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CONTRIBUTION

From:	General Secretariat of the Council
To:	Coreper I
Subject:	Fit for 55 package - ETS: Comments from a delegation

In view of Coreper I meeting on 15 June 2022, delegations will find attached a proposal by the FI delegation on navigation in ice conditions and emissions trading.

Proposal by Finland on ETS for maritime transport prior to Coreper 15 June 2022

This proposal was previously tabled on the document WK 737/2022. Annex 1 includes amendments to the ETS Directive and MRV Regulation. Minor technical changes have been made to the Annex I in this updated version of the proposal (highlighted in grey). These changes include mainly completion of requirements on monitoring, reporting and verification of aggregated emissions in cases when shipping companies wish to surrender fewer allowances on the basis of ice-class and/ or nagivation in ice conditions. The changes also include clarifications to the symbols included in formulas that determine the readjusted amount of allowances to surrender. These changes are minor and technical and do not influence the main elements of the proposal or its impacts.

Proposal on navigation in ice conditions in the context of emissions trading

This paper presents a proposal how to take into account sailing in ice conditions in emissions trading for maritime transport. The aim of the proposed method is to **establish a level playing field between ships that navigate in ice conditions and other ships while ensuring that the emissions trading continues to steer all ships, including ice-classed ships to reduce emissions**. Thus, the proposal addresses solely the extra emissions produced due to the specific requirements for ships belonging to the Finnish-Swedish ice classes IA and IA Super or equivalent ice classes and the extra engine power required for safe navigation in ice conditions.

The paper contains the following sections:

Brief description of the proposal
Reasoning - why do we need a specific approach to navigation in ice?
Annex 1 Proposal to amend the Emissions Trading Directive and MRV Regulation
Annex 2 Detailed description of the proposal
Annex 3 Detailed reasoning for the constant 5% reduction on the annual emissions from voyages of ships having an Finnish-Swedish ice class IA or IA Super or equivalent ice class.
Annex 4 Costs caused by ice strengthening of ships and navigating in ice conditions
Annex 5 Example on how sailing in ice conditions impacts ships' fuel use

Brief description of the proposal

We propose the directive to include **a flag-neutral, permanently applied method to take into account additional emissions related to navigation in ice conditions and additional emissions of ice-classed ships when sailing in open water.** This proposal applies to the ice-classed ships, which belong to the merchant fleet. To ensure safe navigation in ice conditions, the winter navigation system in the Baltic Sea area requires that ships entering the ports have a certain ice class. The proposal does not address ice breakers as ice breakers are not included in the scope of the Commission's proposal.

The aim of the method is to readjust the amount of allowances surrendered by regulated entities (shipping companies) with ice-classed ships belonging to the highest ice classes (Finnish-Swedish ice class IA or IA Super or equivalent) and ice-classed ships

sailing in ice conditions. The amount of allowances surrendered are proposed to be **readjusted to a level that corresponds to the emissions from an otherwise similar, non-ice classed ship that sails in open water only**. Thus the shipping companies would continue to be required to purchase emission allowances for all their voyages.

The regulated entities would be obliged to report all their emissions, but surrender emission allowances for the adjusted amount of emissions. This method would ensure within the emissions trading scheme a level playing field for ice-classed ships/ships sailing in ice conditions and ships designed to sail only in open water. Those emissions allowances that are not required to be surrendered due to sailing in ice conditions, would be cancelled. This is in line with the procedures to be applied according to the Commission's proposal for the years 2023-2026 when emissions trading is gradually introduced in maritime transport.

The method to calculate the readjusted amount of allowances that need to be surrendered is based on two elements:

1. The additional fuel consumption of ice-classed ships, when sailing in ice conditions, to be taken into account in the ETS for maritime transport by **deducting the additional emissions caused by sailing in ice conditions**, from the total emissions of these voyages. This would allow to take into account the large variation in ice conditions between years and routes that ships sailing in ice conditions meet.[1]
2. Due to technical reasons (design of the ship), **a constantly applicable 5% reduction of the annual emissions from voyages** of a ship belonging to the highest Finnish-Swedish **ice classes IA or IA Super or equivalent ice classes**[2] to take into account the additional fuel consumption of ice-classed ships, on average, compared to ships designed to sail only in open water. This proposal is based on information provided in Annex 3.

