THE SAFEGUARD VALIDATION DATA SET - SGVDS1
A GUIDE TO THE DATA AND VALDIATION PROCEDURES

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1) TERMS OF USE

As part of the EU FP7 SAFEGUARD project (contract 218493), a series of five semi-unannounced full-scale assembly trials were conducted at sea on three different types of passenger vessel. From these trials five passenger response time data-sets were collected and two full-scale validation data-sets. The two Safeguard Validation Data-Sets (SGVDS) were generated from assembly trials conducted on a large RO-PAX ferry (RP1) operated by ColorLine AS and a Cruise Ship (CS) operated by Royal Caribbean – SGVDS1 and SGVDS2 respectively.

All the information related to the SGVDS1 and SGVDS2 can be downloaded from the FSEG website:

http://fseg.gre.ac.uk/validation/ship_evacuation

All members of the evacuation modelling community are invited to make use of both SGVDS1 and SGVDS2 to evaluate their evacuation modelling tool. By making use of this material you agree to abide by the following usage terms and conditions:

- Whenever work is published (typically, but not exclusively, in academic journals, conference proceedings and reports), which is based in-part or wholly on SGVDS1 or SGVDS2 the following citations to the validation data-sets must be made:
    - Galea, E.R., Deere, S., Brown, R.,Filippidis, L., Two Evacuation Model Validation Data-sets for Large Passenger Ships, SNAME (The Society of Naval Architects and Marine Engineers) Journal of Ship Research, Vol 57, number 3, pp155-170, Sept 2013, http://dx.doi.org/10.5957/JOSR.57.3.120037.
    - Brown, R., Galea, E.R., Deere, S.J., Filippidis, L., Passenger Response Time Data-sets for Large Passenger Ferries and Cruise Ships Derived from Sea Trials, Transactions of the Royal Institution of Naval Architects, International Journal of Maritime Engineering, Vol 155, Part A1, pp 33-48, 2013.
    - Deere, S.J., Galea, E.R., Filippidis, L., Brown, R., Data Collection Methodologies Used in the Safeguard Project to Collect Human Factors Data, RINA SAFEGUARD Passenger Evacuation Seminar 30 November 2012, ISBN No: 978-1-909024-08-3.
    - http://www.safeguardproject.info/
        - In addition, the following references to IMO INF papers concerning the data sets can also be made:

    - The SAFEGUARD Validation Data-Set and Recommendations to IMO to Update MSC Circ. 1238. IMO Committee on Fire Protection, 56th Session, FP56/INF.13, 14 November 2012.
    - Response Time Data for Large Passenger Ferries and Cruise Ships. IMO Committee on Fire Protection, 56th Session, FP56/INF.12, 14 November 2012.
- When the above noted work is published or reported in the public domain, an electronic copy of the publication should be forwarded to e.r.galea@gre.ac.uk within one month of it appearing in the public domain. Where available a DOI for the publication should also be provided.
- The provided publications will be cited on the VALIDATION web page, together with the DOI of the publication.
- If the software tool FSEG_VALIDATION_ASSESSOR is used to assess the degree of agreement with the validation data-set the following citation must be made in any work that is published (typically, but not exclusively, in academic journals, conference proceedings and reports) utilising the assessment:
    - Haasanen, S., Galea, E.R., and Deere, S., Computer Software, FSEG_VALIDATION_ASSESSOR. Download from http://fseg.gre.ac.uk/validation/ship_evacuation

2) INTRODUCTION

This document describes the SGVDS1 and the process of carrying out a validation assessment using the data-set. The document provides all the information to set up and run the validation scenario within the users evacuation software. In particular the document describes the layout of the RP1vessel, the initial population distribution, the final destination of each of the passengers, the population response time distribution and the arrival times for each passenger. Other parameters to be used in the simulations, such as population gender, age distribution, travel speeds are derived from the IMO MSC Circ 1238 documentation. It is assumed that the user of this document has knowledge on how to use their evacuation software and so specific information on how to implement the validation scenario within the specific evacuation simulation software is not provided.

The material in this document is divided into nine sections each dealing with a specific aspect of the validation data or validation procedures. These sections are:

- **Geometry:** Describes the layout of the vessel and provides information concerning the CAD DXF files required to construct the geometry.

- **Population:** Describes the distribution of the population, in particularly the start and end location of each agent in the model.

- **Response Time Distribution:** Describes the response time distributions which should be applied to the population.

- **SGVDS1 Arrival Curves**: Provides the arrival times in each of the assembly stations for each agent and describes how this data should be presented.

- **The Validation Metric:** Provides the measures to assess how closely the simulation results agree with the validation data set.

- **Procedures for Running the SGVDS1 Scenario:** Describes the process of setting up and running the validation scenario. It also explains the process of selecting the appropriate simulation to be used in the validation analysis.

- **SGVDS1 Acceptance criteria:** Provides a set of suggested performance standards that the simulation results should meet in order to be deemed acceptable.

- **Regulatory Documentation:** Provides a set of suggested documentation that should be provided to regulatory bodies to demonstrate that their software has met the standard.

