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MARINE GEOENGINEERING INCLUDING OCEAN FERTILIZATION

Progress report from the Legal Intersessional Correspondence Group on Marine Geoengineering

Submitted by the Co-Chairs of the Correspondence Group

SUMMARY

Executive summary: This document presents a report on the progress made by the Legal Intersessional Correspondence Group on Marine Geoengineering, which was established by the governing bodies in 2022.

Action to be taken: Paragraph 13

Related documents: LC 44/17; LC 44/WP.6 and LC/SG 46/16, annex 2

Introduction

1 In 2023, the governing bodies established a Legal Intersessional Correspondence Group (LICG) on Marine Geoengineering, under the lead of Canada and Germany¹, to address the legal issues identified by the Working Group on Marine Geoengineering (LC 44/17, paragraph 5.17.3). Specifically, the Group was assigned the following terms of reference, outlined in paragraphs 12 and 16 of LC 44/WP.6, as follows:

- .1 actions with respect to implementation of the 2013 amendment before entry into force:
 - .1 consider whether a mechanism for provisional application of the [2013 LP] amendment before its entry into force is needed for implementation, or whether domestic implementation could proceed without a mechanism for provisional application; and

¹ The coordinators, Ms. Suzanne Agius (Canada) and Dr. Harald Ginzky (Germany) can be contacted at Suzanne.Agius@ec.gc.ca and harald.ginzky@uba.de, respectively.

- .2 consider the development of a statement vetted by legal experts to the effect of: Parties to LP and LC, and in particular those who signed the 2013 amendment, should take no actions to undermine the object and purpose of the amendment.
- .2 legal analysis:
 - .1 preparing likely factual scenarios describing the four techniques using the GESAMP WG 41 report [i.e. macroalgae cultivation, alkalization, albedo enhancement, and marine cloud brightening]; and
 - .2 reviewing and reporting views as to whether:
 - .1 the scenarios of the four techniques² as described in paragraph 16.1 [of LC 44/WP.6] were within the scope of LP;
 - .2 LP can regulate activity that is not dumping or placement;
 - .3 LP can regulate where there is no deposit of material at sea from a ship, aircraft, platform or other structure; and
 - .4 there are limits for the 2013 amendment of LP for the regulation of marine geoengineering.

2 Delegations from the following Contracting Parties are contributing to the work of the Correspondence Group: Argentina, Australia, Canada, Chile, China, France, Germany, Iceland, Italy, Japan, Republic of Korea, Mexico, Morocco, Norway, South Africa, Sweden, United Arab Emirates, United Kingdom and United States. In addition, observers from non-Contracting Parties included India, and contributions were also received from observers from ACOPS, GESAMP, Greenpeace International and IMarEST. GESAMP was represented by the Co-Chair of GESAMP WG 41.

3 It should be noted that the governing bodies decided to prioritize the consideration of four marine geoengineering activities for potential further regulation, namely, 1) ocean alkalinity enhancement; 2) macroalgae cultivation and other biomass for sequestration including artificial upwelling; 3) microbubbles/reflective particles/material; and 4) marine cloud brightening. These are therefore the 'four techniques' that all the Correspondence Group work was focused on.

Progress to date

Provisional application of the 2013 LP marine geoengineering amendment

4 As a part of the work described in paragraph 1.1.1 above, LICG is developing a background document outlining preliminary considerations of how a mechanism for provisional application of the 2013 LP amendment could be used and which legal requirements would have to be met in order to apply the mechanism. The background document will be submitted as a separate meeting document.

² The four techniques include 1) alkalization, 2) microbubbles and glass beads for albedo enhancement, 3) macroalgae cultivation, and 4) marine cloud brightening.

Statement about not undermining the object and purpose of the amendment

5 LICG exchanged views by email about the potential wording for this draft statement, noting that it should be consistent with the text of the Vienna Convention on the Law of Treaties, and that it should be clear how obligations of LP versus LC Parties differ in respect to the 2013 amendment. The following text represents the draft statement agreed by the group, with one square bracket left to be resolved:

"Parties to the LP who accepted the 2013 amendment [shall][should] refrain from acts which would defeat the object and purpose of the amendment pending its entry into force, consistent with article 18 of the *Vienna Convention on the Law of Treaties*. Parties to the LP who have not yet accepted the amendment, and Parties to the LC are strongly encouraged to refrain from such acts".

Factual scenarios describing the four marine geoengineering techniques

6 At the 2023 LC/LP Scientific Groups (SGs) Meeting, the SGs revised the 'scenarios' for each of the four marine geoengineering (MGE) techniques identified above (LC/SG 46/16, annex 2), and shared these with LICG immediately after the SG meetings. The 'scenarios' describe the primary objective of each technique as well as variations representing sub-categories for conducting each technique (e.g. using different methods, equipment or materials). These scenarios formed the basis for further work done by both LICG on MGE and the Correspondence Group on MGE established by the SGs.

