Mustering exercise with 600 pax on board M/f Kronprins Frederik

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Introduction

The paper describes the planning and simulated execution of a mustering exercise performed with about 600 passengers onboard the M/F Kronprins Frederik shown below at sea under the MEPdesign project (Mustering and Evacuation of Passengers).

The means of evacuation being lifeboats, slides and davit-launched life rafts were not used and the exercise was stopped when all areas on board were empty and the passengers were to leave the ferry having donned their life jackets.

Description of M/F Kronprins Frederik

The ferry was built at Nakskov Shipyard Ltd, Denmark for the Danish State Railways and delivered 1981 as one of three new train and passenger ferries to operate on the Great Belt between Korsor and Nyborg serving the Inter City train network.

The ferry has later been converted to fit to the international route between Gedser in Denmark and Rostock in Germany primarily now serving as a car- and passengerferry.

Main particulars

Length over all	152,00 m
Breadth	23,70 m
Max draft	6,00 m
Tonnage	5500 t
Max numbers of passengers	1400

General description

The ferry is a twin screw diesel powered day ferry with one train/car deck and two decks with public facilities for passengers above the main deck.

The passenger accommodation is symmetrically around a large central room or square, the height of which extends through the two public decks. Access from the train/car deck is via two stairways to blue and red hall. The colours help to identify the two main zones of the ship. These colours are incorporated in the artistically decorations. The longitudinal “streets” on each side of the decks connect the various functions. Two passenger lifts operate between the train/car deck and the lower public deck. There are no passenger spaces below the main deck and no cabins for overnight passengers.

When the ferry is carrying a full load of 1400 passengers the crew will add up to a total of 39 persons consisting of 15 educated seamen and 24 other safety instructed personal. Most of the members in this group are officers and crew from the catering department. The number of crew in this category varies from 0 up to a total of 24 depending on number of passengers.

The ferry has life saving appliances with a total capacity of 1612 persons as shown below:

Number	Type of appliance	Capacity pax
2	Lifeboat of 50 persons each	100 Persons
4	Cranes each with 5 davit-launched life rafts with a capacity of 35 persons each	700 Persons
2	Fast Rescue Boats	12 Persons
2	Slide of 400 persons each	800 Persons
	Total Capacity	1612 Persons

To make the ferry flexible in its daily use depending on number of passengers it has been divided into 5 modules. Module no 1 is always open. Modules 2 - 5 can be individually opened or closed. The 5 modules are:

Module no 1.	Red and blue hall, Gambling hall, Arcade, Panorama saloon deck 8
Module no 2.	Supermarket and Perfume shop,
Module no 3.	Baltic room
Module no 4.	Restaurant, Starboard and Port Panorama Lounge
Module no 5.	Veranda Saloon and Conference room

Only modules 1, 2, 3 and 4 were used for this exercise. Module 5 was closed.

There are 5 assembly stations on board from which the crew will hand out and instruct the passengers in the proper use of lifejackets. Four assembly stations are placed on the evacuation deck, deck no.9, and one is placed two decks below the evacuation deck on deck 7, which accommodates the Cafeteria and the shopping spaces.

The ferry carries a total of 1600 life jackets type Merman 16 for adults and 146 for children.

Recruiting of passengers

In order to find the approximately 600 passengers, who was the basic number of passengers for the exercise agreed by the consortium, an advertisement was inserted in the local newspaper Lolland Falsters Folketidende on Thursday the 12th of October 2000.

The advertisement announced that Scandlines intended to arrange a realistic exercise on board m/f Kronprins Frederik at sea with approximately 600 passengers representing a typical mix of passengers consisting of children, old people, families and groups of people.

Furthermore it was mentioned that the exercise would take place during a trip to Rostock on Saturday the 28th of October departing Gedser at 20.00 hrs and expected to return at 01.00 hrs on the 29th of October.

In return for participating each passenger would receive a premium together with a free fare and a meal on board.

