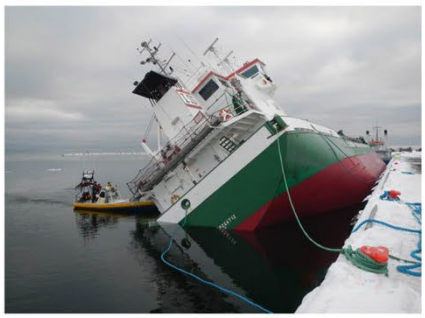
Statens haverikommission
Swedish Accident Investigation Authority



Final report RS 2022:07e

Very serious marine casualty involving a lifeboat in Frihamnen harbour, Stockholm den 12 April 2021

File no. S-76/21

2022-07-13

SHK investigates accidents and incidents from a safety perspective. Its investigations are aimed at preventing a similar event from occurring in the future, or limiting the effects of such an event. The investigations do not deal with issues of guilt, blame or liability for damages.

The report is also available on SHK´s web site: www.havkom.se

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This document is a translation of the original Swedish report. In case of discrepancies between this translation and the Swedish original text, the Swedish text shall prevail in the interpretation of the report.

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Content

General observations

The Swedish Accident Investigation Authority (Statens haverikommission – SHK) is a state authority with the task of investigating accidents and incidents with the aim of improving safety. SHK accident investigations are intended to clarify, as far as possible, the sequence of events and their causes, as well as damages and other consequences. The results of an investigation shall provide the basis for decisions aiming at preventing a similar event from occurring in the future, or limiting the effects of such an event. The investigation shall also provide a basis for assessment of the performance of rescue services and, when appropriate, for improvements to these rescue services.

SHK accident investigations thus aim at answering three questions: *What happened? Why did it happen? How can a similar event be avoided in the future?*

SHK does not have any supervisory role and its investigations do not deal with issues of guilt, blame or liability for damages. Therefore, accidents and incidents are neither investigated nor described in the report from any such perspective. These issues are, when appropriate, dealt with by judicial authorities or e.g. by insurance companies.

The task of SHK also does not include investigating how persons affected by an accident or incident have been cared for by hospital services, once an emergency operation has been concluded. Measures in support of such individuals by the social services, for example in the form of post crisis management, also are not the subject of the investigation.

The investigation

SHK was informed on 12 April 2021 that a very serious marine casualty had occurred that same day at 09.14 hrs at a maritime safety training centre involving a lifeboat of the type VIKING-Norsafe JYN57.

The accident has been investigated by SHK, represented by John Ahlberk, Chairperson, Daniel Söderman, Investigator in Charge, and Björn Ramstedt, Operations Investigator. SHK has been assisted by Saltech Consultants AB, which conducted testing and investigation of the lifeboat's stability.

Linda Eliasson has participated as coordinator for Swedish Transport Agency.

Investigation material

Interviews have been conducted with course participants, the instructor who was on board the lifeboat at the time of the accident and other employees at the training centre who were involved in servicing and purchasing the lifeboat. Representatives of the manufacturer of the lifeboat have been interviewed and these have also participated in weighing of the lifeboat, as well as in manoeuvring-, load- and inclining tests conducted by SHK. The owner of the privately-owned boat that assisted during the emergency response, and which was also used to tow the lifeboat, has also been interviewed. The manufacturer has provided documentation and plans for the lifeboat.

A fact-finding presentation meeting with the interested parties was held on 15 February 2022. At the meeting, the facts discovered during the investigation, available at that time, were presented.

Final report RS 2022:07e

Ship particulars	
Flag/register	Sweden
Identification	Viking-Norsafe JYN 57T mk I
Vessel data	
Type of ship	Totally enclosed lifeboat with side hatches
Year of construction	2020
Construction material	Fire-retardant glass fibre-reinforced polyester
Length, over all	5.70 m
Beam	2.20 m
Draft, max.	1.2 m
Total height	3.10 m
Empty weight, fully equipped	2,705 kg
Max. weight	4,850 kg (incl. 26 passengers @ 82.5 kg)
Main engine, output	1 3-cylinder diesel engine, 21.6 kW
Propulsion arrangement	Propeller with fixed pitch in a nozzle ring
Lateral thruster	No
Rudder arrangement	Steering nozzle
Service speed	6 knots
Ownership and operation	Safetygruppen & Navigationsgruppen Sverige AB

Details of the occurrence	
Type of voyage	Lifeboat exercise
Number of passengers	6 course participants
Manning	1 instructor

Marine casualty or incident information	
Type of marine casualty	Very serious marine casualty
Date and time	2021-04-12 at 09.14
Position and location of Marine casualty	59° 20.7′ N 018° 07.2′ E
Weather	Westerly wind 1–3 m/s, good visibility
Consequences	
Injuries to persons	No
Environment	No
Vessels	The boat became partly filled with water

SUMMARY

On 12 April 2021, a refresher course in the operation of survival craft and rescue boats was conducted at a training centre in Frihamnen harbour in Stockholm. One of the practise sessions was an exercise in rescuing survivors from the water using a lifeboat. The lifeboat was a totally enclosed model with side hatches that is intended for a maximum of 26 persons. The lifeboat was also approved for use as a rescue boat.

During the exercise, the lifeboat started listing heavily and became flooded with water through a side hatch. Three people ended up in the water and the lifeboat had to be abandoned. None of those on board suffered any injuries.

During the occurrence, the lifeboat was lightly loaded, with few persons on board in comparison to the capacity of the lifeboat. Some of the basic equipment such as water, provisions etc. was not on board either. All the hatches were open to allow the participants to practise bringing casualties on board out of the water. The forces that arose when the participants in the exercise moved around in the boat resulted in a change in the centre of gravity, which led to the lifeboat starting to list heavily and to the edge of the side hatch ending up under the waterline.

The lifeboat complied with applicable stability requirements. Nevertheless, the investigation shows that, under certain conditions, this type of lifeboat has a small stability margin. This means that small forces are able to generate large angles of heel and that, under certain conditions, lifeboats of this type are able to take on water and heel over if the boat is being manoeuvred with open side hatches. This is especially the case when the lifeboat is lightly loaded with few persons on board. It is reasonable to assume that other lifeboats of similar types and sizes may have similar stability properties.

The accident was caused by the lifeboat's stability properties, which meant that small changes in centre of gravity gave rise to large angles of heel. When those on board moved around in the lifeboat in order to allow the helmsman to be changed, the centre of gravity moved upwards. This led to the boat heeling heavily, taking on water through an open side hatch and heeled over. At system level, the accident was caused by insufficient stability requirements for small, enclosed lifeboats with side openings near the gunwale.

Safety recommendations

The Swedish Transport Agency is recommended to:

- Take necessary measures in order to ensure that the problem of lifeboats' stability is noticed within the EU with the aim of ensuring that the requirements in respect of lifeboat stability are fit for purpose and do not constitute a risk to maritime safety. *(RS 2022:07 R1)*
- Act to ensure that instructions are developed at the international level for the safe use of small, enclosed lifeboats with side openings near the gunwale with respect to these boats' stability properties. *(RS 2022:07 R2)*

VIKING Life-Saving Equipment A/S is recommended to:

- Revise the operation and maintenance manual for the lifeboat type and make the adaptations required in order to ensure safe operation with respect to the stability properties. *(RS 2022:07 R3)*

1. FACTUAL INFORMATION

1.1 Sequence of events

Figure 1. The lifeboat at the training centre.

In the winter of 2021, a maritime training centre in Frihamnen harbour in Stockholm, had acquired a newly built, totally enclosed lifeboat that was to be used for training purposes. The training centre was located on a converted barge with classrooms, offices and other spaces. During a refresher course in the operation of survival craft and rescue boats, one of the practise sessions was to practise rescuing survivors from the water using a lifeboat. There were six course participants and one instructor on board the lifeboat. The course participants were experienced merchant marine officers.

A safety briefing was held prior to the exercise and the instructor described the components of the exercise. On previous occasions during the exercise, water had entered the lifeboat through the open side hatches when turning sharply. This was mentioned to the course participants who were instructed not to perform any sharp turns during the exercise.

The course participants were equipped with flotation suits, helmets, gloves, protective shoes and inflatable life jackets. The instructor wore a survival suit, helmet, protective shoes and an inherently buoyant life jacket.

The lifeboat was launched from a davit on the deck of the barge. While being lowered, all those on board were seated on benches, strapped in with four-point seat belts. After being launched, the belts were removed and the five hatches in the lifeboat's superstructure were opened. The lifeboat was then released from the hooks and the boat was driven a little way out into the harbour.

Instead of pulling a real person out of the water, a lifebuoy was used as a dummy. All participants were to be given the opportunity to practise driving the lifeboat during this part of the exercise and the intention was therefore to change helmsman during the exercise.

During the exercise, one participant sat at the helm steering the lifeboat and one was located in the port side hatch in order to pull up the lifebuoy. A third person was standing up, keeping lookout through the forward hatch. The instructor was standing outside, on the platform in the stern. The remaining three participants were sitting down inside the lifeboat.

After having pulled up the lifebuoy for the first time, the helmsman was to be changed. The boat was stopped and drifting. The person who had just been driving climbed down from the helmsman's chair and went to the port side. The person who was to take over stood on the starboard side and were supposed to climb up from there to the helmsman's chair, but felt that there was a handle in the way and decided to instead walk round and climb up from the port side. The boat had limited space inside and, in order to allow this person to get over to the port side, those who were sitting in the stern had to get up on the benches in order to make room. Once over on the port side, the new helmsman would climb up to the helmsman's chair, but at that moment the lifeboat heeled heavily to port, so much so that water began streaming in over the edge of the open side hatch.

The person who was sitting in the side hatch had to throw himself out into the sea and the instructor who was standing outside in the stern fell into the water. The person who was sitting closest to the stern hatch decided to dive out through it and his inflatable life jacket inflated immediately afterwards. Others scrambled out onto the boat's superstructure through the starboard side hatch and the hatch in the bow. Aside from the three people who ended up in the water, the others were able to cling to the lifeboat, which was now lying with a heavy list to port and half filled with water.

Figure 2. At the time of the accident. Image: Safetygruppen & Navigationsgruppen Sverige AB.

Two boats, one from the training centre and a boat that was temporarily visiting the centre, were able to get out to the lifeboat quickly in order to provide assistance. The participants and the instructor were able to climb over to these boats. The lifeboat was then towed back to the davit to be hoisted up later on.

No one suffered any physical injuries.

The approximate location of those on board at the time of the accident.

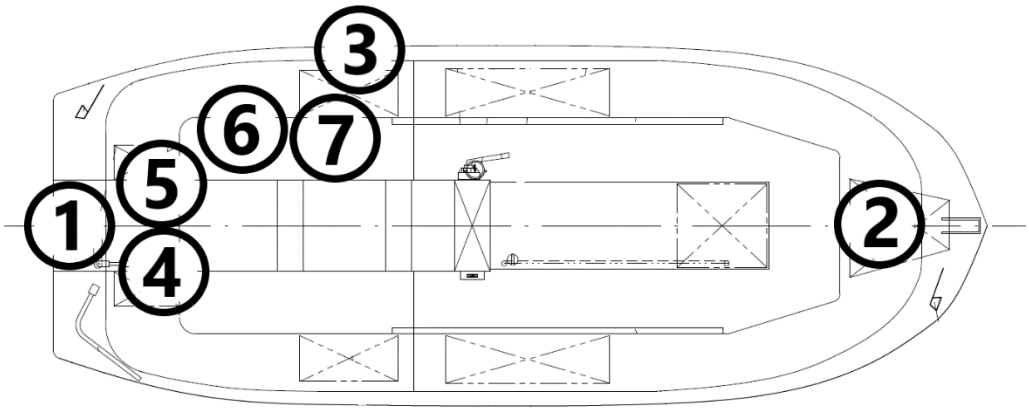

Figure 3. The location of those on board. Image: Viking Life-Saving Equipment A/S. Markings showing where people were located added by SHK:

Person 1 was the instructor and was standing on the small platform in the stern. Fell overboard.

Person 2 was standing with legs wide apart, with the upper body coming out through the forward hatch.

Person 3 was sitting down with the upper body coming out through the port side hatch. Threw himself into the water when the lifeboat heeled over.

Person 4 was standing up in order to let Person 7 pass.

Person 5 was standing up in order to let Person 7 pass. Dived out through the stern hatch and ended up in the water.

Person 6 had just climbed down from the helm and was standing up with feets on the floor in order to let Person 7 pass.

Person 7 was to take over as the new helmsman, was standing up and was supposed to to climb up into the chair from port.

1.2 Damage to the vessel

The lifeboat suffered no damage.

1.3 Accident site

The accident took place around one hundred metres from the training centre in Frihamnen harbour in central Stockholm.

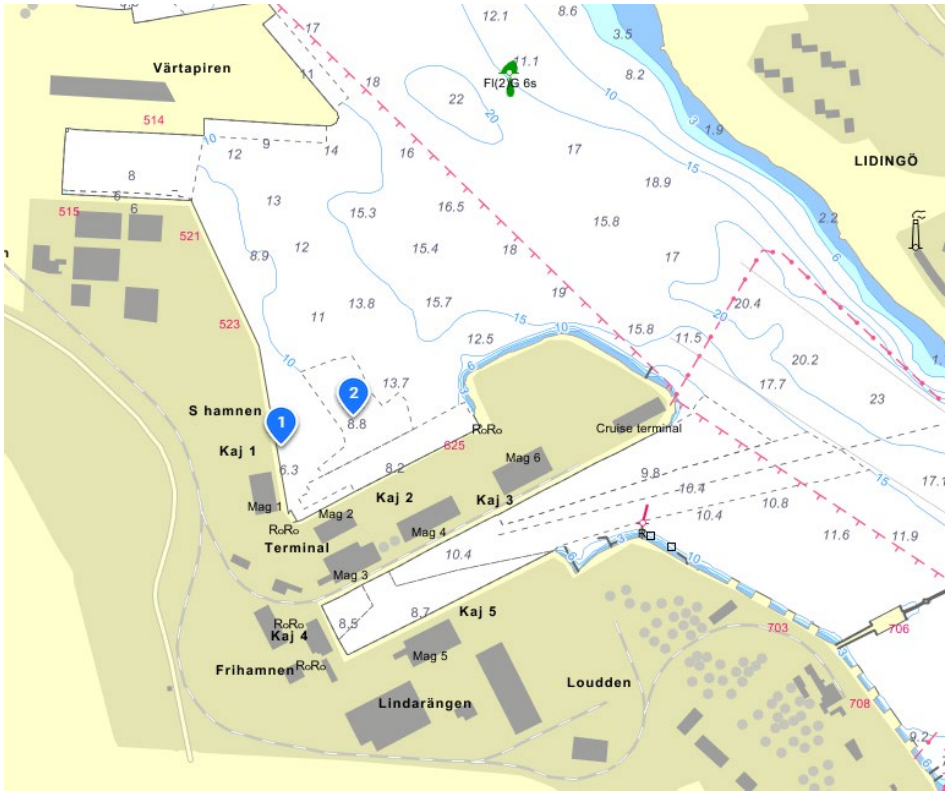

Figure 4. Frihamnen harbour in Stockholm. Point 1 marks the location of the training centre and point 2 the approximate position where the accident took place. Image from Eniro, https://kartor.eniro.se/?c=59.347994,18.121777&z=15&l=nautical&d={%22m%22:[[59.344942,18.117743,null,0],[59.345467,18.120275,null,0]]} Map data © Swedish Maritime Administration permit no. 22-00642.

Figure 5. The barge with the training centre.

1.4 The lifeboat

Figure 6. The lifeboat, a Viking-Norsafe JYN 57T mk I.

The lifeboat is of a totally enclosed model with side hatches and is intended for bulk carriers and tankers. Around 160 units of this model of boat have been built and it has been on the market for over 20 years. This version of the lifeboat has been manufactured since 2009. Before this, there was a version for 28 persons. The rules for weight per person were changed in 2010, from 75 kg to the current 82.5 kg, and the number of spaces was reduced at that time to 26. In conjunction with this, the boat model underwent new testing and certification.

There is a four-point seat belt at each seat. When the lifeboat is upside down, the seat belt will support a person who weighs up to 100 kg.

The lifeboat in question is a tanker version. It is equipped with a sea water pump that supplies an exterior sprinkler system with water in order to cool the hull and superstructure if the boat is forced to drive through a burning oil slick.

The hull and superstructure are made of glass-fibre reinforced polyester with an intermediate layer of polyurethane foam.

The lifeboat is self-righting, which means that if the boat overturns, it does not remain upside down. The self-righting properties persist, even if the lifeboat is filled with water and is fully loaded, provided all those on board are secured in place with the seat belts. The general description of the lifeboat in the manufacturer's operation and maintenance manual[1] stresses the importance of all those on board being seated at all times in their designated places with their seat belts fastened.

The lifeboat is totally self-righting even fully loaded with persons and flooded. Therefore it is important that all passengers fasten their seat belt and remain in their seats at all times.

There is a fuel tank in the bow that has the capacity to supply the engine with fuel for operating at full power for at least 24 hours. The lifeboat is built and certified in accordance with the international rules that apply by virtue of the LSA Code[2].

The lifeboat is also approved for use as a rescue boat, i.e. a boat that is built to be used to rescue people in distress and to organise and lead survival craft.

The operation and maintenance manual contains instructions for rescuing survivors in the water. The instructions state that when conducting a maritime rescue, two people shall be posted at one of the side hatches and one person acting as helmsman. No additional instructions in respect of manning, cargo or handling during a maritime rescue are provided.

Figure 7. The helm.

[1] Operation & Maintenance Manual, Doc. No. MAN-0291.
[2] The International Life-Saving Appliance Code. International regulations concerning life-saving equipment on commercial vessels.

