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SUB-COMMITTEE ON SHIP DESIGN AND
CONSTRUCTION
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REVIEW AND, IF NECESSARY, AMENDMENT OF SOLAS REGULATIONS II-2/13.4.1.1 AND 13.4.2.1 TO CLARIFY THE REQUIREMENTS ON ESCAPE ARRANGEMENTS FROM THE LOWER PART OF MACHINERY SPACES

Comparison of evacuation times from machinery spaces, in accordance with calculation methodology for evacuation travel duration in the *Revised Guidelines on evacuation analysis for new and existing passenger ships* (MSC.1/Circ.1533)

Submitted by IACS

	SUMMARY
Executive summary:	To support the conclusion in document SDC 12/11 that SOLAS regulations need not be revised, this document provides the results of a comparison between evacuation times based on the calculation methodology for evacuation travel duration in the *Revised Guidelines on evacuation analysis for new and existing passenger ships* (MSC.1/Circ.1533). It is demonstrated that an emergency escape trunk which does not extend to the lowest deck level provides equivalent or shorter evacuation times to a safe location than an escape trunk extending to the lowest deck level.
Strategic direction, if applicable:	7
Output:	7.33
Action to be taken:	Paragraph 4
Related documents:	SDC 11/10/3; MSC 110/11/2, MSC 110/21 and SDC 12/11

Introduction

1   In support of the conclusion presented in paragraph 25 of document SDC 12/11 that "in the absence of clear evidence of safety concerns, SOLAS regulations need not be revised", this document provides a comparison of evacuation times for different machinery spaces, based on the methodology in the *Revised Guidelines on evacuation analysis for new and existing passenger ships* (MSC.1/Circ.1533) for calculation of evacuation travel duration onboard passenger ships. While the Revised Guidelines are applicable to passenger ships, the methodology has been used to assess the relative evacuation time across various scenarios. The primary objective is to assess the difference in evacuation times resulting from elevated versus lower access to emergency escape trunks.

2   In some ship designs, physical constraints prevent the escape trunk from extending to the lowest deck level, resulting in the use of inclined stairs to an elevated access.

Summary of the results for the comparison of evacuation times

3   The results for the comparison of the evacuation times in the case of the practically realistic design of the aft positioned escape trunk in the engine-room indicate that an emergency escape trunk which does not extend to the lowest deck level provides equivalent or shorter evacuation times to a safe location than an escape trunk extending to the lowest deck level.

Action requested of the Sub-Committee

4   The Sub-Committee is invited to note and take into account the report provided in the annex when considering document SDC 12/11, concluding that SOLAS regulations need not be revised.

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ANNEX

RESULTS FOR THE COMPARISON OF EVACUATION TRAVEL TIMES IN ACCORDANCE WITH THE CALCULATION METHODOLOGY FOR EVACUATION TRAVEL DURATION IN THE REVISED GUIDELINES ON EVACUATION ANALYSIS FOR NEW AND EXISTING PASSENGER SHIPS (MSC.1/CIRC.1533)

General

1   IACS has conducted a comparative calculation of evacuation times from engine-rooms through the escape trunk using the methodology specified in MSC.1/Circ.1533 for calculation of evacuation travel duration onboard passenger ships.

