

United States Department of Transportation MARAD Annual Modal Research Plan

Cover Page

MARITIME ADMINISTRATION

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Michael Carter/Todd Ripley, POC's

Executive Summary

Existing META Program Summary - The Maritime Environmental and Technical Assistance (META) Program was established by Congress to foster innovation in environmental protection within the U.S. maritime transportation industry and to improve competitiveness through increased efficiencies and technology adoption. The Program is executed through collaboration among the private and public sectors to identify, evaluate, and demonstrate promising new technologies and practices that are likely to result in environmental improvement. META's achievements inform not only industry but provide data for development of national and international maritime environmental policy mechanisms and assessing potential regulatory and permitting reforms.

The META program promotes the research, demonstration, and development of technologies and processes that improve maritime industry environmental sustainability. Since its inception, META's primary focus areas have been control of non-indigenous aquatic species transported by vessels, and reduction in vessel and port air emissions. These two areas present significant continuing challenges for ship owners and operators, the regulatory community, and the public.

Aquatic invasive species are one of the greatest threats to marine and coastal biodiversity world-wide. Aquatic invasions can destroy native ecosystems, overwhelm native species, reduce recreational opportunities, and adversely impact sport and commercial fisheries. Although there are many pathways through which these invasions can occur, transportation in ships' ballast water and in hull biofouling are known contributors.

The Maritime Administration (MARAD) works with the maritime community to address issues related to the introduction of non-indigenous aquatic species through ballast water and hull biofouling. The Agency established its Ballast Water Initiative to assist industry and government agencies in moving treatment technologies from the laboratory to shipboard application as rapidly as possible.

MARAD's ballast water efforts have grown into a multi-state and multi-agency cooperative effort that supports the development of technical and scientific protocols for technology testing and verification, and operation of independent testing facilities to provide the needed data for ultimate certification of ballast water management systems (BWMS) to International Maritime Organization (IMO) and U.S. Coast Guard standards. These facilities also conduct research and development into improved technology and processing to control the spread of non-indigenous aquatic species.

Air pollution results in substantial economic, environmental, and human health costs. Criteria pollutant and greenhouse gas emissions from large marine engines have the potential to affect not just coastal and port communities, but also to impact populations hundreds of miles away.

For clean emissions initiatives to advance, there must be a process for assisting stakeholders in making

decisions on the most beneficial and practical approaches. Whether selecting alternative fuels or technologies, the investment by industry is significant. Therefore, an important component of MARAD's META Program is to test, evaluate, and demonstrate the viability and applicability of alternative fuels and technologies with the objectives of improving fuel efficiency, compliance with national and international fuel and air emissions regulations, and reduction in vessel operating costs. With respect to alternative fuels landside infrastructure and colocation for multi-modal use must be considered.

META is authorized to coordinate with other federal, state, and local agencies to carry out its goals. Since the program's inception, MARAD has partnered with numerous agencies, industry, and academia to complete research and demonstration projects. Regarding non-indigenous aquatic species, MARAD has partnered with the U.S. Coast Guard, Naval Research Lab, US Naval Sea Systems Command, and state agencies such as the California State Lands Commission and the Maryland Port administration. Pertaining to air emissions reductions and energy conservation, MARAD works closely with the US EPA, USCG, DOE, state agencies such as the Maryland Department of Transportation, research universities, and maritime academies.

No FY2019 funds were requested. Therefore, no FY2019 funded projects are identified.

FY 2017/FY2018 Completed Project Highlights

Exhaust Gas Treatment System – MARAD partnered with a Great Lakes shipping company (Interlake Steamship) to complete an exhaust gas treatment system (i.e. scrubber) emissions testing project on one of its vessels. Vessel scrubbers are a new technology that the industry is using to comply with more stringent emission regulations. The objective was to obtain emissions data and understand lessons learned on installation and operation of the scrubber. The project was completed in early FY18 and met both META's program goals and aligned with DOT Strategic Goals of accountability and innovative technologies. A report of the project is being completed and will be made publicly available on the META website. This report will help inform the industry, public, and government agencies of the challenges of installation and operation of this alternative technology as well as provide emissions testing data that proves the technology. The total cost of the project to the company exceeded \$5 million with MARAD contributing less than 10%.

LNG Emissions Testing – MARAD, in partnership with Transport Canada, the National Research Council of Canada, and the University of California Riverside recently completed an LNG emissions testing campaign on a new cargo ferry. The objective of the campaign was to record in-situ criteria pollutant and carbon emissions from the vessel while operating on LNG and on low sulfur diesel fuel. This was the first campaign of its kind in North America. The campaign yielded emissions comparison data that will inform the industry, public, and regulatory agencies. This project fits squarely under the META program goals. MARAD contributed about 50% of the funding for the emissions testing, with the other half being supported by Transport Canada. The vessel operator also contributed in-kind services by altering revenue operations for emissions testing.

