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WORK PROGRAMME

Development of non-mandatory guidelines for safety of ships using ammonia as fuel

Submitted by Japan, Singapore, ICS and INTERCARGO

SUMMARY

<i>Executive summary:</i>	This document proposes a new output to develop non-mandatory guidelines for safety of newly built ships using ammonia as fuel
<i>Strategic direction, if applicable:</i>	SD 2 and SD 3
<i>Output:</i>	To be decided
<i>Action to be taken:</i>	Paragraph 24
<i>Related documents:</i>	Resolution MEPC.304 (72); Fourth IMO GHG Study 2020 – Full Report; CCC 7/INF.8 and MSC 104/15/10

Introduction

1 This document, submitted in accordance with paragraph 4.6 of MSC-MEPC.1/Circ.5/Rev.2, proposes a new output to be included in the 2022-2023 biennial agenda of the CCC Sub-Committee to develop safety requirements for newly built ships using ammonia as fuel.

Background

2 To achieve the levels of ambition set out in the annex to the *Initial IMO Strategy on reduction of GHG emissions from ships* (resolution MEPC.304 (72), annex), utilization of alternative fuels is essential, and ammonia is one of the promising alternative fuels, as mentioned in the Full Report of the Fourth IMO GHG Study 2020.

3 Japan has started research and development (R&D) on ships using ammonia as a main fuel. Various R&D on ships fitted with ammonia combustion engines have also been launched in the world, as introduced, for example, in the following references (in chronological order):

- .1 MAN Energy Solutions, 2019, Engineering the future two-stroke green-ammonia engine, MAN B&W engines powered by zero-carbon fuels (<https://www.man-es.com/discover/two-stroke-ammonia-engine>);

- .2 ITOCHU Corporation announced that it has come to an agreement with Imabari Shipbuilding Co., Ltd., MAN Energy Solutions, Mitsui E&S Machinery Co., Ltd., ClassNK, ITOCHU ENEX Co. Ltd. on jointly developing ships equipped with a main engine using ammonia as its main fuel (Press release (ITOCHU) on April 30, 2020);
- .3 CCC 7/INF.8 "*Forecasting the alternative marine fuel: ammonia*" submitted by the Republic of Korea (July 10, 2020);
- .4 NYK announced that it has come to an agreement with IHI Power Systems Co., Ltd., ClassNK and NYK on jointly making R&D for realizing an ammonia-fuelled Tug boat. (Press release (NYK) on August 18, 2020);
- .5 A Joint Development Project (JDP) to develop an ammonia-fuelled tanker design was launched by LR, MISC Berhad, MAN Energy Solutions and Samsung Heavy Industries (SHI). Yara International ASA, a giant Norwegian chemicals company and major ammonia producer, and the Maritime and Port Authority of Singapore (MPA) have signed up to join what has been named 'The Castor Initiative', taking the JDP partnership to six. (Press release (Lloyd's Register) on February 24, 2021); and
- .6 Parties of a total of 23 companies have entered into a memorandum of understanding on joint study of common issues on ammonia as an alternative marine fuel beyond industry boundaries. The 23 founding signatories of this Joint Study framework include ABS, ANGLO AMERICAN, CLASSNK, DNV, EQUINOR, FORTESCUE METALS GROUP, GENCO SHIPPING & TRADING, JERA, K-LINE, MAN ENERGY SOLUTIONS, MITSUI E&S MACHINERY, NIHON SHIPYARD, NS UNITED, PAVILION ENERGY, TOTALENERGIES, TRAFIGURA, UBE INDUSTRIES, UNIPER SE, UYENO TRANSTECH, VALE, VOPAK TERMINAL SINGAPORE, ITOCHU ENEX and ITOCHU. In line with the agreed procedure, common issues including (1) Safety assessment of NH₃ fuel ship under guideline, (2) Safety assessment of NH₃ bunkering, (3) NH₃ fuel specification, and (4) NET CO₂ emission at NH₃ production, are going to be discussed in this Joint Study framework. (Press release (ITOCHU) on June 11, 2021).

4 Under circumstances in which demand for design and/or construction of ammonia-fuelled ships are emerging in the world, the co-sponsors consider it necessary to develop the relevant safety requirements for ships using ammonia as a fuel, to facilitate the utilization of ammonia as fuel on ships.

