Guidelines For Classification And Construction

Part 5 Offshore Technology

Volume 4

GUIDELINES FOR AQUACULTURE

2022

Biro Klasifikasi Indonesia

www.bki.co.id

Guidelines For Classification And Construction

Part 5 Offshore Technology

Volume 4

GUIDELINES FOR AQUACULTURE

2022

Biro Klasifikasi Indonesia

Jl. Yos Sudarso No. 38-40, Tanjung Priok
Jakarta 14320 - Indonesia
rules@bki.co.id
www.bki.co.id

The following Guidelines come into force on 1st July 2022.

Foreword

The Guidelines for Aquaculture contains class requirements for the design, construction, installation, and survey of aquaculture units or installations. The arrangement of sections of this Guidelines is as follows:

- Section 1 – Principle and Procedure for Classification
- Section 2 – Survey
- Section 3 – Design and Construction
- Section 4 – Structure
- Section 5 – Stability
- Section 6 – Mooring System
- Section 7 – Fire Safety, Life-Saving, Machinery and System

This Guidelines is available to be downloaded at www.bki.co.id. Once downloaded, these Guidelines will be uncontrolled copy. Please check the latest version on the website.

Further queries or comments concerning these Guidelines are welcomed through communication to BKI Head Office.

This page intentionally left blank

Table of Content

This page intentionally left blank

Section 1 Principle and Procedure for Classification

A. Introduction

Aquaculture is the farming of aquatic organisms in offshore areas but not limited at sea involving interventions in the rearing process to enhance production.

1. General

This Guidelines presents the terms and procedures for assigning and maintaining classification, including listing of the applicable technical references to be applied for classification of aquaculture units or installations.

The requirements for conditions of classification are contained in the separate, generic Rules of Offshore Technology - Rules for Classification and Survey (Pt.5, Vol.I).

Additional requirements specific to aquaculture units or installations are contained in the following Subsections.

For aquaculture structure intended to certification, this guidelines may be used in conjunction with other relevant recognized rules or standards. Aquaculture which has been constructed and tested under survey of BKI according to other recognized rules or standard may receive a Certificate of Compliance by BKI.

2. Application

This Guidelines is applicable to units and installations of aquaculture with self-propelled or non-self-propelled, as clustered in Fig.1.1 that was described in 3.1.

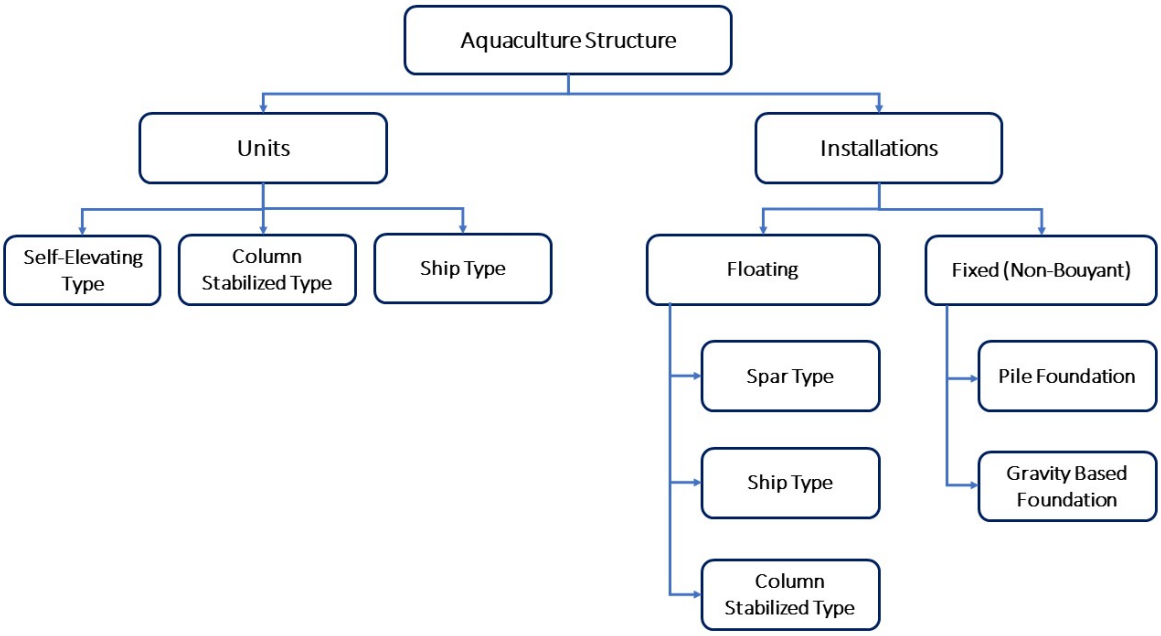

Fig. 1.1 Clustering of Aquaculture Structure

The types of units or installations covered by this Guidelines as shown in Fig.1.1 are listed below:

1) Spar-type aquaculture installation
2) Column-stabilized type aquaculture unit or installation
3) Ship type aquaculture unit or installation
4) Self-elevating type aquaculture unit (e.g. by using its deck structures for aquaculture purposes)
5) Fixed-type aquaculture installation

Other types may be agreed with BKI case by case.

