GUIDE FOR BUILDING AND CLASSING

OFFSHORE FISH FARMING INSTALLATIONS

AUGUST 2018

American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862

Foreword

This Guide provides class requirements for the design, construction, installation and survey of non-self-propelled, sited offshore fish farming installations, so as to obtain the classification notation **Offshore Fish Farm Installation, Manned** or **Offshore Fish Farm Installation, Unmanned**. It addresses three major elements: the fish farming hull structure, the mooring system or foundation, and onboard machinery, equipment and systems that are not part of the aquaculture systems.

Aquaculture systems installed in the offshore fish farming installations under the jurisdiction of local authorities are not within the scope of classification and are not covered by the Guide.

This Guide is to be used in conjunction with the ABS *Rules for Building and Classing Floating Production Installations (FPI Rules)*, the ABS *Rules for Building and Classing Offshore Installations (OI Rules)*, the ABS *Guide for Building and Classing Floating Offshore Wind Turbine Installations (FOWT Guide)*, the ABS *Guide for Building and Classing Bottom-Founded Offshore Wind Turbine Installations (BOWT Guide)* and applicable Statutory Regulations.

This Guide becomes effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.

GUIDE FOR BUILDING AND CLASSING

OFFSHORE FISH FARMING INSTALLATIONS

CONTENTS

This Page Intentionally Left Blank

SECTION 1 General

1 Application

This Guide is applicable to non-self-propelled, sited offshore fish farming installations defined in 1/8.1. The types of installation covered by this Guide are listed below.

i) Spar-type floating fish farming installation

ii) Column-stabilized type floating fish farming installation

iii) Ship-shape floating fish farming installation

iv) Non-buoyant fish farming installation

Other types will be considered on a case by case basis.

2 Classification

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

Additional requirements specific to offshore fish farming installations are contained in the following Sections.

2.1 Scope

The classification of an offshore fish farming installation addresses three major elements which are subject to the requirements of this Guide:

i) The offshore fish farming hull structure

ii) The mooring system/foundation

iii) Onboard machinery, equipment and systems that are not part of the aquaculture systems

Classification of additional equipment and systems may be offered if requested by the Owner.

Aquaculture systems installed in the offshore fish farming installations under the jurisdiction of local authorities are not within the scope of classification and are not covered by the Guide. Examples of aquaculture systems include:

i) Fish net pens and associated equipment

ii) Fish feeding and production facilities

iii) Feedstock facilities

iv) Fish escape prevention apparatus

2.2 Classification Symbols and Notations

The following class notations apply to the offshore fish farming installation, as defined in 1/8.1.

2.2.1 Installations Built under ABS Survey

Installations built and constructed to the satisfaction of ABS Surveyors and to the requirements of this Guide or to their equivalent, where approved by ABS for service for the specified design environmental conditions, are to be classed and distinguished in the ABS *Record* by the following symbol for the intended service and hull type given below:

✠ A1 Offshore Fish Farm, Manned (hull type)

✠ A1 Offshore Fish Farm, Unmanned (hull type)

The Maltese cross symbol (✠) signifies that the installation was built, installed and commissioned to the satisfaction of the ABS Surveyors.

The intended service for manned or unmanned installations is defined in 1/2.3, and the relevant requirements provided in this Guide are to be complied with. The service notation will be appended by one of the following: **Spar-Type**, **Column-Stabilized Type**, **Ship-Shape** or **Non-Buoyant** to indicate the hull type. The hull structural configurations of these installations are described in 1/8.1.

Examples of notations for installations are:

Offshore Fish Farm, Manned (Spar-Type)

Offshore Fish Farm, Manned (Column-Stabilized Type)

Offshore Fish Farm, Manned (Ship-Shape)

Offshore Fish Farm, Unmanned (Non-Buoyant)

2.2.2 Installations Not Built under ABS Survey

Installations not built under ABS survey but submitted for classification, are subject to special consideration. Where found satisfactory, such installations may be classed with the below notations:

A1 Offshore Fish Farm, Manned (hull type)

A1 Offshore Fish Farm, Unmanned (hull type)

2.2.3 New Construction

Site-specific environmental data will be indicated by the (S) qualifier following the basic notation of 1/2.2.1 or 1/2.2.2. The qualifier will then to be followed by a descriptor of the site. For example, **✠ A1 Offshore Fish Farm, Manned (hull type) (S) Mississippi Canyon Block 779.**

2.3 Manned or Unmanned Installations

A manned fish farming installation is one with permanent occupied living accommodations or one that requires the continuous presence of personnel for more than 12 hours in successive 24-hour periods.

An unmanned fish farming installation is intended to be designed to have a safety level considering that operation can be shut-in during the design environmental event, equivalent to the medium exposure level (L2) as defined in ISO 19904-1.

3 Additional Class Notations

3.1 Notations for Automatic or Remote Control and Monitoring Systems for Manned Installations

For automatic or remote control and monitoring systems of the machinery other than the propulsion machinery as referenced in 1/1 of the ABS *Guide for Remote Control and Monitoring for Auxiliary Machinery and Systems (other than Propulsion) on Offshore Installations*, ABS will consider additional classifications with symbols ✠ **AMCC** or ✠ **AMCCU**, as appropriate, provided that the applicable requirements of the ABS *Guide for Remote Control and Monitoring for Auxiliary Machinery and Systems (other than Propulsion) on Offshore Installations* are satisfied.

3.2 Design Life

Offshore fish farming installations designed and built to the requirements in this Guide and maintained in accordance with the applicable ABS requirements are intended to have a structural design life of not less than 20 years for a new build hull structure. Where the structural design life is greater than 20 years and the offshore fish farming installations are designed for uninterrupted operation on-site without any drydocking, the nominal design corrosion values (NDCV) of the hull structure are to be increased in accordance with

5A-3-1/1.7 of the ABS *Rules for Building and Classing Floating Production Installations (FPI Rules)* for ship-shape floating fish farming installations or an acceptable equivalent criteria for non-ship-shape installations. ABS will consider additional classification with the notation **HL*(number of years)***, where ***(number of years)*** refers to a design life greater than 20 years (in 5-year increments).

