MARITIME SAFETY COMMITTEE
102nd session
Agenda item 21

MSC 102/21/7
11 February 2020
Original: ENGLISH
Pre-session public release: ☒

## WORK PROGRAMME

### Proposal for a new output for the fire protection on containerships regarding the review of relevant parts of SOLAS chapter II-2 with regard to fire protection in the cargo area on and under deck

**Submitted by the Bahamas, Germany, IUMI, BIMCO and CESA**

**SUMMARY**

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| *Executive summary:* | This document proposes a new output on the need for amendments to regulations in SOLAS chapter II-2 regarding enhanced provisions for early fire detection and effective control of fires in containerized cargoes stowed on and under deck of containerships |
| *Strategic direction, if applicable:* | 6 |
| *Output:* | Not applicable |
| *Action to be taken:* | Paragraph 28 |
| *Related documents:* | SOLAS chapter II-2, as amended; MSC 83/25/5; FP 54/15, FP 54/INF.2; MSC 102/INF.2 and MSC 102/INF.3 |


1 This document is submitted in accordance with the provisions of paragraph 4.6 and 6.12.2 of the *Organization and method of work of the Maritime Safety Committee and the Marine Environment Protection Committee and their subsidiary bodies* (MSC-MEPC.1/Circ.5/Rev.1) on the submission of proposals for new outputs.

**Background**

2 The worldwide fleet of full cellular containerships has grown to 5,255 units[1] in 2019, whereas their number was about 4,639 only 10 years earlier in 2009.[2] The newly launched ships are predominantly large units compared to the ships that are taken out of service and

[1] Shipping Statistics and Marked Review 2019 Volume 63 No.1/2 (Institute of Shipping Economics and Logistics ISL).

[2] Shipping Statistics and Marked Review 2009 Volume 53 No.1/2 (Institute of Shipping Economics and Logistics ISL).

scrapped. As a result of the growth in size, the average capacity of full cellular containerships grew from 1,753 TEUs with up to six tiers of containers in 2000[3] to 4,185 TEUs with up to 11 tiers of containers in 2019 on deck. If the growth continues at this pace, containerships will have an average capacity of approximately 5,800 TEUs in 2030.[4] The exposure increases with the size of the ships due to their larger capacities. In addition, the potential of fire incidents increases in correlation to the growing number of containers per ship.

3 The severity of fires in the cargo area of containerships is well known. Catastrophic examples of the past are **Hanjin Pennsylvania** (4,000 TEU, fire on 11 November 2002, two fatalities, constructive total loss), **Hyundai Fortune** (5,551 TEU, fire on 21 March 2006), **MSC Flaminia** (6,732 TEU, fire on 14 July 2012, three fatalities and two seriously injured, constructive total loss); and recently **Maersk Honam** (15,262 TEUs, fire on 6 March 2018, five fatalities) and **Yantian Express** (7,510 TEUs, fire on 3 January 2019). The often disastrous development of containership fires can be attributed to the cargoes carried, their misdeclaration or non-declaration, the technical design and specifications for containerships, the compact pattern of container stowage in containerships and the inadequate technical provisions for fire detection, fire localization and fire fighting, in particular, on deck. This situation persists despite the amendments to SOLAS regulation II-2/10 in 2014 (resolution MSC.365(93)), where the additional equipment of containerships with some mobile water monitors and at least one water mist lance was made mandatory for new buildings from 1 January 2016 onward. The **Maersk Honam** had the newly required equipment on board, yet it was rendered useless. Portable monitors and water mist lances are designed to fight incipient fires. However, all incidents listed above, with the exception of the **Yantian Express**, were related to an explosive combustion. Such fires cannot be tackled by the additional equipment required since 1 January 2016.

4 Fortunately, the number of fatalities in such cargo fire incidents is comparatively low in relation to fires in accommodation or machinery spaces. However, the involvement of dangerous goods in such cargo fires constitutes a significant threat to crew from toxic vapours/gases and unexpected explosions. Also serious are the significant losses of material property (MSC 102/INF.2), as well as the concurrent impact on the confidence of those involved in shipping. Therefore, the co-sponsors of this document have prepared the application of this issue with the aim to initiate a revision of the provisions on fire protection in the cargo area of containerships.

