



*Strategic Research Priorities (SRP)
for the U.S. Center for Maritime Innovation (USCMI)*

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1.0 INTRODUCTION

This document summarizes the Strategic Research Priorities (SRP) for the U.S. Center for Maritime Innovation (USCMI). The USCMI is housed under the U.S. DOT's Maritime Administration (MARAD) Maritime Environmental and Technical Assistance (META) Program and operated by a third-party Secretariat in partnership with META. Additional information about the organization and operation of the USCMI is available online at www.uscmi.org.

2.0 INFORMATION ABOUT THIS SRP DOCUMENT

2.1 PURPOSE

The purpose of this document is to communicate to all stakeholders in the maritime community MARAD's strategic priorities under the USCMI. The priorities are distilled from broad maritime stakeholder input, including:

- META's statutory priorities
- Input from the Secretariat on maritime industry challenges and priorities
- Input from USCMI Consultative Panels reflecting federal interagency, non-governmental, and state, local, tribal, and territorial (SLTT) priorities and needs
- Input from USCMI Technical Working Groups on specific technical areas of interest
- Input from USCMI Regional Working Groups on specific regional challenges for the industry
- Input from broader stakeholder engagement activity on maritime innovation priorities at various conferences, events, and workshops

MARAD and the Secretariat use this document to generate annual research project plans for the USCMI aligned to the strategic investment objectives. This document helps stakeholders, especially those interested in participating on specific research and demonstration project opportunities, determine how and where to engage with the USCMI.

The SRP is a dynamic document that will evolve as the USCMI matures. This document communicates strategic priorities in a broad sense; however, MARAD and the Secretariat may deviate from the SRP as determined necessary by MARAD. MARAD will make the actual investment decisions in alignment with many factors as described in the *Standard Operating Principles (SOP)* document for the USCMI.

2.2 DOCUMENT AUTHORSHIP, APPROVAL, and CONTROL

This document is prepared and maintained by the Secretariat for the USCMI. Any requests for clarifications, changes, or additions/subtractions from this document should be made to the Secretariat for the USCMI by submitting a written request to secretariat@uscmi.org.

2.3 DISTRIBUTION STATEMENT

The Secretariat will post the most current version of the document on the USCMI's website at www.uscmi.org.

3.0 SRP for the USCMI

3.1 PRIORITIES ESTABLISHED IN THE AUTHORIZATION FOR THE USCFI

The James M. Inhofe National Defense Authorization Act for Fiscal Year 2023 (NDAA) directs the Secretary of Transportation, through a competitive cooperative agreement, to establish a United States Center for Maritime Innovation to support the study, research, development, assessment, and deployment of emerging marine technologies and practices related to the maritime transportation system (MTS).

The scope of the USCFI is to support a wide range of maritime innovation critical to a safe, efficient, and competitive MTS. As directed by Congress, the authorization and direction for the USCFI may evolve with future legislation and executive branch policy imperatives.

3.2 PRIORITIES IDENTIFIED BY THE USCFI

3.2.1 Challenges the USCFI Aims to Address

Maritime innovation has been chronically underfunded and often supported in silos by government agencies related to the MTS according to individual agency priorities. The U.S. maritime industry stakeholders have had challenges in:

- (1) developing and maintaining high priority research agendas that address issues key to government and industry; and
- (2) executing aligned portfolios of research projects that engage multi-disciplinary, multi-organizational expertise that transcend parochial interests of individual institutions, organizations, and companies.

The USCFI presents a unique opportunity to help build research priority alignment among government agencies and with industry, academia, and other stakeholders to best advance the interests of a safer, more secure, and competitive MTS.

The USCFI also serves as a clearinghouse for maritime innovation research and best practices.

The USCFI provides the collaborative forum to approach research in a new way – not just issuing competitive grants/contracts for project execution, but rather formulating collaborative teams that bring together many stakeholders in new ways. There are many specific technical challenges to address, but the fundamental challenge is changing the approach to maritime innovation.

