MARINE VESSEL ENVIRONMENTAL PERFORMANCE ASSESSMENT

Phase 1 Pilot Project Report

Prepared for:
SNAME Technical & Research Steering Committee

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File No. 09068.01
29 January 2010
Rev. A

Contents

Note: Attachments are listed on following page.

References

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Executive Summary

The Marine Vessel Environmental Performance Assessment (MVEP) is being developed to provide vessel designers, owners, operators, and other governing bodies with a standard methodology to assess the relative merits of environmental practices. Based on objective technical information, standard performance criteria will be provided to quantify the environmental impact of a vessel's life cycle.

The Phase 1 Pilot Project presented in this report confirms that such an assessment is technically feasible and meets a demand in the maritime community. Specifically, this project:

- Developed a checklist of environmental topics that holistically addresses areas of marine vessel environmental impacts including Energy Efficiency, Air Emissions, Water Emissions, and other General Measures.

- Analyzed three specific environmental impact topics as proof cases to document system utility and to identify technical development challenges.

- Obtained feedback from the maritime community to confirm that industry needs this information to support design issues, as well as to assess issues such as reductions in port fees, reduced insurance rates, preferential cargo handling, and/or support of corporate environmental policy.

Phase 2 will complete the technical assessment process by analyzing the other environmental topics. The effort will leverage the established Technical & Research (T&R) infrastructure of the Society of Naval Architects and Marine Engineers (SNAME), and culminate with technical guidance published as a SNAME T&R Bulletin.

Phase 3 will deploy these assessment criteria throughout the international marine industry, as an important, relevant reference document to any:

1. Vessel designer seeking guidance on environmental design practices.
2. Public entity that needs to assess a marine vessel's impact on the environment.
3. Vessel owner seeking recognition on environmental performance.
4. Classification agency or regulatory body that would find this information useful in developing classification notations, a rating system, or calculating "environmental credits" like carbon credits are calculated today.

The primary benefits of this effort are reductions in air and water pollution, and improvement in energy efficiency. With an established assessment system, vessel owners will have a knowledge-based framework where they can implement practices intelligently. By understanding the relative impacts, the breadth and depth of environmental stewardship will grow, industry based solutions can move ahead of regulation, and effective emerging technology will be promoted.

Section 1 Project Execution

How will MVEP be developed?

1.1 Mission and Objectives

Marine Vessel Environmental Performance Assessment (MVEP) will provide vessel designers, owners, operators and other governing bodies with a standard methodology to assess the relative merits of environmental practices. It will be based on objective technical information, and provide a standard performance criteria to quantify the environmental impact of a vessel's life cycle.

The overall objective of MVEP is to minimize marine vessel environmental impact, as follows:

- Phases 1 and 2 provide objective technical metrics that leverage current best practices to define "how green is green" through a holistic approach.

- Phase 3 provides a path forward for the use of this technical guidance throughout the international marine community, and implements a plan for continued updates.

The next sections discuss the status of each of these phases, and outline a plan for completion.

Figure 1: MVEP Phases and Timeline

1.2 Phase 1 – Pilot Project

The completed Phase 1 Pilot Project confirmed MVEP technical feasibility and maritime community demand. The following sections outline the Phase 1 methods and results.

1.2.1 MVEP Credit Structure

The MVEP organizational structure is based on the United States Green Building Council's LEED™ (Leadership in Energy and Environmental Design) for New Construction Rating System (Reference 2). This structure provides a framework wherein a checklist tracks distinct and measurable improvement efforts. Further, the framework divides the checklist items into categories.

Existing maritime vessel environmental initiatives and challenges from conference proceedings, journal and magazine publications, current and proposed regulations, and classification society publications populated the checklists. This broad range of information was normalized into distinct and measurable "Credits." Credits are organized into four "Categories" to assist technical development and tracking efforts. Section 3 of this report, *Existing Environmental Efforts*, provides a summary of current maritime community environmental efforts. Section 4, *System Structure*, introduces the categories and credits for assessment of environmental performance.

The basic structural levels are outlined in Figure 2.

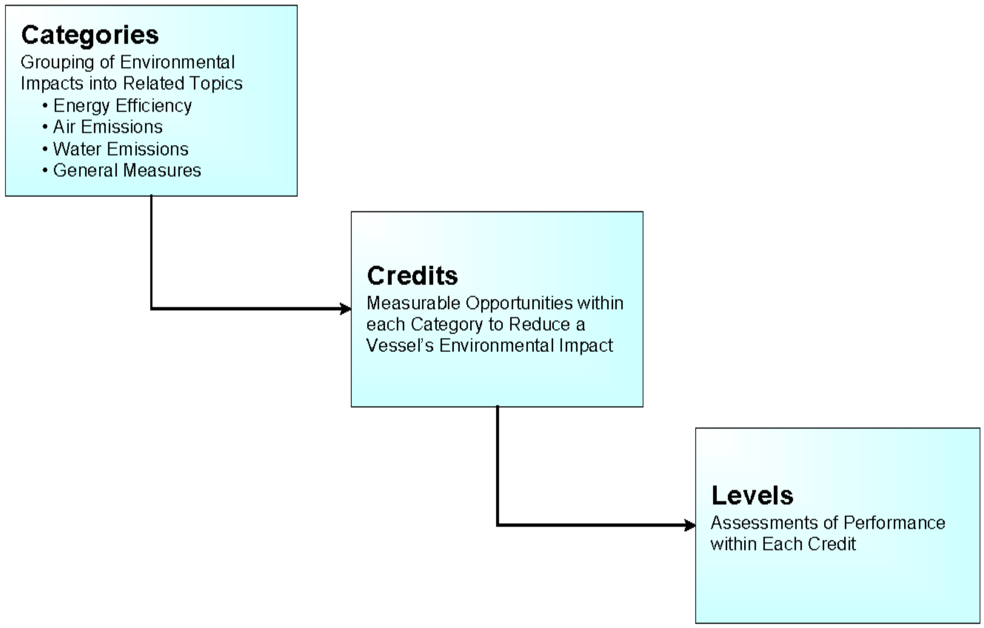


Figure 2: MVEP Structural Levels

1.2.2 Structural Levels and Proof Cases

LEED™ provided further guidance on how to assess the performance of each credit. Broadly, the system introduced the concept of a combination of minimum requirements, checklists of prescriptive measures, and more complex calculation of performance. MVEP incorporated this approach into proof cases for three credits in Phase 1. Based on feedback from the proof cases, four levels of performance assessment were developed. Minimum performance as defined by regulatory compliance is assumed and precedes MVEP's four levels: standard, good, best, and zero emissions. The maximum level of environmental performance of zero emissions may not be feasible at this time, but it is critical to set this level as the ultimate goal.

The MVEP levels and a summary of the MVEP Assessment Guides are provided in Section 5, *Evaluation Metrics*.

1.2.3 Maritime Community Outreach

In September 2009, MVEP was presented to broadly-based marine industry members at the Green Pacific Conference in Long Beach, California, and at the Global Greenship Conference in Washington, D.C. In both cases, the goals were as follows:

- Determine what, if any, market forces would drive future implementation of MVEP.
- Provide industry feedback to the Pilot Project team for incorporation into current efforts.

Both venues provided positive feedback for MVEP.

- The Port of Long Beach suggested that an assessment system would help them assess reductions in port fees for environmentally responsible vessels.
- Allianz, a major marine insurance company, indicated that that an assessment system would help them offer favored carrier rates to environmentally responsible vessels.
- MVEP might be integrated into corporate ISO 14001, *Environmental Management Systems* (Reference 3).
- EPA suggested that IMO might be an implementation route.

1.2.4 Phase 2 Template

Phase 1 confirmed that MVEP is technically feasible and meets a demand in the maritime community. The objective of Phase 2 is to utilize Subject Matter Experts to write MVEP Assessment Guides for the remaining credits. In order to facilitate this effort in a consistent manner, a Panel Package was developed (Attachment 1). This package incorporates lessons learned from the development of the proof examples. The package includes descriptions for all 34 credit areas and a guide template for presenting the desired technical information and a standard methodology of performance assessment for the designers, owners, operators, and regulators. The three first draft assessments are included as appendices.

The next section discusses the logistics of developing these assessments in *Phase 2, T&R Bulletin Development*.

1.3 Phase 2 – T&R Bulletin Development

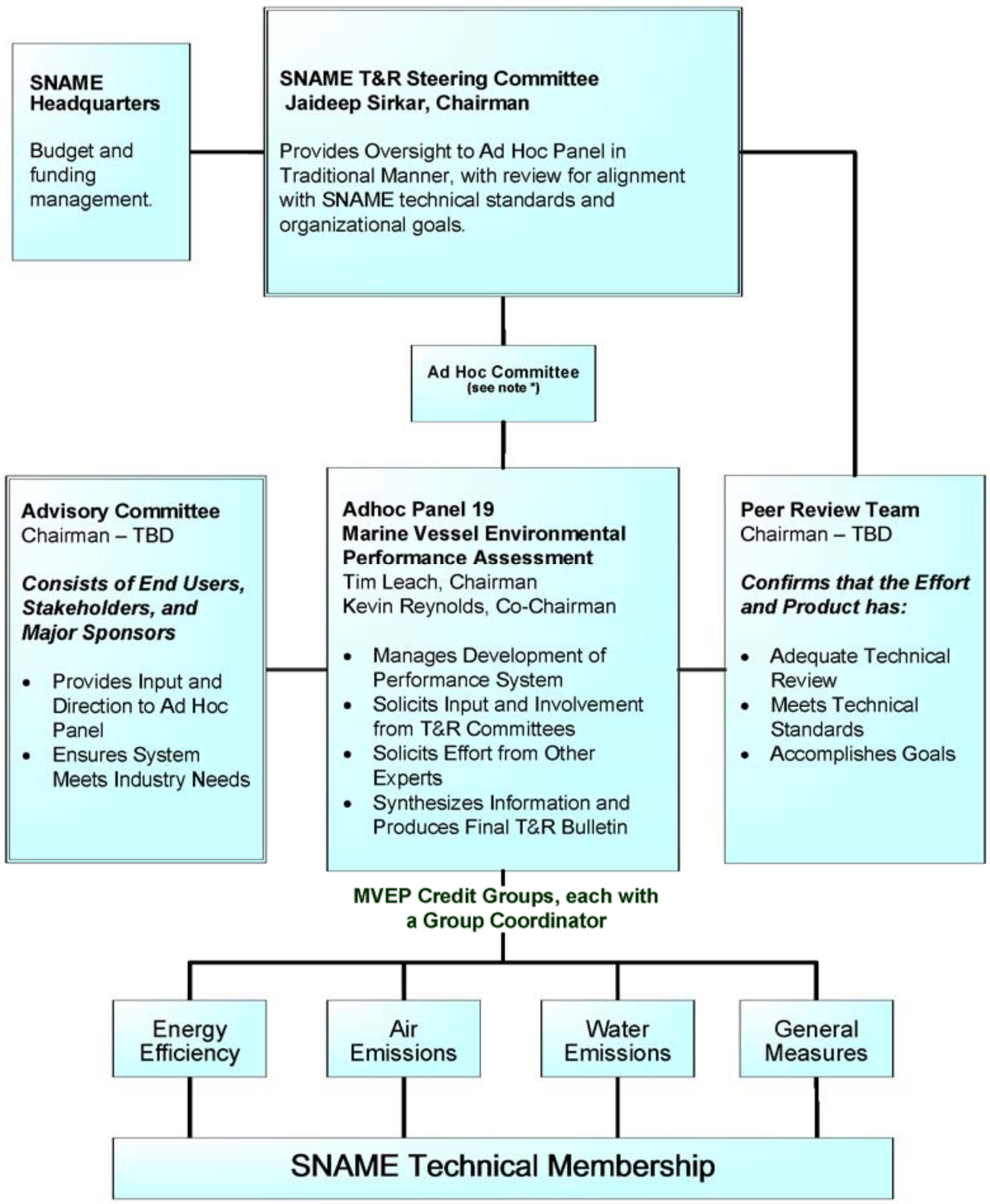
The second phase of MVEP will build on the performance assessment structure and panel package developed in Phase 1. The goal of this phase is to complete the assessment guidance by developing the checklist credits and defining the levels of environmental performance that can be earned for each credit.

The bulletin development will be managed by a newly established SNAME T&R Ad Hoc Panel. The task of developing the Assessment Guide for each Credit will fall to the Subject Matter Experts who are, preferably, SNAME members. The Subject Matter Experts will be supplied with the *MVEP Panel Package* developed in Phase 1 to assist them with their task. Each Subject Matter Expert will be a temporary member of the Ad Hoc Panel while they are developing their Credit Performance Report, and will rotate out of the panel when their efforts are complete.

The Subject Matter Experts will be supported and managed by the permanent members of the Ad Hoc Panel. There are four general categories for the credits; Energy Efficiency, Reduction of Air Emissions, Reduction of Water Emissions, and General Measures. There will be one or two permanent members of the Ad Hoc Panel assigned to each of these four categories. The permanent members' roles will be to manage the efforts on the credits for which they are responsible, and to work with the Subject Matter Experts to ensure that the end product provides the necessary information. Additionally, if there are credits for which no one has volunteered as the Subject Matter Expert, the permanent members will work to try and find a Subject Matter Expert to develop that credit. The four to eight permanent members will report to the Ad Hoc Panel Chair.

The Chair will be responsible for the overall progress of the project and will work to consolidate all of the incoming information. The Chair will also interface with the Advisory Committee and the Peer Review Team.

The Ad Hoc Panel will be responsible for consolidating the information from the Subject Matter Experts into a T&R Bulletin of recommended practices to improve the environmental performance of marine vessels. This bulletin will be consistent with and complementary to worldwide environmental rule and regulation developments such as the Energy Efficiency Design Index for New Ships (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP). This bulletin will be a dynamic document, updated as needed to stay current with technology and regulatory changes. In addition to the development of the bulletin, the panel will recommend a path ahead to ensure that the information remains relevant.



* *Note:* Full T&R Org Chart can be viewed at http://www.sname.org/SNAME/SNAME/UploadedImages/T&R%20Organization%20Chart%2021December2009.pdf

Figure 3: MVEP Panel Integration with SNAME T&R Committee Framework

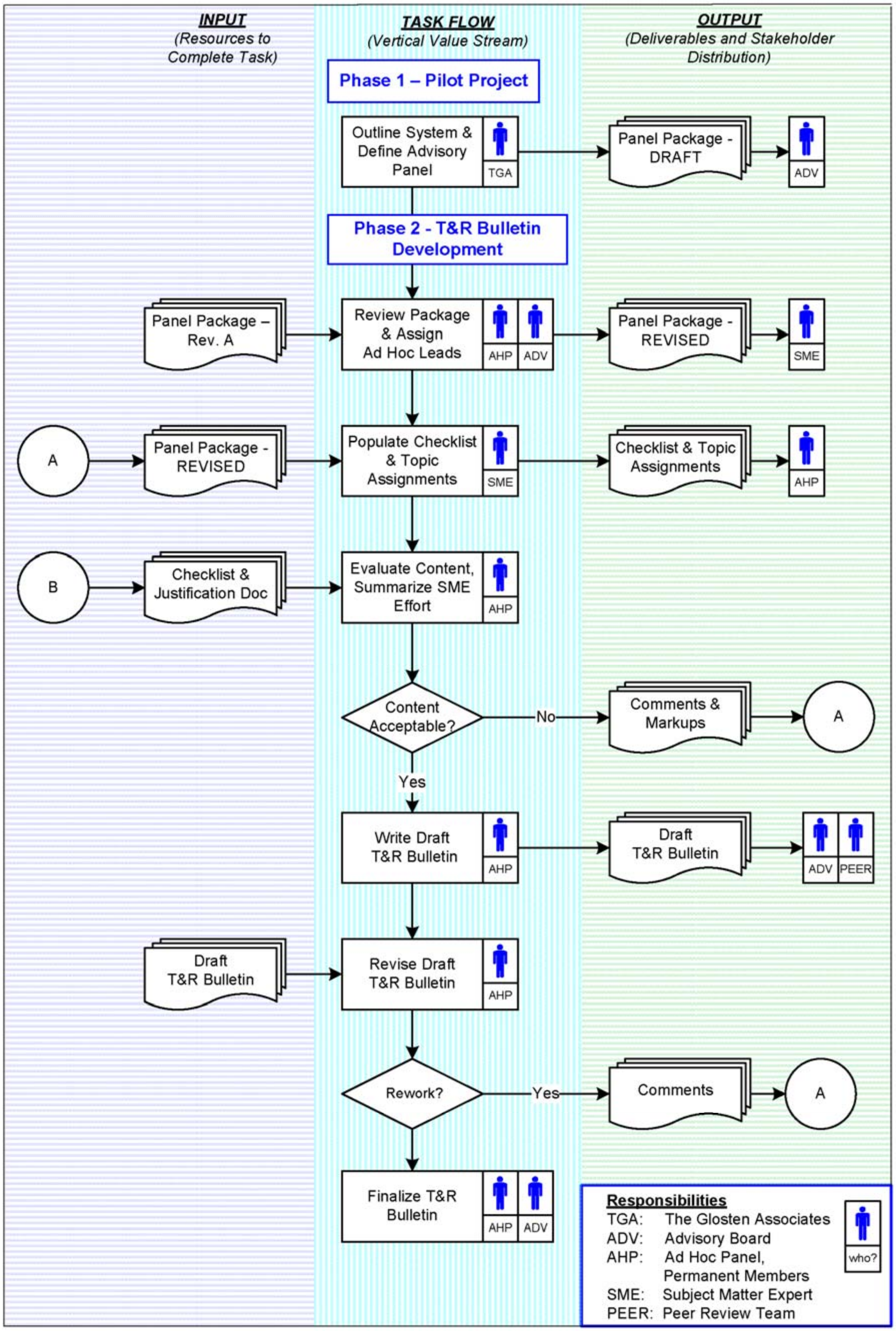


Figure 4: MVEP Phase 2, Work Process Flow Chart (Draft)

1.4 Phase 3 – Implementation

The T&R Bulletin developed in Phase 2 will serve as guidance to designers, owners, and operators interested in reducing the environmental impact of their vessels. The vision for Phase 3 is to take the set of technical environmental performance assessment criteria developed in the bulletin and deploy it through the marine industry on an international scale. Additionally, Phase 3 will implement a technical continuity plan to keep the T&R Bulletin current and relevant. The goal is to provide a lasting effective tool to assist:

1. Vessel designers, owners, and operators seeking guidance on progressive environmental design practices.

2. Public entities that need to assess a marine vessel's impact on the environment.

3. Vessel owners seeking recognition for a high level of environmental performance.

4. Classification agencies or regulatory bodies that are developing classification notations, rating systems, or calculations of "environmental credits" similar to the method that carbon credits are calculated today.

In order to implement the technical guidance, any third party will need to develop:

1. Baselines and Performance Thresholds:

   The bulletin defines how to measure an absolute environmental impact. Further consideration on normalizing impact per service provided is suggested, and the definition of the required performance measure to meet for recognition is needed. See discussion in Section 5.2 Baseline Considerations.

2. Verification:

   A third party implementer will need to assess the extent of verification is required to suit their needs. This could vary from an honor system to regular inspections.

3. Incentives:

   In order to encourage adherence to a system, the third party implementer will need to evaluate what incentives and recognition can be offered.

Section 2 Definitions

2.1 Project Terms

Baseline: The first level of environmental assessment for a given group of vessels, from which additional environmental impact reductions can be measured.

Credit: An area of environmental performance related to vessel design or operational improvement which can be measured; i.e., Ballast Water in the Water Emissions Category.

Metric: Quantitative measurement of performance in vessel design or operational practice.

Checklist: Tool for identifying the credits and potential methods of identifying progress in the four major categories; e.g., Energy Efficiency, Water Emissions, Air Emissions, and General Measures.

2.2 Acronyms

EPA = Environmental Protection Agency

IMO = International Maritime Organization

LEED™ = Leadership in Energy and Environmental Design

MARPOL = Marine Pollution Convention (International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto)

MEPC = Marine Environmental Protection Committee (of IMO)

T&R = Technology and Research (of SNAME)

USGBC = United States Green Building Council

Section 3 Existing Environmental Framework

How does MVEP fit into the marine environmental movement?

A review was conducted of the existing regulations, guidance and incentive programs in order to:

- Avoid the duplication of effort by building on existing regulations, guidance, and efforts.
- Assess the need for a commonly available holistic approach to looking at vessel environmental performance.
- Determine the level of performance currently required by regulations.

A brief summary is given in Table 1.

MVEP differs from existing environmental efforts in three key ways:

1. It is performance and industry driven by a broad base of professionals,
2. The complete ship system is assessed, and
3. MVEP qualification represents an explicitly higher standard than the existing regulations and notations.

Further, a maximum performance level of zero emissions is now introduced. The collective experience of the SNAME's membership enables the bottom up approach, as discussed in Subsection 3.5. The development of a whole ship perspective is discussed in Section 4, and the careful formulation of a far-reading metric is structured in four levels as presented in Section 5. MVEP serves a need in the marine field for a uniform standard of environmental performance.

Table 1: Overview of Existing Environmental Initiatives

Organization	Country	Product	Main Focus	Incentive
ABS	USA	Green Passport	Hazardous Materials Ship Recycling	Class Notation
ABS	USA	ENVIRO and ENVIRO+	Sea and Air Emissions	Class Notation
CE Delft	Netherlands	Environmental Ship Index (ESI)	Air Emissions	Port compliance
Clean Shipping Project	Sweden	Clean Shipping Index	Chemicals, Sea and Air Emissions, Fuel	stewardship
DNV	Norway	Clean and Clean Design Notation	Sea and Air Emissions Risk Mitigation	Class Notation
DNV	Norway	Triple-E	Environmental Management Fuel, Emissions, EEDI	stewardship
GL	Germany	CO2 Index Certification Environmental Passport	Sea and Air Emissions	Documentation for ISO 14001 Class Notation
Green Award	Netherlands	Green Award Flag	Risk Mitigation, Efficiency, Operations and Management	Reduced fees at ports
IMO MEPC	International	Energy Efficiency Design Index (EEDI) and EEOI, SEMP	CO2 Efficiency	To Be Mandatory
Lloyd's Register	UK	Green Passport	Hazardous Materials Ship Recycling	Documentation for ISO 14001 Class Notation
Lloyd's Register	UK	Environmental Protection	Sea and Air Emissions	Class Notation
MAN, Aalborg, Mærsk, and Odense Steel	Denmark	Green Ship of the Future	Air Emissions	Technology Development

3.1 Classification Society Efforts

The major classification societies provide various environmental notations (see Table 1); these include ABS (Enviro, Enviro+, Green Passport, see References 4 and 5), GL (Environmental Passport, CO_2 Index, see Reference 6), DNV (Clean, Clean Design, and Triple-E, see References 7 and 8), ClassNK (Environmental Guideline, see Reference 9), and Lloyd's Register (Green Passport and LR Environmental Protection, see Reference 10).

3.2 IMO Efforts

The IMO EEDI, EEOI, and SEEMP efforts were drafted in 2009 (Reference 11). EEDI, the Energy Efficiency Design Index, is an efficiency measure for new ships. EEOI, the Energy Efficiency Operational Index, is for existing ships. SEEMP, the Ship Energy Efficiency Management Plan, is a guide and appraisal of ship operations.

3.3 Consulting Services

Various consulting services, including classification societies, are offering plans for reducing fuel consumption and increasing energy efficiency. The DNV's Triple-E, also released in 2009, leverages the EEDI percentile ranking to identify high achievement levels. CE Delft's system, the Environmental Ship Index (ESI), gives 10 points on their 100-point scale for simply calculating the EEDI (Reference 12). Rightship also now offers an EEDI- and EEOI-based Environmental Rating (Reference 13).

