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INTERIM GUIDELINES FOR A SIMPLIFIED EVACUATION ANALYSIS OF HIGH-SPEED PASSENGER CRAFT

1   The Maritime Safety Committee, at its seventy-third session (27 November to 6 December 2000), adopted the International Code of Safety for High-Speed Craft, 2000 (2000 HSC Code) by resolution MSC.97(73), which is expected to enter into force on 1 July 2002. This Code requires in section 4.8.2 that "an evacuation procedure, including an evacuation analysis carried out taking into account the guidelines developed by the Organization shall be developed for the information of the Administration in connection with the approval of fire insulation plans and for assisting the owners and builders in planning the evacuation demonstration required in 4.8.3" of the Code.

2   The Committee, at its seventy-fourth session (30 May to 8 June 2001), noting that computerized simulation systems are still under development, decided that a simplified evacuation analysis method was needed in the interim and, having considered a proposal by the forty-fifth session of the Sub-Committee on Fire Protection, approved the Interim Guidelines for a simplified evacuation analysis of high-speed passenger craft, together with the worked example appended thereto, as set out in the annex.

3   Member Governments are invited to apply the annexed Interim Guidelines when implementing the requirements of section 4.8.2 of the 2000 HSC Code and submit to the Sub-Committee on Fire Protection information on experience gained in the implementation of the Interim Guidelines and on any progress made in the development of computerized simulation systems.

4   Member Governments are also invited to bring the annexed Interim Guidelines to the attention of craft designers, craft owners and other parties involved in the design, construction and operation of high-speed passenger craft.

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**INTERIM GUIDELINES FOR A SIMPLIFIED EVACUATION ANALYSIS
OF HIGH-SPEED PASSENGER CRAFT**

1 General

1.1 In addition to the relevant requirements for means of escape, escape routes in high-speed passenger craft are required to be evaluated by an evacuation analysis early in the design process, under the International Code of Safety for High-Speed Craft, 2000 (2000 HSC Code), section 4.8.2.

1.2 The purpose of the Interim Guidelines is to provide guidance on how to execute a simplified (hydraulic) evacuation analysis and use its results to plan the evacuation demonstration required in section 4.8.5 of the 2000 HSC Code.

2 Definitions

2.1 *Ideal deployment time (t_M)* is the time needed for the preparation and launching of the marine evacuation system (MES) and the first survival craft in calm water.

2.2 *Ideal travel time (t_I)* is the time needed for the slowest group of people to reach the embarkation point in calm water. Unless otherwise stated in the evacuation procedure, the number of people of the slowest group should be assumed equal to the capacity of the largest survival craft onboard. For the purpose of these Interim Guidelines, t_I is assumed to run concurrently with t_M.

2.3 *Ideal embarkation time (t_E)* is the time needed for all passengers and crew to board the survival craft in calm water.

2.4 *Structural fire protection time (SFP)* is the protection time for areas of major fire risk as defined in section 4.8.1 of the 2000 HSC Code.

2.5 *Slowest group of people* is the group of evacuating persons for which the highest travel time is obtained from calculations according to paragraph 3.6.3.3.

3 Method of evaluation

The steps in the evacuation analysis are:

3.1 *Description of the system*

     .1   Identification of assembly stations.

     .2   Identification of embarkation stations, MES and survival craft.

     .3   Description of the evacuation procedure including the role of the crew.

     .4   Identification of groups and their escape route.

3.2   *Assumptions*

This method for estimating evacuation time is basic in nature and, therefore, common evacuation analysis assumptions should be made as follows:

.1   passengers and crew should carry out the evacuation in a sequence of groups according to the evacuation procedure;

.2   passengers and crew will evacuate via the primary escape route;

.3   walking speed depends on the type of escape facility, assuming that the flow is only in the direction of the escape route, and that there is no overtaking;

.4   passengers' disabilities or medical conditions that will severely hamper their ability to keep up with the flow are neglected (see paragraph 3.2.8.1 below);

.5   passenger load is assumed to be 100% (full load);

.6   full availability of escape arrangements is considered;

.7   people can move unhindered;

.8   the allowable evacuation time as per section 4.8.1 of the 2000 HSC Code is given by $\frac{SFP - 7}{3}$ (min), where:

