



MAX1 SURVEY KEY FINDINGS

August 21, 2015

Overall, our survey takers were relatively positive about the effectiveness of MARPOL Annex I waste stream management, but suggested many areas for improvement, especially regarding increasing and improving training, running drier bilges, and improving Port Reception Facilities¹.

Introduction

The MAX1 Survey was a key component of the MAX1 Studies, which had the following overarching goals:

1. To establish the current state of shipboard waste stream management and OWS knowledge across a wide range of maritime occupations and roles
2. To determine perceived effectiveness of current waste stream management and OWS systems
3. To solicit opinions on increasing the effectiveness of waste stream management and OWS systems

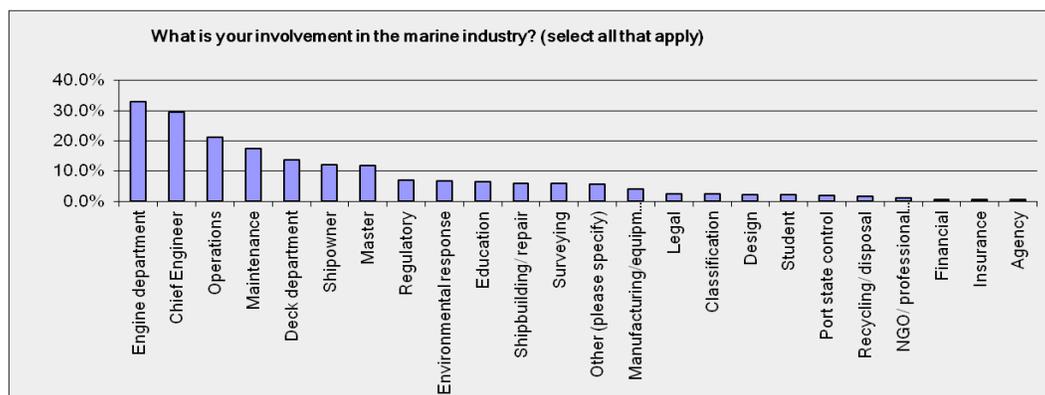
The survey was developed in consultation with MAX1 Partner Organizations². It was opened on April 28, 2015, and remains open to accept responses. Responses are completely anonymous. The below analysis was conducted using the data up to June 25, 2015. At that time there was a total of 500 responses. Since that time, 13 additional responses have been received.

The survey continues to be available at the following link: www.surveymonkey.com/s/max1survey

The full list of survey questions, survey skipping logic, and survey results (including raw data) are available at the link: <http://www.martinottaway.com/technical-documents/MAX1-Studies/survey>

Survey taker demographics

Over 98% of the survey takers indicated that they were at least partially a member of the marine industry at some point in time, in the following reported capacities:



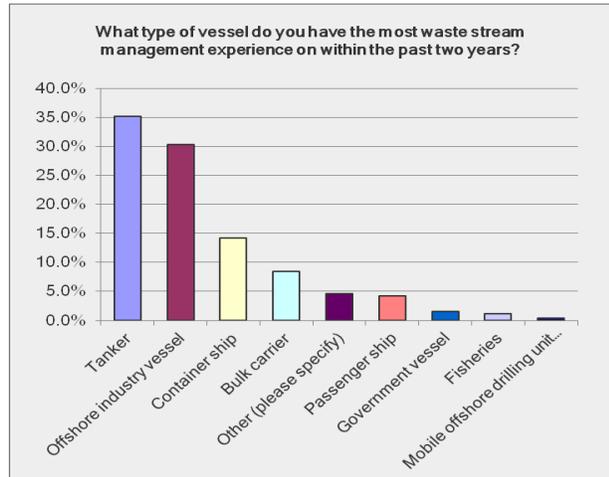
¹ Many survey takers also suggested improving OWS technology, but the majority of specific complaints with OWS tech involved problems generally associated with OWS technology designed to comply with MEPC Resolution 60(33). As ships constructed after 2005 must be fitted with units that comply with MEPC Resolution 107(49), MEPC.60(33) units are no longer manufactured, and therefore we have not made this a main focus for improvement.

² The list of MAX1 Partner Organizations can be found [here](#).



Average number of years in the industry was 20 years (median = 15 years, mode = 15 years). 42% of respondents live in North America, 34% live in Europe, 20% live in Asia, and the remaining 4% live in Africa, South America, and Australia.