Energy Efficiency -- AEP River Operations (renamed: ACBL Company) which operates tug services on the inland river system, was funded under META to design, fabricate, install and test a "cruising genset hybrid" (the genset) on board one its tugs. The 200 kW 480VAC genset, which gets its power from the main engine, operates in place of or complimentary to the auxiliary engines, has outperformed expectations in terms of both environmental and energy savings performance. The vessel operator has

nearly eliminated need to use the auxiliary diesel engines during the cruise operations of the tug, thereby reducing fuel consumption and related air emissions.

Ballast Water Management System Verification/Certification – Over the past several years, over 50 BWMS or monitoring/rapid detection systems have been tested at three MARAD-supported and USCG certified facilities and the MARAD RRF vessel MV CAPE WASHINGTON. In FY2017-18 alone, five promising treatments and/or treatment systems were tested. The objective of the testing was to validate and provide data on the efficacy of systems to treat ballast water in marine, brackish, and fresh waters. In two of these cases, the data was included as part of final submissions to the IMO or USCG for approval. In other cases, additional data was needed or systems required further development, which was informed by the testing.

This project is ongoing. It meets both META's program goals and is in alignment with DOT Strategic Goals of accountability and innovative technologies. A lot is learned from this project. Specifically, not all systems work according to vendor claims and can be challenging to operate in the marine environment (versus laboratory). Research output was empirical data on the efficacy of the system/treatments. Further testing/verification is required – the facilities are in a unique position to provide unbiased third-party data that will affect the decisions made by ship owners. Without this type of testing, there would be no credible source of data. Two of the facilities, the Golden Bear Facility and the Maryland Environmental Resource Center (MERC) facility, receive funding from non-federal sources for the testing. Depending on the type and complexity of the tests, at least five non-federal dollars are received for approximately one federal dollar spent on the project. Thus, for the \$250,000 outlay for facility infrastructure maintenance, approximately \$1.25M was received.

MARAD ITS-JPO Collaboration Research Activities Summary – The ITS MARAD Program is a joint USDOT initiative, co-led by the ITS JPO (Intelligent Transportation Systems Joint Program Office) and MARAD with modal participation from FHWA and FMCSA. The goal of the Program is to use ITS to improve the performance of maritime ports and terminals along with the larger freight network. MARAD currently does not have a budget for any of the projects, but by working jointly with the ITS-JPO and FMCSA, we have directed work benefiting our port stakeholders and communities.

The Program completed the Business Case Assessment project in October 2017. The team conducted outreach with stakeholders, and developed a portfolio of business case assessments for four candidate ITS solutions.

We continue to work on identifying a portfolio of projects that agencies, including port authorities, can implement through ATCMTD (Advanced Transportation and Congestion Management Technologies Deployment) and other grants to address port and freight-related challenges.

Through the Program we are working toward a long-term outcome of field operational testing of the technology solutions, one of which may include automated truck queuing at ports. Working closely with relevant maritime stakeholders will help ensure effective technology transfer activities of the completed products and tools, and assist in developing plans for future evaluation activities.

Section 1 – Program Descriptions, FY 2019

FY 2019 RD&T Program Funding Details

RD&T Program Name	FY 2019 Pres. Budget (\$000)	FY 2019 Basic (\$000)	FY 2019 Applied (\$000)	FY 2019 Development (\$000)	FY 2019 Technology (\$000)
META*	0	0	0	0	0
MARAD ITS-JPO*	0	0	0	0	0
Totals					

* The Maritime Environmental and Technical Assistance (META) program was zeroed out in the President's Budget Request for 2019, but may possibly receive some congressional appropriations. META operates by authority of 46 USC 5037. META funding is generally a line item in MARAD's Operations and Training budget; this funding is not provided under a designated Research and Development (R&D) account. META expenditures are, however, primarily used for maritime transportation technology and operational innovation and demonstration projects. This plan is nevertheless provided in order to provide OST visibility of this program.

* MARAD ITS-JPO Activities are funded from and in cooperation with the Intelligent Transportation Systems Joint Program Office (ITS-JPO) funded under the Federal Highway Administration and aligns with their budget submittal.

FY 2019 RD&T Program Budget Request by DOT Strategic Goal

RD&T Program Name	FY 2019 Pres. Budget (\$000)	SAFETY (\$000)	INFRA-STRUCTURE (\$000)	INNOVATION (\$000)	ACCOUNT-ABILITY (\$000)
META*	0	0	0	0	0
MARAD ITS-JPO*	0	0	0	0	0
Totals					

*When funded META funds do not fit neatly into the above categories; there is some overlap. For example, a project exploring the use of domestically produced liquefied natural gas (LNG) for vessel propulsion would have safety, mobility improvement, infrastructure and environmental dimensions.

