American Society of Civil Engineers

Proposed Standards Development Activity: Create New Standard
Designing Offshore Aquaculture Facilities
Date of Proposal: [*April/23/2026*] revised 6/15/26

Executive Summary

This work will be a cross-disciplinary project of the American Society of Civil Engineers (ASCE). The objective of this work is to establish an ASCE standards activity for the development of a new consensus standard governing the acceptable design of offshore aquaculture structures. Offshore aquaculture is the rearing of marine organisms for commercial purposes, and is distinguished from other aquaculture ventures by its location in the U.S. Exclusive Economic Zone. This region is defined as the area of U.S. and territorial waters extending from 3 to 200 nautical miles offshore when measured from the shoreline. Structures in offshore waters are often subject to high energy winds, waves, and currents, which necessitates robust engineering for any structure intended for deployment in this area. Currently, an American National Standard (ANS) does not exist for the offshore aquaculture industry in the United States, a gap which complicates the permitting process. The institution of sound engineering standards for the offshore aquaculture industry is essential for the safe growth of the sector, to protect the environment and nearby mariners, and to support federal permitting processes.

Background

Globally, aquaculture is rapidly replacing traditional capture fishing as the primary source of much of the world's seafood, of which the United States is the second largest consumer. US aquaculture accounts for less than 1% of the global aquaculture production value. Due in part to low domestic aquaculture production and high demand, the US maintains a $20B deficit in seafood imports. To address these issues, Executive Order 13921 - Promoting American Seafood Competitiveness and Economic Growth - designated NOAA as the lead agency for "aquaculture projects located outside of the waters of any State or Territory and within the exclusive economic zone of the United States." Additionally, NOAA "...shall be responsible for navigating the project through the Federal environmental review and authorization process."

Due to the current regulatory framework, aquaculture projects in federal waters are currently permitted by the US Army Corp of Engineers (USACE) by use of Section 10 of the Rivers and Harbors Act, with NOAA providing subject matter expertise during the process. Section 10 of the Rivers and Harbors Act requires "...authorization from the Secretary of the Army, acting through the Corps of Engineers, for the construction of any structure in or over any navigable water of the United States." This includes offshore aquaculture facilities. The USACE relies on knowledgeable engineering firms with experience in the offshore aquaculture industry to specify components and engineer the proposed structures appropriately. The engineering firms usually base their designs on aquaculture engineering standards from foreign countries where the industry is further developed, such as Norwegian Standard (NS) 9415 or A Technical Standard for Scottish Finfish Aquaculture. Sometimes, standards from other industries may be applied, such as the American Bureau of Shipping's (ABS) Guidance Notes on the Application of Fiber Rope for Offshore Mooring. Unfortunately, there is no ANS specifically for offshore aquaculture

in the United States. Developing an ANS for offshore aquaculture will streamline the federal permitting processes with respect to engineering in accordance with Goal 1 of the NOAA Aquaculture Strategic Plan (2023-2028) to "Improve regulatory processes for sustainable coastal and marine aquaculture through collaboration with partners."

References:
NOAA. 2022. Guide to Permitting Marine Aquaculture in the United States; https://www.fisheries.noaa.gov/resource/document/guide-permitting-marine-aquaculture-united-states-2022

NOAA. 2025. NOAA Aquaculture Strategic Plan (2023-2028); https://www.fisheries.noaa.gov/resource/document/noaa-aquaculture-strategic-plan-2023-2028

Memorandum of Understanding
This work falls under the purview of the existing Memorandum of Understanding (MOU) between ASCE and NOAA, whose goal is to work together to leverage NOAA's climate expertise and resources to better provide the civil engineering community with the information it requires to plan, design, and operate climate-resilient and sustainable infrastructure. The MOU can be found here: asce-noaa-mou.pdf.

