

MARITIME

# Evacuation Preparedness of Modern Cruise Ship Designs

**Dr. Daniel Povel**

2014-03-26

**NTSB Cruise Ship Safety Forum**  
**25/26 March 2014**



Evacuation Preparedness

# Escape Routes - Definition

---

## ■ **Escape Routes**

- At least two means of escape from all spaces or group of spaces
- Requirement on width of escape ways (stairways, doors, corridors and landing areas)
- Marking by lighting or photoluminescent strip indicators  
(=> electric illumination shall be supplied by emergency source of power)

## ■ **Assembly Stations**

- Allocating and mustering of all persons on board in emergencies
- Shall be in the vicinity of embarkation stations

# Escape Routes - Definition

---

- **Embarkation Stations**

- Lifeboat and life raft embarkation deck

- **Requirements for different phases of an evacuation**

- Evacuation to assembly stations
  - => Evacuation simulation to calculate the evacuation duration and limitation of congestions (mandatory for Ro-Pax) (SOLAS II-2/13 and MSC.1/Circ. 1238)
- Embarkation process (incl. boarding and launching)
  - => max. 30 Min. (SOLAS III/21)
- Boarding time for lifeboats
  - => max. 10 Min. (LSA Code)

## MSC.1/Circ.1238 Guideline for Evacuation Analysis

---

- **Simplified and advanced method**
- **DNV GL recommends the use of the advanced method**
- **Simulation of 4 standard cases**
  - Case 1: Night case, fully available escape routes
    - Passenger and main crew are located in the cabins, reduced reaction time
  - Case 2: Day case, fully available escape routes
    - Passenger are mainly located in the public spaces
  - Case 3/4: Night/Day case, reduced stairway capacity
    - one staircase having largest capacity considered unavailable
    - or additional 50% of the persons in one of the main vertical zones neighbouring the identified main vertical zone are forced to move into the zone and to proceed to the relevant assembly station.

### **=> Benchmarking Simulation Scenarios**

(does not correspond with reality to 100%)

Calculated total evacuation time:

$$1. \quad 1.25 T + 2/3 (E + L) \leq n$$

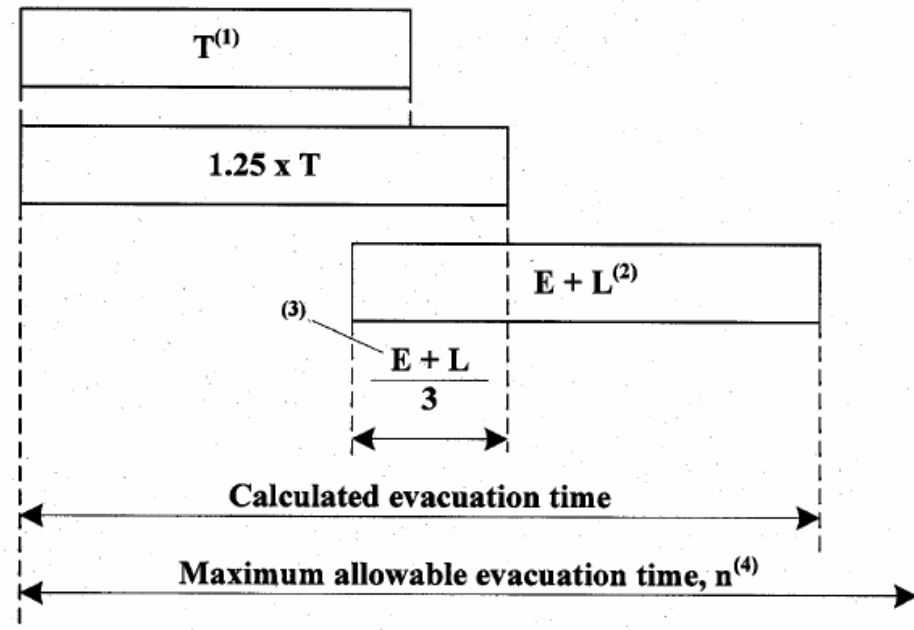
$$2. \quad E + L \leq 30 \text{ min}$$

- **n = 60 min**

(ro-ro passenger ships or other passenger ships with no more than three main vertical zones)