3.4 Port Specific and Other Programs

The Green Award was developed in collaboration with the Rotterdam Municipal Port Management and the Dutch Ministry of Transport (Reference 14). There are now over 200 tankers that have been awarded the Green Award, for which they receive reduced port fees.

Another notable private project is the Clean Shipping Project (Reference 15). Their network includes 22 Swedish cargo owners committed to assessment of 5 categories on a 150-point scale measuring CO_2, NOx, SO_2, PM, chemicals, fuel, water, and waste control.

Air emissions are seen as the most pressing topic. ESI solely measures NOx and SOx. LR Environmental Protection, ENVIRO, and ClassNK guidelines strongly focus on air and sea emissions. They, along with most other guidelines, reference MARPOL Annex regulations for pollution by oil, noxious liquids, sewage, garbage, and SOx, NOx, and CO_2 emitted to the air.

In addition to MARPOL 73/78 Annexes, these regulations were also referenced: Safety of Life at Sea (SOLAS), Engine International Air Pollution Prevention Certificate (EIAPP), Operational CO2 Index Certification, IMO Ballast Water Management Plan International Convention for the Control and Management of Ships' Ballast Water and Sediments, IMO "International Convention on the Control of Harmful Anti-Fouling Systems on Ships," and IMO Guidelines on Ship Recycling.

3.5 SNAME T&R Program and MVEP

The SNAME Technical & Research program has active committees with panels ranging from Hull Structure Materials, Propulsion, and Hydrodynamics, to Alternative Fuels and Oily Water Separators. SNAME membership crosses all marine industries, from cruise ships and military, to offshore and small craft. The SNAME T&R Committees are engaged in the development of technical bulletins and guidance documents to support the maritime community. The new Ad Hoc Panel is an extension of the SNAME T&R structure, which is tasked specifically to produce the Phase 2 bulletin on the holistic assessment of ships' environmental performance. By drawing upon the breadth and depth of expertise within the society, the MVEP development program will objectively evaluate performance, independent from the influence of product manufacturers, and will cover the spectrum of environmental impacts.

Section 4 System Structure

How will MVEP capture all aspects of the marine vessel?

The MVEP approach to assessing environmental performance applies to all vessel design elements and operational practices where environmental impact can be managed and reduced. The T&R Bulletin, to be developed in Phase 2, will present a holistic view of environmental impacts and provide guidance for conducting environmental assessments of marine vessels.

Distinct and measurable credits form the basis of MVEP. These are items such as “non-indigenous species reduction” and “particulate matter reduction.” MVEP is structured to ease management of the credits, and provide a standard means of assessing performance.

The top tier of the structure consists of four ***Categories***. These categories contain similar credits, focusing resources with similar expertise (**energy efficiency, air emissions, water emissions, general measures**) and limiting overlap of efforts in the development, implementation, and verification. The challenges and scope of categories is outlined in Section 4.1, *Development Approach*.

The middle tier consists of the ***Credits***. Four tables of credits are provided in Section 4.2. The bottom tier consists of four ***Levels***, or measures of performance, for each credit. These levels are detailed in Section 5, *Evaluation Metrics*. This tiered structure is shown Figure 5 (repeated from Section 1).

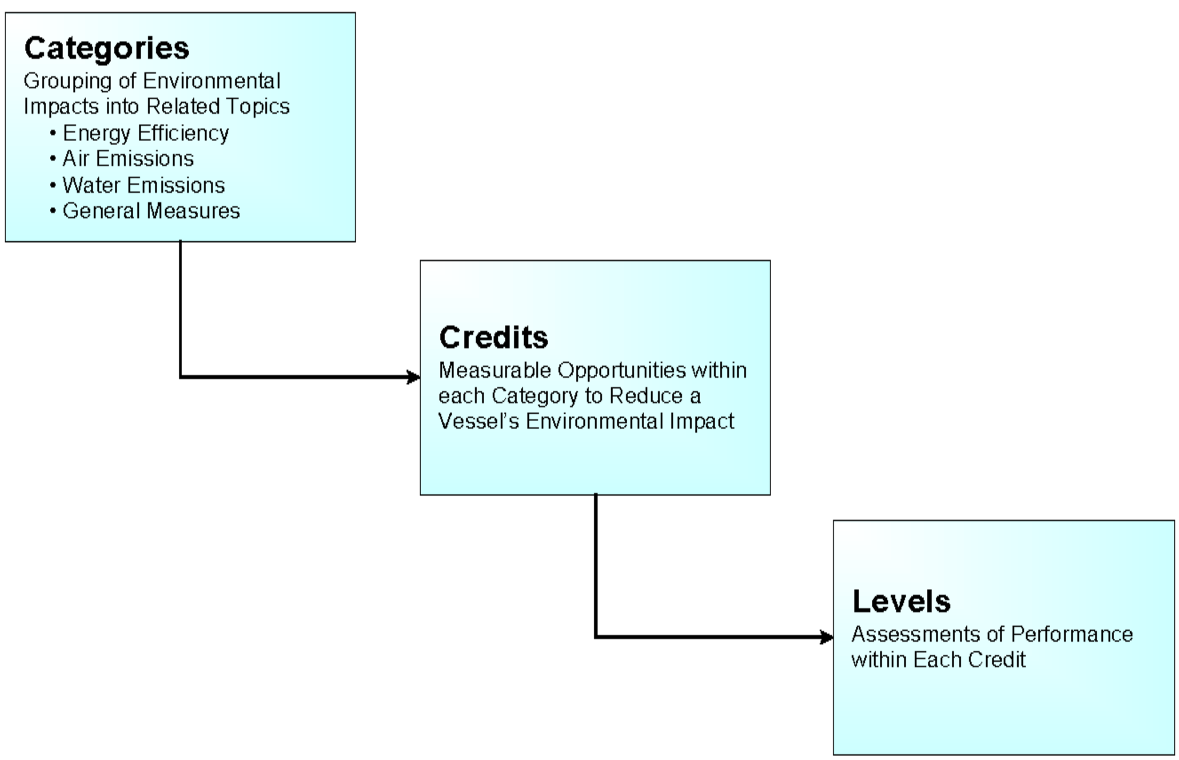


Figure 5 - MVEP Structural Levels

4.1 Development Approach

The MVEP development approach calls for the consideration of all environmental impacts (credits) and the synergies between them. The checklist of credits was derived from surveying multiple sources: existing maritime vessel environmental initiatives, current and proposed regulations, journal and magazine publications, conference proceedings, LEED™ for New Construction (Reference 2), and the project team's internal expertise. While this list is not asserted to be exhaustive, it is intended to be inclusive enough that the downstream effect of any credit is captured by another. This is an important consideration, as meeting an upper level for one credit may impact meeting an upper level in another credit; for example, installing a ballast treatment system may qualify for Level 3 in the ballast water credit, but the added power and fuel consumption needed to run that treatment system will adversely affect the energy efficiency credit. The credits in all four categories should be evaluated for a truly holistic assessment.

Another aspect of the MVEP development approach is that design elements need to be carefully integrated with operational practices. There are many cases where a design element could bring environmental performance to a certain level, but not used in operations; for example, a vessel could have a waste heat recovery system installed, but not use it on a regular basis.

Lastly, there are a number of topics that are outside the scope of the first version of MVEP. These topics can be addressed by general guidance in the T&R Bulletin, as follows:

- **Shipyard Practices** to minimize the environmental impact of the shipbuilding process.
- **Crew Training** to minimize the environmental impact of the vessel operations.
- **Human Factors** to allow for reduced environmental impact without adversely impacting human comfort levels.

4.2 Credit Descriptions

Tables 2 through 5 list the credits for the four categories of Energy Efficiency, Air Emissions, Water Emissions, and General Measures. Credits in the EE category address fuel conservation measures, alternate energy sources, and overall carbon footprint. Air emission credits assess NOx, SOx, particulate matter, greenhouse gases, ozone-depleting substances, and emissions in port. The water emissions category examines: oil, oily water, ballast, hull fouling, sanitation, refuse, and incidental discharges. Life cycle and operational measures are included in the general measures category. This includes the hotel water load, shore protection, hazardous materials control, ship recycling, and others. Performance Levels are rated for each credit as 1 (Standard), 2 (Good), 3 (Best), or 4 (Zero Emissions). This list of credits is considered final and complete for Version 1, but this is not a static or an exhaustive list. As the nature of ship production and operation advances, this list will have to be updated for relevance and accuracy.

MVEP credit descriptions are provided as part of the Panel Package in Attachment 2 of this report. In each credit is a short description of the problem or potential benefit. Also included is some guidance for establishing each credit's performance criteria so that they can be developed in a relatively balanced way for the envisioned T&R Bulletin. Initial thoughts pertaining to all four performance levels are listed, but the Subject Matter Experts will decide on either expanding these initial thoughts or proposing a new direction.

Table 2: Energy Efficiency—Credit Checklist

Credit		Performance Level Achieved				
		Prereq	1	2	3	4
Prerequisite EE	Energy Efficiency Category Prerequisites	☐				
Credit EE1	Energy Optimization Measures		☐	☐	☐	☐
EE1.1	Lighting		☐	☐	☐	☐
EE1.2	HVAC		☐	☐	☐	☐
EE1.3	Pump and Piping Systems		☐	☐	☐	☐
EE1.4	Mechanical Equipment Operations & Maintenance		☐	☐	☐	☐
EE1.5	Hull/ Propeller Operations & Maintenance		☐	☐	☐	☐
EE1.6	Route Optimization		☐	☐	☐	☐
EE1.7	Vessel Speed Optimization		☐	☐	☐	☐
EE1.8	Waste Heat and Energy Recovery		☐	☐	☐	☐
EE1.9	Hull Optimization		☐	☐	☐	☐
EE1.10	Other		☐	☐	☐	☐
Credit EE2	Innovations		☐	☐	☐	☐
EE2.1	Other Fuels		☐	☐	☐	☐
EE2.2	Renewable Energies		☐	☐	☐	☐
EE2.3	Other		☐	☐	☐	☐
Credit EE3	Carbon Foot Print Reduction		☐	☐	☐	☐

Table 3: Air Emissions—Credit Checklist

Credit		Performance Level Achieved				
		Prereq	1	2	3	4
Prerequisite AE	Air Emissions Category Prerequisites	☐				
Credit AE1	Nitrogen Oxides (NOx) Reductions		☐	☐	☐	☐
Credit AE2	Sulfur Oxides (SOx) Reductions		☐	☐	☐	☐
Credit AE3	Particulate Matter (PM) Reductions		☐	☐	☐	☐
Credit AE4	Organic Compounds		☐	☐	☐	☐
Credit AE5	Other Green House Gases (GHGs)		☐	☐	☐	☐
Credit AE6	Ozone-Depleting Substances		☐	☐	☐	☐
Credit AE7	Port Air Emissions Reduction		☐	☐	☐	☐

Table 4: Water Emissions—Credit Checklist

Credit		Performance Level Achieved Prereq	1	2	3	4
Prerequisite WE	Water Emissions Category Prerequisites	☐				
Credit WE1	Oily Water		☐	☐	☐	☐
Credit WE2	Non-Indigenous Species Control		☐	☐	☐	☐
WE2.1	Ballast Water & Sediment		☐	☐	☐	☐
WE2.2	Hull Fouling		☐	☐	☐	☐
Credit WE3	Sanitary Systems		☐	☐	☐	☐
Credit WE4	Solid Waste		☐	☐	☐	☐
Credit WE5	Incidental Discharges		☐	☐	☐	☐
Credit WE6	Structural Protection of Oil		☐	☐	☐	☐

Table 5: General Measures—Credit Checklist

Credit		Performance Level Achieved Prereq	1	2	3	4
Prerequisite GM	General Measures Category Prerequisites	☐				
Credit GM1	Materials: Reduction/Reuse/Recycle Construction and Operations		☐	☐	☐	☐
Credit GM2	Hotel Water Use: Reduction/Reuse/Recycle		☐	☐	☐	☐
Credit GM3	Ocean Health and Aquatic Life		☐	☐	☐	☐
GM3.1	Lighting and Underwater Noise—Aquatic Life Impact		☐	☐	☐	☐
GM3.2	Wake Wash and Shore Protection		☐	☐	☐	☐
Credit GM4	Hazardous Materials Control—Inventory Program		☐	☐	☐	☐
Credit GM5	Ship Recycling		☐	☐	☐	☐

The evaluation of these credits is reviewed in Section 5, *Evaluation Metrics*. This section also summarizes evaluated proof cases, and introduces the challenge of establishing baselines.

Section 5 Evaluation Metrics

How does MVEP define excellence?

The MVEP performance assessment will identify clear metrics for each credit to meet a specific performance level. These levels define: **minimum requirements, good practices, best practices,** and **zero impact**. Excellence is defined by meeting the highest achievable level for a single credit and holistically for the entire vessel. These levels are defined and discussed in Section 5.1, *Credit Levels* and in Section 5.2, *Credit Level Approach*.

MVEP also recognizes that the objective of minimizing marine vessel impact on the environment also needs to address **performance based measures**. The performance metrics, such as number of organisms discharged with ballast water, will be provided in the T&R Bulletin; however, this document cannot specify the threshold value to meet "best" performance. This effort is part of the implementation that will occur in Phase 3. A discussion of these challenges is provided in Section 5.2, *Baseline Considerations*.

Figure 6 shows the relationship of the levels, and how the various levels may be interpreted by users in Phase 3.

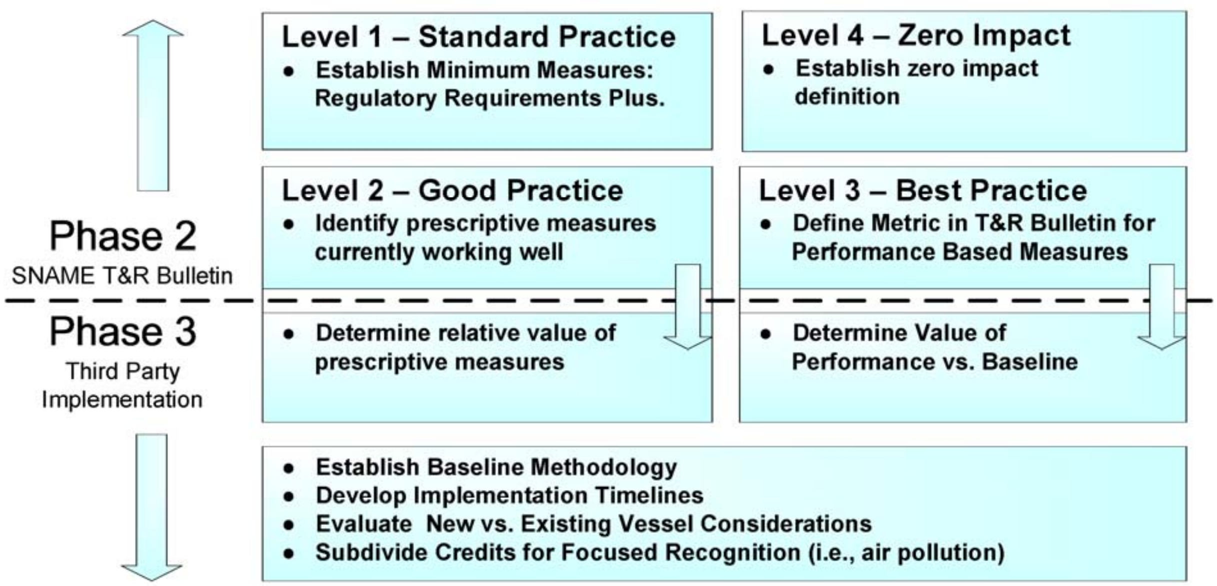


Figure 6: Performance Levels, Bulletin vs. Implementation Responsibilities

5.1 Credit Levels

One objective of MVEP is to recognize the leaders of environmental stewardship. Leaders achieve performance above and beyond what is currently required. MVEP levels extend beyond, but may still draw from the regulatory framework. Compliance with current rules is assumed.

MVEP leverages existing research, development, standards, and accepted best practices to assess environmental impact. Within each credit, a vessel's performance is assessed as having attained one of four levels:

Level 1: Prerequisites are required. This is a level of **Standard Environmental Performance**, which is explicitly higher than simply meeting the minimum required applicable regulations for a given ship. To reach this level, a vessel must meet all IMO environmental regulations, regardless of ship type, location, or age, and including those future regulations with published implementation dates. Vessel size limitations and applicability need to be defined by the Subject Matter Experts.

Level 2: Prescriptive measures for **Good Environmental Performance** are met. These prescriptive measures apply practical, proven technology that is currently and readily available to owners.

Level 3: Performance based measures representing **Best Environmental Performance**. This performance based level is quantitatively assessed, and allows for innovation beyond what is currently good environmental practice. This quantitative measurement may be expressed in terms of either a hard limit, or a percentage of improvement from a predefined baseline. The currently available measures described in Levels 1 and 2 build capability for achieving the performance criteria established in Level 3.

Level 4: Performance measures with either zero or least possible impact on the environment, representing **Zero Emissions Environmental Performance** from ideal design elements or operational practices. Achieving this performance level may not be practical at the current time, and as such, technological or operational limitations and anticipated time scale to achieving zero emissions are identified. Because MVEP is voluntary, it can ask for the absolute most from its ships.

5.2 Baseline Considerations

Performance based measures (Level 3) require an absolute metric to determine a performance number, and a comparative baseline against which that number can be valued. The T&R Bulletin will provide the methodology to determine the performance number, such as number of organisms discharged in ballast water; however, because a comparative baseline is subjective, the T&R bulletin document cannot provide it.

The comparative baseline must be developed and maintained as part of the implementation phase. In this way, the group(s) implementing MVEP will be able to adjust baselines to most effectively meet their objectives and keep current with the best available technology and practices. Such a baseline may reflect the current operational conditions of existing vessels, or current best practice for new designs. Because the MVEP performance measures recognize improvements from a baseline, a continual shift towards decreased environmental impact may be achieved.

In Phase 2, the Advisory Panel will discuss baseline approaches with consideration to providing a guidance document for implementation by others. Initial baseline approaches include:

- **Fixed Numerical Objective.** A fixed number, such as kW per cargo-ton-mile, is assigned. Performance is then measured against this objective. This approach simplifies implementation by fixing the objective; however, it is difficult to develop a baseline that recognizes the difference in vessel types, sizes, and trade routes. The IMO EEDI system is currently struggling with this approach.

- **Self-Improvement.** The subject vessel performs an audit to determine current status. A second audit is conducted after equipment and procedures are updated to reduce environmental impact, with performance evaluated on the amount of improvement; however, this approach tends to provide the greatest recognition to vessels which are currently poor performers.

- **Peer Group.** The subject vessel selects a peer group of vessels that perform a similar service. Assuming the peer group is from recent builds, the subject vessel is evaluated on improvements over this group. This approach offers the possibility of continued progress, as each successive vessel in the peer group needs additional improvements to meet the increasing performance levels. The challenge is in defining suitable peer groups.

5.3 Developing a Holistic Assessment

The credit checklist was developed so that each credit is assessed on its own merit and the compilation of all credit assessments makes clear the trade-offs of various measures giving a holistic view of the ship's performance. The weighting of different credits is left to the party implementing the guidance.

Impacts outside the scope of a technical assessment should still be considered. A criterion for a specific credit may well be valid, but meeting that criterion may impact vessel safety, human factors, or the vessel's economic profile. Less tangible impacts, such as crew comfort from reducing AC plant output, will affect overall crew morale and, in turn, affect vessel performance. Encompassing all impacts in a meaningful way across the range of vessel types and services is reliant on further developments in Phase 3. Section 1.4 describes these challenges.

Section 6 Performance Assessment Guides

What does a credit assessment include?

Phase 1 development of the MVEP system was shaped by the development of Performance Assessment Guides for three example credits. A brief summary of each of these examples is provided here, with the full versions provided in the Panel Package, Attachment 1.

6.1 WE2.1 Non-Indigenous Species Control: Ballast Water and Sediment

The Performance Assessment Guide for *Non-Indigenous Species Control, Ballast Water and Sediment*, found in Attachment 1 to this report, is intended to assist owners and operators with assessing and reducing the transfer of non-indigenous species (NIS) and harmful pathogens by means of ballast water discharges. This guidance identifies methods to decrease and eventually eliminate this harmful discharge. This topic falls within the category of *Water Emissions*.

The output of this effort is a ranking of the alternative ballast water management practices, as well as a procedure for quantifying discharge impact from readily available documentation. Using this guidance will allow an owner or operator to assess their environmental performance for this credit as Standard, Good, Best, or Zero Emissions, as defined in the following section.

6.1.1 Performance Levels

The performance levels for the reduction of transfer of aquatic nuisance species are based on current and proposed regulations. The recommendation is to comply with anticipated regulation as soon as possible, without waiting for the mandatory dates. Ideally, in addition to a treatment approach, there would be a reduction or elimination of ballast discharge in port.

Level 1	Prerequisites - Required	• Meet the requirements and timelines established in the IMO Ballast Convention for all geographic areas.
Level 2	Prescriptive Measures - Good	• Install treatment system which meets California/USCG Phase Two treatment standard.
Level 3	Measureable Performance - Best	• Minimize propagule pressure by reducing ballast discharge volumes, and increasing the efficacy of management techniques. • Participate in peer reviewed efficacy and toxicity test program to document performance.
Level 4	Zero Impact	• Zero discharge of ballast water in port or coastal waters.

6.1.2 Program Technical Considerations

The criteria for this credit were relatively apparent, given the upcoming regulations related to this topic. The organism count is based on the rated efficacy of the installed treatment system and the volume of ballast discharged near shore or in port.

The criteria for this credit will change as the regulations come into effect. It is envisioned that potential recommendations for the future, once all ships are required to treat their ballast water, will be focused only on reduction of the annual organism count. Future assessments will consider the interaction of ballast water with hull fouling and sediment management issues.

6.2 WE1 Oily Water

The Performance Assessment Guide for Oily Water, provided in Attachment 1 to this report, is intended to assist owners and operators with assessing and reducing the environmental impact of their vessels. This guidance identifies methods to decrease and eventually eliminate processed oily water effluent discharges into the ocean from most vessels. This topic falls within the category of *Water Emissions*.

This report dictates a minimal performance level, recommends prescriptive measures for improved performance, and defines a performance metric to objectively quantify achievement. Owners and operators are encouraged to assess their environmental performance for this credit against the levels established here.

6.2.1 Performance Levels

The performance levels for oily water discharge reduction are based on existing and proposed regulations. The recommendation is to implement those regulation measures as soon as possible, without waiting for the mandatory dates. The following table is a brief summary of these levels.

Level 1	Prerequisites - Required	• Comply worldwide with MARPOL 73/78 Annex 1, *Regulations for the Prevention of Pollution from Oil,* and related amendments.
Level 2	Prescriptive Measures - Good	• Perform a vessel assessment of contributors of water, oil, and other contaminants to bilgewater quantity and quality. • Install protective and preventive equipment: diapers, drip-trays, coamings, leak-proof seals, tamper proof monitoring and alarm system.
Level 3	Measureable Performance - Best	• Calculate and minimize impact by reducing volume and oil density of discharge.
Level 4	Zero Impact	• Zero discharge of oily water. • Store and dispose of oily water at shore side facilities.

6.2.2 Program Technical Considerations

The criteria for this credit were relatively apparent, given the upcoming regulations related to this topic. The calculation of oil outflow impact is based on the rated efficacy of the treatment system and the amount of oily water discharged.

Level 1 of this credit will need to be updated as regulations change. As treatment systems improve, it is envisioned that future recommendations will be focused on continued reduction in the oil outflow.

6.3 EE1.2 Energy Optimization Measures: Heating, Ventilation and Air Conditioning

The Performance Assessment Guide for *Heating, Ventilation, and Air Conditioning (HVAC)*, found in Attachment 1 to this report, is intended to assist owners and operators with assessing and reducing the HVAC portion of the energy load on vessels in reasonable ways. HVAC systems are potentially a large portion of the energy demand on a vessel depending on many factors: such as the type of vessel, the size of the vessel, the number of people aboard the vessel, the quantity of heat producing equipment aboard the vessel, and the service area of the vessel. This topic falls within the category of *Energy Efficiency*.