.8.1   division by 3 accounts for the safety factor, which includes passengers' ages and disabilities, restricted visibility due to smoke, effects of waves and craft motions on deployment, travel and embarkation time and of violations to the evacuation procedure;

.8.2   subtraction of 7 min accounts for initial detection and extinguishing action (section 4.8.1 of the 2000 HSC Code); and

.8.3   for category B craft, the passenger awareness time, the time needed for passengers to reach assembly stations and the time needed for manning emergency stations is included in the 7 min time (see section 4.8 of the 2000 HSC Code);

.9   as the evacuation procedure is designed to carry out evacuation under controlled conditions (section 4.8.1 of the 2000 HSC Code), no counter flow takes place; and

.10   when using table 3.6 it is assumed that at the beginning of the evacuation, passengers are located at a distance not greater than two decks from the embarkation station.

3.3   *Scenarios to be considered*

3.3.1   For the purpose of calculating the evacuation time in category A craft, passengers should be assumed to be distributed in a normal voyage configuration (section 4.8.4.1 of the 2000 HSC Code).

3.3.2   For the purpose of calculating the evacuation time in category B craft, passengers and the crew should be assumed to be distributed among assembly stations and be ready for embarkation (section 4.8.4.2 of the 2000 HSC Code).

3.4   *Performance standards*

3.4.1   The following two performance standards should be complied with for calculating the overall evacuation time:

$$t_M + t_E \leq \frac{SFP - 7}{3} \qquad (3.4.1.1)$$

$$t_I + t_E \leq \frac{SFP - 7}{3} \qquad (3.4.1.2)$$

3.4.2   Both performance standards are derived from section 4.8.1 of the 2000 HSC Code.

3.5   *Calculation of t_E and t_M*

3.5.1   The values t_E and t_M should be calculated separately based on:

    .1   the results of full scale trials on similar craft and evacuation systems; or

    .2   data provided by the manufacturers; however, in this case, the method of calculation should be documented.

3.5.2   Safety factors on t_E and t_M are accounted for by dividing by 3 in performance standards formulae (3.4.1.1) and (3.4.1.2).

3.6   *Calculation of t_I*

3.6.1   Parameters to be considered:

    .1   clear width, W_c , is:

        .1   measured off the handrail(s) for corridors and stairways;

        .2   the actual passage width of a door in its fully open position;

        .3   the space between the fixed seats for aisles in public spaces; and

        .4   the space between the most intruding portions of the seats (when unoccupied) in a row of seats in public spaces;

    .2   speed of persons, S (m/s) is the speed of evacuees along the escape route (table 3.6 provides the values of S which should be used for the analysis);

.3 specific flow of persons, F_s (p/(m/s)), is the number of evacuating persons past a point in the escape route per unit time per unit of clear width W_c (table 3.6 provides the values of F_s which should be used for the analysis)

Table 3.6[*]

Type of Facility	Speed of persons S (m/s)	Specific Flow Fs (p/(m/s))
Stairs (down)	0.55	1.1
Stairs (up)	0.44	0.88
Corridors, doorways	0.67	1.3

.4 calculated flow of persons, F_c (p/s), is the predicted number of persons passing a particular point in an escape route per unit time. It is obtained from:

$$F_c = F_s \cdot W_c \qquad (3.6.1.4)$$

.5 flow time, t_F (s), is the total time needed for a group of N persons to move past a point in the egress system. It is calculated as:

$$t_F = N / F_c \qquad (3.6.1.5)$$

.6 walking time, t_w (s), is the total time needed for a person to cover the distance between the assembly station and the embarkation station.

3.6.2 Transitions

Transitions are those points in the egress system where the type of a route changes (e.g. from a corridor to a stairway) where routes merge or branch out.

3.6.3 Procedure for calculation of t_I is as follows:

.1 Groups of people:

For the purposes of evacuation, the total number of persons on board is broken down into one or more groups of people. It should be assumed that all persons in a group carry out the evacuation at the same time, along the same route and towards the same embarkation station. The number of persons in each group, the number of groups and the embarkation station assigned to each group should be in accordance with the evacuation procedure.