1.5 The people on board

There were seven people on board at the time of the occurrence, one instructor and six course participants.

The instructor was 49 years old and had been working in rescue services since 2009, including as a rescue coordinator and was a qualified chief fire officer. He had been working at the training centre since November 2020 and had a nautical qualification, ship's officer, class VIII

The course participants were deck or engineering officers.

1.6 The companies involved

Safetygruppen & Navigationsgruppen Sverige AB

The company offers courses in safety and navigation for the shipping industry. The business operates from Frihamnen harbour in Stockholm, in premises located on a converted barge that has been given the name *Stockholm Training Port 203*. The barge, which was built in 1979, is around 75 metres long and 21 metres wide and, in its original condition, was able to carry 4,500 tonnes. The barge was converted to adapt it to its current use in 2020. The courses are approved by the Swedish Transport Agency and comply with the requirements set out in the STCW Convention[3].

VIKING Life-Saving Equipment A/S

VIKING Life-Saving Equipment A/S is a Danish company that operates world-wide and manufactures and sells life-saving equipment for the shipping industry. In 2018, the company took over the Norwegian manufacturer Norsafe AS, which specialised in lifeboats. Marketing of lifeboats takes place through the brand Viking Norsafe. Lifeboats are manufactured in Norway, Greece and China.

1.7 Weather

The weather at the time of the occurrence was calm, with wind of around 1–3 m/s and good visibility. The water temperature was around 5°C.

1.8 Regulatory framework

1.8.1 The SOLAS Convention[4] and the LSA Code

The basic provisions concerning maritime safety are contained in the SOLAS Convention, which is a regulatory framework linked to the International Maritime Organization (IMO[5]). The convention contains provisions governing how vessels are to be built and equipped and

[3] International Convention on Standards of Training, Certification and Watchkeeping.
[4] International Convention for the Safety of Life at Sea, 1974.
[5] International Maritime Organization, the UN body for shipping and maritime safety.

encompasses, amongst other things, rules on stability and life-saving. The more detailed provisions concerning life-saving equipment are included in the LSA Code, which is part of the SOLAS Convention (SOLAS Chapter III, Regulation 34).

Under the LSA Code, the following applies.

Stability of lifeboats

For lifeboats on passenger vessels, the maximum permitted number of persons on board is calculated on the basis of an average weight per person of 75 kg. For lifeboats on cargo vessels, the average weight is given as 82.5 kg (LSA 4.4.2.2).

A lifeboat shall be stable and have a positive metacentric height (GM) when the boat is loaded with half of the maximum number of persons permitted on the boat when those on board are sitting in their normal positions on one side of the boat's centreline (LSA 4.4.5.1). A lifeboat shall have a minimum freeboard of 1.5 per cent of the length of the lifeboat or 100 millimetres, whichever is greater (LSA 4.4.5.2.1).

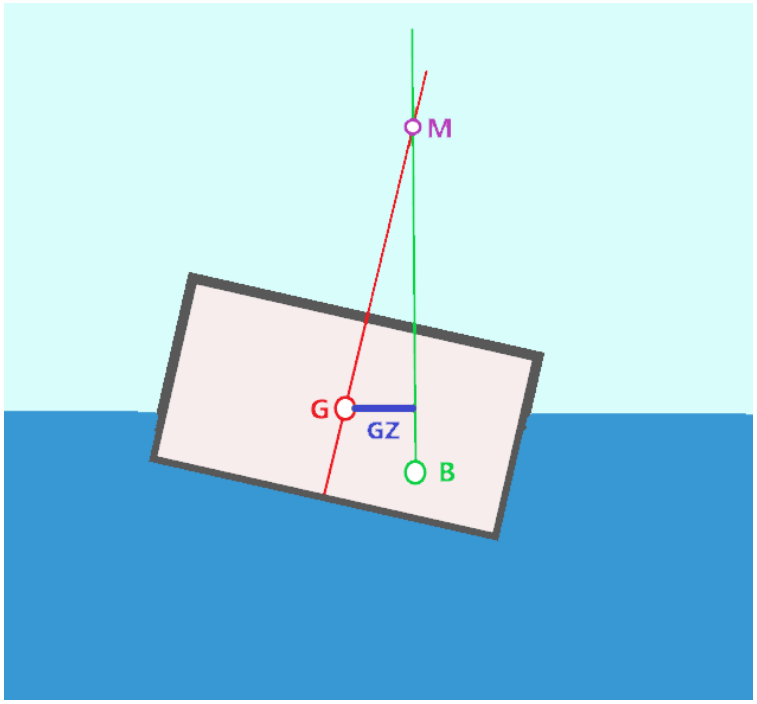

Figure 8. The metacentric height **GM** is the distance between a vessel's centre of gravity **G** and its metacentre **M**. The metacentre is formed when the direction of the object's heeled centre of gravity crosses the vertical line originating from its centre of buoyancy **B**. The distance between **G** and **M** is directly proportional to the stability of the object. If **M** is below **G**, the vessel is unstable. **GZ** is the righting lever.

4.4.5.1 All lifeboats shall be stable and have a positive GM value when loaded with 50% of the number of persons the lifeboat is permitted to accommodate in their normal positions to one side of the centreline.

4.4.5.2 Under the condition of loading in paragraph 4.4.5.1:

.1 each lifeboat with side openings near the gunwale shall have a freeboard, measured from the waterline to the lowest opening through which the lifeboat may become flooded, of at least 1.5% of the lifeboat's length or 100 mm, whichever is the greater; […]

The lifeboat is 5.7 metres long, which means that the freeboard may not be less than 100 millimetres.

The provisions concerning stability also contain a requirement regarding maximum permitted list when the boat is loaded with half of the maximum number of people permitted on the boat when those on board are sitting in normal positions on one side of the boat's centreline. However, the provisions only apply to lifeboats without openings near the gunwale. A requirement of a maximum permitted list of 20 degrees applies to these. There are no requirements regarding maximum permitted list for lifeboats with side openings near the gunwale (LSA 4.4.5.2.2).

4.4.5.2 Under the condition of loading in paragraph 4.4.5.1:

.1 […]

.2 each lifeboat without side openings near the gunwale shall not exceed an angle of heel of 20° and shall have a freeboard, measured from the waterline to the lowest opening through which the lifeboat may become flooded, of at least 1.5% of the lifeboat's length or 100 mm, whichever is the greater.

The lifeboat type in question has side openings near the gunwale and the list can therefore exceed 20 degrees without breaching the LSA Code.

Under LSA 4.4.1.8.2 an enclosed lifeboat that has a capacity of 24 persons or more shall have a minimum interior height of 1.7 metres. As the same height requirement applies to all lifeboats within the capacity segment, this means that the centre of gravity is shifted upwards the smaller the lifeboat is, which affects the stability properties.

Equipment

The LSA Code contains relatively detailed provisions concerning the equipment on lifeboats. In addition to certain equipment of a more technical nature (e.g. flares, tools, sea-anchor etc.), a lifeboat shall carry three litres of drinking water and 500 grammes of food per person (LSA 4.4.8).

The combined weight of the drinking water, food and equipment that shall be carried on a lifeboat approved for 26 people is approx. 140 kg. If the boat is fully fuelled, there is also 170 litres of diesel, which weighs approx. 140 kg.

Lifeboats for training purposes are often used without the stipulated equipment and that was also the case in this occurrence.

Rescue boats

Under SOLAS Chapter III, Regulation 31, each cargo vessel must have at least one rescue boat. The rules governing how a rescue boat is to be constructed are contained in LSA 5.1. There are no specific stability requirements for rescue boats other than those that apply to lifeboats. A lifeboat may be approved for use as a rescue boat if it meets the requirements in LSA 5.1 and has a length of between 3.8 and 8.5 metres.

5.1.1.7 Rescue boats shall have sufficient mobility and manoeuvrability in a seaway to enable persons to be retrieved from the water, marshal liferafts and tow the largest liferaft carried on the ship when loaded with its full complement of persons and equipment or its equivalent at a speed of at least 2 knots.

5.1.1.12 Every rescue boat shall be so arranged that an adequate view forward, aft and to both sides is provided from the control and steering position for safe launching and manoeuvring and, in particular, with regard to visibility of areas and crew members essential to man-overboard retrieval and marshalling of survival craft.

1.8.2 Marine Equipment Directive

The Marine Equipment Directive[6] is a common regulatory framework for EU member states, the aims of which include improving maritime safety through consistent application of the international instruments regarding marine equipment, including the SOLAS Convention. Another of the aims of the directive is to ensure free movement of marine equipment within the EU.

The European Commission sets out in an implementing regulation what requirements in the international instruments are to be met.[7] For lifeboats and rescue boats, the implementing regulation refers to the provisions of the SOLAS Convention.

A product that has been tested in accordance with the directive in an EU member state may be placed on an EU vessel, regardless of which member state's flag the vessel is flying. A product that is approved in accordance with the directive bears a "wheel mark", a symbol with a stylised ship's wheel.

The assessment of whether a product meets the requirements of the directive is done by a "notified body". The member states have to appoint a notifying authority or accreditation body for the assessment

[6] Directive 2014/90/EU of the European Parliament and of the Council of 23 July 2014 on marine equipment and repealing Council Directive 96/98/EC.
[7] Commission Implementing Regulation (EU) 2021/1158 of 22 June 2021 on design, construction and performance requirements and testing standards for marine equipment and repealing Implementing Regulation (EU) 2020/1170.

and monitoring of the notified bodies. The Swedish Board for Accreditation and Conformity (Swedac) is the notifying authority in Sweden.

The directive has been implemented in Swedish law through the Marine Equipment Act (2016:768) and the Marine Equipment Ordinance (2016:770). The Swedish Transport Agency exercises market surveillance and other supervision pursuant to the act.

Under Section 4 of the Marine Equipment Act, marine equipment must meet the requirements that apply by virtue of directly applicable legal acts that have been issued by virtue of the directive. Section 8, third paragraph of the Marine Equipment Ordinance states that the Swedish Transport Agency shall inform the European Commission and other member states when marine equipment is deemed to constitute a risk to maritime safety, health or the environment, despite meeting the requirements referred to in Section 4 of the Marine Equipment Act.

The lifeboat model in question has a type approval certificate with the number MEDB000036M, issued by the notified body DNV AS.

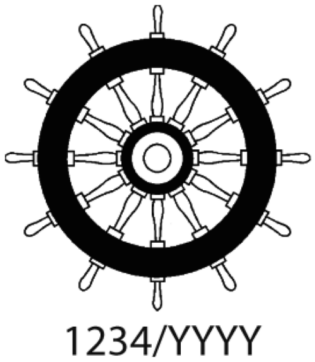

Figure 9. Example of a wheel mark on a product approved in accordance with the directive. Image from the Swedish Transport Agency. 1234 = The code for each Notified Body. YYYY = The year of approval

1.9 Tests and examinations

1.9.1 Manoeuvring tests

SHK has conducted manoeuvring tests with the lifeboat in order to assess its properties in the water.

The lifeboat was launched with four people on board. Three people sat on the benches inside the boat and one person sat at the helm. Sharp turns were performed at full speed, 6 knots, and the list was measured. The highest recorded list was measured at approx. 20 degrees. All hatches except the upper most at the helm were kept closed during the test.

Figure 10. Picture from manoeuvring tests. Four people, including a helmsman, were on board. A sharp starboard turn was performed at a speed of 6 knots.

1.9.2 Load test

In order to assess whether the lifeboat met applicable requirements in the LSA Code regarding stability and freeboard (LSA 4.4.5), SHK, in collaboration with Saltech Consultants AB, has conducted a load test of the boat. Representatives from the manufacturer of the lifeboat and staff from the training centre also participated when these tests were performed.

The load test was conducted using eleven weight packages each weighing 80 kg placed in each seat on the port side of the lifeboat. One person (80 kg) was placed at the helm and one person (93 kg) was placed in the foremost of the three seats on the bench in the centreline. Five weights each weighing 20 kg were placed on the floor close to the centre in along the keel line in order to simulate the weight of provisions, water and other equipment.

A maximum list of 40 degrees and a freeboard of 110 millimetres were measured during the test.

It was established that even very small movements by the two people on board affected the size of the list.

Figure 11. The list during the load test.

Figure 12. Port side

Figure 13. Picture from inside the lifeboat during the load test.

Inclining test

An inclining test was conducted in order to determine the lifeboat's vertical centre of gravity. A pendulum consisting of a weight suspended from a piece of string was hung in the lifeboat's centreline. The weight was attenuated by being suspended in a viscous liquid. One or two steel weights were then moved a set distance to starboard and port, respectively. After each movement of the steel weights, the list was read by means of the pendulum. The length of the pendulum was 2,070 millimetres. A total of eleven weight movements were conducted. Calculation of the vertical position of the centre of gravity and deductions for weights to be removed were made on the basis of both weighings. The results are reported in Appendices 1 and 2 to the appended stability investigation.

1.10 Stability investigation

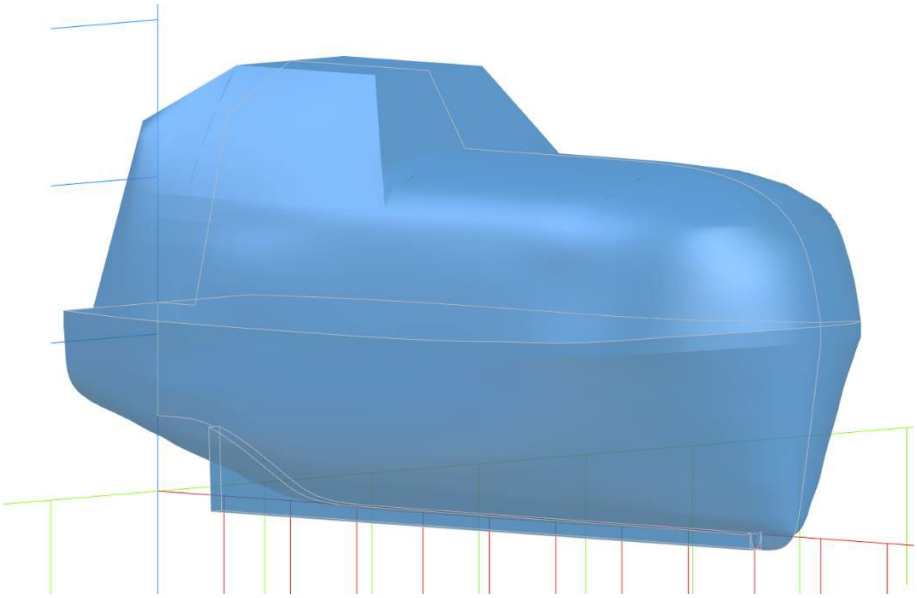

Figure 14. The digital model used as a calculation model for the stability investigation.

Saltech Consultants AB has, on behalf of SHK, conducted a theoretical stability investigation on the lifeboat (see Appendix).

The investigation has used data from the load and inclining tests as a basis. Data from the manufacturer has also been used. This includes coordinates from the plans for the lifeboat.

In order to obtain correct data for the calculations, interviews have been held with the people on board at the time of the occurrence, and their height, weight and location in the lifeboat have been established.

The stability properties, including the vessel's centre of gravity along the keel line, are dependent on the weight of the vessel. According to the manual for the lifeboat type, the weight of the boat without passengers but including the stipulated equipment[8] is 2,705 kg. To assess any discrepancies between data from the manufacturer and the actual weight of the boat, the boat has been weighed by means of crane scales. The weight has also been determined by determining the boat's draught in the sea in order to compare the theoretical calculation models with the lifeboat's actual draught.

The weight has been determined using the crane scales at 2,633 kg. The complete values from the weighings are reported in the appended stability investigation.

[8] See section 1.8.1.

In order to implement the stability investigation, a calculation model has been produced with the help of the software NAPA. Various physical properties have been applied to the model with the help of the loading and stability tests that were conducted and data concerning the lifeboat's weight. It has then been possible to calculate the stability properties theoretically under various loading conditions. The circumstances of the stability investigation are described in more detail in the appendix.

The following loading conditions were used in the calculations.

DESIGNATION	EXPLANATION
LK0	The lifeboat's lightweight condition.
LK1	Loading condition as per load test in the LSA Code where half of the number of passengers are seated in allocated places.
LK2	Loading condition as per supplied information about the location of people at the time of the accident.
LK3	Loading condition similar to **LK2** with people on board placed in the centreline.
LK4	Fully loaded lifeboat with a maximum number of people seated in each allocated place.
LK5	Loading condition where one person is placed seated in the helmsman's chair and two people are positioned at the hatch and are lifting in a third person from the water. This condition can be associated with a maritime rescue.
LK6	Loading condition where three people are sitting in designated places, one person is seated in the helmsman's chair, one is posted as a lookout in the bow and two people are posted at the side hatch.
LK7	The people are placed as in **LK6** but are lifting in an eighth person out of the water.

The investigation indicates that the stability properties deteriorate the fewer people are loaded in the lifeboat. The worst stability calculated was under loading condition LK5, with extreme lists and a high risk of the lifeboat to heel over or water coming in through the side openings. A risk of large angles of heel was also calculated under loading condition LK7.

In summary, the stability investigation shows while the lifeboat is able to meet the stability and freeboard requirements in the LSA Code, it does have a small stability margin where small forces generate large

angles of heel. This is especially the case when the lifeboat is lightly loaded with few people on board.

1.11 Previously conducted tests on the lifeboat model

The change in the regulations concerning prescribed weight per person in 2010, from 75 kg per person to the current 82.5 kg per person, necessitated a modification to the lifeboat type. The capacity was reduced from 28 to 26 people. The total weight of the maximum permitted number of people on board increased slightly, from 2,100 kg to 2,145 kg. New stability tests were required for approval of the lifeboat type. At that time, the freeboard was measured at 140 millimetres and the list at 34 degrees.