3.3 Design Fatigue Life

Where an offshore fish farming installation's design calls for a minimum design fatigue life of 20 years or in excess of the minimum design life of 20 years, the design fatigue life is to be verified to be in compliance with the fatigue criteria in this Guide. The "design fatigue life" refers to the target value set by the owner or designer, not the value calculated in the analysis.

For example, if the design fatigue life is specified as 25 years, the fatigue calculations of hull structural components are to satisfy a fatigue life of (25 × FDF) years. The fatigue calculations of the position mooring hull interface structures, hull mounted equipment interface structures, and position mooring system are to also satisfy a fatigue life of (25 × FDF) years, where FDF are the fatigue safety factors specified in 3/2, for hull interface structures and Section 5 for mooring lines.

The required fatigue strength analysis of critical details and welded joints in offshore fish farming installations is to be in accordance with 3/2.

Only one design fatigue life value notation is to be assigned and published in the *Record* for the hull, hull interface structure, position mooring system and components. The hull interface structural requirements for ship-shape installations are described in 3/2.4 and the position mooring system requirements in Section 5. When spectral fatigue analysis of 3/2.4 for ship-shape installations or fatigue analysis of 3/2.1 , 3/2.2 and 3/2.3 for non-ship-shape installations is performed for either unrestricted service wave environment or the transit and site specific wave environment, the class notation **SFA(*number of years*) *Year*** is assigned for ship-shape installations and **FL(*number of years*), *Year*** is assigned for non-ship-shape installations, where **Year** denotes the year of maturation of fatigue life in the defined site location. The fatigue life will be identified in the *Record* by the notation **FL(number of years), Year**; For example, the notation **FL(30), 2041** denotes an offshore fish farming installation built in 2011 with a specified minimum design fatigue life of 30 years.

The **(*number of years*)** refers to the design fatigue life equal to 20 years or more (in 5-year increments), as specified by the applicant. Where different design fatigue life values are specified for different structural elements within the installation, such as hull structure components, hull interface structures and position mooring system components, the **(*number of years*)** refers to the least of the target values.

3.4 Dynamic Loading Approach (DLA)

Where the system's hull structure has been built to plans reviewed in accordance with the procedure and criteria in the ABS *Guide for "Dynamic Loading Approach" for Floating Production, Storage and Offloading (FPSO) Installations (DLA Guide)* or ship-shape fish farming installations for calculating and evaluating the behavior of hull structures under dynamic loading conditions, in addition to compliance with other requirements of this Guide, the installation will be classed and distinguished in the *Record* by the notation **DLA**. The **DLA** notation will be placed after the appropriate hull classification notation.

The dynamic load components considered in the evaluation of the hull structure are to include the external hydrodynamic pressure loads, internal dynamic loads (fluids stored onboard, ballast, major equipment items, etc.) and inertial loads of the hull structure. The magnitude of the load components and their combinations are to be determined from appropriate installation motion response calculations for loading conditions that represent the envelope of maximum dynamically-induced stresses in the installation. The adequacy of the hull structure for all combinations of the dynamic loadings is to be evaluated using an acceptable finite element analysis method. In no case are the structural scantlings to be less than those obtained from other requirements in this Guide.

If the wave environment of the intended site is used during the analysis, the notation will include an **S** qualifier, followed by the design return period at the defined site. For example, if the 100-year return period was used, the following may apply: **DLA (S100)**. Transit conditions to the intended site are also to be included in the DLA evaluation.

3.5 Relocation of Floating Fish Farming Installations

When a floating fish farming installation is relocated to a new site, either within the same field or in a different operating area, the strength of the unit is to be reassessed to satisfy that the unit will remain in compliance with applicable requirements. In addition, the fatigue life of the unit is to be reassessed to satisfy that the unit's remaining fatigue life for the new operating conditions is within the design fatigue life of the unit. The position mooring system, including chain and any other mooring components, is also subject to reassessment if it is to be used at the new site.

4 Rules for Classification

4.1 General

The criteria in this Guide are applicable to offshore fish farming installations fabricated as defined in 1/2.1 and further in 1/8.1.

The criteria are applicable to those features that are permanent and can be verified by plan review, calculation, survey or other appropriate means. Any statement in the Rules and the criteria in this document regarding other features are to be considered as guidance to the designer, builder, and Owner.

The application of the criteria to systems other than the above will be considered on a case-by-case basis.

4.2 References

References are made in this Guide to ABS *Rules* and other criteria issued by ABS and other organizations. 1/9 contains a list of such references. Unless otherwise noted, the applicable edition of a reference is the one officially issued and available on the date the Agreement for Classification is accepted by ABS. Where a particular edition or date associated with a reference is given, it means that particular edition is relevant to the topic being presented in this Guide. Upon the request of the Owner, ABS may at its discretion consider the application of other appropriate alternative methods and recognized codes of practice.

4.3 Risk Evaluations for Alternative Arrangements and Novel Features

Risk assessment techniques may be used to demonstrate that alternatives and novel features provide acceptable levels of safety in line with current offshore and marine industry practice. The ABS *Guide for Risk Evaluations for the Classification of Marine-Related Facilities* provides guidance to ABS clients on how to prepare a risk evaluation to demonstrate equivalency or acceptability for a proposed offshore fish farming installation.

Risk evaluations for the justification of alternative arrangements or novel features may be applicable either to the installation as a whole, or to individual systems, subsystems or components. ABS will consider the application of risk evaluations for alternative arrangements and novel features in the design of the offshore fish farming installations.

Portions of the offshore fish farming installation or any of its components thereof not explicitly included in the risk evaluation submitted to ABS are to comply with all applicable parts of the ABS Rules and Guides. If any proposed alternative arrangement or novel feature affects any applicable requirements of Flag and Coastal State, it is the responsibility of the Owner to discuss with the applicable authorities the acceptance of alternatives based on risk evaluations.