Discussion and proposal

5 A flashpoint as physical property is applied only to a material in liquid phase. The flashpoint of ammonia has not been consistently identified in relevant publications such as Safety Data Sheet. Therefore, it is unclear whether or not ammonia is a low flashpoint fuel as defined by SOLAS regulation II-1/2.29. Although the applicability of the International Code of Safety for Ships using Gases and other Low-flashpoint Fuels (IGF Code) is not clear for these reasons at this stage, it would be necessary to identify appropriate safety measures for ships using ammonia as a fuel.

6 Furthermore, taking into account the aforementioned ongoing R&D on ammonia fuelled ships to be engaged on international voyages, as well as the importance of GHG reduction by using such ships as soon as possible, it would be urgent to develop internationally agreed instruments to cover safety measures for ships using ammonia as a fuel. The co-sponsors, therefore, propose to develop non-mandatory guidelines, as an interim

measure, for newly built ships using ammonia as a fuel. Such guidelines will preferably be functional rather than too prescriptive, not to exclude specific technologies.

7 Apart from this proposal, paragraph 16.9.2 of the IGC Code prohibits the use of cargoes identified as toxic products as fuel and ammonia is identified as a toxic product in accordance with paragraph 1.2.53 and chapter 19 of the IGC Code. Therefore, in accordance with the IGC Code, an ammonia gas carrier shall not use its cargoes (ammonia) as fuel.

8 This issue has been already pointed out at the last row of the table as the annex to document MSC 102/21/14 and the Committee, at its 103rd session, having considered this document together with documents MSC 102/21/1 and MSC 102/21/16, agreed to include in its post-biennial agenda an output on "Review of the IGC Code" without limiting the scope of this output to specific paragraphs (MSC 103/WP.1/Rev.1, paragraphs 18.1 and 18.2). Therefore, the prohibition of the use of ammonia cargoes as fuel will be considered under a separate agenda of the CCC Sub-Committee.

IMO's objectives

9 The development of safety requirements for ships using ammonia as fuel is in line with SD 2 "Integrate new and advancing technologies in the regulatory framework" and SD 3 "Respond to climate change".

Need

10 Various R&D on the use of ammonia as a fuel have already been started, as mentioned in paragraph 3, and ships using ammonia as fuel will be launched in the near future. There is an urgent need for the development of safety requirements for such ships to prevent accident proactively.

Analysis of the issue

11 Ammonia is a lighter-than-air gas, which is not liable, in general, to accumulate at a lower part of a confined space even in the case of leakage, as the vapour cloud of ammonia may be denser than the atmosphere and tends to travel along the bottom vicinity of the location of release of liquefied ammonia.

12 According to the International Maritime Dangerous Goods (IMDG) Code, ammonia, precisely speaking "AMMONIA, ANHYDROUS", is a class 2.3 dangerous good having subsidiary hazard class 8, while class 2.1 is not assigned. Namely, ammonia is a toxic and corrosive gas, but not a "flammable gas" in accordance with the definitions of dangerous goods.

13 Table 1 shows the minimum requirements for bulk transport of ammonia specified in the IGC Code. With regard to the vapour detection, "T: toxic vapour detection" is required, while "F+T: Flammable and toxic vapour detection" is not required.

Table 1 – Minimum requirements for Ammonia, anhydrous (IGC Code)

Ship type	2G/2PG
Independent tank type C	NOT required
Control of vapour space within cargo tanks	No special requirements
Vapour detection	Toxic vapour detection
Gauging	Indirect or closed
Special requirements	14.4 (Personal protection); 17.2.1 (Materials of construction is mercury, copper and copper-bearing alloys or zinc); and 17.12 (Special requirements against stress corrosion cracking.)

14 Therefore, it is considered that the major hazards possessed in handling of ammonia are the toxicity and then corrosivity, with the flammability/explosivity not being a significant hazard, although not negligible. In view of this, early detection and rapid alerting of leakage of ammonia will be among some of the essential safety measures needed to ensure the safety of the crew. Means for safe escape of crews will be also important for safety. The outline of the hazard identification study of ammonia fuelled ships conducted by Japan is provided in the annex to document MSC 104/15/10. Regardless of the above preliminary view and the hazard identification study, hazards will be revisited during the in-depth consideration of safety measures.

15 Risk assessments, including consideration on types and positions of detectors, may also be required, in order to maintain the safety and a degree of freedom of ship design.

Analysis of implications

16 The development of the requirements for ships using ammonia as fuel:

- .1 does not create any additional cost to maritime industry, while cost of safety measures will be proportional to the risks of such ships;
- .2 may facilitate the work of Administrations intending to permit such ships; and
- .3 neither creates legislative nor administrative burdens.