- **Additional Information:** Provides a summary of the files required, in addition to this document, to run and analyse the validation case.

3) GEOMETRY

This section describes the layout of the vessel and provides information concerning the autoCAD DXF files required to construct the geometry.

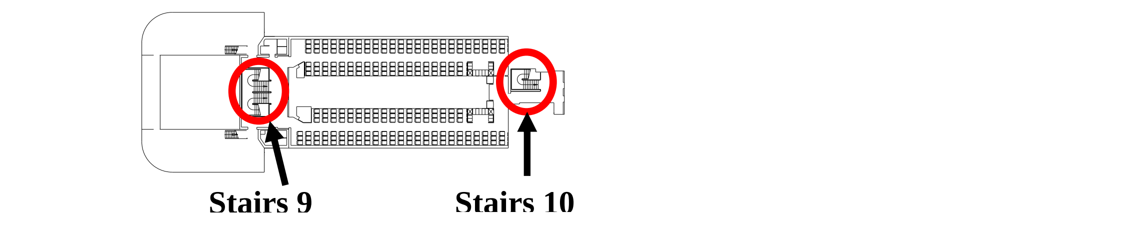
The populated decks used during the trial consisted of three decks described by three DXF files:

a) SGVDS1-Deck-1.dxf
b) SGVDS1-Deck-2.dxf
c) SGVDS1-Deck-3.dxf

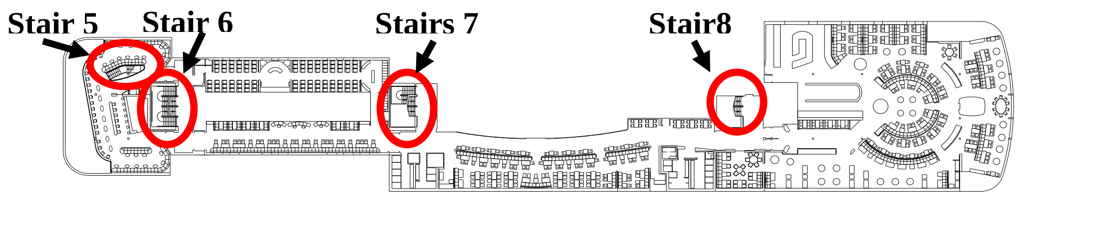
These files can be found on the internet at the following location:

http://fseg.gre.ac.uk/validation/ship_evacuation

Please note that the scales in the DXF files are set to millimetres. The vessel layout constructed using these autoCAD files is presented in Figure 1. Also shown in this diagram is the location of the six stairs used during the assembly drill.



SGVDS1-Deck-3.dxf



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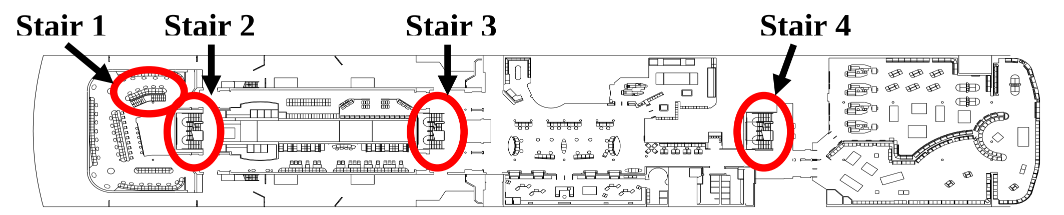


SGVDS1-Deck-1.dxf

Figure 1 – the autoCAD drawings of the vessel layout showing the location of the stairs

In addition to the DXF files, the following geometry information is required in order to construct the ship geometry.

3.1 Deck Heights
The height of the three decks are as follows:
Deck 1: 3.0 metres high
Deck 2: 3.0 metres high
Deck 3: 2.8 metres high

3.2 Stair dimensions:
Each of the stairs shown in Figure 1 has dimensions outlined below. Please note that each stair width is measured from the inside of the handrail to the inside of the handrail and so represents clear stair width. The length of the stair also represents its horizontal length (i.e. it does not represent the length measured down the slope).

- Stair 1/Stair 5: Located inside the bar area, connects Deck 1 to Deck 2. The stairs from Deck 1 up to the landing are 1m wide, 1.5m high and 2m long. They consist of a single lane with 8 risers (7 treads). The Landing is 1m wide and 1.3m long. The stairs from the landing up to Deck 2 are 1m wide, 1.5m high and 2m long. They consist of a single lane with 8 risers (7 treads)

- Stair 2/Stair 6: Located outside the bar area, connects Deck 1 to Deck 2. The stairs from Deck 1 up to the landing are 1.35m wide, 1.5m high and 1.9m long. They consist of two lanes with 9 risers (8 treads). The Landing is 1.8m wide and 6.2m long. The stairs from the landing up to Deck 2 are 1.35m wide, 1.5m high and 1.9m long. They consist of two lanes with 9 risers (8 treads)

- Stair 3/Stair 7: Located amidships, by the AS A and AS D areas, connects Deck 1 to Deck 2. The stairs from Deck 1 up to the landing are 1.35m wide, 1.5m high and 1.9m long. They consist of two lanes with 9 risers (8 treads). The Landing is 1.8m wide and 6.2m long. The stairs from the landing up to Deck 2 are 1.35m wide, 1.5m high and 1.9m long. They consist of two lanes with 9 risers (8 treads)

- Stair 4/Stair 8: Located in the fore of the vessel, by retail area, connects Deck 1 to Deck 2. The stairs from Deck 1 up to the landing are 1.35m wide, 1.5m high and 1.9m long. They consist of two lanes with 9 risers (8 treads). The Landing is 1.8m wide and 6.2m long. The stairs from the landing up to Deck 2 are 1.35 metre wide, 1.5m high and 1.9m long. They consist of two lanes with 9 risers (8 treads).