.2 Schematic representation:

The escape routes from assembly stations to embarkation stations are represented as a hydraulic network, where the pipes are the corridors and stairways, the valves are the doors and restrictions in general.

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[*] Data derived from land-based stairs, corridors and doors in civil buildings, and are extracted from the publication "SFPE Fire Protection Engineering Handbook, 2nd edition NFPA 1995".

.3 For each foreseen group of people:

.1 The walking time, t_w, is calculated by using the speed of persons specified in table 3.6 and the distance between the pertinent assembly and embarkation stations.

.2 The flow time, t_F, of each portion of the escape route is calculated using the specific flow F_s from table 3.6 and the appropriate clear width of that portion of escape route. The total flow time is the largest value obtained.

.3 The travel time is obtained as the sum of the walking time and the total flow time.

3.6.4 Ideal travel time t_I

Calculations as per paragraph 3.6.3.3 should be repeated for each foreseen group of people. The highest resulting travel time is then taken as the ideal travel time for use in performance standard in paragraph 3.4.

4 Corrective actions

If the performance standards under paragraph 3.4 are not fulfilled, corrective actions should be considered at the design stage by either modifying one or more components in the evacuation system (e.g., escape routes, life-saving appliances, passengers load, etc.) or by modifying the evacuation procedure.

5 Documentation

The documentation of the analysis should report the following items:

.1 the basic assumptions for the analysis;

.2 a schematic representation of the layout of the craft;

.3 position and role of the crew during the evacuation, according to the evacuation procedure;

.4 the method for the analysis, if different from these Interim Guidelines;

.5 details of the calculation; and

.6 the resulting overall evacuation time.

APPENDIX

EXAMPLE OF APPLICATION

1   General

The example provides an illustration on the application of the Interim Guidelines. Therefore it should not be viewed as a comprehensive and complete analysis nor as an indication of the data to be used. More specifically, the short description of the evacuation procedure provided in paragraph 3.3 is only an outline, for the purpose of the evacuation analysis, of the complete evacuation procedure the embarkation time and the deployment time used in paragraph 4 below are purely illustrative.

2   Craft characteristics

The high-speed craft considered is a Category B craft with a total capacity of 800 persons (784 passengers and 16 crew members). As shown in figure 1, when the order to abandon the craft is given, passengers are distributed in the public spaces on two decks (210 on the upper deck and 574 on the lower deck), the lower deck is equipped with 4 MES. The structural fire protection time (SPF) is 60 min.
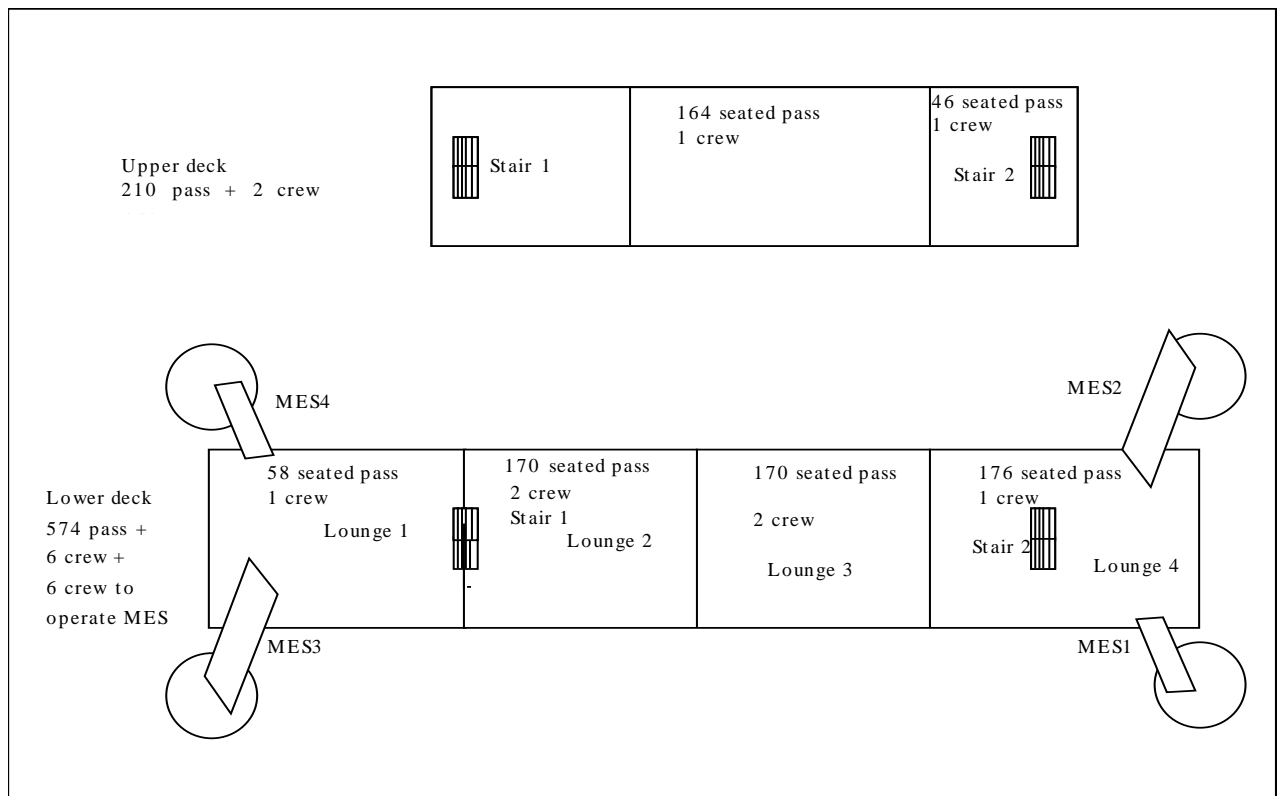

