Requirements for Building and Classing

Aquaculture Service Vessels

July 2022

REQUIREMENTS FOR BUILDING AND CLASSING

AQUACULTURE SERVICE VESSELS
JULY 2022

American Bureau of Shipping
Incorporated by Act of Legislature of
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Foreword *(1 July 2022)*

The ABS *Requirements for Building and Classing Aquaculture Service Vessels* contains the requirements for Fish Farm Support Vessels, Fish Pellet Carriers, Live Fish Carriers, Fish Harvest Vessels, Fish Slaughter/ Processing Vessels, Fish Factory Vessels, and Refrigerated Fish Carriers.

This document provides class requirements for the design, construction and survey of self-propelled vessels intended for unrestricted service, so as to obtain the classification notation **ASV-Support**, **ASV-Fish Pellet** or **ASV-Live Fish**. It addresses five major classification elements:

- Structures
- Subdivision and stability
- Fire safety measures and systems
- Equipment and navigation
- Vessel systems and machinery.

This document is to be used in conjunction with the ABS *Rules for Building and Classing Marine Vessels (Marine Vessel Rules)* and applicable Statutory Regulations.

The July 2022 version changes the document type from “Guide” to “Requirements”. “Requirements” documents contain mandatory criteria for Classification and issuance of Class Certificates, while Guides contain only requirements for optional Notations (see 1-1-4/1.5 of the ABS *Rules for Conditions of Classification (Part 1)*). The title is changed from "*Guide for Building and Classing Aquaculture Service Vessels*" to "*Requirements for Building and Classing Aquaculture Service Vessels*". Accordingly, editorial changes are made throughout this document.

This document 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 is the most current.

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

REQUIREMENTS FOR BUILDING AND CLASSING

AQUACULTURE SERVICE VESSELS

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SECTION 1
General

1 Application *(1 June 2020)*

This document is applicable to self-propelled vessels intended for unrestricted service, which are primarily engaged in aquaculture operations. These operations may include, but are not limited to, inspection, maintenance and repair of aquaculture installations, delousing and fish treatment, transportation and distribution of fish pellets, transportation of live fish, harvesting fish, and/or processing fish. The types of vessels listed below are defined in 1/6 and covered in this document.

i) Fish Farm Support Vessels

ii) Fish Pellet Carriers

iii) Live Fish Carriers

iv) Fish Harvest Vessels, Fish Slaughter/Processing Vessels, Fish Factory Vessels or Refrigerated Fish Carriers

Fish Harvest Vessels, Fish Slaughter/Processing Vessels, Fish Factory Vessels or Refrigerated Fish Carriers fitted with refrigerated holds are to comply with the mandatory requirements in Section 6-2-15 of the ABS *Rules for Building and Classing Marine Vessels (Marine Vessel Rules)*. Vessels fitted with ammonia refrigeration systems including plate freezers are to comply with the mandatory requirements of Section 6-2-11 of the *Marine Vessel Rules*. Vessels requesting the optional notation ✠ **RFC** are to comply with 6-2-1/7.1.6 of the *Marine Vessel Rules.*

Other types of vessels will be considered on a case-by-case basis.

ABS may also consider the flag Administration's Ship Safety Regulations as an alternative to satisfying specific portions of the applicable Rules and this document.

2 Classification

The requirements for conditions of classification are contained in the ABS *Rules for Conditions of Classification (Part 1)*. Additional requirements specific to aquaculture service vessels are contained in the following Sections.

2.1 Scope

The classification of an aquaculture service vessel addresses five major elements which are subject to the requirements of this document.

i) Structures

ii) Subdivision and stability

iii) Fire safety measures and systems

iv) Equipment and navigation

v) Vessel systems and machinery

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

2.2 Classification Symbols and Notations

2.2.1 Vessels Built under ABS Survey

Vessels which have been built to the satisfaction of the ABS Surveyors to the requirements as contained in this document for types of vessels described in Section 1, Table 1 and which are approved by the Committee for unrestricted ocean service at the assigned freeboards, will be classed and distinguished in the *Record* by the symbols ✠ A1 followed by the appropriate class notation, **ASV-Support**, **ASV-Fish Pellet** or **ASV-Live Fish**.

TABLE 1
Classification Notations

Types of Vessel	*Classification Notation*	*Requirements for Classification in this Document*
Fish Farm Support Vessel	**ASV-Support**	Sections 1 to 5 & 6/1, 6/6 & Section 8
Fish Pellet Carrier	**ASV-Fish Pellet**	Sections 1 to 5 & 6/1, 6/2 if applicable, 6/6 & Section 8
Live Fish Carrier	**ASV-Live Fish**	Sections 1 to 6 & Section 8

2.2.2 Vessels Not Built under ABS Survey

Vessels which have not been built under ABS survey, but which are submitted for classification, will be subjected to a special classification survey. Where found satisfactory and thereafter approved by the Committee, they will be classed and distinguished in the *Record* by the symbols and notations as described in 1/2.2.1 and the following Sections, but the symbol ✠ signifying survey during construction will be omitted.

2.2.3 ✠ AMS Notation

Machinery, and boilers if installed, which have been constructed and installed to the satisfaction of the ABS Surveyors to the full requirements of the *Marine Vessel Rules*, when found satisfactory after trial and approved by the Committee, will be classed and distinguished in the *Record* by the notation ✠ **AMS**. This notation is mandatory for classification of self-propelled commercial vessels built under ABS survey, classed and distinguished in the *Record* by the symbol ✠ A1.

2.2.4 AMS Notation

Machinery, and boilers if installed on self-propelled vessels, which have not been constructed and installed under ABS survey, but which are submitted for classification, will be subjected to a special classification survey. Where found satisfactory and thereafter approved by the Committee, they will be classed and distinguished in the *Record* by the notation AMS. The symbol ✠ signifying survey during construction will be omitted.

2.2.5 Equipment Symbol

The symbol Ⓔ placed after the symbols of classification, thus: ✠ **A1** Ⓔ, will signify that the equipment of anchors and chain cables of the vessel is in compliance with the requirements in Section 3-5-1 of the *Marine Vessel Rules*. Compliance with Ⓔ requirements is a condition of classification for vessels, for which the equipment number (EN) calculated in accordance with 3-5-1/3 of the *Marine Vessel Rules* is equal to or greater than 205.

Vessels for which EN is less than 205 are not required to have Ⓔ as a condition of classification. (See Section 3-5-3 of the *Marine Vessel Rules*). For vessels under 90 m (295 ft) where the symbol Ⓔ is not desired, see Section 3-5-3 of the *Marine Vessel Rules*.