Legal analysis

7 To respond to the legal questions outlined in paragraph 2.2 of the TOR above, LICG used the factual scenarios describing the four marine geoengineering techniques, including variations on the techniques, to consider the extent to which the techniques would meet the various criteria in the definition of marine geoengineering adopted as part of the 2013 amendment, and satisfied other relevant provisions of LP surrounding placement of matter into the sea from a ship, aircraft, platform or other man-made structure.

8 For uniform consideration of the four marine geoengineering techniques, including variations, according to the legal questions outlined in paragraph 2.2., the Group decided to work with a table format.

9 The preliminary results of these analyses are presented in table format at annex to this report. Each table was drafted by a volunteer lead, with input from the rest of LICG. Although views on many aspects of the analysis have been consented, there is still text in each of the draft tables to be discussed.

10 In addition, there is a set of open questions at the end of each table. These questions reflect summaries of the aspects of the tables that are still to be discussed. There was also one comment made about biomass cultivation in particular that could apply to all of the tables. Specifically, it was noted that the Group has conducted its analyses on the assumption that a proponent is conducting one technique at a time. In reality, many proposals seek to combine techniques into hybrid projects with multipurpose designs (e.g. combining biomass cultivation with ocean alkalinity enhancement).

11 To complement the tables, LICG is also working on a summary of the answers provided with regard to the four techniques and their subcategories which will be submitted in a separate meeting document.

Conventional aquaculture and mariculture

12 During a virtual meeting of LICG, it was noted that the word 'conventional' in the amendment resolution LP.4(8) could apply to aquaculture only, instead of applying to both aquaculture and mariculture. During discussions, it was agreed that among LICG, participants interpret the term 'conventional' as applying to *both* aquaculture and mariculture. It was further noted that there may be merit in exploring whether and how this can be clarified for others going forward.

Action requested of the governing bodies

13 The governing bodies are invited to note the information provided and comment, as they deem appropriate.

ANNEX

LEGAL ANALYSIS TABLES

ALKALINIZATION SUBCATEGORY 1

Table to decide whether the techniques under review are MGE in the sense of London Protocol and in addition Ocean Fertilization Activities

A. Decision whether the techniques under review are MGE in the sense of London Protocol

1. Relevant provisions of London Protocol and the amendment of 2013

Article 6*bis* No.1: "Contracting Parties shall not allow the placement of matter into the sea from vessels, aircraft, platforms or other man-made structures at sea for marine geoengineering activities listed in annex 4, unless the listing provides that the activity or the subcategory of an activity may be authorized under a permit."

Article 1 No.4.2.2.: "placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this Protocol;"

Article 1 No.7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."

Article 1, No.5*bis*: "Marine geoengineering" means a deliberate intervention in the marine environment to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."

2. Table – Marine geoengineering in the sense of article 6*bis*, article 1 No.4.2.2. and No.7 and article 1 No.5*bis*:

TECHNIQUE/SCENARIO: Alkalinization Subcategory 1: adding alkaline matter directly to the ocean (e.g. carbonate or silicate materials)	
Criteria	Annotations
	Subcategory 1: adding alkaline matter into the marine waters
Article 6 <i>bis</i> No.1: "placement of matter"	Yes, matter is introduced. Yes, adding alkaline matter directly to the ocean meets the criterion of "placement of matter" since the matter is deposited or released, thus placed for the purpose of enhancing alkalinity.
Article 6 <i>bis</i> No.1: "into the sea"	Yes. There are three variations: <ul style="list-style-type: none"> • Introduction directly into open waters • Introduction in shallow waters close to the coast • Introduction at beaches with the intention that tides mobilize the material to end in the oceans. As the idea of all concepts is to bring the material to the oceans, the legal criteria is fulfilled.

Article 6bis No.1: "from vessels, aircraft, platforms or other man-made structures at sea"	Yes. The matter could be introduced via pipelines. In this case, this criterion would not be met.
Article 6bis No.1: placement of matter <u>and</u> article 1 No. 4.2.2.: "for a purpose other than the mere disposal thereof"	Yes. Alkali matter is placed to enhance ocean alkalinity.
Article 6bis No.1: "into the sea" <u>and</u> article 1 No.7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."	Yes. Alkali matter is placed into seawater (which may include the internal waters of states).
Article 6bis No.1: "for marine geoengineering activities" and article 1 No.5bis	Yes. The placement of alkali matter meets this criterion since it fits within the definition of article 1 paragraph 5bis.
Article 1 No.5bis: "a deliberate intervention in the marine environment"	Yes. All activities are undertaken by humans. Deliberate actions.
Article 1 No.5bis: "to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, ..."	Natural processes would be manipulated as by the introduction of material the alkalinity of the oceans should be increased.
Article 1 No.5bis: "and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."	Yes. See statement of the Scientific Groups https://www.imo.org/en/MediaCentre/Pages/WhatsNew-1854.aspx

3. Consequence

If a technique is regarded as MGE in the sense of London Protocol, it could be listed in annex 4.

