size w or $0.7t_{p\ell}$ + 2.00 mm ($0.7t_{p\ell}$ + 0.08 in.), whichever is less.

In determining weld sizes based on the above equations, the nearest half millimeter or one-thirty second of an inch may be used.

The throat size, t, is to be not less than 0.70 w.

For the weld size for $t_{p\ell}$ of 6.5 mm (0.25 in.) or less, see 3-2-3/3.11.

3.3 Length and Arrangement of Fillet

Where an intermittent weld is permitted by 3-2-3/19 TABLE 1, the length of each fillet weld is to be not less than 75 mm (3 in.) for $t_{p\ell}$ of 7 mm (0.28 in.) or more, nor less than 65 mm (2.5 in.) for lesser $t_{p\ell}$. The unwelded length on one side is to be not more than 32 $t_{p\ell}$.

3.5 Intermittent Welding at Intersection

Where beams, stiffeners, frames, etc., are intermittently welded and pass through slotted girders, shelves or stringers, there is to be a pair of matched intermittent welds on each side of each such intersection, and the beams, stiffeners and frames are to be efficiently attached to the girders, shelves and stringers.

3.7 Welding of Longitudinal to Plating

Welding of longitudinals to plating is to have double continuous welds at the ends and in way of transverses equal in length to depth of the longitudinal. For deck longitudinals only, a matched pair of welds is required at the transverses.

3.9 Stiffeners and Webs to Hatch Covers

Unbracketed stiffeners and webs of hatch covers are to be welded continuously to the plating and to the face plate for a length at ends equal to the end depth of the member.

3.11 Thin Plating

For plating of 6.5 mm (0.25 in.) or less, the requirements of 3-2-3/3.1 may be modified as follows:

$$w = t_{p\ell}\, C\, \frac{s}{\ell} + 2.0\left(1.25 - \frac{\ell}{s}\right) \text{ mm}$$

$$w = t_{p\ell}\, C\, \frac{s}{\ell} + 0.08\left(1.25 - \frac{\ell}{s}\right) \text{ in.}$$

$$w_{min} = 3.5 \text{ mm (0.14 in.)}$$

The use of the above equations for plating in excess of 6.5 mm (0.25 in.) may be specially considered depending upon the location and the quality control procedure.

5 Tee-Type End Connections

Tee-type end connections where fillet welds are used are to have continuous welds on each side. In general, the leg sizes of the welds are to be in accordance with 3-2-3/19 TABLE 1 for unbracketed end attachment, but in special cases where heavy members are attached to relatively light plating, the sizes may be modified. Where only the webs of girders, beams and stiffeners are required to be attached to plating, it is recommended that the unattached face plate or flanges be cut back.

7 Ends of Unbracketed Stiffeners

Unbracketed stiffeners of shell, watertight and oiltight bulkheads are to have double continuous welds for one-tenth of their length at each end.

Unbracketed stiffeners of non-tight structural bulkheads, deckhouse sides and after ends are to have a pair of matched intermittent welds at each end.

9 Reduced Weld Size

9.1 General

Reduction in fillet weld sizes, except for slab longitudinals of thickness greater than 25 mm (1.0 in.), may be specially approved by the Surveyor in accordance with either 3-2-3/9.3 or 3-2-3/9.5, provided that the requirements of 3-2-3/3 are satisfied.

9.3 Controlled Gaps

Where quality control facilitates working to a gap between members being attached of 1 mm (0.04 in.) or less, a reduction in fillet weld leg size *w* of 0.5 mm (0.02 in.) may be permitted.

9.5 Deep Penetration Welds

Where automatic double continuous fillet welding is used and quality control facilitates working to a gap between members being attached of 1 mm (0.04 in.) or less, a reduction in fillet weld leg size of 1.5 mm (0.06 in.) may be permitted, provided that the penetration at the root is at least 1.5 mm (0.06 in.) into the members being attached.

11 Lapped Joints

11.1 General

Lapped joints are generally to have overlaps of not less width than twice the thinner plate thickness plus 25 mm (1.0 in.).

11.3 Overlapped End Connections

Overlapped end connections of longitudinal strength members are to have continuous fillet welds on both edges each equal in size *w* to the thickness of the thinner of the two plates joined. All other overlapped end connections are to have continuous welds on each edge of size *w* such that the sum of the two is not less than 1.5 times the thickness of the thinner plate.

11.5 Overlapped Seams

Overlapped seams are to have continuous welds on both edges of the sizes required by 3-2-3/19 TABLE 1 for the boundaries of deep tank or watertight bulkheads, except that for seams of plates 12.5 mm ($^1/_2$ in.) or less clear of tanks one edge may have intermittent welds in accordance with 3-2-3/19 TABLE 1 for watertight bulkhead boundaries.

13 Plug Welds or Slot Welds

Plug welds or slot welds may be specially approved for particular applications. Where used in the body of doublers and similar locations, such welds may be spaced about 305 mm (12 in.) between centers in both directions.

15 Weld in Tubular Joints

The weld design of joints of intersecting tubular members which are used in fixed structure in a tower mooring is to be in accordance with Part 1, "Structures" of the *Offshore Installation Rules*.

17 Full or Partial Penetration Corner or Tee Joints

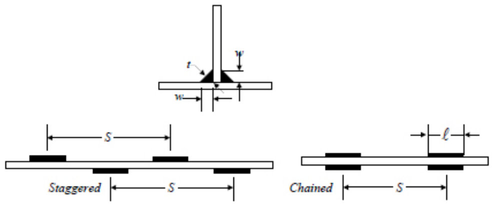
A full or partial penetration weld may be required critical joints.

Measures taken to achieve full or partial penetration corner or tee joints, where specified, are to be to the satisfaction of the attending Surveyor. The designer is to give consideration to minimize the possibility of lamellar tearing in such joints.

19 Alternatives

The foregoing are considered minimum requirements for electric-arc welding in hull construction, but alternative methods, arrangements and details will be considered for approval. See 2-4-3/5 of the ABS *Rules for Materials and Welding (Part 2)*. Fillet weld sizes may be determined from structural analyses based on sound engineering principles, provided that they meet the overall strength standards of the Rules.

TABLE 1
Weld Factors



w = leg size in mm (in.) t = throat size in mm (in.)

I.	**Periphery Connections**		**Factor C**
		C	= Continuous
		DC	= Double Continuous
A.	Tight Joints		
	1. Main bulkhead to deck, bottom or inner bottom		0.42 DC
	2. All other tight joints		
	a. watertight bulkhead, $t_{pl} \leq$ 12.5 mm (0.50 in.	one side	0.58 C
		other side	0.12
	b. all other joints		0.35 DC
B.	Non-tight Joints		
	1. Platform decks		0.28 DC
	2. Swash bulkheads in deep tanks		0.20
	3. Non-tight bulkheads other than B2		0.15
II.	**Bottom Floors**		
	1. To Shell		0.20 DC
	2. To Inner Bottom		0.20 DC
	3. To Main Girders		0.30 DC
	4. To Side Shell and Bulkheads		0.35 DC
	5. Open Floor Bracket		
	a. to center girder		0.15
	b. to margin plate		0.30 DC
III.	**Bottom Girder**		
	1. Center Girder		0.25
IV.	**Web Frames, Stringers, Deck Girders and Deck Transverses**		
	1. To Plating		
	a. in tanks		0.20
	b. elsewhere		0.15
	2. To Face Plates		
	a. face area ≤ 64.5 cm^2 (10 in^2)		0.12
	b. face area > 64.5 cm^2 (10 in^2)		0.15
	3. End Attachment		
	a. unbracketed (see note 1)		0.55 DC
	b. bracketed		0.40 DC
V.	**Frames, Beams and Stiffeners**		
	1. To Shell		0.25 DC
	2. To plating elsewhere		0.12
	3. End attachment		
	a. unbracketed (see note 1)		0.45 DC
	b. bracketed		0.35 DC
VI.	**Hatch Covers**		
	1. Oiltight Joints		0.40 DC
	2. Watertight Joints		
	Outside		0.40 C
	Inside		0.15
	3. Stiffeners and Webs to Plating and to Face Plate (see note 2)		0.12
	4. Stiffeners and Web to Side Plating or other stiffeners		
	—unbracketed (see note 1)		0.45 DC
	—bracketed		0.35 DC
VII.	**Hatch Coamings and Ventilators**		
	1. To Deck		
	a. at hatch corner		0.45 DC
	b. elsewhere		0.25 DC
	2. Coaming stays		
	a. to deck		0.20 DC
	b. to coaming		0.15 DC
VIII.	**Foundations**		
	1. Main Engine and Major Auxiliaries		0.40 DC

Note:

1. The weld size is to be determined from the thickness of the member being attached.
2. Unbracketed stiffeners and webs of hatch covers are to be welded continuously to the plating and to the face plate for a length at ends equal to the end depth of the member.
3. With longitudinal framing, the weld size is to be increased to give an equivalent weld area to that obtained without cut-outs for longitudinals.

PART 3

CHAPTER 3
Stability

CONTENTS

PART 3

CHAPTER 3
Stability

SECTION 1
Stability and Watertight/Weathertight Integrity

1 Stability

The hull is to be divided by bulkheads into watertight compartments. Watertight manholes are to be provided for access to all main floodable compartments.

1.1 Intact Stability

1.1.1 Conditions

The hull is to be stable under the following conditions.

i) In calm water without mooring leg(s) in place

ii) During installation

iii) In the operating environment with all mooring legs in place and pretensioned under the operating hawser load

iv) Under tow, if the buoy is towed

1.1.2 Designer Verification *(2019)*

The designer is also to verify the following:

i) The metacentric height is to be positive in the calm water equilibrium position for all afloat conditions without any mooring leg(s) in place.

ii) The righting energy (area under the righting moment curve) at or before the angle of the second intercept of the righting and the overturning moment curve or the down flooding angle, which is less, is to reach a value of not less than 40% in excess of the area under the overturning moment curve to the same limiting angle. Overturning moments are to be taken as moments which result from the environmental and operational loads during towout, installation, operation, and disconnected mode corresponding to environmental conditions with return period of 100 years where applicable. Static angle of heel due to overturning moment is to be below the first downflooding point.

iii) The hull is to reserve enough buoyancy so that the buoy will not capsize or sink due to the pull of the anchor legs under pretension and of the underbuoy hoses/flexible risers under the Design Environmental Condition.

1.3 Damage Stability *(2014)*

The designer is to verify that the buoy has enough reserve buoyancy to stay afloat in a condition with at least one compartment (adjacent to the sea) damaged. It is also required to verify that the final damage waterline is below the first downflooding point. The cause of flooding shall normally be taken according to 3-3-2/1.3.2 of the ABS *Rules for Building and Classing Mobile Offshore Units (MOU Rules)* in association with the operational draft. in a damage equilibrium condition with one compartment damaged under the design operating condition.

PART 3

CHAPTER 4
Equipment

CONTENTS

PART 3

CHAPTER 4
Equipment

SECTION 1
Anchoring and Mooring Equipment *(2014)*

1 General

The mooring legs and anchors of an SPM are to be designed to protect against the failure of the underbuoy hose or riser with one anchor line broken, for the design environmental conditions described in 3-1-2/7.1. In lieu of the foregoing a means of closure that isolates the SPM from the undersea pipeline may be accepted, but this alternative applies to a hose that is qualified to OCIMF standards (see 4-1-2/7).

3 Anchor Points

The anchors are to be designed to have adequate holding capacity. For mooring systems with drag anchors, the holding capacity of each anchor is to be determined by using the soil characteristics of the bottom samples. The type of anchorage for the anchor leg(s) is to be selected according to conditions of the seabed and the maximum design anchor load.

The factor of safety is defined as the minimum holding capacity of an anchor divided by the maximum design anchor load. The required minimum factors of safety, given below, depend on whether the mooring system is considered intact or broken and how the design loads are calculated. The minimum required factors of safety can be based on one of the following two options. The option selected is to match that used in 3-4-1/5.

Option i) When the mooring system is considered as being intact and the design loads are calculated in accordance with 3-2-1/7.1 and 3-2-1/7.3, required minimum factors of safety are:

For the Design Operating Load Case of 3-2-2/7.1.i:	2.0
For the Design Environmental Load Case of 3-2-2/7.1.ii:	1.5

Where lower factors of safety of anchor leg(s) are desired with additional mooring analysis for any one line broken case as indicated in 3-4-1/5, the factor of safety on the holding capacity of the anchor in a broken line case for the Design Operating Load Case should not be less than 1.60.

Option ii) The criteria of 3-4-1/7.

In the case of an SPM system using anchor piles, it is recommended that pile foundations be designed to comply with the appropriate sections of API RP 2A. A pile driving record or pile grouting record is to be taken and submitted for each pile. The method of installation of the piles and the equipment employed is to be included in the pile driving record.

Where the anchoring system uses gravity boxes, resistance against sliding, uplifting, and overturning of the gravity boxes are to be analyzed. The forces due to environmental, gravity and mooring are to be taken into account appropriately. Scour effects on the gravity boxes are to be considered in the design.

Where a Vertically Loaded Anchor (VLA) is used, reference is to be made to 3-4-1/7.

After the mooring system is deployed, each mooring line will be required to be pull-tested. During the test, each mooring line is to be pulled to the maximum design load determined by dynamic analysis for the intact design condition and held at that load for 30 minutes in presence of ABS Surveyor. The pull test load is to be the greater of the following two values:

- Maximum design load of mooring line for the Design Operating Load Case
- Maximum design load of mooring line for the Design Environmental Case

For certain high efficiency drag anchors in soft clay, the test load may be reduced to not less than 80 percent of the maximum intact design load. For all types of anchors, the attainment of design-required minimum soil penetration depth is to be verified at the site.

ABS will determine the necessity of a maximum intact design tension pull test depending on the extent of the geotechnical investigation, the magnitude of loading, analytical methods used for the geotechnical design and the experience with the soils in the area of interest. For suction piles, ABS will review the pile installation records to verify the agreement between the calculated suction pressures and the suction pressure used to install the suction piles. For conventional piles, ABS will review the pile installation records to verify agreement between the calculated pile driving blow counts and the actual blow counts required to drive the piles to the design penetrations.

If the maximum intact design tension pull tests are waived, ABS will require preloading each anchor to a load that is necessary to develop the ultimate holding capacity of the anchor, but not less than the mean intact design tension, and to verify the integrity and alignment of the mooring line.

5 Anchor Leg(s)

The minimum factor of safety against the breakage of each anchor leg component can be based on one of the following two options. The option selected is to match that used in 3-4-1/3.