* MARAD ITS-JPO Activities are funded from and in cooperation with the Intelligent Transportation Systems Joint Program Office (ITS-JPO) funded under the Federal Highway Administration and aligns with their budget submittal.

Maritime Environmental and Technical Assistance Program Funding Request (\$0,000,000)

Program Description/Activities: MARAD will continue to implement the META program by continuing oversight of existing projects and continued outreach with stakeholders to maintain continuity through FY2020.

The META Program is designed to identify, study, evaluate, test, demonstrate or improve emerging marine technologies and practices that are likely to achieve environmental improvements by reducing air emissions, water emissions or other ship discharges, increasing fuel economy or the use of alternative fuels and alternative energy, and controlling non-indigenous aquatic species.

Non-indigenous aquatic species -- MARAD will maintain its support for the BWMS testing, validation and certification process with established facilities and scientific teams, including the California Maritime Academy school ship Golden Bear, the Great Waters Research Collaborative, and the University of Maryland Maritime Environmental Resource Center. In addition, underwater hull fouling and in-water cleaning projects started with pre-FY2019 funding will be ongoing. In all cases, one element of the projects is to support commercialization of economical technologies that will assist the maritime industry in achieving environmental requirements and enhance environmental performance.

Alternative Fuels and Energy Efficiency – MARAD will continue oversight of existing projects and engagement in maritime focused efforts related to bio-fuels, fuel cells, liquefied natural gas, and energy efficiency. That work supports the industry and innovation efforts to address port and vessel operating costs, technology transfer to the maritime transportation sector, and opening new markets for technology and alternative fuels development.

MARAD will maintain and expand upon its collaboration with other Federal, state and local governments, such as the U.S. Coast Guard (USCG), Environmental Protection Agency (EPA), U.S. Navy, National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers and the Department of Energy (DOE) and maritime stakeholders to provide the maritime technical expertise on projects outside the META program.

Finally, because MARAD school ships and NDRF vessels play an important role in supporting MARAD innovation and META related projects, we will continue to work with industry and other stakeholders to provide opportunities for technology testing and demonstration.

Statutory Requirements: No

The META Program is authorized but not mandated. Per 46 USC 50307, the Secretary (delegated to MARAD) is authorized to establish META to “identify, study, evaluate, test, demonstrate or improve emerging marine technologies and practices that are likely to achieve environmental improvements by reducing air emissions, water emissions or other ship discharges, increasing fuel economy or the use of alternative fuels and alternative energy and controlling aquatic invasive species.” The META Program supports MARAD’s statutory mission to “foster, promote and develop the merchant maritime industry of the United States” (49 USC 109(a)). As described in other sections the program, projects and activities align closely with the statutory mandate.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
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Safety Innovation Accountability	Promoting safety Preserving the environment
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Non-indigenous aquatic species are one of the greatest threats to marine and coastal biodiversity worldwide. Aquatic invasions can destroy native ecosystems, overwhelm native species, reduce recreational opportunities, and adversely impact sport and commercial fisheries. Although there are many pathways through which these invasions can occur, transportation in ships' ballast water and in underwater hull biofouling are known contributors. The threat of introduction and spread of aquatic invasive species does not distinguish between rural and urban communities, however, many of the impacts of the species affect jobs and recreational opportunities, such as commercial and sport fishing, that are important to rural communities.

Air pollution results in substantial economic, environmental, and human health costs in all communities. Pollution from mobile transportation sources remain a serious issue. Air pollution from large marine diesel engines has the potential to affect not just coastal and port communities, but also populations hundreds of miles away. While emissions from land-side mobile sources have been reduced substantially, maritime sources remain challenging.

Because of the unique ship operating environment, safety is a fundamental concern when considering alternative fuels and energy sources, as well as technologies that can create heat or use chemicals. Safe handling, storage and management of energy such as liquefied natural gas (LNG), hydrogen, batteries are key to their ultimate utility in maritime operations. As such, much of the work being done under the META program must and does include key elements of safety.

Program Objectives:

Regulations on ballast water discharge and air emissions continue to become more restrictive and compliance in the maritime context is particularly challenging. Innovative technology and alternative energy will play a large role in the success of meeting those challenges. Commercial operating and safety requirements limit opportunities to test, demonstrate, validate, and assess technologies and alternative energy for marine applications, particularly with ships.

As with other modes of transportation, there are many potential methods for achieving emissions reductions and improving energy efficiency such as cleaner burning fuels, emissions abatement equipment on board vessels, and more efficient design and operation of ships. For clean emissions initiatives to advance, there must be a process for assisting stakeholders in making decisions on the most beneficial approaches. Whether selecting alternative fuels or technology, the investment by industry is significant. Therefore, an important component of MARAD's META program is to test, evaluate and demonstrate the viability and applicability of alternative technologies, to generate data and information useful to the marine community, regulatory agencies and the public.