17 The checklist for identifying administrative requirements, i.e. annex 5 to MSC-MEPC.1/Circ.5/Rev.2, is provided in annex 1 to this document.

Benefits

18 The development of the requirements for ships using ammonia as fuel will facilitate the utilization of ammonia as fuel on ships. The requirements will contribute to reduction of GHG in shipping and lead the achievement of the levels of ambition in the initial IMO strategy on reduction of GHG emissions from ships set out in the annex to resolution MEPC.304 (72).

Industry standards

19 National regulations and industrial standards have been developed for ammonia used as a refrigerant and for refrigerating systems with ammonia, for example as shown below, and the documents may provide useful information:

- .1 29 CFR § 1910.111 – Storage and handling of anhydrous ammonia, by Occupational Safety and Health Administration (OSHA) of the United States;
- .2 ANSI/CGA G-2.1-2014 "requirements for the storage and handling of anhydrous ammonia";
- .3 ASHRAE Standard 15-2019 – Safety Standard for Refrigeration Systems;
- .4 ISO 5771:2008 "Rubber hoses and hose assemblies for transferring anhydrous ammonia – Specification";
- .5 ISO 7103:1982 "Liquefied anhydrous ammonia for industrial use – Sampling – Taking a laboratory sample";

- .6 ISO 7105:1985 "Liquefied anhydrous ammonia for industrial use – Determination of water content – Karl Fischer method"; and
- .7 ISO 7106:1985 "Liquefied anhydrous ammonia for industrial use – Determination of oil content – Gravimetric and infra-red spectrometric methods".

Output

20 The intended output is to develop non-mandatory guidelines for safety of newly built ships using ammonia as fuel.

Human element

21 The non-mandatory guidelines to be developed should include education and training for crew onboard, and operational requirements to address safe and environmentally sound operations. On the other hand, it is assumed that amendments to the STCW Convention and the Code will be considered at a later stage in conjunction with the development of mandatory requirements for ships using ammonia as fuel.

22 The completed Checklist for Considering Human Element Issues by IMO Bodies (the annex to MSC-MEPC.7/Circ.1) is provided in annex 2 to this document.

Priority/Urgency

23 The urgency of the proposed output is very high for the following reasons:

- .1 reduction of GHG emissions from ships is urgent and promoting the use of alternative fuels is indispensable;
- .2 various R&Ds are ongoing and ships using ammonia as fuel is under development; and
- .3 ensuring the safety of such ships is paramount and the development of internationally applicable safety requirements will proactively contribute to safety.

Action requested of the Committee

24 The Committee is invited to include the proposed new output in the 2022-2023 biennial agenda of the CCC Sub-Committee and the provisional agenda for CCC 8, to start the consideration as early as possible.

ANNEX 1

CHECKLIST FOR IDENTIFYING ADMINISTRATIVE REQUIREMENTS
(MSC-MEPC.1/Circ.5/Rev.2, Annex 5)

This checklist should be used when preparing the analysis of implications required in submissions of proposals for inclusion of outputs. For the purpose of this analysis, the term "administrative requirement" is defined in accordance with resolution A.1043(27), as an obligation arising from a mandatory IMO instrument to provide or retain information or data.

Instructions:

- (A) If the answer to any of the questions below is **YES**, the Member State proposing an output should provide supporting details on whether the requirements are likely to involve start-up and/or ongoing costs. The Member State should also give a brief description of the requirement and, if possible, provide recommendations for further work, e.g. would it be possible to combine the activity with an existing requirement?
- (B) If the proposal for the output does not contain such an activity, answer **NR** (Not required).
- (C) For any administrative requirement, full consideration should be given to electronic means of fulfilling the requirement in order to alleviate administrative burdens.