3. Definitions

No	Item	Definition
1.	Types of aquaculture unit or Installations:	1) Spar-Type 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.
		2) Column-Stabilized Type An unit or 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.
		3) Ship Type Ship type is single displacement hulls, either ship-shaped or barge-shaped unit or installation with or without the side or bottom structure.
		4) Self Elevating Type An unit or installation equipped with legs which are capable of raising the hull above the sea surface by means of a jack-up system. These units have hulls with sufficient buoyancy and they are also known as jack-up units. The movable legs of a self-elevating unit are supported on the sea-bed when in the elevated condition and may be equipped with enlarged sections or footings to reduce the soil penetration or may be attached to a bottom pad or mat.
		5) Fixed Type A fixed type aquaculture 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.
2.	Manned Installations	A manned aquaculture installation is one with permanent occupied living accommodations or one that requires the continuous attendance of personnel for more than 12 hours in successive 24-hour periods.
3.	Unmanned Installations	An unmanned aquaculture installation which is unattended, but which may be visited regularly, and where its operations are aligned with requirements from the national authority and owner's

		classification of pre-determined risk severity (e.g. safety level may be considered that operation can be shut-in during the design environmental event, equivalent to the medium exposure level (L2) as defined in ISO 19904-1) Such installations are provided with accommodation that is suitable for the intended visits to the installation.
4.	Floating Aquaculture Structure	A floating aquaculture structure is a site-dependent structure supported by buoyancy and maintained on location by a mooring system.
5.	Aquaculture Units	Floating aquaculture structure are not intended for service at one particular location, and which can be relocated without major dismantling or modification and equipped with position mooring system (mobile mooring).
6.	Aquaculture Installations	Aquaculture installations include floating aquaculture structure and non-buoyant aquaculture structure which is designed and intended for use at one particular location for an extended period. The floating aquacultures are provided with position mooring system (permanent mooring).
7.	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.	Position mooring	Anchoring system for position keeping at the unit`s or installation's working location, including mobile and permanent mooring.
9.	Mobile mooring	A mooring system, generally retrievable, intended for deployment at a specific location for a short-term operation (normally less than 5 years).
10.	Permanent mooring	A mooring system normally used to secure floating structures deployed for long-term operations (typically more than 5 years or for fixed location).

4. References

- Rules for Mobile Offshore Units (Pt.5, Vol.VI)
- Rules for Fixed Offshore Installations (Pt.5, Vol.VII)
- Rules for Structures (Pt.5, Vol.II)
- Rules for Hull (Pt.1, Vol.II)
- Rules for Materials (Pt.1, Vol.V)
- Rules for Welding (Pt.1, Vol.VI)
- Guidelines for Floating Production Installations (Pt.5, Vol.3)
- Guidelines for Spectral-Based Fatigue Analysis (Pt.7, Vol.3)
- Guidelines for Dynamic Loading Approach (Pt.7, Vol.2)
- Guidance for Risk Evaluations for the Classification of Marine-Related Facilities (Pt.4, Vol.A)
- Guidance for Fatigue Assessment of Offshore Structures (Pt.5, Vol.B)
- Guidance for Buckling and Ultimate Strength Assessment for Offshore Structures (Pt.5, Vol.C)
- API RP 2SM, Recommended Practice for Design, Manufacture, Installation, and Maintenance of Synthetic Fiber Ropes for Offshore Mooring.

– API SPEC 17E, Specification for Subsea Umbilicals.
– ISO 19904-1, Petroleum and Natural Gas Industries – Floating Offshore Structures, Part 1: Monohulls, Semi-submersibles and Spars
– IEEE1120, Guide for the Planning, Design, Installation, and Repair of Submarine Power Cable Systems.

B. Classification

1. Scope

The classification of an aquaculture unit or installation covered three major elements which are subject to the requirements of this Guidelines as follows:

1) The hull structure, including:
   – materials
   – hull design and fabrication
   – stability, load line, watertight and weathertight integrity
2) The mooring system or foundation, including:
   – Position mooring system for aquaculture unit or installation is to be provided with additional notation "**POSMOSYS**", either mobile or permanent mooring, for detail see 2.3.2
   – Temporary mooring for self-propeller unit will be provided with symbol ⓘ
3) Onboard machinery including electrical installation, equipment and systems that are not part of the aquaculture systems, unless for aquaculture unit equipped with self – propellered will be assigned with class symbol **SM**.

   If requested by owner, BKI may issue machinery class certificate that mention machinery class symbol and notations that represents the fulfillment of machinery and electrical installations requirements, refer to Guidance for Class Notation (Pt.0, Vol.B).

Aquaculture systems installed in the aquaculture units or installations under the jurisdiction of local authorities are not within the scope of classification and are not covered by the Guidelines. Examples of aquaculture systems include:

1) Fish net pens and associated equipment
2) Fish feeding and production facilities
3) Feedstock facilities
4) Fish escape prevention apparatus

2. Class Designation

2.1 General

The units or installations complying with this Guidelines will be assigned with class designations in accordance with Guidance for Class Notation (Pt.0, Vol.B), Sec.1 as applicable.

– construction symbol
– class symbol
– anchoring equipment symbol
– service area symbol
– ship type notation

– special notation and/or additional notation

2.2 Character Class and Class Notations for Hull

The following class notations apply to the aquaculture units or installations, as defined in 3.1

2.2.1 Units or Installations Built under BKI Supervision

Units or Installations built and constructed to the satisfaction of BKI Surveyors and to the requirements of this Guidelines or to their equivalent, are to be classed and distinguished in the BKI Register by the following class notation as given below:

1) Unit

✠ A100 ⓘ Self-Elevating Unit, Aquaculture

✠ A100 ⓘ Column Stabilized Unit, Aquaculture
POSMOSYS

✠ A100 ⓘ P Barge, Aquaculture
POSMOSYS

✠ A100 ⓘ P Special Service Ship, Aquaculture
POSMOSYS

✠ A100 ⓘ Special Service Ship, Aquaculture
POSMOSYS

2) Installations

A) Floating Structure

✠ A100 Floating Aquaculture Installation (*hull type*), Manned
POSMOSYS, in Java Sea

✠ A100 Floating Aquaculture Installation (*hull type*), Unmanned
POSMOSYS, in Java Sea

The class notation will be appended by one of the following qualifier: Spar-Type, Column-Stabilized Type, Ship-Type to indicate the hull type. The intended service for manned or unmanned installations is defined in 3.2 or 3.3, and the relevant requirements provided in this Guidelines are to be complied with.