- **n = 80 min**

(passenger ships more than three main vertical zones)



- (1) calculated as in the appendix to the Interim Guidelines
- (2) maximum 30 min in compliance with SOLAS regulation III/21.1.4
- (3) overlap time =  $1/3 (E+L)$
- (4) values of  $n$  (min) provided in paragraph 3.5.2

# Evacuation Simulations

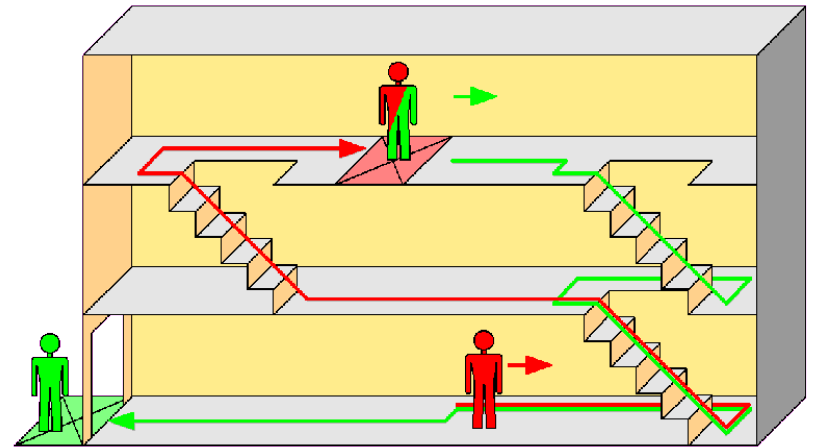
---

## Characteristics of simulation models

- Each person is represented in the model individually (advanced method).
- The abilities of each person are determined by a set of parameters, some of which are probabilistic.
- The movement of each person is simulated and recorded.
- The parameters should vary among the individuals of the population.
- The basic rules for personal decisions and movements are the same for everyone, described by an universal algorithm.
- The time difference between the actions of any two persons in the simulation should be not more than one second of simulated time, e.g. all persons proceed with their action in one second (a parallel update is necessary).

# Evacuation Software AENEAS

- **Agent-based method**
  - individual persons
  - discrete space
  - discrete time
- **Individual agent behaviour within specified parameter ranges**
- **Freely definable routes**
- **Fast calculation** (due to simple and uniform movement algorithm)
- **Certified by German Flag Authority according to MSC.1/Circ.1238 Annex 2**