6.3.1 Performance Levels

As there are no existing regulations related to the efficiency of HVAC systems, the performance levels for the reduction of energy used for HVAC are primarily based on prescriptive measures that are known to improve system efficiencies.

Energy gains in HVAC should be viewed within the larger context of the ship's efficiency. In practice, performance is measured through fuel consumption with all the other energy loads.

Level 1	Prerequisites - Required	• Control indoor climate for proper operation of shipboard equipment and the comfort of onboard personnel
Level 2	Prescriptive Measures - Good	• Utilize waste heat and recover exhaust energy. • Use high efficiency and dynamically controlled components to meet current load. • Reduce HVAC losses with insulation.
Level 3	Measureable Performance - Best	• Monitor, benchmark, and reduce HVAC fuel consumption.
Level 4	Zero Impact	• Reduce HVAC load as far as prerequisite allows. A zero HVAC load is not reasonable.

6.3.2 Program Technical Considerations

As an energy efficiency credit, the benefits of the measures proposed in this credit are primarily captured in the ship's overall calculation of energy efficiency. Therefore, it became apparent that for these credits there may not be a separate, measurable performance attributed to just one effect.

Section 7 Recommendations

How does SNAME move MVEP towards implementation?

The MVEP overall objective is to minimize marine vessel environmental impact. Phase 1 has advanced that goal by confirming technical feasibility and maritime community demand. Phase 1 has also provided a basic structure, methodology, worked examples, and a template to assist efforts to complete the development of the performance assessment guidance in Phase 2.

MVEP should be advanced by the following actions:

- Establish the Advisory Committee.
- Implement the Phase 2 Project Plan.

7.1 Establish the Advisory Committee

It is recommended that the Advisory Committee be established. This committee is to be comprised of “end-users” of MVEP and, therefore, populated by executives representing: an ocean going vessel shipping company, an inland or coastal shipping company, large and small shipyards, a port official, a regulatory agency representative, an environmental advocacy group representative, a classification society representative, and a naval architect. The responsibilities of the advisory committee will include:

- Guide Phase 2 Development Efforts. The purpose is to ensure that the performance assessments meet the needs of the maritime community.
- Develop Phase 3 Implementation Plan. This effort will foster adoption of MVEP through outreach to classification societies, port authorities, and others. The committee should consider providing guidelines for developing baselines.
- Develop Continuation Plan. This will consider means for continuing updates to the performance assessment, as well as implementation efforts.

7.2 Phase 2 - Execution

Phase 2 will see the identification of the Advisory Group and SNAME Ad Hoc Panel members, as well as the distribution of the Panel Package to the Subject Matter Experts. Phase 2 will culminate in the development of a SNAME T&R Bulletin. This will be a rich body of information to be used throughout the industry to design and operate ships with the improved environmental resource intelligence necessary to reduce shipping’s environmental impact.

7.3 Phase 3 – Technical Support and Continuation

Additional support in the format of guidelines may be appropriate from the performance assessment team. These guidelines might include the following considerations.

It is also appropriate to consider incorporating MVEP into IMO (MEPC or ISM), ISO, or other international environmental standards.

7.3.1 Technical Continuity Plan

The assessment guidance will need systemic review and amendment to keep pace with emerging technologies and change to regulations. Phase 3 shall formulate a long term plan to maintain MVEP's relevance and high technical standards. It is also appropriate to consider incorporating MVEP into IMO (MEPC or ISM), ISO, or another international standard.

7.3.2 Peer Group Considerations

Peer Groups of vessels will need to be defined, so that a given vessel can be compared against other vessels of a similar type, a similar service, and similar economic constraints.

7.3.3 Relative Benefits and the Weighting of Credit Levels

Relative environmental impacts between each level and among the various credits will be very difficult, if not impractical, to determine; for example, the relative impact reduction of a credit received for a Level 3 oily water separator compared to the credit received for a Level 2 ballast treatment system. Consideration should be given to weighting factors for credit values.

7.3.4 Geographic Considerations

Geography is an important consideration in assessing performance, because some environmental impacts are more severe to a local geography than to the global environment, and vice versa. For example, particulate emissions into the atmosphere from stack exhausts are serious in the Port of Long Beach because of the human health impacts to local residents, where during a transit and away from port, the impact is reduced as they fall into the ocean and are dispersed. Carbon dioxide emissions, on the other hand, are equally damaging regardless of where they are emitted.

Section 8 Acknowledgements

The project team acknowledges the financial support received from the American Bureau of Shipping and the Society of Naval Architects and Marine Engineers, as well as the advisory support from: Herbert Engineering Corporation; John Larkin, Rick Thorpe, and Spencer Schilling from HEC, Jennifer Zeien of Slater & Zeien, L.L.P.; and Jaideep Sirkar, Chair of the T&R Steering Committee.

David Larsen and Bob Van Slyke of The Glosten Associates are recognized for authoring the HVAC Energy Load Reduction and Oily Water Assessment Guides, respectively.

Thank you to SNAME President Keith Michel, SNAME T&R Environmental Committee Chair Bruce Russell, and ABS Vice President Global Technology and Business Development Kirsi Tikka, for their continued guidance and feedback on the initial release of this report.

Attachment 1. MVEP Panel Package

MARINE VESSEL ENVIRONMENTAL PERFORMANCE ASSESSMENT

MVEP Panel Package

Prepared for:
SNAME Technical & Research Steering Committee

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File No. 09068.01
29 January 2010
Rev. A

Contents

Revision History

Section	Rev	Description	Date	Approved

Overview

This document provides supplemental information for Subject Matter Experts assisting with the development of the Marine Vessel Environmental Performance Assessment (MVEP) Technical & Research Bulletin. Specifically, each ***MVEP Credit*** is described and assigned a draft ***Performance Level***.

> *Marine Vessel Environmental Performance Assessment (MVEP) will provide vessel owners and operators with a standard methodology to assess the relative merits of environmental practices. It will be based on objective technical information, and provide a standard performance criteria to quantify the environmental impact of a vessel's life cycle.*
>
> *-MVEP Phase 1 Report*

The MVEP organizational structure is based on the LEED™ (Leadership in Energy and Environmental Design) for New Construction Rating System (Reference 2). This structure provides a framework wherein a checklist tracks distinct and measurable improvement efforts. Further, the framework divides the checklist items into super categories.

Information on existing maritime vessel environmental initiatives and challenges to populate the checklists was gathered from conference proceedings, journal and magazine publications, current and proposed regulations, and classification society publications. This broad range of information was normalized into distinct and measurable "Credits." Each credit is assigned to one of four "Credit Categories" to assist technical development and tracking efforts. The basic structural levels are outlined in Figure 1. The following section discusses the development of Performance Levels.

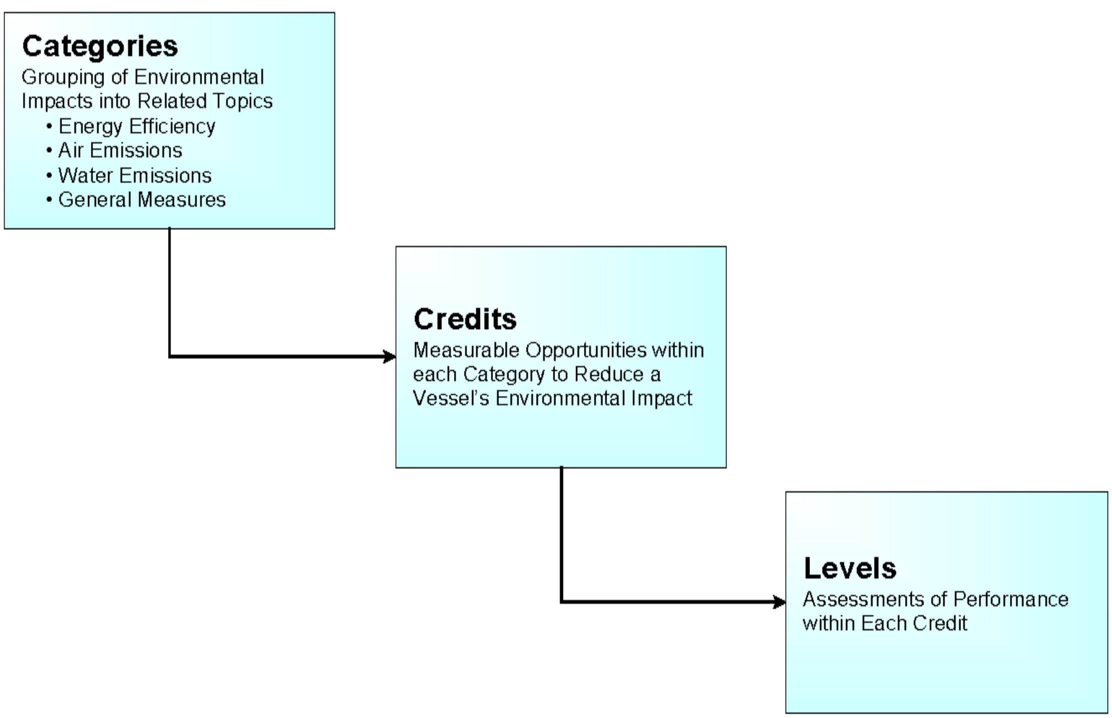

Figure 1: MVEP Structural Levels

Performance Assessment

The performance assessment of each credit is being performed by Subject Matter Experts (Experts). Section 1, *Credit Checklists*, ensures a holistic review of marine vessels. Experts may develop one credit item, or several.

The descriptions in the following sections define the scope and range of the credit. The descriptions also provide each Expert with the ability to cross-reference other credits. The Performance Level designations represent the initial thoughts developed in Phase 1, and are for guidance only. Levels 1, 2, and 3 should rely on proven, practical, and effective technologies or practices. Experts are expected to supersede the proposed Performance Level designations as part of the performance assessment process.

Credit Levels

MVEP is designed to leverage existing research, development, standards, and accepted best practices to assess environmental impact. Within each credit, a vessel's performance is assessed as attaining one of four levels:

Level 1: Prerequisites are required. This is a level of **Standard Environmental Performance**, which is explicitly higher than simply meeting the minimum required applicable regulations for a given ship. To reach this level, a vessel must meet all IMO environmental regulations, regardless of ship type, location, or age, and including those future regulations with published implementation dates. Vessel size limitations and applicability will ultimately be decided by the Subject Matter Experts.

Level 2: Prescriptive measures for **Good Environmental Performance** are met. These prescriptive measures apply practical, proven technology that is currently and readily available to owners.

Level 3: Performance based measures representing **Best Environmental Performance**. This performance based level is quantitatively assessed, and allows for innovation beyond what is currently good environmental practice. This quantitative measurement may be expressed in terms of either a hard limit, or a percentage of improvement from a predefined baseline. The currently available measures described in Levels 1 and 2 help to achieve the performance criteria established in Level 3.

Level 4: Performance measures with either zero or least possible impact on the environment, representing **Zero Emissions Environmental Performance** from ideal design elements or operational practices. Achieving this performance level may not be practical at the current time, and as such technological or operational limitations and anticipated time scale to achieving zero emissions are identified. Because MVEP is voluntary, it can ask for the absolute most from its ships.

Section 1 Credit Checklists

These credit checklists were developed so that each credit is assessed on its own merit, and the compilation of all credit assessments makes clear the trade-offs of various measures giving a holistic view of the ship's performance. The weighting of different credits is left to the party implementing the guidance.

Table 1: Energy Efficiency—Credit Checklist

	Performance Level Achieved				
Credit	**Prereq**	**1**	**2**	**3**	**4**
Prerequisite EE Energy Efficiency Category Prerequisites	☐				
Credit EE1 Energy Optimization Measures		☐	☐	☐	☐
EE1.1 Lighting		☐	☐	☐	☐
EE1.2 HVAC		☐	☐	☐	☐
EE1.3 Pump and Piping Systems		☐	☐	☐	☐
EE1.4 Mechanical Equipment Operations & Maintenance		☐	☐	☐	☐
EE1.5 Hull/ Propeller Operations & Maintenance		☐	☐	☐	☐
EE1.6 Route Optimization		☐	☐	☐	☐
EE1.7 Vessel Speed Optimization		☐	☐	☐	☐
EE1.8 Waste Heat and Energy Recovery		☐	☐	☐	☐
EE1.9 Hull Optimization		☐	☐	☐	☐
EE1.10 Other		☐	☐	☐	☐
Credit EE2 Innovations		☐	☐	☐	☐
EE2.1 Other Fuels		☐	☐	☐	☐
EE2.2 Renewable Energies		☐	☐	☐	☐
EE2.3 Other		☐	☐	☐	☐
Credit EE3 Carbon Foot Print Reduction		☐	☐	☐	☐

Table 2: Air Emissions—Credit Checklist

	Performance Level Achieved				
Credit	**Prereq**	**1**	**2**	**3**	**4**
Prerequisite AE Air Emissions Category Prerequisites	☐				
Credit AE1 Nitrogen Oxides (NOx) Reductions		☐	☐	☐	☐
Credit AE2 Sulfur Oxides (SOx) Reductions		☐	☐	☐	☐
Credit AE3 Particulate Matter (PM) Reductions		☐	☐	☐	☐
Credit AE4 Organic Compounds		☐	☐	☐	☐
Credit AE5 Other Green House Gases (GHGs)		☐	☐	☐	☐
Credit AE6 Ozone-Depleting Substances		☐	☐	☐	☐
Credit AE7 Port Air Emissions Reduction		☐	☐	☐	☐

Table 3: Water Emissions—Credit Checklist

Credit		Prereq	1	2	3	4
		Performance Level Achieved				
Prerequisite WE	Water Emissions Category Prerequisites	☐				
Credit WE1	Oily Water		☐	☐	☐	☐
Credit WE2	Non-Indigenous Species Control		☐	☐	☐	☐
WE2.1	Ballast Water &Sediment		☐	☐	☐	☐
WE2.2	Hull Fouling		☐	☐	☐	☐
Credit WE3	Sanitary Systems		☐	☐	☐	☐
Credit WE4	Solid Waste		☐	☐	☐	☐
Credit WE5	Incidental Discharges		☐	☐	☐	☐
Credit WE6	Structural Protection of Oil		☐	☐	☐	☐

Table 4: General Measures—Credit Checklist

Credit		Prereq	1	2	3	4
		Performance Level Achieved				
Prerequisite GM	General Measures Category Prerequisites	☐				
Credit GM1	Materials: Reduction/Reuse/Recycle Construction and Operations		☐	☐	☐	☐
Credit GM2	Hotel Water Use: Reduction/Reuse/Recycle		☐	☐	☐	☐
Credit GM3	Ocean Health and Aquatic Life		☐	☐	☐	☐
GM3.1	Lighting and Underwater Noise—Aquatic Life Impact		☐	☐	☐	☐
GM3.2	Wake Wash and Shore Protection		☐	☐	☐	☐
Credit GM4	Hazardous Materials Control—Inventory Program		☐	☐	☐	☐
Credit GM5	Ship Recycling		☐	☐	☐	☐

Section 2 Energy Efficiency

PreEE Energy Efficiency Category Prerequisites

In addition to the prerequisites for the individual credits, there also are general category prerequisites that should be applied more broadly. These category prerequisites represent the minimum level of practice considered sufficient from an environmental standpoint.

Provide recommendations for these more broadly applied prerequisites.

Note: Each prerequisite will be treated individually in the checklist.

Credit EE1 Energy Optimization Measures

Energy optimization measures assist marine vessels in reducing overall energy consumption. The following sub-credit items address these measures.

Note: The overall assessment of energy efficiency, such as fuel efficiency and alternative power sources, will be captured in Credit EE3, *Carbon Footprint Reduction*.

Note: Materials selection and recycling are covered in a separate credit.

Credit EE1.1 Lighting

Lighting systems consume significant amounts of energy. Efficient design and installation can significantly reduce lighting demand and energy requirements.

Provide an assessment on how to reduce lighting energy consumption.

Level 1	Prerequisites - Required	Designate relevant standard(s) that promote efficient energy use.
Level 2	Prescriptive Measures - Good	Identify best practices such as use of CFL or LED lighting, motion sensing switches, isolation switches, etc. Designate energy efficient design conditions, such as minimum and maximum lighting levels for the designated space use.
Level 3	Measurable Performance - Best	Identify or provide a method to measure lighting load, such as an energy audit. Provide metrics for determining performance, such as total energy, energy per person, and energy per space area.
Level 4	Zero Impact	Identify opportunities for eliminating electric lighting, such as adding natural light sources for use during daylight hours.

Credit EE1.2 HVAC

Heating, ventilation, and air conditioning systems consume significant amounts of energy. Efficient design and installation can significantly reduce the demand for HVAC and energy requirements.

Provide an assessment on how to reduce HVAC energy consumption.

Note: Operations and maintenance is covered by a separate sub-credit.

Note: Piping and pump systems are covered by a separate sub-credit.
Note: This credit has been addressed in the Pilot Project however; review by a Subject Matter Expert is recommended.

Level 1	Prerequisites - Required	Designate relevant design standard(s) which promote efficient energy use.
Level 2	Prescriptive Measures - Good	Identify established best practices focused on efficiency such as insulation factors, zone control, and demand based conditioning. Identify efficiency focused minimum and maximum environmental conditions, heating and cooling targets, and ventilation rates.
Level 3	Measurable Performance - Best	Identify or provide a method to measure HVAC load, such as an energy audit of key equipment. Provide metrics for determining HVAC performance such as total energy, energy per person, energy per space volume, energy per cargo weight, energy per machinery space load.
Level 4	Zero Impact	Identify opportunities for zero energy consumption such as natural ventilation and spaces not requiring ventilation.

Credit EE1.3 Pump and Piping Systems

Pump and piping systems are significant consumers of energy. Efficient design and installation can significantly reduce the demand to move fluids, and the energy required to move what is required. It is also reasonable to improve thermal efficiency, and optimize system temperatures and pressures further reducing energy consumption.

Provide an assessment on how to reduce pump and piping systems energy consumption.

Note: Operations and maintenance is covered by a separate sub-credit.
Note: Waste heat systems are covered by a separate sub-credit.

Level 1	Prerequisites - Required	Designate relevant standard(s) which promote efficient energy use.
Level 2	Prescriptive Measures - Good	Identify best practices such as piping insulation factors, use of demand based controls, and materials selection. Designate energy efficient design conditions such as minimum and maximum pump operating points, piping velocities, system temperatures and pressures.
Level 3	Measurable Performance - Best	Identify or provide a method to measure piping system loads, such as an energy audit of key equipment. Provide metrics for determining piping system performance such as total energy, energy per installed propulsion power, energy per auxiliary power, energy per crew/passenger, energy per HVAC load.
Level 4	Zero Impact	Identify opportunities that eliminate the demand for piping systems, require no additional energy, or allow the systems to be periodically secured. Such methods may include use of air cooled units, no flush toilets, gravity drains, and use of demand based control systems.

Credit EE1.4 Mechanical Equipment Operations and Maintenance

The operation and maintenance (O&M) of mechanical equipment bears a significant impact on equipment consumption of energy and spare parts. This includes all systems consuming energy such as engines, pumps, fans, compressors, dishwashers, elevators, and cranes. Slowing down a fan on a cool day, and fixing a compressed air leak are example of energy efficient operation and maintenance practices.

Provide an assessment of on how to reduce energy through operations and maintenance.

Level 1	Prerequisites - Required	Designate relevant O&M standard(s) which promote efficient energy use.
Level 2	Prescriptive Measures - Good	Identify conditional measures for operational adjustments, such as temperature control and equipment shut-down during low use periods. Identify conditional measures for maintenance, such as equipment overhaul upon loss of designated loss of efficiency.
Level 3	Measurable Performance - Best	Identify or provide a method to measure equipment loads, such as an energy audit of key equipment. Designate audit program in which efficiency is compared to “new” condition. Provide metrics comparing “new” to actual efficiency to determine performance.
Level 4	Zero Impact	Identify operational methods where equipment can be secured for significant periods of time.

Credit EE1.5 Hull/Propeller Operations and Maintenance

The proper maintenance and cleaning of the hull and propellers bears a significant impact on the energy required to propel a ship.

Provide an assessment on how to minimize energy consumption through hull coating and propeller operations and maintenance.

Level 1	Prerequisites - Required	Designate relevant standards such as: Coatings should be in compliance with the IMO AFS/CONF/26, "International Convention on the Control of Harmful Anti-Fouling Systems on Ships" 2001.
Level 2	Prescriptive Measures - Good	Identify methods of determining maximum periods between cleanings. Focus on ongoing monitoring programs as the best practice. Identify methods to reduce the amount of or impact of hull and propeller fouling
Level 3	Measurable Performance - Best	Identify or develop metric to determine the loss of efficiency during operations, including instantaneous and annual average.
Level 4	Zero Impact	Not Applicable

Credit EE1.6 Route Optimization

Plan voyages to promote safety of the ship, crew, and environmentally sensitive areas. Optimize routes to use weather patterns, typical currents and wind to best advantage. Maximize cargo area utilization and reduce idle time in port.

Provide an assessment of the benefits of a route optimization program.

Note: Speed optimization is covered by a separate sub-credit

Level 1	Prerequisites - Required	Designate any relevant standards or recommendations regarding route optimization.
Level 2	Prescriptive Measures - Good	Identify a method, or suitable commercial or public programs, for determining optimal routes. Also address any items that need to be considered when developing a program to take advantage of natural conditions as well as schedule optimization to reduce idle time, etc.
Level 3	Measurable Performance - Best	Identify of method of quantifying potential reductions in fuel consumption related to route optimization.
Level 4	Zero Impact	Not Applicable

Credit EE1.7 Vessel Speed Optimization

Vessels traveling at slower speeds tend to have improved energy efficiency, which can translate into reduced fuel consumption on a distance basis. This is particularly true if the operating zone is within the efficient operating range of the propulsion machinery. However, a reduction in speed may result in the need for additional ships which could negate the benefits of the reduction in speed.

Provide a method of assessing an operating profile to determine the benefits of a speed reduction program.

Note: Route optimization is covered by a separate sub-credit

Note: Vessel speed optimization may impact overall fleet operations. This broader issue may be discussed, but not directly addressed in this assessment guide.

Note: Speed reduction may not produce a reduction in CO_2 emissions, particularly for existing vessels. This is addressed by establishing methods to determined optimum speeds for existing vessels.

Level 1	Prerequisites - Required	Designate any relevant standards or recommendations regarding slow steaming.
Level 2	Prescriptive Measures - Good	Identify a method of determining an optimal speed for fuel efficiency. This should include identifying measures to be considered / optimized for slow steaming.
Level 3	Measurable Performance - Best	Identify of method of quantifying reductions in fuel consumption related to running at an optimum speed.
Level 4	Zero Impact	Not Applicable

Credit EE1.8 Waste Heat and Energy Recovery

Significant energy is exhausted to atmosphere or pumped overboard from ships. This is lost energy. Efficient design and installation can capture significant quantities of this energy for transfer to HVAC plants, making fresh water, heating fuel, or generating electricity.

Provide an assessment on how to maximize waste heat and energy recovery measures.

Note: Operations and maintenance is covered by a separate sub-credit.

Level 1	Prerequisites - Required	Designate relevant standard(s) which promote efficient energy use.
Level 2	Prescriptive Measures - Good	Develop an assessment methodology for identifying opportunities for waste heat and energy recovery. Identify metrics for requiring equipment installation based on assessment process. For example, use of engine cooling water for making water if heat balance and space constraints are appropriate.
Level 3	Measurable Performance - Best	Identify a methodology for determining a vessel's thermal load, or amount of waste heat and energy lost to the environment. Provide metrics for determining performance such as total thermal load, load per installed propulsion power, load per auxiliary power, load per crew/passenger, and load per cargo-ton-mile.
Level 4	Zero Impact	Identify key opportunities to reduce thermal loads to near zero by either recovery, or alternative equipment. Such opportunities may include use of a nitrogen generator instead of a combustion unit, and closed loop piping systems.