B) Fixed Structure

✠ A100 Fixed Aquaculture Installation(*foundation type*), Manned
POSMOSYS, in Java Sea

✠ A100 Fixed Aquaculture Installation (*foundation type*), Unmanned
POSMOSYS, in Java Sea

The class notation will be appended by one of the following qualifier: Pile Foundation or Gravity Foundation to indicate the foundation type. The intended service for manned or unmanned

installations is defined in 3.2 or 3.3, and the relevant requirements provided in this Guidelines are to be complied with.

The hull structural configurations of these unit or installations are described in 3.1. The construction symbol "✠" signifies that the units or installations were built, installed and commissioned to the satisfaction of the BKI Surveyors.

2.2.2 Units or Installations not Built under BKI Supervision

Aquaculture units or installations have been constructed under supervision of and in accordance with rules other recognized Classification Society or Authority, the class symbol, ✠, will be assigned.

For aquaculture units or installations not built under BKI supervision but submitted for classification, are subject to special consideration. Where found satisfactory, such units or installations may be classed with the construction symbol "⊗" signifies that the unit or installation was not built under BKI.

2.3 Additional Class Notations

2.3.1 Site-specific environmental data for Aquaculture Installations.

Site-specific environmental data will be indicated by the additional notation **in** *site* following the basic notation of 2.2.1.2). This additional notation **"in"** will then to be followed by a descriptor of the site. For example, ✠ **A100 Floating Aquaculture Installation (*hull type*), Manned in South Java Sea.**

2.3.2. Position Mooring Systems

The aquaculture units or installations are to be provided with position mooring systems designed to maintain the units or installations on station in all design conditions valid for its intended site of operation. The design mooring systems are to comply with Rules for Mobile Mooring System (Pt.5, Vol.VI) Sec.7 for mobile mooring system or Guidelines for Floating Production Installation (Pt.5, Vol.3), Sec. 6 for permanent mooring system, will be assigned with additional notations **POSMOSYS**.

2.3.3 Automations and Monitoring Systems for Unit and Manned Installations

If requested by owner, units or installations may be assigned **OT-S** and **OT** additional notation in accordance with Rules for Automation (PT.1, Vol.VII). This additional notation will be affixed after machinery class symbol.

2.3.3. Design Life for Aquaculture Installations

Aquaculture installations designed and built to the requirements in this Guidelines and maintained in accordance with the applicable BKI 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 aquaculture 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 Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.4,C.1.1.4 for ship-type aquaculture installations or an acceptable equivalent criteria for non-ship-type installations. BKI will consider additional notation i.e. **HL(number of years)**, where (**number of years**) refers to a design life greater than 20 years (in 5-year increments).

2.3.4 Design Fatigue Life for Aquaculture Installations

Where an aquaculture 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 Guidelines. 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 Guidelines for Floating Production Installation (Pt.5, Vol.3) Table 2.1 or Table 6.4 for hull interface structures or for mooring lines respectively.

The required fatigue strength analysis of critical details and welded joints in aquaculture installations is to be in accordance with Section 4.B. Only one Design fatigue life value notation is to be assigned and published in the Register for the hull, hull interface structure, position mooring system and components. The hull interface structural requirements for ship-type installations are described in Section 4,B.5 and the position mooring system requirements in Section 6.

When spectral fatigue analysis of Section 4, B.5 for ship-type installations or fatigue analysis of Section 4, B.1, B.2, and B.3 for non-ship-type 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-type installations and **FL(number of years), Year** is assigned for non-ship-type installations, where **Year** denotes the year of maturation of fatigue life in the defined site location. The fatigue life will be identified in the Register by the notation **FL(number of years), Year;** For example, the notation **FL(30), 2051** denotes an aquaculture installation built in 2021 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.

2.3.5 Dynamic Loading Approach (DYLA)

Where the system's hull structure has been built to plans reviewed in accordance with the procedure and criteria in the Guidelines for Dynamic Loading Approach (Pt.7, Vol.2) for ship-type aquaculture installations to calculate and evaluate the behavior of hull structures under dynamic loading conditions, in addition to compliance with other requirements of this Guidelines, the installation will be classed and distinguished in the Register by the additional notation **DYLA**. The **DYLA** 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 Guidelines.

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: **DYLA (S100)**. Transit conditions to the intended site are also to be included in the **DYLA** evaluation.

2.3.6 Relocation of Floating Aquaculture Installations

When a floating aquaculture installation is relocated to a new site, either within the same field or in a different operating area, the strength of the installation is to be reassessed to satisfy that the installation will remain in compliance with applicable requirements. In addition, the fatigue life of the installation is to be reassessed to satisfy that the installation's remaining fatigue life for the new operating conditions is within the design fatigue life of the installation. 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.

For detail requirements related relocation of floating aquaculture installations, see Guidelines for Floating Production Installation (Pt.5, Vol.3) Sec.1.A.3.4 or Sec.1.A.3.5 for ship-type installation or for non-ship-type installations respectively.

3. Rules for Classification

3.1 General

The criteria in this Guidelines are applicable to aquaculture units or installations constructed as defined in 1. and further in A.3.1.

The criteria are applicable to those features that mentioned in 1. 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.

3.3 References

References are made in this Guidelines to BKI Rules and other criteria issued by BKI and other organizations. Subsection A.4 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 BKI. 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 Guidelines. Upon the request of the Owner, BKI may at its discretion consider the application of other appropriate alternative methods and recognized codes of practice.

3.4 Alternative Arrangements and Novel Designs.

Alternative arrangements and novel designs may be accepted by BKI, provided that the BKI is satisfied that such construction, equipment, machinery and their arrangement and scantlings are equivalent to those required in this Guidelines. In order to proof of equivalence of alternative arrangements and novel designs, direct calculation or risk evaluation may also be used to demonstrate acceptable level of safety.