2.3 Optional Class Notations

Upon the Owner's request, vessels which comply with the ABS Rules and Guides listed below may be assigned the optional class notations described below. The Maltese Cross, ✠, symbol is assigned to vessels for which the hull construction and/or the manufacture of its machinery and components and any associated required testing, as applicable, is carried out under ABS survey. For a vessel constructed under survey of another recognized Classification Society or Authority, the Maltese Cross, ✠, symbol will be omitted from the hull and/or machinery classification notations.

A listing of Classification Symbols and Notations available to the Owners of vessels may be viewed and downloaded from the ABS website: http://www.eagle.org. This Section introduces notations that may be common for Aquaculture Service Vessels. Additional and/or optional classification symbols and notations are described in the Rules and Guides governing marine vessels.

2.3.1 Automatic Bridge Centralized Control Unmanned, ✠ ABCU

The **A**utomatic **B**ridge **C**entralized **C**ontrol **U**nmanned notation ABCU indicates that a self-propelled vessel is fitted with the required automation and remote monitoring and control systems to enable the propulsion machinery space to be periodically unattended (similar to an ACCU classed vessel) and the propulsion control to be effected primarily from the navigation bridge, and signifies compliance with the requirements of Section 4-9-7 of the *Marine Vessel Rules*.

2.3.2 Automatic Centralized Control, ✠ ACC

The **A**utomatic **C**entralized **C**ontrol notation **ACC** indicates that a vessel has the means to control and monitor the propulsion-machinery space from a continuously manned centralized control and monitoring station installed within or adjacent to, the propulsion machinery space and signifies compliance with the requirements of Section 4-9-5 of the *Marine Vessel Rules*.

2.3.3 Automatic Centralized Control Unmanned, ✠ ACCU

The **A**utomatic **C**entralized **C**ontrol **U**nmanned notation **ACCU** indicates that a vessel has the means to control and monitor the propulsion-machinery space from the navigation bridge and from a centralized control and monitoring station installed within or adjacent to, the propulsion machinery space and signifies compliance with the requirements of Section 4-9-6 of the *Marine Vessel Rules*.

2.3.4 Crane Register Certificate, ✠ CRC

The **C**rane **R**egister **C**ertificate notation **CRC** signifies that an ABS Register of Lifting Appliances is issued under the provisions of the ABS *Guide for Certification of Lifting Appliances*.

2.3.5 Athwartship Thruster, ✠ APS

This notation **APS** indicates that a self-propelled vessel is fitted with athwartship thrusters intended to assist in the maneuvering of the vessel and signifies compliance with the applicable requirements of Section 4-3-5 of the *Marine Vessel Rules*.

2.3.6 Dynamic Positioning System, ✠ DPS-1, DPS-2, DPS-3

The **D**ynamic **P**ositioning **S**ystem notation **DPS-1**, **DPS-2** or **DPS-3** indicates that a self-propelled vessel is fitted with a system of thrusters, positioning instruments and control systems with a centralized manual position control and automatic heading control to maintain a desired position and heading at sea without external aid under specified maximum environmental conditions, and that the systems are in accordance with the applicable requirements of the ABS *Guide for Dynamic Positioning Systems*.

2.3.7 Underwater Noise Notation, ✠ UWN

The Underwater Noise Notation (**UWN**) indicates that the vessel complies with underwater noise criteria. Two different **UWN** notations **UWN(T)** and **UWN(Q),** are available. The notation **UWN (T)** and/or **UWN (Q)** can be assigned provided the vessel can meet the underwater noise criteria under Transit conditions for normal operation and/or Quiet Operation conditions for low speed operation in environmentally sensitive areas. If the vessel can meet more stringent underwater noise criteria, the **UWN+ (T)** and/or **UWN+ (Q)** notations can be assigned. Requisite criteria are specified in the ABS *Guide for the Classification Notation Underwater Noise and External Airborne Noise*.

2.3.8

Aquaculture service vessels with more than twelve (12) Special Personnel are to comply with the requirements of the flag Administration. At the request of the Owner, the **SPS** notation will be assigned if the vessel complies with Section 5D-1-2 of the *Marine Vessel Rules*. Other standards acceptable to the flag Administration will also be considered.

2.4 Strengthening for Navigation in Ice

Where it is intended to strengthen the vessel for navigating independently in ice-covered Polar waters, and the Owner desires a notation in the *Record*, the vessel is to comply with the requirements in Part 6, Chapter 1 of the *Marine Vessel Rules*. It is the responsibility of the Owner to determine which ice class is most suitable for his intended service.

2.5 Vessels Using Gases or Other Low-Flashpoint Fuels

Where a vessel is arranged to burn natural gas as fuel or a low flashpoint fuel other than natural gas for propulsion or auxiliary purposes, the vessel is to comply with the requirements in Part 5C, Chapter 13 of the *Marine Vessel Rules*.

2.6 Novel Features

Aquaculture service vessels, machinery and systems which contain alternative arrangements and novel features of design to which the provisions of this document are not directly applicable may be classed, when approved by the Committee, on the basis that this document, insofar as applicable, has been complied with and that special consideration has been given to the novel features, based on the best information available at that time.

Risk evaluations for the justification of alternative arrangements or novel features may be applicable either to the aquaculture service vessel as a whole, or to individual systems, subsystems, equipment or components. The ABS *Guidance Notes on Review and Approval of Novel Concepts* and ABS *Guidance Notes on Risk Assessment Applications for the Marine and Offshore Industries* provide guidance on how to prepare a risk evaluation to demonstrate equivalency or acceptability for proposed novel features and alternative aquaculture service vessel design.

2.7 Administration Requirements

Requirements additional to those given in each Section of this document may be imposed by the National Administration with whom the vessel is registered or by the Administration within whose territorial jurisdiction the vessel is intended to operate.

Approval of structural fire protection, fire extinguishing systems, and/or stability of the vessel by a National Administration, in accordance with requirements equivalent to those by class, may be considered as complying with the class requirements provided such approval can be satisfactorily documented.

2.8 Selection of Class Notations

It is the responsibility of the Owner to select the class notations most suitable for the intended service and to operate the vessel in a safe environment with respect to the risk of fire and explosion. Vessels intended

for multiple services may be classed with combinations of the applicable notations for the relevant services.

3 Optional Certification of Equipment and Systems

The equipment and systems designed for specific aquaculture operations such as fish loading and unloading systems, plate freezers, or delousing treatment systems, including those intended for temporary installation on board vessels classed with ABS may be certified according to the applicable requirements in Section 7, upon request by the Owner.