1.12 Similar occurrences

During the investigation, SHK has searched for information about accidents and incidents that have been reported in accident databases in the EU, USA and Australia. A total of 583 reported accidents or incidents have been identified. None of these occurrences involved lifeboats that filled with water or capsized.

Figure 15. One of the three lifeboats that were tested by Chalmers University of Technology. The lifeboat in the picture is of another make than the one in question. Image from Chalmers Technical University, Report SK-17/219.

In 2017, an occurrence took place at a training facility at Chalmers University of Technology that involved a lifeboat of a similar type demonstrating unstable tendencies while in use. As a consequence of this occurrence, and within the scope of a diploma thesis[9], load tests and stability calculations were performed on three different lifeboats. The load test was conducted using weights equivalent to half of the permitted number of passengers on one side, i.e. in accordance with the requirements in the LSA Code. According to the report, the tests

[9] https://odr.chalmers.se/handle/20.500.12380/248907

showed that one of the lifeboats did not meet the requirement of a minimum freeboard of 100 millimetres. It is notable that the test was conducted using bags of water as weights, the shape and centre of gravity of which changed shape as the list increased, which may have affected the results.

2. ACTIONS TAKEN

Safetygruppen & Navigationsgruppen Sverige AB

Immediately after the accident, the training centre informed the manufacturer of the lifeboat about the occurrence. The boat was sent back to the manufacturer in Norway after SHK's investigations.

VIKING Life-Saving Equipment A/S

On site in Norway, the manufacturer has performed its own calculations of the lifeboat's stability. These calculations indicate somewhat better stability when compared with the calculations performed by Saltech Consultants AB on behalf of SHK.

To compensate for the fact that the lifeboat is being used without basic equipment, the manufacturer has moulded 300 kg of extra ballast into the boat. In addition, the capacity of the lifeboat in question has been reduced from 26 to 16 people. The aim of these adaptations is to improve the lifeboat's stability properties during training activities.

The manufacturer has also sent out a *technical message* to the company's service centres in order to get these to inform training centres to which they have supplied lifeboats. The manufacturer also plans to perform similar modifications to all lifeboats that have been supplied for training purposes. Lifeboats that are intended for use only for training activities will in future be modified at the time of manufacture, with permanent ballast and reduced capacity. In the technical message, the manufacturer also recommends the following.

- The lifeboat shall be manoeuvred with closed hatches and those on board shall sit in their designated places in the lifeboat with their seatbelts fastened.
- Only a limited number of people should be permitted to move about when the roles of those on board are changing, if the boat is to be hooked onto the davit or if a person is to be rescued from the water.
- The manufacturer advises against standing or sitting outside of the lifeboat and from turning the lifeboat sharply at full speed.

3. ANALYSIS

3.1 Fundamental aspects of the sequence of events

In order to establish the cause of the accident and answer the question of what can be done to prevent similar occurrences in the future, the following areas have been identified as of particular relevance to the analysis.

- What were the lifeboat's stability properties?
- How did the handling of the boat affect the sequence of events?
- Are the regulations concerning the stability of lifeboats fit for purpose?
- Overall assessment – what measures should be taken in order to reduce the risk of similar occurrences?

3.2 Stability of the lifeboat

The stability of the lifeboat has been investigated within the scope of the investigation. This investigation has taken the form of stability, loading and manoeuvring tests, as well as simulations of the stability of the lifeboat under various loading conditions. The tests show that the lifeboat complied with applicable stability requirements but that relatively large angles of heel arose during certain manoeuvres under certain loading conditions. During the loading test, the freeboard was measured at 110 millimetres and the largest list at 40 degrees. These results are within the permitted values but indicate that there can be small margins before there is a risk of water coming in through any of the side hatches if the lifeboat is being manoeuvred with the hatches open.

The modelled stability calculations, both those of SHK and those of the manufacturer, show that the lifeboat complied with the requirements in the LSA Code for a positive metacentre value (GM) and a freeboard of at least 100 millimetres under the conditions specified in the regulations. The two stability calculations have somewhat diverging results, with the manufacturer's calculation model indicating somewhat better stability. The difference may be explained by factors including difficulties to precisely defining the vertical centre of gravity in such a small vessel. This means that small variations of the centre of gravity generate noticeable differences in the calculated stability. Nevertheless, the calculations do show that large angles of heel can arise under certain loading conditions, especially when the lifeboat is lightly loaded and with few persons on board.

3.3 Handling

The staff at the training centre were aware that the lifeboat could be perceived as unstable and the course participants had therefore been instructed to take this into account when manoeuvring the lifeboat.

When the lifeboat started listing so much that water began to come in through the side hatch, none of the seven people on board were sitting in the marked seats. The course participants were standing up or moving around inside the lifeboat in order to allow the helmsman to be changed. The instructor was standing on the platform aft of the superstructure. One further person was located in the forward hatch as a lookout. Accordingly, the location of the participants diverged from the operation and maintenance manual, which states that all those on board shall sit down with their seatbelts fastened at all times. This moved the centre of gravity upwards and to port, which had a negative impact on stability. Under these conditions, only very small dynamic force changes were required in order to generate large angles of heel.

The instructions for rescuing survivors from the water that are included in the operation and maintenance manual (see section 1.4) do not contain any operational limitations with respect to the stability properties. On the contrary, the instructions may give the impression that the lifeboat can be safely manoeuvred with only three people on board. This corresponds to loading condition LK5 in the stability investigation, the results of which were the worst from the perspective of stability. In this context, it should be noted that the instruction in the operation and maintenance manual that all those on board remain seated with their seatbelts fastened is worded in such a way that it gives the impression that this has a view to the self-righting properties of the lifeboat if the boat fills with water and is not a prerequisite for safe handling more generally. This may explain why the staff at the centre had not perceived the text about seatbelt use as essential to safe use in any other context. In addition, the limited internal space in the lifeboat meant that, under certain conditions, e.g. if space needed to be made for a person who has been rescued from the water, it may be necessary for one or more people to stand up to allow the required movements inside the boat.

During the occurrence, one person was located standing through the forward hatch as lookout, which had a further negative impact on stability. The reason for placing the lookout here was the limited view forward from the helm, with the surface of the water only becoming visible around 2.5 boat lengths forward of the boat when the helmsman is seated (see Figure 16). The lookout's job is to guide the helmsman, e.g. to allow a person to be pulled from the water. For comparison, the requirement for larger commercial vessels is that it has to be possible to observe the surface of the water from the bridge no more than two times the length of the vessel forward of the vessel. LSA 5.1.1.12 (see section 1.8.1) states that the view in all directions from the helm of a rescue boat shall be sufficient for man-overboard situations. However, what actually is sufficient is not defined. This provides the scope for subjective assessments. In light of this, the assessment is made that the location of the lookout may be justified under certain conditions, e.g. situations similar to that which prevailed at the time of the accident. In the same way, driving the boat with the side hatches open may be justified under certain conditions.

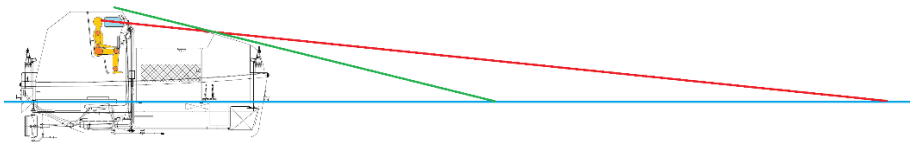

Figure 16. The red line shows the view from the helm and the green line the view for a relatively tall person standing up through the helmsman's roof hatch. Image from Viking Life. The red, blue and green lines have been added by SHK.

3.4 Regulatory framework

The LSA Code has been subject to continual changes over the years. New regulations have gradually been added without there being any overall review of the regulatory framework as a whole. This appears to have led to some inconsistencies in the format of the regulations. One example is that the stability requirements for lifeboats without side openings near the gunwale differ from those that apply to lifeboats with side openings near the gunwale. For enclosed lifeboats without side openings, a list in excess of 20 degrees is not allowed when half of the maximum number of passengers are sitting on one side. However, there is no maximum list requirement for a lifeboat that has side openings near the gunwale, only a requirement for a minimum freeboard of 100 millimetres or 1.5 per cent of the length of the lifeboat. During the loading test performed on the lifeboat, a list of almost 40 degrees was measured, i.e. almost double what would have been permitted had the lifeboat been built without side openings near the gunwale.

The stability requirements are designed for static conditions in calm water and there are no requirements in respect of dynamic forces or heavy weather. The regulatory framework also fails to take into account the fact that each individual person on board a small lifeboat has significantly more impact on its stability, compared with a larger lifeboat.

3.5 Overall assessment

In summary, it can be concluded that the lifeboat complied with the stability requirements under the Swedish Marine Equipment Act (2016:768), which implements the EU directive, and under the LSA Code. However, the sequence of events itself, combined with the modelled stability calculations, show that this type of boat can become unstable under certain loading conditions. If the lifeboat is being manoeuvred with the side hatches open and the lifeboat is lightly loaded with few persons on board, there is a risk of the lifeboat to heel over and taking in water. This is the case even if the lifeboat is carrying the stipulated equipment in the form of water, provisions and fuel (or an equivalent weight of ballast).

It is not unreasonable to envision a scenario in which the lifeboat is being used under live conditions and being manoeuvred in a way similar to the manoeuvres performed at the time of the accident. Examples of

such situations are if the lifeboat is being used as a rescue boat or if a vessel needs to be abandoned quickly and the crew have already jumped overboard. The circumstances during the exercise, where all those on board were standing up at the time of the occurrence, was indeed special. Consequently, similar situations could to some extent be prevented through clearer instructions and training, but in a real situation, especially in heavy weather, there should be no doubt that a lifeboat has sufficient stability for the rescue tasks that may need to be performed, at least within reasonable limits.

The lifeboat was approved for use as both a lifeboat and a rescue boat. In such cases, the same stability and freeboard requirements apply under the directive and the LSA Code, regardless of in which role the boat is being used. When a lifeboat is being used as a rescue boat, for example to rescue a person who has ended up in the water, the boat is typically lightly loaded with few people on board. Therefore, the risks from the perspective of stability that are associated with the lifeboat model in question may be particularly prominent when the lifeboat is being used as a rescue boat.

Even though the results of the investigation take aim at the lifeboat model in question, it is reasonable to assume that other lifeboats of similar types and sizes have similar stability properties. This assumption is supported by the investigations at Chalmers University of Technology in 2017.

Consequently, the stability requirements for lifeboats, and lifeboats that may also be used as rescue boats, should be tightened up such that they also take into account dynamic properties such as heavy seas and maritime rescue with few persons on board. The changes that should be considered include tightening up the requirements for minimum permitted freeboard and introducing a requirement for maximum permitted list under specific conditions for all types of lifeboats, i.e. even lifeboats with side openings near the gunwale. A tightening-up of the regulations should preferably take place on an international level through amendments to the LSA Code.

Stability requirement for lifeboats and rescue boats are also regulated within the EU by the Marine Equipment Directive. By virtue of Section 8, third paragraph of the Marine Equipment Ordinance (2016:770), the Swedish Transport Agency shall inform the European Commission and other member states when marine equipment is deemed to constitute a risk to maritime safety, health or the environment, despite meeting the requirements referred to in Section 4 of the Marine Equipment Act (2016:768).

A safety recommendation should therefore be issued to the Swedish Transport Agency to take necessary measures in order to ensure that the problem of lifeboats' stability is recognised within the EU with the aim of ensuring that the requirements concerning the stability of lifeboats are fit for purpose and do not constitute a risk to maritime safety.

Regardless of if or when a change to the regulatory framework is implemented, lifeboats of this type and with these stability properties

will probably remain at sea for a long time to come. It is therefore vital that people who may end up using lifeboats in their profession are made aware of the risks smaller lifeboats with side openings near the gunwale may be exposed to from the perspective of stability. Consequently, the Swedish Transport Agency should be recommended to act to ensure that instructions are developed at the international level for the safe use of small enclosed lifeboats with side openings near the gunwale with respect to these boats' stability properties. Furthermore, a safety recommendation should be issued to the manufacturer to revise the operation and maintenance manual for the lifeboat type in order to ensure safe operation with respect to the stability properties.

4. CONCLUSIONS

4.1 Findings

a) There were seven people on board during the exercise.
b) All the hatches were open.
c) None of the people on board were sitting in the marked places.
d) The conditions were favourable, with a light wind in sheltered waters.
e) The lifeboat lacked basic equipment in the form of fresh water, provisions etc.
f) When some of the passengers changed places with each other, a change in the centre of gravity arose which led to the lifeboat listing heavily.
g) The edge of the side hatch ended up under the waterline, the lifeboat took on water and heeled over heavily.
h) The people were not able to right the lifeboat themselves and had to be evacuated to another boat.
i) The lifeboat type is approved in accordance with the EU Marine Equipment Directive (wheel marked).
j) The load test demonstrated a freeboard of 110 millimetres and a list of 40 degrees.
k) The lifeboat complies with the stability requirements under applicable regulations.
l) The stability investigation shows that small enclosed lifeboats with side openings near the gunwale can comply with the requirements in the Marine Equipment Act (2016:768) and the LSA Code while simultaneously having loading conditions that have a small stability margin. This is especially the case when the lifeboat is lightly loaded with few persons on board.

4.2 Causes/contributing factors

The accident was caused by the lifeboat's stability properties, which meant that small changes in centre of gravity gave rise to large angles of heel. When those on board moved around in the lifeboat in order to allow the helmsman to be changed, the centre of gravity moved upwards. This led to the boat heeling heavily, taking on water through an open side hatch and heel over. At system level, the accident was caused by insufficient stability requirements for small enclosed lifeboats with side openings near the gunwale.

5. SAFETY RECOMMENDATIONS

The Swedish Transport Agency is recommended to:

- Take necessary measures in order to ensure that the problem of lifeboats' stability is noticed within the EU with the aim of ensuring that the requirements in respect of lifeboat stability are fit for purpose and do not constitute a risk to maritime safety. *(RS 2022:07 R1)*

- Act to ensure that instructions are developed at the international level for the safe use of small, enclosed lifeboats with side openings near the gunwale with respect to these boats' stability properties. *(RS 2022:07 R2)*

VIKING Life-Saving Equipment A/S is recommended to:

- Revise the operation and maintenance manual for the lifeboat type and make the adaptations required in order to ensure safe operation with respect to the stability properties. *(RS 2022:07 R3)*

The measures taken by Safety & Navigationsgruppen Sverige AB in consultation with the manufacturer as a result of the accident are deemed sufficient and SHK is not issuing any recommendations to the company.

The Swedish Accident Investigation Authority respectfully requests to receive, by **14 October 2022 at the latest**, information regarding measures taken in response to the recommendations included in this report.

On behalf of the Swedish Accident Investigation Authority,

John Ahlberk Daniel Söderman

Appendix

Stability investigation performed by Saltech Consultants AB on behalf of SHK.

Document No.
R674-001-01

Technical Report

Revision
3

Date
01/07/2022

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1

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Stability investigation
Lifeboat JYN-57

Background

On 14 April 2021, an exercise was conducted in a small lifeboat in Frihamnen harbour in Stockholm. When two people on board were to change places, the lifeboat listed heavily with people ending up in the water and water entered through an open side hatch.

SALTECH Consultants AB has been commissioned by the Swedish Accident Investigation Authority to conduct a stability investigation in order to establish the stability properties of the lifeboat.

Summary

A calculation model was designed for the lifeboat using the material provided. With the aid of weighings and stability tests, the physical properties could be applied to the model. Various loading conditions were then investigated in order to examine the stability properties.

The conclusion of the investigation is that lifeboats of this type are able to comply with the requirements in the LSA Code but may still be unstable under light conditions.

Revision history

Revision	Description	Date	Sign.
0	First edition	05/10/2021	ASv
1	Comments from SHK introduced	22/11/2021	ASv
2	Update to loading conditions in Appendix 3	23/06/2022	ASv
3	Additional loading conditions (LK6 and LK7) in Appendix 3	01/07/2022	DZ

Table of contents

1 The lifeboat

The lifeboat is a totally enclosed lifeboat of the type JYN-57. The type is approved for 26 persons and is shown in Figure 1–1 below. Its main dimensions are shown below in Table 1.

Table 1 Main dimensions

Length	*5.7 m*
Beam	*2.2 m*
Height	*3.1 m*

Figure 1-1 The lifeboat that was involved in the accident

1.1 Calculation model

A calculation model has been drawn up in the software NAPA in order to analyse the stability properties of the lifeboat. The model is based on the coordinates in the supplied drawings from the manufacturer. There is no confirmation of these coordinates with respect to how well they reflect the actual lifeboat. The origin in the model is the intercept between the transom and the baseline in the central plane, and the forward perpendicular is located in the stem.

Lines emerged from these coordinates that appeared to be uneven, which is why some of the coordinates were corrected in order to get a more even hull in the model. The calculation model in NAPA is shown in Figure 1–2 below.

