United States Coast Guard
Shipboard Technology Evaluation Program (STEP)

Ship Enrollment Application
for
Ballast Water Management Systems

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STEP Overview and Implementation

Purpose: The primary purpose of the Shipboard Technology Evaluation Program (STEP) is to facilitate shipboard testing for U.S. type approval of ballast water management systems (BWMS) under 46 CFR 162.060. The program also provides opportunities for vessel owners/operators to test the effectiveness of prototype systems under real world operational conditions. Vessels discharging ballast water treated by test systems into the waters of the United States must be enrolled in STEP. Specific vessels will be accepted into the STEP; treatment systems will not be accepted to the program independent of a specific vessel.

Treated discharges from vessels accepted into this program will be deemed in compliance with ballast water discharge standard regulations until the BWMS receives type approval or during the Experimental Phase for prototype systems, which is the period from acceptance into STEP through 18 months after the conclusion of the experimental testing described in the STEP Study Plan. However, if subsequent information on the experimental system indicates the potential for an adverse effect on the environment, risk to the vessel or human health, the testing of the system will be discontinued and acceptance in the STEP will be withdrawn. In addition, participation in the STEP may be discontinued for noncompliance with program requirements or if a system no longer performs satisfactorily. Vessels operating systems that subsequently receive type approval will be granted an equivalency for the life of the vessel or the system, whichever comes first, provided the system's configuration and operation are consistent with the type approval certificate. For vessels that are testing systems that do not receive type approval, including prototype systems, the vessel owner/operator may request continued participation in STEP, with an extension of the period of deemed compliance for up to a maximum of 10 years or the life of the system, whichever comes first.

Application Package Submission and Review: Application packages will be reviewed by Coast Guard Office of Operating and Environmental Standards (CG-OES-3). Particularly complex applications, including those for prototype systems, may be forwarded to an independent review panel. The applicant should expect the initial review process will take approximately 30 calendar days from the time the application is complete, and any questions are sufficiently answered. When needed, independent review and resolution of any outstanding comments should be expected to require an additional 60 calendar days.

Conditions of Acceptance: The applicant must install the experimental equipment within one year of the acceptance date. All testing and evaluations must be conducted in accordance with the accepted study plan. Specific conditional requirements may be identified for a vessel accepted into the program, based on the details of the vessel's design, operation, and study plan. All testing of BWMS on vessels for purposes of U.S. type approval must be conducted under the oversight of an accepted Independent Laboratory (IL), as described in 46 CFR 162.060-10(b), and meet all requirements of 46 CFR Subpart 162.060. Discharged ballast water must be managed either with the STEP approved BWMS or with another accepted method, as described in U.S. Coast Guard ballast water regulations[1], and discharged ballast water must meet all other

[1] The term "U.S. Coast Guard ballast water regulations," as used in this document, refers to 33 CFR Part 151, Subparts C and D, or to the relevant section(s) in VIDA implementation regulations pursuant to Title IX of the Frank LoBiondo Coast Guard Authorization Act of 2018.

federal, state, local, and tribal environmental regulations (including but not limited to residual concentrations of any primary treatment chemicals, chemicals that occur as disinfection by-products, or other water quality parameters of the discharged ballast water affected by the treatment process).

Experimental systems will be required to achieve minimal levels of biological efficacy to qualify for entry into the STEP. Prior experimental work must demonstrate a strong likelihood that the proposed BWMS can achieve the ballast water discharge standards.

Vessels accepted into STEP will be required to comply with ballast water record keeping and reporting requirements specified in U.S. Coast Guard ballast water regulations and 46 CFR 162.060-28(i), and to maintain documents as detailed in 46 CFR 162.060-34(f). STEP participants will be required to submit quarterly and annual status reports to environmental_standards@uscg.mil, as outlined in Subsection 6.3 of the STEP application. Vessels accepted into STEP will be subject to routine verification by Coast Guard personnel.

Instructions for the Applicant

The acceptance of a vessel into STEP is based upon the ability of the applicant to show supported claims of treatment effectiveness relative to the removal or inactivation of the diversity of taxa present in ballast water. This requires the presentation of test data quantifying the effectiveness of either physical removal or mortality/inactivation of organisms produced by the proposed BWMS. It is understood that data may not be available for all taxonomic groups at the time of the application; however, taxa specific information is needed for full evaluation of a BWMS.

The applicant should carefully read the requirements and provide all requested information; any substantive additions or omissions of information should include an explanation of the reasons for the change. The STEP application is flexible, and the applicant may provide requested information in narrative or tabular form, or otherwise modify the application as needed to suit a particular test project. The applicant may cite technical references to support their responses in the application.

This package includes an optional checklist for the applicant to assist in tracking completion of all required components of the application. The package also includes several tables in the appendix as optional templates to aid the applicant in providing requested data. Note that supplementary descriptions and data may be required in addition to the tables to provide all the information requested in the application.

Submission process: Complete applications should be submitted to the U.S. Coast Guard at the following email address: environmental_standards@uscg.mil. We recommend labeling all submitted documents and pages with identifying information such as the Applicant (Owner/Operator), Vessel name and IMO number/CG Official Number (O.N.), and/or BWMS model.

Applicant Checklist

This checklist is intended to assist applicants when completing the STEP Application. Note that applications for prototype systems require more detailed information because these systems typically are at an earlier stage of development, with less extensive previous testing than type approval systems, and are often tested without oversight by an approved IL.

Documents Required	Type Approval System Testing Under IL Oversight	✓	Prototype System Testing	✓
1.0 Applicant's Test Program Organization and Management Plan				
1.1 ***Letter of Commitment***	May substitute Letter of Intent for Type approval (46 CFR 162.060-10(a)).		Applicant and vessel information.	
1.2 ***Documentation of BWMS Readiness for Testing***	Copy of IL's readiness determination (46 CFR 162.060-42).		Attestation that the prototype system meets the specified requirements.	
1.3 ***Program Organization and Management Plan***	Organizational chart or description of key elements of organizations involved.		Organizational chart or description and Project Management Plan.	
1.4 ***Proposed Schedule***	Summary of completed and planned activities. Use of a Gantt or PERT chart is strongly encouraged.		Summary of completed and planned activities. Use of a Gantt or PERT chart is strongly encouraged.	
2.0 Vessel Service and Ballast Water System Specifications				
2.1 ***Vessel Service***	General description of vessel's area of operation, route(s) and ballast operations.		General description of vessel's area of operation, route(s) and ballast operations.	
2.2 ***Ballast Water System***	General description of ballasting system and cross-connections. List of ballast tanks.		Thorough description of ballasting system and cross-connections, including a description of piping and components. List of ballast tanks	
3.0 Ballast Water Management System Description				

Documents Required	Type Approval System Testing Under IL Oversight	✓	Prototype System Testing	✓
3.1 ***Operation, Maintenance, and Safety Documentation***	Operation, Maintenance, and Safety Manual (OMSM) (46 CFR 162.060-38).		Operation, Maintenance, and Safety Manual (OMSM) or similar documentation for the BWMS.	
3.2 ***Physical Configuration and Shipboard Installation***	One set of plans or drawings describing the BWMS (as described at 46 CFR 162.060-14(a)(2)).		One set of plans or drawings describing the BWMS.	
4.0 Proof of Ballast Water Treatment Performance				
4.1 ***Summary and Results of Prior Treatment Performance Testing***	Documentation that the BWMS successfully completed land-based testing for type approval (46 CFR 162.060-26) or meets the IMO D-2 discharge standard [or complete Subsection 4.2].		Must complete Subsection 4.2.	
4.2 ***Summary of Prior Experiments at Bench Scale, Pilot Scale, Full Scale***	Not applicable.		Summary description and results of prior testing work that demonstrates a strong likelihood the proposed BWMS can achieve treatment goals.	
5.0 STEP Study Plan				
5.1 ***Test Team Responsibilities***	Not applicable.		Description of the structure and management of the team conducting the biological experimental program.	
5.2 ***Treatment Performance Goals***	Not applicable.		Discussion of quantitative treatment goals by size fractions.	
5.3 ***Ballast Water Treatment Experimental Design***	Shipboard Test Plan (46 CFR 162.060-24).		Summary of the experimental design.	
5.4 ***Sampling and Analyses***	Not applicable.		Details of the specific methods to be used for biological, physical, and chemical analyses.	
5.5 ***Quality Assurance Project Plan***	Quality Assurance Project Plan (QAPP) (46 CFR 162.060-36).		Quality Assurance Project Plan (QAPP).	