- Stair 6/Stair 9: Located outside the bar area, connects Deck 2 to Deck 3. The stairs from Deck 2 up to the landing are 1.35 m wide, 1.5m high and 1.9m long. They consist of two lanes with 9 risers (8 treads). The Landing is 1.8m wide and 6.2m long. The stairs from the landing up to Deck 3 are 1.35m wide, 1.5m high and 1.9m long. They consist of two lanes with 9 risers (8 treads).

- Stair 7/stair 10: Located amidships, by the AS D area, connects Deck 2 to Deck 3. The stairs from Deck 2 up to the landing are 1.2m wide, 1.5m high and 1.9m long. They consist of a single lane with 9 risers (8 treads). The Landing is 1.65m wide and 2.6m long. The stairs from the landing up to Deck 3 are 1.2m wide, 1.5m high and 1.9m long. They consist of a single lane with 9 risers (8 treads).

4) POPULATION

This section provides details of the population within the validation data set.

4.1 Number of Agents:

The model consists of two populations, a main population and a secondary population. The main population consists of 764 agents. These agents represent the passengers who wore the Infra-red (IR) tracking devices and so their starting position, end position and arrival time in the assembly station are known.

In total 569 passengers did not wear the IR tags as they indicated that they did not want to participate in the assembly exercise – which was not compulsory for ethical and legal reasons. However, of the 569 passengers who did not take an IR tag, a significant number did eventually decide to participate in the assembly exercise. This was determined by a combination of analysis of video footage, passenger questionnaire responses and team members who were in the assembly stations collecting the IR tags from the participants. By participating in the trial, the presence of the untagged individuals in the evacuation routes will have had an impact on the overall evacuation, especially in the highly congested areas. However, their assembly times will not have been recorded in the overall assembly data.

Some of the untagged passengers actually participated in the trial and so had an effect on the movement of those passengers wearing the IR tags during the assembly exercise. It is not known how many of the 569 passengers participated in the trial but we cannot ignore the fact that a large number of passengers, who were not wearing IR tags participated in the assembly exercise and so had an impact on the overall result. In an attempt to take this into account, it is assumed that 250 of these passengers, approximately half, did actually participate in the assembly exercise. These passengers are included in the evacuation simulation as moving passengers, but are not included in the analysis of the assembly station arrival curves and the total assembly times.

These 250 passengers constitute the secondary population and are represented by 250 agents.

4.2 Population Attributes:

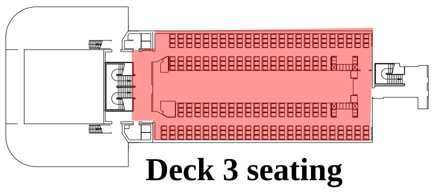
Both the main and secondary population are assigned population attributes of age, gender and travel speeds according to those set out in the IMO MSC 1238 guidelines [1].

4.3 Population Starting Locations:

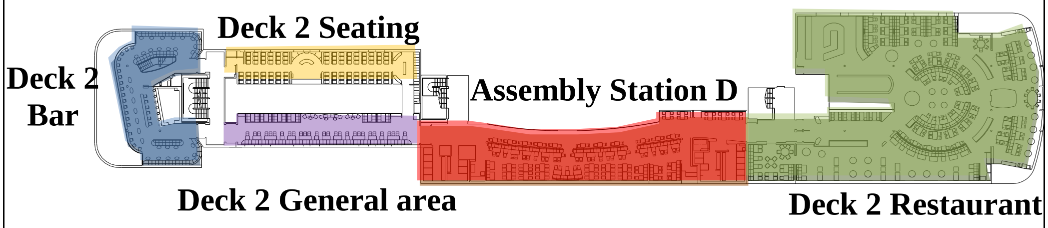
The starting locations for both the main and secondary populations are distributed throughout the vessel e.g. Deck 3 seating area, Deck 2 restaurant, Deck 1 lockers, Deck 1 retail, etc. The location and extent of all the available starting locations are indicated in Figure 2. The starting location of the agents in the main population is shown in Table 1.

As the starting locations of the secondary population are not known they are distributed throughout the vessel according to the population distribution of the main population. The starting location of the agents in the secondary population is shown in Table 2.