There are many market factors that affect the maritime industries efforts to address environmental issues and more generally innovation. Among those factors are:

- Enormous expense associated with investment necessary for equipment, retrofit, construction and operation of technologies for ships;
- Limited availability of commercial opportunities for research, demonstration and testing of potential technologies, fuels and innovations under operating vessel conditions. For example, commercial ship owners are reluctant to test alternative fuels in multi-million dollar engines or

take vessels out of service even for short periods for conducting tests or adding experimental equipment because of lost cargo revenue which can well exceed \$20,000 a day.

- There are limited US based vendors/innovators for much of the marine equipment that is required for US maritime operations and thus, less incentive for innovation.

Through efforts with stakeholders, MARAD has created opportunities to address these shortfalls through, for example, the establishment of dedicated facilities and teams for ballast water management technology testing, and the use of school and NDRF vessels for ballast water treatment, in-water hull cleaning and energy efficiency technologies, and testing of alternative energy/fuels.

Research Collaboration Partners:

Most of META's project have been developed because of an expressed need from the maritime industry. The META program is built on the premise of public-private partnerships and collaboration with Federal, state and local government, academia, maritime industry and non-governmental organizations. Many META projects provide for substantial cost sharing with other governmental, academic, and private industry partners. MARAD partners have included:

- Vessel operators, such as TOTE Services (a U.S. Flag ocean going vessel operator), FOSS, Young Brothers, American Electric Power River Operators (AEP) (an inland barge operator), Interlake Steamship and American Steamship Company (Great Lakes vessel operators), the Ship Operations Cooperative Program - a non-profit consortium that includes ship owners/operators, maritime educational entities, maritime labor, and a consortium of Great Lakes maritime industry, academia, and Federal, state and local government from both U.S. and Canada.
- Local and Regional entities, such as Pittsburgh Region Clean Cities, California State Lands Commission, San Francisco Department of Environment, Puget Sound Clean Air Agency, Maryland Department of Transportation.
- Ports, including the Maryland Port Authority, Ports of LA & Long Beach, Port of Seattle, Massachusetts Port Authority, Hawaii Ports;
- Federal agencies such as EPA, USCG, DOD, DOE, NOAA, and USDA;
- Academic partners, including the University of Maryland, University of Wisconsin, California Maritime Academy, Maine Maritime Academy, SUNY Maritime Academy, Massachusetts Maritime Academy, University of Delaware, Rochester Institute of Technology, University of California Riverside.

Acquisition/Assistance:

The META program uses a variety of different vehicles/methods to establish research projects and collaborations. Multi-year cooperative agreements have been the primary vehicle used to date because they provide flexibility in managing efforts in targeted areas while adjusting to and building upon information learned in various project or project phases. Project scopes of work are developed within the cooperative agreements.

Competitive procurements are also used where possible and appropriate, typically through requests for proposals. Sole source agreements are used where appropriate. Because of the limited availability of commercial platforms for testing and demonstration projects and/or technical expertise in an area, MARAD may entertain an unsolicited proposal that provides a unique opportunity for furthering the program area objectives.

The program uses both single and multi-year acquisitions. Typically, cooperative agreements are up to five years. Projects typically take multiple years to complete, but funding obligated for the project is single fiscal year.

Interagency agreements are also used, particularly where there are multiple government agencies involved with a project. Various partners include DOD, DOE, EPA, and USCG.

Most all META projects require funding and/or in-kind services. Cost sharing is typically more than 50% from the collaborating entities.

Technology Transfer (T2):

Technology testing, validation and verification is a fundamental part of the META program. As such, much of the work supports T2 opportunities and the distribution of information about the costs, benefits, and performance of technologies to assist industry in making decisions regarding capital investments and choosing among technology options that best fit their operations. At the same time, META provides opportunities that are otherwise unavailable to innovators to perform some R&D outside of the laboratory in real or near real operations.

Test results, reports, studies and industry guidelines are available through MARAD's website, the Research Hub and most partners' websites. Technical papers from the projects are regularly presented to journals, industry magazines, TRB and other public venues.

Evaluation / Performance Measurement:

The legislative language defines the goal of the META program as "Foster collaborative efforts amongst Federal agencies, academia, industry, and the public to address critical marine transportation issues." Because of the nature of this program, which is focused on providing technical assistance in areas where environmental challenges exist, the development of baselines, broad goals and metrics has been difficult. The program does not have defined objectives that cross the overarching program. Rather, the program office manages 3-year outlooks, consistent with agency goals that identify program focus areas and potential projects to support those areas.

As a practical matter, areas of focus or concentration are reviewed at least annually in developing spend plans. Priorities are guided or influenced by stakeholder input, lessons learned from previous research, regulatory changes, and an effort to complement or build on work of others, both nationally and internationally. In addition, META takes advantage of "projects of opportunity," where MARAD will add to projects that are being undertaken or planned by others. For example, MARAD might perform pre and post emissions testing when a ship owner performs a repower or switches fuel types.