Documents Required	Type Approval System Testing Under IL Oversight	✓	Prototype System Testing	✓
5.6 ***Itinerary of Test Voyages***	Not applicable.		Information about test locations and schedule for each planned test voyage and experiment.	
5.7 ***Environmental, Health, and Safety Plans***	Not applicable.		Discussion of potential environmental, health, and safety issues; unusual operating requirements; and any issues related to the disposal of treated ballast water, by-products, or waste streams.	
6.0 Long-Term Performance Monitoring				
6.1 ***Long-Term Performance Monitoring Plan***	Not applicable.		Monitoring Plan covering the Experimental Phase (STEP acceptance through 18 months after conclusion of testing)	
6.2 ***Logs for Long-Term Performance Monitoring***	All STEP participants must maintain the required logs.		All STEP participants must maintain the required logs.	
6.3 ***Quarterly and Annual Reporting Requirements***	All STEP participants must submit regular progress reports to the USCG unless granted type approval equivalency.		All STEP participants must submit regular progress reports to the USCG.	
7.0 Environmental Compliance for Active Substances	Documentation described at 46 CFR 162.060-14(a)(7).		Documentation described at 46 CFR 162.060-14(a)(7) and detailed discussion of any treatment chemicals and/or chemical byproducts and residuals.	
NOTES:				

Section 1.0 Applicant's Test Organization and Management Plan

***1.1 Letter of Commitment*:** Submit a Letter of Commitment including the following information:

- Name and contact information of vessel operator (and owner if different from operator);
- Name, type of vessel, IMO number or CG VIN;
- BWMS Manufacturer's name, address, and point of contact, with email address and telephone number;
- A statement indicating whether testing is for the purpose of U.S. type approval or if it is a prototype system;
- Name and location of testing laboratory and associated test facilities and subcontractors, plus expected dates and locations for actual testing (if known);
- Name and contact information for applicant's authorized STEP Project Manager; and
- Model name, model number, and type of BWMS.

A copy of the Letter of Intent for Type Approval as described at 46 CFR 162.060-10 may be substituted for the Letter of Commitment if all information identified above is included.

***1.2 Documentation of BWMS Readiness for Testing*:** Submit a copy of the IL's readiness determination as described at 46 CFR 162.060-42(a). For prototype systems that will be tested without IL oversight, provide an attestation that the BWMS:

- Meets all existing safety and environmental regulatory requirements for all locations and conditions where the system will be operated during the testing and evaluation period;
- Is designed to meet the U.S. EPA's ballast water discharge standards;
- All ballast water will be managed either with the STEP test system or with another accepted method, as described in U.S. Coast Guard ballast water regulations, and discharged ballast water will meet all other federal, state, local, and tribal environmental regulations; and
- The BWMS is appropriately sized for the vessel it is installed on and is capable of treating the anticipated range of ballast water quality conditions on the vessel's routes.

***1.3 Program Organization and Management Plan*:** Provide an organizational chart or description of the STEP project team, or both, identifying key elements of all organizations involved, including the owner/operator, vessel personnel, treatment system manufacturer(s), and all participating laboratories. For prototype systems that will be tested without IL oversight, also identify principal members of the biological test and long-term monitoring teams.

For prototype systems that will be tested without IL oversight, provide a Program Management Plan that clearly identifies the STEP Project Manager and provides contact information for all key points of contact. The plan should also identify which team member performs each of the following functions:

- Acts with authority regarding financial, operational, and scheduling matters.
- Functions as the primary point of contact with the Coast Guard and independent review panel (as applicable) regarding the program and application.
- Supervises preparation of all documents for submission to the Coast Guard, including the STEP Application, application revisions, and long-term performance monitoring reports.

- Coordinates test plan and shipboard operations, including schedules and activities of the Applicant's operations personnel and subject matter experts with those of the BWMS manufacturer(s) and the biological test team.
- Directs shipboard BWMS installation and testing activities, with the assistance of the port engineer and the vessel's chief engineer.
- Coordinates long-term monitoring, including operation and maintenance tasks, instrument calibration, etc.

The size of the test team must be adequate to complete the sampling and analysis tasks as prescribed in the sampling plan (see Section 5).

***1.4 Proposed Schedule*:** Summarize completed and planned activities supporting the installation, test, and operation of the proposed shipboard BWMS. Identify expected dates and geographic locations for key activities, including all dockside and at-sea engineering tests, as well as land-based and shipboard biological testing. The applicant should be sure to allow adequate time in the schedule for the application review process (see *STEP Overview and Implementation* above). Use of a Gantt or PERT chart is strongly encouraged. The applicant must install the experimental equipment within one year of the acceptance date and should begin test activities as soon as is practicable after installation.

Section 2.0 Vessel Service and Ballast Water System Specifications

***2.1 Vessel Service*:** Provide a general description of the areas in which the vessel typically operates, noting regularly visited ports. In addition, identify any anticipated U.S. ports of call during the testing period. To the extent possible, describe likely routes of voyages to U.S. ports and any ballast water operations (uptake or discharge) expected in U.S. waters.

If possible, identify uptake and discharge locations, volumes, and frequency of ballast operations. Include any available information about chemical and physical water quality characteristics, and depth of the local waters, at both the intake and discharge points for ballast water. If the ship's route changes during the application review or after acceptance into STEP, the Applicant is expected to provide updates to the CG-OES-3.

***2.2 Ballast Water System*:** Provide a general description of the operation of the vessel's ballasting system, including system monitoring and control at local and remote-control stations and any cross-connections with other systems (summarize the purpose and frequency of operations, flushing of piping after use, and how the system is segregated).

Submit a listing of all ballast tanks and capacities, identify dedicated tanks and other tanks and compartments used as ballast tanks. For each tank, include information on the ballast water management method used for the tank (e.g., the STEP test system or another method), as well as any non-ballast use of the tank or compartment (e.g., for holding black or gray water), even if such use is only occasional.
(See template: *Table 2.2-1. Vessel Ballast Tank Table.*)

For prototype systems that will be tested without IL oversight, provide a brief description of the ballast water system, including piping arrangement and design criteria for system components such as pumps, sea chests, strainers, and filters. The applicant should ensure BWMS installation diagrams required in Section 3 show the existing ballast and associated systems, including piping diagrams for cross-connected systems.
(See template: *Table 2.2-2. Process/Equipment Design Criteria for Existing Ballast/Deballast System.*)

Section 3.0 Ballast Water Management System Description

***3.1 Operation, Maintenance, and Safety Documentation*:** Provide an Operation, Maintenance, and Safety Manual (OMSM) for the BWMS that meets the requirements in 46 CFR 162.060-38. For prototype systems that do not have an OMSM, provide a complete description of the BWMS, addressing to the extent possible each of the topics listed in 46 CFR 162.060-38. Detailed design criteria must be provided for BWMS processes and treatment stages. The description must also include information on treatment performance claims and limitations, physical configuration, electrical, instrumentation and control systems, operations and maintenance (O&M) requirements, and health and safety issues.
(See templates: *Table 3.1-1. Process Design Criteria for Ballast Water Management System* and *Table 3.1-2* through *Table 3.1-5. Treatment Stage Design Criteria for BWMS* for different treatment system types.)