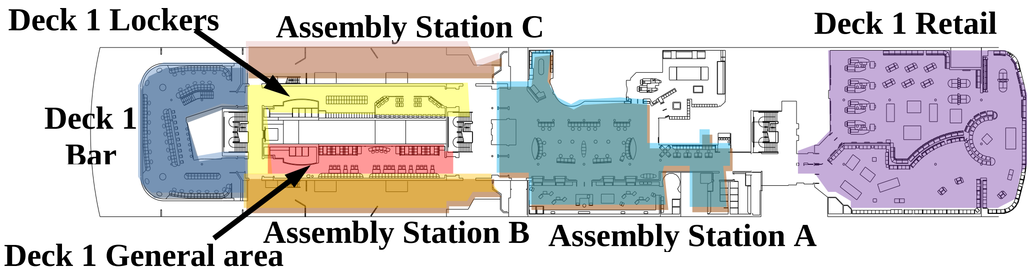
Tables 1 and 2 describes how many agents should be placed in each of the highlighted areas in Figure 2. For example, from Table 1 a total of 77 agents from the main population started in the Deck 3-Seating area while from Table 2 a total of 30 agents from the secondary population started in the Deck 3-Seating area.



SGVDS1-Deck-3



SGVDS1-Deck2

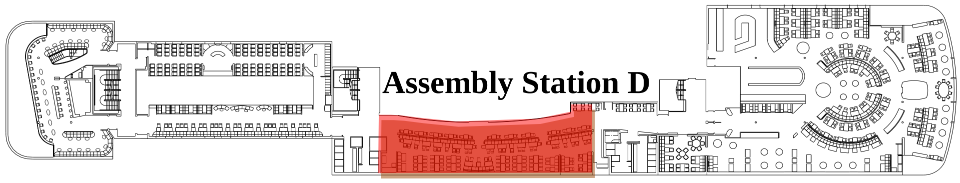


SGVDS1-Deck-1

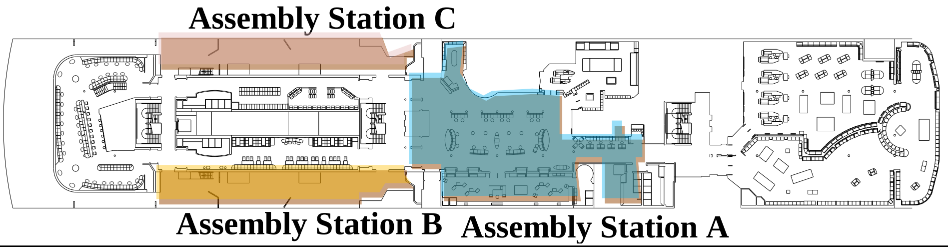
Figure 2 – highlighted starting locations labelled on vessel layout

4.4 Population End Locations:

The end locations for both the main and secondary populations are distributed between the four Assembly Stations (AS), A, B, C and D. The location and extent of the four ASs are indicated in Figure 3. Note that that assembly station areas for AS A, B and C are identical in Figure 2 and Figure 3, however AS D is smaller. The end location of the agents in the main population is shown in Table 1.



SGVDS1-Deck2



SGVDS1-Deck-1

Figure 3 - The SGVDS1 vessel layout showing the 4 assembly station areas

As the end locations of the secondary population are not known they are distributed amongst the four ASs according to the population distribution of the main population. The end location of the agents in the secondary population is shown in Table 2.

Tables 1 and 2 describes how many agents go to each of the ASs. For example, from Table 1, of the 77 agents from the main population that started in the Deck 3-Seating area, 2 go to AS A, 45 go to AS B, 6 go to AS C and 24 go to AS D. Likewise, from Table 2, of the 30 agents from the secondary population that started in the Deck 3-Seating area, 6 go to AS A, 14 go to AS B, 2 go to AS C and 8 go to AS D.

It is important to note that the arrival time for each of the 250 agents in the secondary population ARE NOT INCLUDED in the analysis of the model predicted arrival times, only those from the main population are included it the analysis.

Table 1 - Distributon of main population starting and end locations

Start locations of main population	Total number of agents starting in each area	End Locations - Assembly Station			
		A	B	C	D
Deck 3 - Seating	77	2	45	6	24
Deck 2 – Bar	39	0	9	30	0
Deck 2 - Seating	4	0	0	2	2
Deck 2 – General area	35	6	22	0	7
Assembly Station D	145	5	1	0	139
Deck 2- Restaurant	190	43	0	0	147
Deck - Bar 1	30	3	19	19	0
Assembly Station C	34	3	2	28	1
Deck 1 – General area	35	2	28	5	0
Assembly Station B	30	3	37	1	1
Assembly Station A	99	80	13	1	5
Deck 1 - Shop	7	7	0	0	0
Deck 1 - Lockers	16	3	3	10	0
Total arriving at each assembly station		157	179	102	326

Table 2 - Distribution of secondary population starting and end locations

Start locations of the secondary population	Total number of agents starting in each area	End Locations - Assembly Station			
		A	B	C	D
Deck 3 - Seating	30	6	14	2	8
Deck 2 – Bar	13	0	3	10	0
Deck 2 - Seating	1	0	0	0	1
Deck 2 – General area	11	2	7	0	2
Assembly Station D	46	2	0	0	44
Deck 2- Restaurant	61	14	0	0	47
Deck 1 - Bar	18	2	7	9	0
Assembly Station C	11	1	1	9	0
Deck 1 – General area	11	1	8	2	0
Assembly Station B	13	1	12	0	0
Assembly Station A	32	26	4	0	2
Deck 1 - Shop	2	2	0	0	0
Deck 1 - Lockers	1	0	1	0	0
Total number of agents arriving at each assembly station		57	57	32	104

5) RESPONSE TIME DISTRIBUTION

The passenger response time distribution (RTD) was established from video footage and determined for each of the main space types on the vessel. There are five response time distributions for the following main types of areas on the vessel: airline seating, bar area, general area, restaurant area and retail area.