4 Materials

For fish farm support vessels, the materials used are to be in accordance with the ABS *Rules for Materials and Welding (Part 2)*. If fish farm support vessels are intended to carry limited amounts of hazardous and noxious liquid substances, the materials of construction are to be in accordance with 5D-2-3/9.11 of the *Marine Vessel Rules.*

For fish pellet carriers, the materials used are to be in accordance with the ABS *Rules for Materials and Welding (Part 2)*. Where a fish pellet carrier intended to carry refrigerated pellets, the additional requirements for materials are provided in 6-2-3/5 of the *Marine Vessel Rules.*

For live fish carriers, the materials used are to be in accordance with the ABS *Rules for Materials and Welding (Part 2)* and 5C-11-1/7 of the *Marine Vessel Rules.*

5 Submission of Plans

Hull and machinery plans, as required below, are to be submitted to ABS for review and approval. Plans from designers and shipbuilders should generally be submitted electronically. However, hard copies will also be accepted. All plan submissions originating from manufacturers are understood to be made with the cognizance of the shipbuilder.

5.1 Hull Plans

Plans showing the arrangements, scantlings, details of principal parts of the hull structure, and welding details of each vessel to be built under survey are to be submitted and approved before construction is commenced. These plans are also to include such particulars as the design draft and design speed. Where provision is to be made for any special type of cargo or for any exceptional conditions of loading, particulars of the weights and of their distribution are also to be given. In general, the plans as specified in 1-1-7/1 of the ABS *Rules for Conditions of Classification (Part 1)* together with the subdivision and stability drawings and documents as specified in 3-3-1/5 of the *Marine Vessel Rules* are to be submitted for review or reference.

5.2 Machinery Plans and Data

Plans, test plans, and data required to be submitted to ABS for review and approval are listed in Part 4 of the *Marine Vessel Rules* and Section 6 of this document, as applicable.

5.3 Additional Plans

Additional plans to be submitted for the type of vessel are given in 1/5.3.1 to 1/5.3.3. Where optional equipment and system certification under Section 7 is requested, submission of additional plans and calculations may be required.

5.3.1 Fish Farm Support Vessels

i) The following calculations are to be submitted:

- Calculations to demonstrate the adequacy of the vessel's stability during aquaculture operations. See also Section 3.
- Calculations to demonstrate the strength of the crane supporting structures.

- Calculations to demonstrate the strength of supporting structures for equipment applied in aquaculture operations, if applicable.

ii) The following items are to be submitted:

- Information regarding loading arrangement of deck cargoes, weights, and their centers of gravity, if applicable.
- Structural details and arrangements of structures in way of cargo deck, if applicable
- Lashing arrangement of deck cargoes, if applicable
- Details of integral liquid cargo tanks including vents and/or overflows height and location
- Details of independent liquid and/or dry cargo tanks
- Details of independent tank supports and fastening arrangements
- Piping diagrams of liquid cargo transfer systems
- Piping diagrams of dry bulk cargo transfer systems

5.3.2 Fish Pellet Carriers

i) The calculations and plans listed in 1/5.3.1 are to be submitted.

ii) The plans for refrigerated cargo spaces listed in 6-2-2/3 of the *Marine Vessel Rules*, and the refrigeration system and refrigeration machinery spaces listed in 6-2-2/5 of the *Marine Vessel Rules* are to be submitted if applicable.

5.3.3 Live Fish Carriers

i) The calculations and plans listed in 1/5.3.1 are to be submitted.

ii) The plans for refrigeration systems and refrigeration machinery spaces listed in 6-2-2/5 of the *Marine Vessel Rules* are to be submitted if applicable.

iii) The following hull and machinery plans are to be submitted if applicable:

- Fish tank arrangements and details
- Fish tank construction and material details
- Details of fish tank coating
- Fish pumping arrangements
- Piping diagrams of fish transfer systems
- Recirculation and oxygenation system diagram for the carriage of live fish
- Fish tank stripping system
- Fish tank venting system
- Fish tank washing system (if installed)
- Fish tank water level monitoring system
- Fish tank sounding system
- Fish tank water control system

6 Definitions *(1 June 2020)*

Aquaculture Service Vessels. Vessels intended to primarily engaged in aquaculture operations include fish farm support vessels, fish pellet carriers and live fish carriers.

Fish Farm Support Vessel. A multi-role vessel engaged primarily in aquaculture installation support capable of inspection, maintenance and repair of aquaculture installations, fish delousing, fish pellet carriage, and/or harvesting fish.

Fish Pellet Carrier. A vessel with cargo holds for storing and transporting fish pellets from onshore facilities to aquaculture installations.

Live Fish Carrier. A vessel equipped with systems and tanks for loading, unloading, storing and carrying live fish.

Fish Harvest Vessel, Refrigerated Fish Carrier, Fish Slaughter/Processing Vessel or Fish Factory Vessel. Fishing vessel, fish processing vessel, or mother ship of a fishing fleet, which is provided with facilities for freezing fish and fish products.

Special Personnel. All persons who are not passengers or members of the crew or children under one year of age and who are carried on board in connection with the special purpose of a vessel or because of special work being carried out aboard that vessel.

7 Abbreviations and References

7.1 Abbreviations of Organizations

ABS : American Bureau of Shipping

FAO : Food and Agriculture Organization of the United Nations

HNLS : Hazardous and Noxious Liquid Substances

IMO : International Maritime Organization

IMDG : International Maritime Dangerous Goods

MARPOL : International Convention for the Prevention of Pollution

SOLAS : International Convention for the Safety of Life at Sea

OIE : World Organization for Animal Health

7.2 References *(1 June 2020)*

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

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

iii) ABS *Guide for Dynamic Positioning Systems*

iv) ABS *Guide for Certification of Lifting Appliances*

v) ABS *Requirements for Building and Classing Aquaculture Installations*

vi) ABS *Guide the Classification Notation Underwater Noise and External Airborne Noise*

vii) ABS *Guidance Notes on Review and Approval of Novel Concepts*

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

ix) ABS *Guidance Notes on the Application and Maintenance of Marine Coating Systems*

x) IMO *Code of Safety for Special Purpose Ships (SPS Code)*

xi) ISO 22000, *Food Safety Management Systems - Requirements for any organization in the food chain*

xii) World Organization for Animal Health, *Aquatic Animal Health Code*

SECTION 2
Structures

1 Hull Structures and Arrangement

1.1 Fish Farm Support Vessels

In general, fish farm support vessels are to comply with the applicable requirements for an offshore support vessel as described in Part 3, Chapter 2 of the *Marine Vessel Rules*.

The design of a fish farm support vessel is to be in accordance with Section 5D-2-2 of the *Marine Vessel Rules*, where applicable. Where the vessel is intended to carry Hazardous and Noxious Liquid Substances (HNLS) and dangerous goods covered by the International Maritime Dangerous Goods (IMDG) Code, the requirements are provided in Section 5D-2-3 of the *Marine Vessel Rules.*

1.2 Fish Pellet Carriers

In general, fish pellet carriers are to comply with the applicable requirements for an offshore support vessel as described in Part 3, Chapter 2 of the *Marine Vessel Rules*.