Option i) When the mooring system is considered as being intact and the design loads are calculated in accordance with 3-2-1/7.1 and 3-2-1/7.3, required minimum factors of safety are:

For the Design Operating Load Case of 3-2-2/7.1.i:	3.0
For the Design Environmental Load Case of 3-2-2/7.1.ii:	2.5

A lower factor of safety of 2.5 for anchor leg components will be allowed for the intact Design Operating Load Case if an analysis of the mooring system with any one line broken provides a factor of safety of at least 2.00 with respect to the minimum breaking strength of anchor leg component(s).

Option ii) The criteria of 3-4-1/7.

The mooring structure of a fixed SPM system is to be designed in accordance with 3-2-2/11.

7 Alternative Criteria

When requested, the ABS will accept the criteria contained in Sections 6-1-1 and 6-1-2 of the *FPI Rules* as an alternative to those given in 3-4-1/3 and 3-4-1/5, above. The application of the alternative criteria includes the specified dynamic analyses, anchor leg broken conditions, corrosion assumptions, fatigue life predictions, etc. that are entailed in the referenced sections of the *FPI Rules*. Both the Design Operating Load Case of 3-2-2/7.1.i and the Design Environmental Load Case of 3-2-2/7.1.ii are to be analyzed, and the load case producing the higher design loads is to be used in the application of the alternative criteria.

9 Anchor and Chains *(1 July 2022)*

Anchors are to comply with the requirements of Section 2-2-1 of the ABS *Rules for Materials and Welding (Part 2)*. Chains are to comply with the ABS *Requirements* for the Certification of Offshore Mooring Chain.Equipment designed to other standards will be specially considered.

11 Mooring between Vessel and SPM

When hawsers are used as the connecting links, they are to be designed using the following factors of safety on the breaking strength of the weakest part. The strength of ropes or hawsers is to be determined in accordance with and certified to the latest version of OCIMF *Prototype Rope Testing*. The breaking strength of spliced rope is to be established by appropriate testing. The breaking strength of the hawser to be used is to be the lower value of the hawser in wet or dry condition.

- With one fairlead: F.S. = 1.67
- With multiple fairleads: F.S. = 2.50

Where the vessel is moored to the SPM using hawsers running through more than two (2) fairleads on the vessel, the hawser loads are to be calculated as if there are only two (2) fairleads.

Hawser manufacture is to comply with the OCIMF *Quality Control and Inspection during the Production of Hawsers*.

Note:

The above mentioned OCIMF references are available in volume entitled, OCIMF Guidelines for the Purchasing and Testing of SPM Hawsers.

When a rigid mooring structure is used as the mooring structure between the vessel and the SPM, the connecting structures are to comply with 3-2-4/5 of the *MOU Rules*.

13 Structural Components

If not indicated elsewhere in these Rules, the structural and mechanical components (mooring hardware (e.g., connecting links, shackles, chain stoppers, fairleads, etc.)) which transmit the mooring loads are to be designed to the Minimum Breaking Load (MBL) of the mooring line. Items such as chain stoppers and fairleads can be designed to other criteria if it is intended that they are to maintain structural integrity after failure of the mooring line.

15 Buoyancy Elements *(2019)*

If buoyancy elements are used to support the mooring system, they are to comply with requirements for buoyancy modules in ABS *Guide for Subsea Riser Systems*.

PART 4

Equipment and Systems

CONTENTS

PART 4

CHAPTER 1

Cargo or Product Transfer Systems

CONTENTS

PART 4

CHAPTER 1
Cargo or Product Transfer Systems

SECTION 1
General

1 General

The provisions of this Chapter are applicable to the cargo or product transfer system and associated components of single point moorings (SPM). The cargo or product transfer system includes all system components from the seafloor connection to a pipeline to the first flange on the loading tanker or other type of unit. Pipe Line End Manifolds (PLEMs), if provided, are to comply with the provisions of this Chapter.

1.1 Conditions Applicable to Pipeline Connection

The following conditions apply to the PLEM or connection between the undersea pipeline and the underbuoy hoses/flexible risers.

i) It is to be anchored to the sea bottom to resist forces due to waves, current, and forces imposed by the SPM and the undersea pipeline.

ii) A means of closure is to be provided to permit isolation of the SPM from the undersea pipeline.

3 Materials

Refer to 3-1-3/7 for material requirements for cargo or product transfer systems.

PART 4

CHAPTER 1

Cargo or Product Transfer Systems

SECTION 2

Hoses/Flexible Risers

1 General *(2014)*

The length of the hose/flexible riser system, provision for buoyancy, spreaders between hoses/flexible risers, external restraints (if required), and angle of connection to the pipeline end and the SPM are to be established taking into account at least the following.

i) Maximum excursion of the SPM structure both under the operating conditions with a moored vessel and the design conditions without a moored vessel

ii) Motion of the components of the system

iii) External forces on the hose/flexible riser system

iv) Range of specific gravity of the contents of the hose/flexible riser system including the various cargoes anticipated and sea water

v) Installation tolerances

3 Underbuoy Hoses/Flexible Risers *(2014)*

The system is to be designed to avoid chafing of underwater hoses/flexible risers due to contact with the SPM hull or buoy, anchor legs or applicable mooring system, seabed, and other hoses/flexible risers (if any). Systems designed with wear protection against incidental seabed contact in design environmental condition will be specially considered. Checking of designs for interference is required. Adequately reinforced hoses/flexible risers in areas of maximum hose/flexible riser flexing are to be provided. The procedures for installation, removal (if applicable), and maintenance are to be submitted for review.

5 Floating Hoses

Lifting arrangements are to be provided at the end of the floating hose. Special hose is to be provided at the vessel end to accommodate the bending of the hose over the vessel rail (Tanker Rail Hose). The vessel end of the hose is to be provided with a blind flange to avoid contamination of the sea water. Consideration is to be given to providing swivels, specially reinforced hose, or both, at the connection of the floating hose with components of the SPM system. Consideration is to be given to providing a breakaway coupling with shutoff valves in each floating hose string to provide surge and axial overload protection to the hose string, and to minimize pollution in the event of an excessive pressure surge or tanker breakout.

7 Construction *(2014)*

All hoses are to comply with the OCIMF *Guide to Manufacturing and Purchasing Hoses for Offshore Moorings* and is to be manufactured to ABS Survey and Inspection. Prototype hose approval in accordance with Section 3 of this standard is required.

Variances from the OCIMF *Guide to Manufacturing and Purchasing Hoses for Offshore Moorings* as required to satisfy the system's operating conditions will be considered on a case-by-case basis. Adequate justification for such variances will be required.

The bolting and gasket materials and design are to comply with an applicable recognized design standard and be suitable for their intended service.

Flexible risers, if utilized, are to meet the requirements found in the ABS *Guide for Building and Classing Subsea Riser Systems* and API RP 17B *Recommended Practice for Flexible Pipe*.

9 System Design Pressure

Design pressure is defined as the larger of:

i) The shut-off head at the vessel's manifold at zero flow, plus the gravity head of the contents to the part of the SPM pipe or hose in question.

ii) The head calculated due to surge pressure, resulting from design valve closing times.

11 Testing *(2014)*

Each length of hose is to be subjected to hydrostatic and vacuum tests in accordance with requirements of 1.11.6 and 1.11.8, respectively, of the OCIMF *Guide to Manufacturing and Purchasing Hoses for Offshore Moorings*. These tests are to be witnessed by a Surveyor. In all cases where the design pressure of the system exceeds 15.5 bar (15.8 kgf/cm^2, 225 psi), the hydrostatic test is to be carried out at not less than the design pressure. Where flexible risers are used, they are to be tested using recognized standards.

PART 4

CHAPTER 1
Cargo or Product Transfer Systems

SECTION 3
Cargo or Product Swivels and Related Systems and Equipment

1 Cargo or Product Swivels

1.1 Design

Cargo or product swivels are to be of steel construction with flanged or welded connections. Details of the swivel connecting stationary SPM piping with rotating piping are to be submitted for approval. Such details are to include fixed and rotating parts details, plate thicknesses, nozzle locations and arrangement, seal and bearing design, and welding.

The swivel design is to consider the most adverse combination of applicable loads. At least the following loads are to be considered:

i) Breakaway torque required for each swivel at maximum design pressure

ii) Weight of swivel and its structural components

iii) Dynamic loads due to vessel motion

iv) Piping loads

v) Mooring forces

vi) Pressure loads

vii) Thermal loads

Pressure retaining components of the swivel are to be designed in accordance with a recognized standard such as the ASME *Boiler and Pressure Vessel Code*. Structural components of the swivel and driving mechanism are to comply with Section 3-2-2 of these Rules, the ASME code, or other recognized structural design standard.

1.3 Testing

Testing is to be conducted at the manufacturer's plant in accordance with an approved test procedure in the presence of a Surveyor. The procedure is to address acceptable leakage criteria and is to specify the following tests as a minimum:

i) Hydrostatic pressure test to at least 1.5 times the design pressure for at least two (2) hours.

ii) Hydrostatic pressure test to design pressure through two (2) complete revolutions in each direction at a rate of approximately ten (10) minutes per revolution.

iii) Hydrostatic pressure test to design pressure through four (4) complete revolutions. The first revolution is to be clockwise, and the final counterclockwise. Each rotation is to be in stages of 30 degrees at a rate of approximately 30 seconds per 30 degrees with a 30 second pause between each 30 degree rotation. For each 30 degree rotation, the breakaway torque and the rotating torque are to be recorded. Where fluid assembly swivel rotates in unison with mooring swivel, this test is to be conducted on the combined system.

3 Leak Monitoring, Recovery and Pressurization System

All piping for leak recovery and pressurization systems is to be of steel construction or equivalent and designed in accordance with ASME B31.3.

A pressure balanced, or over-pressured, isolation seal shall be used between the primary seal and the product in gas or gas containing production fluid swivels.

5 Bearings

5.1 Mooring Bearings

Bearings which carry the operating hawser load, rotating structure load and mooring load are to be designed with a safety factor of not less than 2 without destructive yielding of the bearing surfaces.

Bearing mounting bolts are to be designed in accordance with recognized standards. For high tension bolts stress corrosion cracking is to be considered.

5.3 Swivel Bearings

Swivel bearings that do not carry the hawser load are to be designed in accordance with AFBMA Codes (Anti Friction Bearing Manufacturers Association) or other recognized industry standards.

7 Corrosion Protection

The swivels are to be coated on the outside with a suitable corrosion resistant coating. This coating will not be required for parts made of corrosion resistant material. The possibility of corrosion due to the presence of CO_2, O_2, or H_2S in the cargo or product fluid is to be considered in the swivel design.

PART 4

CHAPTER 1

Cargo or Product Transfer Systems

SECTION 4

Cargo or Product Piping Systems

1 Piping *(2014)*

All piping for the cargo or product transfer system mounted on the SPM is to be of steel with welded or flanged connections. Piping is to be securely mounted on the SPM and anchored to resist the forces resulting from internal pressure and flow in the system and loads induced by the hose/flexible riser system connected to it. Provision is to be made for expansion. Piping is to be shop tested after fabrication to a minimum pressure of 1.5 times the design pressure in the presence of a Surveyor.

Cargo or product piping installed on SPMs is to comply with ASME B31.3 and other applicable recognized standards, except that piping less than Standard weight should not be used. Standard weight pipe is defined as the American National Standards Institute Schedule 40 up to a maximum wall thickness of 9.5 mm (0.375 in.).

3 Valves

A shutoff valve is to be provided on the SPM for each cargo transfer line. Valves are to be of steel construction and capable of manual operation. Valves are to be constructed and tested in accordance with recognized standards such as those of the American National Standards Institute (ANSI). Non-standard valves are those valves that are not certified by the manufacturer as complying with a recognized standard. The use of nonstandard valves is subject to special consideration and drawings of such valves showing details of construction and materials are to be submitted for review, as well as the basis for valve pressure rating, such as design calculations or appropriate burst test data.

5 Flanges and Fittings

Flanges and fittings are to be constructed and tested in accordance with recognized standards such as those of the American National Standards Institute (ANSI). Nonstandard flanges and fittings are those components that are not certified by the manufacturer as complying with a recognized standard. The use of non-standard flanges and fittings is subject to special consideration and drawings of such components showing details of construction, materials and design calculations or test results are to be submitted for review.

7 Expansion Joints *(2014)*

Expansion joints are to have a maximum allowable working pressure of no greater than one third of the hydrostatic bursting pressure of the joint. For nonmetallic expansion joints, cross sectional drawings of the joint showing construction of the joint including end fitting attachment and a bill of materials are to be submitted for review. Results of the burst test are to be submitted for review.

For metallic bellows expansion joints, cross sectional drawings of the joint along with a bill of materials are to be submitted for review. Calculations and/or bust test results verifying the pressure and temperature rating and fatigue life are to be submitted for review.

9 PLEM Piping *(2014)*

The requirements of 4-1-3/1, 4-1-3/3 and 4-1-3/5 are also applicable to the piping, valves, flanges and fittings forming the Pipe Line End Manifold (PLEM).

Alternatively, the PLEM may also be constructed and tested in accordance with ASME B31.4 *Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids*.

11 Corrosion Protection

The cargo or product piping, valves and fittings are to be coated on the outside with a suitable corrosion resistant coating. This coating will not be required for parts made of corrosion resistant material. The possibility of corrosion due to the presence of CO_2, O_2, or H_2S in the cargo or product fluid is to be considered in the piping design.

PART 4

CHAPTER 2
Ancillary Systems and Equipment

CONTENTS

PART 4

CHAPTER 2
Ancillary Systems and Equipment

SECTION 1
Requirements for Ancillary Systems and Equipment

1 General

Ancillary systems such as hydraulic, pneumatic, fuel, ballast, telemetry, controls; etc., which may be provided on a single point mooring are to comply with the applicable requirements of the *MOU Rules*, except as specified in this Section.

3 Bilge Pumping

Single point moorings are to be provided with a means for pumping from and draining all tanks and void compartments. Pumping by means of a portable hand operated pump would be acceptable in lieu of a fixed bilge system.

5 Tank Sounding *(2014)*

A manual means of sounding is to be provided for all tanks and void compartments. A sounding pipe is to have a screw cap with chain, a gate valve, or equivalent.

7 Tank Venting

All tanks that are filled or emptied through fixed pumping arrangements and all voids through which pressure piping passes are to be fitted with vent pipes.

The structural arrangement of tanks or voids requiting a vent is to be such as to permit the free passage of air and gasses from all parts of the spaces to the vent pipes. Each tank or void requiring a vent is to be fitted with at least one vent pipe, which is located at the highest part of the tank. Vent pipes are to be arranged to provide adequate self-drainage under normal conditions. Vent outlets on the open deck are to terminate by way of return bends. Satisfactory means, permanently attached, are to be provided for closing the vent pipes.