5.1 Airline Seating (A)

$$y = \frac{1}{\sqrt{2\pi}(0.608)x} \exp\left[- \frac{(\ln(x) - 3.413)^2}{2(0.608)^2} \right] \quad (1)$$

min = 0 max = 145.64 mean (μ) = 3.413 standard deviation (σ) = 0.608

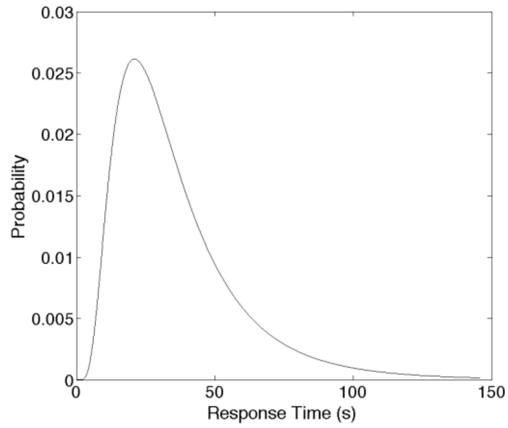


Figure 4: RTD for passengers in airline seating areas

5.2 Bar Area (B)

$$y = \frac{1}{\sqrt{2\pi}(0.924)x} \exp\left[- \frac{(\ln(x) - 3.432)^2}{2(0.924)^2} \right] \quad (2)$$

min = 0 max = 402.4 mean (μ) = 3.432 standard deviation (σ) = 0.924

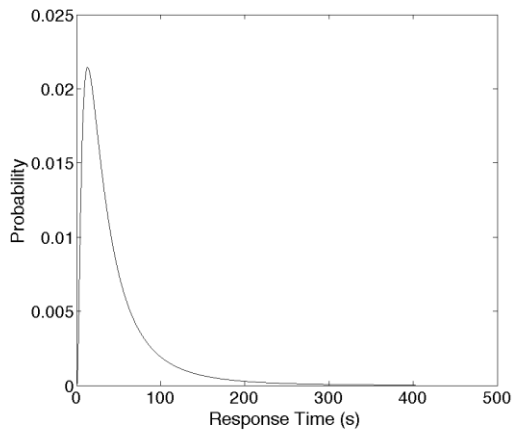


Figure 5: RTD for passengers in bar areas

5.3 General Area (G)

$$y = \frac{1}{\sqrt{2\pi}(1.032)x} \exp\left[-\frac{(\ln(x) - 4.019)^2}{2(1.032)^2} \right] \quad (3)$$

min = 0 max = 311 mean (μ) = 4.019 standard deviation (σ) = 1.032

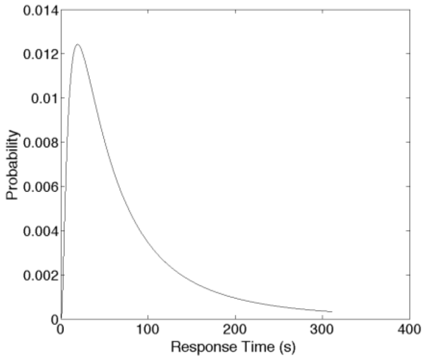


Figure 6: RTD for passengers in general areas

5.4 Restaurant Area (R)

$$y = \frac{1}{\sqrt{2\pi}(0.847)x} \exp\left[-\frac{(\ln(x) - 3.796)^2}{2(0.847)^2} \right] \quad (4)$$

min = 0 max = 259.56 mean (μ) = 3.796 standard deviation (σ) = 0.847

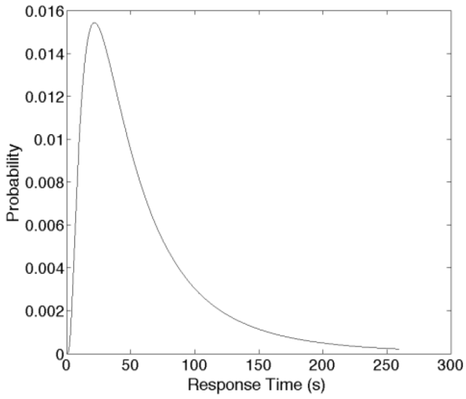


Figure 7: RTD for passengers in restaurant areas

5.5 Retail / Shopping Area (S)

$$y = \frac{1}{\sqrt{2\pi}(0.89)x} \exp\left[-\frac{(\ln(x) - 2.479)^2}{2(0.89)^2} \right] \quad (5)$$