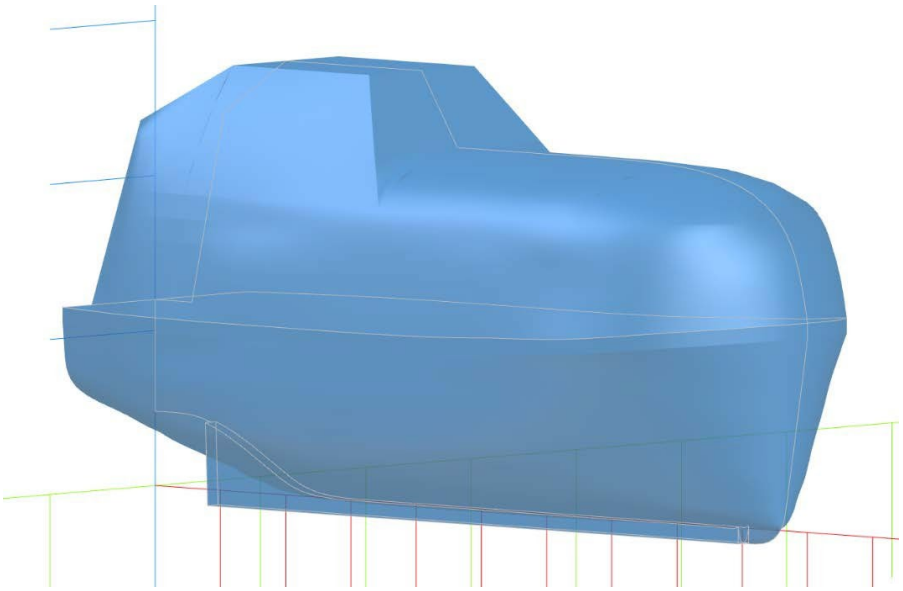


Figure 1–2 Calculation model

The lifeboat has several openings in the form of hatches and vents. Only the two hatches on the sides are included in the model as the hatches in the bow and stern are not limiting to this investigation.

The lifeboat is equipped with a fuel tank in the bow. This is included in the model with the dimensions given in the supplied drawings from the manufacturer.

2 Load test

A load test was conducted on 6 May 2021 in Frihamnen harbour using the lifeboat in question. This was done to establish the stability properties of the lifeboat in relation to the requirements set out in the LSA Code.

The participants during the test were representatives from SHK, Saltech and the manufacturer.

The conditions on the day were unfavourable, with a strong and gusty wind. Consequently, the test was conducted leeward of a high quay.

Figure 2−1 Loading test

2.1 Loading condition

Eleven weight packages each of 80 kg consisting of four 20-kg weights were placed in each marked seat on the port side of the lifeboat. One person (80 kg) was placed in the helmsman's seat and one person (93 kg) was placed in the foremost of the three seats on the bench in the centreline. Five weights each of 20 kg were placed on the floor close to the centre in along the keel line in order to simulate provisions, water and other equipment. Three of them were on the port side and the remaining two on the starboard side.

2.2 Measurement

Under the above loading conditions, it was established that the lower edge of the side hatch was the lowest opening. The vertical distance between this and the surface of the water could not be measured directly as the hatch needed to be closed. This was due to the risk of water coming in. Instead, the surface of the water was measured in relation to a reference point on the hull (lower edge of the rowlock). The distance to the lower edge of the opening could then be measured afterwards in relation to the reference point.

The angle of heel was measured inside the lifeboat by means of accelerometer data from a mobile phone that was placed on the floor and visible to one of the participants in the lifeboat. The angle was measured at 39.7 degrees.

Based on this angle and the reference point on the surface of the water, the vertical distance when the hatch was open could be determined as 110 mm, which is above the minimum margin in the LSA Code of 100 mm.

3 Weighing

Two methods were used to determine the weight of the lifeboat at the time of the accident. The first involved hanging the lifeboat from load cells and the other involved measuring the boat's draught and the calculation model. Weights to be added and removed were checked before the weighings. The procedure for each weighing is presented below.

3.1 Scales

Two load cells were connected between the lifeboat's crane hooks and the davit. The lifeboat was then winched up until it was hanging free of the surface of the water and the values on the load cells could be read. These values are shown in Table 2 below:

Table 2 Readings from load cells

Load cell	***Mass***
Fore	*1,250 kg*
Aft	*1,383 kg*
Total	***2,633 kg***

The longitudinal position of the crane hooks was measured in relation to the transom in order to calculate the longitudinal position of the centre of gravity and is shown in Table 3 below:

Table 3 Position of the crane hooks

Hook	***Forward of the transom***
Fore	*5,480 mm*
Aft	*180 mm*

Based on this, its position before deductions for weights to be removed could be determined as 2,696 mm forward of the transom.

Deductions for weights to be removed are presented in Table 4 below.

Table 4 Weights to be removed at the time of weighing

	Mass	*Lever from transom*	*Force*
Weighing	*2.633 tonnes*	*6.696 m*	*7.099 tf*
Tank contents	*-0.1 tonnes*	*5.117 m*	*-0.512 tf*
Lightweight at the time of weighing	***2.533 tonnes***	***2.600 m***	***6.587 tf***

3.2 Draught measurement

For the second weighing method, the lifeboat's floating position, hull geometry and the density of the water was used to determine its displacement.

The location in which the draught was measured was the same as that of the load test, with the same quay as a windbreak.
The floating position of the hull was measured between the lower edge of both cleats in the bow and stern and the surface of the water. The distances are shown below in Table 5.

Table 5 Draught measurement using cleats

Draught	***Distance***
Bow	*495 mm*
Stern	*193 mm*

The list was determined as 0°. The position of the lower edge of the cleats was measured by means of the supplied drawings from the manufacturer.

The floating position was put into the calculation model and the resulting hydrostatics for the measured density of 1.000 tonnes/m^3 are presented below in Table 6:

Table 6 Hydrostatics

Depth	*0.377 m*
Trim	*-0.324 m*
Displacement	*2.37 tonnes*

Deductions for weights to be removed were then made in accordance with Table 7 where the item *Weights to be added/removed* consist of two heeling weights each of 20 kg, one person of 80 kg and a trough of fluid weighing 10 kg.

Table 7 Weights to be removed at the time of weighing

	Mass	*Lever from transom*	*Force*
Weight during stability test	*2.37 tonnes*	*2.659 m*	*6.304 tf*
Weights to be added/removed	*-0.13 tonnes*	*1.840 m*	*-0.239 tf*
Tanks	*-0.10 tonnes*	*5.117 m*	*-0.512 tf*
Lightweight with draught measurement	***2.141 tonnes***	***2.594 m***	***5.554 tf***

4 Inclining test

After the weighing, an inclining test was conducted in order to determine the vertical centre of gravity.

The test was conducted in the same manner as the tests mentioned previously.

A pendulum with a length of 2,070 mm was used to determine the deflections. A total of eleven weight movements were conducted. The pendulum was attenuated using a viscous fluid in a trough.

Calculation of the vertical position of the centre of gravity and deductions for

weights to be removed were made on the basis of both weighings and are reported in Appendix 1 and Appendix 2.

The resulting lightweights are presented in Table 8 below.

Light weight	*Method*	*Mass*	*VCG [from the baseline]*	*LCG [from the transom]*	*TCG [from the centreline]*
A	*Draughts*	*2.141 tonnes*	*0.936 m*	*2.594 m*	*0 m*
B	*Scales*	*2.533 tonnes*	*1.013 m*	*2.600 m*	*0 m*

5 Loading conditions

The following loading conditions have been investigated for both lightweights in order to examine the stability properties of the lifeboat.

LK0 - The loading condition of the lifeboat.
LK1 - Loading condition as per loading test in the LSA Code where half of the number of passengers are seated in allocated places.
LK2 - Loading condition as per supplied information about the location of people at the time of the accident.
LK3 - Loading condition similar to LK2 with people on board placed in the centreline.
LK4 - Fully loaded lifeboat with a maximum number of people seated in each allocated place.
LK5 - Loading condition where one person is placed seated in the helmsman's chair and two people are positioned at the hatch and are lifting in a third person from the water. This condition can be associated with a maritime rescue.
LK6 - Loading condition with simulated alternative placement at the time of the accident.
LK7 - Loading condition with simulated alternative placement at the time of the accident, and maritime rescue as per LK5.

The people are assumed to weigh 82.5 kg with their vertical centre of gravity located as per TSFS 2009:114 with a height of 300 mm above the seat in a seated scenario and 1,000 mm above the floor when standing. In the loading conditions at the time of the accident the mass of the people is set on the basis of the individuals in the supplied information.

Detailed information about each loading condition is provided in the intact stability report in Appendix 3.

6 Discussion and conclusions

When comparing both the lightweights LK0_A and LK0_B, it is established that the mass differs by 392 kg, which is a significant difference. This is thought to be due partly to sources of error when making draught measurements, which were affected by the difficult conditions and geometric

differences between the calculation model and the actual lifeboat. Other sources of errors can be measurement of the hooks and the reference points for the draught measurements.
Based on these sources of error, it is not possible to say directly that the stability properties in the calculations reflect those of the actual lifeboat.

The load test of the actual lifeboat gave results that comply with the LSA Code. However, it must be pointed out that the weight groups were somewhat light at 80 kg each, compared to the weight of 82.5 kg in the code, and that the weights tended to give a larger moment as they moved out slightly when the boat was listing heavily. A mass of 82.5 kg was used in the calculation model and the weights are fixed in the coordinate system. The results for LK1_A and LK1_B differ; LK1_A complies with the margin set out in the LSA Code, while LK1_B does not. This shows the lifeboat has a vulnerability where a small difference in load leads to large impacts on factors that are checked for regulatory compliance.

The loading conditions at the time of the accident show a resulting list of 13.9˚ for LK2_A and 19.0˚ for LK2_B. At these large angles, it can be difficult for a person to remain in their position, which can lead to a larger moment of heel and list. The GZ curve for both of the conditions shows that the righting lever is only 3 cm for LK2_A and 1 cm for LK2_B at angles larger than the equilibrium.

For loading conditions LK3_A and LK3_B, it can be concluded that the GZ curves have a similar shape to the respective cases in LK2_A and LK2_B yet shifted more vertically. Consequently, there is a larger stability margin when the lifeboat is not listing.

LK4_A and LK4_B display the conditions that are deemed to have the best properties with respect to stability. When the lifeboat is fully loaded and all passengers are sitting in their designated places, the centre of gravity is so low that the righting lever increases as the angle of heel increases. This requires passengers to be strapped in as they are a substantial load that can easily be displaced and generate a large moment of heel.

The final scenario with LK5_A and LK5_B displays major differences. For LK5_A the righting lever is small but still present and at the equilibrium, and for LK5_B the equilibrium is long after the openings have reached the surface of the water. The GZ curve is almost horizontal for both loading conditions, which leads to the large difference in equilibrium. This is a scenario that generates a major risk of capsizing or water entering through the openings.

The loading conditions LK6 and LK7 demonstrate a simulated alternative placement of the people at the time of accident and how this would have affected stability. The alternative placement results in some improvement to stability.

In summary, it can be concluded that the lifeboat is able to comply with the LSA Code but also can have conditions in which there is small stability margin. With this low stability margin, small forces are able to generate large angles of heel. This is especially the case when the lifeboat is lightly loaded with few persons on board.

Appendix 1

Appendix 1; GM calculation and weight and centre of gravity calculation

[SHK LIFEBOAT Lightweight A]

Weighing and displacement

L1	5.7	mm	[distance bow draught measurement forward of FP]
L2	2.85	mm	[distance midships draught measurement forward of L/2]
Displ. corr. for trim and dens.	2.371	tonnes	

Pendulum length

Pendulum		Length	Location
	=	2,070 mm	

Pendulum deflection

Measurement	Weight	Mass[tonnes]	P↔SB	Movement [m]	dM [tf]	M total [tf]	Pendulum deflection		GM [m]
							Stern pendulum		
							Deflection [mm]	Angle [rad]	
0									-
1	1	0.02	P	0.76	0.02	0.02	40	0.0193	0.33
2	1&2	0.04	SB	-0.76	-0.03	-0.02	57.5	0.0278	0.46
3	1&2	0.04	P	0.76	0.03	0.02	62	0.0299	0.43
4	1&2	0.04	SB	-0.76	-0.03	-0.02	54.5	0.0263	0.49
5	1	0.02	P	0.76	0.02	0.00	33	0.0159	0.40
6	2	0.02	P	0.76	0.02	0.02	26	0.0126	0.51
7	1	0.02	SB	-0.76	-0.02	0.00	34.5	0.0167	0.38
8	2	0.02	SB	-0.76	-0.02	-0.02	19	0.0092	0.70
9	1&2	0.04	P	0.76	0.03	0.02	58	0.0280	0.46
10	1&2	0.04	SB	-0.76	-0.03	-0.02	60	0.0290	0.44
11	1	0.02	P	0.76	0.02	0.00	25	0.0121	0.53
							GM average:		0.47

Determination of centre of gravity

KMt above BL	1.407	m			
GMt	0.47	m			
Corr. free fluid surfaces	0.00	m	FSM:	0	tf
VCG above BL	0.936	m	GM't	0.47	m
LCG from AP	2.67	m			

Determination of weight and centre of gravity for empty vessel

Mass		Centre of gravity					
Designation	Weight (tonnes)	VCG above BL		LCG from AP		TCG port of CL	
		Lever (m)	Moment (tf)	Lever (m)	Moment (tf)	Lever (m)	Moment (tf)
Weight during stability test	2.37	0.936	2.219	2.659	6.304	0.000	0.000
Weights to be added/removed	-0.13	1.080	-0.140	1.840	-0.239	0.000	0.000
Tanks	-0.10	0.298	-0.030	5.117	-0.512	0.000	0.000
Total	2.141	0.957	2.049	2.594	5.554	0.000	0.000

Appendix 2

Appendix 2; GM calculation and weight and centre of gravity calculation

[SHK LIFEBOAT Lightweight B]

Weighing and displacement

L1	5.7	mm	[distance bow draught measurement forward of FP]
L2	2.85	mm	[distance midships draught measurement forward of L/2]
Displ. corr. for trim and dens.	2.6	tonnes	

Pendulum length

Pendulum	Length	Location
=	2070 mm	

Pendulum deflection

Measurement	Weight	Mass[tonnes]	P↔SB	Movement [m]	dM [tf]	M total [tf]	Pendulum deflection		GM [m]
							Stern pendulum		
							Deflection [mm]	Angle [rad]	
0									-
1	1	0.02	P	0.76	0.02	0.02	40	0.0193	0.30
2	1&2	0.04	SB	-0.76	-0.03	-0.02	57.5	0.0278	0.42
3	1&2	0.04	P	0.76	0.03	0.02	62	0.0299	0.39
4	1&2	0.04	SB	-0.76	-0.03	-0.02	54.5	0.0263	0.44
5	1	0.02	P	0.76	0.02	0.00	33	0.0159	0.36
6	2	0.02	P	0.76	0.02	0.02	26	0.0126	0.46
7	1	0.02	SB	-0.76	-0.02	0.00	34.5	0.0167	0.35
8	2	0.02	SB	-0.76	-0.02	-0.02	19	0.0092	0.63
9	1&2	0.04	P	0.76	0.03	0.02	58	0.0280	0.41
10	1&2	0.04	SB	-0.76	-0.03	-0.02	60	0.0290	0.40
11	1	0.02	P	0.76	0.02	0.00	25	0.0121	0.48
							GM average:		0.42

Determination of centre of gravity

KMt above BL	1.407	m			
GMt	0.42	m			
Corr. free fluid surfaces	0.00	m	FSM:	0	tf
VCG above BL	0.986	m	GM't	0.42	m
LCG from AP	2.70	m			

Determination of weight and centre of gravity for empty vessel

Mass		Centre of gravity					
Designation	Weight (tonnes)	VCG above BL		LCG from AP		TCG port of CL	
		Lever (m)	Moment (tf)	Lever (m)	Moment (tf)	Lever (m)	Moment (tf)
Weight during stability test	2.63	0.986	2.596	2.696	7.099	0.000	0.000
Weights to be added/removed	0.00	1.080	0.000	1.840	0.000	0.000	0.000
Tanks	-0.10	0.298	-0.030	5.117	-0.512	0.000	0.000
Total	2.533	1.013	2.566	2.600	6.587	0.000	0.000

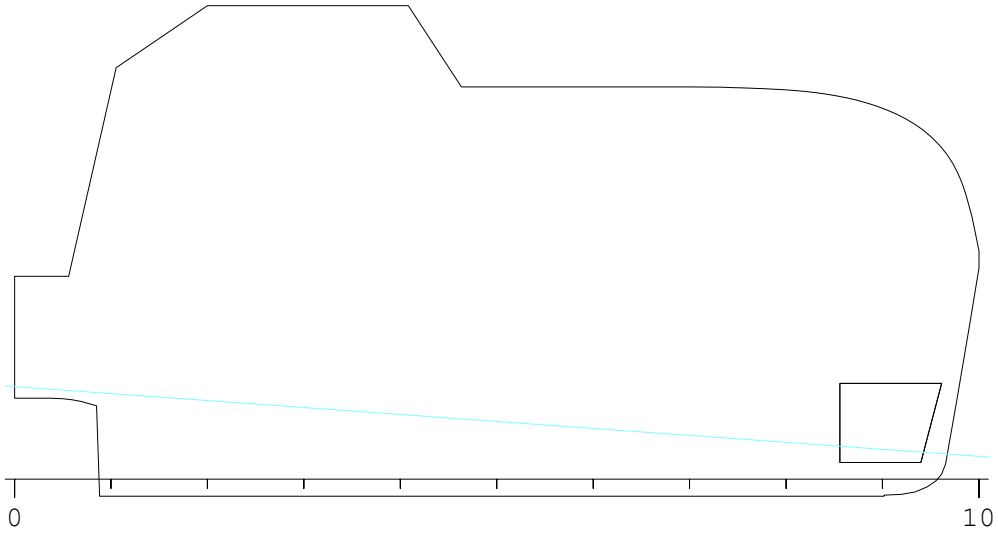
Appendix 3

Summary of loading conditions:

ID	Description	Status
LK0_A	LK0_A, Lightweight condition A.	NOT MET
LK0_B	LK0_B, Lightweight condition B.	NOT MET
LK1_A	LK1_A, Loading test, lightweight A.	NOT MET
LK1_B	LK1_B, Loading test, lightweight B.	NOT MET
LK2_A	LK2_A, Accident, lightweight A.	NOT MET
LK2_B	LK2_B, Accident, lightweight B.	NOT MET
LK3_A	LK3_A, Accident with passengers in CL, lightweight A	NOT MET
LK3_B	LK3_B, Accident with passengers in CL, lightweight B	NOT MET
LK4_A	LK4_A, Max. number of passengers, lightweight A	NOT MET
LK4_B	LK4_B, Max. number of passengers, lightweight B	NOT MET
LK5_A	LK5_A, Maritime rescue in hatch, lightweight A	NOT MET
LK5_B	LK5_B, Maritime rescue in hatch, lightweight B	NOT MET
LK6_A	LK6_A, Accident, alt. placement, lightweight A	NOT MET
LK6_B	LK6_B, Accident, alt. placement, lightweight B	NOT MET
LK7_A	LK7_A, Accident, alt. placement, maritime rescue,	NOT MET
LK7_B	LK7_B, Accident, alt. placement, maritime rescue,	NOT MET

ID	DISP	DW	T	TR	GM	KG
	t	t	m	m	m	m
LK0_A	2.1	0.0	0.342	-0.412	0.520	0.936
LK0_B	2.5	0.0	0.383	-0.407	0.390	1.013
LK1_A	3.5	1.3	0.294	-0.116	0.391	0.896
LK1_B	3.8	1.3	0.266	-0.105	0.308	0.951
LK2_A	2.9	0.8	0.391	-0.493	0.322	1.047
LK2_B	3.3	0.8	0.406	-0.474	0.230	1.093
LK3_A	2.9	0.8	0.420	-0.515	0.322	1.047
LK3_B	3.3	0.8	0.459	-0.507	0.230	1.093
LK4_A	4.5	2.4	0.594	-0.201	0.263	0.946
LK4_B	4.9	2.4	0.630	-0.201	0.204	0.985
LK5_A	2.5	0.3	0.336	-0.444	0.377	1.041
LK5_B	2.9	0.3	-0.261	-0.184	0.272	1.094
LK6_A	2.9	0.8	0.422	-0.268	0.305	1.027
LK6_B	3.3	0.8	0.456	-0.265	0.222	1.075
LK7_A	3.0	0.8	0.388	-0.251	0.283	1.045
LK7_B	3.4	0.8	-0.043	-0.045	0.204	1.090

LOADING CONDITION: LK0_A, Lightweight A.