As designed, the program is largely driven by stakeholder needs. As such, MARAD participates in numerous forums throughout the year such as the Ship Operation Cooperative Program, CMTS, AAPA, IMO, ISO/ASTM, and TRB information on research and technical assistance needs are identified and discussed with both industry and government partners.

In addition, MARAD sponsors workshops, such as the 2017 high-energy battery workshop, and META program public forums.

Finally, at the project level, META work follows specific project scopes of work, with milestones and deliverables, which are monitored by a program technical representative.

MARAD ITS-JPO Collaborative Research Activities

Funding Request (\$0,000,000)

Program Description/Activities: *Current ITS initiatives related to ports include the following:*

Truck Staging Study; The goal of initiative is to create a best practice truck staging report integrating Intelligent Transportation System (ITS) technologies into drayage and other port truck movements. For this effort collaboratively, MARAD, working collaboratively with the USDOT ITS Joint Program Office has completed a report outlining the current state of the practice in truck staging. Based upon that report, MARAD is creating a best practice report. Also as part of this initiative MARAD is conducting a feasibility study for autonomous trucks utilization within a port environment. The overall initiative has an anticipated completion date in early 2019.

Port Planning and Investment Toolkit ITS Module – The goal is knowledge and technology transfer of ITS Technologies into the port environment. Working with the ITS JPO and the American Association of Port Authorities, MARAD is creating a module to add to the Port Planning and Investment Toolkit. The new module will identify knowledge and technology transfer opportunities that will assist ports in the planning, funding, and deployment of ITS applications. This ITS module is anticipated to be completed in early 2019.

Statutory Requirements: No

This is not a statutory requirement for MARAD but is a collaborative partnership that includes ITS-JPO, FHWA, FMCSA and other partners designed to improve freight movement and multimodal efficiencies.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Infrastructure Innovation	Improving Infrastructure Improving mobility

Section 2 - Program Descriptions, FY 2020

Maritime Research and Development Centers (MRDC) Program

Maritime Research and Development Centers (MRDC) Program -- Description/Activities - The Maritime Administration (MARAD) is seeking annual funding to establish a formal broad-based Maritime Research and Development Centers (MRDC) Program. One goal of the program is to initiate and foster innovation, technology, automation and autonomous operations with a focus on the maritime industry and multi-modal connections.

MARAD's overarching mission is to promote the development and maintenance of an adequate, well-balanced United States merchant marine, sufficient to carry the Nation's domestic waterborne commerce and a substantial portion of its waterborne foreign commerce, and capable of service as a naval and military auxiliary in time of war or national emergency. MARAD also seeks to ensure that the United States maintains adequate shipbuilding and repair services, efficient ports, effective intermodal water and land transportation systems, and reserve shipping capacity for use in time of national emergency. Automation is transforming the freight network and it is expected to shape port activities and intermodal connections as well as vessel operations. That transformation will also affect the maritime workforce.

To that end, the proposed MRDC Program will directly address technology deficiencies that currently exist in the United States commercial maritime industry. Technological advancements in the maritime mode are not keeping pace with that of other modes making up our national transportation system; and without being addressed will result in weak links for the maritime elements of the system. The MRDC Program will enable maritime transportation interests to keep pace with other modes that make up the nation's transportation network.

Furthermore, the proposed MARAD MRDC Program will advance maritime safety, security, environmental stewardship, efficiency, economic competitiveness, resiliency and training, which are critical in contributing to the robust development of our national transportation system. Not unlike the UTC program, the MRDC program would leverage technical and scientific expertise through collaborative centers and focus on key maritime areas where research, development and technology are most needed. There will be an emphasis on technology transfer and adaptation to commercial application.

In many of the identified areas, issues such as regulatory and permitting reform to increase economic competitiveness, performance-based regulations and safety, improved efficiency and capacity of freight movement, and cybersecurity will be areas for exploration.

Non-regulatory standards and guidelines, particularly in safety, and likely in areas such as autonomous systems, do and will serve as key operating foundations for the maritime industry. Considering the rapidly changing operating environment and technology advancement, additional emphasis needs to be placed on opportunities to reduce regulatory burdens. The proposed MRDC program would provide multi-disciplinary forums to explore those opportunities.

In addition, demonstrations and technology testing and verification projects are important in informing regulatory and policy decisions. Through testing of ballast water treatment systems, for example, it became clear that various proposed regulatory standards could not be achieved. Similar opportunities exist in other areas.

Complicating the regulatory setting for much of the maritime industry is the interstate and international nature of maritime activities with multiple layers of government authority. As a result, there are opportunities to work towards parity among state and federal requirements and national and international requirements, improving competitiveness and transportation efficiencies.