5 The co-sponsors are of the opinion that the effective avoidance of cargo fires on containerships needs a holistic approach. For prevention purposes, the misdeclaration or non-declaration of dangerous cargoes plays an important role, as these have been identified as root causes for the majority of containership fires. The co-sponsors of this document will support the respective initiatives in the CCC Sub-Committee to address misdeclarations or non-declarations, inter alia, by reconsidering the respective IMDG Code provisions, where appropriate. At the same time, the co-sponsors propose to consider the need for further amendments to the relevant regulations in SOLAS chapter II-2, in order to ensure that successful fire-protection measures are available to the crew when a fire breaks out.

[3] Shipping Statistics and Marked Review (SSMR) 2000 No.1/2 (Institute of Shipping Economics and logistics ISL).

[4] Linear update based on ISL statistics by GDV Transport Department using the sources listed above as well as Shipping Statistics and Marked Review 2010 Volume 54 No.1/2 (Institute of Shipping Economics and Logistics ISL); Shipping Statistics and Marked Review 2015 Volume 59 No.1/2 (Institute of Shipping Economics and Logistics ISL).

**Current safety standards**

6 The current safety philosophy for containerships with regard to fire protection in the cargo area has, in principle, been copied from the traditional general dry cargo ships. Fire detection and fire control in the cargo spaces of a containership is, hence, implemented by the mandatory installation of a combined system of air extraction from holds for smoke monitoring and, when necessary, $CO_2$ injection into the hold for controlling a fire. The intended effect of $CO_2$ is to reduce the oxygen content of the free hold atmosphere down to a concentration of about 15% which, together with the self-inerting effect of the present fire, is sufficient to smother the flames and keep temperatures low. Final extinguishing will, in most cases, be a tedious matter of the local application of water by suitably equipped crew members or by fire brigade in a port of refuge, if available.

7 This equipment scenario has been enhanced for newly built containerships from 2016 onward by a defined number of mobile water monitors, as specified by the *Guidelines for the design, performance, testing and approval of mobile water monitors used for the protection of on-deck cargo areas of ships designed and constructed to carry five or more tiers of containers on or above the weather deck* (MSC.1/Circ. 1472), requiring at least one approved water mist lance. The water monitors shall improve the capability of the ship's crew to contain or even extinguish fires in on-deck stowed containers, which was before restricted to the traditional equipment of water hoses and hand-held nozzles. The water mist lance shall enable the penetration of the wall of a burning container that is within reach to extinguish the fire inside the container.

8 A detailed description of the present equipment of containerships is contained in document MSC 102/INF.3 (IUMI). The description includes the capacity of fire pumps, the water distribution system and the fire-fighters' outfits. The adequacy of this equipment is scrutinized in the following paragraphs.

**Evaluation of risk control conditions**

9 Dangerous goods or products of a self-reactive nature are the principal sources of fires in freight containers underway.[5] Fires evolve in two phases: the heating phase and after ignition, the burning phase. Sources of the heating phase of ignition will most probably originate from a spontaneous or triggered rise in temperature due to chemical or biological reactions of sensitive substances and cargo (such as overcharged battery cells), often promoted or triggered by external heat from sunshine or mechanical stress on sensitive cargo, such as battery cells. Such reactions may be accompanied by the formation of flammable gases. In this context, the proper declaration of dangerous goods, and their appropriate stowage and segregation is important as is the suitability of the cargo for transport in the first place. This includes proper conditioning (e.g. stabilizing) and "fit for purpose" packaging of goods and the proper packing (stuffing) of the container.[6]

10 Early fire detection is of utmost importance. Hostile fires accelerate proportionally to the state they have reached; time is crucial and immediate action is paramount. The container presents a "subspace" which conceals smoke and heat for a considerable time until the fire has broken through the confinement. The latter will generally be the case with dangerous goods of high thermal potential. Only at this time (in the burning phase) will the present equipment of containerships, e.g. the traditional smoke detecting system, report a fire in the cargo hold. Fires in their heating phase could be detected early by temperature monitoring of

5 Tests have shown that fires of ordinary combustible material inside a container will in most cases be smothered by self-inerting without critical heat propagation to neighbouring containers.