Objectives

- An excerpt from the Aquaculture opportunity Area Atlas for Southern California: "The U.S. imports between 70% and 85% (by edible weight) of its seafood, resulting in a $16.9 billion trade deficit (NOAA 2021). A significant portion of this imported seafood is either farmed overseas or harvested by American fishermen, exported overseas for processing, and then imported back into the U.S. for consumption (NMFS 2021a). For decades, the U.S. has relied on seafood imports, largely from aquaculture in Asia and Central and South America, to satisfy demand. Americans are the second largest consumer of the world's seafood supply, yet the U.S. only contributes to 9% of the global capture fisheries and aquaculture production combined (Food and Agriculture Organization 2020). The U.S. aquaculture industry accounts for less than 1% of farmed seafood production globally and is ranked 17th as a minor aquaculture producer (NOAA, 2021)
- It is imperative to develop domestic engineering standards for the offshore aquaculture industry that are specific to the conditions experienced in the United States. Designing structures based on foreign standards introduces inefficiencies and unknown risks. Domestic standards will benefit both regulators and industry by minimizing unnecessary engineering costs, bringing safety specifications in line with intended use cases, and streamlining the regulatory process.
- Applicants can design to the standard specifications to streamline the application approval process. This standard will reduce uncertainty with respect to structural failure due to extreme weather events and will decrease time to market for industry participants.
- Examples of potential end users of the standard include:
    - Kelson Marine
    - Innovasea
    - Manna Fish Farms
    - Ocean Rainforest
    - University of New Hampshire
- It is likely the standard will include both "shall" and "may" language.

References:

Food and Agriculture Organization of the United Nations (FAO). (2020). *The State of World Fisheries and Aquaculture 2020: Sustainability in action*. Rome, Italy. https://doi.org/10.4060/ca9229en

NOAA. 2021. An Aquaculture Opportunity Area Atlas for the Southern California Bight. NOAA Technical Memorandum NOS NCCOS 298. 485 p. DOI: 10.25923/tmx9-ex26

Scope

Offshore aquaculture has three primary sectors: finfish, shellfish, and macroalgae. Offshore shellfish and macroalgae operations are often similar in their design when using long-line methods, and primarily consist of bottom anchors, mooring ropes, buoys, and "long-lines", among other components. Actual culture of the organisms occurs horizontally or vertically on the long line ropes. Finfish aquaculture typically consists of bottom anchors, mooring ropes, buoys, nets, and floating platforms, among other components. Fish are cultured inside the nets, which are either fully closed and submerged underwater, or open at the surface and fixed to a floating scaffolding structure. See the NOAA reference below for additional information. While development of new growing systems is ongoing, the standards developed in this thrust will focus on the current most prevalent methods of aquaculture, referred to here as "long-line" culture and "net-pen" culture. Using the developed standard, diverse variations in both of these categories can be covered. The primary scope of this standard is evaluating offshore aquaculture structures for structural integrity to reduce risk of failure due to extreme weather events. Topics include quantification of various loading scenarios, establishing minimum design criteria (e.g. return periods and safety factors) and will inform component specification. The types of structures and systems covered under this standard include but are not limited to:

- Long-line culture configurations for shellfish and macroalgae cultivation.
- Floating net-pens and their associated surface platform structures.
- Submerged and semi-submerged cage designs.
- Comprehensive mooring and anchoring infrastructure, including bottom anchors, mooring lines, tethers, structural buoys, and connection hardware.

This standard will NOT address structural integrity monitoring and reporting. For a more fundamental understanding of the scope of this standard, the reader may review the documents listed under "Existing Industry Content."

Reference:

NOAA. 2025. Technical Guide to Marine Aquaculture Gear. https://doi.org/10.25923/8kw5-2023

Benefits to the Public

The benefits to the public from creating this standard include:

- Increased economic growth through higher aquaculture output.
- Creation of local jobs through a more robust aquaculture industry.
- Ensuring public safety by reducing the occurrence of marine debris related to aquaculture.
- Protecting the environment through a reduction in lost aquaculture gear, mitigation of fish escapes, and potential reduction in farm footprint.