Figure 1 – Sketch of the considered high-speed craft

3   Description of the system

.1   Identification of assembly stations

Assembly stations coincide with the public spaces where passengers are located (seated). Passengers are wearing life jackets.

.2   Identification of embarkation stations**,** MES and liferafts

.1   Embarkation stations (4, one for each MES) are located at the lower deck.

.2   Each MES consists of an inflatable slide with an attached platform.

.3   Liferafts (8), 135 persons capacity each, are stowed in racks on the lower decks, in the proximity of the MES. The aggregate capacity of liferafts is therefore 1080 persons, or of 810 persons if one embarkation station is not available in accordance with the 2000 HSC Code.

.4   Two rescue boats are available for marshalling the liferafts.

.3   Description of the evacuation procedure

.1   When the order to abandon the craft is given, crew members start operating the MES (total 6 crew members), the rescue boats (1 crew member per boat) and to direct the passengers (as shown in figure 1: two crew members on the upper deck and 6 crew members on the lower deck); all these activities progress in parallel.

.2   PHASE 1: For each MES, the slide is inflated and the first liferaft launched, inflated and connected to the slide's platform. In the mean time the first 4 groups of passengers are formed and directed to the 4 MES, each group is assisted by 1 crew member, for a total of 400 persons, as follows (see figure 2):

- 164 passengers, marshalled by 1 crew member, move from upper deck through stair 1 down to the lower deck and join with 34 passengers and 1 crew member coming from lounge 2. They then move along the central aisle of lounge 1 (corridor 2); at the end of corridor 2 two groups are formed, each composed by 99 passengers and 1 crew member, and move to MES 3 and 4 through doors 2A and 2B respectively;

- 46 passengers marshalled by 1 crew member move from upper deck, through stair 2, down to lower deck, where they merge with 152 passengers and 1 crew member; two groups are then formed, each composed by 99 passengers and 1 crew member, and move to MES 1 and 2 respectively;

- in the meantime the remaining passengers stay in lounges 1 to 4 assisted by 4 crew members.

.3　PHASE 2: Once the first liferaft is ready for boarding, the first group for each MES descends to the liferaft using the slide and platform. When boarding is completed, the liferaft is detached from the slide and floated away by the rescue boat. In the mean time, the second liferaft is launched, inflated and connected to the platform and the second 4 groups of persons move to the embarkation stations.

.4　PHASE 3: Once the second liferaft is ready for boarding, the second group for each MES descents to the liferaft through the slide and platform. Finally, the 6 crew members operating the MES board. When boarding is completed, the liferaft is detached from the slide. The evacuation is now completed.