3.2.2 Vision for the USCFI

MARAD embraces the full potential of the USCFI addressing technology and energy needs for powering the MTS, technologies for improving maritime operations, ways to enhance U.S. maritime competitiveness, and practical approaches for ensuring maritime resilience. Section 3.1 of the USCFI Standard Operating Principles (SOP) provides the specifics for the vision of the Center.

3.2.3 Inputs to the Prioritization Process

MARAD and the Secretariat distilled the priorities in this document from a broad range of input from multiple perspectives. MARAD and the Secretariat will continue to seek input from all of these sources for future iterations of this plan.

3.2.3.1 MARAD META Priorities

The META program supports the research, demonstration, and development of emerging technologies, practices, and processes that improve maritime operations in an effort to support a safe, efficient, and competitive U.S. MTS. META partners closely with other government agencies, industry, academia, and NGOs to carry out its mission. Results of META-funded projects help to "de-risk" new technology applications and provide necessary data for industry to understand "what works." In addition, data from META projects support U.S. policy decisions.

Recognizing that "one size does not fit all," META strives to provide flexibility within the confines of the Program's legislative charge. Depending on the data needs, META projects typically range from investigative studies to demonstration projects as well as modeling tools to technology verification.

As such, the MARAD META program staff maintain a backlog of potential projects that align with the mission of the USCMI, especially under maritime resilience.

3.2.3.2 Input on Priorities from USCMI Working Groups and Panels

The USCMI has several Technical and Regional Working Groups as well as multiple Consultative Panels providing inputs on strategic priorities and potential research and demonstration projects. Figure 3 of the USCMI SOP document identifies these panels and working groups.

MARAD and the Secretariat incorporate input from these groups and panels into the overall strategic investment plans and the resulting annual research plans. Investment areas and project ideas that come with potential funding from other agencies and public-private partnerships receive special attention and consideration in the process.

3.2.3.3 Input on Priorities from Broader Stakeholder Engagement

MARAD and the Secretariat engage with stakeholder groups broadly at industry conferences, meetings, workshops, etc. In addition to providing updates on the USCMI activities, the staff uses a variety of mechanisms (surveys, online data collection tools, focus group discussions, etc.) to gather input on strategic priorities and potential project ideas, which are incorporated into these plans.

3.2.3.4 Input on Priorities from the Secretariat

As the Secretariat, ABS is in a unique position to help inform the strategic investment priorities and potential research projects for the USCMI. As a not-for-profit organization, the ABS goal is to develop and share technology with government and industry to achieve our maritime safety, security, and environmental mission. This includes incorporating the work products of innovation projects into guides, standards, rules, and best practice documents that are openly shared with all maritime stakeholders. ABS provides direct input on major industry needs and trends to help inform the USCMI strategic research priorities.

3.2.4 Decisions on Strategic Priorities

The process for determining strategic priorities, and ultimately which projects are selected for execution, is dynamic with a balanced portfolio approach. The Secretariat works with the MARAD META staff through a facilitated project evaluation process that includes (but is not limited to) the following considerations:

- Alignment with the stated USCMI strategic priorities and research agenda
- Alignment with other national plans/priorities (Administration, Congress, other agencies, etc.)



- Project specific funding availability (such as sponsorship from other agencies or public-private partnership sponsorship)
- Continuation/extension of long-term, high priority initiatives
- Project mix (not just focused on one technical or geographic domain)
- Value proposition of the project for the MTS community
- Compelling public/community impacts
- Ability to fit within available funding constraints

In particular, MARAD and the Secretariat emphasize initiatives in the following areas:

- Critical evaluation of current state of knowledge, technology, and operating practices in the marine industry to produce best available practice guidance and information clearinghouses/data sets that provide trusted information to decision makers across the industry
- Transition of promising technology solutions at low Technology Readiness Levels (TRLs) to higher TRLs via technology demonstrations and evaluations
- Performance evaluation and/or verification and validation of technology solutions (at various stages of development and testing)
- Early-stage maritime innovation projects
- Innovation in maritime education and workforce development to keep up with changing technologies and the needs of the future workforce
- Specialized technical analysis and evaluation to support major transformational initiatives in the maritime domain

3.3 STRATEGIC PRIORITIES FOR THE USCFI

3.3.1 Overview of Strategic Priorities

The strategic priorities for the USCFI fall in four categories:

