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MSC.1/Circ.1552
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AMENDMENTS TO THE GUIDELINES ON ALTERNATIVE DESIGN AND ARRANGEMENTS FOR FIRE SAFETY (MSC/CIRC.1002)

1 The Maritime Safety Committee, at its ninety-seventh session (21 to 25 November 2016), with a view to providing more specific guidance on the application of SOLAS regulation II-2/17, approved amendments to the *Guidelines on alternative design and arrangements for fire safety* (MSC/Circ.1002), as prepared by the Sub-Committee on Ship Systems and Equipment at its third session (14 to 18 March 2016), as set out in the annex.

2 Member States are invited to use the annexed amendments to MSC/Circ.1002 and to bring them to the attention of all parties concerned.

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ANNEX

AMENDMENTS TO THE GUIDELINES ON ALTERNATIVE DESIGN AND ARRANGEMENTS FOR FIRE SAFETY (MSC/CIRC.1002)

1 The following new appendix A is inserted before the existing appendix A and the existing appendices A to C are renamed appendices B to D accordingly:

"**APPENDIX A**

GUIDELINES FOR THE SELECTION OF LIFE SAFETY PERFORMANCE CRITERIA

1 Application

These guidelines are intended to provide a methodology for the selection of performance criteria used to address the survivability of persons on board when exposed to the effects of heat, smoke, toxicity and reduced visibility, as referenced by paragraph 6.3.4.1 of the annex. The primary purpose of these guidelines is to assist Administrations when evaluating proposed alternative designs and arrangements against the fire safety objective "to reduce the risk to life caused by fire" (SOLAS regulation II-2/2.1.1.2). These guidelines may also be used to establish minimum safety margins in the available time for safe escape from spaces approved with alternative design and arrangements in accordance with SOLAS regulation II-2/17. The Administration may require more comprehensive analysis for complex or unusual space arrangements.

2 Definitions

Evacuation time means the time it takes for all persons in the affected space to move from where they are upon notification of a fire to a safe location outside the space, either in an enclosed stairway or another main vertical zone.

Minimum visibility means the minimum visible distance needed to allow escaping persons on board to travel at normal walking speed through spaces obscured by smoke.

Available safe egress time (ASET) means the available time to egress safely the space/spaces affected by the fire or smoke (see also paragraph 4.1.2).

Required safe egress time (*RSET)* means the required time to egress safely the space/spaces affected by the fire or smoke (see also paragraph 4.1.1).

3 General

MSC/Circ.1002 provides a methodology for justifying alternative design and arrangements as permitted by SOLAS regulation II-2/17. The fundamental principle behind this method of analysis is to show that the alternative design provides an adequate level of safety that is at least equivalent to the life safety performance criteria outlined in section 4.2 below or the fire safety level of a comparable prescriptive design if appropriate using SOLAS chapter II-2, whichever is greater using a probabilistic analysis where appropriate. This is typically done with the aid of computer-based simulations of design fire scenarios that show the expected development of fire growth and its related consequences on the affected space. The fire effects over time are typically used in conjunction with an evacuation analysis to show that all persons on board can safely escape from the affected space(s) before the fire effluents reach a level capable of adversely impacting evacuation. In cases where the particular alternative design and arrangement may not require a comparison against the available evacuation time, the Administration should determine how the life safety performance criteria should apply.

The methodology used in MSC/Circ.1002 to provide technical justification for alternative design and arrangements relies on the development of one or more design fire scenarios that define a set of conditions for the development and spread of fire through the affected ship space(s). The design fire scenarios are based on a review of the particular alternative design and arrangement, the type and amount of combustible materials expected in the space(s), and localized ignition sources. The alternative design and arrangement is then exposed to the design fire scenarios using appropriate computer fire modelling. In order to show that a level of safety is achieved that is equivalent to the fire safety objectives and functional requirements specified in SOLAS regulation II-2/2, quantitative performance criteria should be considered to evaluate the exposure of persons on board to heat and smoke, as well as criteria for damage to the ship and the environment.