A large component of our survey takers were crew members or recent crew members, and we note that certain sectors were considerably better represented than others - see below:

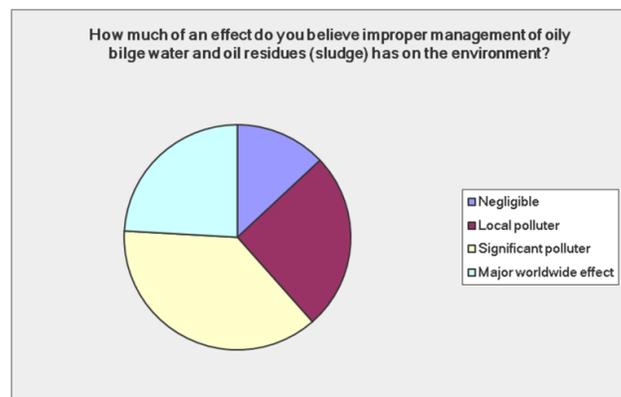


Current state of knowledge (Survey Goal #1)

Over 98% of our survey takers knew what MARPOL was, 99% of survey takers knew what bilge water was, and 96% knew where shipboard oil residues (sludge) comes from. However, since the majority of our survey takers were voluntary³, in all likelihood our survey takers are considerably better informed about these issues than the general maritime population.

There was a wide range of opinions regarding the impacts of improper management of oily bilge water and oil residues on the environment. For the significant proportion of people who thought that the effects were negligible (13%), it may provide an incentive for compliance if they are exposed to compelling evidence that the effects are not negligible.

A majority of the survey respondents were also unaware that there are any valid or legal reasons to discharge untreated oily bilge water or oil residues (sludge) overboard (65% said no valid reasons, and 60% said no legal reasons). If crews and shipowners were made aware that emergency



³ The non-voluntary survey takers included a number of engine room crews that were asked to complete the survey by their shipowners.



situations could be reported without fear of legal repercussions, this could reduce possible cover-ups and mistrust between parties⁴.

Main outcomes

The remainder of this report is broken into the main topics covered by the survey (with respect to MARPOL Annex I wastes), as follows:

- MARPOL regulations
- Shipboard waste stream management (general)
- Oily Water Separators
- Port Reception Facilities
- Training
- Paperwork

Each section discusses current perceived effectiveness (Survey Goal #2) and potential methods for improving effectiveness informed by the survey results (Survey Goal #3).

Before discussing the survey results for the topics listed above, it is informative to look at the results of the final two questions on improving shipboard waste stream management overall first, since they provide a picture of the most important issues to the survey takers, and were, for the most part, reflective of the overall survey results.

In Question 56, survey takers were asked to rate 21 approaches for improving shipboard waste stream management in terms of effectiveness. The top ten rated^{5,6} approaches were:

1. Improve on-board training
2. Run "dry" bilges where possible and minimize OWS operations
3. Improve academy / maritime school training
4. Improve OWS technologies such that OWS operation becomes less labor intensive
5. Develop a concise and ship's crew focused guidance document describing the obligations under MARPOL on a shipboard level
6. Require shipboard testing of OWS systems before acceptance by IMO and/or USCG (in order to test real world ability to produce effluent <15 ppm)
7. Develop methodology that holds equipment suppliers more directly responsible
8. Perform human factors studies
9. Automate waste stream management records through a shipboard plan maintenance system that automatically date stamps entries
10. Automate ORB entries (with automatic date stamped entries)

Question 57 was the corresponding open-ended question on how to improve shipboard waste stream management, and the most common suggestions were, respectively: training, improving/simplifying

⁴ The survey results show that lack of trust is the most common complaint for Port State Control inspections, with 46% of survey takers with waste stream management experience in the past 2 years encountering these problems.

⁵ A rating of "counter-productive" was assigned a value of -1, "not effective" = 0, "somewhat effective" = 1, "extremely effective" = 2, "not sure" = 0, and ratings were averaged over all responses.

⁶ Recall that due to a heavy crew component, the most popular methods may be somewhat biased towards methods beneficial for crew members (e.g. methods with low shipboard time commitment).



equipment, education, increasing the number of Port Reception Facilities (PRFs), reducing ORB paperwork, lowering cost of PRFs, installing bigger storage tanks, and sending all waste ashore. Note that, at the time of survey design, we did not anticipate the extent of the PRF problem and therefore improving PRFs was not included as an option in Question 56.

However, the most popular methods are not necessarily the most effective methods, and technical and systems analysis is also required. For example, while method #6 was a relatively popular suggestion, in reality it would be very difficult to execute effectively, since different OWS systems are more or less effective depending on the vessel type, frequency of use, and type of bilge effluent being processed. In this report, we endeavor to provide the survey results as found, but also discuss these technical and systems considerations where appropriate.

