REQUEST FOR TECHNOLOGIES

Title: Evaluation of In-Water Cleaning Technologies for Ships
Date: November 6, 2017
Programs: Alliance for Coastal Technologies (ACT) & Maritime Environmental Resource Center (MERC)
Application Deadline: Application (form with signed cover letter) must be received by 5:00 p.m. Eastern Time on December 22, 2017.

The Alliance for Coastal Technologies (ACT) and Maritime Environmental Resource Center (MERC), in collaboration with the:

- US Naval Research Laboratory (NRL),
- Smithsonian Environmental Research Center (SERC),
- California States Land Commission (CSLC),
- US Maritime Administration (MARAD), and
- Maryland Port Administration (MPA),

are currently accepting preliminary applications from developers and manufacturers of ship in-water cleaning technologies to participate in independent performance testing. Commercial ship biofouling—or the colonization of wetted surfaces by aquatic organisms —presents significant problems for the maritime industry. The biofouling of vessels can interfere with operations and result in increased corrosion, drag, and fuel consumption and emissions. Ship biofouling is also a significant, if not the most dominant, vector for the global-scale transfer and introduction of non-native aquatic species, which can have enormous ecological and economic impacts on coastal environments. A number of in-water cleaning and material capture technologies and approaches have been developed over the past 10 years, focused mostly on hull husbandry to reduce drag and fuel consumption and to support the maritime industry. However, new innovations are now also targeting biofouling removal and capture from vessel niche areas, with biosecurity and environmental protection as an additional goal (including the capture of biocides in the effluent, usually copper or zinc). There is now a critical need to provide thorough, independent evaluations of ship in-water biofouling cleaning systems to quantify their efficacy and reliability in removing fouling organisms, including the capture of debris and potential contaminants, from complex vessel structures.

The specific goals of this effort are to: (a) refine and customize procedures for evaluating the efficacy of in-water cleaning technologies to remove biofouling from underwater ship surfaces, collect removed biological debris, and remove chemical contaminants from the effluent, (b) provide a third-party evaluations of in-water cleaning technologies, and (c) provide rigorous, independent data on the performance of in-water cleaning systems that can be used to apply for permitted commercial use in ports around the world. This evaluation of in-water cleaning systems will focus on biofouling removal, debris and biocide chemical capture efficacy, and follow the ACT (www.act-us.info) and MERC (www.maritime-enviro.org) approaches for independent testing, including the establishment of a Technical Advisory Committee (TAC), a Test Protocol Workshop, and field testing on MARAD ships in

Baltimore Maryland and Long Beach California. As part of this evaluation, participating technology developers and/or service providers will conduct the in-water cleaning on test ships, with the testing team conducting underwater ship surveys and various related sampling (before, during and after), as agreed to in the final Test Protocols. Like all ACT Technology Evaluations, participation in this effort will be voluntary and free of charge (with some participation support available) for qualifying applicants, and results will be made available to the public in individual reports for each of the technologies or service providers that agree to participate.

Please visit our web sites at www.act-us.info and www.maritime-enviro.org for additional information on ACT and MERC, to download application forms, and for detailed information on this ACT/MERC Technology Evaluation of In-Water Cleaning Technologies for Ships (including deadlines). More information can also be obtained by contacting Drs. Mario Tamburri (tamburri@umces.edu), Lisa Drake (lisa.drake@nrl.navy.mil) and Greg Ruiz (ruizg@si.edu).

Lead Programs

The Alliance for Coastal Technologies (ACT) and Maritime Environmental Resource Center (MERC, www.maritime-enviro.org) have a long history of providing unbiased, independent testbeds for evaluating existing, new and developing environmental and maritime technologies, including evaluations of sensors and platforms for studying and monitoring freshwater, coastal and open ocean environments and Type Approval Certification testing of ballast water management systems for the US Coast Guard and other administrations around the world. ACT and MERC have rigorous Quality Management Systems (QMSs), Quality Assurance Project Plans (QAPPs), and specific and detailed Standard Operating Procedures (SOPs) based on accepted/approved scientific methods and International Organization for Standards (ISO) and US Environmental Protection Agency (EPA) quality requirements. All specific individual Test Protocols are developed under a transparent community process and are also released as stand-alone documents.

It is important to note that ACT and MERC do not certify nor endorse technologies or guarantee that a technology will always, or under circumstances other than those used in testing, operate as expected. ACT does not seek to determine regulatory compliance; does not rank technologies or directly compare their performance; does not label or list technologies as acceptable or unacceptable; and does not seek to determine "best available technology" in any form. ACT and MERC will avoid all potential pathways to picking "winners and losers". Therefore, although evaluation of performance will apply to all technologies evaluated under common testing protocols, no direct comparisons will be made between systems from different manufacturers and final reports will be released to the public for each individual in-water cleaning technology as a final report.