Risk evaluations for the justification of alternative arrangements and novel designs may be applicable either to the units or installations as a whole, or to individual systems, subsystems or components. BKI will consider the application of risk evaluations for alternative arrangements and novel features in the design of the aquaculture installations. The BKI Guidance for Risk Evaluations for the Classification of Marine-Related Facilities (Pt.4, Vol.A) provides guidance to BKI clients on how to prepare a risk evaluation to demonstrate equivalency or acceptability for a proposed aquaculture installation.

Portions of the offshore aquaculture units or installations or any of its components thereof not explicitly included in the risk evaluation submitted to BKI are to comply with all applicable parts of the BKI Rules/Guidelines/Guidance. 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.

3.5 Alternative Calculation Methods

Where indicated in specific sections of the Guidelines, alternative calculation methods to those shown in the Guidelines may be accepted provided it is demonstrated that the scantling and arrangements are of at least equivalent strength to those derived using the Rules.

4. Materials and Welding

4.1 Metallic Materials and Welding

Metallic materials and welding are to be in accordance with Rules for Materials (Pt.1, Vol.V) and Rules for Welding (Pt.1, Vol.VI) together with Rules for Mobile Offshore Unit (Pt.5, Vol.VI), Sec.3,B. and Sec.3,C. or Guidelines for Floating Productions Installation (Pt.5, Vol.3) Sec.4,A.3.1.7; Sec.5,A.2.5; and Sec.5,C.5 for aquaculture units or for floating aquaculture installations respectively and with Rules for Structures (Pt.5, Vol.II) Sec.4. for fixed aquaculture installations.

4.2 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 Rules for Materials (Pt.1, Vol.V) Sec.13.C.

4.3 Fiber Ropes

Materials of synthetic fiber ropes for application in the mooring system can be found in the industry recognized standard, such as API RP 2SM.

5. Submission of Plans, Data, Procedures and Calculations

5.1 Design Documents

The design documentation including reports, calculations, plans, procedures and other documentation necessary to verify the structural strength of the unit or installation and adequacy of the mooring systems, marine systems, firefighting systems, machinery and electrical installation, and equipment not associated with the aquaculture items for aquaculture unit is to be submitted in accordance with Rules for Mobile Offshore Unit (Pt.5, Vol.VI), Sec.2.C.2, and for floating aquaculture installation is to be submitted in accordance with Guidelines for Floating Productions Installations (Pt.5, Vol.3) Sec.1,C where applicable.

Plan, procedures and design data for fixed aquaculture installation is to be submitted in accordance with Rules for Structure (Pt.5, Vol.II), Sec.4 where applicable.

Those documents are to be submiteed to BKI in electronic format.

5.2 Operating Manuals

The Operating Manual of the aquaculture unit and installation is to be submitted for review by BKI to verify that operational procedures and conditions are consistent with the design information, criteria and limitations considered in the classification. BKI is not responsible for the operation of the aquaculture unit or installation.

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

For classification purpose, the operating manual for the aquaculture unit is to include the information in accordance with Rules for Mobile Offshore Unit (Pt.5, Vol.VI)Sec.2,C.3, and for the floating aquaculture installation is to include the information in accordance with Guidelines for Floating Productions Installations (Pt.5, Vol.3) Sec.2, C.1.4 & C.1.5 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.

Section 2 Surveys

A. Surveys During Construction, Installation and Commissioning

The applicable parts of requirements in Rules for Mobile Offshore Unit (Pt.5, Vol.VI) Sec.2.C or Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.3.A apply to the BKI approval procedures and the surveys to be performed on any type of aquaculture unit or floating aquaculture installation respectively.

Surveys during the construction, installation and commissioning of the fixed aquaculture installation are to be in accordance with Rules for Fixed Offshore Installation (Part 5,Vol.VII) Sec.1.D & E, as applicable.

B. Surveys After Construction

Surveys after constructions of aquaculture units or installations are to be in accordance with the following:

- Rules for Mobile Offshore Unit (Pt.5, Vol.VI) Sec.2.E for aquaculture units.
- Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.3.B. for floating aquaculture installations.
- Rules for Fixed Offshore Installation (Part 5,Vol.I) Sec.5 for fixed aquaculture installations.

This page intentionally left blank

Section 3 DESIGN AND CONSTRUCTION

A General

1. Introduction

The design and construction of aquaculture units or floating installations are to be in accordance with the applicable requirements in Rules for Mobile Offshore Unit (Pt.5, Vol.VI) Sec.3, and Sec.4, or Guidelines for Floating Product Installations (Pt.5, Vol.3) Sec.2 respectively. The design and construction of fixed aquaculture installations are to be in accordance with the applicable requirements in Rules for Structures (Pt.5, Vol.2) Sec.2, and Sec.3. However, the design criteria, as given in the Guidelines for Floating Product Installations (Pt.5, Vol.3), 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 aquaculture units or 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.

B. Loading Criteria

1. Loads

An installation's modes of operation in pre-service (load out, 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 and fouling. These loads are to be in accordance with Guidelines for Floating Product Installations (Pt.5, Vol.3) Sec.2.B.4, Sec.5.A.1.3.1, and Sec.5.C.1.3.1 for floating aquaculture installations or Rules for Structures (Pt.5, Vol.2) Sec.2 for fixed aquaculture installations.

Design load of aquaculture units refer to Rules for Mobile Offshore Unit (Pt.5, Vol.VI) Sec.4. A.1.

2. Design Conditions

Aquaculture 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 Guidelines for Floating Product Installations (Pt.5, Vol.3) Sec.2.B.3, Sec.5.A.1.3.2, and Sec.5.C.1.3.2 for floating aquaculture installations or Rules for Structures (Pt.5, Vol.2) Sec.2.B for fixed aquaculture installations. However, the design environmental condition (DEC) and additional design conditions for maintenance and inspection of aquaculture installations are to be in accordance with 2.1 or 2.3 for manned installations and 2.2 or 2.4 for unmanned installations.

Design conditions of aquaculture units refer to Rules for Mobile Offshore Unit (Pt.5, Vol.VI) Sec.4. A.2.