MARPOL regulations

Perceived effectiveness:

The majority of survey takers thought that MARPOL Annex I regulations are generally effective, although apparently less effective than most other MARPOL Annexes:

- 91% thought MARPOL regulations are generally effective at preventing shipboard pollution
- 79% thought MARPOL Annex I regulations are generally effective at preventing *accidental* oil pollution
- 68% thought Annex I regulations are generally effective at preventing *intentional* oil pollution
- Only 2.1% of survey takers agreed with the statement "MARPOL Annex I is broken"

However, in the open-ended questions, a significant number of people noted MARPOL Annex I as too long and too confusing. This is also reinforced by the fact that creating a concise and ship's crew focused MARPOL guidance document was ranked as the fifth highest ranked solution in Question 56.

Increasing effectiveness:

In addition to developing a concise guidance document, the following common and/or interesting suggestions were identified in response to the open-ended question "Do you have any specific suggestions to improve MARPOL Annex I regulations?":

- Simplify and reduce confusion - e.g. "Too much reading, not decisive and clear-cut enough and doesn't get straight to the point like most IMO issued regulations and documentation"
- Shift responsibility to incentivize compliance (e.g. to Captain)
- Ensure adequate crew size through an IMO requirement
- Anonymous feedback mechanisms
- "Reset the limits for overboard discharge to 50 ppm. Most oily water separators can attain this and, more importantly, most monitors, even those using light scatter principles, can reliably indicate oil content as opposed to paint, rust, and sediment within this range."
- "The huge net of Annex 1 is too constrictive, trying to cover 500m ships to 50m yachts. Surely the only, single regulation should be 'Do not intentionally dispose of or discharge hydrocarbons at sea'. How you deal with that is up to you. If you fail, you are in breach & liable to action."



We also received a large number of very general outlooks in this open-ended question related to training, port reception facilities, paperwork, shipboard waste stream management and related topics. It is unclear whether the intent of these suggestions was for actual MARPOL regulations to be modified to make these suggestions required, or whether survey takers were suggesting improvements for increasing compliance within existing regulations⁷.

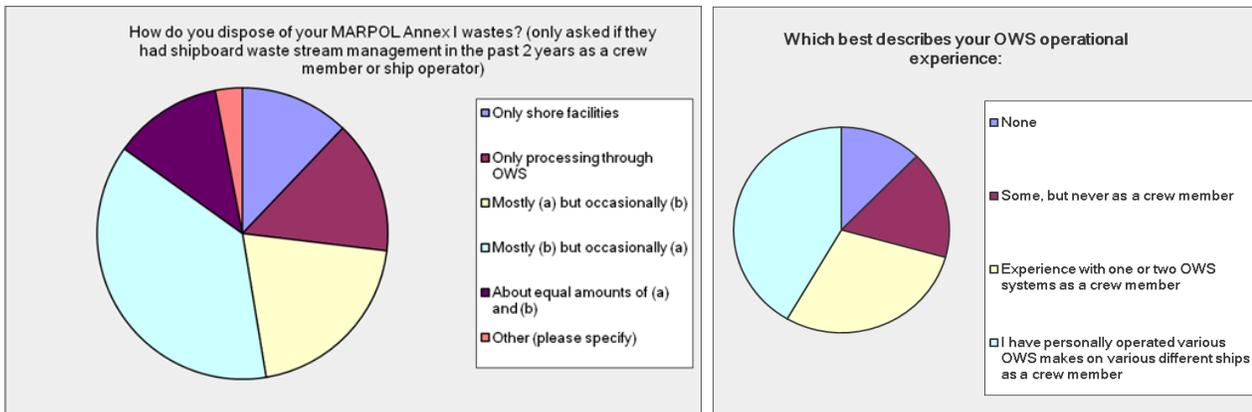
Shipboard waste stream management

Perceived effectiveness:

Perceived frequency of MARPOL Annex I violations remains high, but does appear to be going down, with the perceived percentage of ocean-going ships' crews that violate MARPOL Annex I going down from an average of 28% in 2011⁸, to 20% in our survey.

With regards to the source of MARPOL Annex I wastes, the most common reported problematic bilge water inflow type was leakages (45 respondents), followed by condensation (32 respondents), and then wash water / cleaning (17 respondents).

Regarding disposal of MARPOL Annex I wastes, we note that our survey takers had both significant experience with disposal of MARPOL Annex I wastes via port reception facilities (PRFs) and disposal overboard after processing MARPOL Annex I wastes through an Oily Water Separator (OWS) - see charts below. Specific perceived effectiveness of both of these methods is discussed in their respective sections of this report.