The specific requirements for ice classed ships should be taken into account in the emissions trading to be in line with the international regulation on maritime transport. In the IMO context, the technical properties of ice classed ships are taken into account in the regulations concerning the technical energy efficiency (EEDI) of new ships, see resolution MEPC.308(73) and also in the regulations concerning the technical energy efficiency of existing ships (EEXI), see resolution MEPC.328(76). Correction factors due to technical reasons are also planned for the approved regulation on carbon intensity, for further details see MEPC 76/7/4 and MEPC 76/7/5. In addition, Estonia, Finland, the Russian Federation and Sweden and have also submitted a paper to the IMO on taking into account the voyages in ice conditions in the approved regulation on carbon intensity (CII), see MEPC 76/7/21 and MEPC 76/INF.67.

Inclusion of specific methods to take into account sailing in ice conditions in several policy measures does not in general lead to inappropriate overlapping impacts. Ice class ships and sailing in ice conditions increases the costs of several types of emission reduction measures and the combined costs will further deteriorate the level playing field. This applies also for the policy measures of the Fit for 55 package.

The Commission's impact assessment estimates that impacts of applying emissions trading to maritime transport are negligible to the economy. However, the economic

[1] If validation of claimed actual sailing in ice conditions is needed, this should be based on Baltic states METOCEAN published ice charts (SMHI (Swedish Meterological and Hydrological Institute, FMI Finnish Meteorological Institute, etc.)

[2] For further information on approximate correspondence between ice classes, see HELCOM Recommendation 25/7, see www.helcom.fi

impacts are not modelled either on the member state or sea area level, which leaves regional differences uncovered.

Reasoning - why do we need a specific approach to sailing in ice conditions?

Emissions trading will increase the existing cost difference in maritime transport

Fuel consumption of ice-classed ships is higher than fuel consumption of ships of similar size designed for sailing in open water only and, consequently, they produce more CO_2 emissions. It is also worth of noting that ice-classed ships produce more emissions both in open water and when navigating in ice conditions. More engine power is required to navigate in ice conditions. Ice-classed ships produce more emission also in open water, because their design is not optimized for sailing in open water but is adjusted for navigation in ice.

For the above mentioned reasons, **winter navigation increases the costs of maritime transport especially in the northern parts of the Baltic Sea wherein ships need to be constructed to ensure safe navigation in ice conditions**. The costs of navigation in ice conditions decrease the competitiveness of the countries that are dependent on maritime transport, especially during the ice covered period. The impact is the highest for those parts of the shipping routes, which have prevailing ice conditions for several winter months, e.g. Bay of Bothnia, eastern Gulf of Finland and Gulf of Riga.

Navigation in ice conditions increases the fuel costs and capital cost that are ship's two most significant cost components. For example, fuel costs constituted 40–67% for all ships engaged in Finland's foreign trade[3]. In addition, sailing in ice conditions increases system costs that include for example costs associated with investment and operational costs of ice breakers.

The difference in costs of maritime transport within the EU will be further increased by the planned introduction of emissions trading for maritime transport, unless a level playing field will be specifically guaranteed between the ice classed and other ships.

More information about the capital and system costs associated with ice classed ships and sailing in ice conditions is provided in Annex 4.

Additional fuel use and costs of emissions trading

The additional costs that winter navigation causes in emissions trading are directly proportional to the increase in the use of fuel. As explained above, both the design of the ice class vessel and navigating in ice increase the fuel use.

<u>Additional fuel use caused by sailing in ice conditions</u>

The ice coverage varies in the Baltic Sea area, implying that the Northern most areas are most affected. Gulf of Finland, Gulf of Bothnia and Gulf of Riga are normally affected by ice every year while other areas are affected less often. A larger share of the nautical miles travelled in these areas are sailed in ice conditions annually. **In the routes most impacted by ice, the increase in fuel consumption when sailing in ice conditions is even 20-60% higher than in open water.** This implies

[3] The Finnish Transport Infrastructure Agency 2019. The unit costs of vessel traffic 2018

especially high costs of maritime transport for transport of goods and passengers in these areas. In the Bay of Bothnia ice exists typically up to five months every year.

According to a study by the Finnish Meteorological Institute (FMI), on average, sailing in ice conditions increased the total annual fuel consumption of ships (5000 gross tonnage or above) sailing in ice conditions by about 8 % in the Baltic Sea area during years 2009 – 2019[4]. The total annual average increase of fuel consumption for ships sailing in ice conditions ranged from 2 % in 2019 to 15 % in 2013. Between 2009 and 2019, the average percentage of ships sailing in ice conditions ranged from 21 % in 2015 to 42 % in 2010 due to varying ice extent.