# Example

## Vessel information

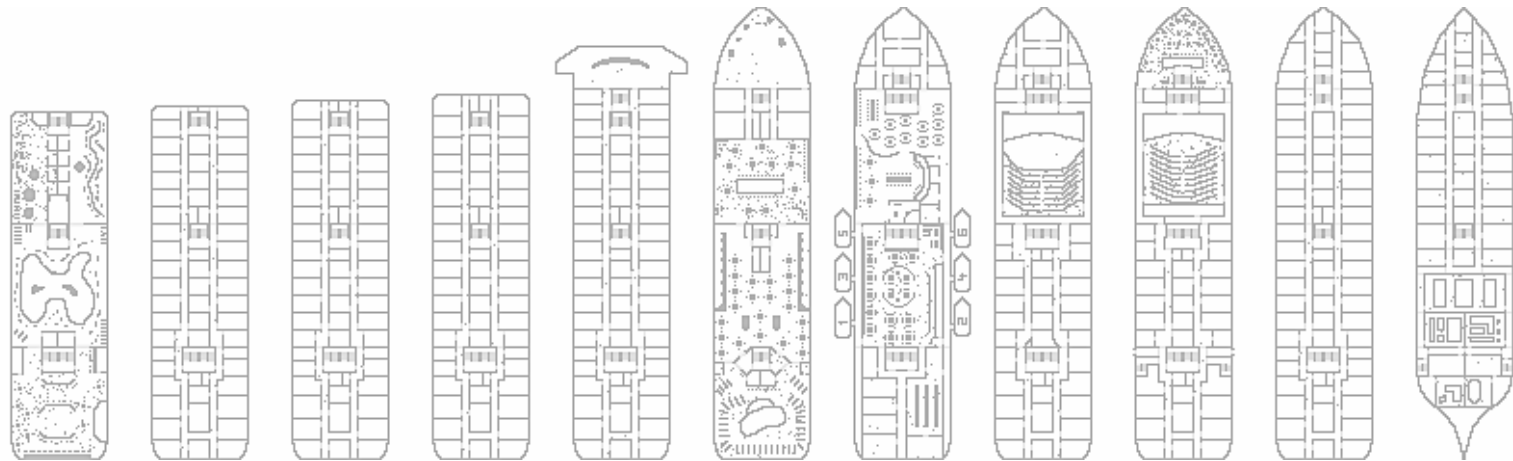
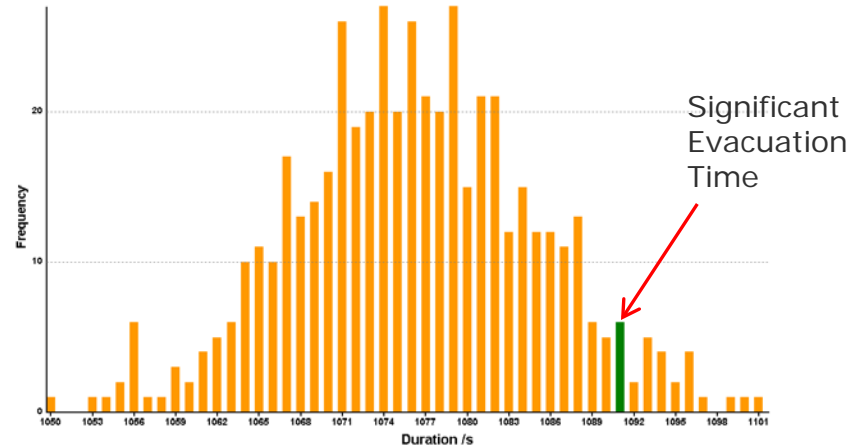
Pax: 800 pers.

Crew: 250 pers.

Decks: 10

Length: 93m

Width: 20m



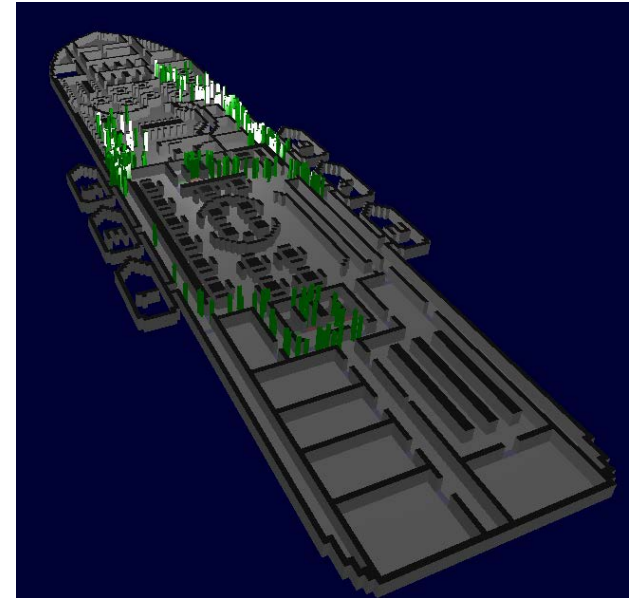


## Example: Results-Density

- The red areas show the the critical density of passengers ( $4P/m^2$ ) at 10% of the total evacuation time.