Increasing effectiveness:

Outside of improving Port Reception Facilities, Oily Water Separators, training, and paperwork requirements, which are all discussed individually below, running drier bilges was mentioned frequently in the open-ended responses, and was also the second highest rated method for improving shipboard waste stream management in Question 56.

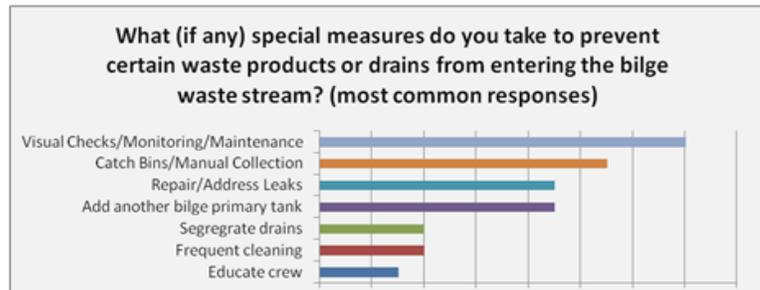
⁷ These general comments may be due to the fact that this question appeared early in the survey, when survey takers were not sure whether they would have open-ended questions later in the survey to provide their opinions on related matters.

⁸ The 2011 data comes from a year-long survey administered by the Society of Naval Architects and Marine Engineers (SNAME) on environmental attitudes regarding the maritime industry. More information on this survey is available [here](#).



Practical methods for running drier bilges, and reducing / stopping bilge water production as much as possible at the source, are relatively self-explanatory. These approaches can be seen in the most common responses to the voluntary open-ended question asked of crew members with recent⁹ shipboard waste stream management experience.

Increasing holding tank capacities and giving crews the resources to conduct regular maintenance were also common suggestions in other open-ended responses.



We note that regular maintenance to minimize bilge water production requires that Owners supply their crews with adequate and good quality spares, and ensure that crews are not overburdened so that there is sufficient time to stay ahead with maintenance.

Other common and/or interesting open-ended suggestions to generally improve shipboard Annex I waste management included:

- Need to invest in a whole system approach rather than just compliance
- Creating a crew culture of compliance - e.g. "It's only as effective as the onboard leadership"
- Increase equipment capacities
- Correctly designed sludge/bilge segregation systems
- Providing adequate spare parts - e.g. "Some owners put CE's in a precarious position by not having a properly functioning OWS, not supporting with supply of necessary spare parts"
- "Most ship visits I have conducted to solve problems involve a lack of operator maintenance, inoperable equipment or the wrong type of equipment for the vessel's operating condition. One size or type of equipment does not solve waste stream problems. Evaluate vessels from a whole vessel and crew perspective to solve discharge problems."

Oily Water Separators

Perceived effectiveness:

The average perceived effectiveness of OWS's was 7.2 out of 10 (median = 8, mode = 8), and as expected, the MEPC 60(33) compliant equipment was perceived as less effective than the MEPC 107(49) equipment¹⁰.

Issues reported when operating an OWS¹¹ included equipment breaking/malfunctioning (14 responses), dirty/muddy water affecting performance (12 responses), frequent maintenance/cleaning (9), clogging (8), staying under the 15 ppm limit (7), alarm/sensor failure (7), soaps/detergents

⁹ Within the past two years

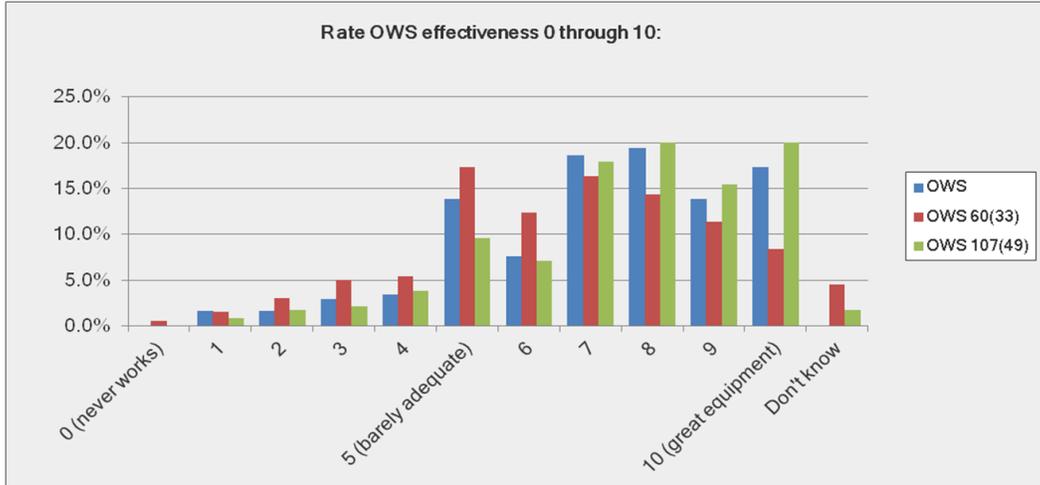
¹⁰ 60(33) Mean: 6.54, Median: 7, Mode: 5