Registration of passengers

In the above mentioned advertisement interested persons were told to send in a slip from the newspaper telling about number of participants, names, address and telephone number. When this information was registered the passengers were further informed through a confirmation letter sent by mail. 735 interested persons reacted to the advertisement and this number was reduced to 635 taking into account that most likely a few more would excuse themselves later or simply stay away, what 38 actually did presumably due to a very bad weather forecast. Hence the exercise was carried out with 592 passengers on board a figure very close to the anticipated 600 passengers

In the confirmation letter it was stated that the passengers would participate in a safety exercise, that they should dress warmly, and that there was no extra safety risk involved for the participants compared to any other normal ferry trip. Furthermore some practical information was given as to where to park, when to arrive and when the participants could expect to be back again. No details were either here given on the exercise.

Boarding the passengers

On the day of the exercise the ferry arrived in Gedser at 19.15 hrs and started unloading cars and passengers after which loading of cars and gangway passengers for the exercise started.

The check-in procedure was carried out in the gangway passenger terminal and at the drive in terminal as the line management had decided to let a part of the passengers board from their cars loaded on the cargo deck.

On check-in each passenger was given an electronic chip and assigned a single sheet of paper stating their individual chip code. On this paper their age, sex and the composition of the group in which they were traveling were written down by the check-in staff. The chip code number for a given chip was printed on the check-in form in advance to speed up the check-in procedure.

Upon entering the ship the Check-in staff made sure that each passenger had fastened his or her individual chip to one ankle just above the shoe. The check-in forms were later delivered to the Danish Maritime Institute (DMI) for processing after the exercise.

After the check-in procedure and correct attachment of the chip on an ankle, tickets for food and a value coupon for use in the supermarket were delivered to the passengers.

Distribution of passengers on board

Based on the passengers lists the Line Manager had prior to the trip prepared the seating of the passengers in the restaurant on deck 8 having yellow tickets, in the Baltic Room on deck 5/7 having green tickets and the Panorama Saloons on deck 7 having red tickets. When the passengers showed the tickets to the crew in the hall on deck 8 it was an easy task to assist the passengers to their predestined tables.

Information to the crew

The crew was prior to the exercise informed that on this trip an exercise would be held with 600 passengers without giving details about the scope except that a number of technicians and observers would be present wearing a yellow cap indicating that these persons were invisible during the exercise.

DMI Technicians and Observers and their Equipment

The recording of the mustering movements during the exercise were done by DMI and their subcontractors being 25 persons in all. The technicians supervised functioning of the chip-registration equipment and observers were placed on various important points and points where automatic equipment could not be arranged.

6 main sorts of recordings and observations in relation to the exercise was made:

Electronic recording of passenger flow
Manual counting and time keeping
Video recording
Interviews after the exercise
Informal observations
Electronic recording of ship roll movement

The recording of passenger flow during the exercise was based on a combination of electronic flow recording, video recording and manual counting & time keeping.

Originally 8 sets of chip-registration equipment were supposed to be available during the exercise placed on the most important registration points. Shortly before the exercise however two more pieces of equipment were offered so the total number of registration stations added up to 10.

Individual passenger movements during the exercise was recorded automatically at selected passageways. The equipment used for these recordings was electronic chips attached to one ankle on each passenger. Each chip carried a 7 digit identification string. When passing a recording station passengers walked through an electromagnetic field generated from a rubber mattress, which also contained receiving antennas. After amplification of the signal, the identification string of the chip was recorded on a PC. Each recording was time stamped and associated with a counter, which identified the number of times a given passenger passed the particular recording site.

A number of tests showed, that it was possible to make the registrations if the registration mattresses (receiving the chip codes) were placed on flamingo a few centimetres above the iron decks and this was done in all of the predestined observation posts.

At 19.00 hrs a meeting involving technicians and observers was held on board. The aim and the headlines of the exercise in general and the role of the group in particular were explained.

Yellow caps were handed out to all members of the group and also here again it was stressed that the yellow cap meant that the observers/technicians were not to be considered as passengers, and that they should not be evacuated. Observers and technicians should under no circumstances answer questions or say anything to the passengers.

The group was instructed to place themselves on their assigned locations for observations in such a way that the passenger flow was not disturbed.

Furthermore the group had the order to proceed to their predestined stations to start and check their equipment ready for the exercise, when the announcement was given on the PA system, that the supermarket would open in 10 minutes, i.e. approximately 20 minutes before the alarm signal.

