Review of Ministry of Land, Infrastructure, Transport and Tourism (MLIT) Ship Scrubber Report and Presentation.

Review by Greg Atkinson: 16th May 2019. Responses from MLIT: 6th June 2019.

Documents Reviewed

1. Reviewed report:

   Report by the expert board for the environmental impact assessment of discharge water from Scrubbers (Japan) - July 2018.

2. Reviewed presentation:

   Washwater discharge from open-looped SOx scrubber system – 19/2/2019.

Reviewer

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Introduction

This document contains the questions and comments submitted to the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in Japan after a review of the materials listed above. The responses received from MLIT are also included.

Document History

Revision	Comments	Date
A	First release. Submitted to MLIT for their final comments.	12th June 2019
B	Minor edits inserted as requested by MLIT.	13th June 2019

Report: Comments & Questions

Overall comments & questions

1) Have any of the papers/chapters in the report been peer reviewed in English or published in a journal?

MLIT Response: Peer review was conducted by independent third committee (expert board) established by Japanese Government (MLIT, Ministry of Environment and Fisheries Agency), and the whole study was approved by it. This expert board consists of authoritative researchers and professors in the field of atmosphere, marine ecologies and science, fisheries, engineer etc.

2) In some areas of the report the meaning of sentences are unclear or ambiguous. This is probably due to the translation from Japanese to English, however if this report was submitted to an international committee (e.g. MEPC) then perhaps the report should have been proof read by experts fluent in English before submission?

MLIT Response: The result of this study was well assessed and endorsed by the expert board in Japanese language. On the other hands, the translation to English has not been reviewed by the expert board. Therefore, there could be some ambiguities or misinterpretations through translation. For example, “an actual scrubber installed on board” in 3.1.2.4 should be “an actual scrubbers to be installed on board”. More specifically, an actual scrubbers which was designed and produced to be used on board ship was used at an on land facility with marine engine. We apologies for those confusions.

3) The report appears to be a series of independent studies related to open-loop scrubbers rather than report related to one specific research study project. Is that correct?

MLIT Response: This research was conducted as one project and the studies were carried out based on the best available data and samples in Japan at that time. Please note that scrubber are not yet used on board ships in Japan because there is no ECA in the sea area around Japan.

4) Overall the report in my opinion does not support the conclusion that open loop scrubbers are safe and/or cause acceptable damage to the marine environment due to the limited scope of the studies contained in the report and the many limitations outlined in this review.

MLIT Response: We do not agree to your views on “limitations” by the reasons explained in the following answers.

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5) It is mentioned that a *“simplified physical model was used”* – is this not an important

limitation that should be stressed?

MLIT Response: Vessels in actual seas are sailing in flow fields with diffusion effects brought by waves, ocean and tide currents, etc. In this simulation, however, we are considering a more stringent condition of dilution than reality. When a uniform flow is put in the condition without any diffusion effects by waves, the calculation of dilution rate in this simulation would not be higher than the one in the actual condition. Therefore, this is not a limitation but a stringent condition.

6) It is stated that the *"ship is sailing straight ahead in calm waters".* This limits the scope of the study and yet the results are applied to a wider group of ships that would be operating at different speeds, under different conditions and also manoeuvring. This is an important limitation and means for example that the results cannot be applied to ships operating at lower speeds. Is that correct?

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7) The scope of the study appears limited to a Panamax bulk carrier (DWT 82,000 tons) with the dimensions outlined in paragraph i) sailing at a constant speed of 12 knots. Again these are important limitations and narrow the scope of the study and applicability of the results. Yet there is no limitations section in the overall report nor in any of the chapters as would commonly be found in a scientific or published paper. Can the lack of a section (or sections) that highlights the various limitations of the report(s) be explained?

8) It is stated *"The vessel's speed was assumed to be constant speed at 12 knots, supposing that the ship is sailing at the maximum speed limit on designated congested routes, regulated by the Japanese Maritime Traffic Safety Act."* This is an assumption that appears overly simplistic and would most likely improve the rate of SDW dilution in seawater compared to ships sailing at lower speeds. Yet the report does not investigate this nor mention it as a significant limitation of the study. In addition a quick review of ship traffic on the 11th May 2019 using an online marine traffic website indicated ships were operating in and near Tokyo Bay at a variety of speeds below 12 knots with the large container ship Wan Hai 505 sailing at 8.9 knots for example. Therefore a study of a ship operating at 12 knots in congested waters is one of many possible scenarios that should been considered. If only a ship operating at 12 knots was considered then the report alone cannot be used as a basis for prediction the potential damage to the marine environment.