Within the maritime domain there are many opportunities to improve freight mobility and efficiencies, leveraging technology, innovations in cargo handling and movement, and processing and managing freight data across the many users and systems. There are also opportunities to leverage efforts in other transportation modes to take advantage technology transfer (T2) opportunities in areas such as use and distribution of alternative fuels and energy, innovations in blockchain technology, IT and automation. The MRDC Program will bring together industry, technology developers, educators, and the next generation of maritime professionals to conceive, test, field and implement these innovations.

In the maritime industry, cyber security threats to vessel navigations systems, cargo handling systems, port infrastructure and operations, and freight data systems present a significant risk to safety and economic well-being of the maritime industry, our nation and the global economy. Therefore, the industry must be proactively addressing vulnerability's through continually hardening, testing, and training to identify and combat cyber breaches. The multi-disciplinary Centers provide a tremendous opportunity to address these emerging issues.

With the support of the Department, MARAD proposes the creation of the MRDC program. Working with the six State maritime academies and the one Federal maritime academy, the program proposes to award and administer cooperative agreements with consortia of colleges and universities across the United States. Each MRDC would be a consortium of two- and four-year colleges and graduate-study universities, industry, and independent organizations that come together to form a unique maritime center of excellence on a specific research topic focus area. Together, they would advance U.S. technology and expertise in the many disciplines comprising maritime transportation through education, solutions-oriented research, technology transfer, and the exploration and sharing of cutting-edge ideas and approaches. The program would allow MARAD to solicit proposals for designated focus areas. As part of the solicitation process, MARAD would give priority to proposals that included a significant role for our maritime schools, thereby incorporating the mariner training pool and ensuring key maritime stakeholder input. The MRDCs would bring together and coordinate considerable maritime and transportation expertise from academia, industry and government. The collaboration within the MRDC's will also ensure that considerations related to automation and the resulting maritime workforce are an integral part of maritime Research, Development & Technology (RD&T) initiatives.

The proposed program would differ from the Departmental UTC program in at least one significant respect: the maritime program would not operate as a grant program, but would operate through focus-area-specific five-year cooperative agreements. In this way, government could serve as a collaborative partner with a more direct role in the nature and extent of the specific projects being selected, ensuring that projects build upon existing knowledge and remain focused on the key areas of concern. MARAD involvement would also limit overlap and duplication of effort and steer collaboration with other RD&T done by industry partners as well as other Federal agencies.

Based upon industry needs and experience gained through programs like META, there is a critical need for technology validation and verification. With that in mind, MARAD would also support the development of MRDCs that could serve as technology testing and verification facilities. Once established, technology providers would be able to fund directly validated and verified testing.

While the MRDC program will be the cornerstone of MARAD innovation and RD&T efforts, MARAD will review and build on the limited existing innovation, research and technical assistance activities currently under programs like META, which include initiatives to use school ships and Ready Reserve Fleet (RRF) vessels as technology testing and innovation platforms. Throughout the agency, MARAD has developed substantial collaborative partnerships with industry, academia, state and Federal agencies that include DOD, DOE, EPA, USCG, NOAA and USACE, where outside resources and expertise have been leveraged to address key industry issues. Current MARAD activities including META will be considered and evaluated regarding how they might be linked to support the MRDC Program.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety Infrastructure Innovation Accountability	Promoting safety Improving Infrastructure Improving mobility Preserving the environment

Program Alignment/Objectives:

The MRDC Program is aligned with DOT Strategic Goal and DOT RD&T Critical Transportation Topic area to initiate and foster innovation, technology, automation and autonomous operations in the maritime industry. Furthermore, this will advance maritime safety, security, environmental stewardship, efficiency, economic competitiveness, resiliency and training, which are critical in contributing to the robust development of our national transportation system. The program would also provide opportunities to assess areas where regulatory and permit reforms or performances-based regulations leveraging commercial consensus standards related to safety and efficiency could be valuable. Sponsored research regarding intermodal infrastructure with cost/benefit analyses to include such things as inland waterway, locks, and dams and marine highways could provide support for an effective assessment of long-term economic system performance and resilience.

Coordinating, developing and delivering innovation to the maritime industry will assist in our objective of a healthy, cost- competitive U.S. maritime industry. The seven focus areas currently identified to benefit the industry are: Efficiency, Remote and Autonomous Operations, Safety, Training, Infrastructure, Security and Environmental.

Focus Areas Include:

1. **Efficiency** – Many factors come into play in the efficiency arena for the maritime industry. First and foremost is energy. Energy for propulsion and subsystems. Improving current systems and finding alternative and cleaner, newer energy sources as well as systems to move and operate our fleets and ports more cost effectively is the cornerstone to keeping a healthy U.S. merchant fleet and maritime transportation system. Engineering subsystems, hull designs, controls and various other portions of this complex industry are important areas that need attention within the efficient and alternative energy areas.