When the alarm signal was given they had to put on their yellow caps signalling to the crew, that they neither belonged to the passengers or the crew.

Observers were equipped with both recording sheets for making manual counts of passenger flow as well as mechanical counters in order to help counting passengers per minute.

On deck 9 where passengers enter the open deck (with muster stations B, C, E and F) mainly electronic recording were used, but supplemented with two human observers (because of 2 extra doors that could not be covered by the equipment). Further two video cameras were placed on deck 9 to record delays and problems in mustering and putting on life jackets on deck 9. On deck 8 electronic coverage of the pathways were

established, from the restaurant below on deck 5/7 a combination of electronic and manual recording for the passageways to the Baltic room were arranged with video cameras observing delays in the Baltic room and in muster station A.

Muster plan for the exercise

A safety card has been made to each of the ferry's 39 crewmembers. The meaning of this card is to help crewmembers to remember exactly what to do in each muster list. The cards have a red side showing each crewmember what to do when the fire signal is sounded and a green side showing what to do when the evacuation signal is given. In this case the green side was used.

37 crewmembers participated in the exercise. Up to the exercise they were tending their normal jobs on deck, on the bridge, in the engine room and in the catering department. Crew, who were off duty were eating their meals in the mess rooms, looking TV, or sleeping in their cabins.

As the crew did not have a chip during the exercise it is not possible to tell exactly where each crewmember were when the signal for evacuation was given.

Only the muster plan for evacuation was used because the MEPdesign consortium had decided to simulate that the ferry had a collision with another ship.

When an evacuation signal normally is given the assembly phase starts by mustering the crew, who then will guide the passengers to make them ready for embarkation. Generally the ferry is considered the safest place for the passengers to stay and most captains want them to be waiting there as long as possible. This phase may take shorter or a longer time. In the present case the exercise stopped when the captain gave the order to the crew to evacuate the ferry

When the order to evacuate the ferry is given on the Public Address system or on the walkie-talkie the crew will help the passengers to come to the life saving appliances and instruct them how to get on board.

Departure

The ferry left Gedser at 20.00 hrs as scheduled for a round trip to Rostock with 597 passengers, a crew of 37 members and 37 technicians, observers and extra crew.

After departure the passengers were welcomed on board and were briefed that the ferry was expected to revert to Gedser at 0100 hrs on the 29th of October. The passengers were told that there would be an announcement on the PA system, when the Supermarket and the Perfume Kiosk would be open.

Weather conditions

Up to and during the exercise the weather had been over clouded with a very good visibility and no rain, the wind was coming from south southwest force 8 m/s, sea state 2 – 4, there was no current in the area. The temperature was 11 degrees Celsius.

The night was very dark, but in general terms the weather was very fine for this time of the year despite the weather forecast. A few days before and a few days after the

exercise there was a storm in the area with very low water and the ferry had to stay in the ferry bed waiting for better weather.

Distribution of passengers up to the time of the exercise

The distribution of passengers was largely given by the distribution fixed by Scandlines on where to dine during the first part of the trip. Not including observers this distribution was predetermined to be:

Baltic room (deck 5/7)	250
Panorama salon (deck 8)	173
Restaurant (deck 8):	179
All told	602

592 passengers were registered to be onboard and it was found that only a few passengers did not comply with the prearranged seating, but roughly it is assumed that this was the distribution. The location of passengers in more detail could not be determined with the electronic equipment, because this was designed to count and record the flow of passengers passing the selected measuring stations during evacuation and not to determine their exact stationary location.

It had been decided that the exercise should be held when most passengers had eaten their meal. In order to see an effect of group binding, which has been properly studied in the project, an announcement was given that the supermarket had opened. The aim was to separate families and other groups. This announcement was given at 21.00 hrs. After a while when a suitable number of passengers appeared in the Supermarket the evacuation signal was sounded. The idea behind opening of the Supermarket a little while before the exercise started was to ease spreading of the passengers around in the accommodation as under a normal voyage.

Two observers were placed in the supermarket and when the sufficient number of passengers in the supermarket had arrived and before any of them reached the payment disk a telephone call was made to the bridge that the exercise could start.