The internal diameter of each vent pipe is not to be less than 51 mm (2 in.) unless specially approved otherwise. Where tanks are to be filled by pump pressure, the aggregate area of the vents on the tank is to be at least 125% of the effective area of the filling line. Notwithstanding the above, the pump capacity and pressure head are to be considered in the sizing of the vents.

Vent pipes are to terminate in the weather and their height is to be at least 760 mm (30 in.) above the deck except where this height may interfere with the working of the SPM, a lower height may be approved provided that the closing arrangements and other circumstances justify a lower height.

9 Ancillary Components

Ancillary mechanical components such as hoists, winches, quick connect and disconnect devices, are to be designed in accordance with applicable industry standards, codes and published recommended practices.

PART 4

CHAPTER 3

Hazardous Areas and Electrical Installations

CONTENTS

PART 4

CHAPTER 3
Hazardous Areas and Electrical Installations

SECTION 1
Hazardous Areas

1 Definitions

Hazardous Areas. Hazardous areas are all those areas where a flammable atmosphere may be expected to exist continuously or intermittently. Hazardous areas are subdivided into Zones 0, 1 and 2 defined as follows:

Zone 0. A zone in which an explosive gas-air mixture is continuously present or present for long periods.

Zone 1. A zone in which an explosive gas-air mixture is likely to occur in normal operating conditions.

Zone 2. A zone in which an explosive gas-air mixture is not likely to occur, and if it occurs, it will exist only for a short time.

Enclosed Space. An enclosed space is considered to be a space bounded by decks and bulkheads which may or may not have doors, windows, or other similar openings.

3 Classification of Areas *(2014)*

The area within 3 meters (10 feet) of a cargo or product swivel is considered a Zone 2 area when in a non-enclosed area.

When a cargo or product swivel is installed within an enclosed space, the space is considered a Zone 1 area.

The inside of tanks, swivels, or pipes containing hydrocarbons are considered Zone 0 areas.

In addition to the hazardous areas defined above, the principles of API RP 500 *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2*; or RP 505 *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2* are to be considered in delineating hazardous areas associated with components of the single point mooring.

PART 4

CHAPTER 3
Hazardous Areas and Electrical Installations

SECTION 2
Electrical Installations

1 General

Electrical installations onboard single point moorings are to comply with the requirements of Part 4, Chapter 3 of the *MOU Rules* and the additional or modified requirements contained in this Section. Alternatively, consideration will be given to installations that comply with the requirements contained in this Section and applicable recognized standards, provided that they are not less effective.

3 Cables and Types of Electrical Equipment Permitted in Hazardous Areas

3.1 Electrical Equipment

The following equipment and cables are acceptable for installation in hazardous locations:

3.1.1 Zone 0 Areas

Only certified intrinsically-safe circuits or equipment and associated wiring are permitted in Zone 0 areas.

3.1.2 Zone 1 Areas

Equipment and cables permitted in Zone 1 areas are to be:

i) Certified intrinsically-safe circuits or equipment and associated wiring

ii) Certified flameproof (explosion proof) equipment

iii) Certified increased safety equipment; for increased safety motors due consideration is to be given to the protection against overcurrent

iv) Pressurized enclosure type equipment (pressurization systems are to comply with applicable industry standards)

v) Permanently installed cables with metallic armor, a metallic sheath, or installed in metallic conduit with explosion proof gastight fittings. Exception: flexible cables, where necessary, may be installed provided they are of heavy duty type.

3.1.3 Zone 2 Areas

Equipment and cables permitted in Zone 2 areas are all equipment approved for Zone 1 areas and the following equipment provided the operating temperature does not exceed 315°C (600°F) and provided any brushes, switching mechanisms, or similar arc-producing devices are approved for Zone 1 areas:

i) Enclosed squirrel-cage induction motors

ii) Fixed lighting fixtures protected from mechanical damage

iii) Transformers, solenoids, or impedance coils in general purpose enclosures

iv) Cables with moisture-resistant jacket (impervious sheathed) and protected from mechanical damage

3.3 Cable Installation *(2023)*

Electrical cables in hazardous areas are to be armored or mineral-insulated metal-sheathed where required by 4-3-3/9.1.2 of the MOU Rules, except for cables of intrinsically safe circuits subject to the requirements in 4-3-3/5.15 of the MOU Rules. In addition, conductors are to be run with a view to avoiding as far as practical, spaces where gas may normally be expected to accumulate. No cable splices are allowed in hazardous areas except in intrinsically-safe circuits. Where it is necessary to join cables in a hazardous area (e.g., flexible cable connections to non-flexible cables), the joints are to be made in approved junction boxes.

5 Electrical Swivels

If installed in a hazardous area, the electrical swivel is to be certified by an independent testing laboratory as suitable for installation within such an area as per Section 4-3-1 of these Rules.

The amperage ratings of electrical swivels (slip rings) are to be adequate to carry the full load current of the equipment supplied.

PART 4

CHAPTER 4
Safety Provisions

CONTENTS

PART 4

CHAPTER 4
Safety Provisions

SECTION 1
General

1 Navigation Aids

1.1 Obstruction Lights

Obstruction lights are to be provided as prescribed by the National Authority having jurisdiction. If the SPM is located outside the territorial waters of any National Authority or if no lights are prescribed by the authority having jurisdiction, the following is to be provided as a minimum:

- One 360 degree white light visible for five (5) miles under an atmospheric transmissivity of 0.85, flashing six (6) times per minute, and arranged for operation at least from sunset to sunrise local time.
- It is recommended that the floating hoses be marked with winker lights.

1.3 Fog Signal

Audible fog signals are to be provided if prescribed by the National Authority having jurisdiction.

1.5 Radar Reflector

A radar reflector is to be provided if prescribed by the National Authority having jurisdiction.

3 Fire Fighting Equipment *(2014)*

SPMs are to be equipped with at least one B-II type portable fire extinguisher. Where the risk of an electrical fire also exists, one C-II type portable extinguisher is also to be provided. In lieu of providing two (2) extinguishers, consideration will be given to a single extinguisher of a type suitable for both oil and electrical fires. A B-II rated portable extinguisher could be 9 liter (2.5 U.S. gallons) foam, 5 kg (11 lb) carbon dioxide or 5 kg (11 lb) dry chemical. A C-II rated portable extinguisher could be 5 kg (11 lb) carbon dioxide or 5 kg (11 lb) dry chemical.

5 Identification Marks *(2014)*

A name or number is to be assigned to each single point mooring and is to conform to requirements of the National Authority having jurisdiction. This name or number is to be permanently displayed on the structure and will be entered in the ABS *Record*. Draft marks are to be permanently marked in at least two (2) places on the outside of the buoy hull indicating maximum permissible draft.

PART 4

CHAPTER 5

Offshore Charging Connections

CONTENTS

PART 4

CHAPTER 5
Offshore Charging Connections

SECTION 1
General Provisions *(2023)*

1 General

This Chapter provides criteria for the effective installation and operation of charging stations onboard SPMs to charge the battery systems onboard vessels. The requirements in this chapter are to be used in conjunction with and as a supplement to Section 4-8-4 of the ABS *Rules for Building and Classing Marine Vessels (Marine Vessel Rules)* and Section 4-3-4 of the *MOU Rules*. The basic safety principles of general electrical safety (such as proper cable sizing, appropriate insulation, and appropriate equipment enclosure ratings) contained in the ABS Rules are to be followed.

SPMs fitted with charging stations are to be readily identifiable with suitable marking. The marking is to denote, as a minimum, the charging voltage(s), available charging power capacity, and capacity for simultaneous charging. Refer to 4-5-1/Table 1 below for appropriate sections of *Marine Vessel Rules* and *Requirements for Use of Lithium-ion Batteries in the Marine and Offshore Industries (Lithium-ion Battery Requirements)*.

TABLE 1
Electrical Equipment Installation and Test

Item	*Rules or Guide Reference*
Degree of Enclosure	4-8-4/1.3 of *Marine Vessel Rules*
Inclination	4-8-4/1.7 of *Marine Vessel Rules*
Generators and Motors	4-8-4/3 of *Marine Vessel Rules*
Accumulator Batteries	4-8-4/5 of *Marine Vessel Rules*
Switchboard and Distribution Boards	4-8-4/7 of *Marine Vessel Rules*
Motor Controllers and Motor Control Centers	4-8-4/9 of *Marine Vessel Rules*
Cable	4-8-4/21 of *Marine Vessel Rules*
Equipment Earthing	4-8-4/23 of *Marine Vessel Rules*
System Earthing	4-8-4/25 of *Marine Vessel Rules*
Electrical Equipment in Hazardous Areas	4-8-4/27 of *Marine Vessel Rules*
Shipboard Tests	4-8-4/29 of *Marine Vessel Rules*

Item	*Rules or Guide Reference*
Battery System Testing Requirements	Section 3 of *Lithium-Ion Battery Requirements*
Transformers	4-8-3/7.3.5 of *Marine Vessel Rules*
Convertors	4-8-3/8.7 of *Marine Vessel Rules*

The recurrence interval for the Design Environmental Condition (DEC) in 3-1-2/7 is to be 50 years as a minimum. A higher recurrence interval may be used based on the risk assessment.

3 Application and Notation

The requirements in this chapter are applicable to SPMs designed to provide charging to marine and offshore assets by means of a battery system providing a source of electrical power with a capacity greater than 25 kWh. The optional notation **OCC** may be granted to those SPM facilities upon compliance of the battery charging connection installation with the requirements of this Section.

Where the optional notation **OCC** is not requested, but the SPM is fitted with a charging facility, then the charging facility is to comply with the minimum requirements prescribed in 4-5-1/Table 2 below and is to be verified by an ABS Surveyor during installation. This is applicable to new construction and existing vessel modifications.

TABLE 2
Minimum Requirements for Charging Station on SPM Where OCC Notation is not Requested

Charging Station	*SPM Rules References*
Grounding	4-5-2/7.3
Control, Monitoring, Alarm and Safety Systems	4-5-2/7.7
Circuit Protection	4-5-3/1
Cable Construction	4-5-3/3
Equipment	4-5-3/5
Emergency Disconnect	4-5-3/9
Testing and Verification	4-5-3/11

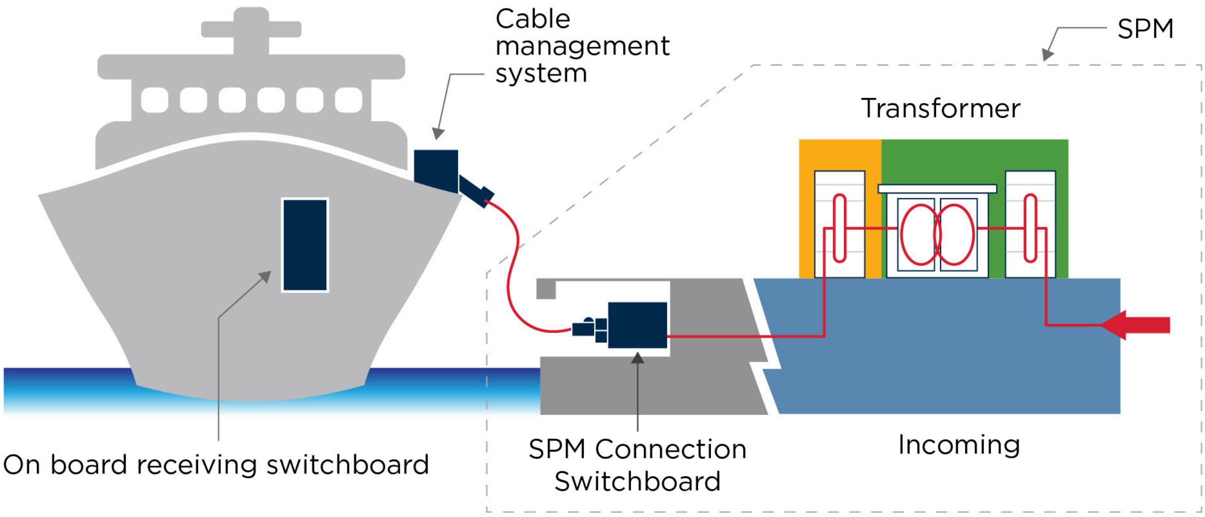
The criteria in this section applies to marine and offshore assets with a lithium-ion battery system or lead acid battery system used as a source of electrical power systems with a capacity of over 25 kWh. However, certain criteria of this section may be applied to assets with a capacity of less than 25 kWh, upon special consideration by ABS.

The requirements in this section may be applied to marine and offshore assets with battery systems other than lithium-ion type upon special consideration by ABS.

A SPM fitted with a charging connection installation which is found to be in compliance with the requirements in this chapter will be assigned the classification notation **OCC**, e.g. **Single Point Mooring (OCC)**.

A typical arrangement of a SPM-Charging buoy connected to a receiving vessel is illustrated in Section 4-5-1/Figure 1.

FIGURE 1
Typical Arrangement of a SPM-Charging Buoy connected to a Receiving Vessel



Note: Cable management system can be located either onboard the receiving vessel or the SPM charging buoy.

5 Scope

The requirements of this chapter are intended for installations with a rated supply voltage up to 1000 VAC or up to 1500 VDC and a rated output voltage up to 1000 VAC or up to 1500 VDC.

Where the SPM facility is equipped with a charging facility with a supply nominal voltage (phase to phase) higher than 1000 VAC up to 15 kV, the requirements in Section 4-8-5 of the *Marine Vessel Rules* are applicable.

For systems with nominal voltages exceeding 15 kV, a recognized standard is to be proposed to ABS for technical review and assessment.

This standard also applies to charging station equipment supplied from on-site storage systems (e.g., buffer batteries). The aspects covered in this chapter include:

- Characteristics and operating conditions of the charging station
- Specification of the connection between the charging stations equipment and the marine or offshore asset
- Requirements for electrical safety for the charging station
- Supply equipment intended to be used on board the SPM

Requirements for electrical devices and components used in charging station supply equipment are not within the scope of this chapter and are covered by their specific product standards, acceptable for use in a marine/offshore environment. This Chapter does not apply to:

- Safety aspects related to maintenance
- Equipment on the marine and/or offshore assets
- EMC requirements for equipment on the marine or offshore asset while connected
- Charging the ESS at a location other than on board the marine and/or offshore asset

7 Terminology and Definitions

Battery Management System (BMS): An electronic system possessing a battery module/pack that can cut power in case of overcharge, overcurrent, over-discharge, and overheating. It monitors and/or manages its state, calculates secondary data, reports that data, and/or controls its environment to influence the battery's safety, performance, and/or service life [IEC 62619].