5 Materials and Welding

5.1 Metallic Materials and Welding

Metallic materials and welding are to be in accordance with ABS *Rules for Materials and Welding (Part 2)* together with 5A-1-3/1.13, 5B-1-2/9 and Section 5B-3-5 of the *FPI Rules* for floating fish farming installations and with Part 2 and Section 3-1-3 of the ABS *Rules for Building and Classing Offshore Installations (OI Rules)* for non-buoyant fish farming installations.

5.2 Mooring Chains and Accessories

Materials and welding of offshore mooring chains and accessories for application in the mooring system are to be in accordance with the ABS *Guide for the Certification of Offshore Mooring Chain*.

5.3 Fiber Ropes

Materials of synthetic fiber ropes for application in the mooring system should be in accordance with the ABS *Guidance Notes on the Application of Fiber Rope for Offshore Mooring*.

6 Submission of Plans, Data, Procedures and Calculations

The design documentation including reports, calculations, plans, procedures and other documentation necessary to verify the structural strength of the installation itself and adequacy of the mooring systems, marine systems, firefighting systems, machinery and equipment not associated with the aquaculture items for floating fish farming installations is to be submitted in accordance with Section 1-1-4 of the *FPI Rules* where applicable.

Plan, procedures and design data for non-buoyant fish farming installations are to be submitted in accordance with Sections 1-1-4 and 3-1-1 of the *OI Rules* where applicable.

7 Operating Manuals

The Operating Manual of the offshore fish farming installation is to be submitted for review by ABS to verify that operational procedures and conditions are consistent with the design information, criteria and limitations considered in the classification. ABS is not responsible for the operation of offshore fish farm.

A copy of the Operating Manual is preferably to be stored onboard of the offshore fish farming installation. Alternatively, the Operating Manual may be retained by the Owner and made readily available to the ABS Surveyor and to service personnel prior to conducting any maintenance or inspection.

Insofar as classification is concerned, the operating manual for the floating fish farming installation is to include the information in accordance with 3-3-1/7 and 3-3-1/9 of the *FPI Rules*, as appropriate.

The Operating Manual required by this Subsection does not need to be in addition to that required by the coastal State or other governmental authorities. These administrations may require that additional information be included in the Operating Manual.

8 Terms and Definitions

8.1 Types of Offshore Fish Farming Installations

8.1.1 Spar-Type Floating Fish Farming Installation

An installation possessing a deep draft, vertical floating structure, usually of cylindrical shape, supporting a topside structure (if any) and moored to the seafloor. The hull can be divided into upper hull, mid-section and lower hull.

8.1.2 Column-Stabilized Type Floating Fish Farming Installation

An installation consisting of surface piercing columns, submerged pontoons and a deck supported at column tops. Buoyancy is provided by the submerged pontoons, surface piercing columns and braces, if any.

8.1.3 Ship-Shape Floating Fish Farming Installation

A ship-shape installation that has the configuration of a ship including displacement hulls with or without the side or bottom structure.

8.1.4 Non-Buoyant Fish Farming Installation

A non-buoyant fish farming installation is a non-buoyant structure supported by or attached to the sea floor. The sea floor attachment afforded to the structure may be obtained by pilings, direct bearing, or other methods.

8.2 Terminology

8.2.1 Offshore Fish Farming Installations

Offshore fish farming installations include floating fish farming installations and non-buoyant fish farming installations.

8.2.2 Floating Fish Farming Installations

Floating fish farming installations include spar-type floating fish farming installations, column-stabilized type floating fish farming installations and ship-shape floating fish farming installations.

8.2.3 Floating Fish Farming Structure

A floating fish farming structure is a site-dependent structure supported by buoyancy and maintained on location by a mooring system.

8.2.4 Design Life

Assumed period for which a structure, a structural component, a system or equipment is expected to be used for its intended purpose with anticipated maintenance, but without substantial repair being necessary.

8.2.5 Owner

An Owner is any person or organization who owns offshore fish farming installations.

9 Abbreviations and References

9.1 Abbreviations of Organizations

ABS	American Bureau of Shipping
API	American Petroleum Institute
IMO	International Maritime Organization
ISO	International Organization for Standardization
MARPOL	International Convention for the Prevention of Pollution
SOLAS	International Convention for the Safety of Life at Sea

9.2 References

i) ABS *Rules for Building and Classing Floating Production Installations (FPI Rules)*

ii) ABS *Rules for Building and Classing Offshore Installations (OI Rules)*

iii) ABS *Rules for Building and Classing Mobile Offshore Drilling Units (MODU Rules)*

iv) ABS *Rules for Building and Classing Steel Barges (Barge Rules)*

v) ABS *Rules for Building and Classing Steel Vessels (Steel Vessel Rules)*

vi) ABS *Rules for Materials and Welding (Part 2)*

vii) ABS *Guide for Building and Classing Bottom-Founded Offshore Wind Turbine Installations (BOWT Guide)*

viii) ABS *Guide for Building and Classing Floating Offshore Wind Turbine Installations (FOWT Guide)*

ix) ABS *Guide for Spectral-Based Fatigue Analysis for Floating Production, Storage and Offloading (FPSO) Installations (SFA Guide)*

x) ABS *Guide for "Dynamic Loading Approach" for Floating Production, Storage and Offloading (FPSO) Installations (DLA Guide)*

xi) ABS *Guide for Remote Control and Monitoring for Auxiliary Machinery and Systems (other than Propulsion) on Offshore Installations*

xii) ABS *Guide for Risk Evaluations for the Classification of Marine-Related Facilities*

xiii) ABS *Guide for the Certification of Offshore Mooring Chain*

xiv) ABS *Guide for Fatigue Assessment of Offshore Structures*

xv) ABS *Guide for Buckling and Ultimate Strength Assessment for Offshore Structures*

xvi) ABS *Guidance Notes on the Application of Fiber Rope for Offshore Mooring*

xvii) ABS *Guidance Notes on Air Gap Analysis for Semi-Submersibles*

xviii) API SPEC 17E, *Specification for Subsea Umbilicals*

xix) ISO 19904-1, *Petroleum and Natural Gas Industries – Floating Offshore Structures, Part 1: Monohulls, Semi-submersibles and Spars*

xx) IEEE1120, *Guide for the Planning, Design, Installation, and Repair of Submarine Power Cable Systems*

SECTION 2 General Requirements

1 General

The design and construction of floating fish farming installations are to be in accordance with the applicable requirements in Part 3 of the *FPI Rules.* The design and construction of non-buoyant fish farming installations are to be in accordance with the applicable requirements in Section 3-2-2 of the *OI Rules*. However, the design criteria, as given in the *FPI Rules* or the *OI Rules*, are to be modified to reflect the structural performance and demands expected for unmanned installations, compared to manned installations positioned at a particular site on a long-term basis.

