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Marine finfish farms — Open net cage — Design and operation

Exploitations de pisciculture marine — Cages à filets ouverts — Opération et conception

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 234, *Fisheries and aquaculture*.

Introduction

This International Standard is developed to ensure that a net cage marine finfish farms are adequately designed, constructed, and maintained to meet the anticipated rigours of the marine environment in which they will be deployed to prevent escapes (unintended impacts) during every day operations and unforeseen events. The standard is to be applied by the farm operators on a site-specific basis. Aquaculture producers are recommended to ensure that the combination of technologies that they have selected for a site meets environmental and other operational considerations for that site. Equipment manufacturers can use this International Standard, methodology, and terminology so that their customers (farm operators) can have the opportunity to meet the requirements with this International Standard.

The physical rigours of the marine environment to which a net cage marine finfish farm can be subjected include tidal currents, wave action, storm surges, hurricanes, wind exposures, icing; equipment design (net cage structures, mooring systems, netting components, predator control, and site markers. Other factors influencing the integrity of a net cage marine finfish farm include qualifications of equipment manufacturers and suppliers, handling practices, inspection and maintenance, reporting and auditing, and stock loss and recovery planning.

Within marine aquaculture, an increasing degree of farming on high energy sites (strong tidal currents, wave action, storm surges, hurricanes, wind exposure, icing) is predicted. Further developments in equipment and technology for farming in cages on high energy sites can result in improved water quality and fish health. The use of high energy locations will necessitate improvements of cages, mooring systems, and feeding systems. It can also require larger boats for servicing, and calls for new techniques for installation and daily operations.

This international technical standard is intended to reduce technical and operational failures, consequently enhancing the sustainability of the industry. All precautions are recommended to be taken to prevent escapes (unintended impacts) from aquaculture installations as a result of improper specification of technical main components or improper operational use. This International Standard will offer one tool in a link of other guidelines needed for the aquaculture industry to be environmentally sustainable.

Marine finfish farms — Open net cage — Design and operation

1 Scope

This International Standard presents a general method to be followed for the systematic analysis, design, and evaluation of net cage marine finfish farms. One common style of a net cage finfish farm is shown in Figure 1. A mooring system holds together a series of net cages which contain finfish. Water from the outside environment freely passes through the nets, providing the necessary environment for farming finfish. The methodology presented in this International Standard allows for determination of the adequacy of a given finfish farm's floating structure, nets, and mooring equipment for a given environment. The standard addresses specification of a design basis through evaluation of environmental conditions and acceptable risk, and specifies acceptable techniques for the design and analysis of finfish farms. This International Standard also provides guidelines for development of a handbook which documents procedures for correct maintenance and operation of the finfish farm.

The application of the standard is intended to reduce the risk of escape from marine finfish farms. This International Standard is designed to be used by the operator of a net cage marine finfish farm. It is intended that through application of this International Standard that increased human safety and system integrity levels can be achieved.

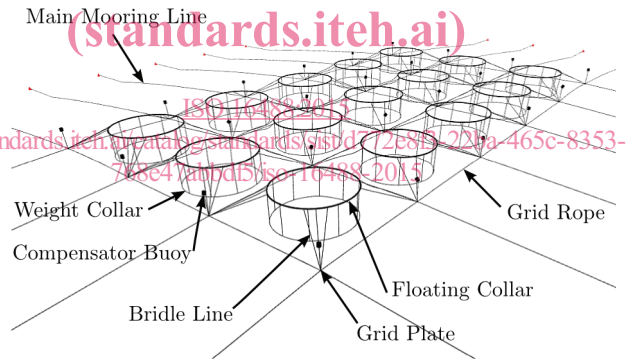

Figure 1 — Typical net cage marine finfish farm design

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1107, *Fishing nets — Netting — Basic terms and definitions*

ISO 19900, *Petroleum and natural gas industries — General requirements for offshore structures*

ISO 19901-1, *Petroleum and natural as industries — Specific requirements for offshore structures — Part 1: Metocean design and operating conditions*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
cage
floating collar with attached net cage for the purpose of containing finfish

3.2
floating collar
frame which provides buoyancy and attachment for one or more net cages

3.3
net cage
net construction attached to a floating collar for the purpose of containing fish

3.4
net pen
net construction that rests on the seabed and whose purpose is to contain fish

3.5
mooring system
system of lines (e.g. polyester rope, chain, wire rope) and bottom attachments for the purpose of keeping the floating components in a desired position

3.6
barge
floating work station on a marine finfish farm, separate or integrated, with technical equipment for performing certain functions connected to fish farming

Note 1 to entry: The barge can have functions as storage, feeding, electricity supply, crewing, and monitoring of the site and others.

3.7
marine finfish farm
containment system for the purposes of farming finfish

Note 1 to entry: A marine finfish farm typically consists of a mooring system, floating collars, anchoring system, net cages, and can include a barge.