Cable Management System: The ship's interface point with the Single Point Mooring facility. The cable management system is typically composed of flexible HV or LV cables with a plug that connects to the SPM power receptacle, cable reel, automatic tension control system with associated control gears, and instrumentation. Charging power is fed to the ship onboard receiving switchboard via the cable management system.

Electrical System Grounding Philosophy: The manner in which the electrical system is grounded (e.g. ungrounded system, solid neutral grounding system, low impedance neutral grounding system, or high impedance neutral grounding system), including the ground potential transformer method. Circuit protection strategy is built around the selected method of system grounding in terms of over voltage prevention, over current prevention or continued operability under single phase grounded condition.

Energy Management System (EMS): A computerized control system regulating the energy consumption of a vessel by controlling and monitoring the operation of energy storage systems, electrical loads and the production of power. The system can monitor environmental and system loads and adjust operations to optimize energy usage and respond to demand conditions. For the purpose of these Rules, the EMS can also provide similar functionalities as a PMS.

Energy Storage System (ESS): A system composed of an energy storage transformation device, a converter (if necessary), controls, and ancillary components and equipment. It is capable of delivering/capturing electrical energy to/from a load at the required voltage and rate (power), and can accommodate the load rate of change of power.

Energy Transformation Device (ETD): A device that converts energy from one form to another. The source energy may be renewable or stored. The transformation may be unidirectional or bidirectional. A fuel cell is a type of ETD.

High Voltage Shore Connection (HVSC) Installation: Those onboard systems that are designed to accept high voltage shore power, typically involving incoming power receptacles, shore connection switchboard, step-down transformer or isolation transformer, fixed high voltage power cables, incoming switchboard, and associated instrumentation. An HVSC is often referred to as Cold Ironing or Alternative Marine Power.

High Voltage (HV): For the purpose of these Rules, a system with nominal voltage between 1 kV AC and 15 kV AC.

Neutral Ground Resistor (NGR): A resistor used in grounding systems to limit maximum ground fault currents to safe levels so that all the electrical equipment in a power system is protected.

Onboard Receiving Switchboard: The receiving switchboard is normally a part of the ship's main switchboard to which the power from the SPM is fed from the SPM's connection switchboard.

Power Management System (PMS): A complete switchboard and generator control system which controls and monitors power generation and distribution including multiple switchboards and ring bus systems. The PMS onboard a vessel is responsible for functions such as load sharing among different power sources, load shedding, and starting reserve generators when power is insufficient. For the purpose of these Rules, the PMS can also have similar functionalities as an EMS.

SPM Connection Switchboard: Where no cable management system is provided on board, the onboard receiving switchboard is normally the ship's interface point with the SPM power system. HV SPM power is *connected to this SPM connection switchboard by means of a HV plug and socket arrangement. The SPM connection switchboard is provided with an onboard receiving switchboard power connection circuit breaker with circuit protection devices.*

9 Abbreviations and Acronyms

BMS Battery Management System

EMC Electromagnetic Compatibility

EMS Energy Management System

ESS Energy Storage System

ETD Energy Transformation Device

HV High Voltage

HVSC High Voltage Shore Connection

NGR Neutral Ground Resistor

PEC Power Electronic Converter

SPM Single Point Mooring

THD Total Harmonic Distortion

11 Plans and Data to be Submitted

i) One-line diagram showing the Single Point Mooring elements for the charging connections

ii) Descriptions of electrical system grounding philosophy

iii) Descriptions of instrumentation, monitoring and alarms

iv) Short-circuit current calculations for each offshore charging facility

v) Protection device coordination study for each offshore charging facility

vi) Arc-flash hazard analyses

vii) Total harmonic distortion calculation

viii) Load analysis

ix) Capacity rating of charging connection installation, including maximum design short-circuit level

x) Details of SPM connection switchboard, including outline view, internal arrangement, dimensions, IP rating, circuit breaker rating, socket rating and schematics

xi) Details of transformer including kVA rating, impedance information and construction details

xii) Cable specifications

xiii) Details of portions of the SPM facility's main switchboard associated with the charging connections interface

xiv) Descriptions of safety interlocks

xv) Details of the cable management system, if installed

xvi) Equipment locations, including the routing of cables

xvii) Operation manual

xviii) Basis of Design Document required by 4-5-2/3

13 Alternative Arrangements

Alternative arrangements that differ from the specific requirements in this Chapter and that provide an equivalent level of safety are to be submitted to ABS for technical assessment and will be considered on a case by case basis.

15 References

ABS *Rules for Building and Classing Marine Vessels* (*Marine Vessel Rules*)

ABS *Rules for Building and Classing Mobile Offshore Unit*s (*MOU Rules*)

ABS *Rules for Building and Classing Facilities on Offshore Installation* (*Facilities Rules*)

ABS *Requirements for Fuel Cell Power Systems for Marine and Offshore Applications*

ABS *Requirements for Direct Current (DC) Power Distribution Systems for Marine and Offshore Applications*

ABS *Requirements for Use of Lithium-ion Batteries in the Marine and Offshore Industries (Lithium-ion Battery Requirements)*

ABS *Requirements for Hybrid Electric Power Systems For Marine and Offshore Applications*

ABS *Requirements for Use of Supercapacitors in the Marine and Offshore Industries (Supercapacitor Requirements)*

ABS *Guidance Notes on Risk Assessment Applications for the Marine and Offshore Industries*

ABS *Guidance Notes on Failure Mode and Effects Analysis (FMEA) for Classification*

ABS *Guide for Dynamic Positioning Systems*

ABS *Guide for Classification And Certification Of Subsea Production Systems Equipment and Components*

ABS *Guide for Nondestructive Inspection*

ACP Recommended Practice for Design, Deployment, and Operation of Submarine Cable in the United States (OCRP5)

IEC 61851 (All series)

IEC 62196-3

PART 4

CHAPTER 5
Offshore Charging Connections

SECTION 2
System Design *(2023)*

1 Charging Modes and Functions

Where arrangements are made for the supply of charging power from the Single Point Mooring facility power supply or other external source within the single point mooring, the following requirements apply:

1.1 Connection Terminal and Cable

A charging connection terminal is to be provided on the Single Point Mooring facility for the connection of power through flexible cable from the Single Point Mooring facility power source. Fixed cables of adequate rating and length are to be permanently installed between the charging connection terminal for connection to the receiving marine or offshore asset's switchboard, which may be the main or emergency switchboard. The fixed cable is to be protected by fuses or a circuit breaker located at the connection terminal. Where fuses are used, a disconnecting means is also to be provided. Provisions are to be made to secure and support the flexible cable to avoid excessive stress on the cable terminal. Any of the following modes of connection are considered acceptable:

i) *Mode 1: AC Supply Charging*

Mode 1 connects the charging connection terminal to a marine or offshore asset through a permanently connected AC supply network, with a control pilot function that extends from the AC charging connection terminal to the marine and offshore asset. Refer to 4-5-A1/Figure 1 for an example of a typical Mode 1 connection.

ii) *Mode 2: DC Supply Charging*

Mode 2 connects the charging connection terminal to a marine or offshore asset through a permanently connected DC supply network, with a control pilot function that extends from the DC charging connection terminal to the marine and offshore asset. Refer to 4-5-A1/Figure 2 for an example of a typical Mode 2 connection.

3 Energy Storage System (ESS) Capacity

The energy storage system (ESS), when provided on the SPM, is to be designed to provide sufficient electric power for the SPM's operation for a predefined period. The ESS design capacity based on the SPM's intended operations and the specified time duration are to be included in the basis of design (BoD) documentation.

5 Supply Voltage Level Requirement

i) *Low Voltage.* The nominal incoming voltage supply to the charging station is not to exceed 1000 AC or 1500 DC.

ii) *High Voltage.* The nominal incoming voltage supply to the charging station is not to exceed 15 kV AC.

7 Control and Instrumentation

A means of transmitting information to the receiving vessel is to be provided at the SPM charging station. The information transmitted from the charging station is to include, as a minimum, the following:

i) Location of the SPM

ii) Rating capability (e.g., kW, MW, Amp-H charging capability)

iii) Amp-H charging capability

iv) The rated current of the cable assembly

7.1 General

The following control pilot functions are to be provided at the charging station:

i) Continuous continuity checking of the protective conductor according to 4-5-2/7.7

ii) Verification that the charging station is properly connected to the marine or offshore asset according to 4-5-2/7.7

iii) Energization of the power supply to the marine or offshore asset

iv) De-Energization of the power supply to the marine or offshore asset

v) Maximum allowable current according to section 4-5-2/9.9

7.3 Grounding

i) *Equipotential Bonding*

Equipotential bonding between the ship and the single point mooring facility is to be provided. An interlock is provided such that the charging station connection cannot be established until the equipotential bonding has been established. The bonding cable may be integrated into the charging station power cable. If the equipotential bonding cable is intended to carry the shipboard ground fault current, the cable size is to be sufficient to carry the design maximum ground fault current.

ii) *Equipotential Bonding Safety Interlock*

An interlock arrangement is to be provided such that the loss of equipotential bonding is to result in the disconnection of the charging station power. See 4-5-2/Table 1.

iii) *System Grounding Compatibility*

Arrangements are to be provided so that when the charging connection is established, the resulting system grounding on board is to be compatible with the receiving vessel's original electrical system grounding philosophy (for instance, the shipboard ungrounded power distribution system is to remain ungrounded, or the shipboard high impedance grounding system is to remain high impedance grounded within the design grounding impedance values). Ground fault detection and protection is to remain available after the charging connection has been established. Examples are shown in 4-5-2/Figures 1 through 4.

iv) *Voltage Rating*

The voltage rating of electrical equipment insulation materials is to be appropriate to the system grounding method, taking into consideration the fact that the insulation material will be subjected to √3 times higher voltage under single phase ground fault condition.

FIGURE 1
Examples for Ungrounded LV Ship's System

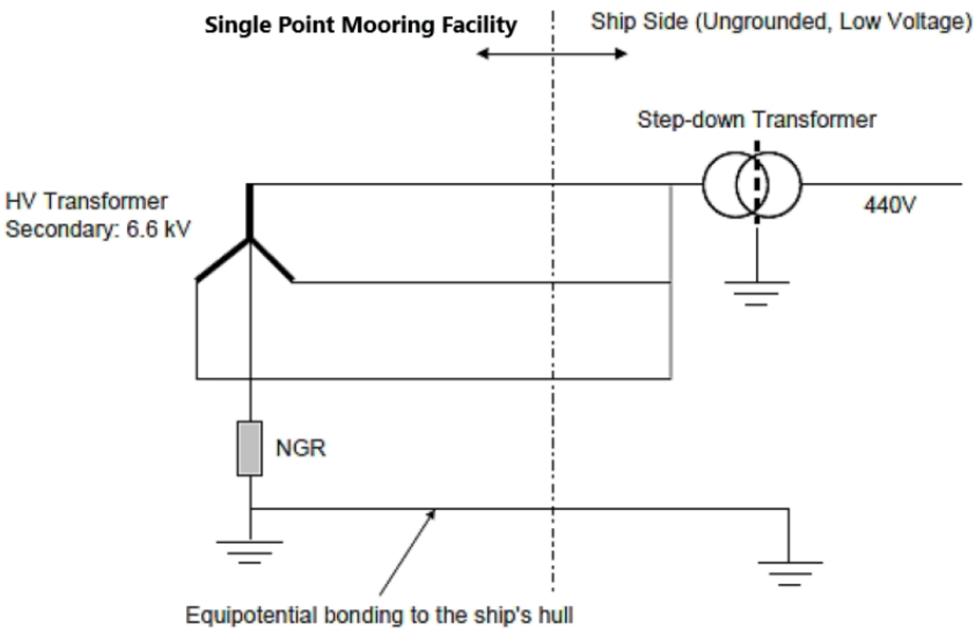


FIGURE 2
Examples for Ungrounded HV Ship's System
(where NGR Value is Compatible with the Ship's Design Ground Current Range, Otherwise 1:1 Isolation Transformer may be Required)

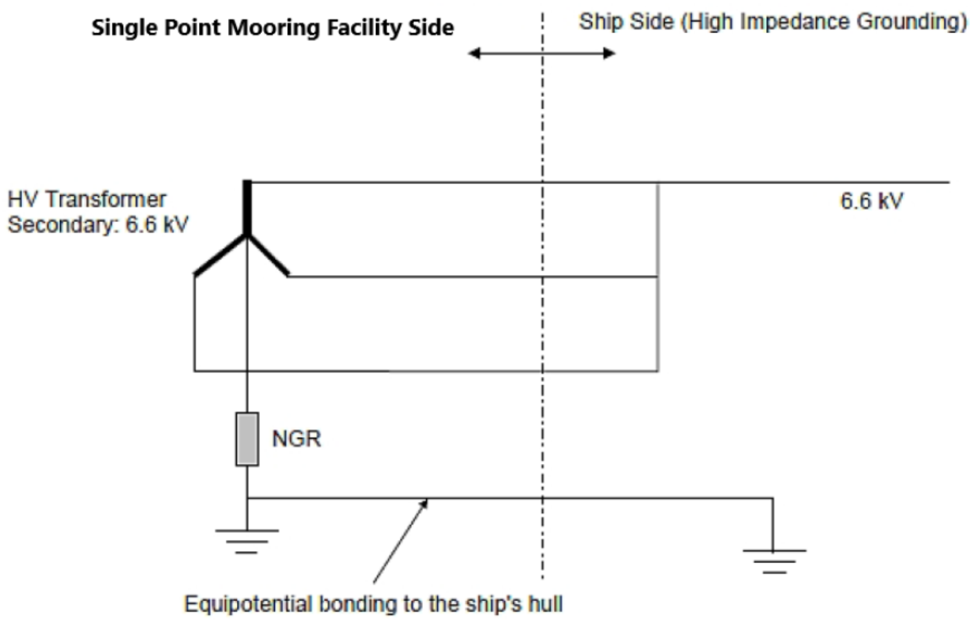


FIGURE 3
Examples for Ungrounded Ship's System (e.g., Oil Carriers and Gas Carriers)