min = 0 max = 104.8 mean (μ) = 2.479 standard deviation (σ) = 0.89

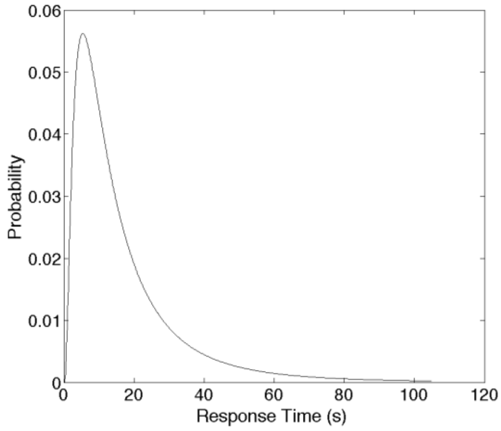


Figure 8: RTD for passengers in retail/shopping areas

5.6 Allocation of RTDs

Each of the RTDs presented in sections 5.1 to 5.5 are identified with a letter signifying the type of space it is associated with, e.g. the Airline Seating area RTD, given by equation 1 is associated with the letter A. In Table 3 each starting location area is associated with a RTD identifying letter, e.g. the Deck 3 – Seating area and the Deck 2 – Seating area are associated with RTD A i.e. equation 1.

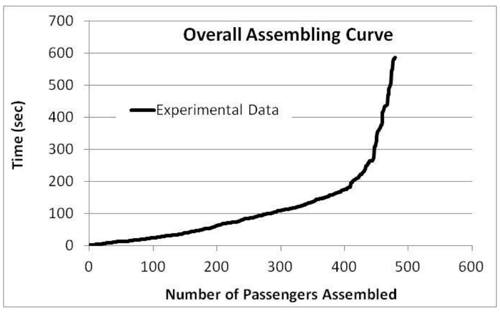
Table 3 – Assignment of RTD to the public spaces on the vessel

Start locations of the Passengers	Response Time Distribution
Deck 3 – Seating	A
Deck 2 – Bar	B
Deck 2 – Seating	A
Deck 2 – General area	G
Assembly Station D	R
Deck 2- Restaurant	R
Deck 1 – Bar	B
Assembly Station C	G
Deck 1 – General area	G
Assembly Station B	G
Assembly Station A	G
Deck 1 – Shop	S
Deck 1 – Lockers	G

6) THE SGVDS1 ARRIVAL CURVES

An assembly curve is available for each of the four ASs and the overall assembly. The detailed data describing each of these assembly curves is provided in the EXCEL SPREADSHEET SGVDS1.XLS. This spreadsheet is available on the same website that this document was downloaded from [2].

Note that all the assembly graphs associated with the SGVDSs are configured so that they present the Assembly Time (in seconds) versus the number of passengers assembled. Thus the X-axis represents the number of passengers assembled while the Y-axis represents the assembly time (in seconds). This orientation is required for the data analysis described in Section 7.



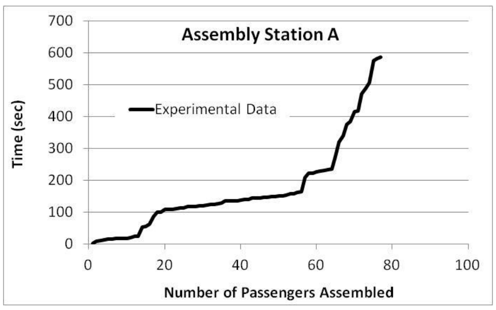


Figure 9. Overall assembly curve and AS A assembly curve for SGVDS1

7) THE VALIDATION METRIC

It is desirable to have objective measures of the level of agreement between predicted and measured performance rather than subjective assessments based on visual inspection of how well the predicted and measured curves agree. This is particularly important if the validation analysis is to be used by regulatory authorities to determine the suitability of an evacuation modelling tool. Thus it is necessary to quantify the level of agreement between predicted and measured performance. This is achieved using a validation metric based on quantifiable differences between the predicted and measured curves. The metric consists of the Euclidean Relative Difference, Euclidean Projection Coefficient and the Secant Cosine. These measures compare the shape of the model prediction to the experimental data as well as the distance apart.

- **The Euclidean Relative Difference (ERD)**

$$\frac{\|E-m\|}{\|E\|}=\frac{\sqrt{\sum_{i=1}^{n}(E_i-m_i)^2}}{\sqrt{\sum_{i=1}^{n}E_i^2}} \qquad (6)$$

This is used to assess the distance between the experimental data (E_i) and the model data (m_i). This value should return a value of 0 if the two curves are identical in magnitude. The smaller the value for the ERD, the better the overall agreement. An ERD of 0.2 suggests that the average difference between the model and experimental data points, taken over all the data points is 20%.