The design of a fish pellet carrier is to be in accordance with Section 5D-2-2 of the *Marine Vessel Rules* with the following considerations, where applicable.

i) Where dry cargo tanks for fish pellets are fitted, these cargo tanks are to be separated from Category A machinery spaces, accommodation spaces, and service spaces by watertight bulkheads and decks.

ii) Where a fish pellet carrier is intended to carry refrigerated pellets, the additional requirements for hull construction are provided in Section 6-2-3 of the *Marine Vessel Rules*.

Part 6 of the *Marine Vessel Rules* contains both mandatory and optional requirements. Note that the mandatory requirements in Section 6-2-3 of the *Marine Vessel Rules* are clearly identified in italics as conditions of classification.

1.3 Live Fish Carriers

In general, the design of live fish carriers is to be in accordance with Section 5C-11-2 of the *Marine Vessel Rules*. Independent cargo tanks are not covered within the class scope. However, where independent tanks are to be used, supports of independent cargo tanks are to be provided such that the stresses in supporting members and hull structures are within the allowable limits specified in 5D-2-2/1.3 of the *Marine Vessel Rules*.

In view of the nature of the intended cargo, double hull structures are not required. The applicable requirements for hull construction and arrangement are provided in Section 5C-11-3 and Appendix 5C-11-A1 of the *Marine Vessel Rules*. Cofferdams are required for segregation of water cargo from other liquids, such as oil products required for operation of the vessel (e.g., common boundaries with fuel tanks).

Cargo tanks are in general to be completely filled with water. Special consideration may be given to the scantlings of cargo tanks intended to be partially filled with water, and the loading particulars are to be submitted.

2 Supporting Structure for Cranes

The design of crane supporting structure is to comply with the requirements of 5D-9-3/7 of the *Marine Vessel Rules*.

3 Refrigerated Cargo Spaces

Where refrigerated spaces are provided, the applicable requirements of the refrigerated spaces in Section 6-2-5 of the *Marine Vessel Rules* are to be complied with.

Part 6 of the *Marine Vessel Rules* contains both mandatory and optional requirements. Note that the mandatory requirements in Section 6-2-5 of the *Marine Vessel Rules* are clearly identified in italics as conditions of classification.

Equipment and fittings such as electric lights, etc., are to be suitably protected to prevent damage during loading and unloading of cargo.

4 Refrigerated Sea Water Tanks

Where refrigerated sea water tanks are provided, the applicable requirements in 6-2-15/13 of the *Marine Vessel Rules* are to be complied with.

SECTION 3
Subdivision and Stability

1 General

1.1 General

In addition to complying with the stability criteria in Subsection 3/2, the guidance provided in 3/1.2 and 3/1.3 is to be followed.

Where large and heavy equipment or structures are intended to be stowed on deck, the estimated weight and height of the center of gravity in the worst possible scenario are to be considered in the stability analysis.

Stability calculations and corresponding information for the Master are to be submitted for review and approval. The submission of evidence showing approval by an Administration of stability of the vessel for aquaculture operations in accordance with a recognized standard may be accepted in lieu of a review of stability by ABS.

The dynamic load chart for each crane is to be included in the Trim and Stability Booklet and is to be posted at the crane operator's station in the clear view of the crane operator.

1.2 Deck Cargo

The stability of the vessel due to deck cargo on board is to be taken into account:

i) The loading conditions are to cover the full range of operating configurations, from no deck cargo to the maximum design deck load on board.

ii) The projected area of the deck cargo is to be included in the calculations for compliance with the Severe Wind and Rolling Criteria. Refer to 3-3-A2/3.3 of the *Marine Vessel Rules*.

iii) If the vessel is intended to carry deck cargoes that may accumulate water, such as open cargo bins, the appropriate free surface correction is to be applied to all conditions.

iv) If pipes are carried as deck cargo, refer to 3-3-A2/7 of the *Marine Vessel Rules*.

1.3 Loading Conditions

Loading conditions covering departure and arrival in full load as well as ballast conditions, along with anticipated operational or intermediate conditions onsite are to be included in the Trim and Stability Booklet of the vessel.

2 Intact and Damage Stability

2.1 Fish Farm Support Vessels

The subdivision and stability of the fish farm support vessel are to be in accordance with the requirements applicable to an offshore support vessel in Part 3, Chapter 3 of the *Marine Vessel Rules*.

Where the fish farm support vessel is engaged in the catching, taking or harvesting of fish, the additional requirements in Section 5C-18-3 of the *Marine Vessel Rules* are to be complied with.

2.2 Fish Pellet Carriers

The subdivision and stability of the fish pellet carrier are to be in accordance with the requirements applicable to an offshore support vessel in Part 3, Chapter 3 of the *Marine Vessel Rules*.

2.3 Live Fish Carriers

The subdivision and stability of the live fish carrier are to be in accordance with the intact stability requirements applicable to an offshore support vessel in Part 3, Chapter 3 of the *Marine Vessel Rules* and the damage stability requirements in Appendix 3-3-A5 of the *Marine Vessel Rules*.

In addition, intact stability of live fish carriers during liquid transfer operation is to be in accordance with Appendix 3-3-A1 of the *Marine Vessel Rules.*

2.4 Damage Stability Consideration

For aquaculture service vessels, piping serving tanks and dry spaces, where installed within zones of assumed damage under damage stability conditions, is also to be considered damaged. Damage to such piping is not to lead to progressive flooding of spaces not assumed damaged. If it is not practicable to route piping outside the zone of assumed damage, then means are to be provided to prevent progressive flooding. Such means, for example, may be the provision of a remotely operated valve in the affected piping. Alternatively, intact spaces that can be so flooded are to be assumed flooded in the damage stability conditions.

In addition, where open-ended piping systems are located below the bulkhead deck and penetrate watertight subdivision bulkheads, means operable from above the bulkhead deck are to be provided to prevent progressive flooding through those piping systems which remain intact following damage to the vessel.

SECTION 4
Fire Safety

1 Structural Fire Protection

For fish farm support vessels and fish pellet carriers, the requirements of structural fire protection are to be in accordance with those applicable to an offshore support vessel in Part 3, Chapter 4 of the *Marine Vessel Rules*.

For live fish carriers, the requirements of structural fire protection are to be in accordance with those applicable to a cargo vessel in Part 3, Chapter 4 of the *Marine Vessel Rules*.

2 Fire Safety Systems

Aquaculture service vessels are to comply with the requirements of fire safety systems in Part 4, Chapter 7 of the *Marine Vessel Rules.*

3 Refrigerated Cargo Spaces, Refrigeration Machinery Spaces or Refrigerant Storage Space

Fire extinguishing systems and equipment for refrigerated cargo spaces, refrigeration machinery spaces or refrigerant storage spaces are to be in accordance with the requirements in Section 6-2-8 of the *Marine Vessel Rules.*

Part 6 of the *Marine Vessel Rules* contains both mandatory and optional requirements. Note that the mandatory requirements in Section 6-2-8 of the *Marine Vessel Rules* are clearly identified in italics as conditions of classification.