B. Decision whether the techniques under review are ocean fertilization in the sense of London Protocol

1. Relevant provisions

Next to the provisions with regard to MGE, annex 4 is relevant.

Annex 4, No.1: "Ocean fertilization is any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans. Ocean fertilization does not include conventional aquaculture, or mariculture, or the creation of artificial reefs."

2. Table

TECHNIQUE/SCENARIO: Alkalinization Subcategory 1: adding alkaline matter directly to the ocean (e.g. carbonate or silicate materials)	
Criteria	Annotations
Any activity undertaken by humans	Yes. This is an activity that would be undertaken by humans.
With the principal intention of stimulating primary productivity in the oceans	No. The intention is to enhance ocean alkalinity, with no intention to stimulate primary productivity.
Not included: conventional aquaculture, or mariculture, or the creation of artificial reefs	Yes. The deposit of alkali material does not constitute conventional aquaculture, or mariculture, or the creation of artificial reefs.

3. Consequence

If a technique is considered within the definition of OF, an additional listing is not required.

C. Open question to be further discussed

- Could a pipeline terminus diffuser could be considered a "platform" or "other manmade structure at sea"?

ALKALINIZATION SUBCATEGORY 2

Table to decide whether the techniques under review are MGE in the sense of London Protocol and in addition ocean fertilization activities

A. Decision whether the techniques under review are MGE in the sense of London Protocol

1. Relevant provisions of London Protocol and the amendment of 2013

Article 6*bis* No.1: "Contracting Parties shall not allow the placement of matter into the sea from vessels, aircraft, platforms or other man-made structures at sea for marine geoengineering activities listed in annex 4, unless the listing provides that the activity or the subcategory of an activity may be authorized under a permit."

Article 1 No.4.2.2.: "placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this Protocol;"

Article 1 No. 7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."

Article 1, No.5*bis*: "Marine geoengineering" means a deliberate intervention in the marine environment to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."

2. Table – Marine Geoengineering in the sense of article 6*bis*, article 1 No. 4.2.2. and No.7 and article 1 No.5*bis*:

TECHNIQUE/SCENARIO: Alkalinization Subcategory 2: electrochemical approaches – Using electrochemistry (splitting water to produce a basic and an acidic stream) in an engineered system to ultimately remove CO₂ from seawater and/or increase ocean alkalinity.	
Criteria	Annotations
Article 6 <i>bis</i> No.1: "placement of matter"	Yes, processed water is introduced for the purpose of enhancing alkalinity.
Article 6 <i>bis</i> No.1: "into the sea"	Yes, the processed seawater should be introduced into the sea, even though the electrochemical process would normally take place outside the sea.
Article 6 <i>bis</i> No.1: "from vessels, aircraft, platforms or other man-made structures at sea"	Yes. However, the seawater could be introduced via pipelines from land. In this case, this criterion would not be met.
Article 6 <i>bis</i> No.1: placement of matter <u>and</u> article 1 No. 4.2.2.: "for a purpose other than the mere disposal thereof"	Yes. A basic stream of matter is introduced into the sea to enhance ocean alkalinity.
Article 6 <i>bis</i> No.1: "into the sea" <u>and</u> article 1 No.7:	Yes. Alkali matter is placed into seawater (which may include the internal waters of states).

"all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."	
Article 6 <i>bis</i> No.1: "for marine geoengineering activities" and article 1 No.5 <i>bis</i>	Yes. The placement of a basic stream meets this criterion since it fits within the definition of article 1 paragraph 5 <i>bis</i> .
Article 1 No.5 <i>bis</i> : "a deliberate intervention in the marine environment"	The introduction of the seawater is a deliberate intervention.
Article 1 No.5 <i>bis</i> : "to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, ..."	Natural processes should be manipulated as by the introduction of processed seawater of the electrochemical process. Thereby the uptake of CO ₂ should be achieved.
Article 1 No.5 <i>bis</i> : "and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."	Yes. See statement of the Scientific Groups: https://www.imo.org/en/MediaCentre/Pages/WhatsNew-854.aspx

3. Consequence

If a technique is regarded as MGE in the sense of London Protocol, it could be listed in annex 4.

Decision whether the techniques under review are ocean fertilization in the sense of London Protocol

1. Relevant provisions

Next to the provisions with regard to MGE, annex 4 is relevant.