Credit EE1.9 Hull Optimization

Optimizing the hull for its intended operations offers the potential for significant fuel savings. This optimization can take the form of a CFD optimization for the hull form and/or finding the optimal size and block coefficient to move cargo most efficiently.

Provide an assessment on hull optimization measures.

Level 1	Prerequisites - Required	Not applicable.
Level 2	Prescriptive Measures - Good	Identify measures to take during the optimization of hull size and shape.
Level 3	Measurable Performance - Best	Provide or identify a method of assessing the benefit of a hull optimization. This could be a percentage reduction from an initial design, or normalized to cargo capacity.
Level 4	Zero Impact	Not applicable.

Credit EE1.10 Other

There are no current guidelines for ***Other***, but this section is included in recognition that not all current or future energy efficiency topics are addressed above. These may include items such as use of low viscosity lubricants, low energy communications equipment, etc. This category is intended to capture those items, some of which may become separate subsections if that is deemed appropriate.

Note: Other items will be listed as Level 2, Prescriptive Measures.

Level 1	Prerequisites - Required	Not applicable.
Level 2	Prescriptive Measures - Good	Identify measures to further improve energy efficiency.
Level 3	Measurable Performance - Best	Not applicable.
Level 4	Zero Impact	Not applicable.

Credit EE2 Energy Innovations

Reductions in CO_2 are possible beyond the energy efficiency options described above. The intent of this credit is to recognize and encourage innovative ways to reduce the production of CO_2 and other emissions.

Credit EE2.1 Alternative Fuels

Alternative fuels represent a potential approach for reductions in CO_2 production, as well as reducing or eliminating other gases. However, implementation of alternative fuels can be problematic and can result in increases in other types of emissions.

Identify alternative fuels and provide an assessment of alternative fuel use and its impact on air emissions, particularly in CO_2 production.

Note: This topic may require sub-categories to address the various alternative fuels such as hydrogen, bio-fuels, nuclear, and LNG.

Level 1	Prerequisites - Required	Designate relative standards for alternative fuel use.
Level 2	Prescriptive Measures - Good	Identify measures to improve performance or reduce operational issues with alternative fuels. Categorize air emissions relative to diesel fuel.
Level 3	Measurable Performance - Best	Identify a method to quantify reductions (or increases) in air emissions. CO_2 reductions may be captured in EE3 – Carbon Footprint Reduction and the same method should be used here.
Level 4	Zero Impact	Identify opportunities for eliminating the production of CO_2 or other gases, such as hydrogen fuel cells or nuclear.

Credit EE2.2 Renewable Energies

The use of renewable energies is encouraged in helping to reduce the CO_2 production of marine transport. Consequently, this credit should address renewable energy measures and levels of performance.

Provide an assessment of renewable energy measures aboard marine vessels and identify a performance metric.

Level 1	Prerequisites - Required	Designate relevant standards for renewable energy use.
Level 2	Prescriptive Measures - Good	Identify potential renewable energy applications such as; wind assisted propulsion, generating power from a renewable source such as wind, solar, and ocean.
Level 3	Measurable Performance - Best	Identify a method to quantify renewable energy use, such as the percentage of energy consumption from renewable sources.
Level 4	Zero Impact	All energy from renewable sources, however this is unlikely in the near future. It may be possible to have a goal to have all the energy for a specific function come from renewable energy.

Credit EE2.3 Other

This credit recognizes that not all current or future innovative technologies are addressed in the current checklist.

Note: This credit solely considers opportunities for Level 2, Prescriptive Measures.

Level 1	Prerequisites - Required	Not applicable.
Level 2	Prescriptive Measures - Good	Identify innovative measures to further improve energy efficiency.
Level 3	Measurable Performance - Best	Not applicable.
Level 4	Zero Impact	Not applicable.

Credit EE3 Carbon Foot Print Reduction

This credit identifies a vessel's overall carbon footprint, including all savings from fuel efficiency measures and alternative power sources by calculating carbon emissions. The reduction of carbon footprint may be a combination of: Energy optimization measures from Credit EE1 and innovative energy technologies from Credit EE2, such as electric propulsion, fuel cells, nuclear power, and other non-combustion fuel sources.

The final form of this credit is pending findings from the SNAME Ad Hoc Panel 18 study. The required calculation here may likely be the EEDI released by IMO MEPC59 2009, with the addition of an operational indicator of energy efficiency.

Provide an assessment of carbon foot print or energy efficiency measures.

Level 1	Prerequisites - Required	Calculate, monitor and record CO_2 production, or measure energy efficiency.
Level 2	Prescriptive Measures - Good	Not applicable.
Level 3	Measurable Performance - Best	Develop or identify methods to track carbon. Or develop or identify metrics for comparing relative ship efficiencies (i.e. EEDI and EEOI).
Level 4	Zero Impact	Not applicable.

Section 3 Reduction of Air Emissions

PreAE Air Emissions General Prerequisites

In addition to the prerequisites for the individual credits, there also general category prerequisites that should be applied more broadly. These category prerequisites represent the minimum level of practice considered sufficient from an environmental standpoint.

Provide recommendations for these more broadly applied prerequisites, such as:

- Meet IMO Annex VI Recordkeeping Requirements.
- Obtain a Main/Propulsion Engine Manufacture Certificate of Compliance.
- Adhere to an IMO-Compliant Refrigerant Handling Program.

Note: Each prerequisite will be treated individually in the checklist.

Credit AE1 Nitrous Oxides (NO_x) Reductions

Nitrous oxides (NO_x) are a by-product of combustion. These emissions have been directly and indirectly linked to public health concerns particularly with respiratory disease.

Provide recommendations on how to reduce or eliminate NO_x emissions.

Level 1	Prerequisites - Required	Designate minimum emissions standard, such as MARPOL Annex VI with NO_x Technical Code for Ocean Going Vessels, EU Port Requirements, and US EPA requirements for inland and coastal craft. Consider broader geographic application beyond IMO requirements; e.g., not just in waters of Annex VI parties.
Level 2	Prescriptive Measures - Good	Identify applicable emissions level targets such as; MARPOL Annex VI Tiers, EU Port Requirements, or U.S. EPA requirements. Identify best practices and equipment that promises to reduce pollutant emissions, without significant impact on other emissions.
Level 3	Measurable Performance - Best	Identify or develop suitable measurement methods, considering continuous, source test sampling, and/or secondary indicators. Identify suitable units for measurement, such as grams per kilowatt-hour. Identify or develop metric for determining performance such as: annual emissions by weight or volume, emissions per vessel size, or emissions per engine size. Consider normalizing with CO_2 counting metrics.
Level 4	Zero Impact	Define zero NOx emissions, and identify methods of achieving zero emissions.

Credit AE2 Sulfur Oxides (SO_x) Reductions

Sulfur Oxides (SO_x) are a by-product of combustion and directly related to the amount of sulfur in the source fuel. These emissions have been directly and indirectly linked to public health concerns and degradation of the natural environment, with impacts ranging from respiratory disease to acid rain. SO_x emissions are primarily addressed by using low sulfur fuels and/or exhaust gas scrubbing systems.

Provide recommendations on how to reduce or eliminate SOx emissions.

Level 1	Prerequisites - Required	See Credit AE1
Level 2	Prescriptive Measures - Good	See Credit AE1
Level 3	Measurable Performance - Best	See Credit AE1
Level 4	Zero Impact	See Credit AE1

Credit AE3 Particulate Matter (PM) Reductions

Particulate matter (PM) is a by-product of combustion. These emissions have been directly and indirectly linked to public health concerns and degradation of the natural environment, with impacts ranging from respiratory disease to the "black carbon" fraction causing increased rate of polar ice melt. PM emissions solutions range from higher efficiency engines and filters, to using lower sulfur fuels.

Provide recommendations on how to reduce or eliminate PM emissions. Include consideration of various PM size and compound fractions.

Level 1	Prerequisites - Required	See Credit AE1
Level 2	Prescriptive Measures - Good	See Credit AE1
Level 3	Measurable Performance - Best	See Credit AE1
Level 4	Zero Impact	See Credit AE1

Credit AE4 Volatile Organic Compounds

Volatile Organic Compounds (VOC) emissions sources include: by-product of combustion particularly unburned fuel; off-gassing from vessel bunkers or hydrocarbon cargoes. These emissions have been directly and indirectly linked to public health concerns and degradation of the natural environment with impacts ranging from smog related respiratory disease to the VOC action as a greenhouse gas. VOC emissions solutions include higher efficiency combustion engines and vapor recovery systems on tank ships.

Provide recommendations on how to reduce or eliminate VOC emissions.

Note: VOC emissions from tank ship and tank barge cargoes are not considered in this credit.

Level 1	Prerequisites - Required	See Credit AE1
Level 2	Prescriptive Measures - Good	See Credit AE1

Level 3	Measurable Performance - Best	See Credit AE1
Level 4	Zero Impact	See Credit AE1

Credit AE5 Other Greenhouse Gases (GHGs)

There are other gases that have higher global warming potential (GWP) than CO_2, but are less common. The production of these gases should be reduced or eliminated from marine vessels.

Identify the top five other GHGs, determine if they are produced by marine vessels, and provide measures to reduce their production.

Note: The US EPA has produced a list of other green house gases: (http://www.epa.gov/Ozone/geninfo/gwps.html).

Level 1	Prerequisites - Required	Identify any regulations that may pertain to these gases.
Level 2	Prescriptive Measures - Good	Identify measures that reduce the production of other GHGs (methane, N_2O, sulfur hexafluoride, etc.) from marine vessels.
Level 3	Measurable Performance - Best	Identify or develop a method to quantify the production of other GHGs.
Level 4	Zero Impact	Define what constitutes zero GHG emissions and identify measures that eliminate the production of other GHGs (methane, N_2O, sulfur hexafluoride, etc) from marine vessels.

Credit AE6 Ozone Depleting Substances

Refrigerants, cleaners, and fire-suppressants should be free of ozone depleting substances (ODS). Ozone Depleting Potential (ODP) can also be limited.

Identify limited substances, including any that are identified to be phased out in the future, that are used on marine vessels.

Note: The US EPA has produced a list of ozone depleting substances, at http://www.epa.gov/Ozone/defns.html.

Level 1	Prerequisites - Required	Designate key standards which designate elimination of particularly harmful ODSs, such as CFCs, HCFCs, and Halons
Level 2	Prescriptive Measures - Good	Provide recommended alternatives, or designate other standards that may list alternatives, for use in refrigeration, cleaners, fire suppression systems, etc.
Level 3	Measurable Performance - Best	Identify or develop a method to measure the release of ozone depleting substances. This method should be related to volume discharged and ODP.
Level 4	Zero Impact	Define what constitutes zero ODS emissions and identify measures that eliminate the release of ODSs.

Credit AE7 Port Air Emissions Reduction

The impact of air emissions from marine vessels on public health has been found to be significantly influenced by proximity. When entering port areas, marine vessels are relatively close to shoreside industrial personnel and, typically, the general population.

In recognition of this proximity impact, efforts have been made to specifically reduce air emissions in port areas. These efforts have included: reducing loads wherever possible, shoreside electrification, selective use of low sulfur fuels, and capture and transfer of stack emissions with shoreside equipment.

Provide an assessment on how to reduce or eliminate emissions in port areas.

Note: Vessel speed reduction is addressed in another credit.

Note: Methods of measuring NO_x, SO_x, and PM emissions are covered in separate sub-credits. These methods should be used in this credit to measure effectiveness of in port solutions.

Note: It is noted that the transfer of power generation or emissions cleaning to shoreside defers the production of air emissions to the land based facility. However, this method would still reduce air emissions in the port and, conceivably, the land based power generation facility may be more able to scrub gases. Tracking of the emissions from the shoreside equipment is not covered by this credit.

Level 1	Prerequisites - Required	Designate relevant standards that reduce emissions related to primary strategies, such as shoreside electrification and low sulfur fuel standards.
Level 2	Prescriptive Measures - Good	Identify measures that effectively reduce port emissions. Identify metrics to determine which reduction strategies are practical for implementation.
Level 3	Measurable Performance - Best	Identify or develop a method to quantify the time in port, and the resulting emissions. Identify a boundary that defines when a vessel is considered in port.
Level 4	Zero Impact	Define zero impact. Identify possible solutions, such as capturing all gases or shoreside electrification. Consider system by system zero impact solutions, such as securing systems that are not required for in port operations.

Section 4 Reduction of Water Emissions

PreWE Water Emissions Category Prerequisites

In addition to the prerequisites for the individual credits, there also general category prerequisites that should be applied more broadly. These category prerequisites represent the minimum level of practice considered sufficient from an environmental standpoint.

Provide recommendations for these more broadly applied prerequisites, such as adherence to:

- Oily Waste Management Plan
- Ballast Management Plan
- Solid Waste Management Plan

Note: Each prerequisite will be treated individually in the checklist.

Level 1	Prerequisites - Required	Not applicable.
Level 2	Prescriptive Measures - Good	Identify category level prerequisites for Water Emissions, such as: • Oily Waste Management Plan • Ballast Management Plan • Solid Waste Management Plan
Level 3	Measurable Performance - Best	Not applicable.
Level 4	Zero Impact	Not applicable.

Credit WE1 Oily Water

Oily water sources include leaks from mechanical equipment and spills from oil based fuels and cargoes. Uncontrolled discharges have been directly and indirectly linked to degradation of the natural environment, with impacts ranging from discoloration of local waters to fouling of animals living in affected habitats. Oily water discharges are generally tightly controlled by the use of separating equipment and discharge monitoring equipment. Nonetheless, uncontrolled discharges continue to be detected in the industry. Additionally, technology and practices continue to develop that further limit or eliminate the amount of oil and contaminants in the controlled discharges.

Provide recommendations on how to reduce or eliminate oily water discharges.

Note: Compliance detection and enforcement, although having a significant impact on overall discharges, is not considered in this credit.

Note: This credit has been addressed in the Pilot Project; however, review by a Subject Matter Expert is encouraged.

Level 1	Prerequisites - Required	Designate relevant standards related to oily water discharge.
Level 2	Prescriptive Measures - Good	Identify measures that effectively reduce the production or discharge of oily water.

Level 3	Measurable Performance - Best	Identify or develop a method to quantify the amount of oil discharged. This should include both quality of the discharged water and the volume.
Level 4	Zero Impact	Define what constitutes zero oily water emissions and identify measures that eliminate the discharge of oily water into the ocean.

Credit WE2 Non-Indigenous Species Control

The transport of local ambient organisms and pathogens to another ecosystem poses a significant environmental and/or health threat when these non-indigenous species (NIS) establish themselves. Associated NIS environmental impacts can translate into significant economic impacts by destroying fisheries, degrading recreation areas, and fouling industrial piping systems.

Credit WE2.1 Ballast Water and Sediment

NIS may be introduced by means of the discharge of ballast water and the associated sediment load from the ballast water tanks. Ballast water management is currently shifting its approach, from one of operational practices to the use of ballast water treatment systems. Also notable is the general trend of cargo planning that results in no-discharge for certain vessel classes.

Provide recommendations on how to reduce or eliminate the ballast water and sediment NIS vector.

Note: This credit has been addressed in the Pilot Project; however, review by another Subject Matter Expert is encouraged.

Level 1	Prerequisites - Required	Designate relevant standards related to NIS control in ballast water and sediment.
Level 2	Prescriptive Measures - Good	Identify measures that effectively reduce the transfer of NIS through ballast water or sediment.
Level 3	Measurable Performance - Best	Develop or identify methods of quantifying propagule pressure of NIS through transfer by ballast water or sediment.
Level 4	Zero Impact	Define what constitutes zero impact and identify methods of eliminating the transfer of NIS by ballast water or sediment.

Credit WE2.2 Hull Fouling

NIS may be transported to another ecosystem by means of organisms living on a marine vessel hull, apertures, sea-chests, and other exterior locations. Current practice is to periodically clean the vessel exterior, typically to reduce drag or protect hull coating systems.

Provide recommendations on how to reduce or eliminate the hull fouling NIS vector.

Level 1	Prerequisites - Required	Designate relevant standards related to hull fouling, NIS control.
Level 2	Prescriptive Measures - Good	Identify measures that effectively reduce the transfer of NIS through hull fouling. Such as, hull coatings or maximum

		cleaning intervals.
Level 3	Measurable Performance - Best	Develop or identify methods of quantifying propagule pressure of NIS through transfer by hull fouling.
Level 4	Zero Impact	Identify methods of preventing transfer of NIS through hull fouling.

Credit WE3 Sanitary Systems

Sewage discharged to the sea can have environmental and health impacts. The goal is to improve the quality of the treated water being discharged, as well as to potentially reduce the amount of contaminated water being discharged.

Provide recommendations on how to minimize effluent discharges.

Level 1	Prerequisites - Required	Designate relevant standards.
Level 2	Prescriptive Measures - Good	Identify established best practices focused on reducing effluent discharge, such as: Alaska Compliant Sewage Treatment System, Grey Water Processing in Treatment System
Level 3	Measurable Performance - Best	Identify or develop a method of quantifying effluent discharged. The method should address quality of discharge as well as volume discharged.
Level 4	Zero Impact	Define what constitutes zero effluent emissions and identify measures that eliminate the discharge effluent into the ocean.

Credit WE4 Solid Waste

Reduce the waste being discharged to the water.

Provide recommendations on how to minimize solid waste discharges.

Level 1	Prerequisites - Required	Designate relevant standards and recordkeeping.
Level 2	Prescriptive Measures - Good	Identify methods of reducing solid waste discharged from marine vessels. Consider both upstream and downstream solutions such as: • Bring less aboard; i.e., buy in bulk to reduce packaging waste. • Trade off disposable items for re-usable and washable items. • Recycling. • Low emissions handling system.
Level 3	Measurable Performance - Best	Identify or develop a method of quantifying solid waste discharges. This method could be based on either weight or volumes recorded in the log.
Level 4	Zero Impact	No solid waste discharged to the water.

Credit WE5 Incidental Discharges

In addition to primary discharges such as oily water, ballast water, and sewage, there are incidental discharges that, when taken as a whole, may contribute a significant impact to the environment. Generally, these are the discharges identified in the US EPA Vessel General Permit program.

Provide recommendations on how to reduce or eliminate incidental discharges

Note: Key discharges are covered in other credits, but the incidental discharges are covered here in a comprehensive fashion.

Level 1	Prerequisites - Required	Designate relevant standards, including the EPA requirements.
Level 2	Prescriptive Measures - Good	Identify general design measures or practices that will reduce incidental discharges.
Level 3	Measurable Performance - Best	Identify or develop potential methods to quantify incidental discharges.
Level 4	Zero Impact	Identify discharges that can be eliminated through design or operational practices.

Credit WE6 Structural Protection of Oil

Structural protection of fuels and oils helps prevent the accidental outflow of oil in the water in the event of incident.

Provide recommendations on structural protection measures to prevent the accidental discharge of oil.

Level 1	Prerequisites - Required	Designate relevant standards related to structural oil protection, such as: MARPOL fuel tank protection, Lube oil tanks elevated greater than 2.5 ft above keel, etc.
Level 2	Prescriptive Measures - Good	Identify general design measures or practices that will reduce the accidental outflow of oil in the event of an incident, such as structural protection of fuel tanks, coamings, etc.
Level 3	Measurable Performance - Best	Not Applicable
Level 4	Zero Impact	Not Applicable

Section 5 General Measures

PreGM General Measure Category Prerequisites

In addition to the prerequisites for the individual credits, there are also general category prerequisites that should be applied more broadly. These category prerequisites represent the minimum level of practice considered sufficient from an environmental standpoint.

Provide recommendations for these more broadly applied prerequisites.

Note: Each prerequisite will be treated individually in the checklist.

Credit GM1 Materials

Due to their size, ships are material intensive. The burden on virgin material extraction can be reduced through the use of recycled materials and the reuse of items recovered from scrapped ships. The energy cost of transporting materials can be reduced by using local sources.

Provide recommendations on minimizing environmental impact of material use, through recycling, local sourcing, and other measures.

Note: This measure considers construction, refit, and maintenance materials. Consumables are covered in a separate credit.

Level 1	Prerequisites - Required	Designate relevant standards related to material use, including class society material requirements.
Level 2	Prescriptive Measures - Good	Identify materials that are available as recycled or reused. I.e. steel / aluminum, joiner panels, insulation, etc.
Level 3	Measurable Performance - Best	Identify or develop a method of quantifying recycled content. Consider including methods for quantifying for a specific material, as well as overall content.
Level 4	Zero Impact	Define what constitutes zero impact and identify methods of maximizing recycled content.

Credit GM2 Hotel Water Use: Reduction/Reuse/Recycle

Potable water is either produced on board, or stored in tanks sized for a voyage. Reducing the amount of water used per person not only reduces the energy used to produce or move that water, it also reduces the volume of gray and black water that requires processing and/or storage on board.

Provide recommendations on reducing water use per person.

Level 1	Prerequisites - Required	Designate relevant standards associated with water use aboard marine vessels.
Level 2	Prescriptive Measures - Good	Identify measures that can be used to reduce the use of potable water, such as low flow showers and sinks, low water use toilets, etc.
Level 3	Measurable Performance - Best	Identify or develop a method of quantifying potable water use, and an appropriate means to normalize the quantity; i.e., gallons per person per day.

Level 4	Zero Impact	As water will always be required, there is no zero use option. Identify any ways to eliminate potable water use in specific applications.

Credit GM3 Ocean Health and Aquatic Life

Credit 3.1 Lighting and Underwater Noise Aquatic Life Impact

Aquatic life is sensitive to noise and light from vessels and their eating, mating, and travel paths may all be affected by ship operations. Document what species will be in close proximity to the vessels route, assess emitted light and noise, and evaluate whether the species will be harmed.

Provide recommendations on how to reduce impacts on ocean health and marine life.

Level 1	Prerequisites - Required	Designate relevant standards related to the protection of aquatic life from marine vessel impacts.
Level 2	Prescriptive Measures - Good	Identify means of assessing impact on aquatic life as well as measures to reduce that impact.
Level 3	Measurable Performance - Best	An approach to quantify these improvements has not been identified and may be impractical.
Level 4	Zero Impact	Identify sensitive ocean locations that marine vessels should avoid if practical.

Credit 3.2 Wake Wash and Shore Protection

Some areas are more sensitive to others regarding wake wash and its impact on shore erosion. This evaluation will be route-specific, and mostly apply to vessels on a consistent route. Recommend an approach to assessing, and if necessary mitigating, the impact of a vessel's wake wash on shore.

Level 1	Prerequisites - Required	Designate relevant standards.
Level 2	Prescriptive Measures - Good	Identify any measures that can be used to reduce the impact on shore erosion.
Level 3	Measurable Performance - Best	Identify methods of undertaking an assessment of wake wash impacts and demonstrate that it meets local criteria.
Level 4	Zero Impact	Identify sensitive shore locations that marine vessels should avoid if practical.

Credit GM5 Hazardous Materials Control

There are at least three Passport type programs offered by the classification societies. They require that any material present on the ship that falls under the category of "hazardous" be inventoried for proper storing, handling, and recycling.

Assess whether or not reducing/limiting the quantities of some materials carried aboard is appropriate.

Level 1	Prerequisites - Required	Designate relative standards such as, Green passport notation

Level 2	Prescriptive Measures - Good	Recommend preferred storage options where appropriate
Level 3	Measurable Performance - Best	Identify or develop a method of quantifying the hazardous materials carried aboard. This quantity measure should be normalized relative to ship size.
Level 4	Zero Impact	Define what constitutes zero impact and identify methods of minimizing the hazardous material carried aboard.