2   In the context of machinery spaces and fire response on cargo ships, actual evacuation times may vary due to personnel, smoke conditions, heat exposure, and PPE requirements. This comparison is limited to the travel duration metrics and does not presume equivalency in actual risk exposure (smoke layer height, thermal conditions, toxicity) or exit point safety.
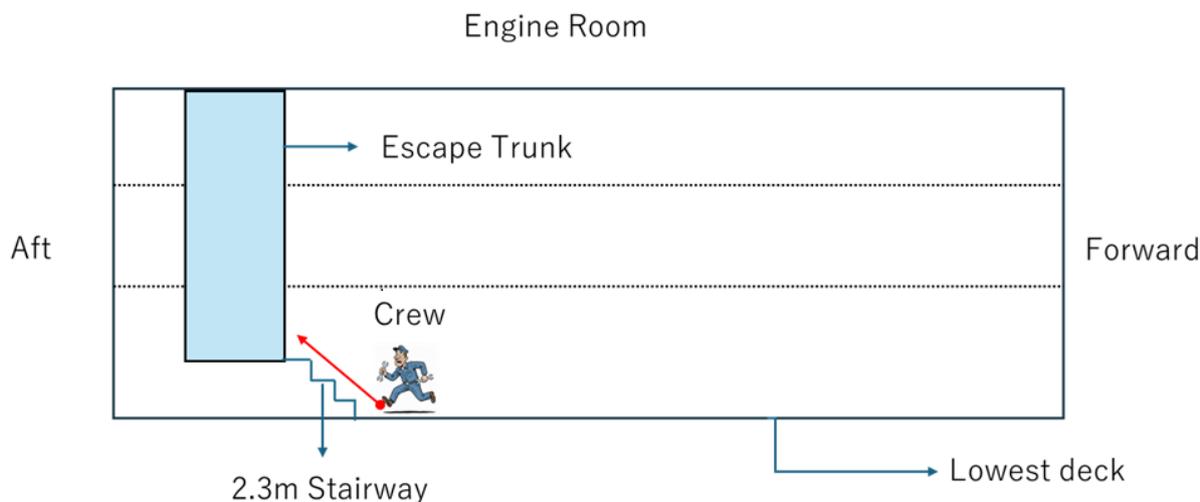
Escape route scenarios

3   The analysis compares two main scenarios for the location of the escape trunk in the engine-room. In the first scenario (Route A), the escape trunk is positioned as far aft as possible in the engine-room. Due to assumed structural constraints in this area, its entrance is elevated 2.3 m above the lowest deck level. The person(s) evacuating is(are) located in this aft area, at the base of the stairs leading up to the entrance to the trunk.

3.1   In the second scenario (Route B), the escape trunk is led all the way down to the lowest deck level, however, due to structural constraints in the aft, the trunk needs to be moved forward, resulting in a horizontal distance that the person located in the aft area must travel before entering the trunk. The distance that the trunk needs to be moved forward may vary depending on hull shape and technical interferences, so this scenario includes a range of possible distances to reflect various design variations.

3.2   In summary; the analysis compares the time required for a person located in the aft area of the engine-room to travel forward to an escape trunk that extends down to the lowest deck level, with the time needed to access an elevated escape trunk located aft.

4   The escape route scenarios are summarized, as follows:

.1   *Route A*: Escape trunk installed at the aft (not at the lowest deck, but the lower part) – escape through an escape trunk installed on a platform in the lower part after climbing a 2.3 m stairway.

.2   *Route B*: A range of escape scenarios, through an escape trunk which is installed at the lowest deck:

.1   at the aft point (similar to Route A scenario (0 m)); and then

.2   at points 5 m, 10 m, 15 m, 20 m and 25 m away from that aft point towards the forward area of the engine-room.