Annex 4, No.1: "Ocean fertilization is any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans. Ocean fertilization does not include conventional aquaculture, or mariculture, or the creation of artificial reefs."

2. Table

TECHNIQUE/SCENARIO: Alkalinization Subcategory 2: electrochemical approaches for ocean alkalinization (i.e. The alkalinity of seawater is increased by electro-chemical processes in a reactor. After the processing the seawater is released into the ocean in order to uptake CO₂.)	
Criteria	Annotations
Any activity undertaken by humans	Yes. This is an activity that would be undertaken by humans.
With the principal intention of stimulating primary productivity in the oceans	No. No intention to stimulate primary productivity.
Not included: conventional aquaculture, or mariculture, or the creation of artificial reefs	Yes. The deposit of alkali material does not constitute conventional aquaculture, or mariculture, or the creation of artificial reefs.

3. Consequence

If a technique is considered within the definition of OF, an additional listing is not required.

B. Open question to be further discussed

- Could a pipeline terminus diffuser could be considered a "platform" or "other man-made structure at sea"?

ALKALINIZATION SUBCATEGORY 3

Table to decide whether the techniques under review are MGE in the sense of London Protocol and in addition Ocean Fertilization Activities

A. Decision whether the techniques under review are MGE in the sense of London Protocol

1. Relevant provisions of London Protocol and the amendment of 2013

Article 6*bis* No.1: "Contracting Parties shall not allow the placement of matter into the sea from vessels, aircraft, platforms or other man-made structures at sea for marine geoengineering activities listed in annex 4, unless the listing provides that the activity or the subcategory of an activity may be authorized under a permit."

Article 1 No.4.2.2.: "placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this Protocol;"

Article 1 No.7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."

Article 1, No.5*bis*: "Marine geoengineering" means a deliberate intervention in the marine environment to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."

2. Table – Marine Geoengineering in the sense of article 6*bis*, article 1 No. 4.2.2. and No.7 and article 1 No.5*bis*:

TECHNIQUE/SCENARIO: Alkalinization Subcategory 3: Controlled alkalinization in reactors with discharge of an CO₂-equilibrated solution to the marine environment.	
Criteria	Annotations
Article 6 <i>bis</i> No.1: "placement of matter"	Yes, alkali material is introduced. Yes, adding alkali material directly to the ocean meets the criterion of "placement of matter" since the matter is deposited or released, thus placed for the purpose of enhancing alkalinity.
Article 6 <i>bis</i> No.1: "into the sea"	Yes. The result of the alkalinization process in a reactor would be introduced into the sea from a ship or platform. The alkalinization process would normally take place outside the sea, in reactors on ships or platforms.
Article 6 <i>bis</i> No.1: "from vessels, aircraft, platforms or other man-made structures at sea"	Yes. The matter could be introduced via pipelines. In this case, this criterion would not be met.
Article 6 <i>bis</i> No.1: placement of matter <u>and</u> article 1 No. 4.2.2.:	Yes, if the end product that is introduced has the property of drawing down CO ₂ from the atmosphere, then it is placed for a purpose other than mere disposal.

<p>"for a purpose other than the mere disposal thereof"</p>	<p>No, if the end product is only intended for disposal and the only drawdown of CO₂ takes place in the reactor. In this case, alkali material is only being disposed of with no other purpose.</p>
<p>Article 6<i>bis</i> No.1: "into the sea" <u>and</u> article 1 No.7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."</p>	<p>Yes. Alkali matter is placed to enhance ocean alkalinity.</p>
<p>Article 6<i>bis</i> No.1: "for marine geoengineering activities" and article 1 No.5<i>bis</i></p>	<p>Yes, if the end product that is introduced has the property of drawing down CO₂ from the atmosphere. In this case, the placement of alkali matter meets this criterion since it fits within the definition of article 1 paragraph 5<i>bis</i>. No, if the end product is only intended for disposal, with the only drawdown of CO₂ taking place in the reactor. In this case, alkali material is only being disposed of with no other purpose.</p>
<p>Article 1 No.5<i>bis</i>: "a deliberate intervention in the marine environment"</p>	<p>Could be yes or no, depending on the end product of the process in the reactor. If the end product changes ocean alkalinity and thereby leads to drawdown of CO₂ then yes. If the end product is equilibrated seawater with changed chemical properties but not alkaline and not intended to draw down CO₂ then no.</p>
<p>Article 1 No.5<i>bis</i>: "to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, ..."</p>	<p>Yes, if natural processes should be manipulated as by the introduction of end product of the process an effect in the marine environment is intended. No, if the introduction of the end product is only intended for disposal and the only drawdown of CO₂ takes place in the reactor, then the introduction of matter is merely an act of disposal with no other purpose, and no intention to manipulate natural processes. Which effect in detail, depends on the specific design and purpose of the process that takes place in the reactor.</p>
<p>Article 1 No.5<i>bis</i>: "and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."</p>	<p>Yes. See statement of the Scientific Groups: https://www.imo.org/en/MediaCentre/Pages/WhatsNew-854.aspx</p>

3. Consequence

If a technique is regarded as MGE in the sense of London Protocol, it could be listed in annex 4.