As explained above, the variation in ice conditions and duration of ice navigation season between regions is very wide, thereby making differences in economical impact even within the Baltic Sea region significant. The fuel consumption when navigating in ice conditions has been estimated by the Finnish Meteorological Institute (FMI) assuming that ships follow an icebreaker, which is often not the case, as the number of icebreakers is limited and they can only provide assistance to merchant vessels for safety shipping.

Adoption of the described method in emissions trading for navigation in ice conditions would produce new and more accurate information on the impact of navigation in ice conditions on fuel consumption.

Annex 5 includes an example on how sailing in ice conditions impacts ships' fuel use.

Additional fuel use caused by the design of the ice-class ships

On the average, ice-classed ships, when sailing in open water, consume about 2-5 % more fuel than ships designed for sailing in open water only. The lower figure 2% represents the increase in fuel consumption in open water for lower Finnish-Swedish ice classes IC and IB or equivalent ice classes, and the higher figure 5% represents the increase in fuel consumption in open water for higher ice classes IA and IA Super or equivalent ice-classes.

The reason for the larger fuel consumption in open water is that the hull form and the propeller of ice-classed ships are less optimal for the operation in open water, as they must be suited for the operation in ice conditions, too. In addition, it is not possible to install all new innovative options like vane wheels, which reduce fuel consumption, to ice-classed ships, because those devices would break or get stuck of ice floes when operating in ice conditions.

Due to increased lightweight caused by the ice strengthening, ice-classed ships have a smaller capacity, i.e. deadweight, compared to their displacement than ships of a similar displacement designed for sailing in open water only. Thus, they transport less freight per voyage than similar ships designed to operate only in open water.

Annex 3 gives more detailed reasoning for the proposal to apply a constant 5% reduction on the annual emissions from voyages of ships having an Finnish-Swedish ice class IA or IA Super or equivalent ice class.

[4] Finnish Meteorological Institute 2021. Effect of sea ice on fuel consumption and carbon intensity of shipping in the Baltic Sea area in 2009 - 2019

ANNEX 1

Proposal to amend the Emissions Trading Directive and the MRV Regulation

We propose the text in red to be added to the Emissions Trading Directive

Article 3gb, the following amendment is made:

In respect of emissions from maritime transport activities listed in Annex I, the administering authority in the respect of a shipping company shall ensure that a shipping company under its responsibility monitors and reports the relevant parameters during a reporting period, and submits aggregated emissions data and if applicable, aggregated readjusted emissions data at company level to the administering authority in line with Chapter II of Regulation (EU) 2015/757 of the European Parliament and of the Council (*)

In Article 3gc, the following amendment is made:

The administering authority in respect of a shipping company shall ensure that the reporting of aggregated emissions data and if applicable, aggregated readjusted emissions data at shipping company level submitted by a shipping company pursuant to Article 3gb is verified in accordance with the verification and accreditation rules set out in Chapter III of Regulation (EU) 2015/757 (*).

Article 12, paragraph 3 c is amended as follows:

"3. The Member States, administering Member States and administering authorities in respect of a shipping company shall ensure that, by 30 April each year:
(a) the operator of each installation surrenders a number of allowances that is equal to the total emissions from that installation during the preceding calendar year as verified in accordance with Article 15;
(b) each aircraft operator surrenders a number of allowances that is equal to its total emissions during the preceding calendar year, as verified in accordance with Article 15;
(c) each shipping company surrenders a number of allowances equal to its total emissions during the preceding calendar year, as verified in accordance with Article 3gc. Shipping companies may surrender fewer allowances on the basis of ships' ice class or navigation in ice or both in line with Annex X.

Member States, administering Member States and administering authorities in respect of a shipping company shall ensure that allowances surrendered in accordance with the first subparagraph are subsequently cancelled.";

To the extent that fewer allowances are surrendered on the basis of ships' ice class or navigation in ice or both compared to the verified emissions from maritime transport, once the difference between verified emissions and allowances surrendered has been established in respect of each year, a corresponding quantity of allowances shall be cancelled rather than auctioned pursuant to Article 10.