3.8
net cage
containment system through which water freely flows through the net cage from the outside environment

Note 1 to entry: This is in contrast to closed containment systems, in which water from the outside environment does not pass freely through the structure.

3.9
predator net
barrier cage preventing predators from entering the net cage

Note 1 to entry: A predator net could be a birdnet, jumpnet or other types of nets used for protection against predators such as e.g. birds, sea lions, seals, and sharks.

3.10
operator
party responsible for the operation of a net cage marine finfish farm and may or may not be the owner or producer

3.11
supplier
organization that provides a product or a service to a customer

3.12
floats
buoys
component which is typically attached to a mooring system to provide buoyancy or mark boundaries

3.13
anchor
device that is used to connect the marine finfish farm mooring system to the sea bed to keep the fish farm in place

3.14
compensator buoy
device used to provide flotation and add compliance to a mooring system

Note 1 to entry: The compensatory buoy is intended to compensate for changes in water level and maintain tension in the mooring system in waves.

3.15
metocean data
meteorological and oceanographic data

3.16
limit state
limit state is a condition of a structure beyond which it no longer fulfils the relevant design criteria

3.17
global analysis
overall numerical analysis of the complete structure, such as a the complete marine finfish farm, to determine overall loads and response

3.18
stability log
document with information and specifications regarding the stability of a barge

3.19
tolerance limit
load capacity limit of a component

3.20
return period
average period between occurrences of an event or a particular value being exceeded

Note 1 to entry: For environmental events, this is typically measured in years.

3.21
floats
flotation devices that are used to give floating to a raft-cage system that arranged in the lower section of hall square cage

3.22
side walk
square structure, preferably galvanized steel, which also allows transit corridors, containing floats at the bottom that give buoyancy to raft-cage system to this place is attached the net cage

3.23
counterweighs
weights that serves to reduce the deformation of the net cage against prevailing currents in the area of culture

Note 1 to entry: Counterweighs are generally constructed of concrete.

4 Basic considerations and general requirements

4.1 General considerations

This International Standard is intended to provide guidelines for the design and operation of permeable net cage marine finfish farms similar in design to those shown in Figure 2 and Figure 3. The owner/operator of a marine finfish farm is responsible, through the use of a risk evaluation, for assessing the environmental conditions at a prospective site, selecting the appropriate equipment for use at the particular site, and for the safe operation of the finfish farm.

The main components should be designed according to ISO standards that are relevant for the component in question. Where ISO standards do not exist, appropriate international or regionally accepted standards should be applied to ensure a high level of system safety and quality assurance. For example, the design of a steel structure should use ISO 19902 or EN 1993.

Internationally accepted codes and standards that exist and which provide guidelines for the technical design and integrity of system components may be used. However, the user must ensure that the design philosophy intended in this International Standard is met and consistent operational and human safety levels are applied.

As shown in Figure 2 and Figure 3, a marine finfish farm typically consists of the following main components:

a) floating collars;

NOTE The floating collar is designed to hold nets in place, and gives the net cage flotation and structural shape. Floating collars are frequently constructed of HDPE plastic pipe or galvanized steel.

b) mooring system;

NOTE The mooring system is used to restrict the motion of the entire finfish farm, enabling it to keep stationary. For example, the mooring system shown in Figure 1 is composed of a mooring grid, bridle lines, and main mooring lines.

c) anchors;

NOTE Anchoring systems typically consist of concrete blocks (gravity anchor) or drag embedment or plate anchors (such as Danforth style anchors) which, when connected with the mooring system, keep the finfish farm in a fixed position.

d) net cage;

NOTE A net cage is typically made of rope and nylon netting and is used to contain finfish.

e) predator net;

NOTE A secondary netted system is often used to prevent predators such as sharks and sea lions from breaking into the net cage.

f) barge;

NOTE Both feed and accommodation barges are common at finfish farms in many regions. The barge is frequently used as a monitoring platform for the fish farm operations.

g) other components.

NOTE These could be floats, sidewalk and counterweights.

