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DEVELOPMENT OF A SAFETY REGULATORY FRAMEWORK TO SUPPORT THE REDUCTION OF GHG EMISSIONS FROM SHIPS USING NEW TECHNOLOGIES AND ALTERNATIVE FUELS

Development of non-mandatory guidelines for the safety of ships using Onboard Carbon Capture Storage

Submitted by the Republic of Korea

SUMMARY

Executive summary:	This document addresses the necessity for the development of non-mandatory safety guidelines related to Onboard Carbon Capture and Storage (OCCS), taking into consideration the risks associated with the operation of onboard carbon capture devices, as well as the hazards associated with capturing and storing carbon dioxide.
Strategic direction, if applicable:	2
Output:	Not applicable
Action to be taken:	Paragraph 27
Related documents:	MSC 107/17/24; CCC 9/10/3, CCC 9/4/3, CCC 9/WP.4 and MEPC 80/7

Introduction

1 This document proposes the development of non-mandatory guidelines to ensure the safety of ships and crew members using onboard carbon capture devices.

Background

2 The Marine Environment Protection Committee (MEPC), at its eightieth session, adopted the 2023 IMO's Greenhouse Gas (GHG) Strategy, setting a net-zero target for 2050 to promote the use of greenhouse gas-zero fuels, technologies, and energy. Among various technologies for greenhouse gas reduction, Onboard Carbon Capture and Storage (OCCS) is gaining attention, as an innovative technology for achieving zero emissions from a lifecycle perspective. The guidelines for the overall assessment of ship fuels, adopted at MEPC 80, acknowledge the reduction attributed to the OCCS technology in the calculation formula for well-to-wake emissions.

3 Additionally, according to document MEPC 80/7 (RINA), several risk factors hindering the commercialization of OCCS were mentioned. The absence of onboard management, maintenance, and safety requirements for the system was highlighted. The proposed solution to address this issue involves the introduction of safety guidelines for ships and crew members.

4 The Sub-Committee on Carriage of Cargoes and Containers (CCC) considered document CCC 9/10/3 (the Republic of Korea) proposing to clarify the applicable requirements on the safe location of storage tanks containing liquefied carbon dioxide (LCO_2) collected from ship's exhaustion gas emissions, with a view to global and uniform implementation, and noted the following views:

.1 OCCS should be considered by the Committee;

.2 it was premature for the Sub-Committee to consider the matter regarding OCCS, as proposed in document CCC 9/10/3, noting that this was currently being considered by MEPC, and that the use of such technology had not yet been agreed. In addition, MSC 107 had agreed to include in the biennial agenda of the Committee an output on "Development of a safety regulatory framework to support the reduction of GHG emissions from ships using new technologies and alternative fuels", and decisions in this regard would be made by the Committee at a future stage;

.3 document CCC 9/10/3 could be kept in abeyance;

.4 a holistic review of the safe use of OCCS should be carried out and other IMO bodies might be involved in the further development of the safety requirements;

.5 provisions on the safe use of OCCS should be developed as goal-based regulations based on a risk assessment associated with such technology; and

.6 noting that amending the IGC Code was the proper way to advance the safe use of OCCS, the CCC Sub-Committee should invite submissions to amend the IGC Code.

5 Subsequently, the CCC Sub-Committee invited interested Member States and international organizations to consider submissions regarding the safe use of OCCS to a future session of the Committee.

6 Meanwhile, MSC 107, in accordance with IMO's strategy (MEPC.304(72), as amended), conducted a regulatory assessment in terms of safety aspects related to greenhouse gas (GHG) emission reduction from ships. IMO has approved the development of a safety regulatory framework to support the reduction of GHG emissions from ships using new technology and alternative fuels as a new output, aiming to assist in reducing GHG emissions from ships.

Discussion

7 While discussions are underway at IMO, encompassing paragraphs 2 to 6 above, the global shipping industry is witnessing an increasing demand for OCCS installations. In this context, the industry in the Republic of Korea plans to install developed OCCS on a 6,000 TEU container ship (**HMM Mongla**) in August 2024, with the ship scheduled to enter an international voyage in October of the same year. Additionally, several other countries and industries are actively engaged in the development and pilot projects of OCCS.*

* https://www.maritime-executive.com/article/researchers-achieve-very-promising-carbon-capture-results-on-lng-carrier

OCCS system overview

8 As described in paragraph 7 above, while discussions on OCCS at IMO are ongoing, the global marine equipment industries, including the Republic of Korea, are actively developing carbon capture and storage technologies within ships to reduce GHG emissions. Korean shipping companies are preparing to install such devices on ships, as illustrated in figures 1.1 and 1.2, to contribute to the reduction of greenhouse gas emissions from ships.