B. Decision whether the techniques under review are ocean fertilization in the sense of London Protocol

1. Relevant provisions

Next to the provisions with regard to MGE, annex 4 is relevant.

Annex 4, No. 1: "Ocean fertilization is any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans. Ocean fertilization does not include conventional aquaculture, or mariculture, or the creation of artificial reefs."

2. Table

TECHNIQUE/SCENARIO: Alkalinization Subcategory 3: Controlled alkalinization in reactors with discharge of an CO₂-equilibrated solution to the marine environment.	
Criteria	Annotations
Any activity undertaken by humans	Yes. This is an activity that would be undertaken by humans.
With the principal intention of stimulating primary productivity in the oceans	No. The intention is to enhance ocean alkalinity, with no intention to stimulate primary productivity
Not included: conventional aquaculture, or mariculture, or the creation of artificial reefs	Yes. The deposit of alkali material does not constitute conventional aquaculture, or mariculture, or the creation of artificial reefs.

3. Consequence

If a technique is considered within the definition of OF, an additional listing is not required.

C. Open question to be further discussed

- Could a pipeline terminus diffuser could be considered a "platform" or "other man-made structure at sea"?
- Under which conditions would subcategory 3 not be regarded being MGE?

BIOMASS CULTIVATION FOR SEQUESTRATION

Table to consider whether the techniques under review are MGE in the sense of London Protocol and in addition ocean fertilization activities

As discussed during the virtual meeting of LICG on 17 January 2023: the tables below set out criteria (in the form of potentially pertinent sections of the LP and its 2013 MGE amendment) and provide space for LICG to consider how the criteria apply to the various categories and sub-categories of MGE techniques set out in the companion document titled "Overview of sub-categories and scenarios for each of the four MGE techniques". There will be one table completed for each subcategory described in the companion document.

A. Decision whether the techniques under review are MGE in the sense of London Protocol

1. Relevant provisions of London Protocol and the amendment of 2013

Article 6*bis* No.1: "Contracting Parties shall not allow the placement of matter into the sea from vessels, aircraft, platforms or other man-made structures at sea for marine geoengineering activities listed in annex 4, unless the listing provides that the activity or the subcategory of an activity may be authorized under a permit."

Article 1 No.4.2.2.: "placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this Protocol;"

Article 1 No.7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."

Article 1, No.5*bis*: "Marine geoengineering" means a deliberate intervention in the marine environment to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."

2. Table – Marine Geoengineering in the sense of article 6*bis*, article 1 No. 4.2.2. and No.7 and article 1 No.5*bis*:

TECHNIQUE/SCENARIO: Marine or terrestrial biomass cultivation for carbon removal and ocean sequestration, including where supported by artificial upwelling	
Criteria	Application of the criteria
Article 6 <i>bis</i> No 1: "placement of matter"	<p>1a) Macro-algae farming with biomass sinking; 2a) micro-algae farming in a confined environment with biomass sinking; and 3) terrestrial biomass sinking all meet the criterion of "placement of matter" since whether the biomass initially comes from land or not, the matter is deposited or released, thus placed, for sinking. The placement of a substrate for biomass cultivation would also meet this criterion.</p> <p>1b) Macro-algae farming without biomass sinking (e.g. harvested for use on land) and 2b) micro-algae farming without sinking (e.g. harvested for use on land) would also meet this criterion, as there is also placement of a matter.</p>

	The use of artificial upwelling to obtain micro or macro algae could also arguably meet the criterion, as the pumps are placed.
Article 6 <i>bis</i> No 1: "into the sea"	Would meet the criterion when placed in marine waters other than internal waters, including on the seabed, according to the definition of "sea" in the London Protocol.
Article 6 <i>bis</i> No 1: "from vessels, aircraft, platforms or other man-made structures at sea"	Criterion met for all sub-categories as long as the placement is indeed from a vessel or another man-made structure at sea.
Article 6 <i>bis</i> No 1: placement of matter <u>and</u> article 1 No 4.2.2.: "for a purpose other than the mere disposal thereof"	Criterion met for all sub-categories, the intent is not to dispose of the matter.
Article 6 <i>bis</i> No 1: "into the sea" <u>and</u> article 1 No.7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."	Same as 3 rows above ("into the sea"): Would meet the criterion when placed in marine waters other than internal waters. (In assessing article 6 <i>bis</i> paragraph 1, we already have to take into account the definition of sea of the London Protocol in article 1 paragraph 7.)
Article 6 <i>bis</i> No 1: "for marine geoengineering activities" and article 1 No 5 <i>bis</i>	Criterion met for all sub-categories, since fits within the definition of article 1 paragraph 5 <i>bis</i> .
Article 1 No.5 <i>bis</i> : "a deliberate intervention in the marine environment"	Criterion met for all sub-categories, the manipulation of natural processes is directly intended.
Article 1 No.5 <i>bis</i> : "to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, ..."	Criterion met for all sub-categories, natural processes would be manipulated; the intent is to remove carbon.
Article 1 No.5 <i>bis</i> : "and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."	Yes. See statement of the Scientific Groups: https://www.imo.org/en/MediaCentre/Pages/WhatsNew-854.aspx