We propose the text in red to be added to the MRV Regulation

in Article 3, the following provisions is added:

(s) 'navigating in ice conditions' means navigating of an ice-classed ship in a sea area within the ice edge.

(t) "Ice edge" is defined by paragraph 4.4. of the WMO Sea-Ice Nomenclature, March 2014 as the demarcation at any given time between the open sea and sea ice of any kind, whether fast or drifting.

(u) 'aggregated readjusted emissions data at company level' means the sum of the CO_2 emissions to be surrendered by a company under Directive 2003/87/EC in accordance with Annex X to Directive 2003/87/EC.

in Article 6, paragraph 4, the following amendment is made:

4. For shipping companies aiming to surrender fewer emission allowances on the basis of ships' ice class or navigation in ice conditions or both under Directive 2003/87/EC ~~T~~the monitoring plan ~~may~~ shall also contain information on the ice class of the ship and~~/or~~ the procedures, responsibilities, formulae and data sources for determining and recording the fuel consumption, the distance travelled and the time spent at sea when navigating in ice conditions. Information on procedures of recording the date, time and location when navigating in ice conditions and whether the voyage occurs between ports under a Member State's jurisdiction, departs from a port under a Member State's jurisdiction or arrives to a port under a Member State's jurisdiction, shall also be provided.

in Article 9, first paragraph, the following provision is added:

(h) ice-class and whether the voyage involved navigation in ice conditions, if the shipping company aims to surrender fewer emission allowances on that basis under Directive 2003/87/EC. If the voyages involved navigating in ice conditions and if the shipping company aims to surrender fewer emission allowances on that basis under Directive 2003/87/EC, the information on date, time, and location when navigating in ice conditions, method used to measure fuel oil consumption, fuel consumption and the fuel's emission factor for each type of fuel when navigating in ice conditions, and distance travelled when navigating in ice conditions shall also be provided. Information on whether the voyage occurs between ports under a Member State's jurisdiction, departs from a port under a Member State's jurisdiction or arrives to a port under a Member State's jurisdiction, shall be provided.

in Article 9, second paragraph, the following subparagraph is added to the end:

However, if the shipping company aims to surrender fewer emission allowances on the basis of ship's navigation in ice conditions under Directive 2003/87/EC, it can only apply the exception under the first subparagraph for those months when the ship does not sail in ice conditions.

in Article 10, first subparagraph, the following provisions are added:

(gbis) aggregated distance travelled separately for voyages between ports under a Member State's jurisdiction, for voyages departing from a port under a Member State's jurisdiction and for voyages arriving to a port under a Member State's jurisdiction, if the shipping company aims to surrender fewer emission allowances on the basis of ship's ice class and / or navigation in ice conditions under Directive 2003/87/EC.

"(k) total aggregated […] emissions of greenhouse gases covered by Directive 2003/87/EC in relation to maritime transport activities in accordance with Annex I of that Directive to be reported under that Directive […] in relation to maritime transport activities, and if applicable, readjusted aggregated emissions ";

(l) ice-class and aggregated CO_2 emissions when navigating in ice conditions separately for voyages between ports under a Member State's jurisdiction, for voyages departing from a port under a Member State's jurisdiction and for voyages arriving to a port under a Member State's jurisdiction and aggregated distance travelled when navigating in ice conditions separately for voyages between ports under a Member State's jurisdiction, for voyages departing from a port under a Member State's jurisdiction and for voyages arriving to a port under a Member State's jurisdiction when navigating in ice conditions, if the shipping company aims to surrender fewer emission allowances on that basis under Directive 2003/87/EC.

Article 11a following amendments are made

1. Companies shall determine the aggregated emissions data at company level, including, if applicable the aggregated readjusted emissions data during a reporting period, based on the data of the emissions report and the report referred to in Article 11(2) for each ship that was under their responsibility during the reporting period, in accordance with the rules laid down in the delegated acts adopted pursuant to paragraph 4.

2. From 2024, the company shall submit to the responsible administering authority by 31 March of each year the aggregated emissions data at company level, including, if applicable the aggregated readjusted emissions data that covers the emissions in the reporting period to be reported under Directive 2003/87/EC in relation to maritime transport activities, in accordance with the rules laid down in the delegated acts adopted pursuant to paragraph 4 and that is verified in accordance with Chapter III of this Regulation (the 'verified aggregated emissions data at company level').