- **The Euclidean Projection Coefficient (EPC)**

$$\frac{\langle E,m\rangle}{\|m\|^2}=\frac{\sum_{i=1}^{n}E_i m_i}{\sum_{i=1}^{n}m_i^2} \qquad (7)$$

The EPC calculates a factor which when multiplied by each model data point (mi) reduces the distance between the model (m) and experimental (E) vectors to its minimum. Thus the EPC provides a measure of the best possible level of agreement between the model (m) and experimental (E) curves. An EPC of 1.0 suggests that the difference between the model (m) and experimental (E) vectors are as small as possible.

- **The Secant Cosine (SC)**

$$\frac{\langle E,m\rangle}{\|E\|\|m\|}=\frac{\sum_{i=s+1}^{n}\frac{(E_i-E_{i-s})(m_i-m_{i-s})}{s^2(t_i-t_{i-1})}}{\sqrt{\sum_{i=s+1}^{n}\frac{(E_i-E_{i-s})^2}{s^2(t_i-t_{i-1})}\sum_{i=s+1}^{n}\frac{(m_i-m_{i-s})^2}{s^2(t_i-t_{i-1})}}} \qquad (8)$$

Unlike the other two measures, it provides a measure of how well the shape of the model data curve matches that of the experimental data curve. It makes use of the first derivative of both curves. The SC measure includes a 'smoothing' term, s, which attempts to remove in noise in both the experimental data and the model prediction. Selecting an appropriate value of *s* is dependent on the number of data points in the data-set, given by *n*. It is desirable to keep the ratio *s/n* as low as possible. Typically the value of S/n should fall in the range 0.01 to 0.05 with steps of 0.01. An SC of 1.0 suggests that the shape of the model (m) curve is identical to that of the experimental (E) curve.

A computer programme has been provided that determines the metric values for any two data-sets. This computer programme can be used to compare the predicted assembly curves with SGVDS1. This programme is called FSEG_VALIDATION_ASSESSOR and is freely available from the same website that this document was downloaded from [3].

Another parameter which is used in the validation metric is the percentage difference between the predicted Total Assembly Time (TAT) and the measured TAT.

% TAT = (Measured TAT – Predicted TAT) * 100 / Measured TAT (9)

8) PROCEDURES FOR RUNNING THE SGVDS1 SCENARIO

8.1 SGVDS1 Summary

The following information summarises the nature of the SGVDS1.

- SGVDS1 is based on a semi-unannounced full-scale ship assembly trial conducted at sea using actual ship passengers.
- Not every passenger during the trial actually participated in the assembly exercise. Participation was voluntary and passengers could refuse to be tracked.
- Of the 1349 passengers on board, 764 were tracked during the assembly exercise – identified as the main population.
- Of the 764 passengers who wore tracked:
    i. some of these were already in assembly stations at the time of the alarm and so did not have to move to the assembly stations.
    ii. Some passengers who were already in an assembly station actually changed assembly station during the exercise.

- 569 passengers were not tracked, of which some actually participated in the trial and so had an effect on the movement of the tracked passengers during the assembly exercise.
- It is not known how many of the 569 passengers participated in the trial but they cannot be ignored. In an attempt to include the impact that these passengers may have had on the assembly process, some assumptions have been made as to what these passengers did:
    i. It is assumed that 250 of these passengers did actually participate in the assembly exercise – identified as the secondary population.
    ii. The secondary population must be included in the evacuation simulation as moving passengers, BUT ARE NOT included in the analysis of the arrival curves and total evacuation times. It is essential that you are able to identify and remove the specific results generated by the secondary population from the final results prior to determining the validation metric values.
    iii. The secondary population are distributed throughout the vessel, some of which are positioned in the assembly stations and so do not move. They are distributed according to the population distribution of the main population.
- SGVDS1 includes the following information:
    i. Vessel layout (Section 3).
    ii. Starting locations for the main and secondary populations (Section 4.3).
    iii. End locations for the main and secondary population (Section 4.4).
    iv. Response time distributions for the main and secondary population which are location specific (Section 5).
    v. Arrival times for each member of the main population in each of the four ASs (Section 6).

8.2 SGVDS1 Validation Protocol

The validation analysis should proceed as follows:

- Construct vessel geometry using the autoCAD files described in Section 3.
- Construct a population consisting of the main and secondary population (764 + 250 agents) and distribute them around the vessel as described in Section 4.3.
    - The population demographics must follow that prescribed by IMO MSC Circ 1238 i.e. using the age, gender and travel speeds described in the regulations. This includes the number of passengers with reduced mobility.
    - DO NOT use the RTD specified in IMO MSC Circ 1238. The RTDs specified in Section 5 must be used.
    - Each agent should be assigned to the assembly stations specified in Section 4.4.
- Run the validation scenario 50 times, changing the population after every 5 simulation runs as stipulated in the IMO MSC Circ 1238.
- The arrival data for the secondary population must be removed from the output of each simulation run.