107(49) Mean: 7.52, Median: 8, Mode: 8

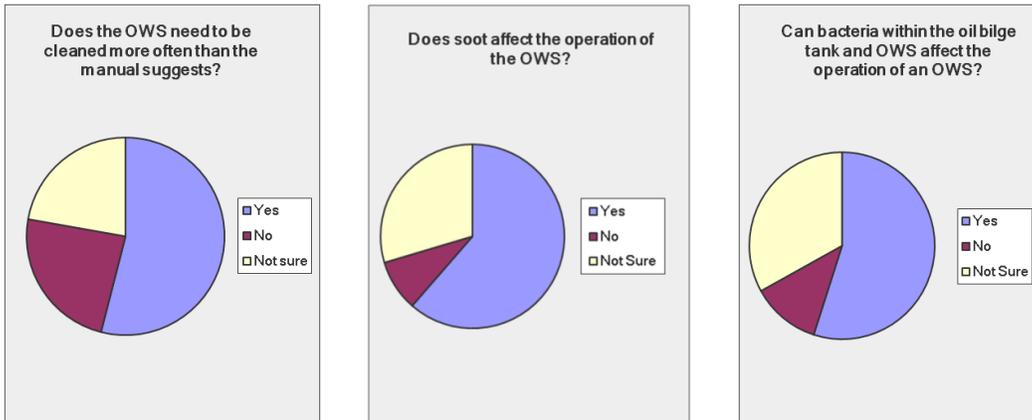
¹¹ In response to the question "What are the common issues you experience (or have heard of) when operating an OWS?", which received 161 responses.



affecting operation (6), contamination (6), emulsions (5), and lack of familiarity/understanding of the system (5).



The following considerations also appear to be relevant:



However, we note that MEPC.60(33) units are no longer manufactured, as ships constructed after 2005 must be fitted with MEPC.107(49) units, and therefore we should focus on problems with 107(49) units. Common complaints about MEPC.107(49) units were:

- Time-intensive maintenance/cleaning
- Faulty OCM readings, e.g. "Better 15 ppm monitor designs. Most monitors give incorrect alarms when the sample is dirty due to mud or rust from pipelines."
- Contamination of the filtering elements, e.g. "Second stage filters (like spirolators) become clogged too fast and are expensive"

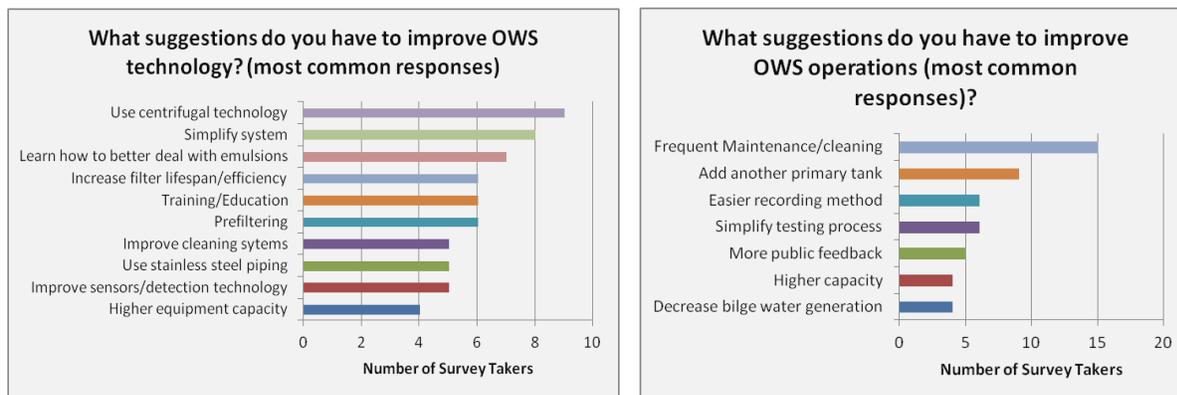
The "favorite" OWS manufacturer was JOWA, followed by Alfa Laval, RWO, Marinfloc, and Coffin (respectively). The favorite OCM manufacturer was Deckma. However, due to the large number of OWS manufacturers, low frequency of individuals with exposure to many different types of OWS



systems, and considering the size of our survey, our survey's rankings are unlikely to be an accurate representation of the preferred manufacturers throughout the industry.