6 The IMO/ILO/UNECE Code of Practice for Packing of Cargo Transport Units provides detailed guidance.

containers. Such early detection at ambient temperature and before the occurrence of smoke would allow the situation to be kept under control, maintain the personnel in safety, protect the adjacent containers by water cooling and take efficient fire-fighting measures. The situation with containers stowed on deck is slightly better because the natural features of a fire (smoke, smell, noise, light and heat) may be perceived in due time by the watchkeeper on the bridge or by crew members who are incidentally passing by. However, the size of the ship, the relocation of the navigating bridge to the forward half of the ship and the density of the deck stow is practically in conflict with an early detection.

11 Positive fire localization should ideally be concurrent with fire detection for initiating appropriate counter measures. This is generally the case with a burning container on deck when smoke becomes visible. However, in the cargo hold, the existing smoke detection system will not identify the location of a burning container. The nature of the burning substance and the potential spreading of the fire to adjacent combustible material is, therefore, difficult to identify, unless suitably equipped crew members undertake to enter the smoke filled space for exploration. This method is similar to the ancient days of conventionally stowed general cargo. The present detection system does not take advantage of the container stowage which permits a well-defined fragmentation of the vast cargo space in terms of bay, row and tier. A known location would identify the container and its contents including the neighbouring containers at risk. Advanced technology may achieve this and combine fire detection, localization and immediate risk assessment to enable an appropriate response.

12 The present means of controlling (damping) a fire in the cargo hold consists of the fixed $CO_2$ flooding system and the further possibility to enter the smoke filled hold through an access port, protected by breathing and heat repellent equipment, with a fire hose under pressure. There is concordance among all experts that the first option is of little effect. About 80% of the cargo hold of a containership in service will be occupied by containers. The $CO_2$ introduced will, thus, protect only about 20% of the space. This is achieved quickly but does not affect the vast amount of the air stored within the containers. As there is no cooling effect of the $CO_2$ introduced, the second option may be chosen. However, this is dangerous to crew, exhausting and also of little prospect to extinguish the fire or at least confine it within its origin. Furthermore, cooling of vital ship structures will be provisional and uncertain.

13 Controlling or preferably extinguishing a fire in deck-stowed containers relies on manual application of water by means of hoses to be connected to local hydrants. Only in new-build containerships (after 1 January 2016) is this endeavour supported by the operation of mobile monitors. However, these monitors must be brought into position by crew members and connected to the water supply by hoses. During these operations, the narrow space between the container bays impedes the rigging of fire hoses and the application of water. The steep angle of water jets and the natural air draught between container bays makes fire fighting with handheld nozzles tedious and ineffective.

14 Fire fighting in the cargo area of containerships is impaired by the size of the ships. Long distances to walk with unwieldy fire-fighter's outfit, rigging lengths of hoses over ladders and narrow walkways, and the height of stows on deck or the depth of stows in holds make this mission strenuous and exhausting. As the number of crew has not grown with the size of the ships, an early physical exhaustion of fire-fighters becomes a significant problem. External assistance by fire-fighting boats or salvage tugs will generally arrive at a later stage and their effect, even though using powerful amounts of water, is often limited by their wave-induced motions and lack of target keeping.

**Reference to an earlier formal safety assessment**

15 Document MSC 83/25/5 (Germany) for initiating the revision of SOLAS regulation II-2/10 in 2007 and the subsequent discussion in the FP Sub-Committee were supported by a formal safety assessment (FSA), of which details are given in document FP 54/INF.2 (Germany). Although the title of this study is directed to "container fire on deck", the scope of the investigation covers also fires in containers under deck, as deck fires often start in the hold. Therefore, the essential findings of this FSA (hazard identification, risk analysis and risk control options) are still valid and useful for the present application of this issue. Only the cost-benefit assessment requires re-consideration, not only due to changed prices but also with regard to global economic aspects in the shipping industry.

**Motivation**

16 The reapplication for a review of the fire protection requirements in containerships is formally motivated by the safety objectives in SOLAS regulation II-2/2, stating:

"The fire safety objectives of this chapter are to:

.1 prevent the occurrence of fire and explosion;

.2 reduce the risk to life caused by fire;

.3 reduce the risk of damage caused by fire to the ship, its cargo and the environment;

.4 contain, control and suppress fire and explosion in the compartment of origin; and

.5 provide adequate and readily accessible means of escape for passengers and crew."