3. Consequence

If a technique is regarded MGE in the sense of London Protocol, it could be listed in annex 4.

B. Decision whether the techniques under review are ocean fertilization in the sense of London Protocol

1. Relevant provisions

Next to the provisions with regard to MGE, annex 4 is relevant.

Annex 4, No.1: "Ocean fertilization is any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans. Ocean fertilization does not include conventional aquaculture, or mariculture, or the creation of artificial reefs."

2. Table

TECHNIQUE/SCENARIO: Marine or terrestrial biomass cultivation for carbon removal and ocean sequestration, including artificial upwelling (CDR)	
Criteria	Application of the criteria
Any activity undertaken by humans	Criterion is met for all sub-categories.
With the principal intention of stimulating primary productivity in the oceans	Criterion is met for macro-algae farming in the sea and for artificial upwelling used for fertilization. Criteria is not met for micro-algae farming, macro-algae farming on land nor for terrestrial biomass sinking.
Not included: conventional aquaculture, or mariculture, or the creation of artificial reefs	Criterion is met for all sub-categories.

3. Consequence

If a technique is considered within the definition of OF, an additional listing is not required.

C. Open question to be further discussed

- More discussions and analysis are needed regarding cultivation approaches that form part of the technique "biomass cultivation for carbon removal and ocean sequestration" (e.g. macro-algae farming in the sea) and whether these can be considered ocean fertilization or should be excluded from its scope, given that the ultimate intention is carbon removal.

REFLECTIVE PARTICLES FOR ALBEDO ENHANCEMENT

Table to consider whether the techniques under review are MGE in the sense of London Protocol and in addition to ocean fertilization activities

As discussed during the virtual meeting of the LICG on 17 January 2023: the tables below set out criteria (in the form of potentially pertinent sections of the LP and its 2013 MGE amendment) and provide space for LICG to consider how the criteria apply to the various categories and sub-categories of MGE techniques set out in the companion document titled "Overview of sub-categories and scenarios for each of the four MGE techniques". There will be one table completed for each subcategory described in the companion document.

A. Decision whether the techniques under review are MGE in the sense of London Protocol

1. Relevant provisions of London Protocol and the amendment of 2013

Article 6*bis* No.1: "Contracting Parties shall not allow the placement of matter into the sea from vessels, aircraft, platforms or other man-made structures at sea for marine geoengineering activities listed in annex 4, unless the listing provides that the activity or the subcategory of an activity may be authorized under a permit."

Article 1 No.4.2.2: "placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this Protocol;"

Article 1 No.7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."

Article 1, No.5*bis*: "Marine geoengineering" means a deliberate intervention in the marine environment to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."

2. Table – Marine geoengineering in the sense of article 6*bis*, article 1 No. 4.2.2. and No.7 and article 1 No.5*bis*:

TECHNIQUE/SCENARIO: Disposition of reflective particles and/or other materials to enhance surface albedo	
Criteria	Application of the criteria
Article 6 <i>bis</i> No.1: "placement of matter"	<p>Yes, each variation of surface albedo enhancement technique involves placement of matter – matter is relinquished without the intention of recovery or abandoned, notwithstanding any co-incidental intention to increase solar reflectivity.</p> <p>1a) Some anticipated surface albedo enhancement techniques may involve placement of solid particles with or without addition of chemical compounds (powder, granular, and/or liquid)</p> <p>1b) Another anticipated surface albedo enhancement technique involves in situ injection or generation of micron-sized air bubbles. Chemical compounds may be added to</p>