2.1 Manned Floating Aquaculture 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 aquaculture 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 aquaculture installations are to be considered as part of Design Operating Condition (DOC) defined in Guidelines for Floating Product Installations (Pt.5, Vol.3) Sec.6.B.1.1.3

2.2 Unmanned Floating Aquaculture 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 aquaculture installations are to be considered as part of Design Operating Condition (DOC) defined in Guidelines for Floating Product Installations (Pt.5, Vol.3) Sec.6.B.1.1.3

2.3 Manned Fixed Aquaculture Installations

The Design Environmental Condition for manned fixed aquaculture is to be in accordance with Rules for Structures (Pt.5, Vol.II) Sec.2.B.

The additional conditions for maintenance and inspection of fixed aquaculture installations are to be considered as part of Operating Environmental Conditions defined in Rules for Structures (Pt.5, Vol.II) Sec.2.B.

2.4 Unmanned Fixed Aquaculture Installations

The Design Environmental Condition for unmanned fixed aquaculture installations is to be in accordance with Rules for Structures (Pt.5, Vol.II) Sec.2.B in association with wind, wave and current loads with 50 years return period.

The additional conditions for maintenance and inspection of fixed aquaculture installations are to be considered as part of Operating Environmental Conditions defined in Rules for Structures (Pt.5, Vol.II) Sec.2.B.

3. Global Structural Analysis

3.1 General

Global structural analysis aquaculture units or installations divided into two types i.e., ship-type and non-ship-type. For ship-type aquaculture units or installations, Global Strength Assessment to be applied see 3.2, while for non-ship type aquaculture units or installations apply Global Performance Analysis in accordance with 3.3.

3.2 Global Strength Assessment

3.2.1 Aquaculture Units

Global strength assessment of aquaculture units refers to Rules for Mobile Offshore Unit (Pt.5, Vol.VI) Sec.4. C.

3.2.2 Floating Aquaculture Installations

Global strength assessment of floating aquaculture installations refers to Guidelines for Floating Product Installations (Pt.5, Vol.3) Sec.4. C.4

3.3 Global Performance Analysis

Global performance analysis of the non-ship-type aquaculture installation is 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 analysis is to be carried out for all critical conditions in the pre-service and in-service phases, represented by the design conditions specified in 2.

Global performance analysis are intended to determine the following parameters:

- Motions of the floating aquaculture installation in six degrees of freedom
- Mooring line tensions, including the maximum and minimum tensions and fatigue loads for mooring component design
- Critical global forces and moments, or equivalent design wave heights and periods as appropriate, for the hull structural analysis
- Hull hydrodynamic pressure loads for global structural analysis

- Accelerations for the determination of inertia loads
- Deck clearance (or Air Gap)

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

- Hydrodynamic analysis for large bodies based on radiation/diffraction theory using panel models
- 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
- 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 analysis 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 analysis 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 analysis. However, for those cases that have highly nonlinear effects, time-domain analysis are normally required.

Common practice in global performance analysis for floating or fixed offshore oil and gas production installations, as summarized in the Guidelines for Floating Product Installations (Pt.5, Vol.3) Sec.5 or Rules for Structures (Pt.5, Vol.II) Sec.3 as well as applicable recognized standards such as those published by API and ISO standards, may be adopted for application to the floating or fixed aquaculture installations respectively.

Global performance analysis of aquaculture units refers to Rules for Mobile Offshore Unit (Pt.5, Vol.VI) Sec.4.

3.3.1 Frequency Domain Analysis

Frequency domain analysis include those in six degrees of freedom of the aquaculture installation in both the wave frequency and the low frequency domains.

In order to evaluate the wave-frequency responses of the floating aquaculture 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 analysis 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 analysis, the viscous drag loads should be linearized and considered in the analysis.

3.3.2 Time Domain Analysis

Time domain analysis is a preferable approach to include the nonlinear effects in global performance analysis of the aquaculture 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 analysis 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.

3.3.3 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 aquaculture installation and waves. The following items are to be considered when determining deck clearance:

- Various environmental headings
- All motions due to wind, waves, and current
- Nonlinearity of wave profile
- Wave diffraction and run-up
- Tide and water level effects
- 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.

3.3.4 Seabed Clearance

A seabed clearance is also to be checked for the floating aquaculture installations to avoid possible contact with the seabed under the design conditions specified in 2.2. The seabed clearance is to be maintained at least 1,0 meters between the lowest point of the floating aquaculture structure and the seabed. The designer is to submit evidence to demonstrate to the satisfaction of BKI that in determining the required seabed clearance, the following items are to be considered.

- Various environmental headings
- All motions due to wind, waves, and current
- Tide and water level effects

- Draft of the installation
- The consistency of the sea bottom material and the characteristics of any protrusion from the sea Bottom
- The level of accuracy of the depth survey data
- Predicted variation of seabed profile due to sediment transport during the design life, where applicable

3.3.5 Interference Check

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

3.3.6 Model Testing

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

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

- Determining the responses of a particular design, such as to calibrate low-frequency damping coefficients.
- Verifying analysis tools for prediction of system responses or simply to correlate the analysis results.
- 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 Guidance for the Corrosion protection and Coating System (Pt.1,Vol.G).

Section 4 Structures

A. General

This Section provides structural requirements to be applied in the design of aquaculture structures. The structural requirements of aquaculture units and 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 Section 3.B for structural design are to be applied along with the requirements specified in this Section.

B. Structural Design Requirements

1. Fixed Aquaculture Installations

The structural design requirements in Rules for Structures (Pt.5, Vol.II) where applicable are to be complied with, along with the following considerations.

- The DEC is to be replaced by Section 3, B.2 for manned and unmanned installations; and
- For unmanned installations, the safety factors for fatigue life of hull structures and topside deck structures are to be replaced by Table 4.1.