These objectives may not be met in the cargo area of containerships, particularly taking into account contemporary technology. More detailed information on the motivation is provided in document MSC 102/INF.3 (IUMI).

**Advanced risk control options**

17 Without anticipating the discussion and decision-making in the appropriate IMO Sub-Committee, a revision of fire protection requirements should consider the following issues for inclusion into a goal-based approach, thereby, ensuring that each potential measure is efficient and, technologically and economically feasible:

.1 definition of fire compartments under deck by means of the transverse bulkheads, including powerful water spray cooling system for hull protection;

.2 establishment of fire compartments above the deck, in line with those under deck, by means of vertical water curtains (shields);

.3 fixed installed monitors at locations permitting a dual attack of each fire on deck;

.4 fixed installed cooling systems for hatch covers and deck girders of the ship;

.5 alignment of pump capacity for the above services including draining of cargo holds;

.6 advanced fire detection and localization system under deck;

.7 advanced fire detection system above the deck for each bay of containers; and

.8 improved protection of deck house and life-saving equipment by means of water curtains.

Concurrently, the equipment of containerships with a combined smoke detection and $CO_2$ flooding system may be put into question.

**IMO objectives**

18 The main goal of this proposal is fire protection of containerships which lies within IMO's mission and vision to promote safe, secure, environmentally sound, efficient and sustainable shipping through cooperation, by adopting the highest practicable standards of maritime safety and security, efficiency of navigation and prevention and control of pollution from ships.

**Compelling need**

19 The fire protection provisions for containerships need to be revised in light of the evidence provided by the casualty records[7] in view of the quoted safety objectives in SOLAS regulation II-2/2 and the need for a contemporary level of protection.

**Analysis of the issue**

20 Suitable measures need to be developed, possibly by amending SOLAS chapter II-2, to explicitly include active and/or passive fire protection provisions on board new containerships. The proposed new output will enable the amendments to be proposed to address these issues and provide for mitigating measures.

**Analysis of implications**

21 There are no additional administrative requirements or burdens and the cost to the shipping industry for additional risk prevention installations will be appropriate in relation to the risk of further containership fires. The checklist for identifying administrative requirements and burdens (MSC-MEPC.1/Circ.5/Rev.1, annex 5) is set out in annex 1.

22 The characteristics and the recurrent catastrophic development of fire incidents in the cargo area of containerships suggest that the revision of the fire protection regulations for containerships is an urgent matter. The considerations outlined in paragraph 3 above, in combination with recent incidents, show that even for ships built and put into service after 1 January 2016 under the revised SOLAS regulation II-2/10 (resolution MSC.365(93)), the fire detection and fire-fighting means on board are not sufficient to effectively tackle and contain the fire. Considering the risks and hazards caused by containership fires as described in this document, as well as in document MSC 102/INF.3, the co-sponsors propose this matter as a new output to be approved by the Committee.

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7 Cefor - The Nordic Association of Marine Insurers, Fires on container vessels 2019, extract of Cefor half-year hull trend report 2019 and Helge Rathje, Analyse von Bränden und Löscheinsätzen auf Vollcontainerschiffen im Zeitraum 2000-2015, Diplomarbeit, Bremen University of Applied Sciences.

**Benefits**

23 The work to be undertaken under the proposed new output will ensure that the objectives of SOLAS chapter II-2 be effectively addressed and complied with on new containerships. This will ensure that the stakeholders will have appropriate means to address fire safety on board containerships.

**Industry standards**

24 The fire protection provisions in SOLAS constitute mandatory industry standards for the carriage of container cargoes by sea. Such standards should be goal-based, as well as technologically and economically feasible.

**Output**

25 The proposed output is to "consider the need for amendments to SOLAS chapter II-2 regulations regarding enhanced provisions for early fire detection and effective control of fires in cargo holds and on the cargo deck of containerships". The scope is:

.1 to consider fire protection in the cargo area of containerships in view of the quoted safety objectives in SOLAS regulation II-2/2 and the need for a contemporary level of protection; and

.2 to develop suitable measures, possibly by amending SOLAS, to explicitly include active and/or passive fire protection provisions on board new containerships.