SECTION 5

Equipment and Navigation

1 Anchoring, Mooring, and Towing Equipment

Aquaculture service vessels are to have complete equipment of anchors and chains that comply with the requirements in Part 3, Chapter 5 of the *Marine Vessel Rules* and 1/2.2.5.

2 Navigation

Aquaculture service vessels are to comply with the requirements of navigation in Part 3, Chapter 6 of the *Marine Vessel Rules.*

SECTION 6
Vessel Systems and Machinery

1 General Requirements

For aquaculture service vessels, prime movers, propulsion and maneuvering machinery, boilers, deck machinery, bilge, fuel transfer, piping and electrical systems are to be in accordance with the applicable sections of Part 4 of the *Marine Vessels Rules*.

2 Refrigeration Systems

Part 6 of the *Marine Vessel Rules* contains both mandatory and optional requirements. Note that the mandatory requirements in Section 6-2-6 and Section 6-2-11 of the *Marine Vessel Rules* are clearly identified in italics as conditions of classification.

i) The refrigeration plant is to be in accordance with Section 6-2-6 of the *Marine Vessel Rules*, as applicable.

ii) For spaces containing toxic refrigerants, see the applicable sections of Section 6-2-11 of the *Marine Vessel Rules*.

iii) In general, the refrigeration units and associated equipment which contain toxic refrigerants are to be located in a dedicated space. However, where separated spaces for toxic refrigerants are not practicable, the subject refrigerating machinery may be installed in the machinery spaces provided that:

- ***a)*** Leak detection and water spray systems are installed.
- ***b)*** Suitable ventilation arrangements are provided in combination with appropriate gas detectors fitted to ensure proper operations.
- ***c)*** Protection of the refrigeration machinery from damage is provided.

3 Ancillary Systems for Live Fish Tanks

3.1 Live Fish Tank Sounding Arrangement

Live fish tanks are to be provided with means for assessing the liquid levels in the tanks. Where permanent sounding arrangements are provided, remote level indicating is to be provided in the fish tank control room or navigation bridge. When the air bubbling type level gauging system is installed in the fish tank, the air is to be from a location on the weather decks with a suction strainer. The air pumping system is to be such that the air will not be contaminated by the air pump lubricant.

3.2 Live Fish Tank Ventilation Arrangement

Tank vents are to comply with 4-6-4/9 of the *Marine Vessel Rules*. An insect screen is to be provided for each vent outlet. The screens to keep bugs out of the vents are to be of dimensions 16 mesh to 25.4 mm (a mesh of 16 wires per inch).

3.3 Additional Considerations for the Bilge System

i) Bilge wells are to be provided in each live fish tank.

ii) Audible and visual alarms for the bilge system are to be provided in the fish tank control room or navigation bridge. Upon completion of the installation, the alarms are to be tested to the satisfaction of the attending Surveyor.

iii) Bilge wells, in bow and stern machinery spaces as applicable, are also to be provided with bilge alarms to warn of high bilge water level at the fish tank control room or at the navigation bridge. Upon completion of the installation, the alarms are to be tested to the satisfaction of the attending Surveyor.

4 Live Fish Loading and Unloading Systems

4.1 Live Fish Piping

i) Pipes, valves, and fittings in the system are to comply with the applicable requirements of Part 4, Chapter 6 of the *Marine Vessel Rules*.

ii) Means are to be provided for isolation of each fish tank in the loading and unloading lines.

4.2 Live Fish Pumps

i) A fixed live fish loading and unloading system is to be fitted.

ii) There is to be a minimum of two pumps capable of taking suction from each fish tank.

iii) Where submersible pumps are used, only one fish pump per tank may be used, provided that an alternative method of pumping fish is available on board the vessel. This alternative method may be by means of pressurizing the fish tanks.

4.3 Miscellaneous Piping Systems

In general, miscellaneous piping systems, such as food feeding and water transfer, between the vessel and a farm facility, their interfaces with piping components (i.e., tubes, flanges, gaskets, bolting, hoses, expansion joints, sight flow glasses, filters, strainers, accumulators, instruments connected to pipes, etc.) and connections are to comply with the applicable requirements of Part 4, Chapter 6 of the *Marine Vessel Rules*. Alternatively, other recognized standards may be accepted provided that such component and connection designs and arrangements are being determined by ABS as not less effective.

5 Live Fish Tank Water Control Systems

5.1 General

Live fish tanks are to be fitted with oxygen supply and continuous flow of water, in order to maintain the levels of carbon dioxide (CO_2) and pH so that the fish health condition is preserved during the vessel's loading/unloading and transporting operations.

5.2 Control and Instrumentation

Instruments for monitoring the live fish tank are to be provided in the fish tank control room or navigation bridge, as indicated in Section 6, Table 1. All alarms are to be audible and visual and are to be of the self-monitoring type so that a circuit failure will cause an alarm condition. There are to be provisions for testing the alarms.

TABLE 1
Live Fish Tank Monitoring and Instrumentation

System	*Monitored Parameter*
Water Circulation	Pressure or Flow – Low/High
Oxygen Supply	Oxygenation – Low/High
Water Treatment	Carbon Dioxide (CO_2) – Low/High
	pH – Low/High
Water Supply	Pressure or Flow – Low/High

6 Examination and Testing

6.1 General

i) All systems and equipment installed on board are to be surveyed and tested in accordance with applicable Sections of Part 4 of the *Marine Vessels Rules*.

ii) All piping systems in Section 6 are to be leak tested in the presence of the Surveyor under working conditions after installation. Where necessary, other techniques of tightness testing in lieu of working pressure test may be considered.

6.2 Specific Systems

The following piping systems are to be hydrostatically tested in the presence of the Surveyor under working conditions after installation and checked for leakage. Where necessary, other techniques of tightness testing in lieu of working pressure test may be considered.

- Water circulation systems
- Live Fish Tank piping system
- Oxygen piping system
- Bilge piping system (See 4-6-2/7.3.3 and 3-7-2/3 of the *Marine Vessels Rules* for bilge system trials)

6.3 Test Plan

A test plan is to be developed by the manufacturer and is to be submitted to the ABS office responsible for performing the plan review at the start of the plan review process. Copies of the test plan are to be submitted to the ABS Survey Office responsible for witnessing the tests and trials for the vessel, prior to performing any tests or trials. The test plan is to identify all equipment and systems and the recommended method of performing the tests or trials by the manufacturer.

6.4 Surveys During Construction

All systems and equipment described in Section 6 are to be examined and tested to the satisfaction of the attending Surveyor during construction and final installation on board in accordance with the approved documentation and the above test plan.