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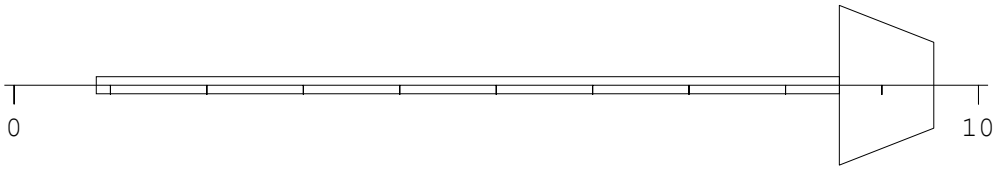

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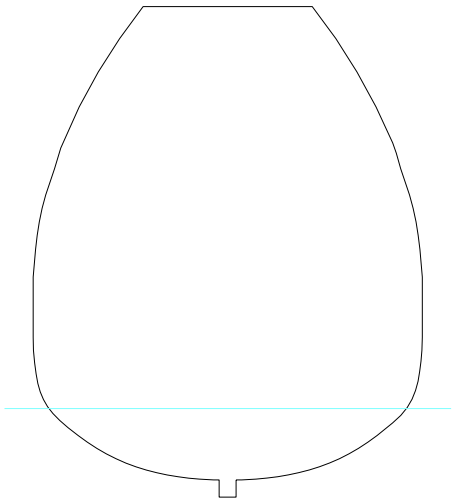

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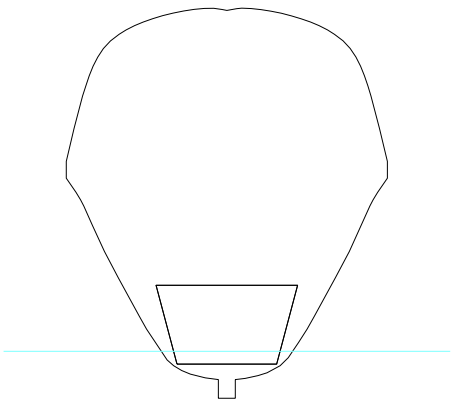

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LOADING CONDITION: LK0_A, Lightweight A.

Lightweight	2.1410	2.594	0.000	0.936
Deadweight	0.0000	0.000	0.000	0.000
Total weight	2.1410	2.594	0.000	0.936

LOADING CONDITION: LK0_A, Lightweight A.

FLOATING POSITION

Draught moulded	0.342	m	KM	1.46 m
Trim	-0.412	m	KG	0.94 m
Heel, PS=+	0.0	deg		
TA	0.548	m	GM0	0.52 m
TF	0.136	m	GMCORR	0.00 m
Trimming moment	-1	tf	GM	0.52 m

STABILITY CRITERIA

Loading condition: LK0_A, Lightweight condition A.

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.053	mrad	0.920	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.080	mrad	0.892	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.027	mrad	0.905	NOT MET
Min. GZ > 0.2	0.200	0.247	m	0.983	OK
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.103	OK
GM > 0.15 m	0.150	0.520	m	1.306	OK

VCG margin

Maximum VCG = 0.89 m
Actual VCG = 0.94 m
VCG reserve = -0.04 m

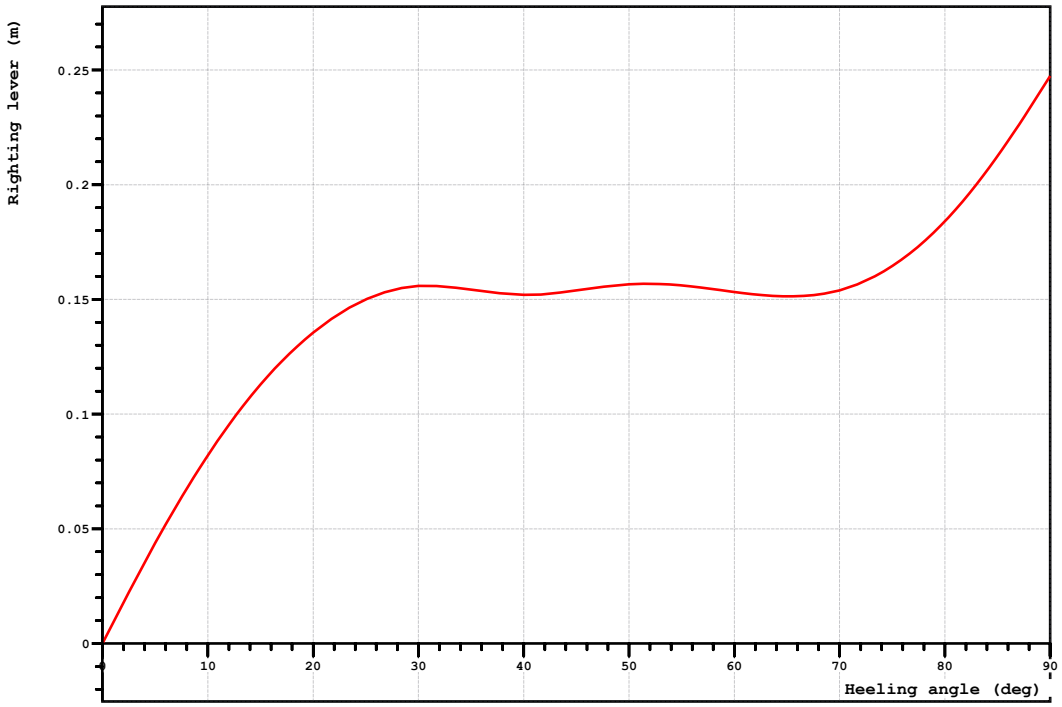
RELEVANT OPENINGS

Loading condition: LK0_A, Lightweight condition A.

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	52.5	0.92
BB2	LOWER EDGE FORE	2.140	1.128	1.360	53.4	0.96
BB3	UPPER EDGE AFT	1.530	0.921	2.110	83.0	1.67
BB4	UPPER EDGE FORE	2.140	0.921	2.110	83.3	1.71
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	0.92
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	0.96
SB3	UPPER EDGE AFT	1.530	0.921	2.110	83.0	1.67
SB4	UPPER EDGE FORE	2.140	0.921	2.110	83.3	1.71

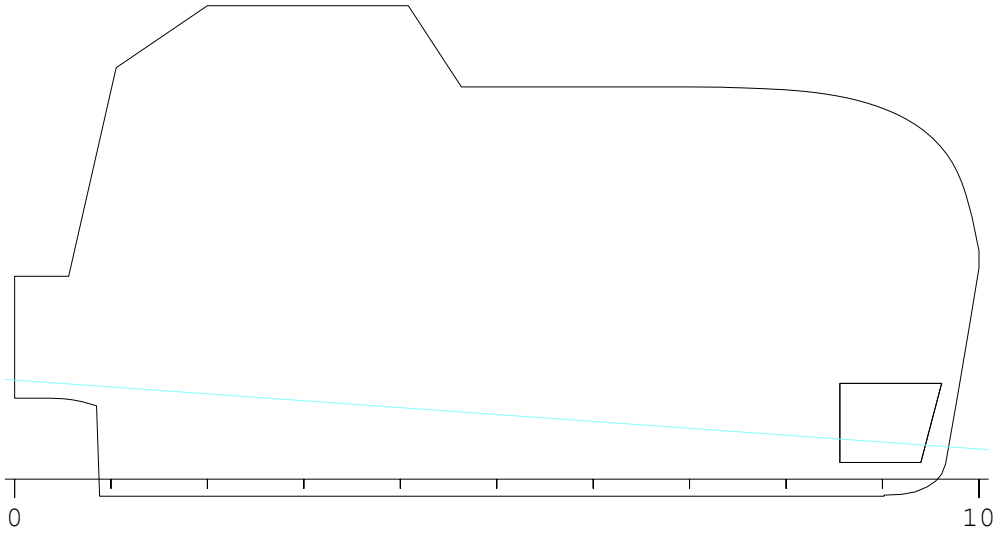
LOADING CONDITION: LK0_A, Lightweight A.

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	0.000	0.000	0.0	0.000
5.0	0.125	0.044	0.002	0.0	0.000
10.0	0.245	0.082	0.007	0.0	0.000
15.0	0.355	0.113	0.016	0.0	0.000
20.0	0.456	0.136	0.027	0.0	0.000
30.0	0.624	0.156	0.053	0.0	0.000
40.0	0.754	0.152	0.080	0.0	0.000
50.0	0.874	0.157	0.107	0.0	0.000
60.0	0.964	0.153	0.134	0.0	0.000
70.0	1.033	0.154	0.160	0.0	0.000
80.0	1.106	0.184	0.189	0.0	0.000
90.0	1.183	0.247	0.227	0.0	0.000

LOADING CONDITION: LK0_B, Lightweight B.



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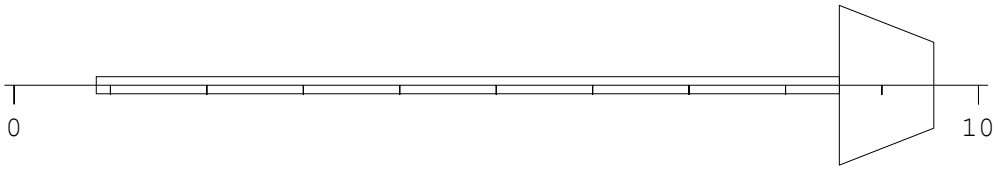

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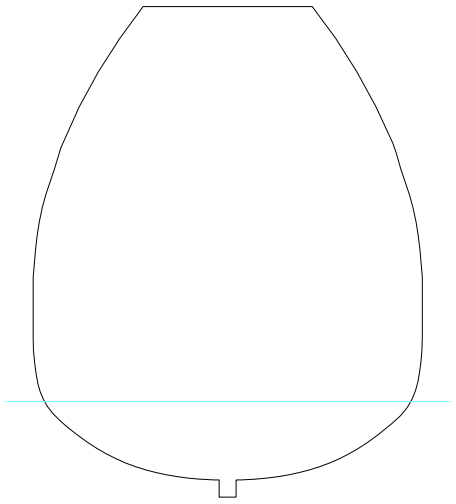

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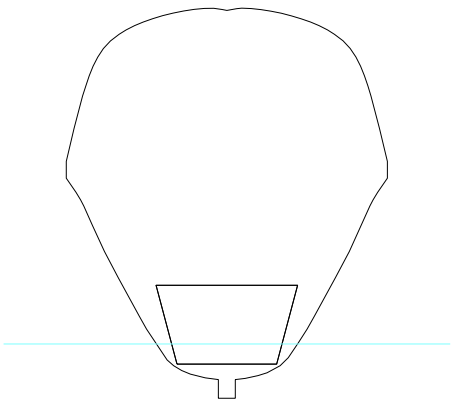

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LOADING CONDITION: LK0_B, Lightweight B.

Lightweight	2.5330	2.600	0.000	1.013
Deadweight	0.0000	0.000	0.000	0.000
Total weight	2.5330	2.600	0.000	1.013

LOADING CONDITION: LK0_B, Lightweight B.

FLOATING POSITION

Draught moulded	0.383	m	KM	1.40 m
Trim	-0.407	m	KG	1.01 m
Heel, PS=+	0.0	deg		
TA	0.586	m	GM0	0.39 m
TF	0.180	m	GMCORR	0.00 m
Trimming moment	-1	tf	GM	0.39 m

STABILITY CRITERIA

Loading condition: LK0_B, Lightweight condition B.

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.039	mrad	0.892	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.057	mrad	0.873	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.018	mrad	0.897	NOT MET
Min. GZ > 0.2	0.200	0.181	m	0.994	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.135	OK
GM > 0.15 m	0.150	0.390	m	1.253	OK

VCG margin

Maximum VCG = 0.87 m
Actual VCG = 1.01 m
VCG reserve = -0.14 m

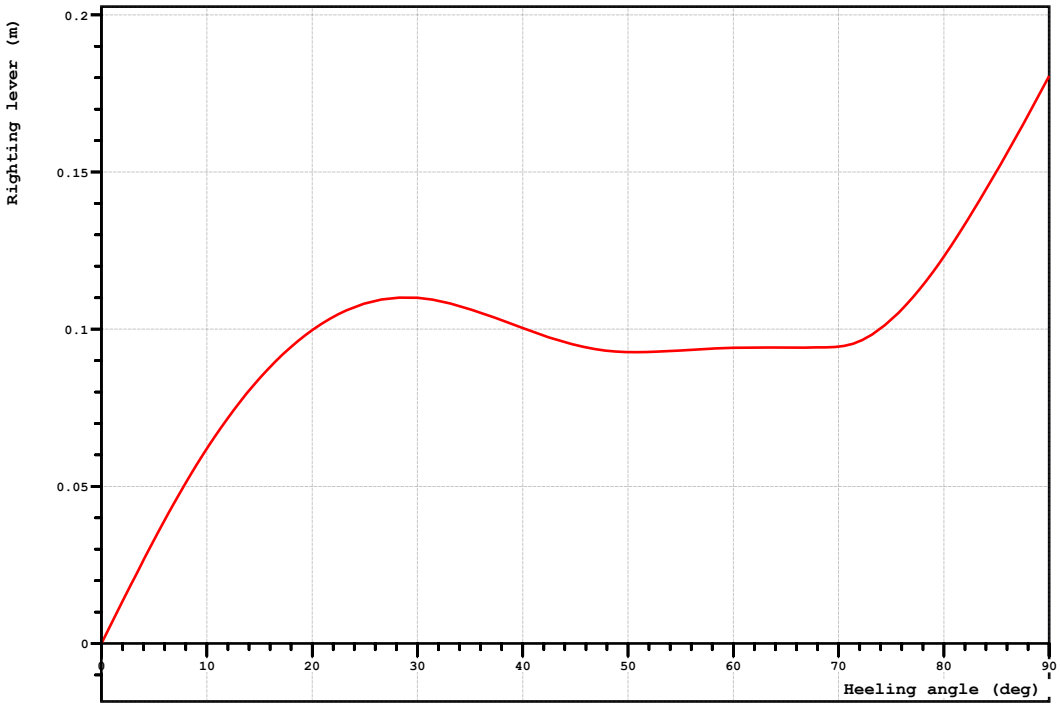
RELEVANT OPENINGS

Loading condition: LK0_B, Lightweight condition B.