	<p>increase the microbubble longevity or to modify other microbubble properties. If device is placed to generate microbubbles, it may be recovered.</p> <p>1c) Finally, materials may be distributed, placed, or cultivated on the ocean surface to enhance natural albedo, for example, foams, reflective films, or other matter to enhance blooms of reflective ocean flora.</p>
Article 6 <i>bis</i> No.1: "into the sea"	Yes, each variation of surface albedo enhancement technique would involve placement of matter into or on ocean waters. And some techniques have been proposed for placement on frozen ocean water (polar sea ice). Therefore, research into these techniques may occur on ice covered internal waters or land.
Article 6 <i>bis</i> No.1: "from vessels, aircraft, platforms or other man-made structures at sea"	Yes, each variation of surface albedo enhancement technique would involve placement of matter from a vessel or aircraft, and is amenable to placement from a man-made structure at sea. But placement of matter for surface albedo enhancement on polar sea ice may also involve placement by terrestrial land vehicles.
Article 6 <i>bis</i> No.1: placement of matter <u>and</u> article 1 No. 4.2.2.: "for a purpose other than the mere disposal thereof"	Yes, most variations of surface albedo enhancement involve placement of matter with the intention to relinquish the matter – to abandon the matter. However, each technique would involve co-incidental intention to increase solar reflectivity rather than "mere" disposal. In addition, if device is placed to generate microbubbles and the technique does not involve addition of chemicals, the device likely would be recovered and therefore would not be for the purpose of disposal.
Article 6 <i>bis</i> No.1: "into the sea" <u>and</u> article 1 No.7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."	Yes, because each technique may involve placement of matter "into the sea" as explained above. Each technique may occur in internal waters of States but not exclusively. None of the techniques would involve placement on the seabed or subsoil thereof.
Article 6 <i>bis</i> No.1: "for marine geoengineering activities" and article 1 No.5 <i>bis</i>	Yes? [Note: these three aspects of article 1.5 <i>bis</i> seem like they could be consolidated. This box says "marine" and that would be confirmed above in the "at sea" box. The next one about "deliberative invention" collapses with the "geoengineering" here.]
Article 1 No.5 <i>bis</i> : "a deliberate intervention in the marine environment"	Yes, the intention for placement of matter for surface albedo enhancement to is intervene in the natural environment.
Article 1 No.5 <i>bis</i> : "to manipulate natural"	Yes, the intention for placement of matter for surface albedo enhancement is to manipulate solar reflectivity to counteract

processes, including to counteract anthropogenic climate change and/or its impacts, ..."	the effects of solar heat on ocean temperature (including in polar regions), whether in localized areas or over larger ocean regions.
Article 1 No.5bis: "and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."	Yes. See statement of the Scientific Groups: https://www.imo.org/en/MediaCentre/Pages/WhatsNew-854.aspx

3. Consequence

If a technique is regarded as MGE in the sense of London Protocol, it could be listed in annex 4.

B. Decision whether the techniques under review are ocean fertilization in the sense of London Protocol

1. Relevant provisions

Next to the provisions with regard to MGE, annex 4 is relevant.

Annex 4, No.1: "Ocean fertilization is any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans. Ocean fertilization does not include conventional aquaculture, or mariculture, or the creation of artificial reefs."

1) Table

TECHNIQUE/SCENARIO: Disposition of reflective particles and/or other materials to enhance surface albedo	
Criteria	Application of the criteria
Any activity undertaken by humans	Yes
With the principal intention of stimulating primary productivity in the oceans	No
Not included: conventional aquaculture, or mariculture, or the creation of artificial reefs	No

1. Consequence

If a technique is considered within the definition of OF, an additional listing is not required.

B. Open questions to be discussed further

With respect to article 6bis No.1: placement of matter and article 1 No.4.2.2. and whether the activity is "for a purpose other than the mere disposal thereof," one commenter notes that the "core intention" is to increase the albedo effect and therefore that there is another purpose. Because the purpose is not "mere" disposal, an issue arises about whether the activity would fall within scope. The analysis otherwise concludes that the disposal purpose (relinquishment of matter with no intention or ability to recover renders the placement to be disposal).

MARINE CLOUD BRIGHTENING

Table to consider whether the techniques under review are MGE in the sense of London Protocol and in addition ocean fertilization activities

As discussed during the virtual meeting of the LICG on 17 January 2023: the tables below set out criteria (in the form of potentially pertinent sections of LP and its 2013 MGE amendment) and provide space for LICG to consider how the criteria apply to the various categories and sub-categories of MGE techniques set out in the companion document titled "Overview of sub-categories and scenarios for each of the four MGE techniques". There will be one table completed for each subcategory described in the companion document.

A. Decision whether the techniques under review are MGE in the sense of London Protocol

1. Relevant provisions of London Protocol and the amendment of 2013

Article 6*bis* No.1: "Contracting Parties shall not allow the placement of matter into the sea from vessels, aircraft, platforms or other man-made structures at sea for marine geoengineering activities listed in annex 4, unless the listing provides that the activity or the subcategory of an activity may be authorized under a permit."