2. **Remote and Autonomous Operations** – Remotely and autonomously operated ships and systems are no longer the vision of futuristic science fiction novels. The technology is maturing and entering our society at a rapid pace. The day will soon be upon us when remotely or autonomously operated vessels (passenger and cargo) and port/intermodal operations are an integral part of our maritime industry. It is vitally important to encourage US private industry to develop the hardware, systems and software for remote and autonomous vessel operation to remain competitive in the global economy. European interests already have a lead, and that gap must be closed. The U.S. industry needs to be sparked to compete and RD &T efforts with academia, in consultation with maritime operators and suppliers, can achieve that result.
3. **Safety** – The maritime industry is dangerous, containing the real potential for loss of life and potentially irreversible damage to the environment. Any innovation improvements that can be implemented to increase safety and protect life and the environment are critically important.
4. **Training** – The manning of our fleet is the single most important aspect of a healthy national security sealift program. Recruiting and training the mariner work force we need today and in the future, will continue to be a challenge. As the maritime industry changes and evolves, so will the need for training of these future mariners. Remotely operated and autonomous systems plus new and improved propulsion systems, along with advances in energy sources will require entirely different skill sets and fundamentally change the way we operate the complex maritime and intermodal transportation industry.
5. **Infrastructure** – Maritime trade is vital to the U.S. economy; 90 percent of American overseas trade passes through the maritime system at one point or another. The American Association of Port Authorities estimates that \$1.3 billion worth of U.S. goods moves in and out of U.S. ports every day. Infrastructure is a critical component in the complex maritime industry. The U.S. merchant fleet and U.S. shipping would not be able to operate without the infrastructure necessary to load and off-load our ships, carry on international trade or forward deploy our military in times of national crisis. Today, infrastructure resilience is an important aspect of long-term infrastructure development. Determining the best way to address that issue will be important to the nation’s military and commercial maritime health.
6. **Security** – As global trade continues to grow and automation transforms our transportation system, addressing maritime security vulnerabilities will become progressively more important. Whether it is the physical threat of piracy or the operational threat of cyber-attacks, innovation is necessary. That security need will become more pronounced as automated systems along the transportation supply chain, at intermodal connections and ports, and on vessels are more automated. Access to and the integrity of aspects including routing, GPS systems and information and security resiliency are other areas of concern.
7. **Environmental** - Environmental concerns, regulations and requirements at the local, state, national and international levels are of increasing importance both in and around ports and with vessel operations. The importance of these factors to the competitiveness of our nation’s maritime industry both at home and abroad cannot be ignored. Due to the long lifespan, and significant capital and operational costs of many maritime assets, rapidly changing requirements can be economically devastating. The need for cost effective and workable solutions is key. Innovation, technology verification and cost/benefit information is vital to maritime industry adoption and creates opportunities for U.S. companies.

Pursuit of the research result in:

Establishment, fostering and implementation of a strong maritime research, development and technology program (MRDC Program) targeted to find solutions to the toughest problems to assist U.S. shipping companies and the industry to compete and thrive both domestically and internationally as a critical part of the nation’s transportation system.

Research, Development, and Technology involving the maritime academies will enhance training and ensure close collaboration with industry to identify and address the needs for our nations maritime industry.

This research will be carried out with collaborative partners:

The MRDC Program will require a broad cross section of academic, industry and government partners to ensure critical maritime research issues are identified and addressed, and financial resources are leverage from all partners in conducting research

MRDC Program will leverage the six State maritime academies and the one Federal maritime academy as partners in awarding and administer cooperative agreements with consortia of colleges and universities across the United States. Each MRDC will be a consortium of colleges and graduate-study universities, industry, and independent organizations that come together to form a unique maritime center of excellence on a specific research topic. As part of the solicitation process, MARAD will give priority to proposals that include a significant role for our maritime schools, thereby incorporating the mariner training pool and ensuring key maritime stakeholder input.

MARAD involvement will eliminate overlap and duplication of effort and steer collaboration with research done by industry partners as well as other Federal agencies.

MARAD will coordinate an Annual MRDC Program Symposium/Public Meeting that will include required participation from MRDC consortiums and the MRDC Board of Directors, plus invite all interested academic, industry and government stakeholders to review research activities and results conducted over the past year, identify critical maritime industry future research needs. In addition, a publicly accessible website will be established and structured to track and make available information on MRDC research, innovation and technology activities and foster increased collaboration. The website will also help build on current MRDC initiatives, facilitate additional research opportunities, and support deployment of resulting innovations and technologies. As a requirement in the cooperative agreements, consortiums will be tasked to maintain and keep current information for their respective maritime research activities.