MLIT Response (to Q6, Q7, & Q8 and later Q16 & Q18): It is a fact that a larger volume of the plume will be discharged when a ship engine is operating at a higher power. If the speed is reduced, the turbulence around the ship will be weakened (or constant in well-developed turbulence field), but at the same time, the volume of the plume will be largely reduced in proportion to cubic of the speed. For example, when reducing ship speed from 12 knots to 8.9 knots (26% reduction), the volume of the plume will drop by approximately 60%. Considering the worst case based on the above, we made calculations assuming all

ships in the selected three bays are operating at the maximum speed limit (12knt) regulated by the Japanese Maritime Traffic Safety Act. In addition, we assumed engines are running at higher power than that for 12 knt. This makes the studies more stringent than reality. It should also be noted that, according to Townsend's law, the scale of turbulence does not change in a well-developed turbulent field around a ship even if the ship speed changes. Therefore, it can be said that the dilution effect will not be changed at lower speed while the amount of discharge will be significantly reduced. When ships are berthing at ports, the volume of discharge harmful substances will be significantly less than the case of ships navigating at 12 knt because the main engines are stopped when berthing.

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9) What is the basis for the assumption that the SDW outlet is 1 m below the waterline? Is this based on the actual location of the SDW on a Panamax ship? If so which ship and what type of scrubber? Also by setting the SDW outlet at 1 m below the waterline this assumes that the draught of a ship does not vary between when the ship is laden or unladen, when the weight of the cargo varies or when the trim of the ship is adjusted. Was any investigation carried out using SDW outlets at various depths and if so, shouldn't the results be included in the report?

MLIT Response: According to some shipyards , manufactures and classes, the SDW outlets are normally located about 1m below the waterline. That is the reason we choose 1m below the waterline. Regarding the type of scrubber, this part of fluid simulation has nothing to do with it. It only simulates turbulence around the ship regardless of the type of scrubber. You are correct that depth of the outlet will change depending on the condition of the ship (e.x., trim, cargo). However, we cannot simulate in detail all conditions for all shiptypes and sizes in detail. Scale and orders are important for simulating fluid dilution in this section and slight differences between ship designs and conditions are not the priority. Some modelling and approximation is inevitable. Therefore we have chosen a typical shiptype and condition, and put worse conditions to some parts. Please also note that in the part of the concussion of this report, it only evaluates the order of the effect (e.x., the additional accumulated concentration by the target substances is less than 100 folds' dilution of the current concentration in the respective target areas (Chapter 4)) and concludes that the risks to the marine environment are in the acceptable range.

10) On Page 11 the design speed is stated as being 14.2 knots with at an MCR of 9.5 MW and then in section iv) the engine power at 14.2 knots is stated as being 7.4 MW. Is there any explanation regarding this difference?

MLIT Response: The engine power of the ship corresponding to the "design" or normal speed (14.2knt) is 7.4MW. The speed at an MCR of 9.5 MW will be higher than 14.2 knt. However, in this study the speed was assumed to be constant at 12 knots, supposing that the ship is sailing at the maximum speed limit as regulated by the Japanese Maritime Traffic Safety Act. The output of main engine corresponding to the set speed (12knt) is 4.5 MW. However, we used 7.4 MW as the condition of engine output in the simulation

without changing the ship speed 12knot to make it more stringent than reality. 9.5MW (MCR) is not used in calculation. This value is shown as just a reference.

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11) The meaning of this sentence is unclear: *"However, to aggregate the adverse effect of the pH and the dissolved oxygen concentration, in this experiment both the dissolved oxygen concentration and the pH were not adjusted at pretreatment with the dilution by a natural seawater, both will be recovered."*

MLIT Response: The statement provides purely methodological issues on WET performed. The methodology used for WET allows pH adjustment by using chemical additives and/or DO adjustment by aeration. Such adjustment is clearly stated both in the methodology of WET by US EPA, and draft methodology for WET developed by the Ministry of Environment Japan. However, in this study, either pH or DO was not adjusted before diluting by a natural seawater to get an actual acute adverse effects by the residual toxicity together with lower pH and DO. For example, the original pH at test site was 3.5, and the pH of dilution series were varied from 3.3 to 8.0, depending on the dilution ratio by the control water with pH 8.0.

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12) The meaning of this sentence is also unclear: *"Scrubber discharge water as a test sample decreases pH and dissolved oxygen concentration due to its characteristics. In this study, exposure tests were carried out with no adjustment either of pH and dissolved oxygen concentration, considering the drop in pH and dissolved oxygen concentration as an influence on the test organism."* This also appears to be an important limitation that should be stressed or is it not important?