Table 4.1 Safety Factors for Fatigue Life of Fixed Aquaculture Installations (Fatigue Design Factors [FDF])

Importance	Inspectable and Repairable	
	Yes	No
Non-Critical	1	3
Critical	3	5

Notes:

1. "Critical" indicates that failure of these structural items would result in the rapid loss of structural integrity and produce an event of unacceptable consequence.
2. A Fatigue Design Factor of 1,0 is applicable to :
   - Inspectable and repairable non-critical structural members above the splash zone
   - Diver or ROV inspectable and repairable redundant framing
3. For critical structure members and fixed aquaculture installations installed above the splash zone, a Fatigue Design Factor of 2,0 may be applied provided that these structures can be inspected during periodic survey or when structural damage is suspected such that critical crack development can be detected and repaired.

Soil investigations and design considerations for the supporting soil and the influence of the soil on the foundation structure for fixed aquaculture installations are to be in accordance with Rules for Structures (Pt.5, Vol.II), Section 7.

2. Spar-Type Aquaculture Installations

The structural design requirements in Guidelines for Floating Production Installation (Pt.5, Vol.3), Sec.5.C.1; 5.C.3; and 5.C.4 are to be complied with, along with the following considerations:

- The DEC is to be replaced by Section 3, B.2 for manned and unmanned installations; and
- For unmanned installations, the safety factors for fatigue life of hull structures and topside deck structures are to be replaced by Table 4.2.

Table 4.2 Safety Factors for Fatigue Life of Spar-Type Aquaculture Installations (Fatigue Design Factors [FDF])

Importance	Inspectable and Repairable	
	Yes	No
Non-Critical	2	3
Critical	3	5

Notes:

1. "Critical" indicates that failure of these structural items would result in the rapid loss of structural integrity and produce an event of unacceptable consequence.
2. A Fatigue Design Factor of 1,0 is applicable to :
   - Inspectable and repairable non-critical structural members above the splash zone
3. For critical structures of the topside structure that is non-integral with the hull structure and the aquaculture structures above the splash zone, FDF = 2,0 may be applied, provided these structures can be inspected during the periodical survey or when structural damage is suspected such that critical crack development can be detected and repaired.

3. Column-Stabilized Type Aquaculture Units or Installations

The structural design requirements of aquaculture installation are to comply with Guidelines for Floating Production Installations (Pt.5, Vol.3), Sec.5.A.1 and 5.A.2, along with the following consideration:

- The DEC is to be replaced by Section 3, B. for manned and unmanned installations; and
- For unmanned installations, the safety factors for fatigue life of hull structures and topside deck structures are to be replaced by Table 4.2.

For aquaculture units refers to Rules for Mobile Offshore Units (Pt.5, Vol. IV), Sec. 5.B.2,

The guidance for performing air gap analysis on aquaculture units and installations is provided in the Rules for Mobile Offshore Units (Pt.5, Vol.VI), Sec.5.B.2.6.

4. Self-elevating Type Aquaculture Units.

The structural design requirements of aquaculture units are to comply with Rules for Mobile Offshore Units (Pt.5, Vol. IV), Sec. 5.A.2.

The guidance for performing air gap analysis on aquaculture units is provided in the Rules for Mobile Offshore Units (Pt.5, Vol.VI), Sec.5.B.2.6.

5. Ship Type Aquaculture Units or Installations

5.1 General

5.1.1 The design and analysis criteria to be applied to the hull structural design are to conform to 5.2 and industry recognized practices of full ship finite element analysis for strength and fatigue assessment acceptable to BKI and 5.2.

5.1.2 The design and analysis of other major hull structural feature and modules on deck are to be in accordance with the applicable requirements of 5.3 and Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.4.A.1, 4.A.4, and 4.A.5 for aquaculture installations and Rules for Mobile Offshore Units (Pt.5, Vol. IV) Sec.5.C.2 for aquaculture units.

5.1.3 Fatigue Life and Additional Structural Analysis for Aquaculture Installations

.1 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 aquaculture 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.

.2 For aquaculture Installations, performance of additional structural analysis in accordance with the Guidelines for Dynamic Loading Approach (Pt.7, Vo.2) can lead to the granting of the optional **DYLA** additional notation, which signifies that the design meets the Dynamic Load Approach criteria. Also, the optional **SFA** additional notation can be granted, which signifies that the design satisfies fatigue strength criteria based on Spectral Fatigue Analysis in accordance with the Guidelines for Spectral Based Fatigue Analysis (Pt.7, Vol.3).

5.2 Initial Minimum Scantlings

The hull structural design requirements for initial minimum scantlings are to be in accordance with Rules for Hull (Pt.1, Vol.II) Sec. 31, B. with the replacement of the longitudinal hull girder strength defined in Rules for Hull (Pt.1, Vol.II) Sec. 31, B. by the following 5.2.1 and 5.2.2:

5.2.1 Section Modulus

The required hull girder section modulus $W_{amidships}$, to the deck and bottom is to be the greater of the values obtained from the following equation or 5.2.2:

$$W_{amidships} = (M_{SW} + M_{WV}) / \sigma_p \qquad [cm^2\text{-m}]$$

where

M_{SW} = maximum still-water bending moment in the governing loaded or ballasted condition [kN-m]

M_{WV} = as specified in Rules for Hull (Pt.1, Vol.II) Sec. 31.B. (for aquaculture units)

= maximum wave induced bending moment expected on-site and during transit to the installation site [kN-m], from the direct calculation in accordance with the Guidelines for Dynamic Loading Approach (Pt.7, Vo.2). (for aquaculture installation only)

σ_p = nominal permissible bending stress [kN/cm^2]

= 17,5 [kN/cm^2]

5.2.2 Minimum Section Modulus

The minimum hull girder section modulus $W_{amidships}$ is not to be less than that obtained from the following equation:

$W_{min} = M_{WV} / \sigma_p$ [cm^2-m] for aquaculture units

$W_{min} = 1{,}59\ M_{WV} / \sigma_p$ [cm^2-m] for aquaculture installations

where

M_{WV} = as defined in 5.2.1 [kN-m]

5.3 Loads and Acceptance Criteria for Structural Design and Analysis for Aquaculture Installations

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 Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.4.A.4 and 4.A.5,.with the following considerations.