The local authorities having jurisdiction where the installation is to operate are to be contacted to obtain any further criteria that are applicable to the offshore fish farming installations. In addition, the relevant criteria contained in the Load Line, SOLAS and MARPOL Conventions issued by the International Maritime Organization are to be considered.

2 Loading Criteria

2.1 Loads

An installation's modes of operation in pre-service (loadout, transportation, installation) and in-service (in-place, maintenance, inspection) conditions are to be investigated using anticipated loads, including gravity loads together with relevant environmental loads due to the effects of wind, waves, currents, and, where deemed necessary by the Owner or designer, the effects of earthquake, temperature, fouling, and ice. These loads are to be in accordance with Section 3-2-4, 5B-1-1/5.1 and 5B-3-1/5.1 of the *FPI Rules* for floating fish farming installations or Section 3-2-1 of the *OI Rules* for non-buoyant fish farming installations.

2.2 Design Conditions

Offshore fish farming installations are to be designed for load scenarios encountered during transit and site-specific conditions. Site-specific conditions are to include the environmental conditions specified in Section 3-2-3, 5B-1-1/5.3 and 5B-3-1/5.3 of the *FPI Rules* for floating fish farming installations or Section 3-1-2 of the *OI Rules* for non-buoyant fish farming installations. However, the design environmental condition (DEC) and additional design conditions for maintenance and inspection of fish farming installations are to be in accordance with 2/2.2.1 or 2/2.2.3 for manned installations and 2/2.2.2 or 2/2.2.4 for unmanned installations.

2.2.1 Manned Floating Fish Farming Installations

The DEC is defined as the extreme condition with a specific combination of wind, waves and current for which the system is designed. The DEC is to be one of the following combinations that results in the most severe loading case:

- 100-year waves with associated wind and current
- 100-year wind with associated waves and current
- 100-year current with associated waves and wind

In areas where the maximum mooring system responses are governed by squalls, 100-year squalls with the following combination are also to be included for the DEC.

- 100-year squalls with associated wave and current.

A squall event is defined as a wind with a rapid increase in speed of 8 m/s, sustained above 11 m/s for at least 1 minute.

In areas with strong currents, additional design environmental load cases may need to be considered.

100-year waves are normally characterized by a significant wave height with a spectral shape type and a range of associated peak wave periods.

A minimum return period of 100 years for the DEC is required for floating fish farming installations. A minimum return period of 50 years will be specially considered if it is accepted by the coastal state. Any environmental combinations with return periods shorter than that of the DEC which induce larger mooring load responses are also to be used in the design.

The additional conditions for maintenance and inspection of floating fish farming installations are to be considered as part of Design Operating Condition (DOC) defined in 3-2-3/1.3 of the *FPI Rules.*

2.2.2 Unmanned Floating Fish Farming Installations

The DEC is defined as the extreme condition with a specific combination of wind, waves and current for which the system is to be designed. The DEC is to be one of the following combinations that results in the most severe loading case:

- 50-year waves with associated wind and current.
- 50-year wind with associated waves and current.
- 50-year current with associated waves and wind.

In areas where the maximum mooring system responses are governed by squalls, 50-year squalls with the following combination are also to be included for the DEC.

- 50-year squalls with associated wave and current.

In areas with high current, additional design environmental load cases may need to be considered.

50-year waves are normally characterized by a significant wave height with a spectral shape type and a range of associated peak wave periods.

The additional conditions for maintenance and inspection of floating fish farming installations are to be considered as part of Design Operating Condition (DOC) defined in 3-2-3/1.3 of the *FPI Rules.*

2.2.3 Manned Non-Buoyant Fish Farming Installations

The Design Environmental Condition for manned non-buoyant fish farming is to be in accordance with 3-1-2/5.1 of the *OI Rules*.

The additional conditions for maintenance and inspection of non-buoyant fish farming installations are to be considered as part of Operating Environmental Conditions defined in 3-1-2/5.3 the *OI Rules*.

2.2.4 Unmanned Non-Buoyant Fish Farming Installations

The Design Environmental Condition for unmanned non-buoyant fish farming installations is to be in accordance with 3-1-2/5.1 of the *OI Rules* in association with wind, wave and current loads with 50 years return period.

The additional conditions for maintenance and inspection of non-buoyant fish farming installations are to be considered as part of Operating Environmental Conditions defined in 3-1-2/5.3 the *OI Rules*.

3 Global Performance Analyses

3.1 General

Global performance analyses of the floating fish farming installation are aimed at determining the global effects of environmental loads on the overall installation and its components, such as topside and hull structures, mooring lines, and anchors. Global performance analyses are to be carried out for all critical conditions in the pre-service and in-service phases, represented by the design conditions specified in 2/2.

Global performance analyses are intended to determine the following parameters:

i) Motions of the floating fish farming installation in six degrees of freedom

ii) Mooring line tensions, including the maximum and minimum tensions and fatigue loads for mooring component design

iii) Critical global forces and moments, or equivalent design wave heights and periods as appropriate, for the hull structural analysis

iv) Hull hydrodynamic pressure loads for global structural analysis

v) Accelerations for the determination of inertia loads

vi) Deck clearance (or Air Gap)

The hydrodynamic loads used in the global performance analysis may be obtained through:

i) Hydrodynamic analysis for large bodies based on radiation/diffraction theory using panel models

ii) Morison's equation for slender members, external hull appurtenances and viscous hull drag with well documented drag coefficients C_d and inertia coefficients C_m

iii) Computational fluid dynamics (CFD) or model test to determine hydrodynamic loads and coefficients on some innovative or unconventional structural components, such as heave plates and fish net pens

Global performance analyses with various design conditions are required. The topside structures, hull, mooring system, and fish net pens is to be considered in the analysis model.