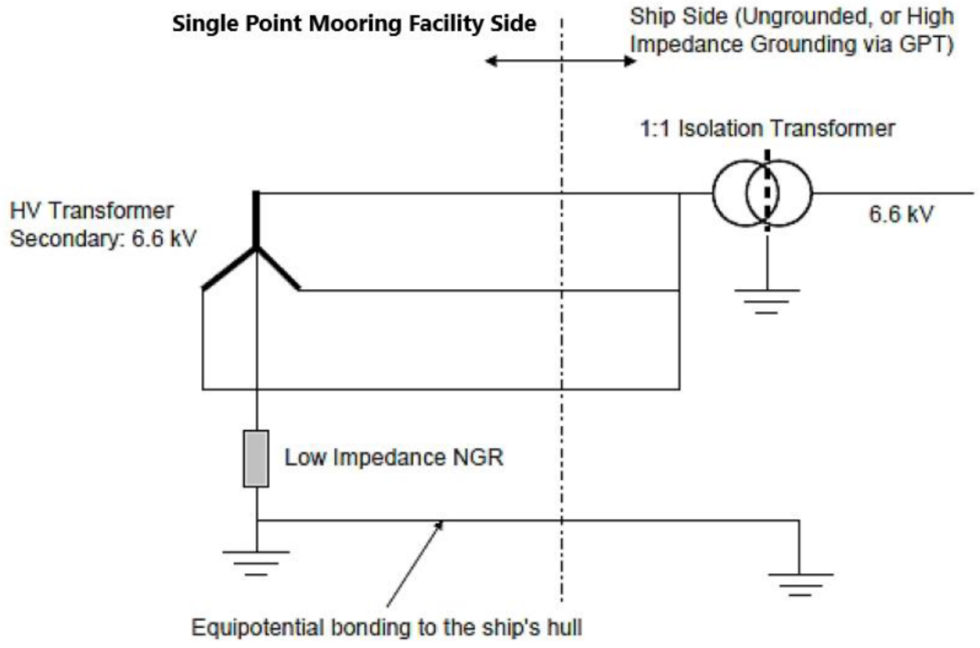
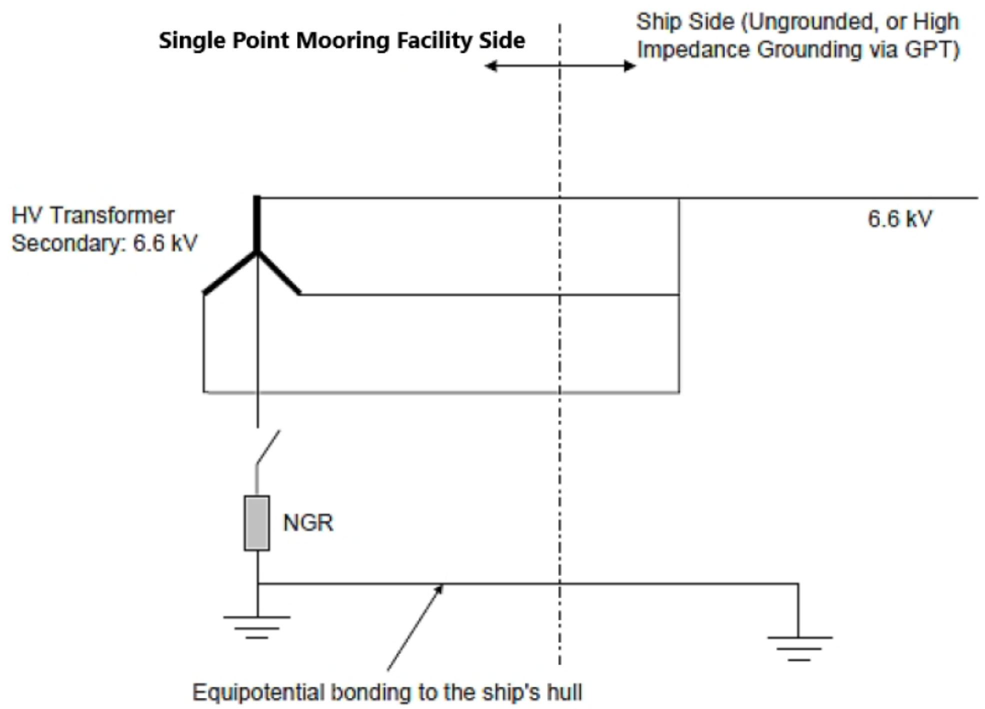


FIGURE 4
Examples for Ungrounded Ship's System where Shoreside Option for Ungrounded Neutral is Available (e.g., Oil Carriers and Gas Carriers)



7.5 Energy Mangement System (EMS)

The EMS is to have several functionalities to supply, schedule, optimize (minimize/maximize) and interact with different energy transformation devices and/or energy storage management systems.

The energy management system may consist of monitor(s), communications equipment, controller(s), timer(s), or other device(s) that monitor and /or control electrical loads, power production and or storage sources.

Automatic control systems are to be designed to provide safe and effective operation in accordance with Section 4-9-2 of the *Marine Vessel Rules*.

The following functions are to be provided as part of the EMS:

i) Control and monitoring Energy Storage System (ESS)

ii) Monitoring Power System supply

iii) Supervision of load sharing between ESS and the marine or offshore assets power supply

iv) Maintenance of energy supply to the essential service loads and propulsion loads, as applicable

v) Alarm in case of failure of the energy management system

vi) Upon failure of the power management system, the available electrical power is to remain unchanged. Failure of the power management system is to be alarmed

7.7 Control, Monitoring, Alarm and Safety Systems

i) Control, monitoring, and safety systems are to have self-monitoring abilities. In the event of failure to the systems or power supply, an alarm is to be activated.

ii) The safety system is to be designed so as to limit the consequence of failures. It is to be constructed on a fail-safe principle such that any failure of the system's components will not cause unsafe operation of the system or the equipment.

iii) Sensors for safety functions are to be independent from sensors used for other purposes (e.g., for alarm system).

iv) Sensors are to be designed to withstand the local environment. The enclosure of the sensor and the cable entry are to be appropriate to the space in which they are located. Any malfunctioning in the sensors is to be detectable.

v) The Charging station is to disconnect the supply to the vessel or offshore asset in case of:

a) Loss of electrical continuity of the protective conductor (i.e., open control pilot circuit) within 100ms.

b) Incapacity to verify the continuity of the protective conductor (e.g., short circuit between pilot wire and protective conductor) within 3 seconds

vi) The safety system is to be designed such that failure of any of the system’s components will not cause unsafe operation of the system or the equipment.

vii) A list of monitored parameters, as a minimum, for alarm and shutdown is provided in 4-5-2/Table 1 below.

TABLE 1
List of Alarms and Shutdown

Systems	*Monitored Parameters*		*A & D*	*Auto Shut down* (1)	*Notes* *[A = Alarm; D = Display; x = applies]*
Energy Storage System *(3)*	A1	State of Charge (SOC)– low	x		
	A2	Charging/Discharging - failure	x	x	
	A3	Current – high	x	x	
	A4	Overload	x	x	
	A5	Voltage – high and low	x	x	
	A6	Frequency – high and low (only AC systems) (5)	x	x	
	A7	Cooling or fan - failure(4)	x	x	
	A8	Emergency Stop(2)	x	x	
	A9	Loss of equipotential bonding	x	x	
	B1	Cooling medium pressure – low or, temperature – high	x		For subsystem having a cooling system.
	B2	Ventilation - failure(6)	x	x	For subsystem having a ventilation system
	B3	Transformer - failure	x	x	For subsystem having a transformer
	B4	Converter - failure	x	x	For subsystem having a converter
	B5	ESS room or space – high ambient temperature	x		
	B6	ESS (cell, module) – high temperature	x	x	Alternative arrangements can be accepted on risk assessment basis
Energy Management System (EMS)	D1	Failure System	x		See 3/Table 3 of ABS *Requirements for Hybrid Electric Power Systems for Marine and Offshore Applications*
Battery Management System (BMS)	D2	Failure System	x		See 3/Table 3 of ABS *Requirements for Hybrid Electric Power Systems for Marine and Offshore Applications*, if fitted
Power Management System (PMS)	D5	Failure System	x		See 4-8-5/5.3.3 of *Marine Vessel Rules*, *DPS Guide*

Notes:

1. An arrangement is made for starting a standby generator (or energy source) and connecting it to the switchboard, in accordance with 4-8-2/3.11 of the *Marine Vessel Rules* to prevent loss of power.
2. The emergency stop circuit is to be hard-wired and independent of any control system signal.
3. Grouped alarms may be allowed.
4. Cooling/Fan failure related to the ESS.
5. The high and low frequency trip settings are to be defined and applied in accordance with the designer's and manufacturer's instructions/recommendations.
6. Ventilation failure related to the space.

9 Power Distribution System

9.1 Power Quality

Electrical power quality of the charging station is to be maintained within the requirements of this section in addition to the requirements as specified in Part 4, Chapter 8 of the *Marine Vessel Rules*, specifically:

- 4-8-2/7.21 – Harmonics
- 4-8-3/1.9 – Voltage/Frequency Variations

Where power quality operating characteristics are outside of the above limits, the electric equipment connected to the power system is to be verified as being capable of operating in the expanded power quality envelope without damage. This is typically found during HEPS integration modeling and simulation process prior to system/equipment installation, in this regard results from this process is expected to be submitted to ABS for review.

For Direct Current (DC) Power Distribution Systems, see the ABS *Requirements for Direct Current (DC) Power Distribution Systems for Marine and Offshore Applications* for supplemental requirements.

9.3 Power Categorization Based on Usage

The charging station can be used to serve essential loads (including emergency loads), during charging in accordance with the *Marine Vessel Rules* and the *MOU Rules*.

9.5 Power Flow

Where the charging station is fitted with bidirectional power flow capability, means to confirm unidirectional flow from the charging station to the marine or offshore asset are to be provided.

9.7 Communication – Availability of Charging Capability

i) For DC charging, a means of establishing digital communication between the DC charging station and the marine or offshore asset that validates the DC energy transfer is to be established. The DC supply to the marine or offshore asset is not to be connected until such complete validation from the vehicle is achieved.

ii) Means to notify approaching assets that the charging station has sufficient charging capability is to be provided.

9.9 Maximum Allowable Current

A means is to be provided to inform the receiving vessel of the value of the maximum current it is allowed to draw. The value of the maximum current permitted is to be transmitted and is not to exceed any of the following:

a) The rated output current of the receiving vessel's supply equipment *b)* The rated current of the cable assembly

The transmitted value may change, without exceeding the maximum allowed current, to adapt to power limitations, (e.g,. for load management).

The receiving vessel's supply equipment may interrupt the energy supply if the current drawn exceeds the transmitted value.

PART 4

CHAPTER 5
Offshore Charging Connections

SECTION 3
Installation Arrangements *(2023)*

1 Circuit Protection

i) *Short Circuit.* Short circuit analysis is to be provided in accordance with the applicable sections of the *MOU Rules*.

ii) *Arc Flash.* An Arc Flash analysis is to be provided in accordance with the applicable sections of the *MOU Rules*.

iii) *Overload Protection.* Overload protection is to be provided in accordance with the applicable sections of the *MOU Rules.*

iv) *Total Harmonic Distortion.* See section 4-8-2/7.21 of the *Marine Vessel Rules*.

3 Cable Construction

For requirements covering cable installation in the charging station, see 4-3-3/5 of the *MOU Rules.*

i) *Weight Consideration*

Consideration is to be given to the weight of the cables installed on the Single Point Mooring facility and its effects on the receiving vessel's stability. See section 3-3-1 of this Rule.

ii) *Protection from Electric Shock*

See 4-3-3/7.9 of the *MOU Rules*.

iii) *Termination*

The charging cable's plug and/or socket is to be of a watertight construction with a degree of protection of at least IP 56. Bolted and other types of cable terminals are acceptable provided they are of watertight construction with a degree of protection of at least IP 56.

5 Equipment

In addition to the specific requirements in this Section, the following references are also to be followed:

i) Electrical equipment is to be designed, constructed and tested to a national, international or other recognized standard and in accordance with the applicable requirements of Part 4, Chapter 8 of the *Marine Vessel Rules* or applicable requirements of Part 4, Chapter 3 of the *MOU Rules*.

ii) Computer-based systems used for control, monitoring, and safety systems are to comply with the applicable provisions of Section 4-9-3 of the *Marine Vessel Rules*.

iii) ABS may consider other industry standards and practices for electrical equipment, on a case-by case basis, with justifications through novel features and/or comparative analyses to be provided to demonstrate equivalent level of safety to the recognized standards.

5.1 Transformers and Converters

Transformers and converters used in the charging station are to be designed, constructed, and tested as follows:

i) *Transformers*

Transformers are to be designed, constructed, and tested in accordance with 4-8-2/3.7, 4-8-3/7 and 4-8-4/3.3.3, 4-8-5/3 of the *Marine Vessel Rules* as applicable.

ii) *Power Electronic Converters*

Power electronic converters are typically considered "two port" devices capable of providing unidirectional or bidirectional conversions with independent control of the input/output frequency and input/output voltage ratio. A transformer may be included with the PEC.

Converters are to be designed, constructed, and tested in accordance with 4-8-2/3.7, 4-8-3/5.9, 4-8-3/8, and 4-8-5/3.7.5 of the *Marine Vessel Rules* as applicable.

iii) *Lightning Protection*

Equipment and structures are to be protected against lightning damage in accordance with NFPA 780 or another recognized standard.

7 Marking and Instructions

Single Point Mooring facilities fitted with charging stations are to be readily identifiable with suitable marking. The marking is to include, as a minimum, the charging voltage(s) available and the charging power capacity.

9 Emergency Disconnect

An emergency disconnect system is to be provided and is to have means to activate in an emergency or fault scenario while a receiving facility is being charged.

