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REDUCTION OF THE IMPACT ON THE ARCTIC OF BLACK CARBON EMISSIONS FROM INTERNATIONAL SHIPPING

Comments on the report of the Correspondence Group on Prevention of Air Pollution from Ships and other relevant documents

Submitted by FOEI, WWF, Pacific Environment and CSC

SUMMARY

Executive summary:	This document comments on issues raised during the work of the Correspondence Group on Prevention of Air Pollution from Ships to develop draft guidelines on the reduction of the impact on the Arctic of Black Carbon emissions from international shipping, technical and potential fuel standards and thresholds, the related question of a paraffinic indicator addressed by the International Organization for Standardization (ISO), and the geographic scope of Black Carbon control measures.
Strategic direction, if applicable:	3
Output:	3.3
Action to be taken:	Paragraph 14
Related documents:	PPR 8/5/1; PPR 10/18, PPR 10/18/Add.1; PPR 11/6, PPR 11/INF3, PPR 11/6/1, PPR11/6/2, PPR 11/6/3 and PPR 11/INF 7

Background

1 This document is submitted in accordance with the provisions of paragraph 6.12.5 of the *Organization and method of work of the Maritime Safety Committee and the Marine Environment Protection Committee and their subsidiary bodies* (MSC-MEPC.1/Circ.5/Rev.5) and provides comments on documents PPR 11/6 (United States), PPR 11/6/1 (Canada et al.), PPR 11/6/2 (ISO) and PPR 11/INF.7 (ISO). The co-sponsors provide the following information and views for consideration by the Working Group expected to be established during PPR 11 and further discussions on this agenda item.

Black Carbon reduction target threshold

2 Black Carbon (BC) emissions from marine engines depend critically on engine and ship type, engine age, operating conditions, and fuel type. The Correspondence Group (CG) has recognized these factors and has avoided a one-size-fits-all engine technology approach and instead focused on developing a voluntary test regime and ship-specific inventory of BC emissions from all onboard marine engines (PPR 11/6). Under this voluntary programme, each ship would be encouraged to set its own voluntary BC reduction target threshold and achieve its individual BC management plan. Measuring emissions at certain points needs to include the engine mode (load and speed) and time-in-mode. Weather and sea ice may be further variables. Combining measurement and operations data can produce a high-quality inventory, but scaling this to all ships to identify consistent trends may be a challenge. Implementation will require both considerable individual ship effort and ideally adherence to a consistent measurement and reporting protocol.

3 Many CG participants noted that, in setting a reduction target threshold, ships might want to consider the BC reduction potential that may be achieved by switching to distillate fuel, as recognized in resolution MEPC.342(77), which was adopted over two years ago. The co-sponsors recommend that implementing resolution MEPC.342(77) should be the starting point for the Guidelines for ships and shipping companies and not merely a reference.

Fuel quality and standards

4 Document PPR 11/6/2 (ISO) notes that ISO's work to develop a paraffinic indicator for marine fuels was triggered by document PPR 8/5/1(Finland and Germany), showing that the aromatic content of marine fuels is directly linked to the amount of BC emissions in the exhaust gas. ISO's approach is based on the Viscosity Gravity Constant (VGC) as described by M R Riazi in a 2005 ASTM fuels publication. This approach was questioned at PPR 10[1] because this older research did not account for changes made to the composition of HFO in order to comply with the global sulphur cap. Riazi acknowledged, in 2005, that VGC is "a parameter defined in the early years of petroleum characterization,"[2] while document PPR 11/INF.7 notes that its formulation has been revised several times. Calculating a fuel's VGC involves a two-step step process – first using the fuel quality results for density and viscosity of fuel test samples, and then using a complex algorithm set out in ASTM D2501. One important limitation of using VGC, already noted as early as 1935,[3] is that "although it is very useful when applied to relatively paraffinic lubricating oil stocks […] its values lose significance when applied to highly aromatic stocks […]. Because of this restricted applicability in regard to both paraffinicity and viscosity, it cannot serve as a general method of characterization applicable to all stocks." Indeed, the ASTM 2501-14 test method for VGC[4] stipulates that it only covers petroleum oils having viscosities in excess of 5.5 mm^2/s at 40°C (104°F) and in excess of 0.8 mm^2/s at 100°C (212°F), which means that the indicator proposed in document PPR 11/6/2 cannot reliably be applied to most of the gasoil type products.