Increasing effectiveness:

Improving OWS technology was a common suggestion throughout the survey results, and more specifically, suggestions from our survey takers included:



Based on the survey results, it appears that a large number of reported issues with MEPC.107(49) units can be improved through adequate crew training¹² (see the training section of this report), and ensuring that the OWS system selected is the proper one for its intended use. For a shipowner, these types of systems considerations will likely provide the greatest improvements to OWS operations.

For the remaining issues, particularly the time-intensive nature of OWS cleaning/maintenance and OCM detection problems, we note that the best method to address issues may not be to amend regulations to make a particular technology required, but rather to incentivize manufacturers to continue to improve OWS/OCM technology¹³.

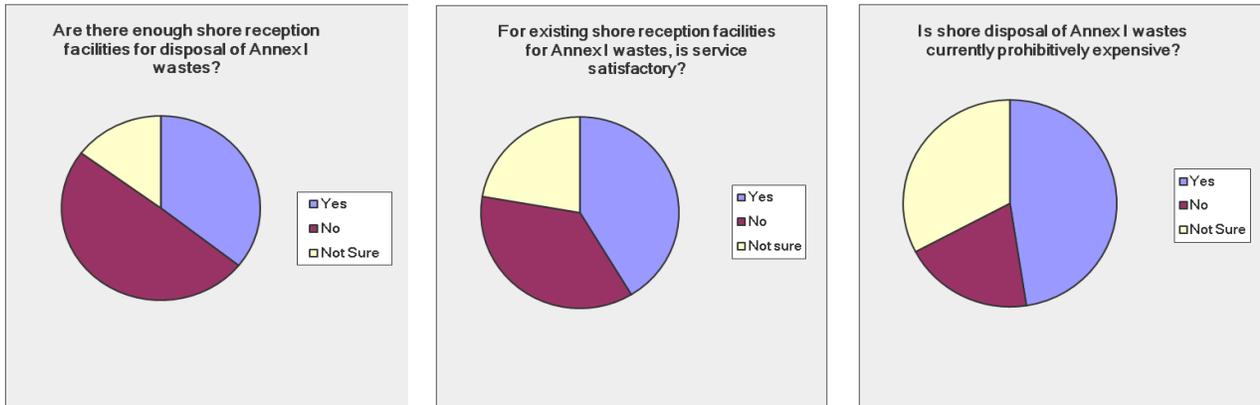
Port Reception Facilities

Perceived effectiveness:

Common issues cited for PRFs were cost, lack of facilities, improper disposal, environmental considerations and time considerations. The following charts show considerable perceived inadequacy of PRFs in terms of availability, service, and cost.

¹² For example, interestingly, 23% of all survey takers with OWS operational experience said that the OWS did not need to be cleaned more frequently than the manual suggests. However, among those that only operated a 107(49) OWS and had had formal OWS training, this number went to 45%.

¹³ For example, Rik van Hemmen proposes that the USCG names both the shipowner and the OWS/OCM manufacturers in press releases regarding OWS-related pollution prosecutions. His blog on this subject is available [here](#).



In the open-ended question asking what the biggest problem with PRFs was, the most popular response among survey takers was cost.

Increasing effectiveness:

Unfortunately, at the time of survey design, we did not anticipate the extent of the PRF problem and therefore did not build questions that mined specific suggestions for improving PRFs.

In any case, it is clear that the availability of PRFs that accept MARPOL Annex I wastes needs to be improved¹⁴. It is possible that this will inherently lead to improved service and reduced costs due to competition and oversight, and if not, new solutions may have to be developed to force PRFs to do so.

Common ideas mined from open-ended questions included:

- Develop relationship between shipboard personnel and shore facilities (feedback mechanisms for customer satisfaction)
- Increase speed of discharge
- Move burden of PRF disposal cost - e.g. "Every port should have mandatory reception facility which should be part of the port dues. This should cover all vessels staying or calling at anchorage"

Training

Perceived effectiveness:

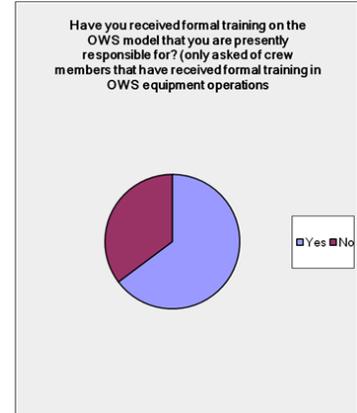
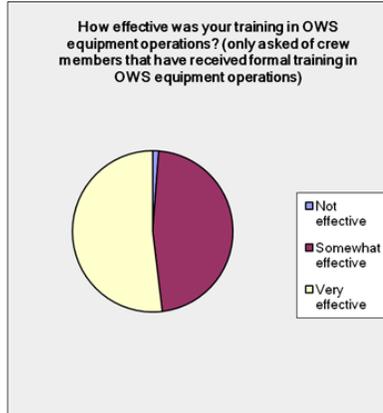
Increased *and* improved training was consistently noted by survey takers as key to improving shipboard waste stream management. Training was also the most common suggestion for the open-ended question on how to improve shipboard waste stream management.