***3.2 Physical Configuration and Shipboard Installation*:** Provide one set of plans or drawings describing the BWMS, as described at 46 CFR 162.060-14(a)(2), including the general arrangement of components and a description of each component of the equipment that includes the name, the manufacturer, and the part identification of each component. The drawings should indicate how the BWMS integrates with existing shipboard piping, utilities, and electrical systems. The applicant should:

- Confirm all drawings have unique titles, drawing numbers, revision numbers and dates, revisions indicated in the body of the drawing (circled or bubbled to highlight changes), page numbering (if a drawing consists of multiple sheets), and drawing date;
- Provide clean, legible copies in English at an appropriate resolution so they can be read;
- Confirm all applicant-supplied drawings have been coordinated with general arrangement and shipboard installation drawings for the BWMS; and
- Include a list of all drawings and diagrams submitted, identifying the revision, date, and preparer (manufacturer, shipyard, design firm, etc.) of each drawing.

Section 4.0 Proof of Ballast Water Treatment Performance

***4.1 Summary and Results of Prior Treatment Performance Testing*:** Submit a summary description and results of prior testing work that demonstrates a strong likelihood the proposed BWMS can achieve the ballast water discharge standards. The summary should include a description of any disinfection chemicals (with doses) and byproducts, the time-course of decay/loss of the chemicals and byproducts, their projected concentration in ballast water upon discharge, and the conditions under which the results were derived (salinity, temperature, etc.). This requirement may be met with any of the following:

- Documentation and results indicating successful completion of land-based testing that meets the requirements of 46 CFR 162.060-26 (proceed to Section 5);
- Documentation and results indicating the proposed BWMS meets the IMO D-2 discharge standards (proceed to Section 5); or
- Documentation and results from experimental testing relevant to the ballast water treatment components and the full BWMS (complete Subsection 4.2).

***4.2 Summary of Prior Experiments at Bench Scale, Pilot Scale, Full Scale*:** Provide demonstrative data and information from testing or use of equipment relevant to components or the full BWMS. Any reference or data source may be included, whether the tests were on ballast water or from other water treatment industries. Altogether, this subsection will include sufficient technical literature and experimental data to provide proof that the applicant's BWMS can likely achieve the STEP shipboard treatment criteria.

Prior experimentation is typically expected to start with bench-scale tests and proceed to pilot-scale and full-scale testing. It is not expected that all levels of testing will always be available in the literature and in testing of the BWMS, only that sufficient information be available to indicate that the performance goals of the proposed BWMS will likely be met under STEP. Note there may be some latitude regarding small-scale tests for proven water treatment technology, but the applicant must satisfy a higher burden of proof to demonstrate feasibility when either the treatment system or the proposed experimental methods for the onboard tests are novel or unproven. Relevant experimental work presented should demonstrate that the applicant has:

- Completed measurements to determine ballast design flows and water quality constraints for the BWMS.
- Completed measurements of disinfection residuals, byproducts and toxicity for BWMS discharges.
- Specified operational ranges and setpoints for the BWMS to achieve biological treatment efficacy targets, based on tests of effectiveness over a range [+/- 20 percent] of key parameter(s) such as biocidal concentration, UV dose, holding time, etc.

The application should include summaries for each scale of testing, as applicable. In addition to identifying relevant prior studies and existing test data, the application should include the following for each applicable scale:

- Any relevant dose/response information, particularly by taxa;
- A brief synthesis of key findings of all biological testing of removal and/or inactivation from testing of the ballast water treatment process (system, components, etc.);
- Only currently available data are available, not future experiments or experiments currently underway for which data are not available;
- Only primary references that are the original source of the data rather than those which only reference the primary work or include later reproductions of figures and tables;
- Copies of all cited references, annotated with the reference identifiers should be included as an appendix to the application.

In the case of well-developed technologies or components, it is important that the applicant includes only key literature needed to support claims made.

(See templates: *Table 4.2-1. Summary of Prior Laboratory Experiments, Literature and Studies; Table 4.2-2. Summary of Existing Test Data on the STEP BWMS;* and *Table 4.2-3. Summary of Existing Test Data for Individual STEP Ballast Water Management Treatment Components.*)

Section 5.0 STEP Study Plan

The purpose of this section is to provide detailed information on the experimental program to be implemented in testing the BWMS. The applicant will summarize test program information relating to experimental design, sampling methods, assays to assess the killing, removal or inactivation of ballast water organisms, the taxa (taxonomic groups, species, etc.) to be assessed, number of experiments to be conducted, replication, etc. While the testing may be designed to meet multiple purposes, please include only information directly related to the shipboard test program that the applicant will conduct for STEP. Vessels that test systems under the oversight of an IL may substitute the Shipboard Test Plan and Quality Assurance Project Plan (QAPP) described at 46 CFR 162.060-24 and 162.060-36, respectively, and proceed to Section 6.

Testing under STEP should begin as soon as possible following BWMS installation and must use sampling and analytical approaches that have been validated for use in the EPA/600/R-10/146, Generic Protocol for the Verification of Ballast Water Treatment Technologies, version 5.1 (ETV Protocol)[2]. Alternative approaches may be considered if they are demonstrated to the satisfaction of the CG-OES-3 to be equivalent to the ETV Protocol. Methods not yet developed may be piloted in parallel with approved methods, but such arrangements should be disclosed prior to use onboard an enrolled ship.

***5.1 Test Team Responsibilities*:** Describe the structure and management of the team conducting the biological experimental program and confirm that the level of staffing is adequate to meet stated sample holding times as described in Subsection 5.4. Describe the responsibilities of the Biological Test Team Coordinator regarding oversight of the experimental program and their role relative to that of the STEP project manager. For all personnel, identify the name, title, organization with which the individual is affiliated, and activity for which the individual is primarily responsible (e.g., oversight of test program, sample collection, sample handling and transport, and assays conducted). For each taxonomic class of organism tested, indicate the responsibility of the individual assigned (sample collection, sample handling, calibration of instruments, assay, and chain of custody).

***5.2 Treatment Performance Goals*:** Identify quantitative treatment goals by size fractions. The goals may, in addition, focus on individual taxonomic groups; however, this is not required. Provide brief discussion of the derivation of numeric treatment goals, with particular reference to experimental results in Section 4. Clearly show how the data supports the selected numeric treatment performance goals for each size fraction and any specific organisms that the BWMS testing will examine (*Vibrio cholerae*, *Escherichia coli*, *Enterococci*, cysts, etc.). Treatment goals that relate to the STEP treatment criteria and the applicant's treatment goals based upon previous testing (per Section 4), as well as any additional standards of the applicant's choosing,

[2] EPA/600/R-10/146, Generic Protocol for the Verification of Ballast Water Treatment Technologies, version 5.1, (dated September 2010). https://www.dco.uscg.mil/Portals/9/ETV%20EPA%20Report.pdf?ver=2018-05-22-081043-607

should be indicated. The applicant should confirm the specified operational ranges and setpoints for the BWMS necessary to achieve the biological treatment performance goals, based on prior experimentation results and in concert with engineering parameters provided in Section 3.
(See template: *Table 5.2. Treatment Performance Goals for Evaluation under STEP.*)