3. The administering authority may require companies to submit the verified aggregated emissions data at company, including, if applicable the aggregated readjusted emissions data level by a date earlier than 31 March, but not earlier than by 28 February.

4. The Commission is empowered to adopt delegated acts in accordance with Article 23 to supplement this Regulation with the rules for the monitoring and reporting of the aggregated data at company level and the submission of the aggregated emissions data and the aggregated readjusted emissions data at company level to the administering authority.

in Article 12, the following amendments are made:

1. The emissions report and the reporting of aggregated emissions data and aggregated readjusted emissions data at company level shall be submitted using automated systems and data exchange formats, including electronic templates.

Article 13, amendment to paragraph 5

"5. The verifier shall assess the conformity of the aggregated emissions data at company level, including aggregated readjusted emissions data if applicable with the requirements laid down in the delegated acts adopted pursuant to paragraph 6.

We propose the following Annex to be added to the Emissions Trading Directive

Option to surrender a readjusted amount of allowances for ice class ships

The readjusted amount of emission allowances to be surrendered for ice class ships shall correspond to a readjusted amount of emissions that is calculated based on the formula presented in this annex. The readjusted amount of emissions shall take into account the technical characteristics that increase emissions of ships belonging to a Finnish-Swedish ice class IA or IA Super or equivalent ice class during navigation at all times and the further increase of emissions due to navigating in ice conditions.

Readjusted amount of emissions allowances to be surrendered annually mean readjusted amount of annual emissions $CO_{2\,R}$.

The annual total emission $CO_{2\,T}$ within the geographical scope of the Emissions Trading for maritime transport are calculated on the basis of reporting according to Regulation (EU) 2015/757 as follows

$$CO_{2\,T} = CO_{2\,T\ voayges\ between\ MS} + CO_{2\,B} + 0.5 \cdot \left(CO_{2\,T\ voyages\ from\ MS} + CO_{2\,T\ voyages\ to\ MS}\right), \quad (1)$$

where $CO_{2\,T\ voyages\ between\ MS}$ denotes the aggregated CO_2 emissions from all voyages between ports under a Member State's jurisdiction, $CO_{2\,B}$ the emissions which occurred within ports under a Member State's jurisdiction at berth, $CO_{2\,T\ voyages\ from\ MS}$ the aggregated CO_2 emissions from all voyages which departed from ports under a Member State's jurisdiction and $CO_{2\,T\ voyages\ to\ MS}$ the aggregated CO_2 emissions from all voyages to ports under a Member State's jurisdiction.

Similarly the annual total emissions of an ice classed ship when navigating in ice conditions within the scope of the proposed Emissions Trading Directive for maritime transport $CO_{2\,I}$ are calculated on the basis of reporting according to Regulation (EU) 2015/757 as follows

$$CO_{2\,I} = CO_{2\,I\ voyages\ between\ MS} + 0.5 \cdot \left(CO_{2\,I\ voyages\ from\ MS} + CO_{2\,I\ voyages\ to\ MS}\right), \quad (2)$$

where $CO_{2\,I\ voyages\ between\ MS}$ denotes the aggregated CO_2 emissions of an ice-classed ship when navigating in ice conditions from all voyages between ports under a Member State's jurisdiction, $CO_{2\,I\ voyages\ from\ MS}$ emissions of an ice-classed ship when navigating in ice conditions from all voyages which departed from ports under a Member State's jurisdiction and $CO_{2\,I\ voyages\ to\ MS}$ emissions of an ice-classed ship when navigating in ice conditions from all voyages to ports under a Member State's jurisdiction.

The annual total distance travelled within the scope of the proposed Emissions Trading Directive for maritime transport D_T is calculated as follows

$$D_T = D_{T\ voayges\ between\ MS} + 0.5 \cdot \left(D_{T\ voyages\ from\ MS} + D_{T\ voyages\ to\ MS}\right), \quad (3)$$

where $D_{T\ voyages\ between\ MS}$ denotes the aggregated distance from all voyages between ports under a Member State's jurisdiction, $D_{T\ voyages\ from\ MS}$ the aggregated distance from all voyages which departed from ports under a Member State's jurisdiction and $D_{T\ voyages\ to\ MS}$ the aggregated distance from all voyages to ports under a Member State's jurisdiction.