MLIT Response: Without adjustment to pH and DO, the residual toxicity will be maximised. In other words, if the adjustment was performed, then the acute ecotoxicity mainly caused by lower pH and DO will be cancelled, and EC50 or EC10 should be higher (near to 100 % dilution ratio). Therefore, the applied methodology could not be one of the limitations.

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13) In section 3.1.2.4 it is stated that the test sample was from an actual scrubber installed on a ship. However the ship type is not mentioned nor is the speed the ship was operating at. Also where was the SDW outlet located and what type of fuel was the ship using? Shouldn't these details be included in the report?

MLIT Response: As we have already answered for question (2), "an actual scrubber installed on board" in 3.1.2.4 should be "an actual scrubbers to be installed on board". Apologies for the confusion. The sample was taken from the scrubber fitted to an engine on land. The depth of outlet and shiptype does not have value, even if the sample was taken from scrubber onboard. The property of the fuel used for this test is shown in Table 3-6.

14) In paragraph ii) it is mentioned that an experimental 4-stroke 257 kW diesel was used. How is this connected to what is described in Chapter 2 or connected to the test sample? Also the discussion regarding the 257 kW diesel seems to be unrelated to the Panamamax bulker. Is that correct?

MLIT Response: The power output of 257 kW is only for chapter 3, has no connection to Chapter 2. In chapter 3, a dilution ratio which can be acceptable for marine organisms are verified from the view point of ecotoxicity. On the other hand, in Chapter 2, it is used for calculation of physical dilution ratio per time elapsed after discharge. Flow mass of discharge water could be relevant to the scale of the engine onboard, but the scale of the engine is not relevant to the concentration of PAH and metals in the discharge water. Moreover, the pH of discharge water was set at a level close to the lower limit required by the IMO EGCS guideline as the worst case by reducing the flow rate against exhaust gas flow rate. The acceptable dilution needed in chapter 3 was led by ecotoxicity methodology, and only the concentration rate was considered in the methodology. This dilution rate can be applied to all engines, if the concentrations are similar. Therefore, there is no relation between the toxicity and the volume of discharge water. Only when considering the duration time to reach the dilution rate, the outputs from chapter 2 was used.

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15) Table 3-6. Why is fuel with a sulphur content of 2.24% used? This appears to be a low sulphur rate for HFO.

MLIT Response: The value was taken from the IMO sulfur monitoring program, it is well known that the actual global average is lower than its limitation of 3.50%.

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16) *"Taking into account that ships are basically moving, and the discharge water would be immediately caught in a turbulence and swirl generated around the hull, it is considered that it is not unlikely that the lower pH in the scrubber discharge water poses any unacceptable risks to the surrounding ecosystem."* How about when ships are operating at lower speeds especially when berthing? Also this statement does not appear to reflect what is actually in the study since the dilution rates at varying ship speeds and SDW outlet depths were not considered.

MLIT Response: As per the answer for Q6, Q7 & Q8.

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17) *"It is considered that the scrubber disparage has less flow rate per one vessel than the hot discharge water from a power plant, and since the former is moving, it is difficult to assume that the scrubber discharge is fixed in one local point."* This seems to be an assumption. Is there any evidence or science to support this?

MLIT Response: The flow rate per one vessel is about around 50 ton/h from main engines of 1 MW at full load, which is far less than the one from a large-scale power plant, 50 ton

/min, according to TEPCO (the major electrical facility company in Japan). Additionally, it is obvious that the continuous plume from the power plant will be discharged from one single point, while ships with full load moves around. Therefore, it can NOT be expected that a large amount of scrubber water be discharged from one local point like on land power plant.

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18) *"Therefore, under the conditions that the ship is moving and the swirl can mitigate the hot plume, the hot plume itself could be steady, and it is quite unlikely that the thermal energy added in the discharge water may cause any risks on the surrounded ecosystem."* This appears to be another assumption is that correct? At what ships' speed is this assumed to occur? At 12 knots? Can this statement really be justified by what is contained in the report?

MLIT Response: As per the answer for Q6, Q7 & Q8.

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19) *"Accordingly, it is less probable that the identified 22 PAHs may cause unacceptable risks."* The meaning of this statement is unclear and this is due to the translation from Japanese to English. It seems to be an important point so can the meaning be clarified?