.4　Identification of groups and their escape routes

In total 8 groups, each composed of 100 persons, are considered. Their (primary) escape routes are shown in figure 2 for the first 4 groups and in figure 3 for the second 4 groups.
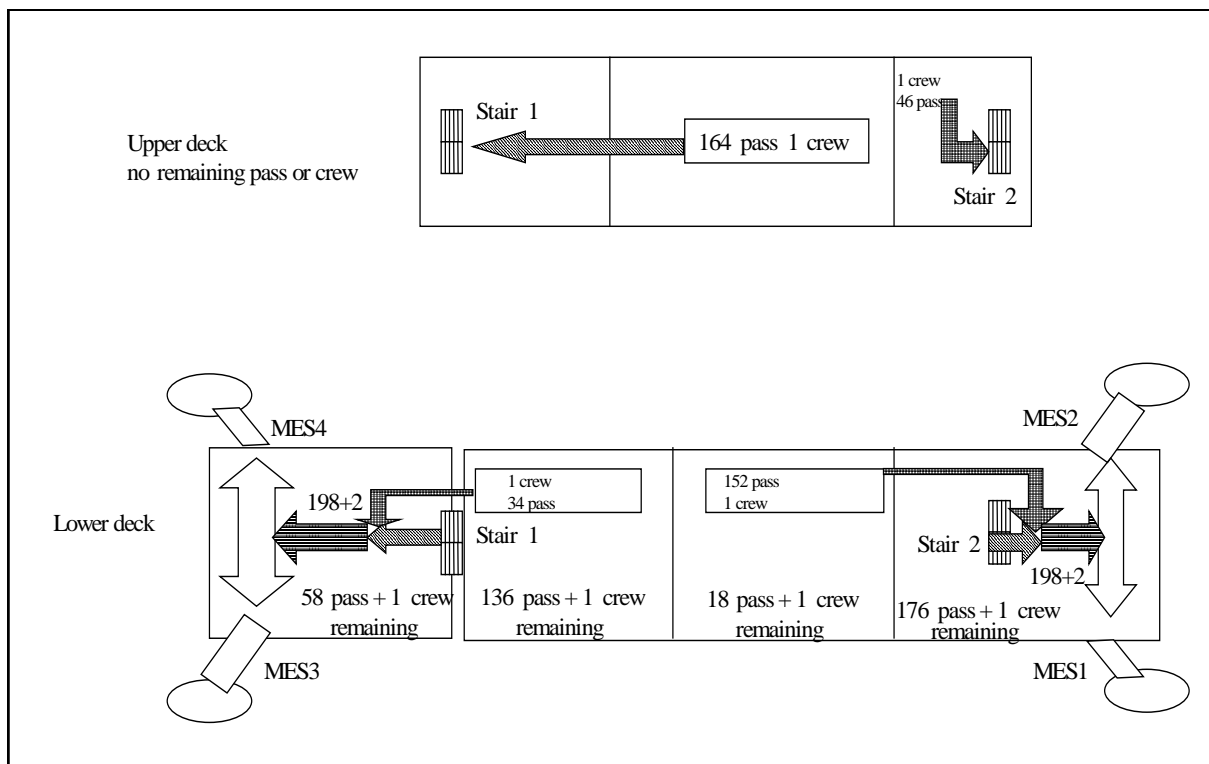