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	49.2	0.88
BB2	LOWER EDGE FORE	2.140	1.128	1.360	50.2	0.92
BB3	UPPER EDGE AFT	1.530	0.921	2.110	80.4	1.63
BB4	UPPER EDGE FORE	2.140	0.921	2.110	80.8	1.67
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	0.88
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	0.92
SB3	UPPER EDGE AFT	1.530	0.921	2.110	80.4	1.63
SB4	UPPER EDGE FORE	2.140	0.921	2.110	80.8	1.67

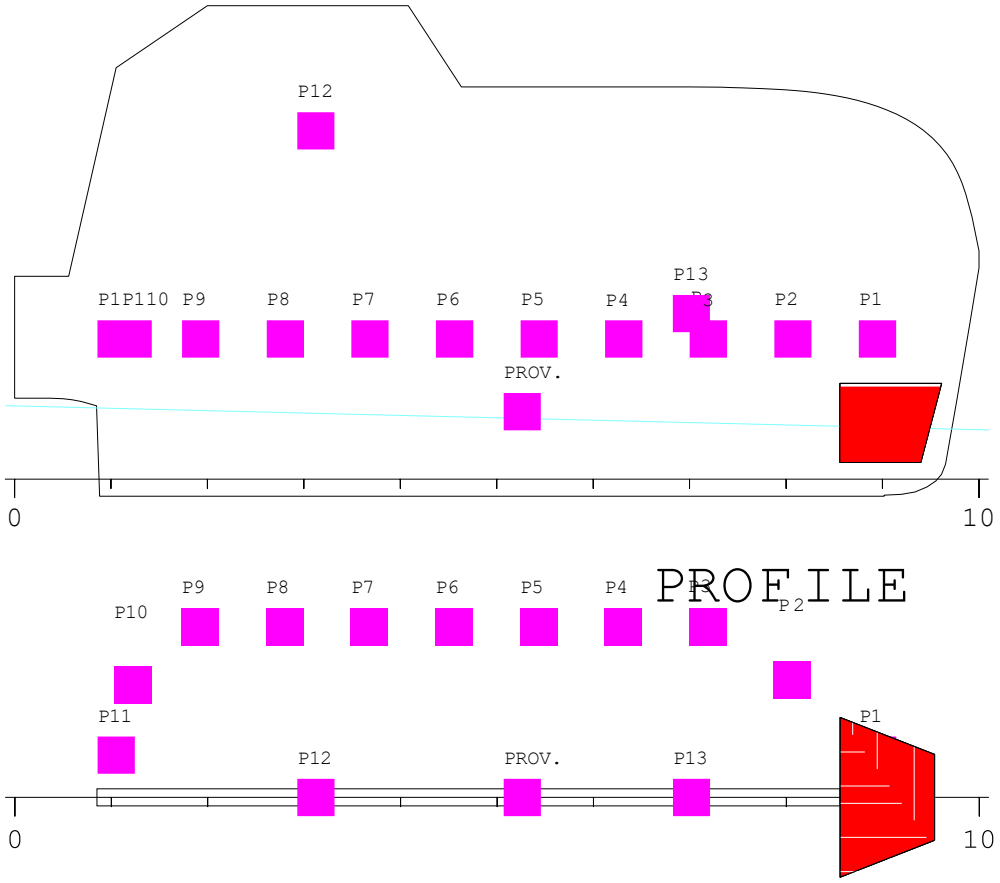
LOADING CONDITION: LK0_B, Lightweight B.

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	0.000	0.000	0.0	0.000
5.0	0.121	0.033	0.001	0.0	0.000
10.0	0.238	0.062	0.006	0.0	0.000
15.0	0.346	0.084	0.012	0.0	0.000
20.0	0.446	0.100	0.020	0.0	0.000
30.0	0.616	0.110	0.039	0.0	0.000
40.0	0.751	0.100	0.057	0.0	0.000
50.0	0.869	0.093	0.074	0.0	0.000
60.0	0.971	0.094	0.090	0.0	0.000
70.0	1.046	0.094	0.107	0.0	0.000
80.0	1.121	0.123	0.125	0.0	0.000
90.0	1.194	0.181	0.151	0.0	0.000

LOADING CONDITION: LK1_A, Load test, lightweight A.



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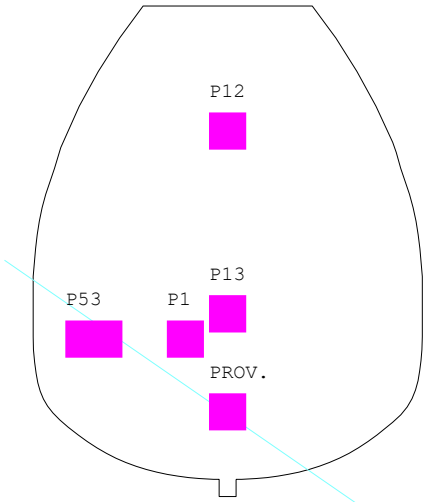

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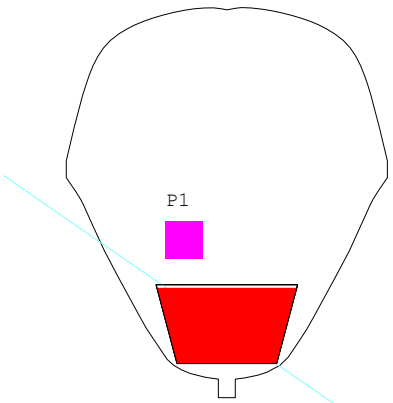

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LOADING CONDITION: LK1_A, Load test, lightweight A.

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
P1	P1	0.0825	0.0	5.100	0.250	0.830	0.00	1.000
P2	P2	0.0825	0.0	4.600	0.732	0.830	0.00	1.000
P3	P3	0.0825	0.0	4.100	0.850	0.830	0.00	1.000
P4	P4	0.0825	0.0	3.600	0.850	0.830	0.00	1.000
P5	P5	0.0825	0.0	3.100	0.850	0.830	0.00	1.000
P6	P6	0.0825	0.0	2.600	0.850	0.830	0.00	1.000
P7	P7	0.0825	0.0	2.100	0.850	0.830	0.00	1.000
P8	P8	0.0825	0.0	1.600	0.850	0.830	0.00	1.000
P9	P9	0.0825	0.0	1.100	0.850	0.830	0.00	1.000
P10	P10	0.0825	0.0	0.700	0.700	0.830	0.00	1.000
P11	P11	0.0825	0.0	0.600	0.250	0.830	0.00	1.000
P12	P12	0.0825	0.0	1.780	0.000	2.060	0.00	1.000
P13	P13	0.0825	0.0	4.000	0.000	0.980	0.00	1.000
PROVIANT	PROV.	0.1000	0.0	3.000	0.000	0.400	0.00	1.000
SUBTOTAL		1.1725		2.717	0.555	0.890	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1418	95.0	5.122	0.000	0.343	0.00	0.860
TOTAL		1.3143		2.977	0.495	0.831	0.00	
Lightweight		2.1410		2.594	0.000	0.936		
Deadweight		1.3143		2.977	0.495	0.831		
Total weight		3.4553		2.740	0.188	0.896		

LOADING CONDITION: LK1_A, Load test, lightweight A.

FLOATING POSITION

Draught moulded	0.294	m	KM	1.29 m
Trim	-0.116	m	KG	0.90 m
Heel, PS=+	34.6	deg		
TA	0.352	m	GM0	0.39 m
TF	0.236	m	GMCORR	0.00 m
Trimming moment	0	tf	GM	0.39 m

STABILITY CRITERIA

Loading condition: LK1_A, Loading test, lightweight A.

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.000	mrad	0.242	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.001	mrad	0.384	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.001	mrad	0.597	NOT MET
Min. GZ > 0.2	0.200	0.311	m	1.008	OK
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.396	OK
GM > 0.15 m	0.150	0.391	m	1.137	OK

VCG margin

Maximum VCG = 0.24 m
Actual VCG = 0.90 m
VCG reserve = -0.65 m

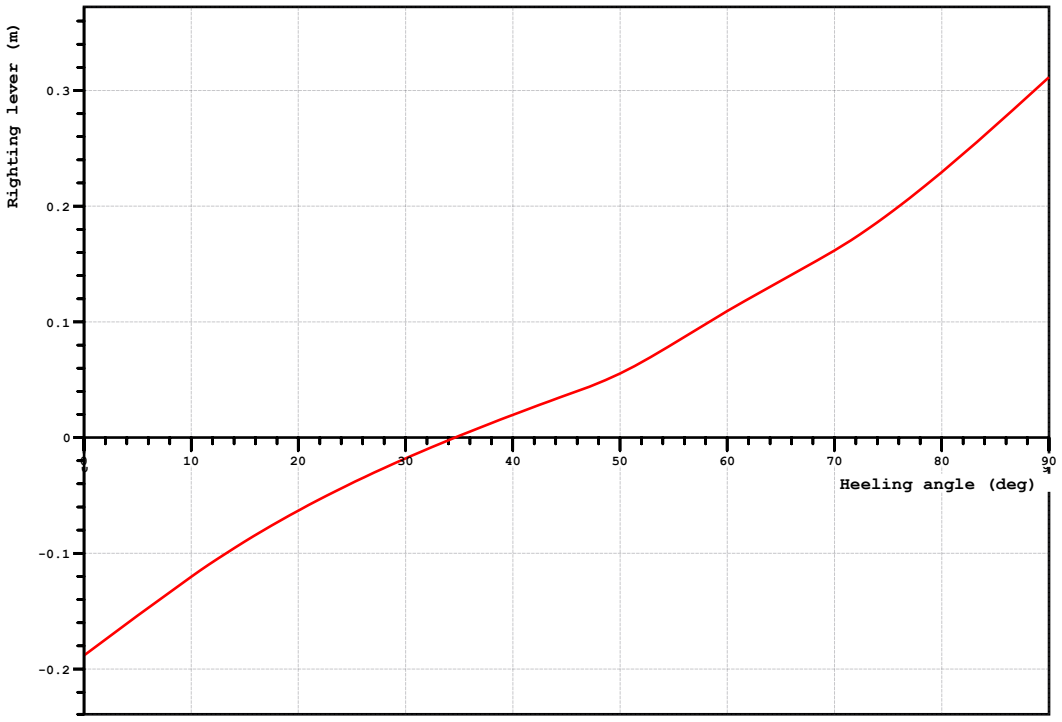
RELEVANT OPENINGS

Loading condition: LK1_A, Loading test, lightweight A.

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	44.2	0.16
BB2	LOWER EDGE FORE	2.140	1.128	1.360	44.6	0.17
BB3	UPPER EDGE AFT	1.530	0.921	2.110	76.7	0.89
BB4	UPPER EDGE FORE	2.140	0.921	2.110	76.4	0.90
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	1.44
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	1.45
SB3	UPPER EDGE AFT	1.530	0.921	2.110	76.7	0.89
SB4	UPPER EDGE FORE	2.140	0.921	2.110	76.4	0.90

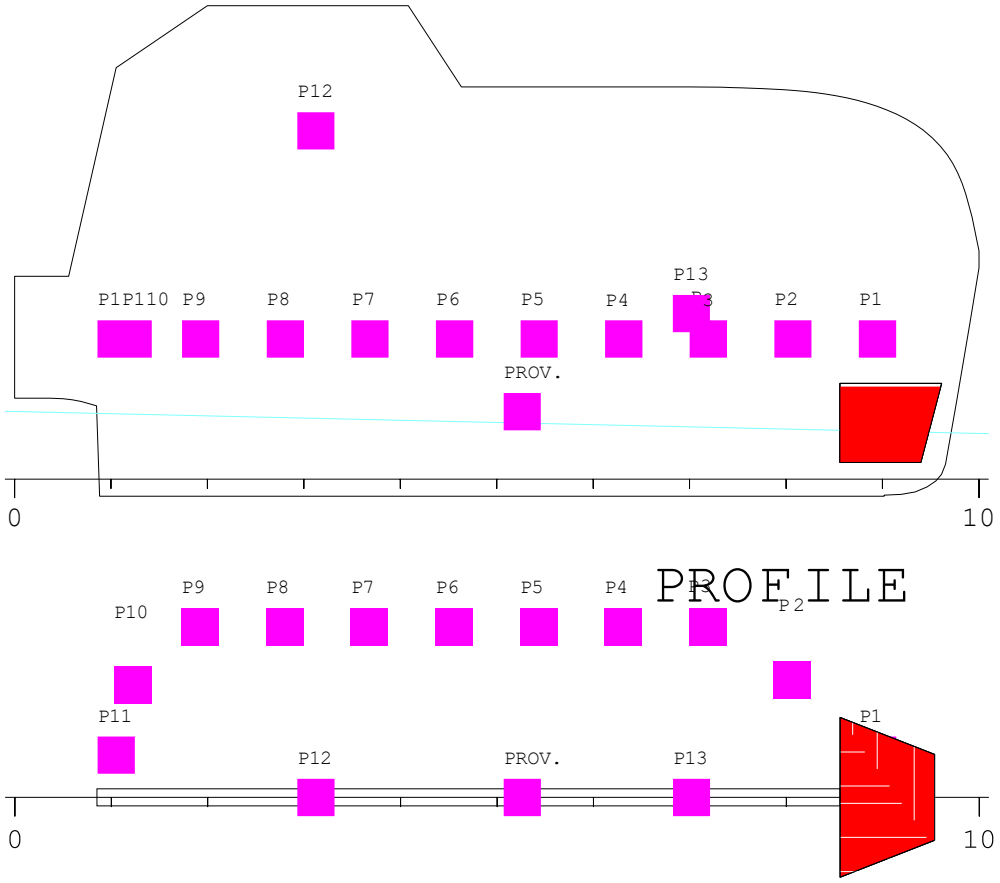
LOADING CONDITION: LK1_A, Load test, lightweight A.

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.188	0.000	0.0	0.000
5.0	0.112	-0.154	-0.015	0.0	0.000
10.0	0.221	-0.120	-0.027	0.0	0.000
15.0	0.324	-0.090	-0.036	0.0	0.000
20.0	0.420	-0.063	-0.043	0.0	0.000
30.0	0.593	-0.018	-0.050	0.0	0.000
40.0	0.740	0.020	-0.049	0.0	0.000
50.0	0.863	0.055	-0.043	0.0	0.000
60.0	0.979	0.109	-0.029	0.0	0.000
70.0	1.068	0.162	-0.005	0.0	0.000
80.0	1.145	0.229	0.029	0.0	0.000
90.0	1.208	0.311	0.076	0.0	0.000

LOADING CONDITION: LK1_B, Load test, lightweight B.



PROFILE

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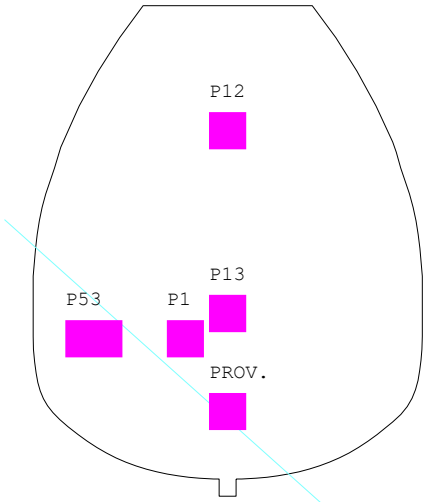

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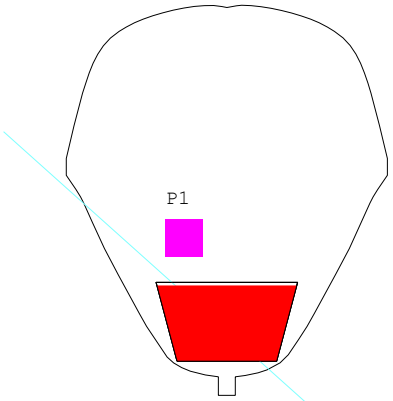

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LOADING CONDITION: LK1_B, Load test, lightweight B.

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
P1	P1	0.0825	0.0	5.100	0.250	0.830	0.00	1.000
P2	P2	0.0825	0.0	4.600	0.732	0.830	0.00	1.000
P3	P3	0.0825	0.0	4.100	0.850	0.830	0.00	1.000
P4	P4	0.0825	0.0	3.600	0.850	0.830	0.00	1.000
P5	P5	0.0825	0.0	3.100	0.850	0.830	0.00	1.000
P6	P6	0.0825	0.0	2.600	0.850	0.830	0.00	1.000
P7	P7	0.0825	0.0	2.100	0.850	0.830	0.00	1.000
P8	P8	0.0825	0.0	1.600	0.850	0.830	0.00	1.000
P9	P9	0.0825	0.0	1.100	0.850	0.830	0.00	1.000
P10	P10	0.0825	0.0	0.700	0.700	0.830	0.00	1.000
P11	P11	0.0825	0.0	0.600	0.250	0.830	0.00	1.000
P12	P12	0.0825	0.0	1.780	0.000	2.060	0.00	1.000
P13	P13	0.0825	0.0	4.000	0.000	0.980	0.00	1.000
PROVIANT	PROV.	0.1000	0.0	3.000	0.000	0.400	0.00	1.000
SUBTOTAL		1.1725		2.717	0.555	0.890	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1418	95.0	5.122	0.000	0.343	0.00	0.860
TOTAL		1.3143		2.977	0.495	0.831	0.00	
Lightweight		2.5330		2.600	0.000	1.013		
Deadweight		1.3143		2.977	0.495	0.831		
Total weight		3.8473		2.729	0.169	0.951		

LOADING CONDITION: LK1_B, Load test, lightweight B.

FLOATING POSITION

Draught moulded	0.244	m	KM	1.26 m
Trim	-0.097	m	KG	0.95 m
Heel, PS=+	41.9	deg		
TA	0.292	m	GM0	0.31 m
TF	0.196	m	GMCORR	0.00 m
Trimming moment	0	tf	GM	0.31 m

STABILITY CRITERIA

Loading condition: LK1_B, Loading test, lightweight B.