- The DEC is to be replaced by Section 3, B.2 for manned and unmanned installations; and
- For unmanned installations, the safety factors for fatigue life of hull structures and topside deck structures are to be replaced by Table 4.2.

Net scantlings are defined as the gross scantlings as denoted in 5.2 minus the Nominal Design Corrosion Values specified in Guidelines for Floating Production Installations (Pt.5, Vol.3), Sec.4.C.1.1.4 for double hull structures, and Guidelines for Floating Production Installations (Pt.5, Vol.3), Sec.4.C.6.1.1 for single hull and double side single bottom structures. Net scantlings are to be used for the DYLA strength assessment procedure and the spectral-based fatigue analysis.

Section 5 Stability

A. Stability and Load Line

1. The intact and damage stability of the floating aquaculture units or installations are to be evaluated in accordance with the requirements of the relevant Flag and Coastal States.

2. The load line of the floating aquaculture units or installations are to comply with the Rules for Mobile Offshore Units (Pt.5, Vol.VI), Sec.6.C, the International Load Line Convention (ILLC) as amended, IMO MODU Code as applicable and MARPOL 73/78 as amended.

3. The stability requirements of aquaculture units and floating aquaculture installations are to meet the requirement as mentioned in Table 5.1. See Guidelines for Floating Production Installations (Pt.5, Vol.3), Sec.2.C.1.5 for general requirements pertaining to the makeup and issuance of loading guidance with respect to stability.

Table 5.1 Stability Requirements for Aquaculture

Aquaculture Type	Stability Requirements					
	IS Code	MODU Code	MARPOL 73/78	ILLC 66 Protocol 88	Rules for MOU (Pt.5, Vol.VI)	Guideline for FPI (Pt.5, Vol.3)
Unit						
Ship type	Part B Chapter 2.6	Chapter 3	Annex I Reg. 27 and Reg. 28	Annex I Chapter I. Reg.1 and Reg. 27	Section 6.A	-
Self-elevating	Part B Chapter 2.6	Chapter 3	-	-	Section 6.A	-
Column stabilized	Part B Chapter 2.6	Chapter 3	-	-	Section 6.A	-
Manned or Unmanned Floating Installation *)						
Ship type	Part B Chapter 2.6	Chapter 3	-	Annex I Chapter I. Reg.1 and Reg. 27	Section 6.A	Section 2.C.1.6
Column stabilized	Part B Chapter 2.6	Chapter 3	-	-	Section 6.A	Section 2.C.1.6 and 5.A.3.
Spar	-	-	-	-	-	Section 5.C.2

Notes:

*) For stability requirements of unmanned floating aquaculture installations (ship type, column stabilized type and spar type), the DEC is to be replaced by Section 3.B.2.

4. The stability analysis is to consider drag forces on the fish net pens due to current or being towed. Analysis is to be performed to verify the fixed aquaculture 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.

5. For large or unique structures, an experimental determination of the centre of gravity of the structure and its means of support, where such exist, is to be performed.

B. Watertight and Weathertight Integrity

Watertight and weathertight integrity and penetrations of aquaculture units and floating aquaculture installations are to be evaluated in accordance with Rules for Mobile Offshore Units (Pt.5, Vol.VI), Sec.6.B.

Watertight and weathertight integrity and penetrations of spar-type aquaculture installations are to be evaluated in accordance with Guidelines for Floating Production Installations (Pt.5, Vol.3), Sec. 5.C.2.2.

Section 6 Mooring Systems

A. General

1. Typically, there are two types of position mooring systems of floating aquaculture installations: a conventional spread mooring system and a single point mooring system, as defined in Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec. 2,A.4.2 and A.4.3. 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 fibre ropes, additional design considerations are defined in the API RP 2SM Design, Manufacture, Installation, and Maintenance of Synthetic Fiber Rope for Offshore Mooring.

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

- Keep the floating aquaculture installation on station at a specific site; and
- Control the directional heading of the floating aquaculture installation if the orientation is important for safety or operational considerations.

2. Mooring systems designs of aquaculture unit may consist temporary mooring and position mooring system as defined in B.

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

4. Towing arrangement for aquaculture unit or installation should meet the appropriate requirements of Rule for Structure (Pt.5, Vol.II) Sec.10.D. or recognized acceptable to BKI and arrangements are to be submitted to BKI for the approval. See also Guidelines for Safe Ocean Towing (Pt.1, Vol.12).

B. Mooring Systems for Aquaculture Units

The definitions, scope and requirements of mooring systems for aquaculture units are to be in accordance with Rules for Mobile Offshore Units (Pt.5,Vol.VI) Sec.7.

C. Mooring Systems for Floating Aquaculture Installations

1. Conventional Spread Mooring Systems

1.1 General

The requirements for conventional spread mooring systems of floating aquaculture installations are to be in accordance with 1.2. for manned installations and 1.3. for unmanned installations.

1.2 Manned Installations

The applicable requirements and criteria for conventional spread mooring systems design in Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.6.B.2 and B.3 are to be complied with.

1.3 Unmanned Installations

The applicable requirements and criteria for conventional spread mooring systems design in Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.6.B.2 and B.3.5 are to be complied with, where the DEC is to be replaced by Section 3.B.2.2.

The safety factors for mooring lines are to be in accordance with Table 6.1. The safety factors for fatigue life of mooring lines are to be in accordance with Table 6.2.