Engine Room

Figure 1 – Simple sketch of Route A

Engine Room
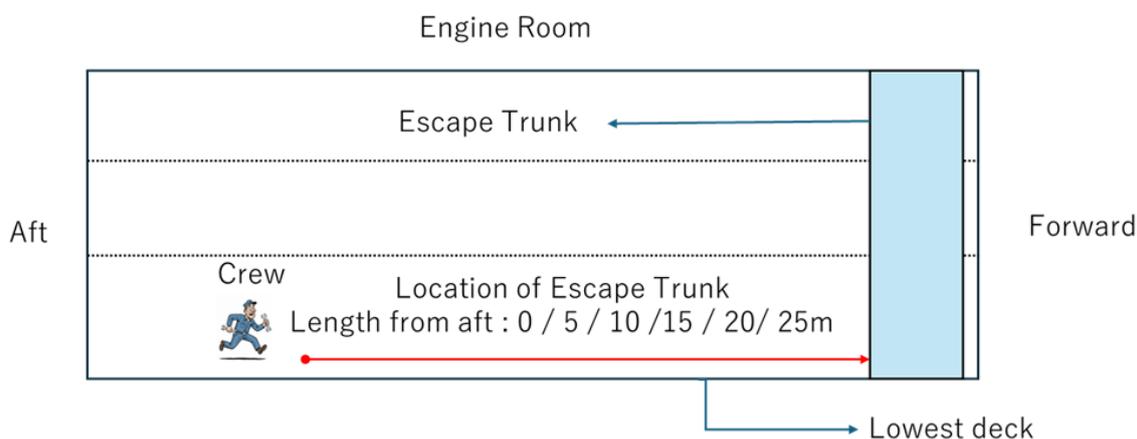
Figure 2 – Simple sketch of Route B.

5   The escape route scenarios specified in paragraph 4 have been determined based on specific factors. It was assumed challenging to place the escape trunk at the aft point (0 m) from the lowest level in the engine-room. Therefore, the escape trunk for Route A is placed at the aft point (0 m) with the entrance located 2.3 m above the lowest deck level. The escape trunk for Route B is placed at the lowest deck level at aft point (0 m) and then at 5 m, 10 m, 15 m, 20 m and 25 m away from that aft point (0 m) towards the forward area of the engine-room, for this comparison. Whilst those are points for Route B, at the same time, it was assumed practically challenging to place the escape trunk at the aft point (0 m) and at points 5 to 10 m away from that aft point (0 m) for the following reasons:

.1   Stern profile configuration, deep reinforcement structures, and inability to maintain the required "clear width" of 800 x 800 mm:

.1   The internal dimensions of protected vertical escape trunks shall maintain a "clear width of 800×800 mm" throughout the entire vertical section (horizontal sections ≥600 mm). As the structure progresses toward the stern, the concentration of shell curvature/bossing and deep floors, webs, and stringers makes it structurally challenging to continuously maintain this clear width requirement.

.2   Hull form and shell plating constraints: the stern section is characterized by the hull shell curvature, bossing structures, and rudder carrier arrangements which make it technically difficult to maintain the effective clear width (800×800 mm) of the trunk.

.3   Structural member interference: creating new openings that penetrate stiffeners, frames, stringers and other steel reinforcements, as well as fire boundaries rated A-0 or higher, necessitates local reinforcement and re-evaluation of thermal and smoke barrier performance.

.2   Interference with propulsion shafting systems and major equipment (near centreline):

.1   The aft engine-room accommodates essential centreline equipment including stern tubes/shaft bearings, propeller shafts, CPP hydraulic/seal systems, and shaft tunnels. Large aft equipment physically obstructs the downward extension of trunks and adversely affects maintainability aspects such as maintenance removal (shaft withdrawal) and shaft alignment accessibility.

.2   Loss of maintenance and emergency equipment access: forced downward extension of trunks may interfere with maintenance routes and emergency power/firefighting access pathways.

.3   Equipment relocation and reinforcement typically require extensive work with implications for weight distribution, vibration characteristics, and alignment parameters.

Summary of assumptions

6   **Travel time formula**: segment time is calculated as T=L/S (distance/speed).

7   **Route definition**:

.1   The reference point is the escape from the aft part of the engine-room via an escape trunk installed on a platform 2.3 m above (standard deck height 2.3 m as per Regulation 33 of ICLL). In all scenarios, the starting point in the engine-room for the evacuation is designated in the aft section as 0 m in front of the ladder leading to that platform.

.2   Route A (escape trunk installed at the aft section (lower part)): from the lowest level of the engine-room at the aft section (0 m to the ladder), ascend 2.3 m via a 60° stairway. Access the escape trunk at the aft section and escape.