The aggregated distance travelled when navigating in ice conditions within the scope of the proposed Emissions Trading Directive for maritime transport D_I is calculated as follows

$$D_I = D_{I\ voayges\ between\ MS} + 0.5 \cdot \left(D_{I\ voyages\ from\ MS} + D_{I\ voyages\ to\ MS}\right), \quad (4)$$

where $D_{I\ voyages\ between\ MS}$ denotes the aggregated distance travelled when navigating in ice conditions from all voyages between ports under a Member State's jurisdiction, $D_{I\ voyages\ from\ MS}$ the aggregated distance travelled when navigating in ice conditions from all voyages which departed from ports under a Member State's jurisdiction and $D_{I\ voyages\ to\ MS}$ the aggregated distance travelled when navigating in ice conditions from all voyages to ports under a Member State's jurisdiction.

The readjusted amount of annual emissions $CO_{2\ R}$ are calculated as follows

$$CO_{2\ R} = CO_{2\ T} - CO_{2\ TF} - CO_{2\ NI} \quad (5)$$

where $CO_{2\ TF}$ denotes the increase in annual emissions due to technical characteristics of ships having a Finnish-Swedish ice class IA or IA Super or equivalent ice class and $CO_{2\ NI}$ the increase in annual emissions of an ice classed ship due to navigating in ice conditions.

The increase in annual emissions due to technical characteristics of ships having a Finnish-Swedish ice class IA or IA Super or equivalent ice class $CO_{2\ TF}$ is calculated as follows:

$$CO_{2\ TF} = 0.05 \times (CO_{2\ T} - CO_{2\ B} - CO_{2\ NI}). \quad (6)$$

The increase in annual emissions due to navigating in ice conditions $CO_{2\ NI}$ is calculated as follows:

$$CO_{2\ NI} = CO_{2\ I} - CO_{2\ RI}\ , \quad (7)$$

where the readjusted annual emissions for navigating in ice conditions $CO_{2\ RI}$ are defined as follows:

$$CO_{2\ RI} = D_I \times \left(\frac{CO_2}{D}\right)_{OW}\ , \quad (8)$$

where $\left(\frac{CO_2}{D}\right)_{OW}$ is the emissions []per distance travelled when navigating in open water and it is calculated with:

$$\left(\frac{CO_2}{D}\right)_{OW} = \frac{CO_{2\ T} - C_{\ 2\ B} - CO_{2\ I}}{D_T - D_I}. \quad (9)$$

List of all symbols:

$CO_{2\ T}$	annual total emissions within the geographical scope of the Emissions Trading for maritime transport
$CO_{2\ T\ voyages\ between\ MS}$	aggregated CO_2 emissions from all voyages between ports under a Member State's jurisdiction
$CO_{2\ B}$	emissions which occurred within ports under a Member State's jurisdiction at berth

$CO_{2\ T\ voyages\ from\ MS}$	aggregated CO_2 emissions from all voyages which departed from ports under a Member State's jurisdiction
$CO_{2\ T\ voyages\ to\ MS}$	aggregated CO_2 emissions from all voyages to ports under a Member State's jurisdiction
D_T	annual total distance travelled within the scope of the Emissions Trading for maritime transport
$D_{T\ voyages\ between\ MS}$	aggregate distance from all voyages between ports under a Member State's jurisdiction
$D_{T\ voyages\ from\ MS}$	aggregated distance from all voyages which departed from ports under a Member State's jurisdiction
$D_{T\ voyages\ to\ MS}$	aggregated distance from all voyages to ports under a Member State's jurisdiction.
D_I	aggregated distance travelled when navigating in ice conditions within the scope of the Emissions Trading for maritime transport
$D_{I\ voyages\ between\ MS}$	aggregated distance when navigating in ice conditions from all voyages between ports under a member state's jurisdiction
$D_{I\ voyages\ from\ MS}$	aggregated distance when navigating in ice conditions from all voyages which departed from ports under a Member State's jurisdiction
$D_{I\ voyages\ to\ MS}$	aggregated distance when navigating in ice conditions from all voyages to ports under a a member state's jurisdiction
$CO_{2\ I}$	annual emissions of an ice classed ship when navigating in ice conditions within the scope of the Emissions Trading for maritime transport
$CO_{2\ I\ voyages\ between\ MS}$	aggregated emissions of an ice-classed ship when navigating in ice conditions from all voyages between ports under a Member State's jurisdiction
$CO_{2\ I\ voyages\ from\ MS}$	aggregated emissions of an ice-classed ship when navigating in ice conditions from all voyages which departed from ports under a Member State's jurisdiction
$CO_{2\ I\ voyages\ to\ MS}$	aggregated emissions of an ice-classed ship when navigating in ice conditions from all voyages to ports under a Member State's jurisdiction