Focus of Evaluation

Specifically, assessments of in-water cleaning technologies that manually and/or mechanically remove both soft- and hard- biofouling from ship hulls and/or niche areas, and collect and dispose or treat captured debris, biocide chemicals and effluent water will be conducted based on biofouling survey methods developed by SERC/MERC/NRL/CSLC and based on Morrisey et al., 2015, *Procedures for evaluating in-water systems to remove or treat biofouling* (ISBN No:978-1-77665).

Test Protocols and a detailed test plan will be developed with the aid of applicants and a Technical Advisory Committee (TAC) to evaluate specific parameters under diverse field conditions and on at least two different MARAD ship types and fouling levels. Although some performance standards for the removal of biofouling exist (e.g., Georgiades and Kluza, 2017*, Evidence-based decision making to underpin the thresholds in New Zealand's craft risk management standards: Biofouling on vessels arriving to New Zealand*, Mar. Tech. Soc. J. 51:76-88), there are currently no accepted US or international in-water biofouling cleaning standards. Therefore, this evaluation will provide data on in-water cleaning technology performance in the form of percent removal (before and after surveys), capture efficacy (captured material versus estimates of removed material) and treatment efficacy (dependent on in-water cleaning systems) and in the context of test methods detection limits.

This evaluation will also measure chemical contaminants in-water resulting from the use of in-water cleaning systems on ship coatings and in effluent from the cleaning systems.

Depending on the design and intended application of the in-water cleaning technology, this evaluation will include assessments of performance on (a) flat sides of the hull, (b) curved and angled areas of the hull, and/or (c) niche areas, including, at a minimum, propellers and shafts, rudders, and gratings. Technologies focused on only specific locations/structures of ships or types of biofouling are encouraged to apply. Test locations on the test ships will be identified with the goal of providing the highest level of biofouling targeted by the individual in-water cleaning technologies. Ship biofouling will be characterized using the US Navy Fouling Rating (FR) scale (Navy Ship Technical Manual, 2006). No distinction will be made between living and dead fouling organisms found on test ship surfaces – only the presence or absence, number of individuals and percent cover will be considered in these assessments, which will provide the most conservative estimate of the likelihood of biofouling release and establishment.

Eligible Technologies Must Be:

- Commercially available, or
- New, near-commercial technologies that are ready for the market with available quality testing data to support performance claims. Preference will be given to technologies that fall above a NASA Technology Readiness Level of 7 or higher (www.nasa.gov/pdf/458490main_TRL_Definitions.pdf), and
- Designed to remove biofouling from ship hulls and/or niche areas, collect and dispose or treat captured debris, biocide chemicals, and effluent water.

One in-water biofouling cleaning and capture system (i.e., equipment, operators and procedures) will be requested from each participant. Qualifying applicants will also be asked to participate in the design of evaluation protocols. The results and summaries from all individual evaluations will be provided to participants and TAC for review prior to public release after evaluations are completed. Because of limited resources, this evaluation may select to evaluate only one type of in-water cleaning technology or approach per individual developer, manufacturer, or service provider depending on the number of qualifying applicants. We will, however, consult with applicants if this selection process is necessary and we anticipate addition in-water cleaning technology evaluations in the future.

Benefits of Technology Evaluation

ACT, MERC and their collaborators will provide technology developers with an independent, scientifically objective process for testing their system under diverse and real-world situations for which their products were designed. Moreover, results will provide potential investors and users of innovative approaches with information on how technologies perform under real-world conditions. Through this process of demonstration, ACT/MERC will ultimately aid in the implementation of effective and reliable technologies that will help minimize the risks associated with non-native species introduction and spread.

Specific benefits for technology developers, manufacturers, and vendors:

- Access to expertise in demonstrating, verifying, and applying environmental and maritime technologies.
- An opportunity to test a technology on a nation-wide basis under different environmental conditions, where appropriate for the technology.
- An unbiased, reputable evaluation of technology performance.
- Increased credibility from having independent performance data (rigorous independent ACT/MERC data may be useful in the future in support of application for regulatory acceptance).
- Rigorous, independent data can increase confidence for investors and increase recognition nationally and internationally of technologies and services.

Specific benefits for technology users:

- Timely information on the performance of in-water cleaning systems to address operational and environmental issues.
- Easily accessible and understandable information on technology performance.
- Credible technology performance evaluations, independent of developer, manufacturer, or vendor claims.
- Performance-based verification and demonstration testing addressing realistic data quality objectives under varying environmental conditions.
- ACT, MERC, SERC, NRL, CSLC, MARAD and MPA review of evaluation results.
- TAC peer-reviewed final reports.

Application and Acceptance:

The application and acceptance process consists of four steps: a preliminary application, conditional acceptance, a full application, and agreement on a test plan. The tentative schedule and deadlines for each step are provided below.