Several analytical methods with varying degrees of complexity may be used. Loading and response predictions for the topside deck structure and hull, and those for the mooring system can be performed either separately or in an integrated form. Methods and models employed in the analyses are to account for the relevant nonlinear and motion coupling effects.

Either frequency or time domain methods, or a combination of both, may be used in global performance analyses. However, for those cases that have highly nonlinear effects, time-domain analyses are normally required.

Common practice in global performance analyses for floating offshore oil and gas production installations, as summarized in the ABS *FPI Rules* as well as applicable recognized standards such as those published by API and ISO standards, may be adapted for application to the floating fish farming installations.

3.2 Frequency Domain Analyses

Frequency domain analyses include those in six degrees of freedom of the floating fish farming installation in both the wave frequency and the low frequency domains.

In order to evaluate the wave-frequency responses of the floating fish farming installation, linear wave theory is usually employed in the wave frequency analysis. Alternative methods may be applied to evaluate the effects of finite amplitude waves. The low frequency motion analysis is to be carried out to evaluate the effects caused by wind dynamics and wave drift forces. The damping levels used in the analyses are to be properly determined and documented.

Hydrodynamic loads on large bodies are in general obtained in frequency-domain based on radiation/ diffraction theory using panel models. For hydrodynamic loads on slender bodies, (i.e., ratio of wave length to diameter of the slender body larger than 5), and viscous drag loads on the hull structures and fish net pens, Morison's equation can be used. For frequency-domain analyses, the viscous drag loads should be linearized and considered in the analyses.

3.3 Time Domain Analyses

Time domain analysis is a preferable approach to include the nonlinear effects in global performance analyses of the floating fish farming installation. These nonlinear effects include hull drag forces, drag of fish net pens, finite wave amplitude effects, nonlinear restoring forces from mooring lines, effects of motion suppression devices or components (e.g., heave plates) and coupling effects of the hull and mooring system. When strong nonlinear responses are expected, a time domain analysis is to be performed and submitted for review.

In time domain analysis, a relevant wave spectrum is to be transferred to random time series for simulating irregular wave elevations and kinematics. The maximum responses are to be predicted using appropriate distribution curves fitted to the simulation results or other recognized statistical techniques. Time domain analyses are to be carried out for a period sufficient to achieve stationary statistics, particularly for low frequency responses. Multiple realizations of the same conditions may be necessary to generate adequate data for statistical analysis and to verify consistency of the simulation. The designer is to demonstrate the adequacy of the selected simulation time duration and the number of realizations.

For spar-type or other deep-draft hull structures, Vortex Induced Motions (VIM) are to be taken into account as appropriate.

3.4 Deck Clearance

Unless topside deck structures are satisfactorily designed for wave impact, reasonable clearance between the bottom of the topside deck structures and the wave crests is to be checked for all afloat modes of operation, taking into account the predicted motion of the installation relative to the surface of the sea.

The deck clearance is normally determined by an appropriate model test. Alternatively, the deck clearance can also be determined by a detailed hydrodynamic analysis that accounts for relative motions between the floating fish farming installation and waves. The following items are to be considered when determining deck clearance:

i) Various environmental headings

ii) All motions due to wind, waves, and current

iii) Nonlinearity of wave profile

iv) Wave diffraction and run-up

v) Tide and water level effects

vi) Draft of the installation

Deck clearance is also to be checked at various points around and on the underside of the topside deck for all of the critical environmental conditions.

A clearance is to be maintained between the lowest point of the topside deck and the wave crest so that the side and the bottom of topside deck structure is not subjected to wave impact in Design Environmental Conditions (DEC), unless the topside deck structure is designed for such loading. Where topside deck structural members are designed for passage of waves or if wave impact to the topside and hull structure is anticipated, local strengthening of these members is required. Structures and equipment subject to wave run-up or green water are to be designed for the associated forces.

3.5 Seabed Clearance

A seabed clearance is also to be checked for the floating offshore fish farming installations to avoid possible contact with the seabed under the design conditions specified in 2/2.2. The seabed clearance is to be maintained at least 1 meter (3.3 feet) between the lowest point of the floating offshore fish farming structure and the seabed. The designer is to submit evidence to demonstrate to the satisfaction of ABS that in determining the required seabed clearance, the following items are to be considered.

i) Various environmental headings

ii) All motions due to wind, waves, and current

iii) Tide and water level effects

iv) Draft of the installation

v) The consistency of the sea bottom material and the characteristics 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, where applicable

3.6 Interference Check

The interference check between the floating offshore fish farming structure with fish net pens and the mooring lines is to be performed under the design conditions specified in 2/2.2 to avoid the possible interference of mooring lines.

3.7 Model Testing

Model testing provides an independent check of system responses under simulated environmental conditions. It is also used for deriving some of the design parameters, such as the air gap and nonlinear effects, particularly for an innovative design. Model testing for deriving some of the design parameters, such as deck clearance and nonlinear effects, is recommended as the final check of floating fish farming installation designs if innovative components are used. Relevant environmental conditions are to be covered in the model testing.

Model testing and numerical analyses are not to be replaced, but are rather to complement each other. The primary objectives of model testing are:

i) Determining the responses of a particular design, such as to calibrate low-frequency damping coefficients.

ii) Verifying analysis tools for prediction of system responses or simply to correlate the analysis results.

iii) Deriving design information as a substitute for numerical analysis.

4 Corrosion Protection of Steel

Unless otherwise approved, all steel work is to be suitably protected by an efficient corrosion prevention system, such as hard protective coatings or the equivalent. Reference can be made to IMO resolution MSC.288 (87), MSC.289(87), MSC.215(82) and MSC.244(83).