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1 PPR 10/18/Add.1, annex 19, pages 1 and 2.

2 Riazi set out VGC's parameters in a joint 1986 study; Mohammad R. Riazi and Thomas E. Dauber, Prediction of Molecular-Type Analysis of Petroleum Fractions and Coal Liquids, Ind. Eng. Chem. Process Des. Dev. 1086, 25, 1009-1015. http://www.riazim.com/sample/CompositionIEC86.pdf

While aromaticity, as defined by its VGC, was evidently first described by Hill and Coates in 1928. US Patent office on 26 May 1953. https://patents.google.com/patent/US2639651A/en

3 "The viscosity-gravity constant proposed by Hill and Coates has the disadvantage of being defined in terms of Saybolt Universal viscosities which limits its application to a relatively narrow range of stocks of lubricating oil viscosities", K M Watson et al., Ind.Eng.Chem,1935, Characterization of Petroleum Fractions p.1460 https://pubs.acs.org/doi/10.1021/ie50312a018

4 https://www.astm.org/d2501-14r19.html See also PPR11/INF 7 para 4.3.2.

5 ISO undertook[5] research to "provide the maritime industry with an indicator to characterize whether a marine fuel tends to be more paraffinic or aromatic in nature". However, as part of this research, only the VGC values of HFO and VLSFO were analysed. Distillates were not analysed, which is particularly problematic as they will generally be even more paraffinic than HFO or VLSFO. Although the co-sponsors do not support moving forward with VGC, the co-sponsors nevertheless propose that the Sub-Committee recommend that MEPC request ISO to carry out a VGC comparison of marine distillate fuel test results with those of HFO and VLSFO, in order to provide a more comprehensive picture.

6 However, as noted in document PPR 11/6/1, the scientific consensus is that the measured hydrogen/carbon (H/C) ratio of a fossil fuel is the best indicator of the aromatic or sooting propensity. Riazi wrote in his 2005 study that "hydrogen is an example of a perfect fuel with a zero CH weight ratio (CH = 0), while BC is an example of the worst fuel with a CH value of infinity"[6] and made clear that the "quality of a fuel is directly related to the hydrogen and sulphur content. A fuel with a higher hydrogen or lower carbon content is more valuable and has a higher heating value." Therefore, a simple test for H/C ratio in marine fuels should be used as a useful qualifier for aromaticity.

7 Document PPR 11/6/2 notes that, inclusion of the H/C ratio in ISO 8217 was not supported by ISO/TC 28/SC 4/WG6. This work, however, was to urgently prepare provisional guidance - ISO/PAS 23263 – on marine fuel quality in view of the imminent global sulphur cap.[7] It was agreed that ISO 8217 would be revised once data on the fuels being used post 2020 was available.[8] Document PPR 11/6/2 indicates that "the H/C ratio is the result of the fuel blend composition and fuel suppliers are not targeting a specific H/C ratio", adding that this "would be very difficult to do." However, no further explanation is provided. ISO nevertheless acknowledged that "the higher the H/C ratio the better the combustion characteristics of a fuel are".[9] Document PPR 11/6/2 is clear that "very little test data on the H/C ratio of marine fuels is available to allow assigning a reference value" in ISO 8217 to determine whether a marine fuel is more aromatic or paraffinic. Since there is "no operational or regulatory need to measure C and H content of a marine fuel, therefore placing the H/C in 8217 would not necessarily result in the H and C tests being carried out".

8 Including a paraffinic indicator in ISO 8217 would be valuable but only, given the foregoing comments, if accompanied by further steps. Document PPR11/6/1 calls on PPR to recommend to MEPC the inclusion of H/C ratio in ISO 8217, encourages ISO to amend the standard accordingly and for IMO Member States to pursue this amendment nationally. An H/C ratio test for marine fuels – document PPR 11/6/1 identifies ASTM 5291 – needs to be incorporated in ISO 8217 in a way that requires fuel suppliers to measure levels. Data on trends and variances could then be generated, which would enable PPR and MEPC to consider implementing appropriate limits, for example, for a Polar fuel standard or for use in Arctic BC ECAs (see document PPR 11/6/3).

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[5] PPR 10/18, paragraph 6.29; and PPR 11/6/2, paragraph 4.