**Human element**

26 The completed checklist contained in the *Checklist for considering human element issues by IMO bodies* (MSC-MEPC.7/Circ.1) is set out in annex 2.

**Urgency**

27 It is recommended that a new output with sufficient level of priority be included in the biennial agenda of the Sub-Committee on Ship Systems and Equipment (SSE) for the 2022-2023 biennium, with completion of the work within four sessions.

**Action requested of the Committee**

28 The Committee is invited to consider the information provided above and endorse the request for a new output for the SSE Sub-Committee.

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## ANNEX 1

## CHECKLIST FOR IDENTIFYING ADMINISTRATIVE REQUIREMENTS

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.

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

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# ANNEX 2

## CHECKLIST FOR CONSIDERING HUMAN ELEMENT ISSUES BY IMO BODIES

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| **Instructions:**<br>If the answer to any of the questions below is:<br>(A) **YES**, the preparing body should provide supporting details and/or recommendation for further work.<br>(B) **NO**, the preparing body should make proper justification as to why human element issues were not considered.<br>(C) **NA** (Not Applicable) – the preparing body should make proper justification as to why human element issues were not considered applicable. | |
| **Subject Being Assessed:** (e.g. resolution, instrument, circular being considered)<br>SOLAS II-2 and related Codes, MSC resolutions and circulars as appropriate | |
| **Responsible Body**: (e.g. Committee, Sub-committee, Working Group, Correspondence Group, Member State)<br><br>Sub-Committee on Safety Systems and Equipment | |
| 1. Was the human element considered during development or amendment process related to this subject? | ☐Yes ☐No ☒NA |
| 2. Has input from seafarers or their proxies been solicited? | ☐Yes ☐No ☒NA |
| 3. Are the solutions proposed for the subject in agreement with existing instruments? (Identify instruments considered in comments section) | ☐Yes ☐No ☒NA |
| 4. Have human element solutions been made as an alternative and/or in conjunction with technical solutions? | ☐Yes ☐No ☒NA |
| 5. Has human element guidance on the application and/or implementation of the proposed solution been provided for the following: | |
| • Administrations? | ☐Yes ☒No ☐NA |
| • Shipowners/managers? | ☐Yes ☒No ☐NA |
| • Seafarers? | ☐Yes ☒No ☐NA |
| • Surveyors? | ☐Yes ☒No ☐NA |
| 6. At some point, before final adoption, has the solution been reviewed or considered by a relevant IMO body with the relevant human element expertise? | ☐Yes ☒No ☐NA |
| 7. Does the solution address safeguards to avoid single person errors? | ☐Yes ☒No ☐NA |
| 8. Does the solution address safeguards to avoid organizational errors? | ☐Yes ☒No ☐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? | ☐Yes ☒No ☐NA |
| 10. Have human element experts been consulted in developing the solution? | ☐Yes ☒No ☐NA |
| **11. HUMAN ELEMENT: Has the proposal been assessed against each of the factors below?** | |
| ❑ CREWING. The number of qualified personnel required and available to safely operate, maintain, support and provide training for system. | ☐Yes ☒No ☐NA |
| ❑ PERSONNEL. The necessary knowledge, skills, abilities and experience levels that are needed to properly perform job tasks. | ☐Yes ☒No ☐NA |
| ❑ TRAINING. The process and tools by which personnel acquire or improve the necessary knowledge, skills and abilities to achieve desired job/task performance. | ☐Yes ☒No ☐NA |

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| ❑ OCCUPATIONAL HEALTH AND SAFETY. The management systems, programmes, procedures, policies, training, documentation, equipment, etc. to properly manage risks. | ☐Yes ☒No ☐NA |
| ❑ 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. | ☐Yes ☒No ☐NA |
| ❑ 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. | ☐Yes ☒No ☐NA |
| ❑ HUMAN FACTORS ENGINEERING. Human-system interface to be consistent with the physical, cognitive and sensory abilities of the user population. | ☐Yes ☒No ☐NA |
| **Comments:**<br>(1) Justification if answers are NO or Not Applicable.<br>(2) Recommendations for additional human element assessment needed.<br>(3) Key risk management strategies employed.<br>(4) Other comments.<br>(5) Supporting documentation. | |