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.000	mrad	0.280	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.000	mrad	0.415	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.000	mrad	0.622	NOT MET
Min. GZ > 0.2	0.200	0.262	m	1.013	OK
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.377	OK
GM > 0.15 m	0.150	0.308	m	1.109	OK

VCG margin

Maximum VCG = 0.28 m
Actual VCG = 0.95 m
VCG reserve = -0.67 m

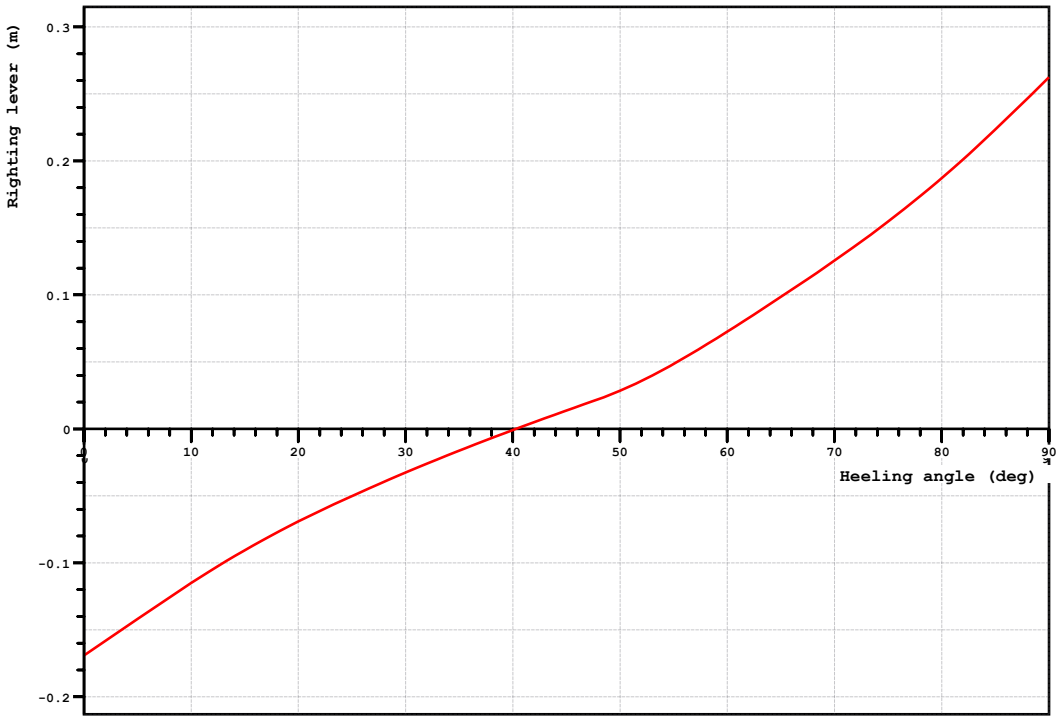
RELEVANT OPENINGS

Loading condition: LK1_B, Loading test, lightweight B.

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	41.4	-0.01
BB2	LOWER EDGE FORE	2.140	1.128	1.360	42.0	0.00
BB3	UPPER EDGE AFT	1.530	0.921	2.110	74.4	0.69
BB4	UPPER EDGE FORE	2.140	0.921	2.110	74.2	0.70
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	1.50
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	1.51
SB3	UPPER EDGE AFT	1.530	0.921	2.110	74.4	0.69
SB4	UPPER EDGE FORE	2.140	0.921	2.110	74.2	0.70

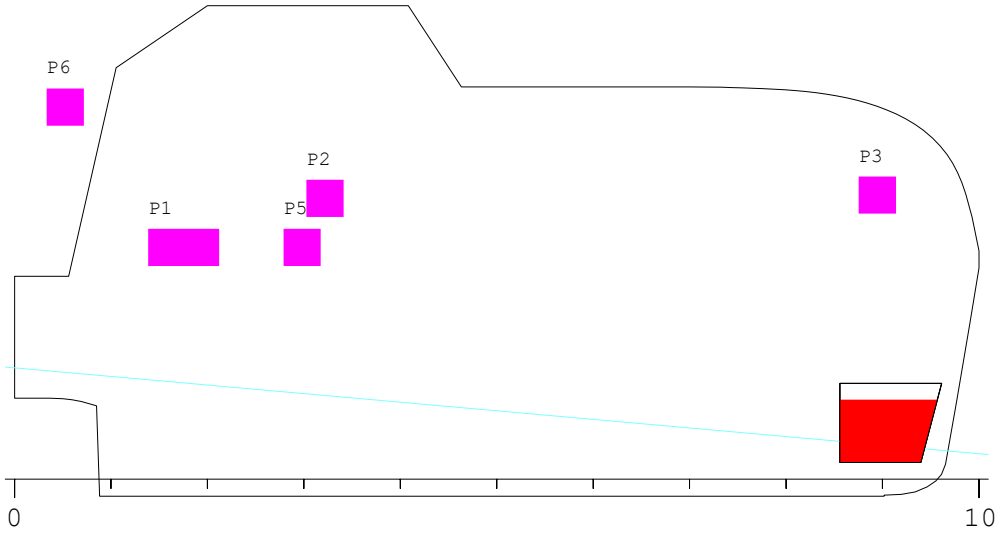
LOADING CONDITION: LK1_B, Load test, lightweight B.

GZ CURVE

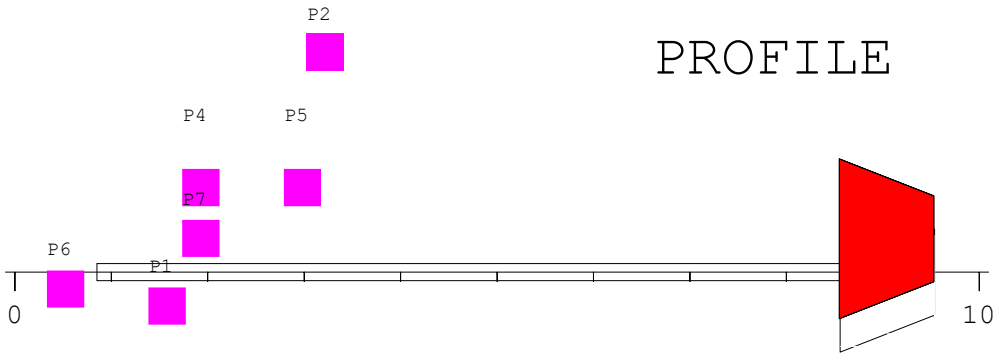


HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.169	0.000	0.0	0.000
5.0	0.109	-0.142	-0.014	0.0	0.000
10.0	0.217	-0.115	-0.025	0.0	0.000
15.0	0.319	-0.091	-0.034	0.0	0.000
20.0	0.415	-0.069	-0.041	0.0	0.000
30.0	0.589	-0.033	-0.049	0.0	0.000
40.0	0.740	-0.001	-0.052	0.0	0.000
50.0	0.866	0.028	-0.050	0.0	0.000
60.0	0.981	0.073	-0.041	0.0	0.000
70.0	1.077	0.125	-0.024	0.0	0.000
80.0	1.153	0.187	0.003	0.0	0.000
90.0	1.213	0.262	0.042	0.0	0.000

LOADING CONDITION: LK2_A, Accident, lightweight A.



PROFILE



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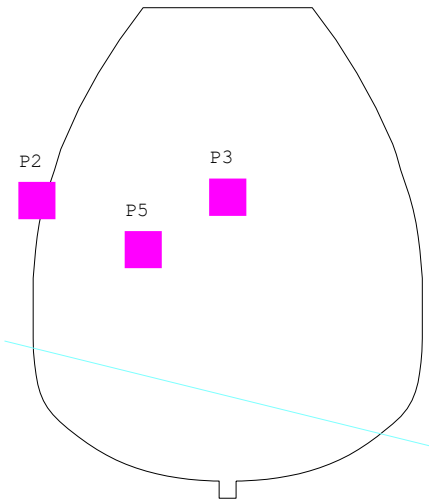

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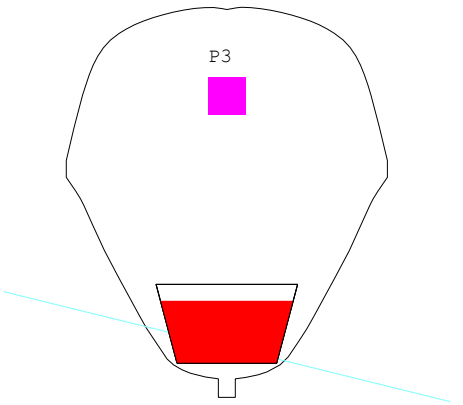


X=#9

LOADING CONDITION: LK2_A, Accident, lightweight A.

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
PERSON_1	P1	0.0940	0.0	0.900	-0.200	1.370	0.00	1.000
PERSON_2	P2	0.0890	0.0	1.835	1.128	1.660	0.00	1.000
PERSON_3	P3	0.0720	0.0	5.100	0.000	1.680	0.00	1.000
PERSON_4	P4	0.0930	0.0	1.100	0.500	1.370	0.00	1.000
PERSON_5	P5	0.1300	0.0	1.700	0.500	1.370	0.00	1.000
PERSON_6	P6	0.0810	0.0	0.300	-0.100	2.200	0.00	1.000
PERSON_7	P7	0.0810	0.0	1.100	0.200	1.370	0.00	1.000
SUBTOTAL		0.6400		1.643	0.314	1.550	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1119	75.0	5.117	0.000	0.298	0.00	0.860
TOTAL		0.7519		2.160	0.268	1.364	0.00	
Lightweight		2.1410		2.594	0.000	0.936		
Deadweight		0.7519		2.160	0.268	1.364		
Total weight		2.8929		2.481	0.070	1.047		

LOADING CONDITION: LK2_A, Accident, lightweight A.

FLOATING POSITION

Draught moulded	0.391	m	KM	1.37 m
Trim	-0.493	m	KG	1.05 m
Heel, PS=+	13.9	deg		
TA	0.638	m	GM0	0.32 m
TF	0.144	m	GMCORR	0.00 m
Trimming moment	-2	tf	GM	0.32 m

STABILITY CRITERIA

Loading condition: LK2_A, Accident, lightweight A

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.006	mrad	0.647	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.012	mrad	0.694	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.006	mrad	0.805	NOT MET
Min. GZ > 0.2	0.200	0.159	m	1.006	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.255	OK
GM > 0.15 m	0.150	0.322	m	1.219	OK

VCG margin

Maximum VCG = 0.65 m
Actual VCG = 1.05 m
VCG reserve = -0.40 m

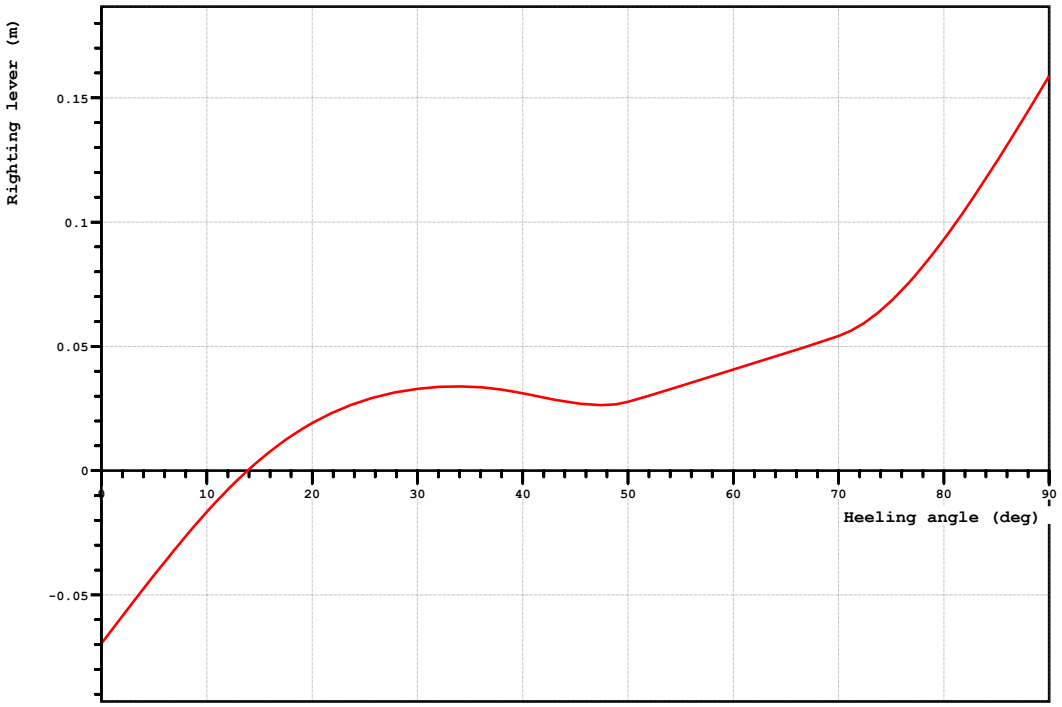
RELEVANT OPENINGS

Loading condition: LK2_A, Accident, lightweight A

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	44.1	0.54
BB2	LOWER EDGE FORE	2.140	1.128	1.360	46.3	0.60
BB3	UPPER EDGE AFT	1.530	0.921	2.110	76.3	1.32
BB4	UPPER EDGE FORE	2.140	0.921	2.110	77.6	1.37
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	1.08
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	1.13
SB3	UPPER EDGE AFT	1.530	0.921	2.110	76.3	1.32
SB4	UPPER EDGE FORE	2.140	0.921	2.110	77.6	1.37

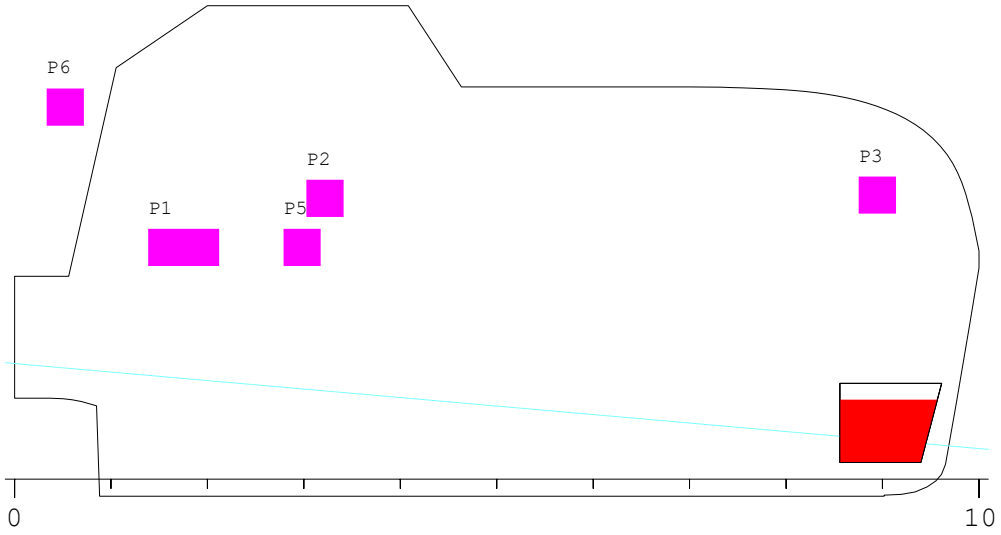
LOADING CONDITION: LK2_A, Accident, lightweight A.

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.070	0.000	0.0	0.000
5.0	0.119	-0.042	-0.005	0.0	0.000
10.0	0.234	-0.017	-0.007	0.0	0.000
15.0	0.342	0.004	-0.008	0.0	0.000
20.0	0.443	0.019	-0.007	0.0	0.000
30.0	0.617	0.033	-0.002	0.0	0.000
40.0	0.758	0.031	0.004	0.0	0.000
50.0	0.875	0.028	0.009	0.0	0.000
60.0	0.982	0.041	0.015	0.0	0.000
70.0	1.062	0.054	0.023	0.0	0.000
80.0	1.136	0.093	0.035	0.0	0.000
90.0	1.206	0.159	0.057	0.0	0.000

LOADING CONDITION: LK2_B, Accident, lightweight B.



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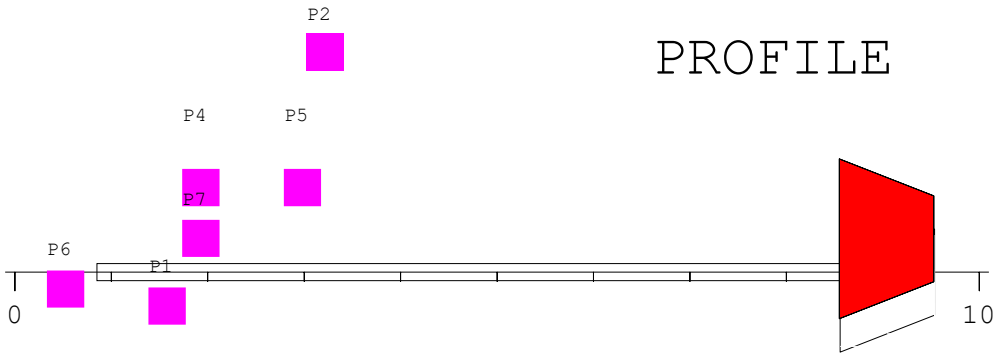

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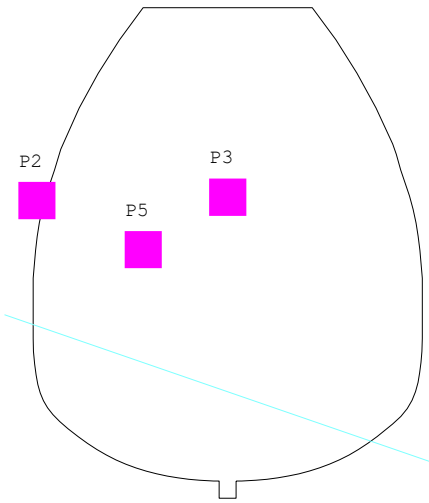

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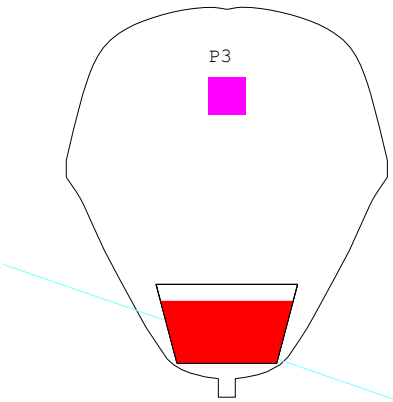


X=#9

LOADING CONDITION: LK2_B, Accident, lightweight B.