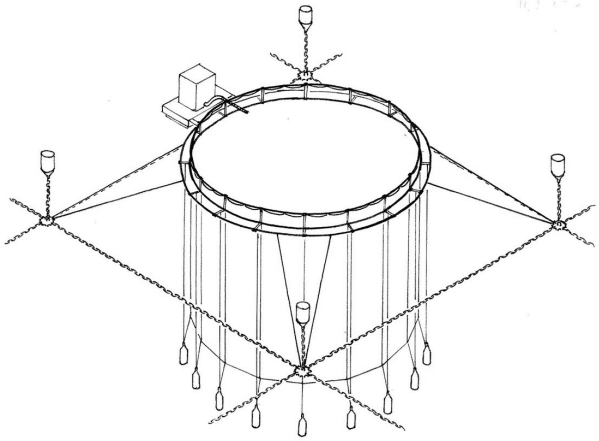

Figure 2 — Typical HDPE floating collar finfish farm configuration

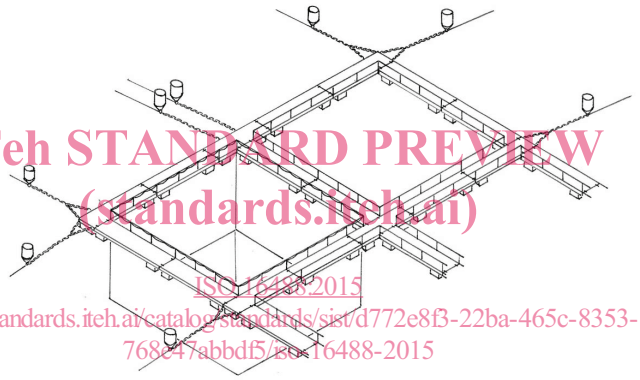

Figure 3 — Typical steel frame floating collar finfish farm configuration

4.2 Site survey requirements and environmental considerations

Fish farming sites range from very protected to the very exposed and, as such, containment structures need to be designed and constructed with particular attention paid to the site-specific rigours of the marine environment in the location where they will be deployed. For example, fetch, bottom type, and tidal currents will vary greatly between sites and can affect wave size, anchoring options, and mooring lines size, respectively.

The site shall be surveyed and described based on bathymetry, topography, and degree of exposure. This data (e.g. fetch, bathymetric map, site boundaries, bottom type, etc.) shall be used for the calculation of environmental conditions and assessment of the suitability of the equipment.

The site survey should be used to determine the feasibility of developing a finfish farm at a potential location.

The design and selection of components for a marine finfish farm will vary depending on the environmental conditions at the site. The impact of currents, wind, and waves on permeable net cages will be relevant to consider in all parts of the world. Additional loads must be considered in certain regions, such as snow and ice loads.

The owner or operator of the site shall assess, or have assessed, the environmental conditions at the site according to the guidelines presented in this International Standard. The assessment shall be completed by experienced and qualified personnel. Expertise and methodologies have been developed

for the effective evaluation of meteorological and oceanographic information for ocean industries such as the marine renewable energy and offshore petroleum and natural gas industries. General guidelines and background information on collection of meteorological and oceanographic information for the purposes of defining extreme environmental conditions for the design of ocean structures can be found in ISO 19900 and ISO 19901-1. Where possible, these existing best practices should be reasonably applied.

It is noted that even in areas such as the Gulf of Mexico and the North Sea where a great deal of reliable measurements have been collected for the purposes of designing ocean structures, this data are often insufficient for rigorous statistical determination of extreme environmental conditions at specific locations. Therefore, the determination of appropriate design parameters must be completed with sufficient care by experienced personnel. Lastly, many fish farms are located in inshore or near shore locations; not all standards for assessing environmental conditions for offshore locations will directly apply to near shore or inshore locations. Therefore, sufficient care should be exercised when using standards developed for offshore locations.

In general, meteorological and oceanographic measurements should be performed on empty sites (i.e. a site without an installation) if possible prior to development. Clause 6 provides guidelines establishing environmental design criteria for a finfish farm.

4.3 Degradation and lifetime considerations

The choice of components must be considered in relation to the lifetime considerations and the degree of inspection and maintenance of the different components.

4.4 Risk analysis requirements

A risk analysis, broken down into probability and consequence, shall be performed in connection with the design and operation of the finfish farm.

The risk analysis shall be based on accepted procedures, such as those laid down in already established applicable ISO standards (i.e. ISO 31000 and IEC 31010) or standards that are comparable to the ISO standards. The various stages shall be documented so that they can be re-examined.

A risk analysis shall be as complete as reasonably possible during the design phase.

4.5 Design of marine finfish farms

4.5.1 General

The marine finfish farm shall be designed with the objective to prevent fish escapes. The design shall be reviewed by personnel with sufficient expertise and experience. Documentation of each of the main components shall be such that the design can be evaluated according to this International Standard. Consideration shall be taken of extra loads one main component receives from the others, and it shall be established by calculations, research, or numerical modelling that each main component has the capacity to withstand these loads.

4.5.2 Limit state analysis

The finfish farm shall be designed according to the requirements and considerations presented in Clause 7. Clause 7 lays out a set of limit states for which different design situations must be assessed. The limit state analysis approach is similarly used for assessment of offshore structures and mooring systems.

Alternative internationally accepted codes and standards exist which provide guidelines for the design of floating structures and mooring systems that may be utilized in lieu of the limit state approach; however, the user must ensure that the design method objectives intended in this International Standard is met and a consistent safety level is applied. For example, API RP 2SK[20] for the design of station keeping systems (moorings) for offshore structures uses a safety factor approach that could be applied to the design of a finfish farm mooring system.