Specific life safety performance criteria should be developed for each proposed alternative design and arrangement, taking into account the nature of the fire hazards in the affected space(s), expected fuel sources, fire extinguishing and detection systems in the affected areas, and the characteristics of persons on board. These life safety performance criteria should be expressed in quantitative terms selected to demonstrate that the alternative design meets the fire safety objectives and functional requirements in SOLAS chapter II-2 with reasonable confidence that it will perform its intended function(s) when necessary and in a manner which satisfies the intent of the prescriptive fire safety requirements outlined in SOLAS chapter II-2.

At a minimum, the effects of radiant heat exposure, air temperature, carbon monoxide concentration and reduced visibility should be included in all SOLAS regulation II-2/17 analyses. Depending on the specific nature of the alternative design and arrangement, the Administration should consider if additional performance criteria may be necessary, such as toxicity of other gases and irritants, and the order of movement for persons on board.

An important part of the overall engineering analysis used in determining the suitability of the alternative design is the quantitative analysis. As described in the annex above, a quantitative analysis should be conducted by evaluating the design fire scenarios against the life safety performance criteria (sections 4.3.5 and 6 of the annex). One should also note that risk may play an important role in this process (section 6.1.2 of the annex). When evaluating probabilistic scenarios, care must be taken to appropriately apply the relevant fire safety engineering design guides and other literature as referenced in section 3 and appendix D of the annex (section 1.3) to ensure that these risks are well understood and accounted for.

Further information on the selection of life safety performance criteria may be found below and in appendix D:

.1 SFPE Engineering Guide to Performance-Based Fire Protection, Society of Fire Protection Engineers and National Fire Protection Association, Second Edition, 2007;

.2 ISO 19706:2011, Guidelines for assessing the fire threat to people;

.3 ISO 13571:2012, Life-threatening components of fire – Guidelines for the estimation of time to compromised tenability in fires; and

.4 ISO 13344:2015 Estimation of the lethal toxic potency of fire effluents.

4 Method

Advanced simulation tools should be used to assess the fire safety performance within the affected space(s) proposed by the alternative design or arrangement.

When evaluating the evacuation time, an advanced evacuation simulation tool, or tools, should be used to determine the maximum time required to evacuate the affected space. Such tools may use varying assumptions and algorithms to simulate walking speeds and the order of passenger movement. The advanced method contained in annex 2 to the *Revised guidelines on evacuation analysis for new and existing passenger ships* (MSC.1/Circ.1533) provides information on the recommended characteristics of the simulation tools used to conduct an evacuation analysis.

Similarly, when evaluating design fires to determine the elapsed time before the effects of fire and smoke directly impact occupant tenability, suitable computational fluid dynamics (CFD) fire modelling software acceptable to the Administration should be utilized (see annex, sections 3.1, 6.2.1, 6.2.3 and appendix D).

4.1 ASET/RSET analysis

In general, an ASET/RSET analysis, as outlined below, should be used to assess the safe escape of all persons or to determine the number of affected persons within the space.

4.1.1 Determine the Required Safe Egress Time (RSET)

Using an appropriate methodology, determine the maximum RSET to completely evacuate the space, using either the day or night case response time distributions, as applicable to the affected space(s), assuming occupancy in accordance with chapter 13 of the FSS Code. If the simulation is carried out according to the advanced methodology in MSC.1/Circ.1238, the safety factor of 1.25 given in annex 2, paragraph 3.5.1 should be applied.

4.1.2 Determine the Available Safe Egress Time (ASET)

The ASET is the time required to maintain tenability between the ignition of a fire and the performance criteria thresholds (specified in section 4.2 below) being exceeded within the range of zero to two metres (0-2 m) above the deck being considered in public spaces and zero to one point eight metres (0-1.8 m) in all other areas. In multiple open deck spaces (e.g. atria), each deck normally accessible to persons on board should be considered simultaneously. These performance criteria are not intended to evaluate the tenability of the volume of space in the immediate vicinity of the fire (if they were, all designs would quickly fail). Instead, this evaluation should identify the expected location of affected populations (at a corresponding time of RSET in a given space) and evaluate their direct exposure to any immediate (e.g. heat flux and temperature) and prolonged (e.g. visibility and toxic environment) exposure to the effects caused by fire.