Figure 1.1: Drone shot of the OCCS

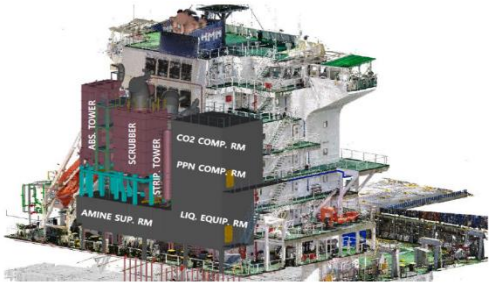

Figure 1.2: General arrangements of the OCCS

9 The planned OCCS for development and installation is a wet type, capable of capturing large volumes of CO_2. This OCCS system comprises a quenching tower for exhaust gas pretreatment, an absorber tower using amine-based solvent for CO_2 capture, a stripping tower utilizing the hot steam from the reboiler to separate solvent and CO_2, a liquefaction plant employing propylene as a refrigerant to transform CO_2 from gas to liquid, and an ISO tank for on-board storage of LCO_2. The conceptual design of the system is depicted in figure 2, and the project specifications are outlined in table 1.

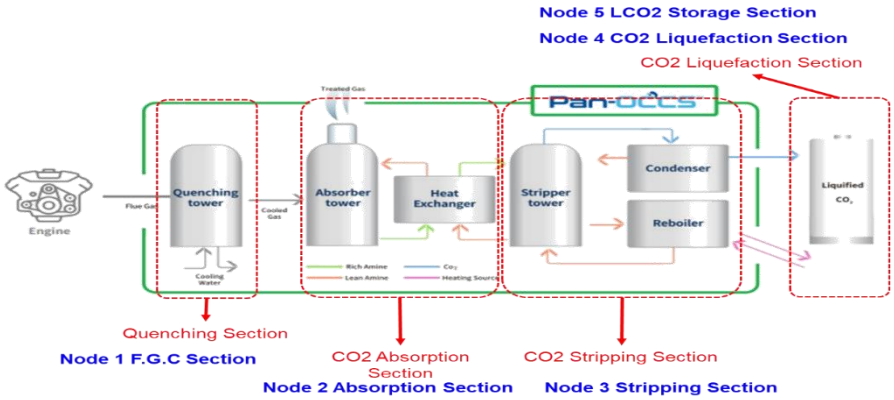

Figure 2: Concept design of Pan-OCCS (Source: PANASIA CO., LTD.)

Table 1. Specification (after DeSOx-Scrubber)

	Project specification			Liquefaction specification		
No.	**Description**	**Specification**	**Unit**	**Description**	**Specification**	**Unit**
1	Flue Gas Volume	14,000	Nm3/h	Flowrate	1,018	kg/h
2	Flue Gas Temp.	28	℃	Liquefaction Pressure	21	barG
3	CO_2 Capture rate	90	%(Wt)	Liquefaction temperature	-30	℃
4	CO_2 Capture Amount	1018	Kg.CO_2/h			

Hazard of carbon dioxide

10 Due to its higher density than air, CO_2 might potentially accumulate in confined spaces if leaked, settling in the lower regions. CO_2 exhibits characteristics, such as a critical point (73.8 bar and 31ºC) and a triple point (5.2 bar and -57ºC), allowing it to transition relatively easily between three states (solid, liquid, and gas) in response to external environmental changes. Additionally, LCO_2 boils at -78.5ºC and during vaporization it can descend to a temperature as low as -83ºC (liquid carbon dioxide release temperature).

11 According to the International Maritime Dangerous Goods Code (IMDG Code), carbon dioxide is transported in packaged forms such as cargo containers. As per the IMDG Code Chapter 3.2, CO_2 is classified as a dangerous good and specified as a non-flammable and non-toxic gas.

12 In relation to the amendment to the IGC Code, CCC 9 discussed the classification of LCO_2 as a toxic substance and deliberated on safety regulations for LCO_2-related ships and crew members, when classified as toxic. Document CCC 9/4/3 (SIGTTO) mentioned that several countries, including China, Japan, the United Kingdom, the United States and the European Union, classify CO_2 as a toxic substance. It was also noted that these countries have similar threshold values for toxicity criteria. However, the current IGC Code focuses on asphyxiation and the triple point, rather than the toxicity of carbon dioxide, outlining safety requirements related to carbon dioxide based on these considerations. Further details can be found in table 2.

Table 2: Minimum requirements for carbon dioxide (high purity)

	Description
Ship type	3G
Vapour detection	Asphyxiant
Gauging	R: Indirect, closed or restricted
Special requirements	17.21 (establishing safety measures for handling carbon dioxide cargo, addressing concerns such as uncontrolled pressure loss, cargo solidification prevention, continuous monitoring, and the use of suitable materials for cargo tanks)

Consideration of the hazards associated with operating OCCS

13 To capture CO_2 from ship exhaust gases, a chemical solvent is required and, through chemical reactions, CO_2 is selectively absorbed. Additionally, a liquefaction facility utilizing a refrigerant is necessary to convert the captured gaseous carbon dioxide into a liquid state. If these solvents and refrigerants possess asphyxiating, toxic or flammable properties, they may pose risks to the safety of the ship and its crew.