SECTION 7

Optional Equipment and Systems Certification

1 General

Application of the requirements of this Section is optional. The following equipment and systems used on board the vessel may be certified by ABS, upon request by the Owner.

1.1 Delousing Treatment System

In order to remove lice from wild fish, a delousing treatment system is used. The certification requirements are to be provided in accordance with the applicable items in Section 7, Table 1.

1.2 Feeding System

The equipment on board for the storage of food and feeding system are used for salmon and live fish. The certification requirements are to be provided in accordance with the applicable items in Section 7, Table 1.

TABLE 1
Optional Certification Details

System	*Items*	*Typical Standards*	*Rule Reference*
Delousing Treatment System	Pumps	Manufacturer's standard or National or International Standards or Codes	
	Pipes, Pipe Fittings and Valves	Manufacturer's standard or National or International Standards or Codes	4-6-1 and 4-6-2 of the *Marine Vessel Rules*, as applicable
	Motor and Electrical System	Manufacturer's standard or National or International Standards or Codes	4-8-2 of the *Marine Vessel Rules*, as applicable
	Filter and Counting System	Manufacturer's standard or National or International Standards or Codes	
	Heating and Temperature Control System	Manufacturer's standard or National or International Standards or Codes	

System	*Items*	*Typical Standards*	*Rule Reference*
Feeding System	Transport Pipes, Fittings and Feed Valves	Manufacturer's standard or National or International Standards or Codes	4-6-1 and 4-6-2 of the *Marine Vessel Rules*, as applicable
	Motor, Electrical Equipment and Programmable Logic Controller (PLC)	Manufacturer's standard or National or International Standards or Codes	4-8-2 of the *Marine Vessel Rules*, as applicable
	Food Cooling System	Manufacturer's standard or National or International Standards or Codes	
	Food Storage System	Manufacturer's standard or National or International Standards or Codes	
	Feeding Control System	Manufacturer's standard or National or International Standards or Codes	
	Air Blower	Manufacturer's standard or National or International Standards or Codes	

2 Approval Process

The ABS certification requirements for systems and equipment are a three-step process as outlined below:

i) Design review of the systems and equipment, including installation

ii) Survey of systems and equipment at vendor's shop during manufacturing process

iii) Survey of installation and commissioning on board the vessel

The ABS review process for systems and equipment commences with drawings and documentation detailing the general arrangements/assembly drawings of equipment, structural fire protection of enclosures where applicable, electrical configuration, structural design, machinery and piping systems being submitted to the ABS Technical Office for engineering review. Upon completion of the technical review, the submitter will be notified, and the reviewed drawings and documentation will be made available to the attending ABS Surveyor.

After the equipment has been selected for the specific aquaculture service vessel, the design review for installation approval can be commenced. Upon receipt of the documentation detailing the systems and equipment and the proposed location on board the vessel, the ABS Technical Office can review the arrangements. Once the ABS engineers have determined that the proposed location on board the vessel is acceptable for the subject systems and equipment, the proposal will be accepted and made available to the attending ABS Survey Office. Upon receipt of these drawings, the ABS Surveyor will attend the vessel to confirm that the installation of the equipment is in accordance with the previously approved arrangements.

3 Examination and Testing

3.1 Test Plan

A test plan is to be developed by the manufacturer and is to be submitted to the ABS office responsible for performing the plan review at the start of the plan review process. Copies of the test plan are to be submitted to the ABS Survey Office responsible for witnessing the tests and trials for the vessel, prior to

performing any tests or trials. The test plan is to identify all equipment and systems and the recommended method of performing the tests or trials by the manufacturer.

3.2 Survey

All systems described in Section 7 are to be examined and tested to the satisfaction of the attending Surveyor in accordance with the approved documentation and the above test plan.

1 Testing, Trials and Surveys During Construction

Tank, bulkhead and rudder tightness testing is to be carried out in accordance with Section 3-7-1 of the *Marine Vessel Rules.*

In general, equipment, components, and systems are to be tested during trials in accordance with the applicable Sections of Part 4 of the *Marine Vessel Rules*.

The systems and equipment described in Section 6 are to be examined and tested to the satisfaction of the attending Surveyor in accordance with Subsection 6/6.

The systems and equipment described in Section 7 are to be examined and tested to the satisfaction of the attending Surveyor in accordance with Subsection 7/3.

Anchor windlass trials, bilge system trials, and steering trials are to be carried out in accordance with Section 3-7-2 of the *Marine Vessel Rules.*

Surveys of hull construction, hull construction welding and fabrication, and hull castings and forgings are to be carried out in accordance with Section 3-7-3 of the *Marine Vessel Rules.*

2 Surveys After Construction

2.1 General

Surveys after construction are to be carried out in accordance with the ABS *Rules for Surveys After Construction (Part 7).*

Annual or Renewal surveys after construction are also to be carried out for systems and equipment as referred to in Section 6 and 7, as applicable.

2.2 Annual Surveys

2.2.1 Refrigeration Installation

The cargo refrigeration installation is to be generally examined so far as can be seen and placed in satisfactory condition. This is to include an examination and test of the machinery under working conditions and should include the following:

2.2.1(a) Liquid and Gas Piping.

Liquid and gas piping together with their respective valves, receivers, separators, condensers, and evaporator coil terminals are to be examined externally as far as practicable.

2.2.1(b) Direct-Expansion System.

Where a direct-expansion system is employed, the cooling coils are to be examined under working conditions.

2.2.1(c) Brine System.

The brine return tanks, brine pumps, piping, and valves are to be examined as far as practicable. Where brine may escape to bilges, the cement, where fitted, is to be examined.

2.2.1(d) Insulation.

The insulation is to be carefully examined and bored where considered necessary, particularly under the line of decks and side stringers in order to determine fullness and dryness. The test holes are to be subsequently closed. The cargo battens and gratings, where fitted, are to be examined.

2.2.1(e) Cargo Gratings.

The cargo gratings are to be examined. All limbers are to be removed, the bilge or bilge wells cleaned, and the suction and sounding pipes examined. All hatches and access doors, air trunks, thermometer tubes, ventilator coamings and deck connections are to be examined and where air trunks pass through watertight bulkheads, the watertight doors are to be worked.

2.2.1(f) Ventilators.

Ventilators to refrigerated spaces including their closing appliances are to be examined for satisfactory condition and operation.

2.2.1(g) Bulkhead and Deck Penetrations.

Bulkhead and deck penetration seals of refrigerant pipes are to be examined.

2.2.1(h) Alarm and Monitoring Systems.

The alarm and monitoring systems, including cargo hold temperature measurement equipment and CO_2 content meters, are to be generally examined and to be proven in satisfactory condition. Evidence of periodic instrument calibration is to be verified.

2.2.1(i) Air Coolers and Cooling Grids.

The drainage arrangements, including liquid seal traps and drip trays under air coolers or cooling grids, are to be examined for satisfactory condition.