11 Testing and Verification

i) Where required by these Rules and Sections 4-8-3, 4-8-4, and 4-9-10 of the *Marine Vessel Rules*, equipment is to be inspected by, tested in the presence of and certified by the Surveyor, preferably at the manufacturer's plant. Such equipment includes switchboard and distribution board, power electronic converters (for sources and loads connection and protection), PMS and control related equipment, protective devices (circuit breakers, switches, and fuses), bus duct, and cables as applicable.

ii) Voltage tolerance testing of the system and the components is to be conducted to demonstrate the equipment capability of operating under the various loads specified by the system designer.

iii) Factory Acceptance Test (FAT) procedure is to include, but is not limited to:

a) Visual inspection (e.g., exterior, cooling system pipes and hoses, converter, bus ducts/ cables, earth insulation, protection equipment, connections, etc.)

b) Functional test

c) Software Test

PART 4

CHAPTER 5

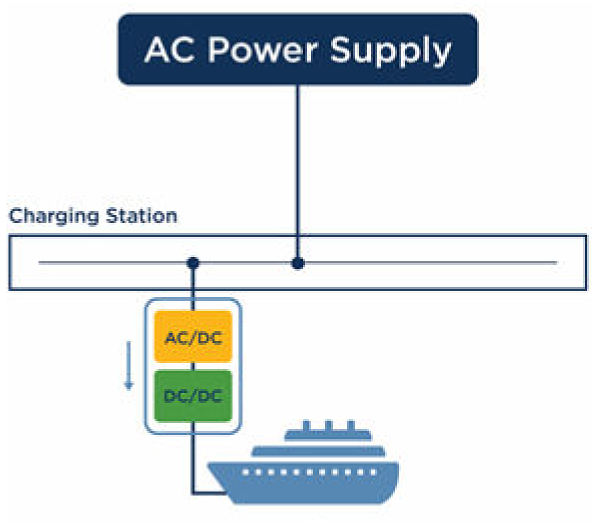
Offshore Charging Connections

APPENDIX 1

Commentary on Charging Stations

1 AC-Connected System

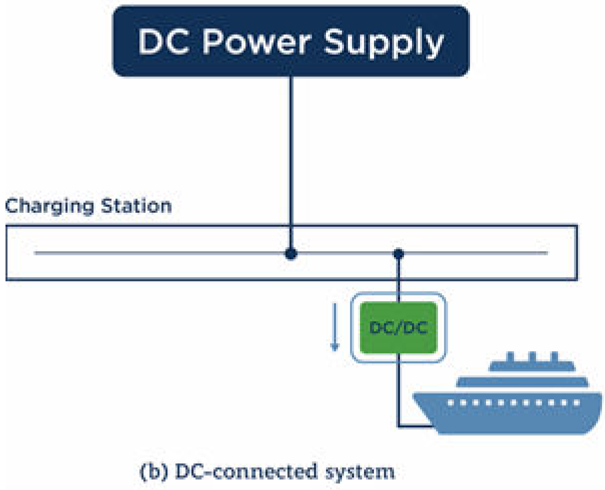
FIGURE 1



(a) AC-connected system

2 DC-Connected Sytem

FIGURE 2



PART 5

Testing and Surveys

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PART 5

CHAPTER 1
Testing During Construction

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PART 5

CHAPTER 1
Testing During Construction

SECTION 1
Requirements for Testing During Construction

1 Survey of Buoy Structures, Buoyancy Elements, PLEM Structures, and other Structures *(2022)*

1.1 General

Paragraphs 5-1-1/1-6 detail the requirements for surveys at the manufacturer of the buoy, buoyancy elements, PLEM strcutures and other structures not included in 5-1-1/11.3 TABLE 2.

All items of the buoy hull structure and associated outfitting are to be surveyed during construction, outfitting and testing.

Welding and fabrication of structural components are to be in accordance with Sections 2-4-1 and 2-4-3 of the ABS *Rules for Materials and Welding (Part 2)*, as applicable.

The Quality Control Program for the construction of a unit is to include the following items, as appropriate:

i) Material Quality, Suitability, and Traceability

ii) Welder Performance Qualification and associated Records

iii) Welding Procedure Specifications and Welding Procedure Qualification Records

iv) Preparation for welding including; forming, edge preparation, fit-up, alignment, cleanliness, and tack welds

v) Inspection of production welding including: environmental conditions, welding sequence, preheat, post-heat, back gouging, fairing, soundness of welds, and necessary repair procedure

vi) Nondestructive Testing (NDT)

vii) Corrosion Control Systems

viii) Compartment testing

Where structure is assembled in blocks or modules, the Surveyor is to inspect the fit-up, piping and electrical connections, and to witness the required tests on the completed assembly in accordance with the quality control program, and in accordance with the approved plans and Rule/Guide requirements. The progress and suitability of structural fit-up and joining of constructed/fabricated blocks/modules are to be to the satisfaction of the attending Surveyor. All erection joints of hull structure are to be visually examined, proven tight, and the extent of Nondestructive Testing (NDT) carried out is to be to the satisfaction of the attending Surveyor.

2 Materials *(2022)*

Materials for structural applications are to be certified in accordance with Section 2-1-1. The builder is to maintain a system of material traceability to the satisfaction of the attending Surveyor. Data showing place of origin and results of tests for materials shall be retained and are to be readily available to the attending Surveyor upon request.

When forming changes base plate properties beyond acceptable limits, appropriate heat treatments are to be carried out to reestablish required properties. Unless approved otherwise, the acceptable limits of the reestablished properties should meet the minimums specified for the original material before forming. Formed members with the forming dimensional tolerances specified by the design are to be examined.

3 Welding *(2022)*

3.1 Qualification of Welding Procedures and Welders

Welders, welding specifications and associated welding procedures are to be qualified in presence of and to the satisfaction of the attending Surveyor. Welders and welding techniques are to be qualified in accordance with Section 2-4-3 of the ABS *Rules for Materials and Welding (Part 2).*

For qualification of welders and welding procedures, only the applicable ABS Rules are to be used. Other alternative standards will be subject to special consideration and require prior review and approval by ABS.

3.2 Production Welding

Production welding and forming of steel is to be to the satisfaction of the Surveyor and in accordance with Section 2-4-1 of the ABS *Rules for Materials and Welding (Part 2)*. 7-1-2/9 of the *Rules for Building and Classing Mobile Offshore Units (MOU Rules)* is to be used as a reference for thick materials, fillet welds and visual examiantion details

4 Nondestructive Examination *(2022)*

Prior to commencement of any NDT, an NDT plan is to be submitted to the attending Surveyor for review and acceptance, and is to conform to 2-4-1/5.17 of the ABS *Rules for Materials and Welding (Part 2)*. NDT is to be carried out in accordance with the ABS *Guide for Nondestructive Inspection (NDI Guide)*.

All NDT procedures are to be reviewed and accepted by the Surveyor before commencement of NDT. Radiographic Testing (RT), Ultrasonic Testing (UT), Magnetic Particle Inspection (MPI), Penetrant Testing (PT), Eddy Current (EC) or Alternating Current Field Measurement (ACFM) is to be carried out to the satisfaction of the Surveyor. With the exception of RT, the Surveyor may require to witness the NDT carried out by a qualified technician.

4.1 Type and Extent of NDT

The percentage of weld joint to be subjected to NDT and type of NDT carried out (e.g., Radiographic Testing (RT), Ultrasonic Testing (UT), Magnetic Particle Inspection (MPI), Penetrant Testing (PT), Eddy Current (EC) or Alternating Current Field Measurement (ACFM)) will depend on the design of the unit and is to be proposed by the designer or manufacturer and reviewed by the Surveyor.

Minimum NDT is to include 10% volumetric and 20% surface examination of joints of less than 19 mm and 50% volumetric and 100% surface NDE of joints 19 mm and over.

Additional NDT may be requested by the Surveyor if the quality of fabrication or welds is not in accordance with these Rules and applicable Standards.

NDT personnel, records, and acceptance standards are to be in accordance with the *NDI Guide*.

5 Tank, Bulkhead and Fittings/Tightness Testing *(2022)*

5.1 General

After all hatches and watertight accesses are installed, penetrations including pipe connections are fitted, all tanks and watertight bulkheads or flats are to be tested and proven tight. Refer to 5-1-1/11.3 TABLE 1 for specific test requirements. Close visual examination combined with NDT may be accepted in certain areas where specialty approved, as an alternative to hose testing.

5.3 Tank Testing *(2022)*

A tank testing procedure is to be submitted to the Surveyor for acceptance. 5-1-1/11.3 TABLE 1 lists the types of tests which normally apply.

Compartments and spaces which are designed to be watertight, gas-tight or fire-tight are to be tested in presence of a Surveyor by a procedure aaccepted by the attending Surveyor. Any access doors, hatches, manholes or closures of such compartments and spaces as well as any type of pipe or electrical penetration pieces through such boundaries are to be completed and tested in similar manner to the satisfaction of the attending Surveyor.

Details of testing methods are to be in accordance with 7-1-2/23.9 through 7-1-2/23.27 of the *MOU Rules*.

Tank testing is to be carried out to the satisfaction of the attending Surveyor, and additional or alternative testing may be required at the Surveyor's discretion.

The following two types of testing may be required:

i) Structural Testing is a test to verify the structural adequacy of tank construction. This may be hydrostatic or hydropneumatic testing in accordance with 5-1-1/1.5 .

ii) Leak Testing is a test to verify the tightness of a boundary. Unless specific testing is indicated, this may be hydrostatic/hydropneumatic testing or air testing as specified in 5-1-1/11.3 TABLE 1. A hose test may be considered an acceptable form of leak test for certain boundaries, as specified in 5-1-1/11.3 TABLE 1.

Where permitted in 5-1-1/11.3 TABLE 1, air testing or combined air hydrostatic testing may be accepted by the Surveyor.

5.3.1 Testing of Watertight Boundaries and Doors *(2022)*

After all hatches and watertight doors are installed, penetrations including pipe connections are fitted, and before cement work, ceiling or special coatings are applied, all watertight bulkheads and flats, as indicated on the watertight compartmentation plan are to be tested and proven tight. Shop primer may be applied prior to testing.

5.5 Hydrostatic Testing *(2022)*

Tank designs and configurations of a non-conventional nature may be required to be hydrostatically tested. Tanks or units which will be submitted in service and designed to withstand external hydrostatic loading will require hydrostatic testing unless otherwise approved.

When hydrostatic testing applies, tanks are to be tested with a head of water to the overflow or to the highest point to which the contents may rise under service conditions, whichever is higher. Tests may be carried out before or after the buoy is launched. Special coatings may be applied before hydrostatic testing provided all welded joint and penetrations are visually examined to the satisfaction of the Surveyor before special coating is applied.

6 Tank Test for Structural Adequacy *(2022)*

In order to demonstrate the structural adequacy, representative hydrostatic testing of tanks or buoyant structures may be required in connection with the approval of the design. In general this would include at least one tank of each type of new or unusual buoy design. Tank testing for structural adequacy is to be carried out to the satisfaction of the attending Surveyor with input from the designer and ABS Engineering for submerged structures.

7 Mooring System Equipment Fabrication and Installation Tests *(2022)*

Each. anchor leg is to be examined together with attachments and securing devices provided for connection to the buoy. Proper fitting of components, connectors and securing devices is to be demonstrated and certification for equipment presented to the Surveyor.

7.1 Anchor Legs *(1 July 2022)*

Anchor legs consist of mooring chains, ropes, wires, connectors such as shackles, connecting links, and other fittings.

- Chain and accessories are to be in accordance with the ABS *Requirements for the Certification of Offshore Mooring Chain* and tested in the presence of the attending Surveyor.
- Synthetic mooring lines are to be in accordance with the ABS *Guidance Notes on the Application of Fiber Rope for Offshore Mooring* or API RP 2SM
- Wire ropes are to be in accordance with API Specification 9A

Each mooring leg is to be pull tested upon installation in accordance with an approved procedure in the presence of a Surveyor. The pull test is to be in accordance with 3-4-1/3.

7.3 Mooring Equipment between Vessel and SPM *(1 July 2022)*

Mooring between vessel and SPM, which may include either flexible hawsers or rigid mooring structure (rigid arms and yokes) are to be examined. The hawsers are to be examined and verified for size, materials, specifications, and type of the approved design. Proper fitting and securing of all components is to be verified. NDT of the rigid mooring structure to the SPM buoy is to be carried out to the satisfaction of the attending Surveyor.

- Steel components such as chafe chains, shackles, etc, that are installed on the hawser line between the vessel and SPM, are to be certified in accordance with the ABS *Requirements for Certification of Offshore Mooring Chain*.
- Synthetic mooring lines are to be in accordance with the ABS *Guidance Notes on the Application of Fiber Rope for Offshore Mooring* or API RP 2SM
- Wire ropes are to be in accordance with API Specification 9A

Other recognized standards may be specially considered upon request.

7.5 Tower Mooring

A tower mooring designed as a fixed structure, usually made of tubular members, may be used in place of buoyant structure and mooring lines. The testing of such mooring structure is to be in accordance with the *Offshore Installation Rules*.

7.7 Piles and Anchors *(2022)*

Where piles or gravity boxes are used as anchoring system of an SPM system, NDT is to be performed in accordance with the *Offshore Installation Rules*. Piles are to be fabricated in accordance with ABS *Rules for Materials and Welding (Part 2)* and the ABS *Guide for Nondestructive Inspection* to a standard acceptable to the Surveyor.

Surveys regarding the manufacturing and testing of anchors are to be in accordance with Section 2-2-1 of the ABS *Rules for Materials and Welding (Part 2)*.

8 Cargo Transfer System

The entire cargo transfer system including hoses/flexible risers, swivels, and valves is to be hydrostatically tested after installation to the design pressure. Refer to 5-1-1/11 and 5-1-1/11.3 TABLE 2 for specific requirements.

9 Control and Safety System

All control and safety equipment is to be examined and proven to be adequate for the intended service. Refer to 5-1-1/11.3 TABLE 2 for specific requirements.

10 Hoses/Flexible Risers *(2022)*

10.1 Hose/Flexible Riser Testing

Refer to 4-1-2/11 of these Rules.

10.2 Buoyancy Tank Pressure Test

Any buoyancy tank intended to be pressurized to equalize the external pressure will be hydrostatically tested to a pressure 1.5 times the maximum allowable working pressure.

11 Surveys at the Vendor Manufacturer's Facility *(2022)*

11.1 General *(2022)*

Survey requirements for equipment and component units at the plant of manufacturer are summarized in 5-1-1/ TABLE 2.

Each vendor is required to have an effective quality system, which is to be verified by the attending Surveyor prior to the start of fabrication. Additionally, vendors are encouraged to obtain ABS Quality System accreditation through the ABS Quality Assurance scheme.

11.2 Pre-Fabrication Meeting *(2022)*

When the Surveyor's attendance at the manufacturer's plant and at the assembly site is required by the applicable ABS Rules, the manufactured/assembled system and/or equipment will be verified for satisfactory compliance with the codes and/or standards, and the requirements of this Rule.