External Activities

The following are publications supported by the NOAA Aquaculture program which are of relevance to the proposed standards development activity:

Project funded by the Northeast Regional Aquaculture Center for "Developing Structural Engineering Guidelines for Open Ocean Aquaculture Installations".
https://www.nrac.org/funded-projects/developing-structual-engineering-guidelines-for-open-ocean-aquaculture-installations

Project Deliverables:
Sunny et al., (2024). Design considerations for a continuous mussel farm in New England Offshore waters. Part I: Development of environmental conditions for engineering design. Aquacultural Engineering, Volume 107, November 2024, 102476.
https://doi.org/10.1016/j.aquaeng.2024.102476

Sunny et al., (2025). Design considerations for a continuous mussel farm in New England Offshore waters. Part II: Using validated numerical models to estimate the probability of failure. Aquacultural Engineering, Volume 111, 15 October 2025, 102575.
https://doi.org/10.1016/j.aquaeng.2025.102575

Existing Industry Content:
Below are adjacent standards that might be useful to guide the development of this ANS.

- "Recommended design practice for offshore and nearshore seaweed growing systems" (DNV, 2023)
- DNV-RU-OU-0503 - Floating fish farming units and installations
- NS 9415: Floating aquaculture farms - Site survey, design, execution and use. (Standard Norge, 2021)
- ISO 16488:2015 - Marine finfish farms — Open net cage — Design and operation
- "A Technical Standard for Scottish Finfish Aquaculture" (Ministerial Group for Sustainable Aquaculture's Scottish Technical Standard Steering Group, 2015)
- "Basis-of-Design Technical Guidance for Offshore Aquaculture Installations In the Gulf of Mexico" (Fredriksson & Beck-Stimpert, 2019).

Rationale for ASCE involvement:
ASCE's involvement stems from its history of collaboration with NOAA and the strong alignment of the project's technical content with the society's engineering expertise (e.g. Coasts, Oceans, Ports, and Rivers Institute [COPRI]). As an ANSI-accredited standards developer, ASCE provides the necessary structure and oversight to establish these requirements as a recognized ANS.

Potential Collaborations:
United States Army Corps of Engineers
Environmental Protection Agency
American Bureau for Shipping

American Petroleum Institute

ANS Designation

Are you seeking ANS Designation for this document? [Yes]

UN Sustainable Development Goals

Please select all that apply. For more details about each goal, please visit: THE 17 GOALS | Sustainable Development (un.org).

- ☐ No Poverty
- ☐ Zero Hunger
- ☐ Good Health and Well-Being
- ☐ Quality Education
- ☐ Gender Equality
- ☒ Clean Water and Sanitation
- ☐ Affordable and Clean Energy
- ☐ Decent Work and Economic Growth
- ☐ Industry, Innovation and Infrastructure
- ☐ Reduce Inequalities
- ☐ Sustainable Cities and Communities
- ☒ Responsible Consumption and Production
- ☐ Climate Action
- ☒ Life Below Water
- ☐ Life on Land
- ☐ Peace, Justice and Strong Institutions
- ☐ Partnerships for the Goals

Regulatory Adoption Possibilities

The NOAA "Guide to Leasing, Permitting, and Authorizing Commercial Aquaculture Operations off the California Coast" (NOAA, 2025) identifies a requirement for an "engineering analysis of proposed gear" to be submitted to the U.S. Army Corps of Engineers (USACE) to support the Section 10 of the Rivers and Harbors act permitting for aquaculture projects being proposed in both state and federal waters. Currently, there are no U.S. engineering standards that guide the methodology and establish minimum design criteria for such analysis. Further, specifically for finfish aquaculture projects, the Environmental Protection Agency (EPA) typically requires a National Pollutant Discharge Elimination System (NPDES) permit prior to project authorization to ensure compliance with the Clean Water Act (NOAA, 2022). Fish escapement due to structural failure is a concern that relates to the NPDES permitting activity. The lack of U.S. engineering design standards for aquaculture precludes permitting agencies from assessing a quantified level of risk of failure due to extreme weather events.

Although it is not yet determined exactly how the engineering standard will be implemented in state or federal permitting processes, the need is evident. NOAA is in the process of engaging USACE and EPA to establish an implementation plan for the engineering standard.