Article 1 No.4.2.2: "placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this Protocol;"

Article 1 No.7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."

Article 1, No.5*bis*: "Marine geoengineering" means a deliberate intervention in the marine environment to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."

1. Table – Marine Geoengineering in the sense of article 6*bis*, article 1 No.4.2.2. and No.7 and article 1 No.5*bis*:

TECHNIQUE/SCENARIO: Marine Cloud Brightening	
Criteria	Application of the criteria
Article 6 <i>bis</i> No. 1: "placement of matter"	<p>Term 'placement' should be given plain English meaning: i.e. the action of placing something in a particular location. Note the action is deliberate.</p> <p>MCB involves the deliberate placing of particles in the atmosphere above the ocean.</p> <p>Most of those particles will ultimately, and inevitably, 'fall' into the sea. It is arguable whether this part of the MCB 'process' involves 'placement of matter'. It is arguable that the introduction of the particles into the sea better fits the definition of 'dumping' or 'pollution' in Art 1 LP.</p>

<p>Article 6bis No. 1: "into the sea"</p>	<p>The primary objective (or action) of MCB is the placement of particles in the atmosphere. The atmosphere above the ocean is not part of the 'sea' as defined at Art 1(7) LP. The particles placed in the atmosphere will ultimately fall 'into the sea'.</p>
<p>Article 6bis No. 1: "from vessels, aircraft, platforms or other man-made structures at sea"</p>	<p>Particles placed in the atmosphere for the purpose of MCB will be placed through one of the means listed here.</p>
<p>Article 6bis No. 1: placement of matter <u>and</u> article 1 No. 4.2.2.: "for a purpose other than the mere disposal thereof"</p>	<p>If we accept that MCB involves placing matter in the sea, then it can be strongly argued that the placement is for the purpose of disposal. This suggests that the 'placement' of particles in the sea from MCB falls within the scope of 'dumping' as defined at Art 1(4) LP: <i>"Dumping" means: .1 any deliberate disposal into the sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea;</i></p>
<p>Article 6bis No.1: "into the sea" <u>and</u> article 1 No.7: "all marine waters other than the internal waters of States, as well as the seabed and the subsoil thereof; it does not include sub-seabed repositories accessed only from land."</p>	<p>As above. It is clear that particles used for MCB will fall into the sea – but it is arguable as to whether the particles are 'placed' into the sea.</p>
<p>Article 6bis No.1: "for marine geoengineering activities" and article 1 No.5bis</p>	<p>See analysis below.</p>
<p>Article 1 No.5bis: "a deliberate intervention in the marine environment"</p>	<p>The term 'marine environment' should be interpreted as having a different meaning to the term 'sea'. While the term 'sea' is defined in Art 1 LP. The term 'marine environment' is used throughout the LP but is not defined. It is possible to argue that the term 'marine environment' includes the atmosphere immediately above the ocean. If this argument is accepted, then MCB involves an 'intervention in the marine environment'. It is clear that the term 'marine environment' includes the 'sea'. If it is accepted that the process of MCB extends to 'placement' of particles in the ocean, then MCB involves an 'intervention in the marine environment'.</p>
<p>Article 1 No.5bis: "to manipulate natural processes, including to counteract anthropogenic climate change and/or its impacts, ..."</p>	<p>This is the purpose of MCB.</p>

Article 1 No.5bis: "and that has the potential to result in deleterious effects, especially where those effects may be widespread, long lasting or severe."	It is strongly arguable that MCB has this potential. [See statement from the Scientific Groups: (https://www.imo.org/en/MediaCentre/Pages/WhatsNew-1854.aspx)]
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1. Consequence

If a technique is regarded as MGE in the sense of London Protocol, it could be listed in annex 4.

A. Decision whether the techniques under review are ocean fertilization in the sense of London Protocol

1. Relevant provisions

Next to the provisions with regard to MGE, annex 4 is relevant.

Annex 4, No. 1: "Ocean fertilization is any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans. Ocean fertilization does not include conventional aquaculture, or mariculture, or the creation of artificial reefs."

1. Table

TECHNIQUE/SCENARIO: Marine Cloud Brightening	
Criteria	Application of the criteria
Any activity undertaken by humans	Yes. MCB involves depositing matter into the atmosphere to create saltwater clouds.
With the principal intention of stimulating primary productivity in the oceans	This is not the principal intention of marine cloud brightening. The principal intention of marine cloud brightening is to manage solar radiation.
Not included: conventional aquaculture, or mariculture, or the creation of artificial reefs	Yes. MCB does not comprise conventional aquaculture, or mariculture, or the creation of artificial reefs.

1. Consequence

If a technique is considered within the definition of OF, an additional listing is not required.

A. Open questions to be discussed

- The legal interpretation remains unclear. Further discussion is required.