It is recommended pre-fabrication or kick-off meeting between the manufacturer/fabricator and ABS-designated Surveyor(s) is scheduled in order to, but not limited to:

i) Confirm and/or establish the main point of contacts (PoCs) for the manufacturer and ABS

ii) Review the project quality plans

iii) Review project manufaturing and delivery schedules

iv) Review and confirm project "hold points"

v) Review any proposed sub-contractor lists and/or qualifications *vi)* Confirm specification, drawings and/or documentation associated with the manufacturing process

11.3 ABS Survey *(2022)*

ABS Surveyor's attendance is typically for the following purposes, but not limited to:

i) Confirm that the facilities to manufacture, fabricate or repair of systems, subsystem, equipment or and/or components have and maintain an effective quality control program covering design, procurement, manufacturing and testing, as applicable, and meeting the requirements of a recognized standard applied to their products.

ii) Qualify or verify welder's qualifications to the extent deemed necessary by the attending ABS Surveyor.

iii) Qualify or verify welding procedure specifications (WPS) and corresponding weld procedure qualification records (PQR) to the extent deemed necessary by the attending ABS Surveyor

iv) Verification that materials used for the construction of equipment in 5-1-1/11.3 TABLE 2 are tested in the presence of a Surveyor in accordance with Section 2-1-1

v) Survey fit-up prior to major weldments

vi) Survey final weldments

vii) Witness, as far as deemed necessary, nondestructive examination tests of welds and to review records of nondestructive examinations

viii) Verify records of post-weld heat treatment

ix) Verify dimensions are as shown on approved drawings

x) Check dimensional tolerances and alignment of mating surfaces

xi) Witness pressure and/or proof-load testing of equipment and as a unit, as applicable and as specified in the fabrication procedures

xii) Witness final testing and functional testing of subassemblies and completed units, as specified in the fabrication procedures

xiii) Verify all purged and pressurized systems, motor controllers, consoles and instrumentation and control panels are in compliance with approved drawings

xiv) Carry out other survey activities as agreed upon during prefabrication meeting

TABLE 1
Initial Tank and Bulkheads Tightness Test Requirements

Item	*Test Method*
Tanks	Air Test or Hydro Test
Watertight Bulkheads, Flats and Boundaries	Air Test or Hydro Test
Dry Spaces	Air Test or Hydro Test
Chain Lockers	To be Filled with Water
Hawse Pipes	Hose Test
Watertight Closing Appliances	Hose Test
Oil Storage	Air Test or Hydro Test
Void Space Boundaries Required to be Watertight	Air Test or Hose Test

Note: "Hose Test" in this Table and 5-1-1/5.7 is intended to mean testing of boundaries with a stream of water from a hose provided for this purpose.

TABLE 2
Certification Details - Equipment *(1 July 2023)*

Item	*ABS Approval Tier (1)*	*Rule Reference (2)*
Piles/Anchors	5	3-4-1/9 5-1-1/5.7
Buoyancy Elements	5	3-4-1/15 3-2-2/15 5-1-1/1-6
Cargo/Product Swivel and Bearings	4/5	4-1-3/1 4-1-3/5.3
Hydraulic Swivel	4/5	4-1-3/1 4-1-3/5.3
Electrical Swivels	4/5	4-3-2/5 4-1-3/1
Swivel Driving Mechanism	2	4-1-3/1
SPM Main Bearings	4/5	4-1-3/5.1
Flexible Risers, Underbuoy Hoses	4/5	4-1-2/3 4-1-2/7
Floating Hoses	4/5	4-1-2/5 4-1-2/7
Pipeline End Manifold (PLEM)	5	3-2-2/17 4-1-4 5-1-1/1 to 6
Expansion Joints of Piping	2	4-1-4/7
Mooring Chain, Mooring Wire, Synthetic Mooring Rope and Mooring Components, Steel Components between SPM and vessel such as Chafe Chains, Shackles, etc.	5	3-4-1/9 5-1-1/5
Chain Stopper	5	3-4-1/13
Mooring Hawser	4/5	3-4-1/11 5-1-1/7
Standard Valves, Fittings, Flanges	1	4-1-4/3 4-1-4/5
Electrical Controls/Telemetry	2	1-1-4/1
Navigation Aids	2	1-1-4/1 4-4-1/1
Utility Winch	1	
Pull-in Winch for Installation of Chain or Riser(3)	1	
Pull-in Winch used for Periodic Retensioning	4/5	Requirements for Position Mooring Systems 6/11

Item	*ABS Approval Tier* [(1)]	*Rule Reference* [(2)]
Buoy Pull-in Winch	4/5	Requirements for Position Mooring Systems 6/11
Leak Recovery System	4/5	4-1-3/3
Leak Reservoir	4/5	4-1-3/3
Hydraulic Power Unit, Umbilical	1	
Pig Launcher	1	

Notes:

1 Refer to Appendix 1B-1-A3 of the ABS *Rules for Conditions of Classification - Offshore Units and Structures (Part 1B)* for details of Type Approval Tiers.

2 Rule References listed are nominal references, and not comprehensive.

3 Design Calculations may be required.

PART 5

CHAPTER 2

Surveys After Construction

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PART 5

CHAPTER 2
Surveys After Construction

SECTION 1
Conditions for Surveys After Construction

1 Damage

See 1B-1-8/1 of the ABS *Rules for Conditions of Classification – Offshore Units and Structures (Part 1B)*.

3 Notification and Availability for Survey

See 1B-1-8/3 of the ABS *Rules for Conditions of Classification – Offshore Units and Structures (Part 1B)*.

5 Annual Classification Surveys

Annual Classification Surveys are to be made within three (3) months either way of each annual anniversary date of the crediting of the previous Special Periodical Survey or original construction date.

7 Special Periodical Surveys

A Special Periodical Survey is to be completed within five (5) years after the date of build or after the crediting date of the previous Special Periodical Survey. The interval between Special Periodical Surveys may be reduced by the Committee. If a Special Periodical Survey is not completed at one time, it will be credited as of the completion date of the survey but no later than five (5) years from the date of build or from the date recorded for the previous Special Periodical Survey. If the Special Periodical Survey is completed prematurely but within three (3) months prior to the due date, the Special Periodical Survey will be credited to agree with the effective due date. Special consideration may be given to Special Periodical Survey requirements in the case of single point moorings of unusual design, in lay-up or in unusual circumstances. The Committee reserves the right to authorize extensions of Rule-required Special Periodical Surveys under extreme circumstances.

Special Periodical Surveys may be commenced at the fourth Annual Survey and be continued with a view to completion by the due date. In connection with the preparation for the Special Periodical Survey, thickness gaugings required for the Special Periodical Surveys are to be taken to the extent accessible and practical in connection with the fourth Annual Survey.

Where the Special Periodical Survey is commenced prior to the fourth annual survey, the entire survey is normally to be completed within 12 months if such work is to be credited to the Special Periodical Survey.

9 Continuous Surveys

9.1

At the request of the Owner, and upon the approval of the proposed arrangements, a system of continuous Surveys may be undertaken whereby the Special Periodical Survey requirements are carried out in regular rotation to complete all the requirements of the particular Special Periodical Survey within a five (5) year period.

If the Continuous Survey is completed beyond the five (5) year period, the completion date will be recorded to agree with the original due date of the cycle. If the Continuous Survey is completed prematurely but within three (3) months prior to the due date, the Special Periodical Survey will be credited to agree with the effective due date.

The Committee reserves the right to authorize extensions of Rule required Special Periodical Surveys under extreme circumstances. Each part (item) surveyed becomes due again for survey approximately five (5) years from the date of survey. For continuous Surveys, a suitable notation will be entered in the *Record* and the date of completion of the cycle published. If any defects are found during the survey, they are to be dealt with to the satisfaction of the Surveyor.

9.3

At a survey approximately four (4) years after each Special Continuous Survey of an SPM hull or buoy has been credited, thickness gaugings that are required for forthcoming Special Periodical Survey that are accessible are to be taken.

11 Lay-up and Reactivation

11.1

ABS is to be notified by the Owner that the SPM has been laid-up or otherwise removed from service. This status will be noted in the *Record* and any surveys falling due during lay-up may then be held in abeyance until the SPM is placed back in service. Lay-up procedures and arrangements for maintenance of conditions during lay-up may be submitted to ABS for review and verification by survey.

11.3

In the case where the SPM has been laid up for an extended period (i.e., six (6) months or more) the requirements for the surveys for reactivation are to be specially considered in this case, due regard being given to the status of the surveys at the time of the commencement of the lay-up period and the length and the conditions under which the SPM had been maintained during that period.

11.5 *(2022)*

Where the lay-up preparation and procedures have been submitted to ABS for review and survey, verified at the time of lay-up and re-verified annually by survey, consideration may be given to deducting part of all of the time in lay-up from the progression of survey intervals, or to modifying the requirements of the up-dating survey at time of reactivation.

11.7

For an SPM returning to active service regardless of whether ABS has been informed previously that the SPM has been in lay-up, a Reactivation Survey is required.

11.9 Units Laid-up Offshore *(2022)*

Units laid up offshore will be subject to special consideration and will require submittal of plans to ensure integrity of the unit while in layup. The plans will need to detail the measures required to maintain the unit on location in a safe stable condition and consider at least the following:

i) Emergency/contingency scenarios

ii) Availability of shoreside or field support

iii) Schedule of examinations to verify the unit's general condition

iv) Open class findings

v) Mooring system residual fatigue life

vi) Mooring system maintenance and examinations

vii) Sufficient control of the unit to provide for the following capabilities:

  a) Monitor the unit's stability and rectify any stability issues

  b) Monitor the unit's location and take action if an excursion occurs

  c) Periodically verify the unit's general condition

  d) Periodically verify that there is no change in tank levels

13 Incomplete Surveys

When a survey is not completed, the Surveyor is to report immediately upon the work done in order that Owners and the Committee may be advised of the parts still to be surveyed.

15 Alterations

No alterations which affect or may affect classification are to be made to the hull or machinery of a classed SPM unless plans of the proposed alterations are submitted and approved by the ABS Technical Office before the work of alterations is commenced and such work, when approved, is carried out to the satisfaction of the Surveyor. Nothing contained in this section or in the rule or regulation of any government or other administration, or the issuance of any report or certificate pursuant to this section or such a rule or regulation, is to be deemed to enlarge upon the representations expressed in Section 1B-1-1 of the ABS *Rules for Conditions of Classification – Offshore Units and Structures (Part 1B)* thereof and the issuance and use of any such reports or certificates are to in all respects be governed by Section 1B-1-1 thereof.

17 Welding and Replacement of Materials

17.1 Ordinary and Higher Strength Structural Steels

Welding or other fabrication performed on structural steels is to be in accordance with the requirements of Section 3-2-3 of these Rules and Chapter 4 of the ABS *Rules for Materials and Welding (Part 2)*.

17.3 Special Materials

Welding or other fabrication performed on other steel or adjacent to such steel is to be accomplished with procedures approved for the special materials involved. Refer to Section 3-2-3 of these Rules and Chapters 3 and 4 of the ABS *Rules for Materials and Welding (Part 2)*.

17.5 Substitutions and Alterations *(2014)*

Substitutions of steel differing from that originally installed, alteration of original structural configuration, or change from mechanical fasteners to welded joints is not to be made without approval by the ABS Technical Office.

PART 5

CHAPTER 2

Surveys After Construction

SECTION 2

Drydocking Surveys or Equivalent

1 General

An examination of the underwater parts of each SPM and associated mooring hardware is to be made at intervals not exceeding five (5) years, This examination is to align with the due date of the Special Survey.

Parts to be examined include external surfaces of the SPM. Prior to examination, all mooring and anchoring attachments are to be cleaned including all openings to the sea, if any. Anchor legs including connecting hardware are to be examined over the full length from the lowest exposed point at the seabed to the connection point at the SPM.

3 Underwater Survey in Lieu of Drydocking (UWILD) *(2014)*

Underwater Survey in lieu of Drydocking (UWILD) can be accepted provided the following are satisfied.

- The underwater inspection procedures are to be submitted for review prior to execution of the UWILD.
- Divers carrying out the underwater inspection are to be suitably qualified.
- The condition of the SPM found during the UWILD is to be acceptable.

PART 5

CHAPTER 2
Surveys After Construction

SECTION 3
Annual Surveys

At each Annual Survey, the SPM is to be generally examined so far as can be seen and placed in satisfactory condition as necessary. For a fixed mooring system (e.g., tower mooring system), the surveys are to be carried out in accordance with the *Offshore Installation Rules*. For floating SPM systems, the following items are to be examined, placed in satisfactory condition and reported upon:

1 Protection of Hatches and other Openings

i) Hatchways, manholes, and scuttles

ii) Coamings including deck connection, stiffeners, and brackets

iii) Hatches fitted with mechanically operated steel covers including cover plating, stiffener, cross joints, gaskets, cleats and dogs. Exposed steel hatch covers are to be examined to confirm structural integrity and capability of maintaining weathertightness. Where significant wastage of batch covers is noted, thickness gaugings are to be carried out and renewals made as necessary. Proper operation and functioning of hatch covers and securing arrangements is to be confirmed.

iv) Ventilators, air pipes together with flame screens, scuppers and discharges serving spaces in the SPM

v) Watertight bulkheads, bulkhead penetrations, and the operation of any doors in the same

3 Other Areas *(1 July 2022)*

i) Confirmation that the approved Information Booklet and Maintenance Manual is available to the attending Surveyor. See Section 1-1-5 of these Rules.

ii) The maintenance records of the SPM system are to be reviewed and verified. Surveyor is to confirm compliance with the approved Information Booklet and Mainetenace Manual. Review of maintenance records for:

- Swivels
- Main bearing
- Mooring system
- Corrosion protection system
- Hawsers
- Hoses and flexible piping

- Pressure testing
- PLEM
- Product valves
- Product or Cargo Risers

iii) Protection of personnel: guard rails, lifelines, and access ladderways.

iv) Verification of loading guidance and stability data as applicable.

v) Verification that no alterations have been made to the SPM which affect the classification, including verification of mooring chain tensions

vi) Anchoring and mooring equipment

vii) Main bearing

viii) Confirmation that electrical equipment in hazardous locations has been properly maintained

ix) Product lines, swivels, flex joints, expansion joints and seals

x) Confirmation that there are no potential sources of ignition in or near the cargo area and that access ladders are in good condition

xi) Cargo equipment and piping apparatus including supports, gland seals, remote control and shutdown devices

xii) Bilge pumping system

xiii) Ventilation system including ducting, dampers and screens

xiv) Verification that cargo discharge pressure gauges and level indicator systems are operational

xv) Structural areas of the SPM hull or buoy particularly susceptible to corrosion, including spaces used for saltwater ballast, as accessible. Thickness gaugings may be required.

xvi) Lights, navigational aids, etc., if applicable

PART 5

CHAPTER 2
Surveys After Construction

SECTION 4
Special Periodical Surveys *(2022)*

Special Survey No. 1 of the SPM hull or buoy is to include compliance with the foregoing Annual Survey and Drydocking Survey requirements and in addition, the following requirements as listed below are to be carried out as applicable, the parts examined, placed in satisfactory condition, and reported upon.

1 Structure

1.1 SPM Buoy or Platform Structure *(2022)*

The SPM buoy or platform structure including bracing members, tanks, watertight bulkheads and decks, cofferdams, void spaces, sponsons, chain lockers, machinery spaces, and all other internal spaces are to be examined externally and internally for damage, fractures, or excessive wastage. Thickness gauging of plating and framing may be required where wastage is evident or suspected.