2.2.1(j) Hatch Covers.

Drainage and sealing arrangements between the double seals of exposed hatch covers are to be examined.

2.2.2 Ammonia Refrigerating Plant

The following features of the ammonia refrigerating machinery space are to be surveyed and placed in satisfactory condition:

2.2.2(a) Ammonia Refrigeration Machinery Spaces.

Confirmation of gas tightness of ammonia refrigeration machinery space including access doors and all bulkhead and deck penetrations.

2.2.2(b) Exhaust Ventilation System.

Examination and testing of independent exhaust ventilation system, including confirmation that a catastrophic leak of ammonia is easily and rapidly dissipated by means of an automatic starting arrangement of the exhaust ventilation system.

2.2.2(c) Water Dump Tank.

Examination of water dump tank, including venting arrangements, level alarms and water supply control.

2.2.2(d) Water Drainage Arrangements.

Examination and operational test of independent water drainage arrangements.

2.2.2(e) Spare.

General examination of the spare ammonia storage space, including ventilation, handling, and storage/securing arrangements.

2.2.2(f) Vapor Detection and Alarm Systems.

Examination and testing of the two (2) required ammonia vapor detection and alarm systems, including the automatic shutdown of the refrigerating plant and activation of exhaust ventilation system.

2.2.2(g) Electrical Equipment.

Confirmation that electrical equipment within the ammonia refrigerating machinery space complies with the requirements for hazardous areas.

2.2.2(h) Personal Safety Equipment.

Confirmation that the following personal safety equipment is stored outside the ammonia refrigerating machinery space.

- Eye wash and shower unit (at entrance)
- One (1) set of fireman's outfit (in addition to SOLAS requirements)
- One (1) heavy-duty adjustable wrench
- Boric acid, vinegar, and eye cups

2.2.3 Live Fish Tank Sounding

Verify means for assessing the liquid levels in the tanks. Where permanent sounding arrangements are provided, remote level indicating is to be provided in the fish tank control room or navigation bridge.

2.2.4 Live Fish Tank Ventilation

Tank vent pipe "closure devices" installed on the exposed decks are to be externally examined, randomly opened out and their condition verified. Verify an insect screen is provided for each vent outlet (dimensions 16 mesh to 25.4 mm or a mesh of 16 wires per inch).

2.2.5 Bilge System

The audible and visual alarms located in the fish tank control room or at the navigation bridge for each live fish tank and located in the bow and stern machinery spaces are to be tested.

2.2.6 Live Fish Loading and Unloading Systems

2.2.6(a) Live Fish Piping Pipes, Valves, and Fittings.

Live fish piping pipes, valves, and fittings in the system are to be examined. Means of isolation of the loading and unloading lines of each fish tank is to be function tested.

2.2.6(b) Live Fish Pumps.

Pumping arrangements are to be examined.

2.2.7 Live Fish Tank Water Control Systems

2.2.7(a)

The oxygen supply and continuous water flow for maintaining the levels of carbon dioxide and pH for fish health condition is to be examined.

2.2.7(b)

Control and Instrumentation monitoring system is to be examined and tested (water circulation Pressure or Flow – Low/High, Oxygenation – Low/High, Carbon Dioxide – Low/High, pH – Low/High, and water supply Pressure or Flow – Low/High).

2.2.8 Miscellaneous Piping Systems

2.2.8(a)

Delousing Treatment System is to be examined.

2.2.8(b)

Feeding System is to be examined.

2.2.8(c)

Water circulation system, live fish tank piping system, oxygen piping system, and bilge piping system are to be examined and tested as considered necessary.

2.2.8(d)

Food feeding and water transfer, between the vessel and a farm facility, their interfaces with piping components (i.e., tubes, flanges, gaskets, bolting, hoses, expansion joints, sight flow glasses, filters, strainers, accumulators, instruments connected to pipes, etc.) and connections are to be examined and tested as considered necessary.

2.3 Special Surveys

2.3.1 Cargo Refrigerating Plant

2.3.1(a) Machinery Operation.

The machinery is to be examined under working conditions and the vessel's logs examined to ascertain satisfactory operation.

2.3.1(b) Compressors and their Motors.

Centrifugal or reciprocating compressors are to be opened up and examined. Motors driving the compressors, together with gears and air circulating fans, if fitted, are to be opened up and examined as considered necessary by the Surveyor, unless they are maintained under an approved planned maintenance program. For electric motors, the insulation resistance is to be measured unless satisfactory records are made available.

2.3.1(c) Insulation and Coating.

The fullness and dryness of the insulation is to be confirmed in accordance with requirements of 7-9-1/1.1.1(d) of the ABS *Rules for Survey After Construction (Part 7)*. The condition of the coating behind the insulation in cargo spaces is to be examined at random. The examination may be limited to verification that the protective coating remains effective and that there are no visible structural defects. Where poor coating condition is found, the examination is to be extended at the discretion of the Surveyor. The coating is to be reported on.

2.3.1(d) Primary Refrigerating System.

The entire primary refrigerating system, including condensers, economizers, evaporators, brine coolers, receivers, oil receivers, refrigerant storage tanks, oil coolers, dryers, direct expansion cooling coils, and such other similar equipment, are to be examined and leak tested at their working pressure.

2.3.1(e) Piping.

Refrigerant piping, including brine piping, is to be examined, and insulation is to be removed as deemed necessary by the Surveyor. The entire brine system, including air coolers, is to be hydrostatically tested to maximum working pressure. Coating condition of piping or other corrosion protection is to be examined.

2.3.1(f) Relief Valves.

All relief valves and/or other pressure relieving devices of the refrigerating system are to be tested and verified for correct setting.

2.3.1(g) Brine System.

Brine heaters, brine expansion tanks, brine mixing tank, and brine air coolers are to be opened and examined.

2.3.1(h) Pumps.

Condenser sea water cooling pumps, brine pumps, and refrigerant pumps, where installed, are to be opened up and examined.

2.3.1(i) Bulkhead and Deck Penetration Seals.

Bulkhead and deck penetration seals of refrigerant pipes are to be examined.

2.3.1(j) Defrosting.

Arrangement for defrosting, where fitted, are to be confirmed in satisfactory condition.

2.3.2 Live Fish Loading and Unloading Systems

2.3.2(a) Machinery Operation.

The loading and unloading system is to be generally examined including pipes, valves, and fittings. The means of isolation of the loading and unloading lines of each fish tank is to be function tested. The machinery is to be examined under working conditions including a full operational test of the system with seawater is to be conducted.

APPENDIX 1
Food Safety Management

1 ISO 22000 – Food Safety Management Systems

1.1 General

Food safety is related to the presence of food safety hazards at the time of consumption by consumers. Food safety hazards occur at any stage of the food chain, and therefore adequate control throughout the food chain is essential. The adoption of a food safety management system (FSMS) as found in ISO 22000 is recommended to assist an organization in improving its overall performance in food safety.