Table 6.1 Safety Factors for Steel Mooring Lines or Tendons

Loading Condition	Redundancy of the Stationkeeping System	Design Condition of the Stationkeeping System	Safety Factor
Design Load Cases	Redundant	Intact	1,67
		Damaged condition with one broken line	1,07
		Transient condition with one broken line	1,07
	Non-redundant	Intact	2,00
Survival Load Cases	Redundant or Non-redundant	Intact	1,07

Table 6.2 Fatigue Design Factors (FDFs) for Fatigue Life of Steel Mooring Lines or Tendons

Redundancy of the Stationkeeping System	Inspectable and Repairable	Fatigue Design Factors
Redundant	Yes	2
	No	5
Non-redundant	Yes	3
	No	10

2. Single Point Mooring Systems

2.1 General

The requirements for single point mooring systems of floating aquaculture installations are to be in accordance with 2.2 for manned installations and 2.3 for unmanned installations.

2.2 Manned Installations

The applicable requirements and criteria of single point mooring systems design in Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.6.B.2, B.3 and C.9 are to be complied with.

2.3 Unmanned Installations

The applicable requirements and criteria for single point mooring systems design of floating aquaculture installations in Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.6.B.2, B.3.5 and C.9 are to be complied with, where the DEC is to be replaced by Section 3.B.2.2.

The safety factors for mooring lines are to be in accordance with Table 6.1. The safety factors for fatigue life of mooring lines are to be in accordance with Table 6.2.

Section 7 Fire Safety, Life-Saving, Machinery and Systems

A. Fire Safety, Life-Saving Appliances and Equipment

1. Aquaculture Units or Aquaculture Manned Installations

For ship type, fire fighting systems and equipment for service functions are to be in accordance with the applicable requirements of Rules for Mobile Offshore Units (Pt.5, Vol.VI) Sec. 9 and Sec. 10 or Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.4.A.6.1.3 for aquaculture units or aquaculture installations respectively.

For column-stabilized type, spar-type and self-elevating type, fire fighting systems and equipment for service functions are to be in accordance with the applicable requirements of Rules for Mobile Offshore Unit (Pt.5, Vol.VI) Sec.10.C.

The requirements of fire safety, life-saving appliances and equipment for aquaculture unit and aquaculture manned installations, are to be in accordance with the applicable requirements of Chapter 9 and Chapter 10 of IMO MODU Code 2009 and Rules for Mobile Offshore Unit (Pt.5, Vol.VI) Sec.10.B and Sec.11.

2. Unmanned Installations

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.

B. Machinery and Equipment

The following applicable requirements of machinery and equipment for aquaculture unit or aquaculture installations are:

- Ship type refers to Rules for Mobile Offshore Units (Pt.5, Vol VI) Sec.8 and Sec.9 for aquaculture units or Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.4.A.6.1.4. for aquaculture installations.
- Column-stabilized type refers to Rules for Mobile Offshore Units (Pt.5, Vol VI) Sec.8 and Sec.9 for aquaculture units or Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.5.A.4.4, for aquaculture installations.
- Self elevating type refers to Rules for Mobile Offshore Units (Pt.5, Vol VI) Sec.8 and Sec.9. for aquaculture units.
- Spar-type refers to Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.5.C.6.4 for aquaculture installations.

C. 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. The applicable requirements of marine piping for aquaculture units or aquaculture installations as follows:

- Ship type refers to Rules for Mobile Offshore Units (Pt.5, Vol VI) Sec.8 and Sec.9. for aquaculture units and Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.4.A.6.1.1. for aquaculture installations
- Column-stabilized type refers to Rules for Mobile Offshore Units (Pt.5, Vol VI) Sec.8 and Sec.9 for aquaculture units or Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.5.A.4.1, for aquaculture installations.
- Self elevating type refers to Rules for Mobile Offshore Units (Pt.5, Vol VI) Sec.8 and Sec.9. for aquaculture units
- Spar-type refers to Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.5.C.6.1 for aquaculture installations.

D. Electrical Systems

1. General

The applicable requirements of electrical systems for aquaculture units or aquaculture installations as follows:

- Ship type refers to Rules for Mobile Offshore Units (Pt.5, Vol VI) Sec.8 and Sec.9. for aquaculture units and Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.4.A.6.1.2. for aquaculture installations
- Column-stabilized type refers to Rules for Mobile Offshore Units (Pt.5, Vol VI) Sec.8 and Sec.9 for aquaculture units or Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.5.A.4.2 and Sec.5.C.6.2, for aquaculture installations.
- Self elevating type refers to Rules for Mobile Offshore Units (Pt.5, Vol VI) Sec.8 and Sec.9. for aquaculture units
- Spar-type refers to Guidelines for Floating Production Installations (Pt.5, Vol.3) Sec.5.C.6.2 for aquaculture installations.

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

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.

2. Aquaculture Units or Aquaculture Manned Installations

2.1 Main Power

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

2.2 Emergency Power

1) 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.
2) 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.
3) Provisions for emergency power supply, less than those listed herein, will be considered, provided adequate technical justification is submitted.
4) Loads to be supplied by the emergency source of power are listed in 2.3 and 2.4.

2.3 Fire Pump

1) If both fire pumps are electric motor driven, one of these pumps is to be powered by the emergency source of power.
2) The emergency source of power is to have sufficient fuel for at least 18 hours of fire pump operation.

2.4 Other Loads

1) Fire detection
   18 hours
2) Communication
   18 hours
3) Paging and alarm system
   18 hours
4) Emergency lighting from all spaces to all alternative egress points
   18 hours
5) Navigational aids
   As required by the applicable Coastal Authority, but not less than 4 days

3. Unmanned Installations

3.1 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.

3.2 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.

E. Electrical Umbilical Cable Systems

The electrical cable system, where applicable, connects the floating aquaculture 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. Dynamic response of the suspended segment of the electrical cable is to be determined in accordance with the requirements of Section 3.B.3.3 for global performance analyses and with consideration of the Section 6 for the mooring system. The electrical cable is to be designed to accommodate the maximum excursion of the floating aquaculture 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 aquaculture 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.

F. Solar Power Systems

Solar power systems equipment, installed on the BKI classed aquaculture units or 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 BKI 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 aquaculture units or installations. BKI 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 BKI.

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