[6] Riazi and Dauber also set out, in 1986, average values of CH (the carbon to hydrogen weight ratio) for paraffins, naphthenes, and aromatics and quote Fryback (1981) as having shown how the ratio of hydrogen to carbon characterizes different types of oils and petroleum products.

[7] https://www.chevronmarineproducts.com/content/dam/chevron-marine/fuels-brochure/Chevron_Everything%20You%20Need%20To%20Know%20About%20Marine%20Fuels_v8-21_DESKTOP.pdf; https://www.iso.org/obp/ui/#iso:std:iso:pas:23263:ed-1:v1:en

[8] https://standardsdevelopment.bsigroup.com/projects/9020-03769#/section

[9] PPR 11/INF 3, annex 2, page 7.

9 Rapid, economical, and widely accessible H/C ratio ASTM tests are already available and in use for aviation fuels. It was shown in 1973[10] that the hydrogen content of jet fuel is the primary variable affecting combustion performance and a minimum allowable hydrogen content of 13.5% by weight and corresponding ASTM D-1018 test method was recommended. In 2008, ICAO began work[11] to address ultra fine particulate matter (PM) pollution at airports and develop an LTO (landing/take-off) non-volatile PM (nvPM) or soot/BC jet engine standard to replace the old smoke number. The H/C ratio test is now used, inter alia, in the nvPM certification process to ensure a consistent aromatic composition of the test fuels. A standardized test method for jet nvPM emissions was developed[12] and an engine certification emissions stringency requirement set – mg of nvPM per kg of fuel used. This was a collaborative and consensus effort between industry, regulators, and scientists, fair for all engine sizes and set so as not to be disadvantageous to any manufacturer. More stringent standards for new type engines were also agreed. From the first engine tests to ICAO certification standard implementation in 2021 took well over a decade.

10 Around 60% of aviation's climate impact today is due to persistent but short-lived contrails triggered mainly by nvPM in the jet exhaust. The European Commission has just announced a study on fuel issues and potential regulation to reduce the sulphur and aromatics in EU jet fuel as a means to address both BC induced contrail non-CO_2 and local air quality impacts. Fuel quality is also a factor in calculating non-CO_2 equivalent emissions that all airlines operating in Europe will be obligated to report from 2025 as a result of the EU’s "Fit for 55" revision of the aviation Emission Trading System (ETS) Monitoring, Reporting and Verification (MRV) requirements.

11 The longer-term option envisaged by the CG, to develop a ship BC emissions intensity (mg BC/kg fuel consumed) threshold in an Arctic marine engine BC emissions regulation, would need to consider how to address the multitude of engine sizes, types, engine loads and operating conditions and, as with aviation, their potential impact on the regulation's stringency. A fuel quality measure - such as a fuel switch in or near the Arctic - as a first step, followed by a Polar fuel standard based on H/C ratio, would result in all ships benefitting, albeit to varying extents, and individual ship-measured BC emissions inventories will be reduced accordingly. Ship-specific measures, such as filters, advanced engine technologies, and lower emission operating modes can be independently effective in reducing BC emissions and compound the across-the-board benefit of adopting higher H/C ratio fuels.

Consideration of a definition of "in or near the Arctic"

12 Some CG participants called for "in or near the Arctic" to be defined (PPR 11/6, paragraph 11). However, the conclusion was that this was not necessary for guidelines and the current phrasing replicates resolution MEPC.342(77), which the co-sponsors support.

13 In developing BC control measures, as invited by PPR 10, the co-sponsors remind delegates of paragraph 14 in document MEPC 80/9/2 (FOEI et al.), which urged that proposals "should address a wider and more appropriate definition of the Arctic sea area to account for ship BC emissions throughout the whole Arctic region and also ensure that such measures also address the transboundary impacts of BC on the Arctic from ships operating in close proximity or 'near' the Arctic". Geo-location-related climate impacts of BC are also a consideration in aviation. Persistent warming contrails are most prevalent in the northern hemisphere and particularly over Europe and on transatlantic routes.

[10] US Air force Air Propulsion Laboratory 1973, Hydrogen content as a measure of the combustion performance of hydrocarbon fuels. https://apps.dtic.mil/sti/citations/AD0763097

[11] https://www.icao.int/environmental-protection/pages/env2016.aspx p.89

[12] https://www.sae.org/standards/content/arp6320a/

Action requested of the Sub-Committee

14 The Sub-Committee is invited to consider the comments and information provided in this document and take action as appropriate.