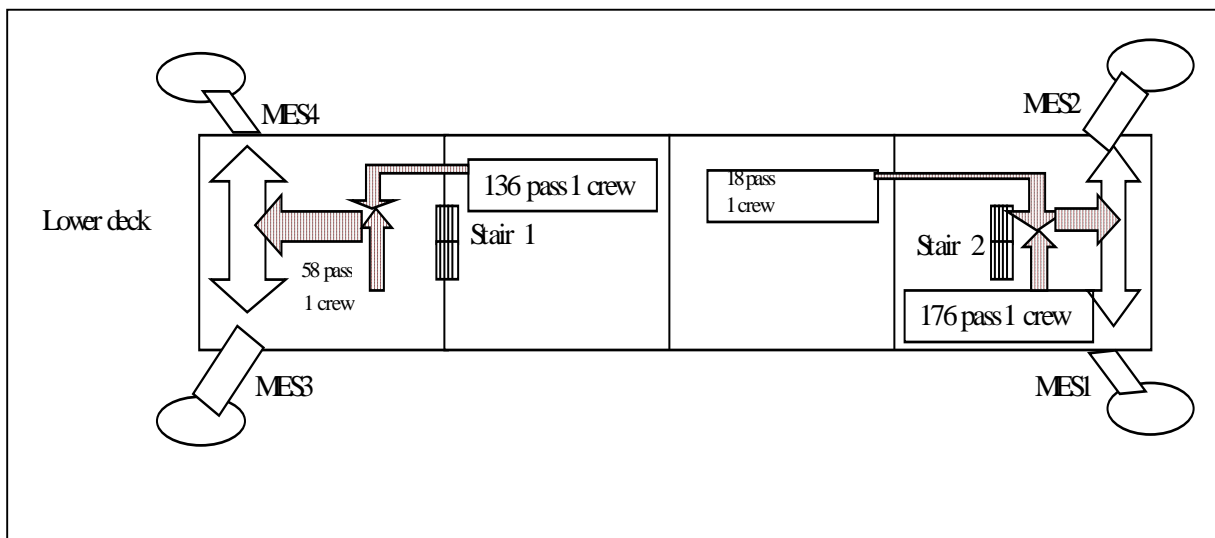**Figure 2 – First 4 groups of persons**

Figure 3 – Second 4 groups of persons

4   Calculation of t_E and of t_M

.1   Embarkation time t_E

According to the evacuation procedure, each MES is used by 200 persons, if all four MES are available. Based on full scale trials on craft having similar arrangements and using the same MES and same number of crew, the total time needed to deploy, inflate and mooring the liferaft and to embark 100 persons is 330 s (5 min and 30 s). Accordingly, the total embarkation time is 660 s (11 min).

.2   Deployment time t_M

Based on full scale trials on craft having similar arrangements and using the same MES, the total time needed to deploy and inflate an MES is 150 s (2 min and 30 s).

5   Calculation of t_I

.1   For the purposes of this example, it is assumed that calculations have been carried out for all the 8 groups of people into which the evacuation is organized, according to the evacuation procedure described in paragraph 3.3 above. It is further assumed that the highest travel time is obtained for the group of people moving (phase 1) from the afterward passenger area in the upper deck down to MES 3 and 4 respectively on the lower deck.

.2   The schematisation of the escape route is shown in figure 4. As it may be seen, the elements composing the escape path are 2 doors, 2 corridors and 1 stairway.

.3 The characteristics of the escape path's elements are as follows:

Table 5.3

Element	L (m)	W_c (m)	F_s	S (m/s)	F_c (p/s)	N people
Door 1	N.A.	1.4	1.3	N.A.	1.82	165
Corridor 1	14	4.2	1.3	0.67	5.46	165
Stairway 1	4.7	3.5	1.1	0.55	3.85	165
Corridor 2	14	3.0	1.3	0.67	3.90	200
Door 2A	N.A	1.4	1.3	N.A	1.82	100
Door 2B	N.A	1.4	1.3	N.A	1.82	100

The values of specific flow (F_s) and speed (S) are taken from table 3.6 of the guidelines; the value of calculated flow (F_c) is obtained by $F_c = F_s W_c$ (see paragraph 3.6.1.4 of the guidelines).

.4 The resulting walking time (t_w) and flow time (t_F), calculated according to paragraphs 3.6.1.5 and 3.6.1.6 of the guidelines are as follows:

Table 5.4

Element	L (m)	W_c (m)	N people	t_w (s)	t_F (s)
Door 1	N.A.	1.4	165	N.A.	91
Corridor 1	14	4.2	165	21	30
Stairway 1	4.7	3.5	165	9	43
Corridor 2	14	3.0	200	21	51
Door 2A	N.A	1.4	100	N.A	55
Door 2B	N.A	1.4	100	N.A	55

The resulting total walking time is the sum of the walking time of each element in the escape path and totals 51 s. The flow time is the highest among all the elements in the escape path and corresponds to 91 s.