Credit GM6 Ship Recycling

Ship recycling has come under more scrutiny in the past few years. The practice of safe and environmentally friendly recycling is encouraged.

Determine if the current or proposed conventions represent the current best practice.

Level 1	Prerequisites - Required	Designate relevant standards related to ship recycling environmental practices.
Level 2	Prescriptive Measures - Good	Identify measures that could be taken during design and construction that would assist in maximizing the recoverable material from marine vessels.
Level 3	Measurable Performance - Best	Not applicable.
Level 4	Zero Impact	Identify any materials or equipment that are likely to be re-used.

Appendix A – MVEP Assessment Guide, Template

MARINE VESSEL ENVIRONMENTAL PERFORMANCE ASSESSMENT GUIDE TEMPLATE

*****List Applicable Credit***

Prepared for

SNAME Technical, Research & Development Panel 19

Presented by

**List Credit Expert(s)

****List Date**
Revision:

Contents

Revision History

Section	Rev	Description	Date	Approved

References

List works cited or directly used in the development of the report. List non-referenced supplementary material in Section 8, Supporting Documents.

1.
2.

Section 1 Scope and Applicability

Scope of the Credit: Identify specific machinery and/or operations that are impacted.

Begin here.

Applicability: Identify specific limits such as tonnage, propulsion method, cargo type or mission, installed power, number of crew, vessel route or range, new construction or existing ship.

Begin here.

Section 2 Statement of the Problem

This section identifies the environmental impact addressed by this credit.

Address who and what is adversely affected by no-control, traditional, or non-environmentally friendly approaches including any: human and animal populations; geographical impact scale (local, oceanic, global, etc); dependencies on seasons, market, or natural resources; long term consequence if impact is not addressed.

Begin here.

Identify challenges to implementing control measures, including stakeholder impact and technology limitations.

Begin here.

Describe current technologies and/or practices, if any, which mitigate the problem.

Begin here.

Section 3 Performance Levels

This performance assessment guide should identify clear metrics to meet a specific performance level. These levels will define: minimum requirements, good practice, best practices, and zero impact.

The metrics for calculating a performance number, such as number of organisms discharged with ballast water, should be provided; however, this document should not specify the required value of that performance number.

This section will need to define the four performance levels for this credit. Background, detail calculations, and other justification information should be provided in Section 4.

3.1 Level 1 Prerequisites - Required

Specify the prerequisites required to reach a level of Standard Environmental Performance that is explicitly higher than simply meeting the minimum required applicable regulations for a given ship. All applicable IMO environmental regulations should be identified as prerequisites, regardless of ship type, location, or age, and include those future regulations with published implementation dates. Define vessel size limitations and applicability.

Begin here.

3.2 Level 2 Prescriptive Measures - Good

Describe prescriptive measures for Good Environmental Performance. These prescriptive measures should apply practical, proven technology that is currently and readily available to owners. Include a cost-benefit estimate, and highlight measures with low cost and high reward.

Begin here.

3.3 Level 3 Measurable Performance - Best

Identify performance based measures representing Best Environmental Performance. This performance based level is quantitatively assessed and allows for innovation beyond what is currently good environmental practice. Express this quantitative measurement in terms of either a hard limit or a percentage of improvement from a predefined baseline. The currently available measures described in Levels 1 and 2 build capability for achieving the performance criteria established in Level 3.

Begin here.

3.4 Level 4 Zero Impact

Identify performance measures with either zero or least possible impact on the environment, representing Zero Emissions Environmental Performance from ideal design elements or operational practices. Achieving this performance level may not be practical at the current time; consequently, technological or operational limitations and anticipated time scale to achieving zero emissions should be identified. Because MVEP is voluntary, it can ask for the absolute most from its ships.

Begin here.

Section 4 Level Justifications

This performance assessment guide is based on a combination of existing technology and practices, which have been identified in Section 3 as representing the four levels of practice: required, good, best, and zero impact. This section provides the justification for this definition. In particular, reference to exemplary marine vessels, technology, and practices identifies the cutting edge in sustainable design and operations.

4.1 Level 1 Prerequisites

Describe applicable rules and regulations, technology examples, operational practice examples, and/or case studies.

Begin here.

4.2 Level 2 Prescriptive Measures

Describe applicable rules and regulations, technology examples, operational practice examples, and/or case studies. Additionally, discuss the predicted efficacy of the prescribed measures.

Begin here.

4.3 Level 3 Measurable Performance

Provide performance measure formulation, including impact quantification, measurement units, and applicable standards.

Begin here.

4.4 Level 4 Zero Impact

Give an explanation of a zero impact solution. If there is no practical method to zero emissions at this time, explain the limitations and when a solution may be available.

Begin here.

Section 5 Regulatory Environment

Identify current, proposed, and anticipated regulations, rules, and standards that impact the credit being assessed. Additionally, provide a narrative of how this regulatory environment impacts typical operations.

Begin here.

Section 6 Directions for Future Research and Development

This section identifies future research and development which is recommended to: further develop MVEP performance assessments; assist the implementation of MVEP; and/or promote the development of new technology or practices which further the MVEP objective of minimizing marine vessel environmental impact.

***MVEP Performance Assessments**: Research and development that will provide additional tools and/or guidance for assessing environmental performance. This may include a forecast for new regulations, technology, or guidance that could suit a reevaluation of the performance levels.*

Begin here.

MVEP Implementation: Identify research and development which will assist the efficient implementation of the MVEP system. This may include development of suitable baselines to suit comparisons of Level 3 performance measures.

Begin here.

New Technology or Practices: Highlight promising technologies that are worthy of investment.

Begin here.

Section 7 Design Integration

Identify other credits or design elements that are either adversely or positively affected by efforts made toward achieving this credit. For example, is there increased energy, materials, or crew requirements? Do the prescriptive measures suggested above alleviate or incur other environmental impacts besides for just this credit?

Credit xyz

Consequence (+ / –)

Begin here.

Section 8 Supporting Documents

List additional documents that are relevant for understanding the credit. Actual works cited should be provided in the reference section.

Begin here.

Appendix B – MVEP Assessment Guide, HVAC Energy Load Reduction

MARINE VESSEL ENVIRONMENTAL PERFORMANCE ASSESSMENT GUIDE

EE1.2 Energy Optimization Measures: HVAC

Prepared for
SNAME Technical & Research Steering Committee

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29 January 2010
Rev. A

Contents

Revision History

Section	Rev	Description	Date	Approved

References

Works cited or directly used in the development of the report. Non-referenced supplementary material is listed in Section 8, Supporting Documents.

1. ISO 7547:2002 Ships and marine technology -- Air-conditioning and ventilation of accommodation spaces -- Design conditions and basis of calculations.
2. ISO 8861:1998 Shipbuilding -- Engine-room ventilation in diesel-engined ships -- Design requirements and basis of calculations.
3. ISO 8862:1987 Air-conditioning and ventilation of machinery control-rooms on board ships -- Design conditions and basis of calculations.
4. ISO 9099:1987 Air-conditioning and ventilation of dry provision rooms on board ships -- Design conditions and basis of calculations.
5. ISO 9785:2002 Ships and marine technology -- Ventilation of cargo spaces where vehicles with internal combustion engines are driven -- Calculation of theoretical total airflow required.
6. *Calculations for Merchant Ship Heating, Ventilation, and Air Conditioning Design*, T&R Bulletin 4-16, Ship Technical Operations Committee of the Society of Naval Architects and Marine Engineers, August 1980.
7. *Thermal Insulation Report*, T&R Bulletin 4-7, Ship Technical Operations Committee of the Society of Naval Architects and Marine Engineers, January 1974.

Section 1 Scope and Applicability

This guide is intended for use by Owners, Operators, Designers, and others as a means of assessing their HVAC efficiency efforts, as well as its effect on their overall environmental performance.

Scope of the credit: Specific machinery and/or operations that are impacted.

This guide provides recommendations to reduce the heating, ventilation, and air conditioning (HVAC) energy load on vessels.

To develop these recommendations, this guide considers the impact of mechanical systems on the ability to maintain suitable environment for equipment and personnel, including: natural ventilation ducting; powered ventilation ducting and air movers; heating and cooling equipment including chilled water and direct expansion; associated electrical and control systems.

Additionally, this guide considers the impact of operational practices on the ability to maintain suitable environment for equipment and personnel, including: turning off equipment when not required; modulating equipment performance based on environmental conditions; increasing energy efficiency.

Refrigeration loads are not considered in this guide.

Proper care and use of refrigerants are addressed in a separate guide, and not considered here.

The efficiency of piping systems, pumps, and other mechanical equipment is recognized to have significant impact on marine vessel power consumption. These are the subjects of separate guides, and not addressed here.

Applicability: Identify specific limits such as tonnage, propulsion method, cargo type or mission, installed power, number of crew, vessel route or range, new construction or existing ship.

These recommendations apply to all marine vessels.

Section 2 Statement of the Problem

This section identifies the environmental impact addressed by this credit.

Address who and what is adversely affected by no-control, traditional, or non-environmentally friendly approaches including any: human and animal populations; geographical impact scale (local, oceanic, global, etc); dependencies on seasons, market, or natural resources; long term consequence if impact is not addressed.

This guide addresses a means of reducing energy consumption. The consumption of energy, if fossil based, may lead to depletion of this natural resource while contributing to global warming and reducing local air quality.

Identify challenges to implementing control measures, including stakeholder impact and technology limitations.

HVAC systems are potentially a large portion of the energy demand on a vessel. HVAC systems serve accommodation areas, machinery spaces, and cargo holds. Variations in system demands in these areas significantly impact the energy required to properly condition them. HVAC systems are generally installed to ensure:

1. Comfort of the personnel aboard the ship.
2. Proper operation of shipboard equipment.
3. Maintenance of cargo.

At the most basic level, HVAC systems can be turned completely off and cut energy consumption to zero, but with potential severe consequences to persons, equipment, and cargo.

Additionally, HVAC systems are integral to firefighting systems and structural fire protection typically requiring large fire dampers at certain boundary locations.

Describe current technologies and/or practices, if any, which mitigate the problem.

Reducing HVAC energy load can be accomplished in multiple ways, including:

- Reduction of the heating and cooling demand.
- Improvement of HVAC system design methodologies.
- Intelligent control system technologies.
- Selection of high efficiency equipment.

Section 3 Performance Levels

This performance assessment guide should identify clear metrics to meet a specific performance level. These levels will define: minimum requirements, good practice, best practices, and zero impact.

The metrics for calculating a performance number, such as number of organisms discharged with ballast water, should be provided; however, this document should not specify the required value of that performance number.

This section will need to define the four performance levels for this credit. Background, detail calculations, and other justification information should be provided in Section 4.

Level 1 Prerequisites - Required

Specify the prerequisites required to reach a level of Standard Environmental Performance that is explicitly higher than simply meeting the minimum required applicable regulations for a given ship. All applicable IMO environmental regulations should be identified as prerequisites, regardless of ship type, location, or age, and include those future regulations with published implementation dates. Define vessel size limitations and applicability.

Marine vessels following this guide can meet performance Level 1 Prerequisites by implementing HVAC design standards such as those listed in the references section. These standards provide guidance for sound practice including reasonable design temperatures and ventilation rates. A system designed outside of sound practice could fail its mission requirement, or conversely burden the vessel with excess energy consumption.

This prerequisite applies to all additional levels of performance assessment, unless specifically noted.

Level 2 Prescriptive Measures - Good

Describe prescriptive measures for Good Environmental Performance. These prescriptive measures should apply practical, proven technology that is currently and readily available to owners. Include a cost-benefit estimate, and highlight measures with low cost and high reward.

Marine vessels that meet or exceed the applicable prescriptive measures herein are assessed as good environmental performers for HVAC. An applicability survey may be conducted to determine if the measures are both practical and effective. In the absence of a survey, the measures herein are considered applicable.

The following is a list of steps that can be taken during the design and construction of a ship to increase HVAC efficiency. This is done in one of two ways: by reducing the heating and cooling demand, and by reducing HVAC losses to the environment. HVAC can be reduced by using efficient components, waste heat utilization, natural ventilation, and intelligent control systems. Components can be integrated together in a holistic design approach to optimize the overall system.

Design Conditions

Design conditions such as assumed outside air temperature or required inside air temperature significantly drive HVAC energy loads. The standards used for system design should be revisited considering: expected operating environment; cargo requirements; equipment requirements; willingness of personnel to extend their comfort zone to reduce energy consumption.

Component Efficiency

Component efficiency can be increased by:

- Utilizing waste heat recovery to heat the vessel. This is the most efficient method to heat a vessel, as it only requires fuel for the circulating machinery.
- Recovering energy (heating or cooling) with a heat exchanger on exhaust air. Exhaust air preheats incoming air in the heating season and pre-cools incoming air in the cooling season. In vessels like cruise ships, owners may elect to reduce the impact of high makeup air quantities by employing this energy recovery method.
- Using high efficiency pumps, fans, electric motors, boilers, and other machinery depending on the type of HVAC system. High efficiency machinery lowers energy consumption across the board whenever the equipment is operating. The amount of impact on energy consumption is dependent on the type of HVAC system. Energy rated equipment is preferable when possible.

Intelligent Control System Technologies

Intelligent controls can dynamically reduce the HVAC load under conditions of a reduced need for heating or cooling that allows lower energy consumption. Some of these technologies include:

- Variable air volume ventilation. These systems reduce fan speed and delivered air volumes.
- Load sensing variable frequency driven machinery (dependent on type of HVAC system). These systems can reduce pump speed in hot water heating and/or chilled water air conditioning systems.
- Thermostatic setbacks. At periods of low compartment occupancy or night, the system will automatically reduce the load.

System Efficiency

System Efficiency can be increased by:

- Selecting ambient design conditions appropriate for the ships' geographic range at the preliminary design phase; e.g., reducing outdoor ambient and raising inside design temperature in summer and vice versa for winter. Ambient design conditions can potentially be the largest determining factor in heating and air conditioning equipment sizing. ASHRAE has applicable geography dependent criteria.
- Limiting electric resistance heating, unless electricity is generated by energy recovery. Electric resistance heating with power generated by a diesel generator is the lowest efficiency method of heating a ship, with thermal efficiencies on the order of 40%. Oil fired heating machinery is typically about 80% efficient.

HVAC Losses

HVAC losses can be reduced by:

- Providing at least 3" of thermal insulation on air conditioned boundaries (include a 1-1/2" beam wrap on stiffeners). Acoustic and structural fire protection insulation would contribute toward this value.
- Implementing energy conservation ratings equivalent to commercial buildings to minimize heat gain and loss on all windows and glass on air conditioned boundaries. The September, 2009 US Federal Government Tax Credits require a U-factor of less than 0.30 and SHGC of less than 0.30.

Minimum Indoor Air Quality

Makeup air quantities have a significant impact on the overall energy consumption of an HVAC system. Cruise ships and other high density passenger vessels often use 100% makeup systems to ensure good indoor air quality. Shore side energy codes have been reducing makeup air quantities dramatically to reduce energy consumption. The pursuit of energy efficiency must not come at the cost of an unhealthy air quality. Maintain the minimum indoor air quality (i.e., limit amount of makeup air) necessary to comply with ASHRAE recommendations.

Arrangement Integration

- Where possible in a space with a high HVAC load, use a sub-floor to pump air up from the bottom for rooms with high equipment loads: “galleys, pantries, laundries, radio rooms, wheelhouses, resistor houses, deck machinery compartments, and specialized spaces such as computer rooms or engine control rooms.” (Reference 7)
- When it is predictable and reliable, take advantage of apparent wind for ventilation. Use internal arrangements / structures to direct the flow. Use natural circulation to vent spaces rather than pumping air out.
- Reduce HVAC load by choosing equipment that does not excessively emit wasted heat.
- To reduce solar radiation gain, use a light color paint on the house and superstructure.

Level 3 Measurable Performance - Best

Identify performance based measures representing Best Environmental Performance. This performance based level is quantitatively assessed and allows for innovation beyond what is currently good environmental practice. Express this quantitative measurement in terms of either a hard limit or a percentage of improvement from a predefined baseline. The currently available measures described in Levels 1 and 2 build capability for achieving the performance criteria established in Level 3.

Marine vessels may be assessed as best environmental performers by:

- Determining the marine vessel HVAC energy consumption, and

- Participating in a third party program that ranks the calculated value against some baseline.

The HVAC energy consumption can be determined by means of an energy audit. Alternatively, monitoring systems can be utilized to automatically track the total energy consumption of the HVAC systems.

Level 4 Zero Impact

Identify performance measures with either zero or least possible impact on the environment, representing Zero Emissions Environmental Performance from ideal design elements or operational practices. Achieving this performance level may not be practical at the current time; consequently, technological or operational limitations and anticipated time scale to achieving zero emissions should be identified. Because MVEP is voluntary, it can ask for the absolute most from its ships.

Marine vessels may be assessed as having zero impact on the environment for HVAC by eliminating all powered HVAC equipment. Practically, this will be a significant challenge as marine vessels typically endure severe climates, large energy consumers, and demands for passenger and crew comfort.

However, zero impact is practical for select spaces on most vessels. This includes the use of natural ventilation where allowed by regulation in lockers and machinery spaces. Additionally, it is possible to secure ventilation to certain spaces when either unoccupied or when associated equipment is not used.

Section 4 Level Justifications

This performance assessment guide is based on a combination of existing technology and practices, which have been identified in Section 3 as representing the four levels of practice: required, good, best, and zero impact. This section provides the justification for this definition. In particular, reference to exemplary marine vessels, technology, and practices identifies the cutting edge in sustainable design and operations.

Level 1 Prerequisites

Describe applicable rules and regulations, technology examples, operational practice examples, and/or case studies.

The recommended standards have been in use for an extended period, providing adequate HVAC for personnel, equipment, and cargo.

Level 2 Prescriptive Measures

Describe applicable rules and regulations, technology examples, operational practice examples, and/or case studies. Additionally, discuss the predicted efficacy of the prescribed measures.

The measures chosen have demonstrated reliable gains in energy efficiency. Many can also be applied to existing vessels. This is not presented as an exhaustive list, but as highlights of the measures giving the greatest benefit and value.

Level 3 Measurable Performance

Provide performance measure formulation, including impact quantification, measurement units, and applicable standards.

Energy audits are commonplace in shoreside industrial plants, including HVAC systems.

Level 4 Zero Impact

Give an explanation of a zero impact solution. If there is no practical method to zero emissions at this time, explain the limitations and when a solution may be available.

Crew and tug boats in temperate climates are examples of marine vessels which utilize no active ventilation. Further, this basic concept of natural ventilation was once commonplace with the use of air-scoops for machinery and accommodation space ventilation. While attaining 100% reduction ship-wide is challenging, gaining a 100% reduction in a few select areas is a reasonable objective.

Section 5 Regulatory Environment

Identify current, proposed, and anticipated regulations, rules, and standards that impact the credit being assessed. Additionally, provide a narrative of how this regulatory environment impacts typical operations.

There are significant marine vessel regulations concerning fire and flooding protection of HVAC systems, principally documented in the Safety of Life at Sea (SOLAS). Additionally, there are limited requirements by certain administrations (such as the U.S. Coast Guard) which require minimum ventilation rates for crew comfort and health.

There are no energy efficiency requirements for marine vessels.

Section 6 Directions for Future Research and Development

This section identifies future research and development which is recommended to: further develop MVEP performance assessments; assist the implementation of MVEP; and/or promote the development of new technology or practices which further the MVEP objective of minimizing marine vessel environmental impact.

***MVEP Performance Assessments**: Research and development that will provide additional tools and/or guidance for assessing environmental performance. This may include a forecast for new regulations, technology, or guidance that could suit a reevaluation of the performance levels.*

It is recommended that this Guide be provided to stakeholders for review and comment before release for use.

It is recommended that the Level 2 prescriptive measures be expanded to further consider innovations from shoreside standards and guidelines such as ASHRAE and the UBC (Uniform Building Code).

It is recommended that the Level 2 prescriptive measures be expanded to designate suitable design conditions. Some considerations include: Indoor design parameters, such as interior temperature and humidity, vary by vessel type. While an interior design temperature of 78°F might be perfectly acceptable on a work boat or container ship in an air conditioning environment, any temperature above 70°F might be unacceptable on a passenger ferry or cruise ship. HVAC design parameters, such as outdoor ambient conditions, vary geographically. Vessels designed for service only in Alaskan waters, for example, will definitely have a heating system, but may forego an air conditioning system. Similarly, vessels only designed to operate in Hawaiian water may forego a heating system but have an air conditioning system. Consequently, a single set of design requirements is not practical.

It is recommended to develop the Level 3 measurement methods. This should include an energy audit means, as well as an automation option. Some considerations include:

- HVAC systems are comprised of pumps, fans, compressors, duct heaters, humidifiers, boilers, heat exchangers, and the controls that support this machinery and equipment. Measuring the actual amount of energy consumed by the entire HVAC system is going to require additional monitoring equipment. It is going to be easiest to use a computer or PLC-based monitoring and data logging system for this task. While almost all modern ships have computer based monitoring systems, they typically are not monitoring HVAC energy consumption.
- For existing ships with HVAC loads spread across the entire electrical system and several potential direct fuel consumers, retrofitting these monitoring points could be a significant investment. For new ships, it would be easier to design for the implementation of such a monitoring system by grouping HVAC loads into more easily monitored subsets.
- Special logging software and hardware is also going to be required.

***MVP Implementation**. Research and development which will assist the efficient implementation of the MVP system. This may include development of suitable baselines to suit comparisons of Level 3 performance measures.*

Improved performance may be defined with respect to the ship's own prior performance or with respect to a peer group of comparable ships. Certain peer groups may grade performance by normalizing the absolute measure to ship service. For example, a larger ship carrying four times more ventilated cargo space than a small ship should not be penalized for discharging twice as much energy load as the small ship. Establishing a peer group and calculating their aggregate performance is not handled in this report. Future MVP development should define a baseline for calculating improvement of new ships with no track record. Either a baseline with a threshold for percent improvement or an absolute threshold will need to be determined to assess best performance.

New Technology or Practices: Highlight promising technologies that are worthy of investment.

No recommendations at this time.

Section 7 Design Integration

Identify other credits or design elements that are either adversely or positively affected by efforts made toward achieving this credit. For example, is there increased energy, materials, or crew requirements? Do the prescriptive measures suggested above alleviate or incur other environmental impacts besides for just this credit?

Credit xyz

Consequence (+ / –)

This guide encourages HVAC design and operational solutions to reduce a marine vessel's environmental impact. However, resulting solutions may have "knock-on" impacts that increase a marine vessel's impact in other areas. The following impacts should be considered:

- Energy usage for HVAC is closely tied to arrangements. From the early design stage, arrangements should be planned to take advantage of integral heat and cooling solutions. Reduce transmission load by separating spaces with larger ΔT. A distributed supply system with more, but smaller, sources can be more efficient that a plant with fewer more powerful ones. By locating source and target closer together, frictional losses are minimized.
- Hotel loads (including HVAC) may be supported by shore-side power in port if shoreside electrification is used. Energy gains in HVAC should be viewed within the larger context of the ship's efficiency. In practice, performance is measured through fuel consumption and in turn through fuel cost with all the other energy loads.

Section 8 Supporting Documents

List additional documents that are relevant for understanding the credit. Actual works cited should be provided in the reference section.

1. "Climatic Design Information," *ASHRAE Handbook*, American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc., Chapter 28, 2005.
2. *Federal Tax Credits for Energy Efficiency*, Energy Star, United States Environmental Protection Agency and United States Department of Energy, http://www.energystar.gov/index.cfm?c=tax_credits.tx_index#c1, updated 14 September 2009.