***5.3 Ballast Water Treatment Experimental Design*:** Provide a summary of the experimental design, referencing the ETV Protocol when applicable and providing detailed descriptions of any alternative methods proposed. The summary should discuss the location and timing of samples. If treatment includes holding ballast water in tanks, indicate whether replicate ballast tanks will be used, whether there will be control and treated ballast tanks (note that use of control tanks is not required for STEP testing), and how the study will ensure that experimental samples are collected from a particular tank. Include a descriptive summary of each type of "experiment" or "test run" to be undertaken.
(See template: *Table 5.3. Ballast Water Treatment Experimental Methods.*)

The experimental design and methods must address several criteria:

- The vessel's ballast water system must be provided with sampling ports as described at 46 CFR 162.060-28(f).
- All ballast water, including from control tanks and processed sample water from control tanks, must be treated prior to discharge.
- Each sample should be collected on a time-integrated basis such that a composite sample of the entire period of tank filling or discharge is acquired.
- The shipboard testing must focus on the removal/inactivation within each of the three size categories (≥50 micrometers, <50 micrometers to ≥10 micrometers, <10 micrometers) in the ballast water biotic assemblage.
- Ballasting locations for testing purposes should have sufficient levels of organisms, turbidity, organic matter, etc. to provide a significant challenge to the efficacy of the BWMS.
- In all STEP tests, source or challenge waters must be analyzed for organisms ≥50 micrometers and organisms <50 micrometers to >10 micrometers. However, to simplify the testing program, these challenge water samples need only be collected and properly preserved then transported for counting by trained microscopists in land-based laboratories. The reported data by taxa (to the lowest reasonably identifiable taxonomic grouping) will be used to characterize the source water biological test conditions that will correspond to the post-treatment samples.

***5.4 Sampling and Analyses*:** Provide details of the specific methods to be used for biological measurements related to treatment effectiveness and physical or chemical measurements related to general ballast water environmental conditions. Reference the ETV Protocol when applicable and provide detailed descriptions of any alternative methods or procedures proposed. The approaches, handling, holding times, etc. must be consistent with the ETV Protocol or shown to be equivalent through previous documentation and references, which should be included in the application package. Provided information must include:

- Sample volumes, methods for sample concentrations and assays to quantify the organisms within each of the three size classes, and information on sample holding times;

- Information on various water quality variables that generally describe the properties of the water to be treated (e.g., temperature, salinity, pH, oxygen content, nutrient and chlorophyll a content, etc.) and properties that can directly influence effectiveness of the BWMS (e.g., parameters that affect the optical properties of water, such as total suspended solids, turbidity, water color, and dissolved organic matter can affect UV treatment systems; variables related to organic matter content of the water that may influence the concentration; and half-life of chemical used for treatment, etc.); and
- A description of disinfection by-product and residuals sampling and analysis, when applicable.

(See templates: *Table 5.4-1. Sample Volumes for Biological Analysis; Table 5.4-2. Biological Sampling and Analysis; Table 5.4-3a. Environmental Parameters and Water Chemistry;* and *Table 5.4-3b. Water Chemistry—Disinfection Byproducts and Residuals.)*

***5.5 Quality Assurance Project Plan*:** The application must include a Quality Assurance Project Plan (QAPP) that specifically identifies quality assurance issues related to the chosen tests and assays and indicates the quality assurance and quality control (QA/QC) procedures to be used in sample collection, handling, analysis, and data reduction/synthesis. In particular, the QAPP must indicate how the available staff conducting the testing will be sufficient, within the appropriate sample holding-time limits, to complete the sampling plan within the QA/QC criteria proposed.

***5.6 Itinerary of Test Voyage(s)*:** Provide information on test locations for each planned test voyage and experiment, in particular characterizing the ballast water uptake and discharge locations for BWMS testing, e.g., tropical, temperate, polar, fresh, marine, open ocean, coastal, estuarine, or harbor. Describe an experimental test schedule for a typical voyage for the ship. If available, the information provided should include testing locations (ports/waters) and season(s).

***5.7 Environmental, Health, and Safety Plans*:** Test Plans must also address potential environmental, health, and safety issues; unusual operating requirements; and any issues related to the disposal of treated ballast water, by-products, or waste streams. When applicable, this should include a description of methods and procedures for storage, handling, and exposure to ballast water treatment chemicals, residuals, and byproducts.

Section 6.0 Long-Term Performance Monitoring

***6.1 Long-Term Performance Monitoring Plan*:** Applications for prototype systems must include a long-term monitoring plan for shipboard testing of the BWMS. The Monitoring Plan must cover the Experimental Phase, which is the period from acceptance into STEP through 18 months after the conclusion of the experimental testing described in the STEP Study Plan. The Monitoring Plan must address monitoring and reporting of:

- Experimental results;
- Operational data for routine system operation (key engineering parameters and setpoints);
- Discharge water quality, including chemical residuals and by-products, if necessary; and
- Changes in system operation or configuration.

Measurement of discharged ballast water quality is required during experimental testing and at the end of the Experimental Phase. The Monitoring Plan must include all relevant water quality

parameters and test methods. The tests should confirm results of prior proof of performance experiments and demonstrate that chemical residuals and disinfection by-products (DPBs) do not exceed EPA's regulated effluent limits or levels specified in the applicant's treatment performance goals. It is intended that these water quality tests required for STEP will also meet the regulatory requirements for discharge monitoring.

It is of particular importance that the engineering monitoring performance parameters in this plan are consistent with the engineering parameters shown in Section 3, the experimental results presented in Section 4, and the study plan in Section 5. Plan revisions must be submitted as needed to address any changes in system operation or configuration based on experimental results. Revised plans should indicate whether routine performance monitoring methods and performance targets also are updated and how changes are linked to the results of biological experiments.

The owner/operator of a vessel testing a BWMS for the purpose of type approval will be required to submit a long-term monitoring plan to be considered for continued participation in STEP if the system fails to receive type approval certification or configuration and operation of the installed system are inconsistent with the certificate.

***6.2 Logs for Long-Term Performance Monitoring*:** All STEP participants must maintain logs of the BWMS engineering performance parameters and the history of preventive and corrective maintenance on the BWMS.

***6.3 Quarterly and Annual Reporting Requirements*:** All STEP participants must submit regular progress reports to the USCG at environmental_standards@uscg.mil:

- Quarterly status reports must be submitted during the Experimental Phase and include:
    - Study plan tasks completed during the reporting period;
    - Unanticipated problems with the BWMS, such as unscheduled or emergency maintenance, shutdowns or repairs, during the reporting period; and
    - Identification and description of all ballast/deballast events that occurred during the reporting period, including confirmation that ballast water was treated or otherwise properly managed in accordance with regulations.
- Annual reports summarizing the work done and results obtained during each year must be submitted within 4 months following the end of each year that the vessel is in STEP and include:
    - Operational logs of BWMS, including key performance parameters for all routine ballast/deballast operations;
    - Results of discharge water quality monitoring, including concentrations of chemical residuals and treatment byproducts;
    - Maintenance and repair logs of BWMS and any modifications of system hardware or operating procedures;
    - Summary of all biological and engineering performance results for the entire Experimental Phase to date; and
    - Summary of all monitoring work and treatment performance results to date.

Vessels that are granted type approval equivalency will subsequently be exempted from these reporting requirements.

Section 7.0 Environmental Compliance for Active Substances

In addition to the Environmental, Health, and Safety Plans required in Subsection 5.7, applicants must provide documentation of all necessary approvals, registrations, and other documents or certifications required for any active substances, preparations, or relevant chemicals used by the BWMS. The documentation must include the following:

- A list of any active substances, preparations, or relevant chemicals that are used, produced, generated as a byproduct, and/or discharged in association with the operation of the BWMS; and
- A list of all limitations or restrictions that must be complied with during the approval testing and evaluations, including any water quality limits established by the Environmental Protection Agency, States, or tribes, under the Clean Water Act.