MLIT Response: As the previous sentence in the report indicates, 9 out of 22 PAHs were detected by actual measurements, but the concentrations of those detected PAHs were slightly above their detection limits (0.005ug/L or 0.01ug/L). Please note that those detection limits are sufficiently low to monitor the environmental concentration. The results indicated that 13 out of 22 were NOT detected in the discharge water, the same as the usual clean sea water around Japanese coastline. These values are far less than the IMO standard (50µg/L). Also, according to other scientific papers and Toxicity Tests which were independently done by Ministry of Environment Japan, those values are far lower than EC50 of those substances. Therefore, we could not find out the needs for further assessment on risks caused by those less amount of PAHs.

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20) Table 4-1. *"Actual measurement of the concentration of Polycyclic Aromatic Hydrocarbons (PAHs) contained in washwater from a scrubber".* Which scrubber does this refer to – the one on the ship or the one used for lab testing?

MLIT response: The sample for this PAH measurement is the same as the sample delivered to WET testing described in Chapter 3. Therefore, it refers to the scrubber used for lab testing.

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21) Table 4.2. Sulphur % m/m for HS HFO (10 samples) is listed as being 0.28 – 2.49. That is quite a large range. Is that correct or perhaps it's an error?

MLIT Response: As it is indicated in the foot note of the table, these samples of HS HFO are taken among the fuels used for domestic shipping lines.

22) Table 4-3. *"Actual measurement of the amounts of heavy metals contained in washwater from a scrubber".* Which scrubber does this refer to – the one on the ship or the one used for lab testing?

MLIT Response: It refers to the scrubber used for lab testing. It is the same one used in measurement of PAHs in the table 4-1.

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23) Tables 4.5 to 4.10 seem to contain background and reference information only not actual measurements or calculations. Is that correct? If so what is the scientific value of this information being included in the report?

MLIT Response: The main purpose of chapter 4 is to assess how the discharge water cause changes in the amount of pollutant that has been regulated or controlled under discharge or ambient standards in Japan. Tables 4.5 to 4.10 explain how the screening was performed to examine whether those pollutant can be theoretically contained in the wash water from scrubber or not.

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24) *"Upon screening, it was clear that following target substances in washwater which may pose risks to the marine aquatic organism; total phosphorus (occurs in minute amounts in fuel oils), total nitrogen (dissolved NOx in exhaust gases) and COD (constitutes a part of unburnt fuel as an organic carbon)."* The meaning of this sentence is unclear. Does the washwater pose a risk to marine aquatic life or not?

MLIT Response: It was intended to mean, "Upon screening, following substances came out as the substances in washwater that might have possibility to pose risks to the marine aquatic organism and should be targeted for detailed assessment: total phosphorus (occurs in minute amounts in fuel oils), total nitrogen (dissolved NOx in exhaust gases) and COD (constitutes a part of unburnt fuel as an organic carbon)." This statement is the results of the screening process that was conducted prior to simulation. This is an usual manner for a screening process. This screening process does not conclude whether or not the washwater pose a risk to marine aquatic life. Sorry for the ambiguity caused by the translation

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25) *"For the purpose of the calculation, it is assumed that, when all number of the ships are installed with scrubbers, therefore, all amount of the sulphur content in fuel oil (2.46% in HFO and 0.61% in MDO) is dissolved into the washwater and discharged to the*

target coastal areas." In Table 4-2 other values for the sulphur content in fuel are listed. Therefore why is it assumed that all ships with open-loop scrubbers would be using HFO will a relatively low sulphur content of 2.46%?

MLIT Response: The value of sulphur (2.46 in HFO and 0.61% in MDO) was taken from the IMO sulfur monitoring program, it is well known that the actual global average is lower than its limitation of 3.50%. As the purpose of chapter 4 is to assess long-term effect on the environmental concentration, we intentionally did not select the actual measurement, instead the global average. The methodology applied is the same as SOx inventory in IMO GHG study which is submitted to UNFCCC.

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26) *"In accordance with the above, the additional accumulated concentration caused by washwater discharge from scrubbers would not introduce adverse effect on the current attainment of the environmental standard of pH, total nitrogen, total phosphorus and COD."* What about heavy metals & PAH's? Also how can that statement be justified from what appears to be a very limited and narrow study as outlined in Chapter 4?