Starting the Exercise

The telephone call from the supermarket was received on the bridge at 21.17 hrs. At this time the ferry was steering 180 degrees and running 18 knots.

To simulate that something serious had happened the helmsman was given the order to give starboard rudder and simultaneously the bow thrusters were activated and the main engines reversed in order to turn and stop the ferry. These manoeuvres were supposed to be heard by at least some of the passengers. The ferry had a simulated collision with an old ship named S/S Martha at 21.17 hrs. The collision took place in a position approximately 2 nautical miles west of the buoy marked “Rostock” with the ferry running with a reduced speed of 15 knots.

The ferry’s position when the collision took place was 54o17´8 North, 11o58´5 East.

Almost immediately after the collision the captain got a situation report from the engine room saying that the ferry had a serious damage in the port side of the engine room and the adjacent room below the waterline. At the same time the ferry started to heel to port, as the captain activated the anti heeling tanks to simulate the effect of incoming water through the hole in the port side. The maximum heeling angle was measured to be 2.5 degrees.

The organisation for Damage control measures was activated and showed that the situation was 'serious' and the captain decided to give the alarm signal for evacuation of the ferry. (Seven short and one long ring with the fire bells).

The alarm signal for evacuation was given at 21.19 hrs.

After the signal had been given the captain informed the passengers and the crew over the PA system, that this was an exercise simulating that the ferry had collided with another ship. He mentioned, that there was no immediate danger and that the situation was under control, but he wanted to make preparations to leave the ferry in case the situation developed in a serious way. The captain asked the passengers to remain calm and to follow crew instructions.

The Marine Rescue Communication Centre (MRCC) in Bremen was informed together with Scandlines headquarters. They had both been told about the exercise some days before it took place.

Mustering the crew and passengers

When the signal was sounded the crew started mustering on their muster stations. This has to be done to ensure the captain that the organisation is still intact and ready to go on with their duties according to the safety cards.

Immediately after mustering and reporting to the bridge the crew went to their predestined positions and started assisting the passengers in accordance with their general instructions or as ordered from the bridge.

The general order to the crew is that they are responsible that the restaurant areas, the toilets and all other areas within their module are emptied. Getting out from these areas the passengers were shown the way to the assembly stations. When this was done and checked the module leader from each module reported to the bridge that the module was empty.

To avoid congestions in the doors from the restaurants and at the lockers where the life jacketlife jackets were handed out the crew are instructed to take a group of passengers from two tables or approximately 20 passengers at the time and lead them to the doors. This could be done because there was no immediate danger for the ship or for the passengers.

When the passengers came to the assembly stations other crewmembers in the same module started to hand out life jackets. The passengers were instructed and assisted in donning their life jackets. It was checked that the life jackets sat properly on each passenger.

The passengers were now ready for embarkation and they were only waiting for the order from the bridge to evacuate the ship.

When the order came to evacuate the ferry the passengers assembled on deck 9 were led aft on this deck and down on deck 8 in the veranda saloon to simulate that they had been led on board one of the means of evacuation, being the rescue boats, slides or davit-launched inflatable rafts.

The crew did not prepare the means of evacuation, as they would have done in a realistic situation at this stage of evacuating the ferry, because this was agreed not to be a part of the MEP design project.

Initial delay

Passengers did not react to the alarm or the call for mustering at once. This initial delay was expected and passengers were in fact instructed by the captain to await further instructions from the crew. It is therefore not surprising that they did not initiate mustering before they were locally instructed to do so by crewmembers.

The time to assemble crewmembers before instructing passengers was from 2 min (for module-4 assembling crew in restaurant and panorama lounge) and up to 7 min (for module-2 assembling crew from the two shop areas). The average time for mustering of the crew in the 4 modules were 3 3/4 min (200 sec.).

Delay at assembly stations

The delay is only relevant for assembly station "A" on deck 7. The crew imposed the delay as a waiting time before there was room on deck 9 for embarkation. The delay was the same for all passengers independent on age and without variation.