.3   Route B (escape trunk installed at points moving from aft to forward (lowest deck)): from the same starting point (0 m), move horizontally away from that point to the escape trunk installed (at various points) towards the forward part of the engine-room and then access the escape trunk to escape.

.4   Distance from the starting point (0 m) at aft to the trunk forward H: comparative calculations based on assumed lengths of 0 / 5 / 10 / 15 / 20 / 25 m.

8   **Speed parameters**:

    .1   **Flat terrain speed** = 1.11 m/s, the speed is minimum walking speed on flat terrain of crew males specified in table 3.4 – Walking speed on flat terrain (e.g. corridors), Annex 3, MSC.1/Circ.1533.

    .2   **Stair ascent speed** = 0.5 m/s, the speed is minimum walking speed on stairs, stairs up, of crew males specified in table 3.5 – Walking speed on stairs, Annex 3, MSC.1/Circ.1533.

9   **Stair geometry**: sin 60° = 0.8660.

10   **Correction factor k** = 1/sin 60° = 1.1547.

11   **Congestion capacity (stairway width 600 mm)**:

    .1   **Specific flow of persons (F_S (max))** = 0.88 p/m/s, the values of maximum specific flow is specified in table 1.2 – Value of maximum specific flow, Annex 2, MSC.1/Circ.1533.

    .2   **Calculated flow of persons (F_C)** = 0.528 p/s (Calculation: w = 0.6 m, Fs(max) = 0.88 p/m/s $\Rightarrow$ F_C = 0.88 × 0.6 = 0.528 p/s), the calculation is specified in paragraph 1.5 - Calculated flow of persons (F_C), Annex 2, MSC.1/Circ.1533.

    .3   **Flow duration time (tF)** = N (Number of persons) / F_C, the calculation is specified in paragraph 1.6 – Flow duration (tF), Annex 2, MSC.1/Circ.1533.

Step-by-step calculation methodology

12   **Stairway ascent (2.3 m, 60°)**

    .1   **Inclined length** L = h x k = 2.3 m × 1.1547 = 2.6558 m.

        .1   **h**: **vertical ascent height (m)**: vertical distance between departure point and escape trunk located platform (e.g., standard deck height 2.3 m).

        .2   **k**: **correction factor (dimensionless):** k=1/sin θ (reciprocal of the sine of angle θ), geometric conversion coefficient used to convert vertical height to inclined length.

    .2   **Travel time** T_A = L/S_{stair} = 2.6558 m / 0.50 m/s (stair ascent speed specified in paragraph 8.2) = 5.31 s.

    .3   **Under congested conditions (multiple personnel)**, the completion time for the last person is $T_{A,last}$ = tF + T_A = N/F_C + T_A (F_C = 0.528 specified in paragraph 11.2):

        .1 $T_{A, last}$ (N=1) $\Rightarrow$ tF(1 / 0.528) + T_A (5.31) = 7.21s

        .2 $T_{A, last}$ (N=3) $\Rightarrow$ tF(3 / 0.528) + T_A (5.31) = 10.99s

        .3 $T_{A, last}$ (N=5) $\Rightarrow$ tF(5 / 0.528) + T_A (5.31) = 14.78s

        .4 $T_{A, last}$ (N=10) $\Rightarrow$ tF(10 / 0.528) + T_A (5.31) = 24.25s

13   **Horizontal movement (engine-room aft to forward area, H = 0/5/10/15/20/25 m)**

.1   **Travel time** $T_B = H/S_{flat}$ (S_{flat} = 1.11 m/s specified in paragraph 8.1)