4.2 Life safety performance criteria

4.2.1 The following life safety performance criteria should be used when evaluating the ASET in section 4.1 above:

Maximum air temperature	60ºC
Maximum radiant heat flux	2.5 kW/m^2
Minimum visibility	10 m; 5 m in spaces ≤ 100 m^2
Maximum CO concentration	1200 ppm (instantaneous exposure) 500 ppm (for 20 min cumulative exposure times)

These four performance criteria are deemed sufficient for designs where alternative geometry, physical dimensions or safety systems are proposed. For other types of alternative designs, especially related to changes in combustible materials, ventilation, etc. specific quantities of other toxic gases or irritants may be appropriate (e.g. HCN, HCl).

4.2.2 If the ASET in all cases exceeds the RSET, no further analysis is needed. Control measures such as smoke management systems and equipment may be provided to aid in the achievement of this result, subject to the satisfaction of the Administration.

4.2.3 If any of the values in paragraph 4.2.1 are exceeded during the evacuation (ASET < RSET), then at a minimum, a fractional effective dose (FED – thermal dose and/or asphyxiate gases depending on the results) calculation should be performed in accordance with standard ISO 13571:2012 to demonstrate that a maximum threshold criterion of 0.3 will not be exceeded prior to the RSET being reached (note visibility may be the overriding limiting factor). Alternative standards such as risk performance criteria acceptable to the Administration (e.g. using FSA Guidelines (MSC-MEPC.2/Circ.12/Rev.1)) may also be used if desired by the Administration.

4.2.4 Administrations should approve alternative designs and arrangements only when their comprehensive engineering analysis, including a probabilistic analysis as appropriate, demonstrates an acceptable level of performance based upon application of the life safety performance criteria specified in 4.2 above."

2 In the renamed appendix D, the existing paragraph 4 is replaced as follows:

"4 Other important technical references include:

.1 Custer, R.L.P. and Meacham, B.J., "Introduction to Performance-Based Fire Safety", Society of Fire Protection Engineers, USA, 1997;

.2 Engineering Guide to Assessing Flame Radiation to External Targets from Liquid Pool Fires, Society of Fire Protection Engineers, Bethesda, MD, 1999;

.3 Engineering Guide to Predicting 1st and 2nd degree Skin Burns, Society of Fire Protection Engineers, Bethesda, MD, 1999;

.4 Fire Protection Handbook, 20th Edition, A. E. Cote, ed., National Fire Protection Association, Quincy, MA, 2008;

.5 Hadjisophocleous, G. and Benechou, N., "Performance criteria used in performance-based Design", Automation in Construction, 8 (489-501), 1999;

.6 Hurley, M.J. and Bukowski, R.W., "Fire hazard analysis and techniques", NFPA Fire Protection Handbook 20th Ed., Sec. 3 Ch. 7, 2008;

.7 ISO 13344:2015, Estimation of the lethal toxic potency of fire effluents;

.8 ISO 13571:2012, Life-threatening components of fire – Guidelines for the estimation of time to compromised tenability in fires;

.9 ISO 13943:2008, Fire safety – Vocabulary;

.10 ISO 19706:2011, Guidelines for assessing the fire threat to people;

.11 Jin, T., "Studies of Emotional Instability in Smoke from Fires", Journal of Fire and Flammability, Vol. 12 (130-142), 1981;

.12 Klote, J.H. and Milke, J.A., "Principles of Smoke Management", American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA, 2002;

.13 Milke, J.A. et al., "Tenability Analyses in Performance-Based Design", Fire Protection Engineering, 2005;

.14 NFPA 550, "Guide to the Use of the Fire Safety Concepts Tree", National Fire Protection Association, 1995;

.15 Purser, D.A., "Assessment of Hazards to Occupants from Smoke, Toxic Gases, and Heat", The SFPE Handbook of Fire Protection Engineering, 4th Edition, National Fire Protection Association, Quincy, MA, 2002;

.16 SFPE Engineering Guide to Performance-Based Fire Protection, Society of Fire Protection Engineers and National Fire Protection Association, 2nd Edition, 2007;

.17 SFPE Handbook of Fire Protection Engineering, 4th Edition, P. J. DiNenno, ed., The Society of Fire Protection Engineers, Boston, MA, 2008; and

.18 Wade, C. et al., "Developing Fire Performance Criteria for New Zealand's Performance Based Building Code", Presented at the Fire Safety Engineering International Seminar, Paris, France, April, 2007."

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