Appendix C – MVEP Assessment Guide, Non-Indigenous Species Control, Ballast Water Management

MARINE VESSEL ENVIRONMENTAL PERFORMANCE ASSESSMENT GUIDE

WE2.1 Non-Indigenous Species Control: Ballast Water and Sediment

Prepared for:
SNAME Technical & Research Steering Committee

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29 January 2010
Rev. A

Contents

Revision History

Section	Rev	Description	Date	Approved

References

List works cited or directly used in the development of the report. List non-referenced supplementary material in Section 8, Supporting Documents.

1. *International Convention for the Control and Management of Ships' Ballast Water and Sediments,* International Maritime Organization, Ballast Convention, 2004.
2. *Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters*, Draft, United States Coast Guard, Department of Homeland Security, 33CFR Part 151, 46 CFR Part 162, United States Federal Register, Volume 76, No. 166, 28 August 2009.
3. Dobroski, Scianni, Gehringer and Falkner, *2009 Assessment of the Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for use in California Waters*, California State Lands Commission, January 2009.
4. *USCG Proposed Rules for Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters,* United Stated Coast Guard, Proposed Rule and Notice, 28 August 2009.
5. *Ballast Water Management in Washington State: A report of the State Ballast Water Work Group to the 2007 Regular Session of the Washington State Legislation*, Puget Sound Action Team – Office of the Governor, State of Washington, March 2007.
6. Kotinis, M. and Parsons, M. G., "Hydrodynamic Optimization of the Ballast-Free Ship Concept," *Transactions,* SNAME, 115, 2007.
7. *TOTE Ships – Orca Class*, Totem Ocean Trailer Express, Inc., Manufacturer Specification, http://www.totemocean.com/ts-ships.htm, November 2009.
8. *IUCN Marine Ecoregions of the World*, as published in the journal BioScience, 2007, Vol. 57 No. 7.
9. *Ballast Water Treatment Technology Current Status*, Lloyd's Register, September 2008.
10. Dobroski, N., Takata, L., Scianni, C, and Falkner, M.; *Assessment of the Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for use in California Waters*, California State Legislature, December 2007.
11. *Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (VGP)*, United States Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES), effective 19 December 2008.
12. *U.S. Coast Guard Draft Programmatic Environmental Impact Statement for Standards for Living Organisms in Ship's Ballast Water Discharged in U.S. Waters*, U.S. Coast Guard, DOT Document No. USCG-2001-10486, 28 August 2009.
13. *Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters*, Department of Homeland Security, Federal Register, Proposed Rules, Vol. 74, No. 166, 28 August 2009

Section 1 Scope and Applicability

This guide is intended for use by Owners, Operators, Designers, and others as a means of assessing their ballast water and sediment management efforts, as well as its effect on their overall environmental performance.

Scope of the Credit: Identify specific machinery and/or operations that are impacted.

This guide provides recommendations for ballast water and sediment management (BWM) that minimize or eliminate the introduction of non-indigenous species (NIS) and harmful pathogens into aquatic ecosystems.

To develop these recommendations, this guide considers the impact of mechanical systems on the efficacy, toxicity, and recordkeeping of BWM, including: ballast water treatment systems; cleaning and disposal of sediment from ballast water tanks; sea chests, overboard, and piping systems; tank arrangements and structure; electrical and control systems. The impact of this equipment on energy consumption is not considered in this guide.

This guide considers the impact of operational practices and recordkeeping of BWM, including: uptake procedures; discharge procedures; ballast water exchange procedures; sediment disposal logs; management plans, logs, and reports.

Hull fouling is recognized as a significant marine vessel NIS vector. This is the subject of a separate guide, and not addressed here.

Mechanical systems and operational practices have significant impact on marine vessel power consumption. These are the subjects of separate guides, and not addressed here.

Applicability: Identify specific limits such as tonnage, propulsion method, cargo type or mission, installed power, number of crew, vessel route or range, new construction or existing ship.

This guide applies to all marine vessels that carry ballast water.

Ballast water exchange, treatment practices, and timetables apply to marine vessels that transit between the more restrictive of different marine ecoregions in accordance with *IUCN Marine Ecoregions of the World*, or in accordance with the regulatory authority where the ballast water is to be discharged.

This guide does not supersede any applicable international, federal, regional, or local requirements, guidelines, or voluntary programs.

Section 2 Statement of the Problem

This section identifies the environmental impact addressed by this credit.

Address who and what is adversely affected by no-control, traditional, or non-environmentally friendly approaches including any: human and animal populations; geographical impact scale (local, oceanic, global, etc); dependencies on seasons, market, or natural resources; long term consequence if impact is not addressed.

The local ambient organisms and pathogens present in ballast water intake may pose a significant environmental and/or health threat if transported and discharged to another ecosystem. Additionally, these environmental impacts translate into a significant economic impact, which has been quantified as follows:

> *Based on the cumulative impacts of invasions, we have calculated a mid-range estimate of annual costs for all harmful ballast water-introduced invasions over the 10 year period of 2012 to 2021 at $2.016 billion at 7 percent discount rate.*
>
> *United States Federal Register 2009 (Reference 2)*

Identify challenges to implementing control measures, including stakeholder impact and technology limitations.

Marine vessel ballast water operations are fully integrated into marine vessel design, operations, and safety systems. Ballast water is shifted, taken up, or discharged to control trim, list, draft, stability, and hull stresses. Ballast operations are optimized to support logistics, and require precise calculation and planning based on approved methods to account for consumed fuel, discharged cargo, or environmental changes such as rough weather. Sediment which collects in ballast tanks over time is cleaned out periodically: if the weight is impacting vessel cargo carrying capacity; or if required to suit structural inspections or repair.

At least one jurisdiction, State of California, has identified in regulation the objective of discharges containing no viable organisms or pathogens. The less restrictive *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (Ballast Convention) Regulation D-2 and companion *Guidelines for Approval of Ballast Water Management Systems* (G8) allow removal of organisms to a zooplankton standard 1,000 times less efficient for approval of BWM treatment systems.

Meeting these standards requires either: a change in operational practices, if possible, to not discharge ballast water; or installation and use of a treatment system that typically includes filtering and disinfection steps. Treatment systems present significant challenges, as: machinery spaces are already optimized for other purposes; filter backpressures can significantly slow ballasting rates, which can increase a vessels time in port; disinfection producing equipment can increase energy demand on electrical plants, which might not have adequate margin for new large power consumers; disinfection chemicals in bulk require transfer and storage systems with consideration of risks to personnel safety.

New recordkeeping requirements and additional operational and maintenance tasks present an additional burden on crews. Modern shipping trends have reduced crew sizes, while increasing workloads from new environmental and safety requirements, these changes make the burden of new requirements more difficult.

Describe current technologies and/or practices, if any, which mitigate the problem.

BWM is currently shifting its approach, from one of operational practices to the use of ballast water treatment systems. Also notable is the general trend of cargo planning that results in no-discharge for certain vessel classes.

International BWM practices are outlined in the Ballast Convention. Other federal and regional jurisdictions require similar practices. BWM practices include: avoidance of high concentrations of organisms or pathogens when taking up ballast water; the flushing of ballast tanks with deep ocean seawater with an assumed low organism loading; removal and disposal of sediment; development and maintenance of management plans, logs, and reports.

There are multiple ballast water treatment systems which have gain Type Approval status. Type Approval is issued by an Administration, and documents that the system is seaworthy and meets international efficacy and toxicity requirements. Additionally, an assessment by the State of California indicates that a small number of systems may be capable of meeting its significantly more restrictive discharge requirements. Despite recent approval activity, installations of treatment equipment have not been widespread.

Section 3 Performance Levels

This performance assessment guide should identify clear metrics to meet a specific performance level. These levels will define: minimum requirements, good practice, best practices, and zero impact.

The metrics for calculating a performance number, such as number of organisms discharged with ballast water, should be provided; however, this document should not specify the required value of that performance number.

This section will need to define the four performance levels for this credit. Background, detail calculations, and other justification information should be provided in Section 4.

3.1 Level 1 Prerequisites - Required

Specify the prerequisites required to reach a level of Standard Environmental Performance that is explicitly higher than simply meeting the minimum required applicable regulations for a given ship. All applicable IMO environmental regulations should be identified as prerequisites, regardless of ship type, location, or age, and include those future regulations with published implementation dates. Define vessel size limitations and applicability.

Marine vessels following this guide can meet performance Level 1 Prerequisites by meeting the requirements and timelines established in the Ballast Convention, including the expanded geographic areas and vessel applications detailed in Section 1 of this guide, *Scope and Applicability*.

In general, the Ballast Convention requires:

- Execution of certain management and controls such as: a management plan and record book; disposal of sediments; ballast water exchange and treatment in accordance with a prescribed timetable and specific standards (Sections B and D).
- Adherence with special requirements in certain areas, such as: following additional measures required by local and regional authorities; following specific warnings regarding site-specific hazards such as sewage outfalls (Section C).
- Perform and support survey and certification requirements for ballast water management such as: regulatory review of plans and logs; surveys of installed equipment in accordance with prescribed timetables; maintenance of prescribed certificates (Section E).

These prerequisites apply to all additional levels of performance assessment, unless specifically noted.

3.2 Level 2 Prescriptive Measures - Good

Describe prescriptive measures for Good Environmental Performance. These prescriptive measures should apply practical, proven technology that is currently and readily available to owners. Include a cost-benefit estimate, and highlight measures with low cost and high reward.

Marine vessels that meet or exceed the applicable prescriptive measures herein are assessed as good environmental performers for ballast water management. An applicability survey may be conducted to determine if the measures are both practical and effective. In the absence of a survey, the measures herein are considered applicable.

Prescriptive measure: Develop, execute, and document a ballast water plan in which all near land discharges meet or exceed the standard described in Table 1. Near land is considered within 50 nautical miles of nearest land or marine sanctuary for vessels on coastal voyages in which the marine vessel is always within 200 nautical miles of nearest land; and 200 nautical miles for oceanic voyages.

Table 1: California Marine Invasive Species Act – Interim Standard

Organism Size Class	Discharge Density Standard: Number and Type of Allowed Discharge	Per Volume
> 50 µm	No detectable living organisms	cubic meter
10 to 50 µm	< 1 living organisms	100 mL
< 10 µm	< 10^3 Bacteria	100 mL
	< 10^4 Viruses	
	< 126 Colony Forming Units (CFU) of E. Coli	
	< 33 CFU of Intestinal enterococci	
	< 1 CFU of Toxicogenic Vibrio cholerae	

Prescriptive measure: Develop, execute, and document a sediment management plan which at a minimum meets the Ballast Convention requirements.

3.3 Level 3 Measurable Performance - Best

Identify performance based measures representing Best Environmental Performance. This performance based level is quantitatively assessed and allows for innovation beyond what is currently good environmental practice. Express this quantitative measurement in terms of either a hard limit or a percentage of improvement from a predefined baseline. The currently available measures described in Levels 1 and 2 build capability for achieving the performance criteria established in Level 3.

Marine vessels may be assessed as best environmental performers for ballast water management by:

- Determining the marine vessel contribution to NIS propagule pressure, and
- Participating in a third party program that ranks the calculated propagule pressure against some baseline.

This guide provides the method to determine propagule pressure, as below. It does not, however, provide any baseline from which to compare that number.

Propagule pressure is a primary factor in the success of a non-indigenous species in invading a new habitat. This factor considers the total number of non-indigenous organisms introduced, and the frequency of introductions. Thus, propagule pressure of ballast water considers both the quantity and quality of the discharge. Quantity is tracked through ballast water logs in cubic meters annually. Quality is determined by ballast water management to one of four levels:

T1. No Management. (Discharging untreated ballast water.)

T2. Exchange. Ballast water exchange in accordance with Regulation D-1 of the Ballast Convention.

T3. Treatment – D2: Ballast water treatment in accordance with Regulation D-2 of the Ballast Convention.

T4. Treatment – CA: Ballast water treatment in accordance with the California Marine Invasive Species Act Interim Standard (Table 1).

Equation 1 provides a numerical equivalent of propagule pressure, wherein a number of 0 would indicate no pressure and best practice.

$$p = V_1T_1 + V_2T_2 + V_3T_3 + V_4T_4 \qquad (1)$$

Where:

p = Propagule pressure numerical equivalent (no units)

V_1 = Volume of water discharged without treatment or exchange (m^3)

V_2 = Volume of water discharged that had been exchanged (m^3)

V_3 = Volume of water discharged that had been treated to IMO levels (m^3)

V_4 = Volume of water discharged that had been treated to California levels (m^3)

T_1 = 100

T_2 = 84

T_3 = 48

T_4 = 12

3.4 Level 4 Zero Impact

Identify performance based measures representing Best Environmental Performance. This performance based level is quantitatively assessed and allows for innovation beyond what is currently good environmental practice. Express this quantitative measurement in terms of either a hard limit or a percentage of improvement from a predefined baseline. The currently available measures described in Levels 1 and 2 build capability for achieving the performance criteria established in Level 3.

Marine vessels may be assessed as having zero impact on the environment for BWM by eliminating ballast water and sediment discharges within 200 nautical miles of any coastline.

Section 4 Level Justifications

This performance assessment guide is based on a combination of existing technology and practices, which have been identified in Section 3 as representing the four levels of practice: required, good, best, and zero impact. This section provides the justification for this definition. In particular, reference to exemplary marine vessels, technology, and practices identifies the cutting edge in sustainable design and operations.

4.1 Level 1 Prerequisites

Describe applicable rules and regulations, technology examples, operational practice examples, and/or case studies.

The non-treatment components of the Ballast Convention are commonly held as good practice and practical. Most of the components of this 2004 document built upon the generally accepted 1997 Resolution A868(20), *Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens*.

It is generally accepted that ballast water treatment systems meeting the Ballast Convention are currently available in limited numbers. As of November 2009, six systems had received Type Approval, with an additional six having received Final Approval from the IMO and currently waiting for the Administration issuance of Type Approval status. The primary hurdle for treatment systems is that the Ballast Convention is not yet ratified. This lack of ratification is resulting in owners taking a "wait and see" approach. This is likely to continue adjusting the implementation timeline.

4.2 Level 2 Prescriptive Measures

Describe applicable rules and regulations, technology examples, operational practice examples, and/or case studies. Additionally, discuss the predicted efficacy of the prescribed measures.

The State of California has determined that a ballast water treatment standard roughly two orders of magnitude greater than the Ballast Convention Standard is feasible as listed in Table 1. Subsequently, the United States Coast Guard (USCG) proposed the same standard for adoption by marine vessels, as the second of its two-phase standard, to meet the California treatment standard.

USCG released *Draft Programmatic Environmental Impact Statement for Standard for Living Organisms in Ship's Ballast Water Discharged in U.S. Waters* (EIS) in August of 2009. This document states: "Alternative 4 could be 85% more effective than BWE and 100% more effective than unmanaged ballast water discharge in preventing the probability of biological invasions indicates that this higher standard is more effective." Alternative 4 is one order of magnitude less stringent than Table 1; as such, the USCG estimates are conservative. (Note: BWE refers to ballast water exchange.)

4.3 Level 3 Measurable Performance

Provide performance measure formulation, including impact quantification, measurement units, and applicable standards.

The benefit of treating ballast water to a very low density of organisms can be lost due to greater volumes of discharge. Therefore to meet the higher performance level, the volume of ballast water discharge must be evaluated in addition to the impact per volume. The absolute performance measure sums the product of annual discharged volume V in cubic meters and the treatment impact factor T of the 4 levels.

Relative percent effective measures, shown below, are found from the USCG EIS Table 5-9, "Comparison of the Relative Effectiveness of Alternatives from Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters" (Reference 4). The first row can be read as "The Alt 2 standard is 52% more effective than No BWM and is 37% more effective that BWE." No BWM is MVEP Level 1; BWE is Level 2. Alternative 2 is equivalent to *IMO Regulation D-2*, or treatment Level 3. Alternative 3 is not used. Alternative 4 is a conservative estimate of the efficacy of treatment Level 4, the California standard as the standard for USCG Alternative 4, which allows more organisms in the > 50 microns and in the 10 to 50 microns size classes. The relationship between no BWM and treatment Levels 2, 3, and 4 is derived assuming Ne = 1.

Table 2: Comparison of the Relative Effectiveness of Alternatives from Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters

	Ne = 1		MVP Treatment Level
	No BWM (percent)	BWE (percent)	
Alt 2	52	37	3
Alt 3	73	64	n/a
Alt 4	88	85	4

The percent greater effectiveness of BWE over No BWM is found to be 16% by Equation 2, as follows:

$$\frac{BWE}{NoBWM} = \frac{{}^{Alt2}\!/\!{}_{NoBWM} - {}^{Alt2}\!/\!{}_{BWE}}{100 - {}^{Alt2}\!/\!{}_{NoBWM}} \times {}^{Alt2}\!/\!{}_{NoBWM} = \frac{52-37}{100-52} \times 52 = 16 \qquad (2)$$

The impact factor is found by subtracting the relative effectiveness from 100, Table 3.

Table 3: Impact Factors for treatment levels determining best practice

Treatment	MVP Treatment Level	USCG Relative Effectiveness over No BWM	MVP Impact Factor, T
No BWM	1	0	100
BWE	2	16	84
IMO	3	52	48
California	4	88	12

Table 4: Ballast Convention D-2 and State of California Discharge Density Standards

		Discharge Density Standard		
Size Class	Organism	3. IMO Reg D-2	4. California	Per Volume
> 50 µm		< 10 organisms	0 ~ No Detectable	cubic meter
10 < Size < 50 µm	All	< 1000	< 1 organism	100 mL
< 10 µm	Bacteria	n/a	< 10^3 Bacteria	100 mL
	Viruses	n/a	< 10^4 Viruses	
	E. Coli	< 250 CFU	< 126 CFU	
	Intestinal enterocci	< 100 CFU	< 33 CFU	
	Vibrio cholerae	< 1 CFU	< 1 CFU	

4.4 Level 4 Zero Impact

Give an explanation of a zero impact solution. If there is no practical method to zero emissions at this time, explain the limitations and when a solution may be available.

Certain vessel classes have been able to significantly reduce or even eliminate their need to discharge ballast water within 200 nautical miles of coastlines. This has been accomplished through careful cargo planning, and sometimes in combination with designs that use permanently enclosed ballast water systems.

These systems have been widely implemented in the container fleets entering Puget Sound in Washington State. Novel approaches include the “ballast-free ship concept” (Kotinis and Parsons, Reference 6), which is designed to have zero impact by continuously flowing local water through ballast trunks. Another is the TOTE Orca Class ships’ ballast system, which is comprised of fully internal moving ballast within the ship that eliminates the need to discharge.

Section 5 Regulatory Environment

Identify current, proposed, and anticipated regulations, rules, and standards that impact the credit being assessed. Additionally, provide a narrative of how this regulatory environment impacts typical operations.

The regulatory environment for ballast water management is Balkanized with overlapping and sometimes conflicting international, federal, regional, and local requirements. These various regulations generally cover a combination of reporting, recordkeeping, management plan requirements, uptake and discharge best practices, exchange requirements, treatment requirements, phase-in schedules, and emergency treatment requirements (such as chlorine for cholera treatment in Argentina). Table 5 provides a partial overview of this complex regulatory regime.

Shipping companies have generally campaigned for a uniform set of regulations to avoid confusion, and competitive advantages based on environmental requirements. However, best practice is sometimes defined by the specific ecological nature, such as tidal flows or native species habitat, of the local environment.

Testing requirements and approval processes for ballast treatment systems are subject to competing requirements from IMO, USCG, and the State of California.

There is no clear path to simplifying ballast water management requirements.

Table 5: Jurisdictional Management Practices

JURISDICTIONS	MANAGEMENT PRACTICE											
	Enforced Ballast Management Regulations	Proposed Ballast Management Regulations	Regulations (Enforced or Proposed) Under Review	Provides Ballast Management Guidelines	Possible Location of Geographic "Special Area"	Has Unique Ballast Exchange Requirements	Jurisdiction Specific Ballast Log or Report	Requires Maintenance of Ballast Log	Requires Submission of Ballast Report to Jurisdiction	Requires Ballast Management Plan	Proposed or Enacted Ballast Treatment Timeline	Proposed or Enacted Ballast Treatment Standard
International (IMO)		x	x	x	x	x	x	x		x	x	x
Argentina	x			x	x	x	x	x	x	x		x
Australia	x			x	x	x	x	x	x	x		
Australia - Victoria	x			x	x	x	x	x	x	x		
Baltic Sea					x							
Black Sea					x							
Brazil	x			x	x	x	x	x	x	x		
Canada - British Columbia	x			x	x				x	x		
Canada - Great Lakes	x		x	x	x	x	x		x	x		
Chile	x				x	x		x	x			
Croatia	x				x	x	x	x	x			
Israel	x			x	x	x	x	x	x	x		
Mediterranean Sea					x							
New Zealand	x			x	x	x	x	x	x	x		
Panama	x				x							
Peru	x			x	x	x	x		x			
Russian - Novorossiysk	x			x	x	x						
Ukraine	x				x	x		x				
Saint Lawrence Seaway	x		x	x	x	x	x		x	x		
United States - California	x		x	x	x	x	x	x	x	x	x	x
United States - Alaska			x		x							
United States - General	x	x	x	x	x	x	x		x	x	x	x
United States - Great Lakes	x	x	x	x	x	x	x		x	x	x	x
United States - Hawaii	x				x	x			x			
United States - Maryland	x								x	x		
United States - Michigan	x		x	x	x		x	x	x	x	x	x
United States - Oregon	x				x	x						
United States - Virginia	x				x				x			
United States - Washington	x	x	x	x	x	x	x		x	x	x	x
Uruguay	x			x	x	x		x				x

Section 6 Directions for Future Research and Development

This section identifies future research and development which is recommended to: further develop MVEP performance assessments; assist the implementation of MVEP; and/or promote the development of new technology or practices which further the MVEP objective of minimizing marine vessel environmental impact.

***MVEP Performance Assessments**: Research and development that will provide additional tools and/or guidance for assessing environmental performance. This may include a forecast for new regulations, technology, or guidance that could suit a reevaluation of the performance levels.*

It is recommended that this Guide be provided to stakeholders for review and comment before release for use.

It is recommended that this Guide be updated annually through 2016, given the rapid change in technology and regulatory requirements.

It is recommended that the Level 3 performance measure be subdivided into salt and fresh water considerations. This will require additional research as the USCG EIS does not specifically address fresh water impacts.

MVEP Implementation: Identify research and development which will assist the efficient implementation of the MVEP system. This may include development of suitable baselines to suit comparisons of Level 3 performance measures.

Improved performance may be defined with respect to the ship's own prior performance or with respect to a peer group of comparable ships. Certain peer groups may grade performance by normalizing the absolute measure to ship service. For example, a larger ship carrying four times more cargo than a small ship should not be penalized for discharging twice as much as the small ship. Establishing a peer group and calculating their aggregate performance is not handled in this report. Future MVEP development should define a baseline for calculating improvement of new ships with no track record. Either a baseline with a threshold for percent improvement or an absolute threshold will need to be determined to assess best performance.

New Technology or Practices: Highlight promising technologies that are worthy of investment.

Additional research and development is not currently recommended, as there is significant work currently being conducted that is driven by market forces.

Section 7 Design Integration

Identify other credits or design elements that are either adversely or positively affected by efforts made toward achieving this credit. For example, is there increased energy, materials, or crew requirements? Do the prescriptive measures suggested above alleviate or incur other environmental impacts besides for just this credit?

Credit xyz

Consequence (+ / –)

This guide encourages ballast water management design and operational solutions to reduce a marine vessel's environmental impact. However, resulting solutions may have "knock-on" impacts that increase a marine vessel's impact in other areas. The following impacts should be considered:

- Increased air emissions resulting from power required for conducting ballast water exchange and operation of a ballast water treatment systems,
- Required hazardous waste disposal from the use of certain ballast water treatment chemicals,
- Toxicity to marine life resulting from treated ballast water effluent (generally covered by treatment system approvals),
- Release of potentially harmful gases created during on board generation of treatment chemicals.