- Investment Area 1: Maritime Energy
- Investment Area 2: Maritime Operations
- Investment Area 3: U.S. Maritime Competitiveness
- Investment Area 4: Maritime Resilience

3.3.2 Investment Area 1: Maritime Energy

The maritime industry has growing and changing energy needs to keep up with the expansion of maritime operations and the needs of different types of domestic and international vessels. The industry is experiencing a generational change affecting everything from the equipment and systems used in the MTS, operational strategies for maritime operators, macro changes in approaches to freight movement through the MTS and associated educational and workforce development needs for maritime workers going forward. There are broad range of initiatives that challenge the industry to innovate in order to respond to maritime energy needs through an all-of-the above approach for energy sources. This section of the SRP describes key areas of focus in this initiative area.

3.3.2.1 Vessel Energy Efficiency & Operational Optimization

Objective: MARAD understands that the most immediate opportunities related to maritime energy lie with vessel energy efficiency and optimization of maritime operations. The cheapest and lowest emission



fuel/power is the energy that is never actually needed, so improving onboard energy efficiency and overall efficiency of maritime operations is low hanging fruit. Onboard vessels, technology innovations for efficient hull forms, coatings and hull cleaning technology for reducing hull resistance, power use reductions, and other technologies are helping the industry make important progress toward efficiency and freight movement optimization goals. At the operational planning level, options like operating at reduced speeds and scheduling to avoid wait times provide further efficiency improvements.

Directives: The following topics have been identified by the USCFI for further study:

1. New vessel designs and innovative technology for reducing energy demands and/or improving onboard energy efficiency with various types of vessel operations
2. Digital technologies in vessel operations and freight flow management that make maritime operations more energy efficient

3.3.2.2 Vessel Electrification

Objective: Electrification has many applications in maritime transportation, including hybrid vessels that combine electrification with other power sources or fully electric vessels. Electrification is a great option for certain types of vessel operations, but a range of rules, requirements, and guides covering energy storage, energy distribution, energy generation, and electrical charging in the maritime domain are needed to ensure safety and to meet performance expectations. MARAD is interested in vessel electrification technologies that reduce costs/complexity and improve reliability/resilience for maritime operators.

Directives: The following topics have been identified by the USCFI for further study:

1. Higher energy density and lower cost of marine batteries and power storage systems
2. Fast-charging and non-contact charging technology for vessels and port equipment
3. Safety/risk issues with electrification technology, providing additional safeguards to prevent safety and equipment damage incidents

3.3.2.3 Maritime Fuels & Engine Technology

Objective: Domestic and international vessels trading in U.S. ports need access to a range of maritime fuels. The industry is adopting an all-of-the-above strategy for the different types of fuels needed, covering a range of options that fit different operational scenarios. U.S. ports and maritime operators must have sources of required fuels and bunkering facilities for delivering those fuels to vessels in order to support maritime commerce and critical supply chains for U.S. consumers. MARAD wants to continue its evaluation of fuel options and fuel use strategies in the maritime industry. This includes both evaluation of engine and propulsion technology using various fuels as well as fuel bunkering and energy transportation options. Transportation of U.S. energy in fuels on vessels for domestic use and international export are also key areas of interest.

Directives: The following topics have been identified by the USCFI for further study:

1. Best practice guidance and innovative technology for leveraging abundant U.S. fuels to meet maritime energy demands



2. Best practice guidance and data to help maritime operators determine the most viable long-term mix of fuels for U.S. maritime operations
3. Data on anticipated bunkering needs (types, quantities, required infrastructure, etc.) to support international vessels of various types trading in U.S. ports
4. New vessel designs and associated technology for transportation of U.S. energy in fuels domestically and for international export
5. Developmental support and testing of new engine technology for various types of fuels and operating strategies

3.3.2.4 Maritime Advanced Nuclear

Objective: Advanced nuclear technology provides a unique opportunity to support maritime energy demand and potentially to provide a strategic differentiator for the U.S. maritime industry. Other nations are moving now to try to capitalize on this strategic technology, and the U.S. needs to maintain leadership in this area. Whether this technology is used directly to power ships or provide floating power for a variety of potential uses (power ports, feeding electrical power grids, powering energy intensive industrial operations, and supporting military operations), advanced nuclear can be a game changing technology. MARAD recognizes that this technology will take time to reach implementation and wants to support its development and use in the maritime industry.