Applicants also must comply with the requirements of 46 CFR § 162.060-32, including submission with the STEP application of the described assessment, if applicable.

For prototype systems, the application should include detailed discussion of any treatment chemicals and/or chemical byproducts and residuals. If necessary, include a description of the conditioning of treated ballast water or waste stream. This discussion should include the following:

- Quantitative data on chemical residuals, including peak concentrations in ballast water, concentrations at discharge, and a time-course of chemical breakdown or dissipation (i.e., concentration versus time) for different waters and temperatures, as appropriate;
- Appropriate toxicity test data;
- Comparison of concentrations against relevant (e.g., EPA) standards for seawater quality;
- Description of how discharge concentrations will be monitored and reported; and
- A conclusion as to the fate of the chemicals:
    - That they will degrade to acceptable levels and pose no environmental threat upon discharge, or
    - That the treated ballast water or waste stream must be conditioned prior to discharge to reduce concentrations of said chemicals to acceptable levels.

Appendix:
STEP Application Optional Templates

Table 2.2-1. Vessel Ballast Tank Table

	Compartment Name and Number and Coating (if any)	**Ballast Water Capacity (metric tons)**	**Compartment Type (dedicated ballast tank or SBT, multi-use tanks, liquid cargo tank, dry cargo hold, other)**	**Ballast Water Management Method (STEP test BWMS, type approved BWMS, other method)**	**Non-ballast Use (black or gray water, etc.)**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
	Add rows as necessary				

Table 2.2-2. Process/Equipment Design Criteria for Existing Ballast System (pt. 1)

General Description	[Describe configuration and operation, pumps used in SOP, backup arrangements, integration with other systems, use of "mixing manifolds," etc.]		
Cross-connections to Other Systems	**(Y/N)**	**Segregation: Valves & Controls**	**Procedural Description: Line-up of Pumps and Valves, Tanks Used**
Firefighting		[Describe valves and controls related to each cross-tie system]	[Describe line-up of pumps and valves; number of tanks used]
Gray Water		[Describe valves and controls related to each cross-tie system]	[Describe line-up of pumps and valves; number of tanks used]
Bilge		[Describe valves and controls related to each cross-tie system]	[Describe line-up of pumps and valves; number of tanks used]
Back-up General Service Pump		[Describe valves and controls related to each cross-tie system]	[Describe line-up of pumps and valves; number of tanks used]
Other		[Describe valves and controls related to each cross-tie system]	[Describe line-up of pumps and valves; number of tanks used]
Design Parameter	**Units**	**Criteria/Description**	**Comments (optional)**
Ballast Water System Design Flows			
Average Uptake Flow Rate	MT/hour		
Average Discharge Flow Rate	MT/hour		
Ballast Pumps			
Number of Pumps	#		
Manufacturer and Model #	Name		
Design Flows	MT/hour		
Discharge Pressure	kg/cm^2		
Motor Size	kW		
Motor Type	CS or VFD		

Table 2.2-2. Process/Equipment Design Criteria for Existing Ballast/Deballast System (pt. 2)

Design Parameter	Units	Criteria/Description	Comments (optional)
Sea Chests			
Number	#		
Size (diameter, or length by width)	meters		
Location(s) (frame and height above baseline)	meters		
Rack/Screen Opening Size	cm		
Anti-fouling System (if present)	#		
Screen/Filter/Strainer Units			
Number and Type	#		
Manufacturer and Model	NA		
Capacity	MT/hour		
Maximum Retained Particle Size	mm		
Backwash Type	Manual or Automatic		
Backwash Flow Rate	MT/hour		
Ballast Tank Level Monitors			
Type	NA		
Typical Tank Arrangement	NA		
Ancillary Equipment			
Type	NA		
Number	#		
Capacity	MT/hour		
Location(s) and Type(s) of Overboard Discharge Openings	NA		

Table 3.1-1. Process Design Criteria for Ballast Water Management System

Design Parameter	Units	Criteria/Description	Comments/Explanation
Ballast Water Management System			
Design Flows			
- Maximum	MT/hr	[Required]	[Optional]
- Average	MT/hr	[Required]	[Optional]
- Minimum	MT/hr	[Required]	[Optional]
Number of Treatment Stages	#	[Required]	[Optional]
Ballast Water Point of Treatment		[Select one or more of the following locations: in-line at ballast uptake, in-line at ballast discharge, in ballast tanks	[Optional]
Treatment Stage #1			
Treatment Process		[Select one or more of the following treatment processes: physical separation, physical disruption, thermal inactivation, chemical, hydrocyclone, strainer, cartridge filter, membrane, chlorine, chlorine dioxide, hydrogen peroxide, ozone, UV, heat, pH adjustment, advanced oxidation process (AOP)]	[Optional]
Treatment Mechanism		[Select one or more of the following treatment mechanisms: inactivation, sterilization, removal, disruption, other]	[Optional]
Target Organism(s) or Organism Group(s)		[Select one or more of the following target organism groups: zooplankton, phytoplankton, protozoa, bacteria, virus, other]	[Optional]
Treatment Stage #2 (if applicable)			
Treatment Process		[Select one or more of the following treatment processes, as above	[Optional]
Treatment Mechanism		[Select one or more of treatment mechanisms, as above	[Optional]
Target Organism(s) or Organism Group(s)		[Select one or more target organism groups, as above	[Optional]
Treatment Stage #3 (if applicable)			
Treatment Process		[Select one or more of the following treatment processes, as above	[Optional]
Treatment Mechanism		[Select one or more of treatment mechanisms, as above	[Optional]
Target Organism(s) or Organism Group		[Select one or more target organism groups, as above	[Optional]

Add rows as necessary

Table 3.1-2. Treatment Stage Design Criteria for BWMS - All Treatment Systems (pt. 1)

Design Parameter	Units	Criteria/Description	Comments/Explanation
General Information			
Treatment Stage Number	#	[Use Treatment Stage # from Table 3.1-1]	[Optional]
Manufacturer	--	[Required]	[Optional]
Model Number	--	[Required]	[Optional]
Ballast Water Design Flows			
Maximum	MT/hr	[Required]	[Optional]
Average	MT/hr	[Required]	[Optional]
Minimum	MT/hr	[Required]	[Optional]
Primary Treatment Unit			
Type	--	[Describe type of treatment unit and treatment mechanism]	[Optional]
Method of Removal/Inactivation	--	[Describe physical mechanism for achieving treatment target]	[Optional]
Number of Units per Treatment Stage	#	[Required]	[Optional]
Capacity per Unit	MT/hr	[Required]	[Optional]
Materials of Construction	--	[List materials for treatment vessel, seals and wetted parts]	[Optional]
Overall Dimensions (length, width, height)	cm	[Required]	[Optional]
Dry Weight	kg	[Required]	[Optional]
Wet Weight	kg	[Required]	[Optional]
Inlet Pipe Size (diameter)	cm	[Required]	[Optional]
Outlet Pipe Size (diameter)	cm	[Required]	[Optional]
Power Requirements	kW	[Required]	[Optional]
Other	--	[Add additional design criteria if necessary (one criterion per row)]	[Optional]

Table 3.1-2. Treatment Stage Design Criteria for BWMS - All Treatment Systems (pt. 2)