Section 8 Supporting Documents

List additional documents that are relevant for understanding the credit. Actual works cited should be provided in the reference section.

Reynolds, K. and Hurley, W.; *Ballast Treatment Systems*, The Glosten Associates, August 2006.

Ballast Water Treatment Technology Current Status, Lloyd's Register, September 2008.

Dobroski, N., Takata, L., Scianni, C, and Falkner, M.; *Assessment of the Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for use in California Waters*, California State Legislature, December 2007.

Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels (VGP), United States Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES), effective 19 December 2008.

International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004, International Maritime Organization, International Conference on Ballast Water Management for Ships, Agenda Item 8, BWM/CONF/36, 16 February 2004.

U.S. Coast Guard Draft Programmatic Environmental Impact Statement for Standards for Living Organisms in Ship's Ballast Water Discharged in U.S. Waters, U.S. Coast Guard, DOT Document No. USCG-2001-10486, 28 August 2009.

Parsons, M., and Kotinis, M.; *Hydrodynamic Optimization Testing of Ballast-Free Ship Design*, Great Lakes Maritime Research Institute, 30 October 2007.

Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters, Department of Homeland Security, *Federal Register*, Proposed Rules, Vol. 74, No. 166, 28 August 2009.

Appendix D – MVEP Assessment Guide, Oily Water Discharge Reduction

MARINE VESSEL ENVIRONMENTAL PERFORMANCE ASSESSMENT GUIDE

WE1 Oily Water

Prepared for:
SNAME Technical & Research Steering Committee

Presented by:
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29 January 2010
Rev. A

Contents

Revision History

Section	Rev	Description	Date	Approved

References

List works cited or directly used in the development of the report. List non-referenced supplementary material in Section 8, Supporting Documents.

1. Resolution MEPC.117(52), Revised Annex I of MARPOL 73/78, Regulations for the Prevention of Pollution by Oil, Adopted 15 October 2004,

2. Resolution MEPC.141(54), Amendments to Annex I of MARPOL 73/78, Regulations for the Prevention of Pollution by Oil, Adopted 24 March 2006

3. U.S. Code of Federal Regulations, Chapter 46, Part 151 – Vessels Carrying Oil, Noxious Liquid Substances, Garbage, Municipal or Commercial Waste, and Ballast Water

4. SNAME T&R Bulletin 6-1, Guide to Diagnosing Contaminants in Oily Bilgewater: Operation and Maintenance of Bilgewater Treatment Systems

Section 1 Scope and Applicability

This guide is intended for use by Owners, Operators, Designers, and others as a means of assessing their oily water discharge reduction efforts, as well as its effect on their overall environmental performance.

Scope of the credit: Specific machinery and/or operations which are impacted.

This guide provides recommendations regarding technology and management practices that reduce pollution of marine environment from marine vessel oily wastewater and bilgewater discharges.

To develop these recommendations, this guide considers the ability of mechanical systems to remove contaminants and monitor that removal efficiency, including; oily water separators, polishing units, and oil content monitors. The impact of this equipment on energy consumption is not considered in this guide.

Additionally, this guide considers the impact of operational practices and recordkeeping, including: procedures to reduce the quantity and improve the quality of oily wastewater and bilgewater; discharge procedures; management plans, logs, and reports.

The impact of equipment and operational practices on energy efficiency is not considered, and is the subject of a separate guide.

Dewatering systems to combat flooding are not considered here.

Management of waste oil is not considered here, and is the subject of a separate guide.

Management of cargo tank wastes is not considered here, as it is vessel type specific with minimum management practices prescribed by international regulations.

Applicability: Specific limits such as tonnage, propulsion method, cargo type or mission, installed power, number of crew, vessel route or range, new construction or existing ship.

Management of bilgewater discharges applies to all marine vessels that utilize or carry oil based products.

This guide does not supersede any applicable international, federal, regional, or local requirements, guidelines, or voluntary programs.

Section 2 Statement of the Problem

This section identifies the environmental impact addressed by this credit.

Address who and what is adversely affected by no-control, traditional, or non-environmentally friendly approaches including any: human and animal populations; geographical impact scale (local, oceanic, global, etc); dependencies on seasons, market, or natural resources; long term consequence if impact is not addressed.

The environmental impact of bilgewater discharges is generally outlined in the below table.

Table 1: Oil Discharge Environmental Impacts

Oil Type	Removal and Response	Environmental Impact
Very light oils (jet fuels, gasoline)	Highly volatile (they will evaporate within 1-2 days). It is rarely possible to clean up the oil from such spills.	Highly Toxic: Can cause severe impacts to shoreline resources.
Light oils (diesel, no. 2 fuel oil, light crudes)	Moderately volatile, but will leave a residue after a few days. Clean-up can be very effective for these spills.	Moderately Toxic: Has the potential to create long-term contamination of shoreline resources.
Medium oils (most crude oils)	Some oil (about one-third) will evaporate in 24 hours. Clean-up is most effective if conducted quickly.	Less Toxic: Oil contamination of shoreline can be severe and long-term, and can have significant impacts to waterfowl and fur-bearing mammals.
Heavy oils (heavy crude oils, No. 6 fuel oil, bunker C fuel)	Little or no oil will evaporate. Clean-up is difficult.	Less Toxic: Heavy contamination of shoreline resources is likely, with severe impacts to waterfowl and fur-bearing mammals through coating and ingestion.

Source: U.S. Government Accountability Office, 2007

Identify challenges to implementing control measures, including stakeholder impact and technology limitations.

The Environmental Protection Agency (EPA) describes bilgewater as follows:

> *Bilge water is the mixture of water, oily fluids, lubricants, cleaning fluids, and other similar wastes that accumulate in the lowest part of a vessel from a variety of different sources including the main and auxiliary engines; boilers, evaporators and related auxiliary systems; equipment and related components; and other mechanical and operational sources found throughout the machinery spaces of a vessel. It is not uncommon on ships for oil or water to leak into the bilge from these sources, various seals, gaskets, fittings, piping, connections, and from related maintenance and activities associated with these systems. These leaks, along with onboard spills, wash waters generated during the daily operation of a vessel, and waste water from operational sources (e.g., condensate from air coolers, etc.), collect in the bilge.*

In addition to containing oil and grease, bilge water may contain solid wastes such as rags, metal shavings, paint, glass, and a variety of chemical substances (U.S. Environmental Protection Agency, 1997). Bilge water may contain various oxygen-demanding substances, volatile organic compounds, semi-volatile organics, inorganic salts, and metals. Bilge water also may contain other contaminants such as soaps, detergents, dispersants, and degreasers used to clean the engine room. These cleaning agents create an emulsion and prevent separation of oil and water.

Environmental Protection Agency 2008

Marine vessels can not indefinitely hold the complex and varying mixture called bilgewater. Bilgewater is therefore either processed until suitable for discharge overboard, or held for discharge to a shoreside reception facility. Unfortunately, shore reception facilities are not widely available and are typically expensive. Additionally, use of processing equipment presents significant challenges as well, which are described as follows.

A lack of understanding of present day contaminants remains an obstacle in the efficient operation and troubleshooting of bilge water treatment systems. Furthermore, many equipment manufacturer's maintenance, operating, and troubleshooting manuals do not adequately address the larger problem of contaminants, and the need for proper shipboard oily waste water and bilge water management. Improper bilge water management practices are a major factor in problems which can lead to equipment failure.

Society for Naval Architects and Marine Engineers 2009

As a result of these challenges, some marine vessels have been found to by-pass treatment equipment and discharge unprocessed bilgewater overboard as reported by the U.S. Coast Guard (USCG).

Investigations into these incidents have revealed that ship owners and vessel crews have concealed accidental or deliberate discharges of oily waste and sludge caused by malfunction equipment, poor maintenance programs, or as an effort to reduce operational cost.

USCG Proceedings 2009

Describe current technology and/or practices, if any, which address the problem.

Bilgewater collects in the low points of machinery spaces where, typically, a bilge piping system can transfer the bilgewater to: an oily water separator (OWS) and oil content monitor (OCM) for processing directly to a shore reception facility, or to a holding tank for settling prior to processing and/or collection before pumping to a shore reception facility.

Processing systems, when working properly, will use an OWS to separate oil and other contaminants from water that is passed through an OCM before passing overboard. The OCM will engage the automatic stop valve at readings above 15 parts per million oil content; this will close the overboard, sound an alarm, and re-circulate the effluent. The separated oil and contaminants are transferred to storage tank, for either transfer to a shore facility or destruction in an onboard incinerator.

Section 3 Performance Levels

This performance assessment guide should identify clear metrics to meet a specific performance level. These levels will define: minimum requirements, good practice, best practices, and zero impact.

The metrics for calculating a performance number, such as number of organisms discharged with ballast water, should be provided; however, this document should not specify the required value of that performance number.

This section will need to define the four performance levels for this credit. Background, detail calculations, and other justification information should be provided in Section 4.

3.1 Level 1 Prerequisites - Required

Specify the prerequisites required to reach a level of Standard Environmental Performance that is explicitly higher than simply meeting the minimum required applicable regulations for a given ship. All applicable IMO environmental regulations should be identified as prerequisites, regardless of ship type, location, or age, and include those future regulations with published implementation dates. Define vessel size limitations and applicability.

Marine vessels following this guide can meet performance Level 1 Prerequisites by meeting the requirements of MARPOL Annex I and its current revisions. Marine vessels not meeting the applicability of Annex I (smaller vessels), should meet the requirements of 46 CFR 151, as well as an equivalent to the IOPP Certificate. These requirements should be met in all jurisdictions, even those that are not party to MARPOL.

In general, these regulations require that:

- Effluent must not be discharged unless: outside of special areas, the vessel is underway, approved processing and monitoring equipment is used, oil content is less than 15 parts per million, and/or it does not originate from cargo pump rooms and is not mixed with oil cargo residues.
- Recordkeeping and survey requirements are met, including the International Oil Pollution Prevention (IOPP) Certificate and Oil Record Book for tank vessels above 150 gross tons and cargo vessels above 400 gross tons.
- Tanks are adequate for oil residues and have a standard discharge connection.
- Oil is not to be carried in the forepeak or forward of the collision bulkhead.
- Oil is not to be carried in a double bottom tank for vessels built after August 2010.

These prerequisites apply to all additional levels of performance assessment, unless specifically noted.

3.2 Level 2 Prescriptive Measures - Good

Describe prescriptive measures for Good Environmental Performance. These prescriptive measures should apply practical, proven technology that is currently and readily available to owners. Include a cost-benefit estimate, and highlight measures with low cost and high reward.

Marine vessels that meet or exceed the applicable prescriptive measures herein are assessed as good environmental performers. An applicability survey may be conducted to determine if the measures are both practical and effective. In the absence of a survey, the following prescriptive measures are considered applicable.

1. Perform a bilgewater quality and performance review in **accordance with the procedures detailed in the SNAME T&R Bulletin 6-1,** *Guide to Diagnosing Contaminants in Oily Bilgewater* (T&R 6-1). This process identifies and provides solutions for ensuring efficient operation of bilgewater processing.

2. Perform a vessel assessment of contributors of water, oil, and other contaminants to bilgewater quantity and quality. Refit measures should include: containments, drip trays, or other means to contain oil leaks at potential leak locations such as pumps and manifolds; use or refit of existing oil pumps with leak-proof mechanical type seals to limit oil leakage; installation of soot filtering equipment in wash streams.

3. Perform a vessel assessment of contributors of water, oil, and other contaminants to bilgewater quantity and quality. Operational measures should include those detailed in T&R 6-1, such as: control of solvents, detergents, and degreasers entering the bilge; prompt control of any leak such as from seawater cooling or sewage; maintenance of bilge areas to prevent rust build up; maintenance of pipe and tank coatings.

4. Perform no discharges, regardless of filtering level, within 12 nautical miles of nearest land.

3.3 Level 3 Measurable Performance - Best

Identify performance based measures representing Best Environmental Performance. This performance based level is quantitatively assessed and allows for innovation beyond what is currently good environmental practice. Express this quantitative measurement in terms of either a hard limit or a percentage of improvement from a predefined baseline. The currently available measures described in Levels 1 and 2 build capability for achieving the performance criteria established in Level 3.

Marine vessels may be assessed as best environmental performers by:

- Determining the total amount of oil discharged in terms of quantity of bilge water and rating of filtering equipment, and

- Participating in a third party program that ranks the quantity of oil discharged against some baseline.

To assess the total environmental impact from oily water, determine the oily water discharge volume and the oil content. Impact reduction is achieved by reduced quantity *q*, and oil content ρ. A single discharge's impact is defined as ($q \cdot \rho$). The annual impact is found by taking an average over all discharges *N* as documented in the *Oil Record Book*.

$$\text{Annual Oily Water Impact } = \sum_{i}^{N} q \cdot \rho \tag{1}$$

where

N = Total Number is discharges in the year.

q = Quantity measured in gallons annually.

ρ = Oil Density in ppm.

3.4 Level 4 Zero Impact

Identify performance measures with either zero or least possible impact on the environment, representing Zero Emissions Environmental Performance from ideal design elements or operational practices. Achieving this performance level may not be practical at the current time; consequently, technological or operational limitations and anticipated time scale to achieving zero emissions should be identified. Because MVEP is voluntary, it can ask for the absolute most from its ships.

Marine vessels may be assessed as having zero impact on the environment if they eliminate bilgewater discharges anywhere in the world.

Section 4 Level Justifications

This performance assessment guide is based on a combination of existing technology and practices, which have been identified in Section 3 as representing the four levels of practice: required, good, best, and zero impact. This section provides the justification for this definition. In particular, reference to exemplary marine vessels, technology, and practices identifies the cutting edge in sustainable design and operations.

4.1 Level 1 Prerequisites

Describe applicable rules and regulations, technology examples, operational practice examples, and/or case studies.

Adherence to MARPOL 73/78 is standard practice. Crew and equipment achieve this measure where the convention is ratified, and therefore it can be met worldwide. Compliance is demonstrated by maintenance of the International Oil Pollution Prevention Certificate.

4.2 Level 2 Prescriptive Measures

Describe applicable rules and regulations, technology examples, operational practice examples, and/or case studies. Additionally, discuss the predicted efficacy of the prescribed measures.

Measures chosen have demonstrated reliable gains in reducing oily effluent. Many can also be applied to both new and existing vessels. For example, drip trays are cost effective measures. This is not presented as an exhaustive list, but to highlight the measures of greatest benefit and value.

4.3 Level 3 Measurable Performance

Provide performance measure formulation, including impact quantification, measurement units, and applicable standards.

The proposed annual impact calculation takes into account the two factors that determine the environmental impact of oily water discharge content, which are:

1. Quantity

2. Quality

Quantity

The amount of collected oily bilge is a function of operations, and good operational practices can go a long way to make up-stream improvements. Front-end solutions that negate the need for oil entirely are preferable, but not required; for example, a sea-water lubricated stern tube has zero risk of leakage.

Quality

The quality of the effluent is measured in parts per million (ppm) of oil content. This is determined by the efficacy (and proper maintenance and usage) of the oily water separator. Per published vendor data, all effluent levels are achievable at this time by use of the newest available equipment. Oil water processing units currently available are reported by manufacturers to support a 5 ppm limit.

4.4 Level 4 Zero Impact

Give an explanation of a zero impact solution. If there is no practical method to zero emissions at this time, explain the limitations and when a solution may be available.

The credit objective is to eliminate of the discharge of oily effluent. To achieve that currently, the vessel would need to collect and store the effluent and discharge at one of its ports of call. This would require ports to provide and develop reception facilities. To be truly effective, these facilities must be developed to support the operators’ schedules, have adequate capacity, and meet any other vessel-specific requirements. Although the technology is available, there are associated port costs to construct and maintain these facilities and to service vessels.

Section 5 Regulatory Environment

Identify current, proposed, and anticipated regulations, rules, and standards that impact the credit being assessed. Additionally, provide a narrative of how this regulatory environment impacts typical operations.

Oil pollution from marine vessels is primarily regulated by enforcement of Annex I (Regulations for the Prevention of Pollution by Oil) of MARPOL (International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978).

Annex I has been revised as recently as 2006, with modifications in certificate requirements, standards of OWS equipment, and structural protection. MARPOL generally applies to ocean going vessels on international voyages, as outlined in Table 2.

Generally, the parties of MARPOL apply the same requirements of their domestic fleets. The United States, for example, extends similar requirements for smaller vessels.

Table 2: Current Oily Water Regulations under MARPOL

Vessel Size	Current Regulation Summary
Under 400 tons gross.	• Equipped as far as practicable and reasonable with installations to ensure the storage of oil residues on board and their discharge to a reception facilities or into the sea in compliance paragraph (1)(b) (i.e. oil content of effluent without dilution does not exceed 15ppm)
Over 400 tons gross, but less than 10,000 tons gross.	• Oil content of effluent less than 15 ppm and equipment per regulation 16 (i.e. oily water separator) • Oil record book required • Vessels carrying large quantities of oil have additional requirements similar to vessels of 10,000 tons gross
10,000 tons gross or more.	• Oil content of effluent less than 15ppm and equipment per regulation 16 (i.e., oil water separator with alarms/automatic shut offs) • Oil record book required

Section 6 Directions for Future Research and Development

This section identifies future research and development which is recommended to: further develop MVP performance assessments; assist the implementation of MVP; and/or promote the development of new technology or practices which further the MVP objective of minimizing marine vessel environmental impact.

***MVEP Performance Assessments**: Research and development that will provide additional tools and/or guidance for assessing environmental performance. This may include a forecast for new regulations, technology, or guidance that could suit a reevaluation of the performance levels.*

It is recommended that this Guide be provided to stakeholders for review and comment before release for use.

It is recommended that this Guide be updated in 2012, when the results of the advanced OWS equipment meeting, MEPC 107(49), will have been widely installed and other advanced systems trialed.

It is recommended that the guide scope be expanded to cover MARPOL Annex I comprehensively.

It is recommended that the guide provide further recommendations regarding the integration with shore facility and incinerator options.

MVEP Implementation: Identify research and development which will assist the efficient implementation of the MVEP system. This may include development of suitable baselines to suit comparisons of Level 3 performance measures.

Improved performance may be defined with respect to the ship's own prior performance, or with respect to a peer group of comparable ships. Certain peer groups may grade performance by normalizing the absolute measure to ship service. For example, a larger ship carrying four times more cargo than a small ship should not be penalized for discharging twice as much as the small ship. Establishing a peer group and calculating their aggregate performance is not handled in this report. Future MVP development should define a baseline for calculating improvement of new ships with no track record. Either a baseline with a threshold for percent improvement or an absolute threshold will need to be determined to assess best performance.

New Technology or Practices: Highlight promising technologies that are worthy of investment.

Additional research and development is recommended to determine if distance from nearest land should be incorporated into Level 3 practices. This study would consider if discharges 200 nautical miles are less harmful than those 12 nautical miles from shore.

Additional research and development is recommended to understand the availability and expense of shore reception facilities.

Section 7 Design Integration

Identify other credits or design elements that are either adversely or positively affected by efforts made toward achieving this credit. For example, is there increased energy, materials, or crew requirements? Do the prescriptive measures suggested above alleviate or incur other environmental impacts besides for just this credit?

Credit xyz

Consequence (+ / –)

Oily water management should be evaluated with respect to its effect on the whole ship design. A primary impact may be the decision to retain the oily water aboard, as this could potentially require increased tank capacity.

Section 8 Supporting Documents

List additional documents that are relevant for understanding the credit. Actual works cited should be provided in the reference section.

1. MARPOL 73/78 Consolidated Edition 2002

2. Guide to Diagnosing Contaminants in Oily Bilgewater: Operation and Maintenance of Bilgewater Treatment Systems, SNAME, T&R Bulletin 6-1, 2009.

3. National Pollutant Discharge Elimination System (NPDES) Vessel General Permit (VGP) for Discharges Incidental to the Normal Operation of Commercial and Large Recreational Vessels, U.S. Environmental Protection Agency, Fact Sheet, 2008 Proposed Issuance.

4. AWO Recommended Practice Guide: EPA Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels, The American Waterways Operators, 16 January 2009.

5. Cruise Ship Discharge Assessment Report, Section 4 Oily Bilge Water, U.S. Environmental Protection Agency, 29 December 2008.

6. Manual on Oil Pollution, Section I: Prevention, MEPC/OPRC-HNS/TG 7/3, 13 February 2008.

7. Information of Cleansing Agents for use in Machinery Spaces of Ships, MEPC/Circ. 289.

8. Amendments to the Annex of the Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, 1973, MEPC 52/24/Add.2, 15 October 2004.

9. Implementation of MARPOL 73/78 and the Protocol on Environmental Protection to the Antarctic Treaty as it Pertains to Pollution from Ships Title 33: Navigation and Navigable Waters, Part 151: VESSELS CARRYING OIL, NOXIOUS LIQUID SUBSTANCES, GARBAGE, MUNICIPAL, OR COMMERCIAL WASTE, AND BALLAST WATER, Sub-Part A, 33 CFR 151,09, United States Coast Guard.

10. Oily Water Rules, United States Coast Guard, 16 January 2009.

11. Pollution Prevention Equipment; Final Rule, 33 CFR Parts 155 and 157, 46 CFR Part 162, United States Coast Guard, 16 January 2009.

12. O'Connell, D., LCDR, "International Cooperation on Marine Pollution Enforcement," *Proceedings*, Port State Control, United States Coast Guard, Summer 2009.