Directives: The following topics have been identified by the USCFI for further study:

1. Research into advanced nuclear technologies at scale for vessels and ports
2. Workshops and exercises that engage interagency regulators and policy makers to understand regulatory approval processes for commercial and government uses of advanced nuclear technology in the maritime domain (from both the maritime and nuclear perspective)
3. Concept development and preliminary design work on promising advanced nuclear technology in the maritime domain, including potential de-risking applications by government agencies with applications like icebreakers, strategic sealift, power for dredging operations, other floating power applications, etc.
4. Laboratory and testing facilities for development and testing of advanced nuclear applications in the maritime domain (in partnership with the U.S. Department of Energy)

3.3.2.5 Integrated Port Energy

Objective: U.S. ports are significant energy consumers for a wide range of activities, including cargo handling/lifting equipment, drayage trucks and other vehicles/intermodal transportation assets, various industrial equipment/systems, and even powering vessels at piers. Efficient and resilient freight flow depends on ample and reliable port energy. Additionally, ports are actively working to reduce their impacts on surrounding communities from sound, light, and air pollution. Electrification of equipment and vehicles in ports is growing, and power needs continue to grow with increased throughput in ports. MARAD wants to understand the most cost effective and efficient integrated energy strategies for ports and the equipment/systems needed to support optimized freight flow through U.S. ports.

Directives: The following topics have been identified by the USCFMI for further study:

1. Cross-cutting technical support across ports (especially those implementing energy projects under various grant programs), including assessing and documenting best practices that ports across the country can leverage
2. Shore power technology and implementation strategies for ports, including assessing current and future power availability, shore power demand in ports, and technology options for effective shore power solutions
3. Microgrid and other, non-grid related energy solutions for ports and terminals

3.3.3 Investment Area 2: Maritime Operations

MARAD's interests in maritime innovation includes improved operational effectiveness and competitiveness of maritime operations. Three major areas of change in the maritime industry are:

- (1) the introduction of remote and autonomous functions for vessels, port facilities, and MTS infrastructure,
- (2) a broader digital transformation in how assets and operations leverage digital information in design, construction, operation, and sustainment, and
- (3) how more focused planning and development of transportation corridors can help optimize freight flows and minimize supply chain disruptions through U.S. ports.

This section of the SRP describes key areas of focus in this initiative.

3.3.3.1 Remote and Autonomous Functions

Objective: Remote and autonomous functions in the MTS can improve safety and efficiency. The entire industry is moving toward autonomous systems on vessels, cargo handling equipment, and MTS infrastructure like bridges. While policy makers and companies/labor will determine the right mix of such systems for the country, the USCFMI can play a critical role in helping to ensure that such innovative technology is available, safe, and effective as needed.

Directives: The following topics have been identified by the USCFMI for further study:

1. Application and use of autonomous systems aboard vessels and at ports/terminals
2. Safety and vulnerability assessments for maritime risk issues (accidents, threats, etc.) related to vessels with remote and autonomous operations
3. Investigation of how autonomous systems can be used to provide more frequently updated mapping of navigation areas prone to change (channel shifting, silting, etc.) from storms, droughts, and routine sediment deposition, including how this can improve the flow of commerce in ports and waterways.

3.3.3.2 Digitalization of Maritime Operations

Objective: Like many other industries, the maritime industry is working through a period of change with regard to the availability and use of digital methods and tools. This covers everything from how vessels and

systems are designed and constructed, to how operations occur in ports (including interconnectivity of digital systems and sharing of information among many stakeholders), and to how condition-based information is used to operate and sustain systems and equipment. Topics such as digital twins, condition-based maintenance, 3D design, modeling and simulation to optimize operations, and virtual reality/augmented reality tools to support operations and training are just a few of the topics in this category.