Design Parameter	Units	Criteria/Description	Comments/Explanation
Ancillary Treatment Equipment			
Type	--	[Describe ancillary equipment items and how they relate to primary treatment unit]	[Optional]
Number of Units per Treatment Stage	#	[Required]	[Optional]
Capacity per Unit	MT/hr	[Required]	[Optional]
Materials of Construction	--	[List materials for main vessel, seals and wetted parts]	[Optional]
Overall Dimensions (length, width, height)	cm	[Required]	[Optional]
Dry Weight	kg	[Required]	[Optional]
Wet Weight	kg	[Required]	[Optional]
Inlet Pipe Size (diameter)	cm	[Required]	[Optional]
Outlet Pipe Size (diameter)	cm	[Required]	[Optional]
Power Requirements	kW	[Required]	[Optional]
Other	--	[Add additional design criteria if necessary (one criterion per row)]	[Optional]
Treatment Stage Replacement Components			
Type	--	[Describe major replacement components for this treatment stage]	[Optional]
Number of Components per Treatment Stage	#	[Required]	[Optional]
Expected Service Life	months	[Calculate expected service life assuming 24 ballast water treatment operations per year and normal shipboard wear and tear on equipment]	[Optional]
Other	--	[Add additional design criteria to fully specify replacement components (one criterion per row)]	[Optional]

Table 3.1-2. Treatment Stage Design Criteria for BWMS - All Treatment Systems (pt. 3)

Design Parameter	Units	Criteria/Description	Comments/Explanation
Quality of Treated Ballast Water at Discharge (non-biological)			
Total Suspended Solids (TSS) Concentration Range	mg/L	[Required]	[Optional]
pH Range	unit	[Required]	[Optional]
Maximum Water Temperature Rise	deg C	[Required]	[Optional]
Disinfection Byproduct (DBP) Type	--	[List expected DBPs to be generated by treatment stage]	[Optional]
DBP Concentration Range	mg/L	[List expected DBP concentration range in treated water for each DBP]	[Optional]
Other		[Add additional treated water criteria if needed (one criterion per row)]	[Optional]
Waste Stream Flows			
Type	--	[Describe water/air waste streams to be generated by this treatment stage, and whether continuous or intermittent]	[Optional]
Discharge Flow Range per BWT Event	L/min	[Specify waste stream flow ranges]	[Optional]
Discharge Duration Range per BWT Event	min	[Specify waste stream time duration ranges	[Optional]
Total Discharge Volume Range per BWT Event	liters	[Specify total discharge volume ranges for waste stream]	[Optional]
Waste Stream Water Quality			
Total Suspended Solids (TSS) Concentration Range	mg/L	[Required]	[Optional]
pH Range	unit	[Required]	[Optional]
Maximum Water Temperature Rise	deg C	[Required]	[Optional]
Other	--	[Add additional waste stream criteria if needed (one criterion per row)]	[Optional]

Table 3.1-3. Additional Treatment Stage Design Criteria for Chemical Systems (pt. 1)

Design Parameter	Units	Criteria/Description	Comments/Explanation
Design Dose			
Maximum	mg/L	[Required]	[Optional]
Average	mg/L	[Required]	[Optional]
Minimum	mg/L	[Required]	[Optional]
Chemical Properties			
Product Name	--	[Specify commercial name of chemical product]	[Optional]
Formula	--	[Specify chemical name or formula]	[Optional]
Product Type	--	[Specify whether chemical is delivered "Dry" or "Wet"]	[Optional]
Active Chemical Ingredients (dry chemical)	% Active Ingredient	[Specify percentage of product containing active ingredient]	[Optional]
Solution Concentration (wet chemical)	% Active Ingredient	[Specify percentage of product containing active ingredient]	[Optional]
Chemical Product Name	--	[Required]	[Optional]
Type	--	[Describe tank orientation (vertical or horizontal), materials (FRP, HDPE, steel, etc.)]	[Optional]
Number of Tanks	#	[Required]	[Optional]
Tank Dimensions (length, width, height)	cm	[Required]	[Optional]
Tank Access	--	[Required]	[Optional]
Storage Volume per Tank	liters	[Required]	[Optional]
Number of Treatment Cycles per Storage Volume	#	[Calculate number of expected ballast water treatment cycles prior to a tank refill; list assumptions]	[Optional]
Other		[Provide separate chemical storage design criteria for each treatment chemical]	[Optional]

Table 3.1-3. Additional Treatment Stage Design Criteria for Chemical Systems (pt. 2)

Chemical Feed Pump and Piping System			
Chemical Product Name	--	[Required]	[Optional]
Pump Type	--	[Pump type (e.g., centrifugal, end-suction, vertical turbine, horizontal split-case) and materials of construction for wetted parts]	[Optional]
Number of Duty Pumps	#	[Required]	[Optional]
Number of Standby Pumps	#	[Required]	[Optional]
Design Capacity	L/hr	[Required]	[Optional]
Pump Drive	--	[Specify constant-speed (CS) or variable frequency drive (VFD)]	[Optional]
Motor Size	hp	[Fill-in]	[Optional]
Piping System Type		[Describe piping system type and materials of construction]	
Other		[Provide separate chemical feed pump design criteria for each treatment chemical]	[Optional]

Table 3.1-4. Additional Treatment Stage Design Criteria for UV Systems

Design Parameter	Units	Criteria/Description	Comments/Explanation
Ballast Water Quality Criteria			
Minimum UV Transmittance	%	[Required]	[Optional]
Maximum Total Suspended Solids (TSS)	mg/L	[Required]	[Optional]
Maximum Turbidity	NTU	[Required]	[Optional]
Maximum Water Temperature	deg C	[Required]	[Optional]
Minimum Water Temperature	deg C	[Required]	[Optional]
UV Design Dose			
UV Design Dose	mJ/cm^2	[Fill-in]	[Optional]
Dose Basis	--	[Select "Biodosimetry Testing" or "Numerical Modeling" or Other]	[Optional]
UV Reactor Criteria			
Type of Reactor	--	[Select "Closed-Vessel" or "Open-Channel"]	[Optional]
Lamp Orientation	--	[Select "Parallel to Flow" or "Perpendicular to Flow"]	[Optional]
Materials of Construction		[List materials for reactor vessel, seals and wetted parts]	[Optional]
Number of Reactor Units	#	[Required]	[Optional]
Type of UV Lamps	--	[Select: medium-pressure (MP), low-pressure (LP), low-pressure high-output (LPHO), pulsed (P)]	[Optional]
Number of Lamp Rows per Unit	#	[Required]	[Optional]
Number of Lamps per Row	#	[Required]	[Optional]
Total Number of Lamps per Unit	#	[Required]	[Optional]
Input Power per Lamp	kW	[Required]	[Optional]
Total Operating Electrical Load	kW	[Required]	[Optional]
Total Installed Electrical Load	kW	[Required]	[Optional]
Pressure Drop Through Unit at Design Flow	cm	[Required]	[Optional]
Other	--	[Add additional design criteria if necessary (one criterion per row)]	[Optional]

Table 3.1-5. Additional Treatment Stage Design Criteria for Ozone Systems (pt. 1)

Design Parameter	Units	Criteria/Description	Comments/Explanation
Ozone Design Dose			
Maximum	mg/L	[Required]	[Optional]
Average	mg/L	[Required]	[Optional]
Minimum	mg/L	[Required]	[Optional]
Ozone Generation Equipment			
Type	--	[Describe vessel configuration (horizontal or vertical tubes), type of dielectric (tube or plate) and type of power supply (low-frequency, medium frequency, high frequency)]	[Optional]
Number of Generator Units	--	[Required]	[Optional]
Materials of Construction		[List materials for generator vessel, seals and wetted parts]	[Optional]
Rated Capacity per Unit	grams/hour	[Required]	[Optional]
Ozone-in-Oxygen Concentration	% weight	[Required]	[Optional]
Maximum Cooling Water Temperature	deg C	[Required]	[Optional]
Type of Cooling System	--	[Describe type of generator cooling system (air or water cooled) and main components of cooling system (fan-cooled, water closed-loop with air/water heat exchanger, water closed-loop with chiller, water once-through open-loop, etc.]	[Optional]
Total Operating Electrical Load	kW	[Required]	[Optional]
Total Installed Electrical Load	kW	[Required]	[Optional]
Overall Dimensions (length, width, height)	cm	[Required]	[Optional]
Weight	kg	[Required]	[Optional]
Other	--	[Add additional design criteria if necessary (one criterion per row)]	[Optional]