SECTION 3 Structures

1 General

This Section provides structural requirements to be applied in the design of offshore fish farming structures. The structural requirements of offshore fish farming installations include where applicable, but are not limited to, the scantling design of the hull structure and structural analysis of hull structures, topside deck structures, mooring hull interface, and topside deck structure interface with deckhouse and deck mounted equipment/machinery.

The loading criteria in 2/2 for structural design are to be applied along with the requirements specified in this Section.

2 Structural Design Requirements

2.1 Non-Buoyant Fish Farming Installations

The structural design requirements in Part 3 of the *OI Rules* where applicable are to be complied with, along with the following considerations.

i) The DEC is to be replaced by 2/2.2 for manned and unmanned installations; and

ii) For unmanned installations, the safety factors for fatigue life of hull structures and topside deck structures are to be replaced by 5-2/Table 2 of the ABS *Guide for Building and Classing Bottom-Founded Offshore Wind Turbine Installations (BOWT Guide).*

Soil investigations and design considerations for the supporting soil and the influence of the soil on the foundation structure for non-buoyant fish farming installations are to be in accordance with 3-2-5 of the *OI Rules*.

2.2 Spar-Type Fish Farming Installations

The structural design requirements in Sections 5B-3-1, 5B-3-3 and 5B-3-4 of the *FPI Rules* are to be complied with, along with the following considerations.

i) The DEC is to be replaced by 2/2.2 for manned and unmanned installations; and

ii) For unmanned installations, the safety factors for fatigue life of hull structures and topside deck structures are to be replaced by 7-2/Table 2 of the ABS *Guide for Building and Classing Floating Offshore Wind Turbine Installations (FOWT Guide).*

2.3 Column-Stabilized Type Fish Farming Installations

The structural design requirements in Sections 5B-1-1, 5B-1-2 of the *FPI Rules* are to be complied with, along with the following considerations.

i) The DEC is to be replaced by 2/2.2 for manned and unmanned installations; and

ii) For unmanned installations, the safety factors for fatigue life of hull, integrated deck and column top frame are to be replaced by 7-2/Table 2 of the *FOWT Guide*.

The guidance for performing air gap analysis is provided in the ABS *Guidance Notes on Air Gap Analysis for Semi-Submersibles.*

2.4 Ship-Shape Fish Farming Installations

2.4.1 General

The design and analysis criteria to be applied to the hull structural design are to conform to 3/2.4.2 and industry recognized practices of full ship finite element analysis for strength and fatigue assessment acceptable to ABS and 3/2.4.2. The design and analysis of other major hull structural feature and modules on deck are to be in accordance with the applicable requirements of 5A-1-1, 5A-1-4 and 5A-1-5 of the *FPI Rules* and 3/2.4.3. Fatigue analysis is to be performed to verify adequate strength against fatigue failure within its design life. The fatigue analysis is to consider the loading history of the ship-shape installation including transport and in-place conditions. Attention is also to be given to the designs of structural notches, cutouts, brackets, toes, and abrupt changes of structural sections where they are prone to fatigue damages.

Performance of additional structural analyses in accordance with the *DLA Guide* can lead to the granting of the optional DLA classification notation, which signifies that the design meets the Dynamic Load Approach criteria. Also, the optional SFA classification notation can be granted, which signifies that the design satisfies fatigue strength criteria based on Spectral Fatigue Analysis in accordance with the ABS *Guide for Spectral-Based Fatigue Analysis for Floating Production, Storage and Offloading (FPSO) Installations (SFA Guide).*

2.4.2 Initial Minimum Scantlings

The hull structural design requirements for initial minimum scantlings are to be in accordance with Part 3 Chapter 2 of the ABS *Rules for Building and Classing Steel Barges (the Barge Rules)* with the replacement of the longitudinal hull girder strength defined in 3-2-1/3.1 of the *Barge Rules* by the following 3/2.4.2(a) and 3/2.4.2(b):

2.4.2(a) Section Modulus. The required hull girder section modulus SM_R amidships, to the deck and bottom is to be the greater of the values obtained from the following equation or 3/2.4.2(b):

$$SM_R = (M_s + M_w)/f_p \quad \text{cm}^2\text{-m (in}^2\text{-ft)}$$

where

M_s = maximum still-water bending moment in the governing loaded or ballasted condition in kN-m (tf-m, Ltf-ft)

M_w = maximum wave induced bending moment expected on-site and during transit to the installation site in kN-m (tf-m, Ltf-ft) from the direct calculation in accordance with the *DLA Guide*

f_p = nominal permissible bending stress

= 17.5 kN/cm^2 (1.784 tf/cm^2, 11.33 Ltf/in^2)

2.4.2(b) Minimum Section Modulus. The minimum hull girder section modulus SM_R amidships is not to be less than that obtained from the following equation:

$$SM_R = 1.59M_w/f_p \quad \text{cm}^2\text{-m (in}^2\text{-ft)}$$

where

M_w = as defined in 3/2.4.2(a), in kN-m (tf-m, Ltf-ft)

2.4.3 Loads and Acceptance Criteria for Structural Design and Analysis

The load conditions and the acceptance criteria to be applied to the structural analysis of topside deck structures, mooring hull interface, and the topside deck structure interface with deckhouse and deck mounted equipment/machinery are to be in accordance with Sections 5A-1-4 and 5A-1-5 of the *FPI Rules* with the following considerations.

i) The DEC is to be replaced by 2/2.2 for manned and unmanned installations; and

ii) For unmanned installations, the safety factors for fatigue life of hull interface structures are to be replaced by 7-2/Table 2 of the *FOWT Guide*.

Net scantlings are defined as the gross scantlings as denoted in 3/2.4.2 minus the Nominal Design Corrosion Values specified in 5A-3-1/1.7 of the *FPI Rules* for double hull structures, and 5A-3-6/1.1 of the *FPI Rules* for single hull and double side single bottom structures. Net scantlings are to be used for the DLA strength assessment procedure and the spectral-based fatigue analysis.