.1 T_B, (H=0m) $\Rightarrow$ H(0) / S_{flat} (1.11) = 0s

.2 T_B, (H=5m) $\Rightarrow$ H(5) / S_{flat} (1.11) = 4.50s

.3 T_B, (H=10 m) $\Rightarrow$ H(10) / S_{flat} (1.11) = 9.01 s

.4 T_B, (H=15 m) $\Rightarrow$ H(15) / S_{flat} (1.11) = 13.51 s

.5 T_B, (H=20 m) $\Rightarrow$ H(20) / S_{flat} (1.11) = 18.02 s

.6 T_B, (H=25 m) $\Rightarrow$ H(25) / S_{flat} (1.11) = 22.52 s

.2   To ensure a conservative basis for comparison, no congestion or width limitations are assumed for horizontal movement in Route B to the escape trunk accessed from the lowest deck level.

14   **Equivalent horizontal distance (intuitive comparison)**

.1   **Equivalent horizontal distance** $H_{eq} = S_{flat}$ (1.11) x T_A(5.31) = 5.90 m, ascending 2.3 m at 60° is temporally equivalent to approximately 6 ±1 m of horizontal movement.[1]

Results summary (considering single/multiple personnel inside the engine-room)

15   The results of travel times for Route A and Route B specified in paragraph 4 are summarized in table 1 below.

Table 1 – The results of travel-time calculations for Routes A and B

Route	Input (Key Assumptions)	Results - Travel Times
A: aft 2.3 m upward	S_{stair} = 0.50 m/s	5.31 s
A(congested): last person	w = 0.6 m, F_C = 0.528 p/s	N=1: 7.21s; N=3: 10.99s; N=5: 14.78s; N=10: 24.25s
B: horizontal movement 0 m	S_{flat} = 1.11 m/s	0 s
B: horizontal movement 5 m	S_{flat} = 1.11 m/s	4.50 s
B: horizontal movement 10 m	S_{flat} = 1.11 m/s	9.01 s
B: horizontal movement 15 m	S_{flat} = 1.11 m/s	13.51 s
B: horizontal movement 20 m	S_{flat} = 1.11 m/s	18.02 s
B: horizontal movement 25 m	S_{flat} = 1.11 m/s	22.52 s

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[1] H_{eq} shown for intuition; time-based assessment governs per MSC.1/Circ.1533.

Assessment (key findings)

16   *Single person criterion*: for engine-room lengths of 10 to 25 m, Route A (2.3 m upward) is consistently faster than Route B (horizontal movement) by a factor of approximately 2 to 5 times.

17   *Small group (3 to 5 people) criterion*: the last person in Route A, including waiting time, is almost same or still predominantly faster than or comparable to Route B (10 to 25 m).

18   Even for large groups (10 people), the last person in Route A (24 to 25 s) falls within a comparable range to Route B; however, this assumes extreme congestion with all personnel simultaneously using a single stairway (width 0.6 m). The simultaneous evacuation of 10 people exceeds typical engine-room manning levels (generally comprising Chief Engineer, 1st Engineer, 2nd Engineer, 3rd Engineer, Engine Foreman, and 1-3 Oilers, totalling approximately 8 personnel). Furthermore, the scenario where all personnel converge simultaneously on a single stairway has low probability during actual emergency scenarios, as proper evacuation training and emergency response procedures would facilitate distributed evacuation.

Conclusion

19   Discarding the scenario of the location of the escape trunk at the lowest deck at 0 m or 5 m horizontally of the starting point (being similar in both cases of Route A and B) as unrealistic due to the reasons described in paragraph 5, Route A (upward 2.3 m via 60° stairway followed by escape trunk access) demonstrates temporal superiority over the horizontal movement Route B (10-25 m). This substantiates that an escape trunk that does not extend to the lowest floor provides equivalent or superior safety levels.

20   Even with a width of 600 mm, Route A maintains its advantage for small groups (≤5 people). If multiple personnel simultaneous evacuation is anticipated, enhancing bidirectional distribution guidance and signage to reduce flow duration time tF would be effective, further validating the suitability of the current escape trunk design.

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