$CO_{2\ NI}$	increase in annual emissions of an ice-classed ship due to navigating in ice conditions
$CO_{2\ R}$	readjusted amount of annual emissions
$CO_{2\ RI}$	readjusted annual emissions for navigating in ice conditions
$CO_{2\ TF}$	increase in annual emissions due to technical characteristics of a ship with a Finnish-Swedish ice class IA or IA Super or an equivalent ice class on average, compared to ships designed to sail only in open water
$\left(\frac{CO_2}{D}\right)_{OW}$	[]emissions per distance travelled when navigating in open water

ANNEX 3 Detailed reasoning for the constant 5% reduction on the annual emissions from voyages of ships having a Finnish-Swedish ice class IA or IA Super or equivalent ice class

It is clear that the increased fuel consumption of an ice-classed ship depends on many design parameters, for example ship type, ice class, type of the propulsion system, hull form etc., which makes it difficult to develop a simple formula to take the increased fuel consumption into account. However, we consider that a simplified approach to be preferable in this case. We propose a 5% reduction of the annual fuel consumption of a ship having a Finnish-Swedish ice class IA or IA Super or equivalent to take into account the additional fuel consumption of these ice-strengthened ships, on average, compared to ships designed to sail only in open water.

A memorandum "Estimate on the additional power of ships with ice class" written by Professor Kaj Riska in 2012 (available in Finnish only) was utilized as a basis for our proposal. It describes three sources for the additional power used by ships with the Finnish-Swedish ice class IA Super when operating in open water in comparison to ships designed for sailing in open water only:

1) The propeller efficiency is worse due to ice strengthening of the propeller. This increases the use of power by 2 %.
2) The resistance of the ship increases due to hull form. The effect of hull form increases the use of power
    - 0 % when the ship has a bulb
    - 3 % when the ship has an ice bulb
    - 7 % when the ship has a "light" ice bow (stem angle 40º)
    - 13 % when the ship has an ice bow
3) As the capacity of the ice-strengthened ship is smaller due to ice strengthening of the hull, the ice-strengthened ship must be longer in order to have the same capacity as a similar ship designed for open water only. This increases its use of power. The memorandum gives a formula to estimate the increase of power.

Using the above-mentioned information, the memorandum estimates that 45 cargo and passenger ships with the Finnish-Swedish ice class IA Super use on average 4.5 % more power than open water ships.

In a recent study of Aker Arctic (Saisto et al., 2019[5]), the propulsion efficiency of ice-strengthened ships was analysed for two types of ships, a bulk carrier and a roro ship, concerning the Finnish-Swedish ice classes IC, IB, IA and IA Super. The following results were presented:

- For the vessel 1, the single screw vessel of bulk carrier type, the relative delivered power increase, due propeller strength demands, at optimization point compared to open water propeller is 2.8% higher for IC and IB ice class, 3.3% higher for IA and 4.3 % higher for IAS ice class.
- For the vessel 2, the twin-screw RoRo or ferry, the relative delivered power increase, due propeller strength demands, at optimization point compared to open water propeller is 0.2 % higher for IC and IB ice class, 0.9 % higher for IA and 1.4 % higher for IAS ice class.

Thus the study by Aker Arctic implies that the estimated 4,5 % increase in use of power in Professor Riska's study may be too low, because the worse propeller efficiency of ice-classed ships having an ice class IA or IA Super may increase the use of power more than 2%.

To conclude based on the analysis made by Professor Riska and the study of Aker Arctic, 5% increase in fuel consumption in open water reflects quite well the difference in fuel consumption between ships belonging to Finnish-Swedish ice class IA or IA Super and ships of similar size designed to sail only in open water.

[5] Saisto Ilkka and Turunen Taisto (2019), Effect of the FSICR to propeller efficiency, Aker Arctic Technology Inc, 2019.

ANNEX 4

Costs caused by ice strengthening of ships and navigating in ice conditions

Winter navigation increases fuel costs, capital costs and system costs. Fuel and capital costs constitute the largest cost components of ships. For example, fuel costs constituted the largest (40–67%) and capital costs the second largest (14–26%) expense item for all ships engaged in Finland's foreign trade[6].