For general MARPOL Annex I waste stream management, only 5% of crew members have not received any training.

¹⁴ We note that, in theory, all signatory states that are party to MARPOL Annex I (see Regulation 38) are already required to provide adequate reception facilities.

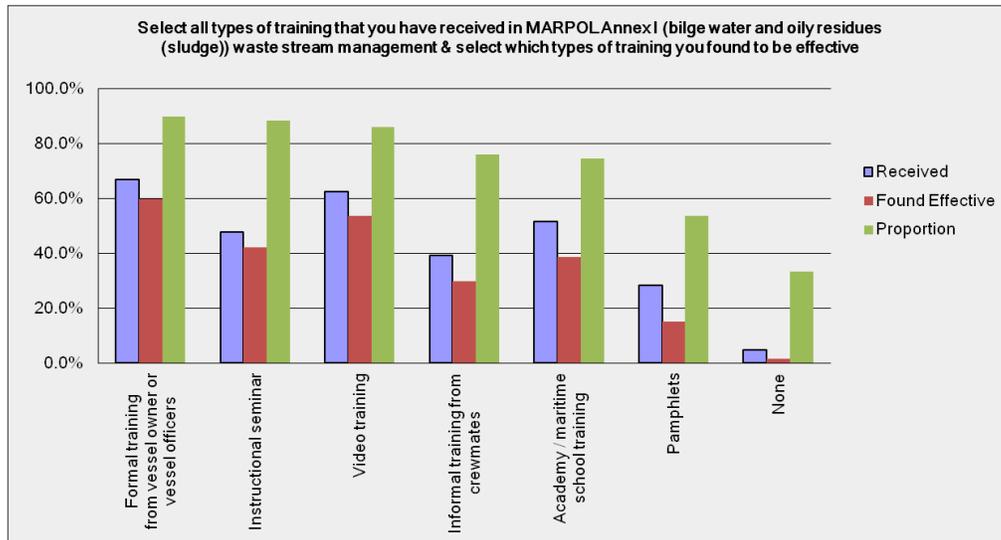


Lack of OWS training was far more common, and of those crew members with OWS operational experience, only 55% have received formal training in OWS equipment operations. Of those with training, the results to the right apply.



Increasing effectiveness:

For MARPOL Annex I training, among crew members, the type of training that was perceived to be the most effective was formal training from vessel owner or vessel officers (designated person), followed by instructional seminar, and video training, respectively¹⁵.



Regarding OWS training, suggestions of *specific* OWS training (by manufacturer) and use of operational training were very common in the open-ended responses.

Paperwork

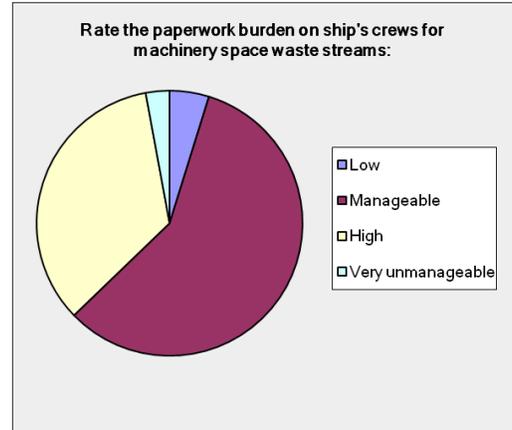
Perceived effectiveness

Paperwork reduction was a common response in a number of open-ended responses, and two solutions related to paperwork reduction were on the top ten list of suggestions to improve shipboard waste stream management (Question 56).

¹⁵ However, when filtering for crew members who live in Asia, the most effective self-reported methods of training were instructional seminars and video training.



The majority of survey takers with waste stream management experience in the past 2 years thought that the paperwork burden on ship's crews for machinery space waste streams was manageable (58%). That said, reducing and streamlining paperwork would allow crews to spend more time maintaining drier bilges (e.g. chasing leaks, staying ahead on maintenance), as discussed in the general shipboard waste stream management section above.