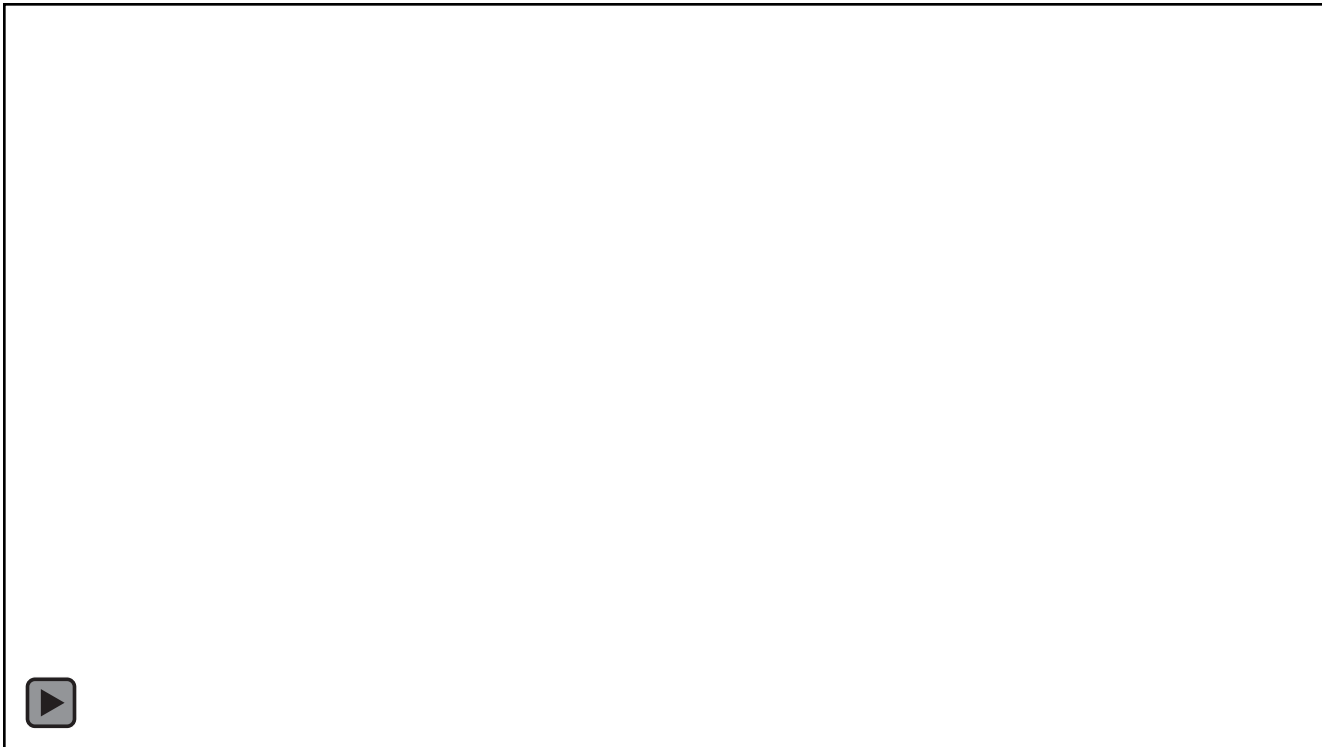


Evacuation Preparedness



## Example: Video

---



## Further Development at IMO

---

- The existing **IMO requirements and guidelines on evacuation analysis are to be reviewed** with reference to the **Costa Concordia accident**.
- IMO will most probably conclude with **mandatory application** of evacuation analysis to all passenger ships.
- **Differentiation** between existing and new passenger ships as well as between different types of passenger ships is needed!
- **Specifics of Cruise Ships** may have to be considered in more detail:
  - Location of crew assembly stations
  - Routing of crew passing main vertical zones
  - Operational measures
  - Counterflow and crossing flows
  - Consideration of open deck areas

# Thank you for your attention!

**Dr. Daniel Povel**

daniel.povel@dnvgl.com

+49 40 36149 7524

**www.dnvgl.com**

**SAFER, SMARTER, GREENER**

**System Capabilities on Modern Cruise Ships**