Some examples of the increase in costs are provided below:

- Capital costs of IAS/IA container vessels are 8% higher than for open water vessels[7]
- The strengthened hulls of the ice class ships make them more expensive to build.[8]
- For bulk vessels, the cost premium in capital costs could be as much as 35%[9]

In addition, to increase in fuels costs and capital costs, **navigating in ice conditions takes time and implies delays which also lead to additional costs** and reduction on competitiveness.

[6] The Finnish Transport Infrastructure Agency The unit costs of vessel traffic 2018

[7] Solakivi, T. Kiiski, T., Ojala, T. (2019) On the cost of ice: estimating the premium of ice class container vessels, Maritime Economics & Logistics, Vol 21, No. 2, pp. 207-222.

[8] (Erikstad S.O., Ehlers. S. (2012) Decision Support Framework for Exploiting Northern Sea Route Transport Opportunities, Ship Technology Research, 59(2): 34-42)

[9] (Solakivi, T. Kiiski, T., Ojala, T. (2018) The impact of ice class on the economics of wet and dry bulk shipping in the Arctic waters, Maritime Policy & Management, Vol. 45 No 4, pp 530-542).

ANNEX 5

Example on how sailing in ice conditions impacts ships' fuel use

Figure 1 gives data obtained from the Finnish Shipowners' Association. It shows that during a harsh winter in the Northern Baltic Sea, the fuel consumption per month may increase even about 30-60 % in comparison to an average fuel oil consumption in open water conditions (May-December). In the case of the example of Figure 1, the annual increase of the fuel consumption is 15 % due to the increased fuel consumption in ice conditions in comparison to the situation that the ships would operate in open water conditions only.

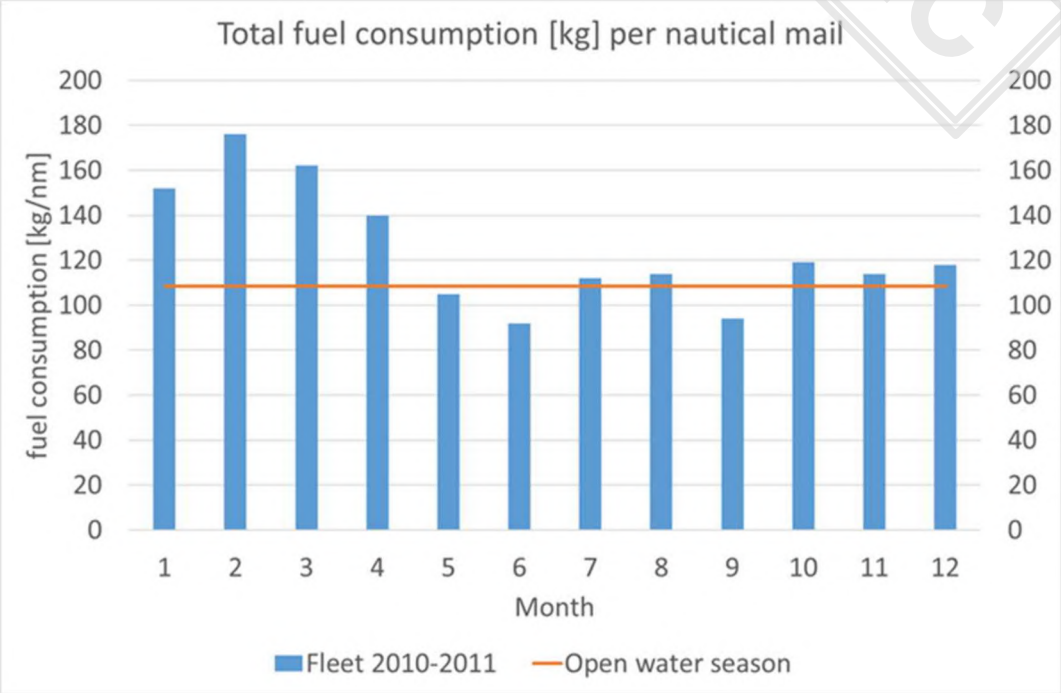

Figure 1. Monthly total fuel oil consumption of 4 ice-classed ships sailing in the Baltic Sea area in 2011. In the period from January to April the ships operated also in ice.