Table 3.1-5. Additional Treatment Stage Design Criteria for BWMS – Ozone Systems (pt. 2)

Design Parameter	Units	Criteria/Description	Comments/Explanation
Ozone Contactor and Dissolution Method			
Type of Dissolution Method	--	[Describe type of ozone dissolution method, i.e., bubble diffusers, venturi injection, static mixers, etc.]	[Optional]
Type of Contactor		[Describe type of contactor vessel and whether ballast tankage is used to meet contact time requirements]	
Number of Contactor Trains	#	[Required]	[Optional]
Materials of Construction	--	[List materials for contactor vessel]	[Optional]
Minimum Contact Time	minutes	[Required]	[Optional]
Overall Dimensions (length, width, height)	cm	[Required]	[Optional]
Weight	kg	[Required]	[Optional]
Other	--	[Add additional design criteria if necessary (one criterion per row)]	[Optional]

Table 4.2-1. Summary of Prior Laboratory Experiments, Literature and Studies; [Bench, Pilot, Full] Scale (Choose one)

Related to the general technology, rather than studies on the specific equipment proposed for STEP. Summary of literature, reports and web site information on the removal or inactivation efficiency of the components or combined systems. Add additional rows as needed.

Treatment Unit Tested (1)	Treatment Unit Specifications (2)	Testing Source Water (3)	Location of Test Lab (4)	Literature Reference (5)	Test Group (6)	Zooplankton (≥50µm)		Phytoplankton/Protist (<50µm - ≥10µm)		Bacteria (<10µm)		Other (9)	
						Taxa (7)	EFF % (8)	Taxa (7)	EFF % (8)	Taxa (7)	EFF % (8)	Taxa (7)	EFF % (8)

Literature and references cited:

[B/P/F]-a

[B/P/F]-b

[B/P/F]-c

[B/P/F]-d

NOTE: Adjust the Column / Row dimensions to fit information provided.

(1) Indicate component tested (UV treatment apparatus, filtration apparatus, etc.).

(2) Indicate the specifications of the Treatment Unit/Component dose, filter size, etc.

(3) Source where water used in testing was obtained (Bay water, harbor water, etc.); include salinity if available.

(4) Location of the test facility where experiments were conducted.

(5) Use scale and letter (e.g., P-a to P-z) identifiers in this column and list references at bottom (Primary Scientific literature, reports, web sites, etc.). Primary sources should be given, defined as those where the experimental design, methods, analysis and data are presented. Unless absolutely necessary, do not list secondary sources, defined as reports where summaries from primary references are presented.

(6) Relates to who conducted the study. Enter "TT" if experiments conducted by manufacturer Test Team. Enter "O" for other if experiments were conducted by an external test team.

(7) The major taxa tested. In some studies, may be general categories such as "copepods," "polychaetes," etc., in other studies more specific taxa or even individual species may have been tested, such as Artemia or Fecal coliform bacteria, etc.

(8) The range of removal or inactivation rates (efficiency of system either as % removal/inactivation). If multiple tests or replicates were conducted give the range of removals, such as 80%-95% or 2-3 logs.

(9) Since the treatment unit may have been tested in other applications (wastewater, drinking water) the organism grouping may be very different than typical of ballast water, the table may be amended to capture these grouping or they may be placed in this "other" grouping in which case they need to be listed.

Table 4.2-2. Summary of Existing Test Data on the STEP BWMS (pt. 1); [Bench, Pilot, Full] Scale (Choose one)

List primary references that present the experimental design, methods and data, avoid listing multiple references that cite the same data set. As necessary, rows should be added under major taxa heading to provide a full list of the taxonomic breakdown. If tests were conducted by size class, rather than taxonomic grouping, the applicant should alter the heading (for example, zooplankton to ≥50 μm).											
Indicate where the bench test studies were conducted											
Test #1:					Location of Testing (source water):						
Citation/report											
Test #2:					Location of Testing (source water):						
Citation/report											
Test #3:					Location of Testing (source water):						
Citation/report											
Test Taxa (1)	Assay Method (2)	Test Platform (3)	Initial # organisms in Test (4)		Test Duration (5)		% Removal/ Inactivation		# Experiments	# Reps/ Expt.	References
			Treated	Control	No Holding	Holding Time	No Holding	Holding Time			
Zooplankton Taxa (≥50μm)											
z1											
z2											
z3											
z_n											
Phytoplankton/Protists (<50μm - ≥10μm)											
p1											
p2											
p3											
p_n											

Table 4.2-2. Summary of Existing Test Data on the STEP BWMS (pt. 2); [Bench, Pilot, Full] Scale (Choose one)

Test Taxa (1)	Assay Method (2)	Test Platform (3)	Initial # organisms in Test (4)		Test Duration (5)		% Removal/ Inactivation		# Experiments	# Reps/ Expt.	References
			Treated	Control	No Holding	Holding Time	No Holding	Holding Time			
Bacteria (<10µm)											
pr1											
pr2											
pr3											
pr_n											
Other											
o1											
o2											
o3											
o_n											
(6) Component #1:											
(6) Component #2:											
(1) Under each major taxonomic grouping add rows to show the taxa tested, (copepods, diatoms, etc., or specific species).											
(2) Give the assay used to determine effectiveness relative to each test taxa (motility for zooplankton, heterotrophic plate counts for bacteria, etc.)											
(3) Enter the number of the bench test study indicated above.											
(4) The number of individuals at the start of the test for each taxa (# bacteria per mL, # copepods per liter, etc.)											
(5) The number of hours or days that a sample is held after treatment before assay to determine treatment effectiveness											
(6) If the BWMS is comprised of more than one component (e.g. filtration+UV or filtration+biocide), and removal effectiveness on individual components has been determined, then fill in the component description and then fill in the appropriate data in Tables 4.2-3.1, etc.											

Table 4.2-3. Summary of Existing Test Data for Individual STEP Ballast Water Management Treatment Components (pt. 1); [Bench, Pilot, Full] Scale (Choose one)

List primary references that present the experimental design, methods and data, avoid listing multiple references that cite the same data set. As necessary, rows should be added under major taxa heading to provide a full list of the taxonomic breakdown. One copy of this table should be filled out for each component with the appropriate component # and description, that is, Component #1 = Table 4.2-3.1, Component #2 = Table 4.2-3.2, etc. As necessary, rows should be added under major taxa heading to provide a full list of the taxonomic breakdown. If tests were conducted by size class, rather than taxonomic grouping, the applicant should alter the heading (for example, zooplankton to ≥50 µm).											
Indicate where the bench test studies were conducted											
Test #1:					Location of Testing (source water):						
Citation/report											
Test #2:					Location of Testing (source water):						
Citation/report											
Test #3:					Location of Testing (source water):						
Citation/report											
Test Taxa (1)	Assay Method (2)	Test Platform (3)	Initial # organisms in Test (4)		Test Duration (5)		% Removal/ Inactivation		# Experiments	# Reps/ Expt.	References
			Treated	Control	No Holding	Holding Time	No Holding	Holding Time			
Ballast Water Treatment Component #1:											
Zooplankton Taxa (≥50µm)											
z1											
z2											
z3											
z_n											
Phytoplankton/Protists (<50µm - ≥10µm)											
p1											
p2											
p3											
p_n											