1.2 Food Safety Management System Principles

ISO 22000 specifies the requirements for a FSMS and is composed of the following recognized key elements:

- Interactive communication
- System management
- Prerequisite programs (ISO/TC 22002 series) for specific sectors of the food chain
- Hazard analysis and critical control point (HACCP) principles

Additionally, ISO 22000 is based on the following management principles:

- Customer focus
- Leadership
- Engagement of people
- Process approach
- Improvement
- Evidence-based decision making
- Relationship management

1.3 Process Approach

The process approach adopted by ISO22000 is to enhance production of safe products and services in compliance with the applicable requirements. The process approach includes the systematic definition and management of processes and their interactions in order to achieve the intended results in accordance with the strategic direction of the organization and food safety policy. Management of the processes and the system can be achieved by implementing the Plan-Do-Check-Act (PDCA) cycle and risk-based thinking to prevent undesirable results.

1.3.1 Plan-Do-Check-Act Cycle

The PDCA cycle is implemented at two levels. The first level is the organizational planning and control, and the second is the operational planning and control. The PDCA is described as:

- *Plan*. Establish the objectives of the system and its processes, identify and address risks and opportunities, and provide the resources needed to deliver the results.
- *Do*. Implement the plan.
- *Check*. Monitor and measure processes and the resulting products and services. Analyze and evaluate information and data from monitoring, measuring and verifying activities. Report the results.
- *Act*. Take actions for improving performance.

1.3.2 Risk-based Thinking

Risk is the exposure to injury, loss, damage, or any other negative outcomes. In addition to the PDCA cycle, risk-based thinking is another key element for achieving the effectiveness of the FSMS that can reduce negative outcomes and increase the positive ones. Risk-based thinking is addressed on organizational level and operational level in ISO 22000.

1.4 Relationship with Other Management System Standards

ISO 22000 has been developed within the ISO high level structure (HLS). The objective of the HLS is to improve alignment between ISO management system standards. ISO 22000 includes the core principle and framework of FSMSs and sets out the specific FSMS requirements for organizations throughout the food chain. Other guidance related to food safety, specifications and/or requirements specific to food sectors can be used together with this framework.

APPENDIX 2

Live Fish Health and Welfare During Transport

1 General

World Organization for Animal Health (OIE) Aquatic Animal Health Code (the OIE Aquatic Code) provides standards for the improvement of aquatic animal health worldwide, and it also includes standards for the welfare of farmed fish and use of antimicrobial agents in aquatic animals. For the welfare of farmed fish during transport, Section 7 of the OIE Aquatic Code is recommended to be complied with.

This Appendix provides general guidance on the basic factors that can influence live fish survival during transport. Different fish species have different water quality requirements such as oxygen, carbon dioxide (CO_2), ammonia (NH_3), pH, salinity and temperature. More relevant research documents can be found in Food and Agriculture Organization of the United Nation (FAO).

2 Factors for Live Fish Survival During Transport

2.1 Stress and Biochemical Changes of Transported Fish

Considering the stress physiology of fish, stressful stimuli can produce a variety of effects on transported fish such as metabolic hormonal and behavioral alterations. Immunosuppressive effects and osmoregulatory problems can activate latent disease organisms and are the major cause of death when fish are handled and transported.

The stressful stimuli may come from each stage during transport such as pre-transport starvation to clear the gut, physical handling during loading/unloading process, and inadequately maintained water quality.

The release of fish at the destination is a critical stage of the transport process. The fish are under some degree of stress in the transport unit and sudden exposure to water of different characteristics or low quality can further cause stress.

2.2 Physical Handling During Loading/Unloading Process

Physical contact between fish and other surfaces can harm the fish (for instance, while dropping fish from pumps or elevators, handling before loading and during the loading itself). It has been shown that the initial loading of fish into the tanks is the most stressful stage for most species during transport.

Use of pumps and pipe systems with moderate flowrates can significantly reduce skin trauma and cortisone levels during the loading/unloading process.

2.3 Quality of Transported Fish

The transported fish should be in good health. Fish that display sign of disease, significant injuries, insufficient or excessive duration of fasting, abnormal swimming, or rapid ventilation should be removed before the transport.

2.4 Dissolved Oxygen

An adequate level of dissolved oxygen is the critical factor for the survival of transported fish. The solubility of dissolved oxygen depends on water temperature, gas composition and salinity.

In general, the amount of oxygen consumption by fish is significantly influenced by fish weight and water temperature. The ability of fish to use oxygen is dependent on the concentration of CO_2, water temperature, pH, the tolerance to stress of transported fish, and metabolic products such as ammonia.

The handling of fish will increase the demand for oxygen about three to five times more over their normal condition. Thus, for the first hour after the loading process, the fish are excited and require a large amount of oxygen with a short time for adjustment.

2.5 Water Quality (PH, CO_2 and NH_3)

Water quality (e.g., pH, CO_2 and NH_3 levels) is a function of the fish concentration and the duration of transport. Water pH is a control factor because the proportions of NH_3 and CO_2 contents are direct functions of pH level. With the increase of transport time, CO_2 production through fish respiration makes water tend towards acidity. NH_3 builds up in transported water because of protein metabolism of the fish and bacteria acting on the waste. Water pH between 7 to 8 is considered optimum.

CO_2 is produced as a by-product of fish metabolism. Elevated CO_2 levels can reduce the concentration gradient between the blood and the water where diffusion occurs through the gills. Excess CO_2 levels can result in hypercapnia and acidosis and can cause the death of fish even when oxygen levels are seemingly adequate.

Proper equipment used for monitoring and maintaining water quality may be required depending on the duration of the transport.

2.6 Water Temperature

Surrounding water temperature is an important control factor that can influence the oxygen consumption by fish and the physiological reaction rates of fish. For instance, if the water temperature is increased by 10°C (18°F), oxygen consumption may be doubled, which means that for each 0.5°C (0.9°F) rise in temperature, the fish load may be reduced by about 5.6%. On the other hand, the fish load can be increased by about 5.6% for each 0.5°C (0.9°F) decrease in temperature.

Lowering the water temperature can increase the stocking density that the fish can tolerate, decrease metabolic rate of the fish, lessen fish activity and reduce the production of NH_3. Care should be taken in the cooling process to avoid the abrupt change in temperature that can cause stress in transported fish.

2.7 Stocking Density of Transported Fish

The ratio of the volume of the transported fish and the transport water should be selected to account for the species of fish, size of fish, water temperature, transport time and oxygen levels. Although some guide numbers of stock density for various species during transport can be found in research documents, it is recommended to carry out a test and adjust the guide number of the intended stocking density if necessary, subject to the specific transport conditions.