SECTION 4 Stability

1 Stability

1.1 General

The intact and damage stability of the floating fish farming installation are to be evaluated in accordance with the requirements of the relevant Flag and Coastal States. Ship-shape installations are to comply with the IMO Code on Intact Stability, the 1966 Load Line Convention, IMO MODU Code as applicable, and MARPOL 73/78. Non-ship-shape installations are to meet the requirements specified in 4/1.2 for manned installations and 4/1.3 for unmanned installations. See 3-3-1/9 of the *FPI Rules* for general requirements pertaining to the makeup and issuance of loading guidance with respect to stability.

The stability analysis is to consider drag forces on the fish net pens due to current or being towed. Analyses are to be performed to verify the non-buoyant fish farming installation, or its means of support where such exist, has sufficient hydrostatic stability and reserve buoyancy to allow for successful execution of all phases of marine operations. For large or unique structures, an experimental determination of the center of gravity of the structure and its means of support, where such exist, is to be performed.

1.2 Manned Installations

The stability of column-stabilized type fish farming installations is to meet the requirements in Section 5B-1-3 of the *FPI Rules*. The stability of spar-type fish farming installations is to meet the requirements in Section 5B-3-2 of the *FPI Rules*.

1.3 Unmanned Installations

The stability of column-stabilized type fish farming installations are to meet the requirements in Section 5B-1-3 of the *FPI Rules* where the DEC is to be replaced by 2/2.2.2. The stability of spar-type fish farming installations is to meet the requirements in 5B-3-2 of the *FPI Rules* where the DEC is to be replaced by 2/2.2.2.

2 Watertight and Weathertight Integrity

2.1 General

Watertight and weathertight integrity and penetrations of column-stabilized type fish farming installations are to be evaluated in accordance with 5B-1-3/1.7 and 5B-1-3/1.9 of the *FPI Rules*.

Watertight and weathertight integrity and penetrations of spar-type fish farming installations are to be evaluated in accordance with 5B-3-2/3 of the *FPI Rules*.

SECTION 5 Mooring Systems

1 General

Typically, there are two types of position mooring systems: a conventional spread mooring system and a single point mooring system, as defined in 3-1-4/3 and 3-1-4/5 of the *FPI Rules*. The mooring system may include mooring lines, winches, piles, anchors, connectors and hardware. For a single point mooring system, a turret, a turntable, buoys, and anchoring legs may also be part of system. For mooring systems incorporating fiber ropes, additional design considerations are defined in the ABS *Guidance Notes on the Application of Fiber Rope for Offshore Mooring*.

Regardless of its type, the mooring system is to be designed to:

i) Keep the floating fish farming installation on station at a specific site; and

ii) Control the directional heading of the floating fish farming installation if the orientation is important for safety or operational considerations.

Innovative mooring system designs (configuration, material, components and equipment) that are not covered by this Guide or other existing industry standards will be subject to special consideration by ABS.

2 Position Mooring Systems

2.1 General

The requirements for position mooring systems of floating fish farming installations are to be in accordance with 5/2.2 for manned installations and 5/2.3 for unmanned installations.

2.2 Manned Installations

The applicable requirements for position mooring systems and anchoring holding power in Sections 6-1-1 and 6-1-2 of the *FPI Rules* are to be complied with.

2.3 Unmanned Installations

The applicable requirements for position mooring systems and anchoring holding power in Sections 6-1-1 and 6-1-2 of the *FPI Rules* are to be complied with, where the DEC is to be replaced by 2/2.2.2.

The safety factors for anchoring lines are to be in accordance with 8-3/Table 1 of the *FOWT Guide*. The safety factors for fatigue life of anchoring lines are to be in accordance with 8-3/Table 2 of the *FOWT Guide*.

3 Single Point Moorings

3.1 General

The requirements for single point mooring systems of floating fish farming installations are to be in accordance with 5/3.2 for manned installations and 5/3.3 for unmanned installations.

3.2 Manned Installations

The applicable requirements of single point mooring systems in Section 6-2-1 of the *FPI Rules* are to be complied with.

3.3 Unmanned Installations

The applicable requirements of single point mooring systems of floating fish farming installations in Section 6-2-1 of the *FPI Rules* are to be complied with, where the DEC is to be replaced by 2/2.2.2.

The safety factors for fatigue life of anchoring lines are to be in accordance with 8-3/Table 2 of the *FOWT Guide*.

SECTION 6 Fire Safety, Life-Saving, Machinery and Systems

1 Fire Safety, Life-Saving Appliances and Equipment

1.1 Manned Installations

For ship-shape fish farming installations, fire fighting systems and equipment for service functions are to be in accordance with the applicable requirements of 5A-1-6/1.5 of the *FPI Rules*.

For column-stabilized type and spar-type fish farming installations, fire fighting systems and equipment for service functions are to be in accordance with the applicable requirements of Part 5, Chapter 2 of the ABS *Rules for Building and Classing Mobile Offshore Drilling Units (MODU Rules)*.

For manned installations, fire safety, life-saving appliances and equipment are to be in accordance with the applicable requirements of Chapter 9 and Chapter 10 of IMO MODU Code 2009, and Part 5, Chapters 1 and 3 of the *MODU Rules*.

1.2 Unmanned Installations

For floating fish farming installations, fire fighting systems and equipment for service functions are to be in accordance with the applicable requirements of 10-1/9 of the *FOWTI Guide*.

Attention is to be given to any relevant requirements of the coastal State or other governmental authorities having jurisdiction over the offshore fish farming installation to be installed.

For unmanned installations, fire safety, life-saving appliances and equipment are to be designed with suitable consideration of the nature of unmanned installations. It is suggested that the coastal State or other governmental authorities having jurisdiction over the unmanned installation be contacted to obtain applicable requirements.

2 Machinery and Equipment

For ship-shape fish farming installations, machinery and equipment are to be in accordance with the applicable requirements of 5A-1-6/1.7 of the *FPI Rules*.

For column-stabilized type fish farming installations, machinery and equipment are to be in accordance with the applicable requirements of Part 4, Chapter 1 of the *MODU Rules*, and Part 4, Chapters 2, 4, and 6 of the ABS *Rules for Building and Classing Steel Vessels (Steel Vessel Rules)*, as applicable.