Attachment 2. SNAME Presentation

THE GLOSTEN ASSOCIATES
Consulting Engineers Serving the Marine Community

Marine Vessel Environmental Performance Assessment (MVP)

Presentation for: SNAME Annual Meeting 2009

22 October 2009, Providence, RI

Presented by: Tim Leach of The Glosten Associates

Agenda

Marine Vessel Environmental **Performance** Assessment **(MVP)**

1. **Overview**
2. **Phase 1 – Pilot Project Efforts**
3. **Phase 2 – Scope and Plan**
4. **Technical Issues**

Overview

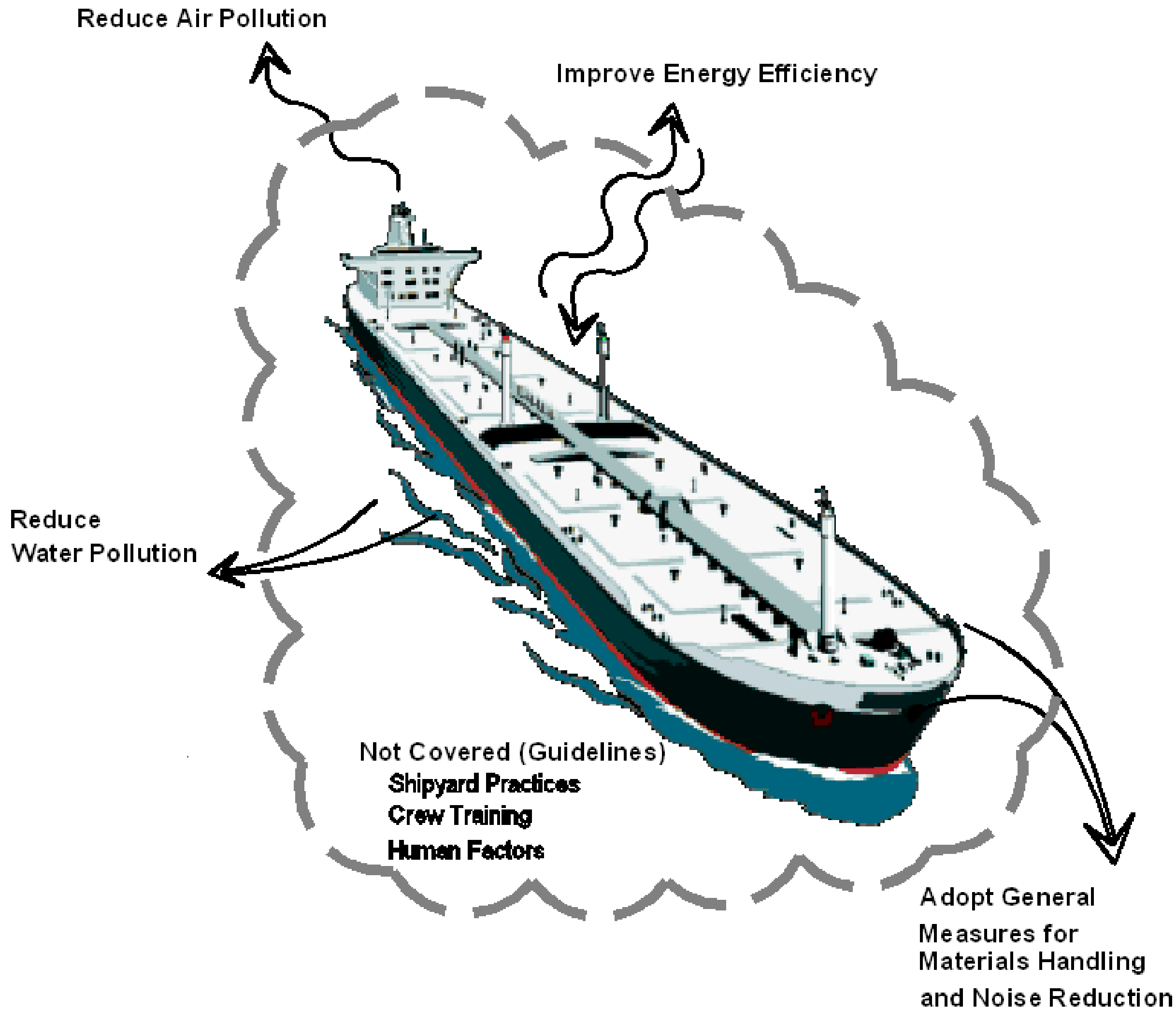
Mission Statement: **"Provide a common technical basis for assessing environmental performance, so that marine vessel designers, builders, and operators can understand relative environmental impacts of design decisions and operational practices."**

Objective: Reduce Emissions from Ships by:

- **Providing Guidance as to the Best Environmental Practice**
- **Recognizing Industry Leaders and Exemplary Performance**
- **Defining "How Green is Green?" through Holistic Vessel Approach**
- **Leveraging Current Best Practices (No new R&D)**
- **Developing VOLUNTARY Open Source Metrics by Teaming Industry, Environmental Groups, and Regulatory Agencies**

Overview

Define “How Green?” through Holistic Approach



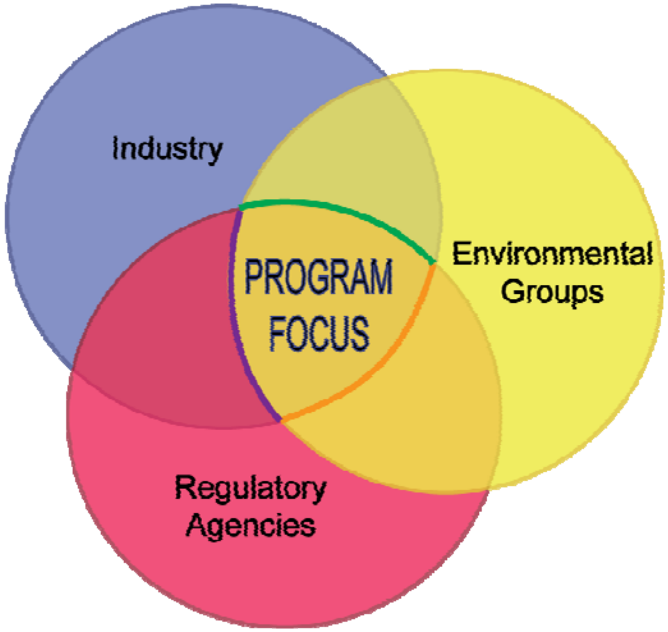
Overview

Develop VOLUNTARY Open Source Metrics by Teaming Industry, Environmental Groups, and Regulatory Agencies

- **Voluntary. Teaming Industry, Environmental Groups, and Regulatory Agencies Can Result in Practical Solutions**

- **Open Source. Technical Document will be Published by SNAME.**

- **Industry Based Solutions Ahead of Regulation**



Development & Implementation

Developing Technical Performance Assessment

Phase 1

<u>TODAY</u>
Pilot Project Underway – Sponsors SNAME, ABS, Glosten

First 3 Categories:
Ballast Water
HVAC
Oily Water

Phase 2

<u>STARTING NOVEMBER</u>
Expand to More Categories

Use full Technical Panel with Advisory Group and Industry Input

<u>OCTOBER 2010</u>
Performance Guide at SNAME Annual Meeting in Pacific Northwest

Development & Implementation

Phase 1 – Pilot Project Scope

1. Review Existing Environmental Assessments
2. Develop a Checklist of Environmental Impacts
3. Develop the Technical Assessment of Three of the Topics in the Checklist
4. Develop Guidance for the Technical Assessment to be Done by Subject Matter Experts
5. Reach Out to Marine Community to Get Feedback

Development & Implementation

Phase 1 – Pilot Project Scope

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Phase 1 – Checklist

1. Energy Efficiency

Credit 1 Energy Optimization Measures

Credit 1.1 Lighting

Credit 1.2 HVAC and Insulation

Credit 1.3 Pump and Piping Systems

Credit 1.4 Mechanical Equipment Efficiency

Credit 1.5 Hull Prop Efficiency Maintenance

Credit 1.6 Route Optimization Program

Credit 1.7 Vessel Speed Optimization Program

Credit 1.8 Waste Heat and Energy Recovery

Credit 1.9 Other

Credit 2 Carbon Foot Print Reduction

(IMO MEPC EEDI & EEOI)

Credit 3 Innovations

Credit 3.1 Alternative Fuels

Credit 3.2 Renewable Energies

Phase 1 – Checklist
2. Air Emissions

Prereq 1 **IMO Low Sulfur Fuel Log Requirements**
Prereq 2 **Main/Propulsion Engine Manufacture Certificate of Compliance**
Prereq 3 **IMO Compliant Refrigerant Handling Program**

Credit 1 **NOx Reductions (Main/Propulsion Engines)**
Credit 2 **Sulfur Reductions (All Engines) ECA & Global**
Credit 3 **PM Reductions (Main/Auxiliary Engines)**
Credit 4 **Organic Compounds**
Credit 5 **Ozone Depleting Substances**
Credit 6 **Emissions Transfer to Shore**

Phase 1 – Checklist

3. Water Emissions

Prereq 1 **Oil Waste Management Plan**
Prereq 2 **Ballast Management Plan**
Prereq 3 **Solid Waste Management Plan**

Credit 1 **Oily Waste Reduction**
Credit 2 **Nonindigenous Species**

Credit 2.1 Ballast Water

Credit 2.2 Hull Fouling

Credit 3 **Sanitary Systems: Treatment Reduction/Retention**
Credit 4 **Solid Waste**
Credit 5 **Incidental Discharges**
Credit 6 **Structural Protection**

Credit 6.1 Double Bottom Fuel Tanks

Credit 6.2 Oil Structural Protections: Oil Free Shaft Seal Systems, Deck Coaming, etc.

Phase 1 – Checklist

4. General Measures

Credit 1 **Materials Resource Reduction / Reuse / Recycle**

Credit 2 **Hotel Water Load Reduction**

Credit 3 **Hull Coating Practices**

Credit 4 **Ocean Health & Aquatic Life**

Credit 4.1 Lighting and Underwater Noise—Aquatic Life Impact

Credit 4.2 Wake Wash and Shore Protection

Credit 5 **Hazardous Materials Control: Inventory Program and Reduction / Control**

Credit 6 **Ship Recycling**

Development & Implementation

Phase 1 – Pilot Project Scope

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Phase 1 – Technical Assessment

3 Topics

Credit EE 1.2	**HVAC and Insulation**
Credit WE 1.0	**Oily Waste Reduction**
Credit WE 2.1	**Nonindigenous Species, Ballast Water**

Development & Implementation

Phase 1 – Pilot Project Scope

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Phase 1 – Guidance

Responsibilities: Credit Development

1. Summary
2. Statement of the Problem
3. Applicability
4. Performance Levels
   - Prerequisites – Minimum
   - Prescriptive Measures – Good
   - Performance Evaluation – Better
   - Zero Impact – Best
5. Regulatory Rules / Guidelines Overview
6. Directions for Future Research & Development

Members: SNAME Members & Industry Experts

Development & Implementation

Phase 1 – Pilot Project Scope

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Phase 1 – Outreach

Presented at Green Pacific – September 2009
Attended Global Green Ship – September 2009

- The Port of Long Beach suggested that reductions in port fees would be considered for MVP vessels
- Allianz, a major marine insurance company, indicated that MVP vessels might gain favored carrier rates.
- MVP might be integrated into corporate ISO 14001, Environmental Management Systems.
- EPA suggested IMO might be an implementation route.

Phase 2 - Credit Performance Basis Development

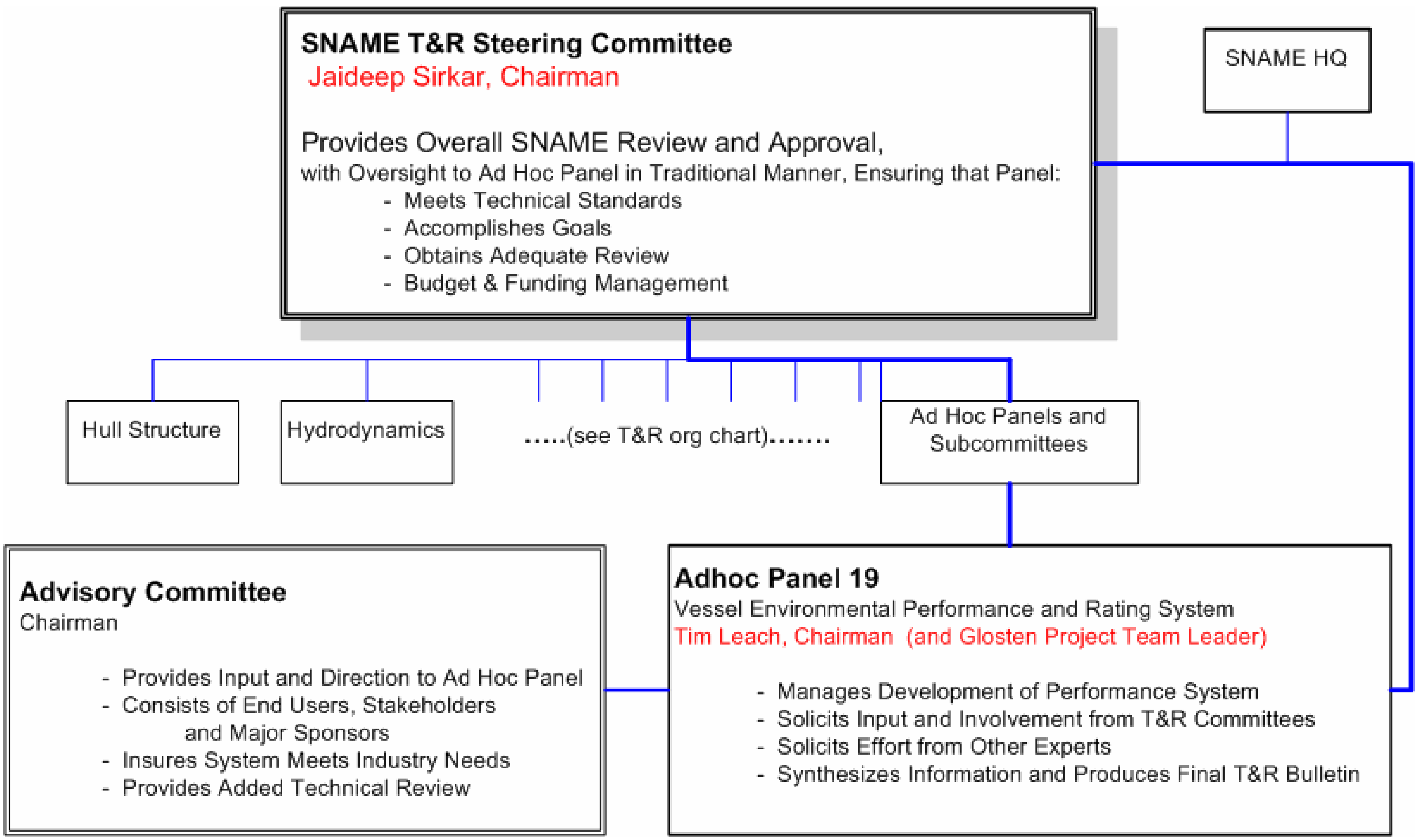
Phase 2 – Scope

1. Develop the Technical Assessment of the Remaining Topics in the Checklist (~30)
2. Assemble a T&R Bulletin

Phase 2 – Schedule

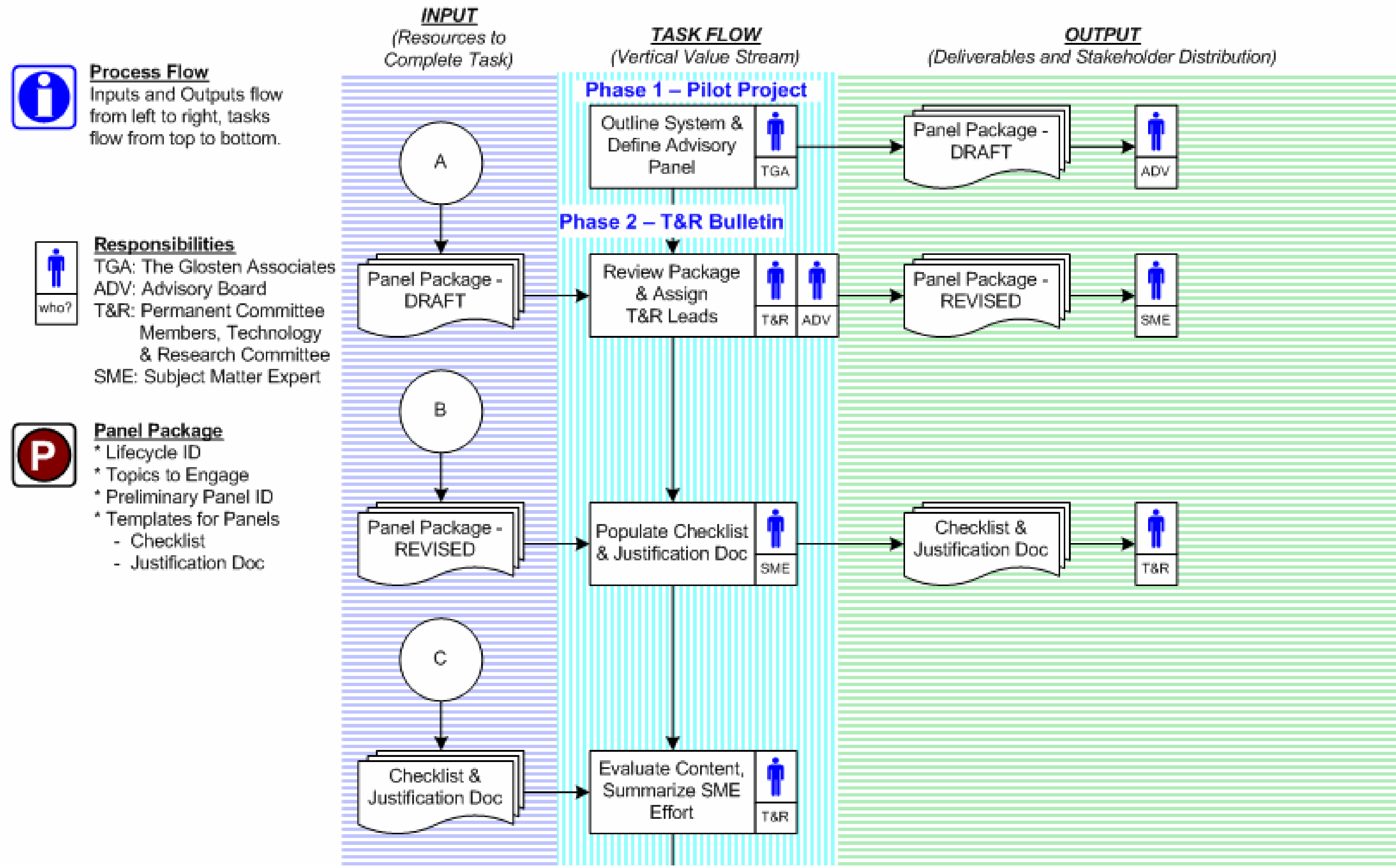
1. Workshop/Webinar in Early 2nd Quarter
2. Complete T&R Bulletin in Time for SNAME Annual Meeting 2010

Phase 2 - Organization

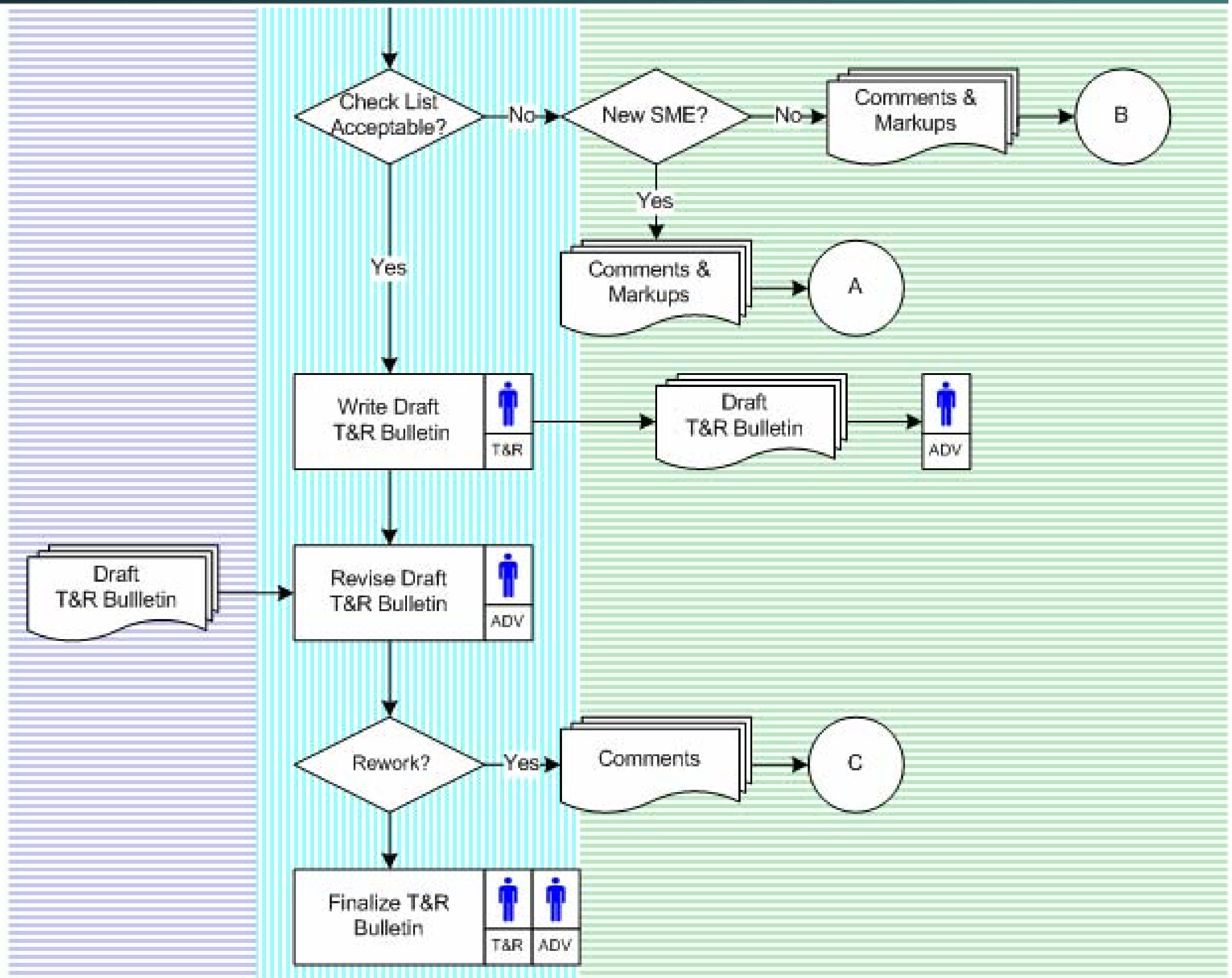


MVP Marine Vessel Environmental Performance Assessment

Work Flow Chart, Revised 12 October 2009



Phase 2 - Process



Stoplight Criteria
TBD

Phase 1 – Technical Assessments

Credit WE 2.1   Nonindigenous Species, Ballast Water

Objective:

Minimize or reduce ballast water as a vector for nonindigenous species

Prerequisites - Minimum

Meet practices and timelines in IMO 2004 Ballast Convention and Annexes

- All locations (not just treaty party locations)
- Recordkeeping and training
- Phase in schedule from ballast exchange to treatment

Prescriptive – Good

Install higher standard treatment system (California/ USCG Phase 2)

Performance – Better

X% Reduction number of viable organisms compared to peer group

- Use of higher standard treatment system, and/or
- Reduction in quantity of ballast water discharged

Zero Impact – Best

No ballast discharge near coastal or in port

Phase 1 – Technical Assessments

Credit WE 1.0 Oily Waste Production – Oily Water Separators

Objective:

Decrease and eventually eliminate processed oily water effluent discharges

Prerequisites – Minimum

Maintain International Oil Pollution Prevention Certificate & Oil Record Book

Crew Training Program on OWS Operation

Prescriptive – Good

Good Housekeeping Measures, MEPC Circ. 289 (i.e., minimize oil & water leaks, oil containments, use of waste oil tanks, avoid emulsifiers, etc.)

Installation of Equipment (OWS and Monitor) compliant with IMO/MEPC 107(49)

Performance – Better

X% Reduction Annual Oil Discharge. Combination of:

- Volume discharged x Documented oil content level

Zero Impact – Best

No discharge – retain for disposal on shore

Phase 1 – Technical Assessments

Credit EE 1.2   HVAC and Insulation

Objective:

Reduce HVAC portion of the energy load on vessels

Prerequisites – Minimum

Meet general requirements of proper operation of equipment and comfort of personnel

Prescriptive – Good

Reduce HVAC Load – More insulation, better / fewer windows, ambient conditions

Improve System Design – Waste heat recovery, recover energy from exhaust air

Intelligent Control – Variable air volume systems, programmable thermostats

High Efficiency Equipment – Pumps, fans, boilers, etc.

Performance – Better

X% reduction in energy usage from baseline

Zero Impact – Best

No HVAC. This is an impractical solution.

Technical Issues Discussion

MVP Benefits (Preferential Treatment, Reduced Fees, etc.)

- **Baselining**
  How do we establish an appropriate baseline?
  - Peer group
  - Existing condition
- **Existing Vessels vs. New Builds**
- **HVAC**
  Prescriptive vs. Performance
  Complexity of calculation
- **Oily Water**
  What is incentive?
  Is reduction in discharge enough to be significant? Or is any reduction significant enough to warrant inclusion?
- **Nonindigenous Species**
  What is reasonable reduction in volume discharged?

Your Help is Needed.

The Advisory Board & Technical Work Group offer opportunities to:

- Provide insight and guidance in the early stages of the system development.
- Work with regulators, marine terminal operators, ocean carriers, tug and barge companies, and others towards the environmentally responsible management of marine vessels.
- Promote, strengthen, and grow relationships between those engaged in environmental compliance, risk management, and vessel operations.

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