1. Notification and reporting? Reporting certain events before or after the event has taken place, e.g. notification of voyage, statistical reporting for IMO Members, etc.	NR <input checked="" type="checkbox"/>	Yes <input type="checkbox"/> Start-up <input type="checkbox"/> Ongoing
Description of administrative requirement(s) and method of fulfilling it: (if the answer is yes)		
2. Record keeping? Keeping statutory documents up to date, e.g. records of accidents, records of cargo, records of inspections, records of education, etc.	NR <input checked="" type="checkbox"/>	Yes <input type="checkbox"/> Start-up <input type="checkbox"/> Ongoing
Description of administrative requirement(s) and method of fulfilling it: (if the answer is yes)		
3. Publication and documentation? Producing documents for third parties, e.g. warning signs, registration displays, publication of results of testing, etc.	NR <input checked="" type="checkbox"/>	Yes <input type="checkbox"/> Start-up <input type="checkbox"/> Ongoing
Description of administrative requirement(s) and method of fulfilling it: (if the answer is yes)		
4. Permits or applications? Applying for and maintaining permission to operate, e.g. certificates, classification society costs, etc.	NR <input checked="" type="checkbox"/>	Yes <input type="checkbox"/> Start-up <input type="checkbox"/> Ongoing
Description of administrative requirement(s) and method of fulfilling it: (if the answer is yes)		
5. Other identified requirements?	NR <input checked="" type="checkbox"/>	Yes <input type="checkbox"/> Start-up <input type="checkbox"/> Ongoing
Description of administrative requirement(s) and method of fulfilling it: (if the answer is yes)		

ANNEX 2

CHECKLIST FOR CONSIDERING HUMAN ELEMENT ISSUES BY IMO BODIES
(MSC-MEPC.7/Circ.1, Annex)

<p>Instructions: If the answer to any of the questions below is:</p> <p>(A) YES, the preparing body should provide supporting details and/or recommendation for further work.</p> <p>(B) NO, the preparing body should make proper justification as to why human element issues were not considered.</p> <p>(C) NA (Not Applicable) – the preparing body should make proper justification as to why human element issues were not considered applicable.</p>	
<p>Subject Being Assessed: (e.g. Resolution, Instrument, Circular being considered) New non-mandatory guidelines for ships using ammonia as fuel</p>	
<p>Responsible Body: (e.g. Committee, Sub-committee, Working Group, Correspondence Group, Member State) The Sub-Committee on Carriage of Cargoes and Containers</p>	
1. Was the human element considered during development or amendment process related to this subject?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
2. Has input from seafarers or their proxies been solicited?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
3. Are the solutions proposed for the subject in agreement with existing instruments? (Identify instruments considered in comments section)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
4. Have human element solutions been made as an alternative and/or in conjunction with technical solutions?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
5. Has human element guidance on the application and/or implementation of the proposed solution been provided for the following:	
• Administrations?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
• Ship owners/managers?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
• Seafarers?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
• Surveyors?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
6. At some point, before final adoption, has the solution been reviewed or considered by a relevant IMO body with relevant human element expertise?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
7. Does the solution address safeguards to avoid single person errors?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
8. Does the solution address safeguards to avoid organizational errors?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
9. If the proposal is to be directed at seafarers, is the information in a form that can be presented to and is easily understood by the seafarer?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
10. Have human element experts been consulted in development of the solution?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
11. HUMAN ELEMENT: Has the proposal been assessed against each of the factors below?	
<input type="checkbox"/> CREWING. The number of qualified personnel required and available to safely operate, maintain, support, and provide training for system.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
<input type="checkbox"/> PERSONNEL. The necessary knowledge, skills, abilities, and experience levels that are needed to properly perform job tasks.	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA

<input type="checkbox"/> TRAINING. The process and tools by which personnel acquire or improve the necessary knowledge, skills, and abilities to achieve desired job/task performance.	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
<input type="checkbox"/> OCCUPATIONAL HEALTH AND SAFETY. The management systems, programmes, procedures, policies, training, documentation, equipment, etc. to properly manage risks.	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
<input type="checkbox"/> WORKING ENVIRONMENT. Conditions that are necessary to sustain the safety, health, and comfort of those on working on board, such as noise, vibration, lighting, climate, and other factors that affect crew endurance, fatigue, alertness and morale.	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
<input type="checkbox"/> HUMAN SURVIVABILITY. System features that reduce the risk of illness, injury, or death in a catastrophic event such as fire, explosion, spill, collision, flooding, or intentional attack. The assessment should consider desired human performance in emergency situations for detection, response, evacuation, survival and rescue and the interface with emergency procedures, systems, facilities and equipment.	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
<input type="checkbox"/> HUMAN FACTORS ENGINEERING. Human-system interface to be consistent with the physical, cognitive, and sensory abilities of the user population.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
<p>Comments: At this stage, it is proposed to develop new guidelines for ships using ammonia as fuel, which amongst others, should address human element aspects and operational requirements with the aim of ensuring safe and environmentally friendly use of this new technology.</p>	