MLIT Response: With respect to PAHs, in the screening process, we found out that only 9 out of 22 PAHs were detected, and the amount of these detected PAHs respectively was extremely low slightly above their detection limits (see question 19) . With regard to heavy metals, the actual amount of them in the discharge water was substantially less than the discharge standard for on land sources in Japan, by order of 100 or more, which is clearly stated in the report. Therefore, we didn't select PAHs and heavy metals as targeted substances for detailed simulation. Please note that Japan does not set its national ambient criteria for seawater on PAHs. Therefore, as for PAHs, we compared the discharge concentration with the EC10 values in a scientific document. Secondly, the discharge scenario is based on facts or international standards, such as the global average of sulphur content in heavy fuel, maximum limits for NOx (emission standard under MARPOL annex VI), and the same Emission Factor for COD(PM) as the IMO GHG study has applied. Also, the worst-case scenario that ALL ships would be installed with scrubber was taken. Therefore, we consider that the conclusion of Chapter 4 is quite clear without any limitations.

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27) *"In conclusion, the effect that washwater from scrubbers causes to the permissible effluent standards upon the target coastal areas is signigficantly limited".* Can this statement really be justified by the data and calculation contained in the report? Were for example any actual samples taken from the ocean after washwater was discharged from a ship fitted with scrubbers? Also please note my earlier comment about dilution rates being related to the speed of the ship.

MLIT Response: As we have already answered for the question (3), this study was carried out based on the best available data and samples in Japan at that time. Please note that

scrubbers are not yet used on board ships in Japan because there is no ECA in the sea area around Japan.

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28) *"As a result of the above-mentioned EIA, it was concluded that the risks either to the marine environment and the marine aquatic organisms are in the acceptable range."* What is the acceptable range? How was this determined?

MLIT Response: Acceptable range is defined according to its purpose. For chapter 3, the duration time to reach to PNEC (a few seconds) was compared to the duration time of exposure test (96 hours). For Chapter 4, the accumulated concentration of the potential pollutants was compared to the national ambient criteria or the current level. They were all substantially far from the concerned level (more than 2 digits away).

29) *"For the reasons stated above, it was further concluded that risks of discharge water from scrubbers to the marine environment and the marine aquatic organism are negligible from short- and long-term perspectives."* Is this statement based on just this report?

MLIT Response: The conclusion was led based on the data in the report, and the conclusions were verified by the expert board, including the experts for marine ecology, marine biology, ecotoxicity and simulation

30) Why are no other scrubber related studies discussed in the report. For example:

Assessment of possible impacts of scrubber water discharges on the marine environment.
https://mst.dk/service/publikationer/publikationsarkiv/2012/jun/assessment-of-possible-impacts-of-scrubber-water-discharges-on-the-marine-environment/ or

A New Perspective at the Ship-Air-Sea-Interface: The Environmental Impacts of Exhaust Gas Scrubber Discharge.
https://www.frontiersin.org/articles/10.3389/fmars.2018.00139/full

MLIT Response: Japan has examined the outputs from these report, and took into account when we considered our methodology for our EIA.

31) Many important limiting factors/limitations related to the studies contained in this report (some of which have been mentioned above) should have been included either in the conclusions section or in separate sections. Isn't this standard practice for a scientific paper or report?

MLIT Response: This report was originally developed as a background paper to support the Japanese government in making domestic policy decision and is not an usual academic research paper. In addition, as we have already answered, peer review was conducted by independent third committee (expert board) established by Japanese Government (MLIT, Ministry of Environment and Fisheries Agency), and the whole study was approved by it.

As mentioned in the previous answers, we do not agree to your comment that there are many important limiting factors/limitations in the study. We believe this study provides sufficiently reliable outcome based on best efforts within limited time and budget utilizing available information and technologies as of today. In this study, the internationally accepted methodologies are applied for ecotoxicity testing to marine organisms and long term simulation estimating accumulated concentrations. Conservative approaches are also taken in many parts of the study. They were all great challenges and we think there are no such studies have arrived at this level so far. If any more reliable counter studies will be provided, we will be pleased to look into them and opened for consideration.

Presentation: Comments & questions from Reviewer

1) Page 11 - The CFD simulation was only for one type of Panamax operating at 12 knots sailing on a straight course in calms seas with the SDW outlet at a constant depth below the waterline. This should have been highlighted.

MLIT Response: As per the response for Q6, Q7, Q8.

2) Page 14 - The statement "*Japan concluded that either any short or long term effects on marine organisms cannot be caused by the use of open-looped scrubber. "* This statement is not in my opinion, supported by the science outlined in the experts report especially if none of the studies or research have been peer reviewed or the results replicated by other researchers.

MLIT Response: As per the response for Q1.

3) Page 18 – The statement *"Japan concluded that the discharge……."* does not appear to be fully supported by what is contained in the expert's report. It also appears further research should have been undertaken before such a statement was made especially if none of the chapters in the report have been peer viewed and/or published in journals. What is MLIT's view regarding this?

MLIT Response: As per the response to Q31.