Open-ended responses also included a number of complaints similar to the following examples:

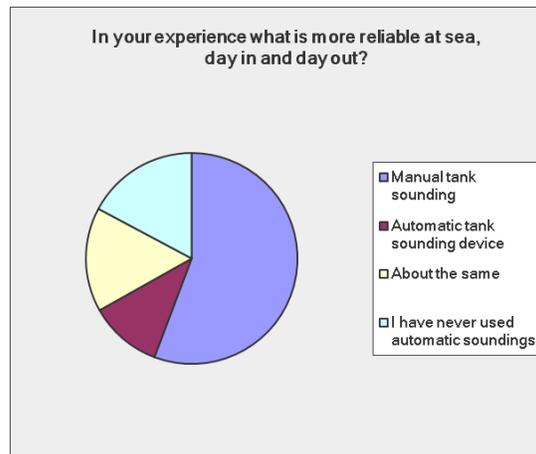
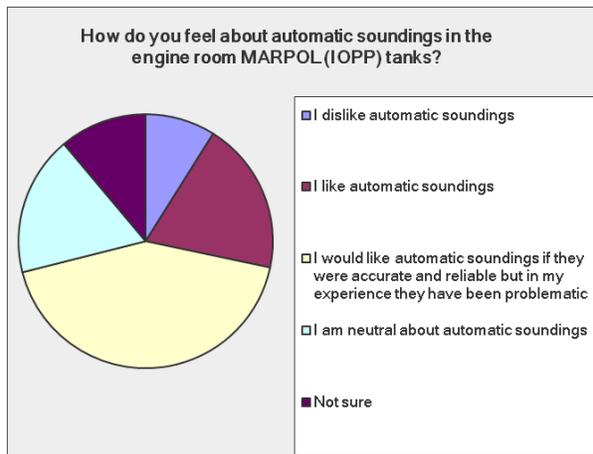
- "Too much paperwork. Cannot operate effectively because we are constantly to see if we have logged the operation correctly."
- "Big problem in US that USCG has not updated ORB since 2007. This makes it difficult to fully comply with changes to MARPOL Annex I that have been adopted."

Increasing effectiveness

Reducing paperwork was a very common suggestion in the open-ended responses. More specific paperwork reduction suggestions included:

- *Approved* automated software systems (e.g. electronic ORB linked to automatic tank soundings)
- Streamline and reduce redundancy, e.g. all waste streams in a joint digital framework
- A "paperwork officer" / "clerk" crew member
- "Think you are at the middle of ocean, rolling about 15 days and manual sounding taken and try to match with Orb. This is an ex. When u want to implement a documentation think you are onboard not on a desk in office."

Automatic soundings could theoretically reduce the handwritten paperwork required for manual soundings and be automatically logged into a computer, but crew members cite accuracy concerns with current technology:





In response to the possibility of electronic Oil Record Books, 41% of people with shipboard waste stream management in the past two years indicated that they would prefer an electronic ORB with more automation. As suspected, when this number is broken down by years in the industry, those that indicated they were in the maritime industry <10 years averaged 53%, and those >30 years averaged 37%, probably as a result of young members of the industry's higher level of familiarity with computers. Interestingly, when filtered by crew members, the percentage did not change significantly, while when filtered for those involved with regulatory maritime matters, the percentage averaged 59%.

Future opportunities

During analysis of the survey results, it quickly became apparent that the survey data collected was incredibly rich, and could be mined for far more data than that detailed above. We endeavored to make the points raised above reflective of the main issues and suggestions raised by survey takers, but certainly have not detailed all valid and interesting data.

The raw data is available in its entirety in Excel format should anyone wish to conduct their own analysis. If you choose to conduct further analysis, please feel free to submit interesting results to Martin & Ottaway via info@martinottaway.com to be used for further dissemination to the public. We compel everyone to use the data responsibly and to avoid "cherry picking" results.

We also note that the survey remains open to accept new responses, and therefore that results may change over time.

Go to www.martinottaway.com/technical-documents/MAX1-Studies/survey to find:

- The electronic version of this report
- Full list of MAX1 Survey questions
- Skipping logic flow chart for MAX1 Survey questions
- Summary results for all questions as of August 11, 2015
- Full raw data for all questions as of August 11, 2015
- Open-ended responses to OWS technology questions
- Selected filtered survey results by age, profession, continent, and vessel type

Finally, we want to thank everyone that was involved in the development and dissemination of the survey, as well as all that took the time to take it. This survey was intended to provide a method for measuring progress for an issue that has very few available metrics, and we believe the results were incredibly valuable for waste stream management improvement. In the words of one of our anonymous survey takers: "Things that are not understood are ignored".