For spar-type fish farming installations, machinery and equipment are to be in accordance with the applicable requirements of Part 4, Chapter 1 of the *MODU Rules*.

3 Marine Piping Systems

Marine piping systems are those systems that are required to conduct marine operations. These systems include, but are not limited to, bilge, ballast, tank venting, sounding and fuel oil. Marine piping systems on ship-shape fish farming installations are to be in accordance with the applicable requirements of 5A-1-6/1.1 of the *FPI Rules*.

For column-stabilized type fish farming installations, marine piping systems that are required to conduct marine operations are to be in accordance with the applicable requirements of 5B-1-4/1 of the *FPI Rules*.

For spar-type fish farming installations, marine piping systems that are required to conduct marine operations are to be in accordance with the applicable requirements of 5B-3-6/1 of the *FPI Rules*.

4 Electrical Systems

Electrical systems on ship-shape fish farming installations are to comply with 6/4.1 and the applicable requirements of Part 4, Chapter 8 of the *Steel Vessel Rules* for manned installations, or 6/4.3 and Part 4, Chapter 8 of the *Steel Vessel Rules* for unmanned installations.

For column-stabilized type and spar-type fish farming installations, electrical systems are to comply with the applicable requirements of Part 4, Chapters 1 and 3 of the *MODU Rules* and 6/4.1 for manned installations, or Part 4, Chapters 1 and 3 of the *MODU Rules* and 6/4.3 for unmanned installations.

The source of main power may be provided by conventional generators, offshore power cables imported from shore (see 6/5), or solar power systems (see 6/6).

Where the Flag Administration permits, the minimum number of required main power sources may be reduced to one. The coastal State or other governmental authorities may require reserve main power or the emergency power source in excess of the above requirements.

4.1 Manned Installations

4.1.1 Main Power

The main power source(s) is to be sufficient to maintain the maximum intended operational load of the unit.

4.1.2 Emergency Power

i) An emergency source of power for systems vital to safety, fire-fighting, and protection of personnel, is to be provided on board to supply the services as listed herein.

ii) Where an emergency power supply has been provided for classification/flag state purposes, this source may also be used to provide emergency loads in production areas, provided the emergency source of power is adequately sized to supply all of the connected loads.

iii) Provisions for emergency power supply, less than those listed herein, will be considered, provided adequate technical justification is submitted.

iv) Loads to be supplied by the emergency source of power are listed in 6/4.1.3 and 6/4.1.4.

4.1.3 Fire Pump

i) If both fire pumps are electric motor driven, one of these pumps is to be powered by the emergency source of power.

ii) The emergency source of power is to have sufficient fuel for at least 18 hours of fire pump operation.

4.1.4 Other Loads

The following loads are to be powered by the designated emergency source of power:

i)	Fire detection	18 hours
ii)	Communication	18 hours
iii)	Paging and alarm system	18 hours
iv)	Emergency lighting from all spaces to all alternative egress points	18 hours
v)	Navigational aids	As required by the applicable Coastal Authority, but not less than 4 days

4.2 Unmanned Installations

4.2.1 Main Power

The main power source(s) is to be sufficient to maintain the maximum intended operational loads of the unit, without the need for emergency source of power.

4.2.2 Emergency Power

An emergency power source, independent of the unit's main power, is to be sufficient to supply services for navigational aids as required by the cognizant Coastal Authority, but not for less than four (4) days.

5 Electrical Umbilical Cable Systems

The electrical cable system, where applicable, connects the floating fish farming installation and the subsea electrical cable on the sea floor. It includes a section of the electrical cable that imports electrical power from shore and may also convey control signals. The electrical cable system is usually connected to a certain location on the hull structure or the topside deck. The local support structure is to be designed for the maximum static and dynamic loading and in accordance with the requirements of Section 3 of this Guide. Dynamic response of the suspended segment of the electrical cable is to be determined in accordance with the requirements of 2/3 for global performance analyses and with consideration of the Section 5 of this Guide for the mooring system. The electrical cable is to be designed to accommodate the maximum excursion of the floating fish farming structure subjected to those design considerations. The calculated fatigue life of the electrical cable is not to be less than five (5) times the design life of the floating fish farming installation. Anticipated fatigue damage accumulation due to reeling, handling, construction, and installation, as well as unplanned events such as partial recovery and reinstallation are to be considered. The procedures for reeling, handling, construction, and installation are to indicate the allowed cyclic loading that has been assumed in the design. Additional design considerations, as applicable, are to be in accordance with applicable recognized industrial standards such as API Specification 17 E and IEEE1120.

6 Solar Power Systems

Solar power systems equipment, installed on the ABS classed offshore fish farming installations to provide electrical power, are required to be a proved type in accordance with recognized standards. The solar power systems type certificate will be reviewed by ABS solely to verify that the information of the installed solar power systems is consistent with the design information, criteria and limitations considered in the classification of offshore fish farming installations. ABS will not review or be responsible for the accuracy of the solar power system certificate. Use of solar power systems lacking an appropriate type certification will be subject to special consideration by ABS.

Local support structure is to be designed for the maximum static and dynamic loading and in accordance with the requirements of Section 3 of this Guide. The solar power systems may serve as one of the two main power sources.

SECTION 7 Surveys

1 Surveys During Construction, Installation and Commissioning

The applicable parts of requirements in Part 7, Chapter 1 of the *FPI Rules* apply to the ABS approved procedures and the surveys to be performed on any type of floating fish farming installation.

Surveys during the construction and installation of the non-buoyant fish farming installation are to be in accordance with Part 5, Chapter 1 of the *OI Rules*, as applicable.

2 Surveys After Construction

Surveys after construction of floating fish farming installations are to be in accordance with Part 7, Chapter 2 of the *FPI Rules*, as applicable.

Surveys after construction of the non-buoyant fish farming installation are to be in accordance with Part 5, Chapter 2 of the *OI Rules*, as applicable.