Step 1. Preliminary Application - Applicants (developers, manufacturers, and vendors are requested to provide summary information about the technology proposed for testing and about their organization by submitting a signed cover letter (no longer than two pages) and by completing the ACT/MERC Application for Evaluation form (available at www.act-us.info/evaluation/rft.php). The purpose of the preliminary application is to determine if the technology meets the minimum criteria/requirements set forth in this Request for Technology, if ACT/MERC and collaborator facilities are capable of conducting an appropriate and safe evaluation, and if a conflict of interest exists. Preliminary applications are screened and categorized by ACT/MERC and collaborative staff based on at least the following criteria:

- Does the technology fit the stated theme?
- Does the technology address the stated priorities?
- Is the technology based on sound scientific and technical principles?
- Is the technology sufficiently commercially ready for demonstration/verification testing?
- Can the applicant demonstrate ownership of the technology?

Step 2. Conditional Acceptance - All applicants that meet the requirements for an ACT/MERC Technology Evaluation will be identified and accepted contingent upon the successful completion of Steps 3 and 4. Acceptance notification will be delivered to the applicant as soon as possible after the receipt of the initial application.

Step 3. Full Application - The Full Application for testing requests additional information about the technology to ensure a clear understanding of the proposed technology, including the scientific and engineering principles of operation, previous performance data (if applicable), and potential users/customers. The application should include appropriate peer-reviewed literature, technical articles, reports, process flow diagrams, equipment specification sheets, operating and maintenance instructions, and other related materials to enable the reviewer to fully understand the technology and processes, and any other data and information that are available to support the application. Full Applications should also include suggestions for methods and/or approaches for conducting this evaluation, particularly for areas or features that may be unique to the specific applicant.

Step 4. Agreement on Test Plan – ACT, MERC and collaborative staff, Technology Advisory Committee, QA/QC Coordinator, and representatives for each qualifying applicant will gather for a workshop tentatively scheduled for March 2018 (final dates TBD), to discuss and draft a Test Plan based on the recommendations for each qualifying applicant and an appropriate QA/QC strategy. The draft will

be externally reviewed by a panel consisting of international, Federal, academic and appropriate industry professionals for appropriateness of experimental design and statistical analyses before a Final Test Plan is submitted to the qualifying applicants. Although ACT and MERC do not conduct direct comparisons of instruments being evaluated, the standardization of methods in Test Plans will allow simultaneous assessment of the various technologies and permit end-users to draw their own conclusions regarding the sensor and/or kit that best meets their needs.

Deadlines and Dates:

- Preliminary Application (form with signed cover letter) must be received by 5:00 p.m. Eastern Time – December 22, 2017
- Notification of Conditional Acceptance – January 19, 2018
- Full Application packages due – February 23, 2018
- Protocol Workshop, Baltimore, MD – March/April 2018 (TBD)
- Final Evaluation Protocols and Test Plan – April 2018 (TBD)
- Baltimore MD field testing tentatively scheduled to begin in May/June 2018 (TBD)
- Long Beach CA field testing tentatively scheduled to begin in September/October 2018 (TBD)

Evaluation Agreement:

A legal agreement (the Agreement) between ACT/MERC and individual qualifying applicants will be drafted to state that all parties agree to conduct the evaluation in accordance with the final Test Plan and that the results will be released to the public. The Agreement will also state that there will be no modifications to final Test Plan, regardless of unforeseen circumstance encountered during testing, without written consent from all parties. Furthermore, the Agreement will clearly state that although the developers, manufacturers, or vendors will be allowed to view the Evaluation Statements before they are released to the public, they will not be allowed to make changes to the final report. Under special circumstances ACT/MERC will consider inclusion of comments (in the form of a one-page letter) from the developers, manufacturers, or vendors as an appendix to Demonstration Statements. Finally, it will be noted that all data collected during demonstrations by the instruments tested are the property of the proponent and cannot be used by any other party without consent. The Agreement will be signed by the ACT/MERC Director and the appropriate representative from the qualifying applicant's organization.

Additional Information and Forms:

Please visit our web sites at www.act-us.info and www.maritime-enviro.org for additional information on the programs, details on the ACT/MERC Evaluation Process, and to download required application forms. More information can also be obtained by contacting Drs. Mario Tamburri (tamburri@umces.edu), Lisa Drake (lisa.drake@nrl.navy.mil) and Greg Ruiz (ruizg@si.edu).

Initial Technical Advisory Committee:

(other subject matter expert may be added)

- William Hertel, US Naval Surface Warfare Center Carderock Division
- Eugene Georgiades, Ministry for Primary Industries, New Zealand
- Graeme Inglis, National Institute of Water and Atmospheric Research, New Zealand
- Carolyn Junemann, US Maritime Administration
- David Elias, San Francisco Regional Water Quality Control Board
- Jesús Cisneros-Aguirre, University of Las Palmas de Gran Canaria, Spain