Directives: The following topics have been identified by the USCMI for further study:

1. Sharing port information among stakeholders to support optimized freight flows and vessel operations
2. Port digital twin applications, including modeling and simulation of port operations
3. Other tools and resources for supporting digital transformation in the maritime industry

3.3.3.3 Transportation Corridors & Freight Flow Optimization

Objective: Government and the freight transportation industry are highly interested in optimized freight movement strategies and maritime transportation of freight has some inherent advantages. Marine transportation has significantly lower emissions per ton-mile than other transportation modes, is most cost-effective mode for freight, can move freight at a scale that other transportation modes cannot match, provides import and export options that other modes cannot reach (or at least not cost effectively), and often has less vulnerability to infrastructure damaging events such as natural disasters. However, marine transportation can take more time and has fewer delivery location options, which requires close partnership with other modes for safe, efficient, cost-effective, and resilient transportation of freight.

The bottom-line metrics of freight moving through the MTS and through the overall intermodal transportation system from origin to destination will drive freight transportation decisions going forward. MARAD is interested in the broader picture of cargo freight optimization along key transportation corridors domestically and internationally.

Directives: The following topics have been identified by the USCMI for further study:

1. Strategies and associated infrastructure requirements for expanding maritime transportation corridors for U.S. produced energy products to domestic users and international export partners
2. Opportunities to leverage U.S. Marine Highways to reduce freight transportation energy consumption and emissions, including modeling and simulation of intermodal freight transportation solutions
3. Coordination and technical support for various maritime freight transportation corridor initiatives domestically and with international port partners, including technical assessments and modeling/simulation support that engage both the maritime industry and beneficial cargo owners/shippers in freight flow optimization

3.3.4 Investment Area 3: U.S. Maritime Competitiveness

U.S. maritime competitiveness is a high priority for the Administration, the Congress, the industry, and the public. The viability and effectiveness of the U.S. MTS as well as our ability to support military operations

with strategic sealift support is critical for national defense and economic security of the country. Three major areas of interest are:

- (1) overall U.S. maritime strategy support,
- (2) innovations to rebuild/revitalize U.S. shipbuilding and sustainment, and
- (3) support to modernize and grow the U.S. maritime workforce.

This section of the SRP describes key areas of focus in this initiative area.

3.3.4.1 U.S. Maritime Strategy, Shipbuilding, and Sustainment

Objective: Congressional interest in U.S. maritime competitiveness is high, with multiple recent bills introduced on the topic, including the most recent bills introduced into Congress. U.S. strategy and policy will need technical analysis and support to be effective, and initiatives aimed at improving U.S. maritime competitiveness will require innovative approaches to achieve these objectives. The USCMI can play a supporting role in improving U.S. national and economic security by supporting and incubating innovative maritime technology.

Directives: The following topics have been identified by the USCMI for further study:

1. Analysis to support U.S. maritime strategy implementation options proposed by MARAD
2. Launch and management of regional maritime innovation incubators
3. Study on how to accelerate the adoption or integration of commercial technologies within the maritime industry
4. Studies on how non-traditional technologies and capabilities can improve the competitiveness of U.S. shipbuilding, ship repair, and the supply chains that support them
5. Development of standard designs for commercial vessels and components and features of commercial vessels to be manufactured in the U.S.
6. Work with Centers of Excellence for Domestic Maritime Workforce Training and Education to develop strategies to support and develop the U.S. maritime workforce

3.3.4.2 Maritime Education & Workforce Development

Objective: MARAD is particularly interested in its efforts to help prepare the current and next generation of mariners for the changes that are coming to the maritime industry. New technology can only be successful if the workforce is equipped to work with that technology.

Directives: The following topics have been identified by the USCMI for further study:

1. Identifying high priority national and regional gaps in advanced technology for mariners, especially around the new technology associated with next generation maritime energy and maritime operations
2. Facilitation of augmented and virtual reality training technology for workforce



3.3.5 Investment Area 4: Maritime Resilience

The MARAD META program mission covers a range of environmental topics related to the maritime industry. Vessel-generated underwater radiated noise, ship-mediated aquatic nuisance species, and other emerging environmental concerns are of high interest for USCMCI work. This section of the SRP describes key areas of focus in this initiative area.