Suspect areas may be required to be tested for tightness, non-destructive tested or thickness gauged. Tanks and other normally closed compartments filled with foam or corrosion inhibitors, and tanks used only for lube oil, light fuel oil, diesel oil, or other noncorrosive products may be waived provided that upon a general examination, the Surveyor considers their condition to be satisfactory. External thickness gaugings may be required to confirm corrosion control.

SPM main bearing and other major load carrying bearings, cargo swivel, bolting and connections are to be examined, weardown and grease records reviewed, and bearing proven to move freely.

1.3 Mooring Components

Mooring components including, chain stoppers, hawser padeyes, etc., are to be examined.

1.5 Foundations and Supporting Structure

Foundations and supporting headers, brackets and stiffeners from cargo transfer related apparatus, where attached to hull or deck structure are to be examined.

1.7 Underwater Parts *(2022)*

Survey of parts of the SPM which are underwater and inaccessible to the Surveyor may be accepted on the basis of an examination by a qualified diver using 2-way audio and visual communication or using a remotely operated vehicle. In either case, the survey is to be carried out in the presence of the Surveyor in accordance with an accepted procedure.

Survey shall include the underwater portions of the buoy, underbuoy hoses or risers and PLEM when part of Class. Any scour identified around PLEM or foundation shall be investigated, documented, and referred to ABS Engineering, and remedial actions applied as necessary.

1.8 Corrosion Protection *(2022)*

Protective systems are to be verified to be effective, through cathodic protection readings of buoy, platform structure and PLEM when anodes are missing, eroded, found ineffective or if wastage is evident.

1.9 Thickness Gaugings *(2022)*

At each Special Survey, thickness gaugings are to be carried out where wastage is evident or suspect. At Special Survey No. 2 and subsequent Special Surveys, representative gaugings will be required. Special attention should be paid to splash zones on the hull, related structure, in ballast tanks, and free-flooded spaces, piles, support structure and PLEM when classed.

Special Survey 1	*Special Survey 2*	*Special Survey 3*	*Subsequent Special Surveys*
1) Suspect areas throughout the facility. 2) Areas around the splash zone where wastage is evident	1) Suspect areas throughout the facility. 2) Plating in way of the splash zone 3) One (1) transverse section of exposed deck plating	1) Suspect areas throughout the facility. 2) Plating in way of the splash zone 3) Exposed shell plating 4) Internals in ballast and free flooding spaces 5) Exposed hatch covers and coamings 6) Main bearing substructure	1) Suspect areas throughout the facility. 2) Plating in way of the splash zone 3) Exposed shell plating 4) Shell plating below waterline 5) Internals in ballast and free flooding spaces 6) Exposed hatch covers and coamings 7) Main bearing substructure

Notes:

i Gauging requirements noted may be modified as deemed necessary or appropriate by the Surveyor if the structure remains effectively protected against corrosion by a permanent type special coating.

ii In any case where excessive wastage is evident, additional gaugings may be required.

iii Splash zone is to be considered as the structural area that is periodically in and out of the water when the unit is at its operating depth.

1.9.1 Wastage Allowances *(2022)*

The following table of wastage allowances is to be used in the absence of ABS approved documentation stating otherwise.

Wastage Allowances	
Main deck, side and bottom shell	15%
Internal bulkheads and stiffeners	25%
Centerwell plating, if fitted	15%
Bearing support structure	5%
Chain table/stopper structure	5%

1.11 Inspection of Underwater Joints

Where inspection of underwater joints is required, sufficient cleaning is to be carried out in way of, and water clarity is to be adequate to permit meaningful visual, video, camera or NDT examination as required. Every effort should be made to avoid cleaning damage to special coatings.

1.13 Openings to the Sea

All openings to the sea, together with the cocks and valves connected therewith are to be examined internally and externally while the SPM is in drydock, or at the time of underwater examination in lieu of drydocking, and the fastenings to the shell plating are to be renewed when considered necessary by the Surveyor.

1.15 Tower Mooring *(2014)*

For the structure of a tower mooring, the applicable requirements of the *Offshore Installation Rules* are to be used.

3 Mooring Hardware

3.1 Complete Mooring System *(2022)*

The complete mooring system including anchors, chains, chain stoppers, mooring line connectors, securing devices, and pilings as applicable are to be examined including selective cleaning and gauging of the mooring chains. Arrangements are to be made for examination of all underwater areas. Areas not accessible by divers may be examined by ROV. All chain and accessories are to be checked for damage or wastage, especially in way of areas of high loading and high relative movement between chain links. These include seabed touch-down areas, chain stoppers and chain connecting shackles. Mooring foundations and piles are to be checked for scour and trenching. Particular attention should be given to mooring components or complete leg assemblies for further examination.

3.3 Examination at End of Design Life *(2021)*

When the mooring system has reached the end of its design life, either 20 years from installation, or as specified by the unit's notation, one of the following items is to be completed for the unit to continue in service:

i) Removal of one section of the mooring system for examination out of the water.

ii) Submittal to ABS Engineering the results of a strength analysis and a fatigue assessment performed in accordance with the ABS *Requirements for Position Mooring Systems (Mooring Requirements)*. This entails the dynamic analysis, anchor leg broken conditions, corrosion assumptions, fatigue life predictions, Fatigue Design Factors (FDFs), etc. specified in the *FPI Rules*. The analyses are to consider the loadings to which the SPM has been subjected to in the past, replacements and repairs carried out on the mooring system, the expected condition of the mooring system components as inferred from the inspection of accessible parts, and the expected future service of the SPM until the next Special Survey. The submitted analyses are to suitably reflect the completeness and accuracy of the service and condition records of the SPM.

3.5 Components (Flexible or Rigid) for Mooring of the Attached Vessel

Mooring system components (flexible or rigid) for mooring of the attached vessel are to be examined throughout provided this equipment is associated with the classed SPM. NDT of high stressed joints in rigid mooring connection may be required at the Surveyor's discretion. Flexible hawsers are to be examined for wear and filament breakage, Items found worn may require replacement.

5 Cargo Hoses or Flexible Risers

5.1 Cargo Hoses

Cargo hoses forming part of the SPM classification are to be removed, disassembled, pressure tested to rated working pressure, and examined at each Special Survey. This requirement applies to all hoses that have been in service for five (5) years. In the event cargo hoses have been renewed or replaced with new hoses within the five (5) year period, the above requirements may be modified and removal and testing deferred until the hose has been in service five (5) years.

Vacuum testing of cargo hoses is required in association with Special Survey or after five (5) years of service as indicated above.

5.3 Flexible Risers

An inspection manual for risers included as part of the SPM classification is to be submitted to ABS for approval. The manual is to include procedures for the following:

i) Underwater examination of the flexible risers including arch support buoyancy tanks.

ii) Examination of high stress areas such as areas in way of the end flanges, in way of the arch support clamps and the bottom of all looped areas.

iii) Examination of wear and tear on spreader bars, if fitted, which separate one riser string from another.

iv) Hydrostatic testing of flexible risers to be carried out to working pressure with special attention paid to upper end terminations.

v) *(2014)* Examination of wear and tear on connecting links padeyes between buoyancy tanks and their clump weights, if fitted. Non-destructive testing to be carried out if found necessary.

7 Safety Equipment

Safety equipment associated with the classification of the SPM is to be examined and tested as required by the attending Surveyor. Refer to Section 4-4-1 for requirements applicable to the safety equipment.

9 Swivel and Cargo Transfer Equipment *(1 July 2022)*

Swivel assemblies; foundations, flex or expansion joints, seals and associated piping assemblies are to be examined externally. Flex elements are to be replaced in accordance with manufacturer's schedule recommendations or other recognized standard acceptable to the Surveyor. Pressure retaining sections which convey corrosive or erosive materials are to be opened and examined internally. Thickness gaugings may be required to be taken on cargo transfer pipe lines and associated exposed equipment. Additional thickness gaugings are to be taken where the cargo piping is used to convey corrosive or erosive materials.

Upon completion of the examination, the swivel assembly and cargo transfer system is to be hydrostatically tested to rated working pressure and the sealing capability of the swivel is to be verified through one complete revolution.

11 Electrical Installations *(2023)*

Satisfactory operation of equipment is to be verified and circuits are to be inspected for possible development of physical changes or deterioration. The insulation resistance of the circuits is to be measured between conductors and between conductors and ground. These values are to be compared with those previously measured. Any large and abrupt decrease in insulation resistance is to be further investigated and either restored to normal or reviewed as indicated by the conditions found.

Electrical equipment, circuits, and cables are to be surveyed to confirm that they are free of any physical change or deterioration. In addition, electrical equipment fitted in hazardous areas is to be surveyed in accordance with 7-2-5/9.5 of the *MOU Rules*.

PART 5

CHAPTER 3

Offshore Charging Station

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PART 5

CHAPTER 3
Offshore Charging Station

SECTION 1
Charging Connections *(2023)*

1 Surveys During Construction

1.1 General

This Subsection pertains to surveys during fabrication at the manufacturer's facility and installation and testing of charging station equipment to be installed onboard a Single Point Mooring facility. For surveys at the manufacturer's facility, in addition to Section 5-1-1, the scope of the survey will be confined to those items that are supplied by the manufacturer upon agreement with ABS.

1.3 Surveys at Manufacturer's Facility

Survey requirements for equipment components at the manufacturer's facility are summarized in the relevant sections of the applicable Rules/Guides.

i) The manufacture, testing, inspection, and documentation of the charging station installation onboard an SPM facility are to be in accordance with applicable MVR, approved plans and data, recognized standards and the requirements given throughout this Chapter and Section 4-5-3 of these Rules.

ii) At the option of the manufacturer, each machine design or type may be enrolled in the ABS Type Approval Program in accordance with the provisions of 1B-1-A3/5.1 of the ABS *Rules for Conditions of Classification (Part 1B)*. The details pertaining to ABS Type Approval can be found on the ABS website, http://www.eagle.org/typeapproval.

1.5 Tests for Control, Monitoring and Safety System

i) Equipment in association with control, monitoring and safety systems of the offshore installations are to be performance tested in accordance with 4-9-9/13 of the *Marine Vessel Rules*, as applicable.

ii) Indications of parameters necessary for the safe and effective operation of the control, monitoring and safety system are to be tested and verified according to 4-5-2/7.7 of these Rules, as applicable.

1.7 Onboard Testing

i) General

a) Onboard testing is to verify that functionality has been achieved with all systems in operation.

b) The charging station installation, as appropriate, is to be examined and tested to the satisfaction of the attending Surveyor in accordance with the approved test plans.

c) Refer to 4-5-1Table 1 for references to the applicable requirements for the electrical equipment installed on board the Single Point Mooring facility, as given in Section 4-8-4 of the *Marine Vessel Rules*.

ii) Test Plan for Commisioning

A Test Plan is to be submitted to ABS at the start of the plan review process. The test plan is to identify all equipment and systems, including details of performance tests and trials for all operating modes, including testing of all automatic functions of the system including the power and energy management systems. Tests for the control, monitoring and safety system are to be included to verify the system complies with 4-5-2/7.7, as applicable.

iii) Operations Mode Trials Plan

An inspection/survey plan for each charging mode (as applicable) is to be developed and submitted for approval by ABS. The inspection/survey plan is to identify components/systems to be examined and/or validated during each survey during the Single Point Mooring facility's operating life.

a) Each charging mode described in section 4-5-2/1.1 is to be subjected to trials in accordance with the approved trials plan required to be submitted for review before the trials. The trials plan is to specify the duration of tests and to include trials in all possible modes and any other trials that may be applicable to the Single Point Mooring facility. During the trial, all functions of components, equipment, subsystems used in control, monitoring and safety systems of charging station are to be tested in accordance with the provisions found in 4-5-2/7.7 of these Rules.

b) The trials plan is to include disconnection (emergency stop) of the charging station for each operating mode. In the event of loss of the power supply to the charging station, the vessel's electrical supply system is to maintain power to equipment necessary for propulsion and steering and for the safety of the vessel.

c) Charging modes testing are to be witnessed by Surveyor during Sea trials.

1.9 Initial Survey

1.9.1 Surveys during Installation

i) In the general, the equipment is to be installed in accordance with the manufacturer's requirements as per the installation approved plans and the ABS Rules, as applicable.

ii) All certified safe systems (as applicable) and instrumentation and control panels are to be verified to be in compliance with approved drawings.

iii) Electrical wiring and connections are to be in accordance with applicable Rules requirements of Section 4-8-4 of the *Marine Vessel Rules*, and Section 4-3-3 of the *MOU Rules*, and checked for continuity and proper workmanship.

iv) Instrumentation is to be tested to confirm proper operation according to its predetermined set points.

v) The Commissioning Test Plan is to be followed and verified by the Surveyor.

1.9.2 Survey During Trials

During the initial trials, the charging station is to be confirmed for its satisfactory operation, including associated controls, alarms and shutdowns. The tests are to be conducted in accordance with the Operating Mode Trials Plan found in 1.7iii) above.

3 Surveys After Construction

3.1 General

Surveys after construction are to be carried out in accordance with the ABS *Rules for Surveys After Construction* (Part 7) for Vessels or *MOU Rules* for Offshore Units as applicable.

Annual or Special surveys after construction are to be carried out for systems and equipment according to 3.3 below, as applicable.

3.3 Annual Surveys

Where the charging station is installed on a Single Point Mooring facility, operating and maintenance records are to be examined to identify any issues with the systems and equipment. In addition to the requirements detailed in Section 5-2-3, the following are to be included during the annual survey:

i) Visual inspection of the installation for deformation, excessive wear, corrosion, fractures, or damages.

ii) Visual inspection confirming means of protection from mechanical damage are maintained where enclosures or assemblies of electrical components or cables are located on deck.

iii) Verification that electrical equipment exposed to the open deck has been properly maintained, particularly, any associated sealing equipment.

iv) Test of the Emergency Disconnect System function.

The overall charging station installation is to be verified to be in acceptable condition and operational in all modes through a review of the SPM's documentation and the system testing in accordance with the Operating mode Trials plan when deemed necessary.

3.5 Special Surveys

In addition to the annual requirements in 3.3 above and the Special Survey requirements of Section 5-2-4, trials are to be conducted as referenced in 1.9.2 above. The results of these tests are to be recorded and maintained on board for reference for subsequent surveys.

3.7 Surveys for Existing SPMs obtaining the New Notation

A Single Point Mooring facility subjected to modifications and retrofits with a charging station as detailed in this chapter are to be examined and tested in accordance with the approved plans and the requirements in this section to the satisfaction of the attending Surveyor.