14 Regarding the content mentioned in paragraph 10 above, it is considered that regulations mentioned in documents CCC 9/4/3 (SIGTTO) and CCC 9/WP.4, specifically paragraph 17.21.8.6 of the IGC Code, would be necessary to review the application requirements for CO_2 carriers.

> ".6 When flammable or more toxic products are used for fuel or reliquefication system, due consideration shall be applied to the additional risk."

However, these regulations are currently under discussion for application to ships carrying carbon dioxide covered by the IGC Code. Currently, there is no consideration for applying these regulations to OCCS.

LCO_2 as ship's waste

15 The Republic of Korea believes that LCO_2 captured from a ship's emission gases should be treated as waste, akin to other by-products like oily sludge, sewage, and garbage, considered wastes under MARPOL.

16 The production and storage of LCO_2 captured from a ship's CO_2 emission gases, without using the ship's cargoes, might not violate SOLAS regulation VI/5-2. This regulation prohibits the physical blending of bulk liquid cargoes during sea voyages and any production processes on board a ship during sea voyages, with exceptions for safety or environmental protection purposes (see CCC 9/10/3).

17 On the other hand, if captured CO_2 is treated as waste, there is currently a lack of applicable international safety regulations developed by IMO. Applying regulations similar to those for cargo ships under the IGC Code to OCCS might not align with the intended scope of the IGC Code or could result in excessive regulations.

HAZID for the OCCS system

18 Considering discussions at IMO (paragraphs 4 and 6 above), along with risks mentioned in paragraphs 10 to 17 above and the ambiguity of applicable regulations, a Hazard Identification (HAZID) study has been conducted by an expert team comprising shipyards, shipping companies, classification societies, and manufacturers. This HAZID study aims to minimize risks associated with the absence of international safety regulations for OCCS, to share knowledge regarding the design and operation of OCCS, and to identify and to establish measures to mitigate potential issues or risks that could significantly impact safety related to the system.

19 The risks associated with the equipment identified in the HAZID study are as follows:

.1 leakage of solvent in the absorption section and stripping Section (including piping); and

.2 leakage of gaseous or liquid CO_2 in the area with the CO_2 liquefaction device and CO_2 storage area (including manifold, LCO_2 pipelines, etc.), as well as leakage of propylene (PPN).

20 The risk factor identified in sub-paragraph 19.2 above includes "CO_2 leakage," which can pose risks, such as asphyxiation, toxicity, and injuries due to low temperatures. Additionally, if the solvents and refrigerants used in OCCS operation, as identified in sub-paragraphs 19.1 and 19.2, exhibit flammable, toxic and asphyxiating characteristics, there is a potential risk of human injury due to fire, poisoning and asphyxiation.

The necessity of regulation development

21 When OCCS is employed to reduce a ship's CO_2 emissions, there may be a significant accumulation of LCO_2. However, it is prohibited to directly discharge LCO_2 into the sea, based on the United Nations Convention on the Law of the Sea (UNCLOS). Consequently, LCO_2 storage tanks within OCCS must be adequately sized, as calculated, to hold LCO_2 until transfer to an appropriate reception facility (see CCC 9/10/3).

22 With regard to using OCCS, there is a lack of international safety regulations to protect crew members from the inherent risks associated with CO_2, solvents and refrigerants. On the other hand, applying the IGC Code to ships that are not subject to its application, simply because OCCS is installed, could be an excessive interpretation, potentially imposing direct constraints on the decision-making process for installing OCCS on ships.

23 Therefore, for the safe use of OCCS, capturing and storing CO_2, as well as handling the substances required for OCCS operation, need careful consideration. Specifically, essential safety measures should include early detection of leaks of these substances, prompt alarms, as well as crew safety measures such as segregation, ventilation, and timely response to ensure crew safety.

24 As mentioned in paragraphs 2 to 4 above, the development of international safety requirements for OCCS aims to facilitate the adoption of OCCS in the international shipping industry. Ultimately, this can contribute to achieving the IMO's goals for reducing greenhouse gas emissions from shipping. Simultaneously, ensuring the safety of ships and the safety and health of crew members, through the development of these safety requirements, will contribute to international maritime safety.

Future plans

25 The Republic of Korea's industry plans to install OCCS on the 6,000 TEU container ship (**HMM Mongla**) in August 2024, with the ship scheduled to enter an international voyage in October 2024. Detailed results of the HAZID study, which includes the risks associated with OCCS operation, and safety requirements and measures to mitigate these risks, will be submitted to MSC 109. Furthermore, when developing international safety requirements related to OCCS, the Republic of Korea intends to contribute to the practical and rational development of safety regulations by presenting empirical data on the safety of the ship to IMO.

Proposal

26 Considering the necessity outlined in paragraphs 21 to 24 above, and referring to the future plans set out in paragraph 25, the Republic of Korea proposes the development of international non-mandatory guidelines to ensure the safe installation and operation of OCCS.

Action requested of the Committee

27 The Committee is invited to consider the proposal in paragraph 26 and to take action, as appropriate.