3.3.5.1 Vessel-generated Underwater Radiated Noise

Objective: The 2023 NDAA expanded MARAD’s authority to facilitate the exploration not only of technologies and operations that can reduce underwater radiated noise but also research and demonstration opportunities that can further elaborate on the linkages between reducing underwater noise and the implementation of electrification and efficiency strategies like various marine fuel options, new vessel designs, and emerging energy and propulsion technologies. MARAD seeks to identify and evaluate novel technologies and practices for reduction of underwater radiated noise from ships. Guidelines targeting the reduction of underwater noise produced by commercial vessels exist, however significant growth in global shipping, increased understanding of underwater noise impacts on marine communities, and recent advancements in acoustic measurement technologies has led to new efforts to improve underwater noise management.

This type of work will not only forward the mission of the META program, but support USCMCI efforts for data acquisition needed for domestic and international decision-making on policies and regulations on underwater noise and emissions from shipping.

Directives: The following topics have been identified by the USCMCI for further study:

1. The state of knowledge for emerging technologies, practices and processes that reduce underwater radiated noise from ships, including identifying significant gaps in knowledge related to emerging marine technologies and practices for reducing underwater radiated noise from ships.
2. The potential viability of active noise cancellation technology for mitigating the impacts of underwater radiated noise from ships
3. Regional underwater noise studies and mitigation planning efforts in high priority areas
4. Joint work on international standards on underwater noise

3.3.5.2 Ship Mediated Aquatic Nuisance Species

Objective: MARAD continues to focus on mitigating ship-mediated introduction and spread of aquatic nuisance species, especially through ballast water and vessel hull biofouling. Aquatic nuisance species (ANS) pose severe threats to aquatic ecosystems, including outcompeting native species, damaging habitats, changing food webs, and altering the chemical and physical aquatic environment. The importance of hull biofouling is evidenced by the International Maritime Organization’s (IMO) 2023 Guidelines for the control and management of ships’ biofouling to minimize the transfer of invasive aquatic species. The approval of the guidelines impacts the shipping community, especially when entering the waters of Member States, who place a high emphasis on “bio-security”.

To that end, submerged vessel surfaces are often inhabited by diverse sessile and sedentary marine organisms, which can directly impact vessel operations and increase the likelihood of invasive species

introductions. Vessel in-water cleaning (IWC) systems have been proposed as primary solutions to these issues and are now being incorporated into biofouling policy. However, rigorous, transparent, and predictive verification testing is vital to regulatory success, especially in the early days of these new innovations. Hull cleaning technologies continue to be developed and assessed for performance.

Directives: The following topics have been identified by the USCMI for further study:

1. Novel technologies and practices for treating ballast water, including the state of knowledge for emerging technologies, practices, and processes for treating ballast water and/or reducing concentrations of aquatic organisms in ballast water (especially against high priority species)
2. Novel technologies and practices for preventing and/or removing biofouling from the hulls of vessels, including the state of knowledge for emerging technologies, practices, and processes for biofouling management (especially against high priority species)
3. Species detection and diagnostic technology and quantifying patterns and mechanisms that can help develop more targeted prevention and mitigation strategies, particularly in regions/locations where concerns are significantly different.

3.3.5.3 Emerging Pollution & Other Issues

Objective: The maritime industry has been working with government agencies and communities to reduce the environmental footprint of ports. This includes air and water emissions, noise, light, and other issues of concern. This time of overall rapid change for the industry provides a good opportunity to address other current and emerging environmental issues. Additionally, ports and MTS infrastructure are vulnerable to various types of natural disasters that can impact operations, cause loss of life, and damage/destroy MTS assets.

Directives: The following topics have been identified by the USCMI for further study:

1. Criteria pollutants associated with various types of maritime fuels
2. Lifecycle impact of marinized batteries and marinized fuel cells
3. Fate studies of commercial marine pollution on the environment
4. Port area pollution (air, noise, water, etc.) mitigation studies for specific ports/regions
5. Commercial marine pollution/discharges (liquid and solid waste streams)
6. Natural hazard vulnerability and risk mitigation for MTS equipment/systems