- Agents who are initially located in and remain in the assembly station should have their arrival time removed from the analysis.
- The filtered arrival data for each simulation run is separated into the overall arrival data and the arrival data for each assembly station.
- The overall arrival data from each simulation is compared to the measured overall arrival data using the Euclidean Relative Difference (ERD) i.e. equation 6 (as explained in Section 7).
    - The computer programme FSEG_VALIDATION_ASSESSOR can be used to simplify the assessment.
- Rank each simulation according to the ERD determined for the overall assembly data.
- Select the simulation producing the smallest ERD which will be the basis of the validation comparison.
- For the selected simulation case go through the two phase assessment process which consists of the following:
    - **Phase 1**: For the predicted total assembly curve, determine ERD, EPC, SC (see equations 6, 7 and 8) and % TAT (equation 9).
    - Determine if all four predicted parameters satisfy the acceptance criteria (Section 9). If so go to Phase 2. If not, the software has failed the assessment.
    - **Phase 2**: For the predicted assembly curve for each of the four assembly stations, determine ERD, EPC and SC.
    - Determine which of the 12 predicted parameters (three for each assembly station) satisfy the acceptance criteria. At least 9 out of 12 criteria must be met for SGVDS1 to satisfy the criteria and it is not acceptable to have two or more failed criteria in any one assembly station.
    - The computer programme FSEG_VALIDATION_ASSESSOR can be used to simplify the assessment.
    - An example results matrix generated from the metric analysis of the overall assembly data and the AS assembly data is presented in Table 4. In Table 4 "n" represents the number of data points in the assembly data-sets for the overall assembly and each AS.

Table 4 - Example validation metric results table

	SC					**n**	**ERD**	**EPC**	**% diff TAT**
s/n	**0.01**	**0.03**	**0.05**	**0.07**	**0.09**				
Overall	**0.8**	**0.9**	**1.0**	**1.0**	**1.0**	**480**	**0.29**	**1.1**	**-27.5**
AS A	**0.4**	**0.6**	**0.8**	**0.8**	**0.9**	**77**	**0.36**	**1.4**	**-29.4**
AS B	**0.7**	**0.8**	**0.8**	**0.9**	**0.9**	**142**	**0.38**	**1.2**	**-27.3**
AS C	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**74**	**0.21**	**1.2**	**-24.8**
AS D	**0.8**	**0.8**	**0.8**	**0.9**	**0.9**	**187**	**0.52**	**0.7**	**-23.1**

9) SGVDS1 ACCEPTANCE CRITERIA:

If the validation protocol is applied as described in Section 8.2 and the software meets the acceptance criteria, it demonstrates that the software is capable of producing an acceptable level of agreement with the experimental data for the entire assembly process. The suggested acceptance criteria are as follows:

(i) ERD $\leq$ 0.45
(ii) 0.6 $\leq$ EPC $\leq$ 1.4
(iii) SC $\geq$ 0.6 with s/n = 0.05
(iv) Predicted TAT for the overall assembly to be within 45% of the measured value. This criterion is only applied to step 1 of the acceptance process.

10) REGULATORY DOCUMENTATION

If the results of the SGVDS1 are to be presented to a regulatory authority to demonstrate that the software is suitable to use in certification analysis it is suggested that the following information is included in the submission:

- i. Software name and version number.
- ii. Input files to generate 50 cases (should be complete to the point that the authority could re-run the cases).
- iii. Complete output files for the 50 cases with time stamp showing date and time generated.
- iv. If software permits, provide replay file for all 50 cases (with date and time of generation).
- v. Metric analysis
    1. Metric analysis to identify the Best ERD – spread sheet showing all 50 overall assembly time data sets, each associated with an ERD.
    2. Spread sheet with the complete data-set associated with the Best ERD i.e. assembly times for each AS and for the overall assembly. Spread sheet should be arranged so that it can be read by the FSEG_VALIDATION_ASSESSOR software.
    3. Table showing metric analysis for the Best ERD case.
    4. Spread sheet with graph showing the SGVDS and the Best ERD prediction for overall and each assembly station.

11) ADDITIONAL INFORMATION

This section provides a summary of the files, in addition to this document, that are required to define and analyse the validation scenario. All of the files are available from the following download area:

http://fseg.gre.ac.uk/validation/ship_evacuation

- DXF files describing each deck.
    - SGVDS1-Deck-1.dxf
    - SGVDS1-Deck-2.dxf
    - SGVDS1-Deck-3.dxf

  Please note that the scales in the DXF files are set to millimetres.

- Spreadsheet containing 5 worksheets:
    - SGVDS1.xls

  Each worksheet contains the data required to construct the assembly curve for the overall assembly, assembly station A, assembly station B, assembly station C and assembly station D. Note that the arrival data ignores the passengers who were in the assembly station at the start of the assembly process (these passengers have a zero assembly time).

- Validation Metric Calculator:
    - FSEG_VALIDATION_ASSESSOR.exe

  Software produced by FSEG to calculate the three components of the validation metric, ERD, EPC and SC.

12) References

1. "Guidelines for Evacuation Analysis for New and Existing Passenger Ships", IMO MSC/Circ 1238, 30 Oct 2007.
2. SGVDS1.XLS. Download from http://fseg.gre.ac.uk/validation/ship_evacuation
3. Haasanen, S., Galea, E.R., and Deere, S., Computer Software, FSEG_VALIDATION_ASSESSOR. Download from http://fseg.gre.ac.uk/validation/ship_evacuation