Table 4.2-3. Summary of Existing Test Data for Individual STEP Ballast Water Management Treatment Components (pt. 2); [Bench, Pilot, Full] Scale (Choose one)

Test Taxa (1)	Assay Method (2)	Test Platform (3)	Initial # organisms in Test (4)		Test Duration (5)		% Removal/ Inactivation		# Experiments	# Reps/ Expt.	References
			Treated	Control	No Holding	Holding Time	No Holding	Holding Time			
Bacteria (<10µm)											
b1											
b2											
b3											
b_n											
Other											
o1											
o2											
o3											
o_n											
(1) Under each major taxonomic grouping add rows to show the taxa tested, (copepods, diatoms, etc., or specific species).											
(2) Give the assay used to determine effectiveness relative to each test taxa (motility for zooplankton, heterotrophic plate counts for bacteria, etc.)											
(3) Enter the number of the bench test study indicated above.											
(4) The number of individuals at the start of the test for each taxa (# bacteria per mL, # copepods per liter, etc.)											
(5) The number of hours or days that a sample is held after treatment before assay to determine treatment effectiveness											

Table 5.2. Treatment Performance Goals for Evaluation under STEP

	Applicant STEP BWMS Treatment Goals Concentration of Live Organisms Discharged or Percentage Removal – Inactivation (1)			References (2)
	% Reduction	Average #	Maximum #	
Size Fraction: ≥50 μm (nominally zooplankton)				
All Taxa Goal				
Size Fraction: <50 μm to ≥10 μm (nominally phytoplankton and protists)				
All Taxa Goal				
Size Fraction: <10 μm (nominally bacteria)				
All Taxa Goal				
Other				
All Taxa Goal				
(1) Complete the % and # for each size fraction that the proposed BWMS is targeted to achieve during STEP testing. If specific taxa have been examined, additional rows can be added.				
(2) Include references where data is presented to support the selected "goals." References should be included in Appendix A				

Add rows as necessary

Table 5.3. Ballast Water Treatment Experimental Methods

Organism Size Grouping		≥50µm	<50µm-≥10µm	<10µm	Environmental Parameters (7)	Other
Types of Source Water (1)						
# Test Cruises (2)					# Experiments per Cruise (3)	
Location in BWMS of samples/assays to be collected. Enter the number of samples that will be taken during a given experiment at each location for each size class. If there will be different numbers of samples used in different experiments then the box should include the samples for each experiment as (1/2/3) for experiments 1, 2, and 3, respectively.	Source Water from Environment Pre-BWMS					
	Treatment Ballast Tank Discharge					
	Control Ballast Tank Discharge					
	Other					
	Other					
Post-BWT Time to Discharge (4)						
# Replicate Tanks per Experiment (5)	Treated					
	Control					
# Replicate Assays per Sample (6)						

(1) Types of ballast water to be tested (harbor, coastal, lake, open ocean, etc.)

(2) Number of Vessel Cruises that testing will have "Full" BWTS Testing and Evaluation

(3) Number of "Test Runs" per Voyage, (e.g., if you are conducting multiple full test runs and ballast tank holding experiments on a single test voyage).

(4) Time that ballast water will be "held" from time of treatment until time of discharge (the functional treatment time).

(5) Number of replicate holding tanks where water is held post-treatment.

(6) Number of sub-samples assayed from a single sample bottle to determine analytical variation.

(7) List, in the appropriate sampling points, the names of environmental parameters to be measured (Total Suspended Solids , temperature, salinity, pH, etc.) and analytical methods to be used.

Table 5.4-1. Sample Volumes for Biological Analysis

	Target Concentration of Organisms (# per m^3)	Sample Volume Per Test Run (m^3)	Volume of Concentrated Sample (mL)	Sample Hold Time	Number and Volume (mL) of Sub-samples to be Analyzed	Approach for Sample Collection and Concentration (1)
Size Fraction: ≥50 µm (nominally zooplankton)						
Size Fraction: <50 µm to ≥10 µm (nominally phytoplankton and protists)						
Size Fraction: <10 µm (nominally bacteria) (2)						
Other Size Fraction or Parameter						
(1) Note whether the approach follows the ETV Protocol or identify other proposed methods.						
(2) Identify target concentration for culturable aerobic heterotrophic bacteria. Bacteria samples do not necessarily need to be concentrated from the whole water sample prior to analysis.						

Add rows as necessary

Table 5.4-2. Biological Sampling and Analysis

Collection, analytical methods, holding, etc. for the BWMS for evaluation under STEP.						
Size Class -->		≥50µm	<50µm - ≥10µm	<10µm	Other	Other
# Replicate Assays per Sample (1)						
Sample Collection Method (2)						
Sample Holding Time for Biological Assays (3)						
Sample Holding Conditions (between sampling and analysis)	Preservative					
	Temperature					
	Method and Duration of Shipping					
	Chain of Custody					
	Quality Control (4)					
Holding Time: Total Count Assays						
Sample Archiving (long-term storage)	Preservation					
	Location					
	# Samples					

(1) Number of sub-samples assay from a single mesocosm to determine analytical variation.

(2) The method used to determine the removal or inactivation of organisms within each taxa (for example: motility in zooplankton).

(3) Time from sample collection to assay for biological assays.

(4) How will integrity of "held" samples be documented.

Table 5.4-3a. Environmental Parameters and Water Chemistry

Sample collection, analytical methods, holding, etc.									
Water Quality/Environmental Parameters		Turbidity	Total Suspended Solids (TSS)	Chlorophyll *a*	Total Organic Carbon	Temperature	Salinity	pH	Dissolved Oxygen (6)
Sample Collection Method (1)									
# Replicate Assays per Sample (2)									
Analytical Method (3)									
Sample Holding Time for Assays (4)									
Sample Holding Conditions (between sampling and analysis)	Preservative								
	Temperature								
	Shipping								
	Chain of Custody								
	Quality Control (5)								
Sample Archiving (Long-term Storage)	Preservation								
	Location								
	# Samples								

(1) Assays are "*in situ*" if inserting a probe in the environment or ballast tank; if grab samples are taken and analyzed separately then enter sampling method.

(2) Number of sub-samples drawn from a single sample bottle to determine analytical variation.

(3) The method used for analysis, include reference to Standard Methods as appropriate.

(4) Time from sample collection to analysis.

(5) How will integrity of "held" samples be documented.

(6) Identify chemical(s) used for the ballast water treatment or created during treatment and indicate details for analysis of the residual concentration released to the environment. Add extra columns as needed.

Table 5.4-3b. Water Chemistry—Disinfection Byproducts and Residuals

Sample collection, analytical methods, holding, etc.									
Water Chemistry: Parameter		Disinfection Byproducts				Residuals			
Chemical Species or Group Name:		1_____ (7)	2_____	3_____	4_____	1_____	2_____	3_____	4_____
Sample Collection Method (1)									
# Replicate Assays per Sample (2)									
Analytical Method (3)									
Sample Holding Time for Assays (4)									
Sample Holding Conditions (between sampling and analysis)	Preservative								
	Temperature								
	Shipping								
	Chain of Custody								
	Quality Control (5)								
(1) Assays are "*in situ*" if inserting a probe in the environment or ballast tank; if grab samples are taken and analyzed separately then enter sampling method.									
(2) Number of sub-samples drawn from a single sample bottle to determine analytical variation.									
(3) The method used for analysis, include reference to Standard Methods as appropriate									
(4)Time from sample collection to analysis.									
(5) How will integrity of "held" samples be documented.									
(6) Identify chemical(s) used for the BWT or created during treatment and indicate details for analysis of the residual concentration released to the environment. Add extra columns as needed.									
(7) Fill in the names of the chemical species or groups assayed for disinfection byproducts or residuals. Add columns as necessary.									