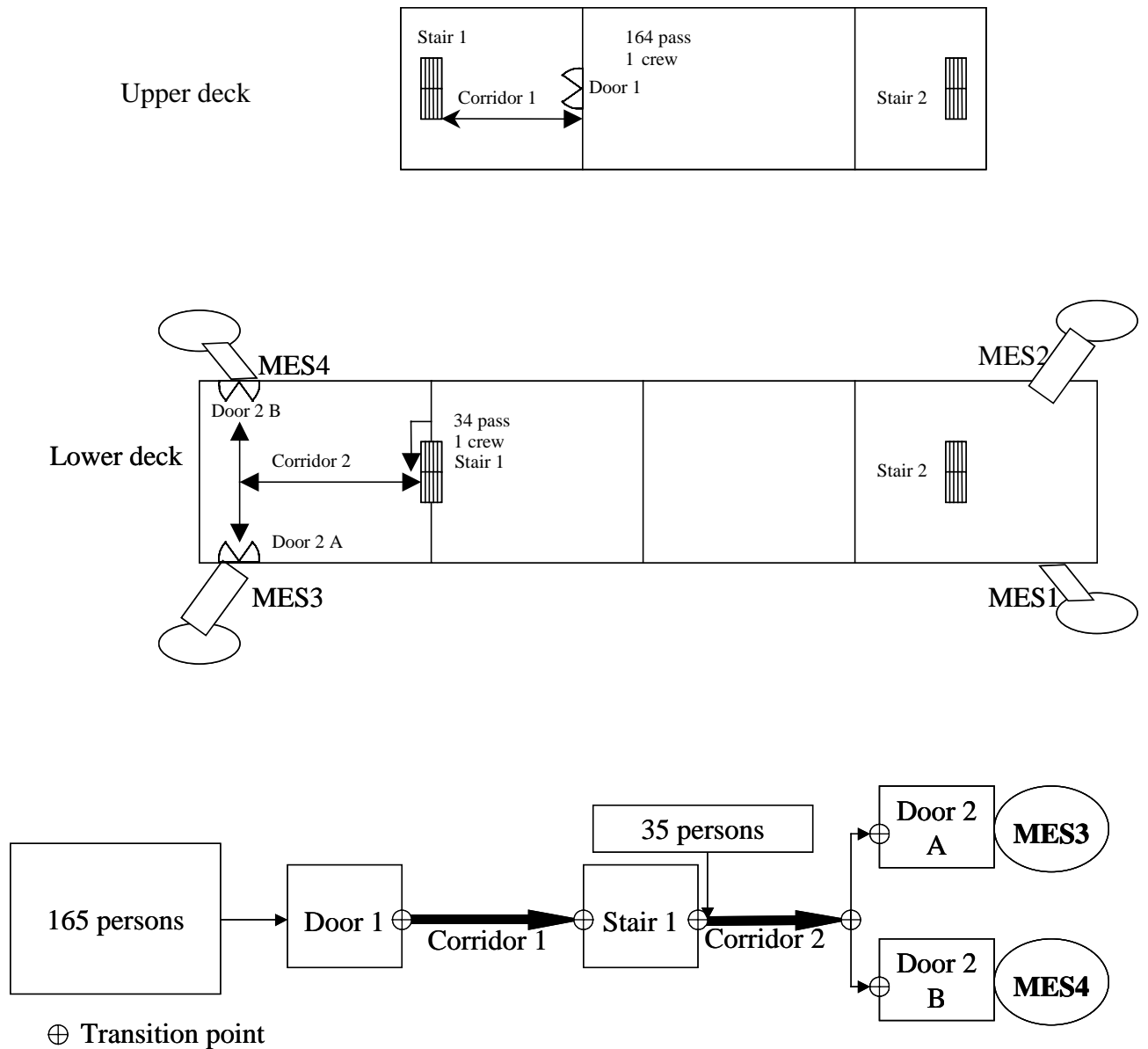Accordingly, the ideal travel time is where, $t_I = 142$ s.

Figure 4 – Sketch of the evacuation path and its schematisation

6   Performance standard

The calculated overall evacuation time: $t_M + t_E = 150 + 660 \leq \dfrac{SFP - 7}{3}$ min = 1059 s

$t_I + t_E = 142 + 660 \leq \dfrac{SFP - 7}{3}$ min = 1059 s

The requirements are fulfilled.

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