References:

NOAA. 2022. Guide to Permitting Marine Aquaculture in the United States; https://www.fisheries.noaa.gov/resource/document/guide-permitting-marine-aquaculture-united-states-2022

NOAA. 2025. Guide to Leasing, Permitting, and Authorizing Commercial Aquaculture Operations off the California Coast https://www.fisheries.noaa.gov/resource/document/guide-leasing-permitting-and-authorizing-commercial-aquaculture-operations

Ancillary Resource Ideas

University courses may be an ancillary resource that emerges from this standards development effort. Collaborating universities may decide to incorporate the produced standards into their classes on aquaculture, engineering, or future R&D proposals. The upcoming NOAA Cooperative Institute Fostering Aquaculture Research and Marketing (CIFARM) partnership may allow for extended cooperation and the production of material promoting the use of these standards.

Primary Proposer Contact Details

Name: Matthew Bowden, P.E.
Company: National Oceanic and Atmospheric Association
Contact Details – Email and Phone Number: matthew.bowden@noaa.gov / 203-687-6983
Other ASCE Committee Affiliation(s):

The committee dedicated to the revision of this standard will be chaired by the following.

Name: Matthew Bowden, P.E.
Company: National Oceanic and Atmospheric Association
Contact Details – Email and Phone Number: matthew.bowden@noaa.gov / 203-687-6983
Other ASCE Committee Affiliation(s):

Potential Membership

The following is a list of organizations and individuals considered ideal to participate in this proposed standards development activity. Participants listed here will be included in the public call for members described below. This list is not all-inclusive and should be viewed as a list of initial contacts for assembling a balanced committee.

Name	Affiliation
Matthew Bowden	National Oceanic and Atmospheric Administration
Eli Kurtz	National Oceanic and Atmospheric Administration
Marcy Cockrell	National Oceanic and Atmospheric Administration
Zachary Davonski	Manna Fish Farms
Javier Infante	Ocean Rainforest
Tobias Dewhurst	Kelson Marine
Michael MacNicoll	Kelson Marine
Zachary Moscicki	Kelson Marine
Corey Sullivan	INOVASEA
David Fredriksson	University of New Hampshire
Igor Tsukrov	University of New Hampshire
Cliff Goudey	C.A. Goudey & Associates
Steven Hall	North Carolina State University
Melissa Landon	WSP

Call for Members

[*To achieve the goal of assembling a balanced committee, a call for members will be sent to multiple outlets and recipients. List suggested outlets for call for members. Note that ASCE is committed to expanding the diversity of participants involved in all its standards activities. This includes new professionals (ASCE's "Younger Members"), historically underrepresented*

professionals, people from marginalized communities, and people with culturally diverse backgrounds.]

In addition to the potential committee members listed above and the Standards Office's existing list of press release contacts, the following should be sent the official call for members press release.

Name	Affiliation
Alton Payne	Bureau of Safety and Environmental Enforcement
Benjamin Coco	Bureau of Safety and Environmental Enforcement
TBD	American Petroleum Institute
TBD	American Bureau for Shipping
Jacob Siegrist	U.S. Army Corps of Engineers
Kip Tyler	Environmental Protection Agency

Preliminary Schedule

By completing this proposal, the proposer acknowledges that this standard activity will require a minimum of 18 months of dedicated work. The proposer also acknowledges that the time commitment for all committee participants includes attending regularly scheduled virtual and/or in-person meetings and availability for document review at key points in the process.

The estimated schedule for this activity is as follows:

1. Submission of proposal to ASCE Standards Office
2. Circulation of proposal for comment
3. Comments addressed and proposal sent to CSC for approval
4. New standard approved by CSC
5. Formal announcement and call for members published
6. Writing begins
7. Draft completed
8. Committee balloting begins
9. Committee balloting concludes
10. Public comment approved
11. Public comment opens
12. Public comment closes
13. Public Comments resolved
14. Publication approved by CSC
15. Final manuscript to Publications staff
16. Review of composed manuscript by committee members
17. Standard published

For ASCE Standards Office Use Only:

Standards Council Approval:_____

Codes and Standards Committee (CSC) Approval Date: _____