Maritime Environmental and Technical Assistance Program

Program Description/Activities:

46 USC 50307 authorizes the Secretary of Transportation to “identify, study, evaluate, test, demonstrate or improve emerging marine technologies and practices that are likely to achieve environmental improvements by reducing air emissions, water emissions or other ship discharges, increasing fuel

economy or the use of alternative fuels and alternative energy, and controlling aquatic invasive species.” The Secretary has delegated responsibility for this program to MARAD.

Projects undertaken in the META program are decided upon annually, after careful review of the maritime industry’s most significant technological challenges and opportunities and consideration of related work being done elsewhere in the United States and abroad. To preclude duplication of effort and ensure maximum synergy, MARAD coordinates each year’s META plan with other agencies interested in maritime technology, the U.S. Coast Guard (USCG), Environmental Protection Agency (EPA), U.S. Navy, National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers and the Department of Energy (DOE).

Anticipated Program Activities:

1. Control of Non-Indigenous Aquatic Species

The presence of non-indigenous aquatic species in U.S. waters has resulted in significant economic costs to municipalities, power plants and farmers by clogging water intakes and outfalls. Invasive aquatic species also diminish the value of U.S. rivers and lakes for recreational purposes, such as when species like Asian Carp or Snakeheads displace native gamefish species such as bass, sunfish, and pickerel.

To minimize or avoid the introduction and spread of non-indigenous aquatic species, the program will continue to support ballast water management system test facilities, which examine the effectiveness of shipboard ballast water treatment systems in preventing the introduction and spread of non-indigenous aquatic species. Projects also include the identification and testing of methods for monitoring ballast water management system effectiveness over time. Additional focus will be placed upon a second, but equally significant maritime transportation vector – hull fouling—which is of increasing concern. Projects will include work on hull cleaning and effluent capture techniques and fouling assessment methods and tools.

2. Maritime Industry Efficiency and Use of Domestically Produced Alternative Fuels

META projects in this area support development and maritime adoption of improved technologies and practices that will lead to greater efficiency, cost savings and a smaller environmental footprint. Projects include demonstration projects to ascertain the feasibility of using hydrogen fuel cells for powering refrigerated containers, providing auxiliary power for large vessels, and providing propulsion power for smaller vessels such as ferries and towboats. The use of domestically produced drop-in biofuels, produced with a variety of feedstocks, will continue to be explored. Other projects will include development and demonstration projects for higher efficiency and lower polluting marine engines, examining technologies such as hybrid engines and improved high-density batteries.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
Safety Innovation Accountability	Promoting safety Preserving the environment

Program Objectives:

META aligns well with some of these goals and objectives. Nearly all the META work supports innovation through testing, verification and demonstration projects related to alternative fuels, energy technology and energy efficiency, emissions controls, ballast water and in-water hull cleaning technology, and analysis of sensor technologies to monitor equipment operation. Projects also are heavily oriented toward safety, particularly as they explore alternative fuels and energy technologies (e.g., LNG, hydrogen, fuel cells and batteries). Safe storage and use in the unique maritime industry environment must be understood and addressed. Likewise, by statutory mandate, and implementation, the META program supports directly, the environmental protection and preservation.

Expected Program Outcomes:

- 1) Advance technology innovation in ballast water management system (BWMS) design and operation, and underwater hull husbandry to address hull fouling. Test, validate and identify methods and technology for easily assessing the effectiveness of BWMS. Advance hull husbandry and hull cleaning practices to reduce the risk of the introduction and spread of non-indigenous aquatic species. Provide ship owners/operators with independent information with which to inform investment decisions.
- 2) Advance alternative energy and energy efficiency technologies and application to expand their use in the maritime industry, with resulting lower costs and increased competitiveness. Provide the maritime industry stakeholders with independent operational, cost/benefit and other information for use in making investment decisions.

Collaboration Partners:

Collaboration partners include the OST-R, FTA, FRA, Department of Defense, Coast Guard, NOAA, EPA, DOE, state and local government agencies, universities and maritime industry stakeholders.

MARAD ITS-JPO Collaborative Research Activities

Program Description/Activities:

MARAD is a Formal Request for Comments/Information seeking information directly from the public and stakeholders to better align MARAD's role and inform future agency research and activities. Although MARAD seeks comments and relevant information and data on all issues related to the development and continued implementation of automated port systems and technologies, MARAD specifically requests comment and data in response approximately 25 questions. They fall under a general category and the following specific subject areas.:

- *Safety and/or Security Issues*
- *Infrastructure*
- *Workforce Viability*
- *Legal/Regulatory Issues*
- *Opportunities for Joint Government/Industry Cooperation*

We hope to have this Request out to the public and our stakeholders before the end of the Summer 2018.

Program Alignment with Strategic Goals:

DOT Strategic Goal	DOT RD&T Critical Transportation Topic
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[END]

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