Assembly station "A" primarily received passengers from the "Baltic Room" restaurant area. The Baltic Room area was evacuated in 11 minutes (at 21.30) counting from the alarm at 21.19 (including the initial delay of the crew who had to muster first). Life jackets were donned in further 5 minutes. The total time for donning the life jackets in "A" was approximately 10 + 5 minutes starting at once, when the first passenger came out from "Baltic Room". ("A" was reported ready for embarkation at 21.35). Further waiting time of 3 minutes were imposed by the crew (waiting for passengers already on deck 9 to clear the area, i.e. simulating disembarkation).

Assembly station "A" was permitted to leave for the embarkation station at 21.38 and clearing the area took 4 minutes (21.42). The last person was on deck 9 at 21.43. The process of walking from "A" at deck 5/7 to the embarkation station at deck 9 took 5 minutes for the group as a whole, but seemed to take 1 min only for the last passenger to leave "A" and arrive at embarkation. Waiting time at "A" was 8 minutes in all (life jackets + imposed waiting).

General remarks

The crew had been a little anxious about the exercise with so many passengers. Up to the exercise they had trained a lot of details in their drills. The crew perceived the exercise as an exam of their proficiency and in general it had been easy to motivate them for all kinds of exercises.

All MEPdesign partners were represented as ordinary passengers during the exercise. A number of instructors from Scandlines and from DFDS, another major passenger ship company in Denmark, teaching leading crewmembers crisis management and human behaviour, participated in the exercise as ordinary passengers. They were mainly interested to see how the crew would tackle the situation of leading big crowds of people and were surprised to see, that the passengers almost evacuated themselves without much help from the crew.

Some members from this group went to the car deck, where they were observed by crewmembers searching the area for passengers and they were at once ordered to go to the evacuation deck.

Assembling the passengers is in general a precautionary measure and can be done when there is no immediate danger and therefore there is no real urgency.

The passengers knew in beforehand that they were going to participate in an exercise and this fact might be the reason why they responded in a very relaxed way. At the same time the captain said in his announcement that this was an exercise. Furthermore he said that there was no immediate danger and asked the passengers to remain calm and to follow the directions from the crew.

The weather was calm and mild so there was no effect of ship motion despite the list to port on mustering speed and (naturally) no perceivable impact of a collision or any other signs of danger or emergency (besides the alarm).

Some passengers arrived before the crew at the assembly station because the crew had something else to do before meeting at the assembly stations. It was important that all areas, restaurants, stairs and toilets had been totally emptied and that no passengers tried to hide himself. In general this must be ensured before the crew goes to the assembly areas and this explains the late arrival of the crew at the assembly stations.

In some areas (such as muster station ‘A’) the crew kept the passengers waiting without telling them what was going to happen.

The crew was not easy to identify after passengers and the crew had donned their life jackets.

In general the crew did not instruct passengers how to donne the life jackets as the crew were fully occupied by the handing out process. However passengers gradually found out how to unbuckle and donne the life jackets. Many of them copied what they saw others doing or they were assisted by fellow passengers.

Handing out the life jackets was clearly a bottleneck. The entrances to the storage areas were very narrow and prevented a fast hand out. Moreover the life jackets were buckled and passengers had problems unbuckling them.

After having donned their life jackets some people remained just off the doors to the lockers and prevented passage of passengers, who had not yet got their life jackets.

Lessons learned by Scandlines

The exercise has been very useful to Scandlines and to the ferry and it has given the input to changes in the ships organisation and in some practical aspects.

The exercise showed that it is important to know exactly who of the crewmembers are going into the life jacket locker, who is handing out the life jackets, who is instructing in donning the life jackets and who look after that the life jackets sit properly and tight on every passenger.

List over actions to be taken

- Go through safety cards and make additions where necessary
- Use megaphones at assembly station A and on deck 9
- Go through PA-system all over the ferry for appropriate volume
- Life jackets to be left unbuckled in the lockers
- Move all wetsuits from lockers on deck 9
- Information to the passengers at least every 5 minutes
- Send crew to life jacket lockers before the passengers
- Empty and stop elevators
- Instructing passengers in donning life jackets to be updated
- Procedure for making flow at assembly stations
- Caps to the crew in a very distinct colour.

Dissemination

A fully description of the exercise is given in the two MEPdesign public deliverables:

- Planning of Mustering Exercise on board m/f Kronprins Frederik.
- Execution of Mustering Exercise on board m/f Kronprins Frederik.

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