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
PERSON_1	P1	0.0940	0.0	0.900	-0.200	1.370	0.00	1.000
PERSON_2	P2	0.0890	0.0	1.835	1.128	1.660	0.00	1.000
PERSON_3	P3	0.0720	0.0	5.100	0.000	1.680	0.00	1.000
PERSON_4	P4	0.0930	0.0	1.100	0.500	1.370	0.00	1.000
PERSON_5	P5	0.1300	0.0	1.700	0.500	1.370	0.00	1.000
PERSON_6	P6	0.0810	0.0	0.300	-0.100	2.200	0.00	1.000
PERSON_7	P7	0.0810	0.0	1.100	0.200	1.370	0.00	1.000
SUBTOTAL		0.6400		1.643	0.314	1.550	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1119	75.0	5.117	0.000	0.298	0.00	0.860
TOTAL		0.7519		2.160	0.268	1.364	0.00	
Lightweight		2.5330		2.600	0.000	1.013		
Deadweight		0.7519		2.160	0.268	1.364		
Total weight		3.2849		2.499	0.061	1.093		

LOADING CONDITION: LK2_B, Accident, lightweight B.

FLOATING POSITION

Draught moulded	0.406	m	KM	1.32 m
Trim	-0.474	m	KG	1.09 m
Heel, PS=+	19.0	deg		
TA	0.643	m	GM0	0.23 m
TF	0.169	m	GMCORR	0.00 m
Trimming moment	-2	tf	GM	0.23 m

STABILITY CRITERIA

Loading condition: LK2_B, Accident, lightweight B

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.001	mrad	0.645	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.003	mrad	0.694	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.001	mrad	0.807	NOT MET
Min. GZ > 0.2	0.200	0.120	m	1.014	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.265	OK
GM > 0.15 m	0.150	0.230	m	1.173	OK

VCG margin

Maximum VCG = 0.65 m
Actual VCG = 1.09 m
VCG reserve = -0.45 m

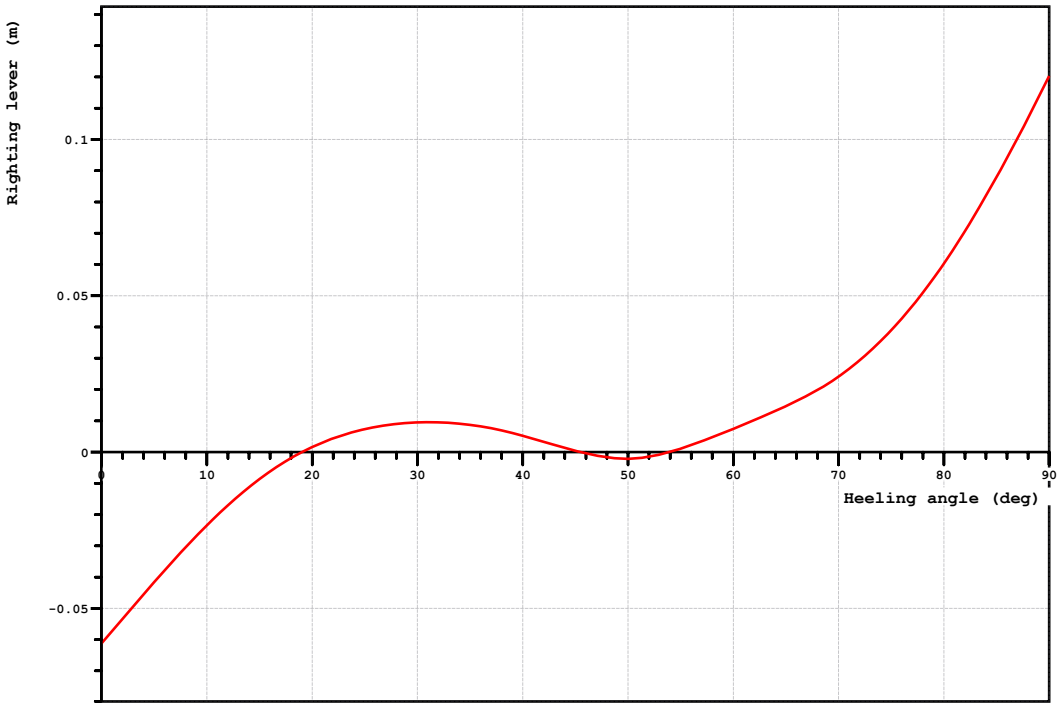
RELEVANT OPENINGS

Loading condition: LK2_B, Accident, lightweight B

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	41.2	0.40
BB2	LOWER EDGE FORE	2.140	1.128	1.360	43.5	0.45
BB3	UPPER EDGE AFT	1.530	0.921	2.110	74.1	1.17
BB4	UPPER EDGE FORE	2.140	0.921	2.110	75.3	1.22
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	1.13
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	1.18
SB3	UPPER EDGE AFT	1.530	0.921	2.110	74.1	1.17
SB4	UPPER EDGE FORE	2.140	0.921	2.110	75.3	1.22

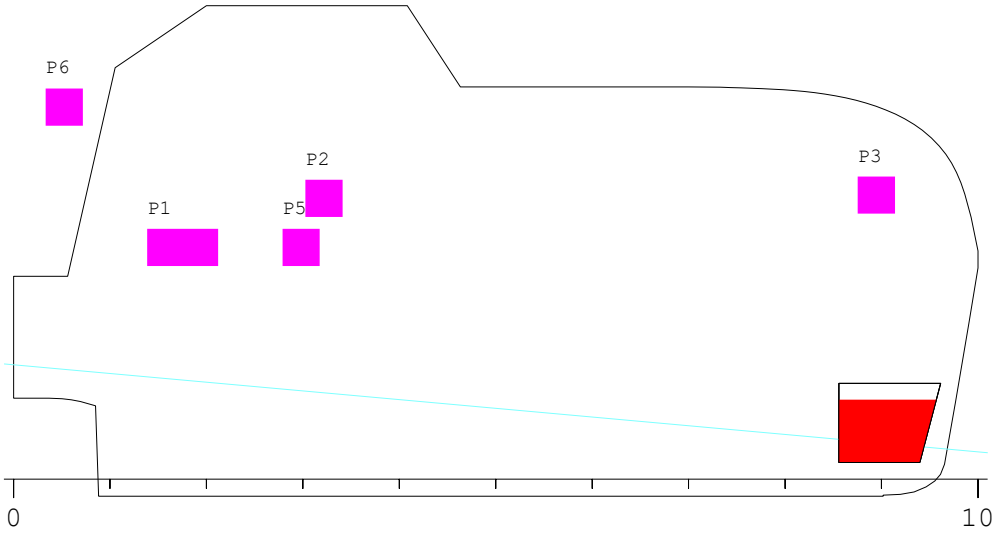
LOADING CONDITION: LK2_B, Accident, lightweight B.

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.061	0.000	0.0	0.000
5.0	0.115	-0.042	-0.004	0.0	0.000
10.0	0.227	-0.023	-0.007	0.0	0.000
15.0	0.333	-0.009	-0.009	0.0	0.000
20.0	0.433	0.002	-0.009	0.0	0.000
30.0	0.609	0.009	-0.008	0.0	0.000
40.0	0.755	0.005	-0.006	0.0	0.000
50.0	0.875	-0.002	-0.006	0.0	0.000
60.0	0.985	0.007	-0.006	0.0	0.000
70.0	1.072	0.024	-0.003	0.0	0.000
80.0	1.148	0.060	0.004	0.0	0.000
90.0	1.214	0.120	0.019	0.0	0.000

LOADING CONDITION: LK3_A, Accident with passengers in CL, lightweight A



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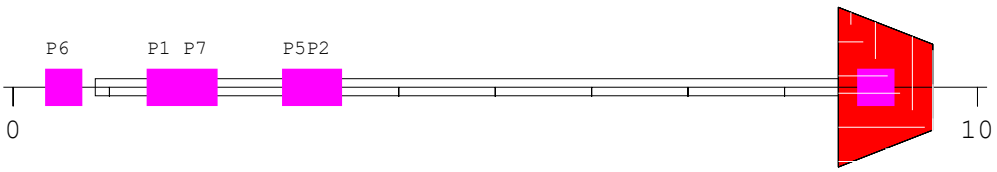

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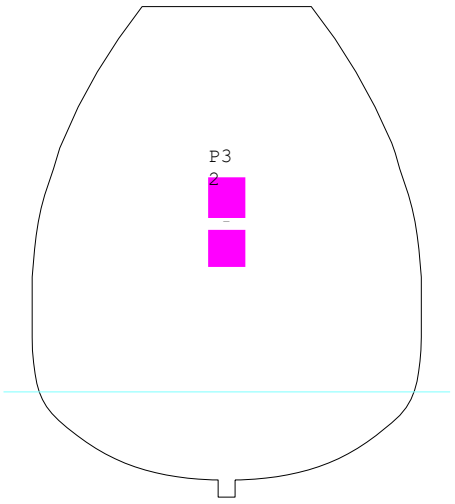

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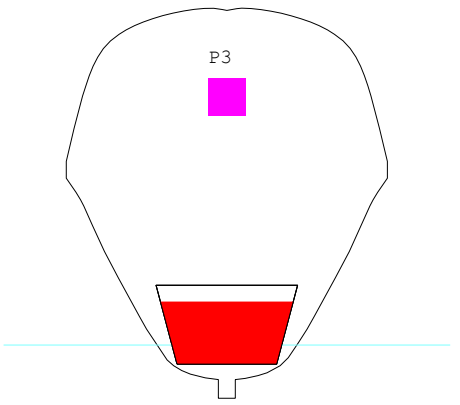


X=#9

LOADING CONDITION: LK3_A, Accident with passengers in CL, lightweight A

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
PERSON_1	P1	0.0940	0.0	0.900	0.000	1.370	0.00	1.000
PERSON_2	P2	0.0890	0.0	1.835	0.000	1.660	0.00	1.000
PERSON_3	P3	0.0720	0.0	5.100	0.000	1.680	0.00	1.000
PERSON_4	P4	0.0930	0.0	1.100	0.000	1.370	0.00	1.000
PERSON_5	P5	0.1300	0.0	1.700	0.000	1.370	0.00	1.000
PERSON_6	P6	0.0810	0.0	0.300	0.000	2.200	0.00	1.000
PERSON_7	P7	0.0810	0.0	1.100	0.000	1.370	0.00	1.000
SUBTOTAL		0.6400		1.643	0.000	1.550	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1119	75.0	5.117	0.000	0.298	0.00	0.860
TOTAL		0.7519		2.160	0.000	1.364	0.00	
Lightweight		2.1410		2.594	0.000	0.936		
Deadweight		0.7519		2.160	0.000	1.364		
Total weight		2.8929		2.481	0.000	1.047		

LOADING CONDITION: LK3_A, Accident with passengers in CL, lightweight A

FLOATING POSITION

Draught moulded	0.420	m	KM	1.37 m
Trim	-0.515	m	KG	1.05 m
Heel, PS=+	0.0	deg		
TA	0.677	m	GM0	0.32 m
TF	0.162	m	GMCORR	0.00 m
Trimming moment	-2	tf	GM	0.32 m

STABILITY CRITERIA

Loading condition: LK3_A, Accident with passengers in CL, lightweight A

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.033	mrad	0.881	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.049	mrad	0.870	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.016	mrad	0.904	NOT MET
Min. GZ > 0.2	0.200	0.159	m	1.006	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.158	OK
GM > 0.15 m	0.150	0.322	m	1.219	OK

VCG margin

Maximum VCG = 0.87 m
Actual VCG = 1.05 m
VCG reserve = -0.18 m

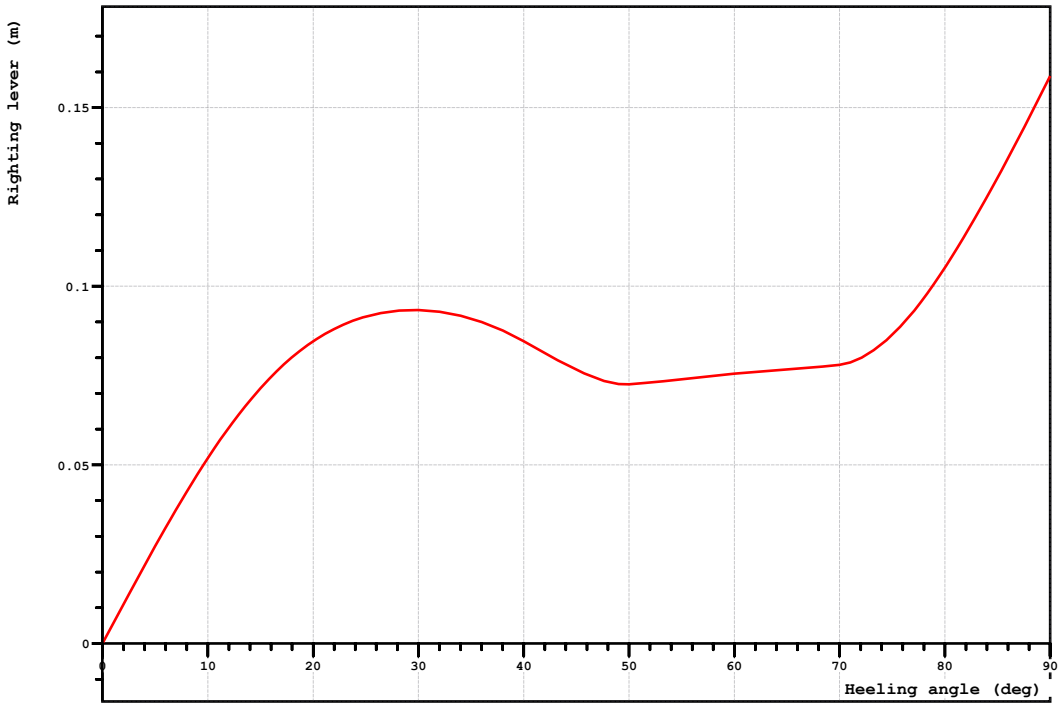
RELEVANT OPENINGS

Loading condition: LK3_A, Accident with passengers in CL, lightweight A

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	44.1	0.82
BB2	LOWER EDGE FORE	2.140	1.128	1.360	46.3	0.87
BB3	UPPER EDGE AFT	1.530	0.921	2.110	76.4	1.56
BB4	UPPER EDGE FORE	2.140	0.921	2.110	77.7	1.62
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	0.82
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	0.87
SB3	UPPER EDGE AFT	1.530	0.921	2.110	76.4	1.56
SB4	UPPER EDGE FORE	2.140	0.921	2.110	77.7	1.62

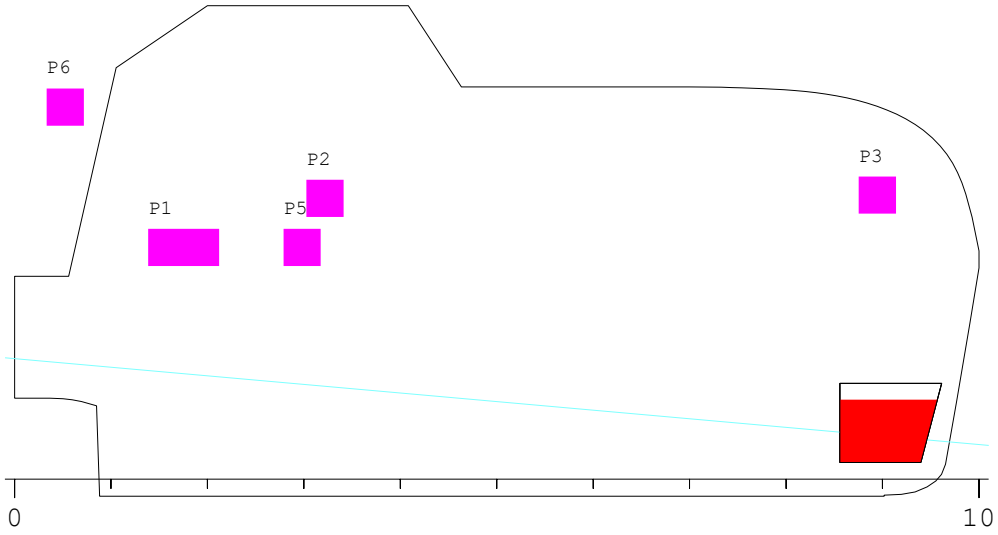
LOADING CONDITION: LK3_A, Accident with passengers in CL, lightweight A

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	0.000	0.000	0.0	0.000
5.0	0.119	0.027	0.001	0.0	0.000
10.0	0.234	0.052	0.005	0.0	0.000
15.0	0.342	0.071	0.010	0.0	0.000
20.0	0.443	0.085	0.017	0.0	0.000
30.0	0.617	0.093	0.033	0.0	0.000
40.0	0.758	0.085	0.049	0.0	0.000
50.0	0.875	0.073	0.062	0.0	0.000
60.0	0.982	0.076	0.075	0.0	0.000
70.0	1.062	0.078	0.088	0.0	0.000
80.0	1.136	0.105	0.104	0.0	0.000
90.0	1.206	0.159	0.127	0.0	0.000

LOADING CONDITION: LK3_B, Accident with passengers in CL, lightweight B



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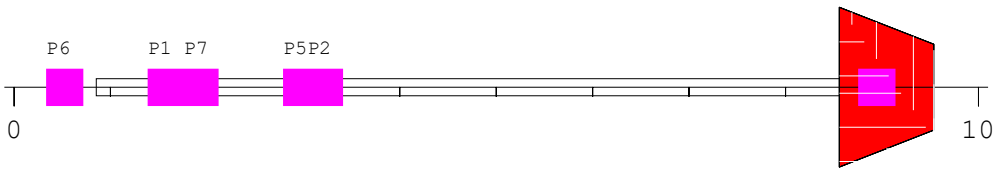

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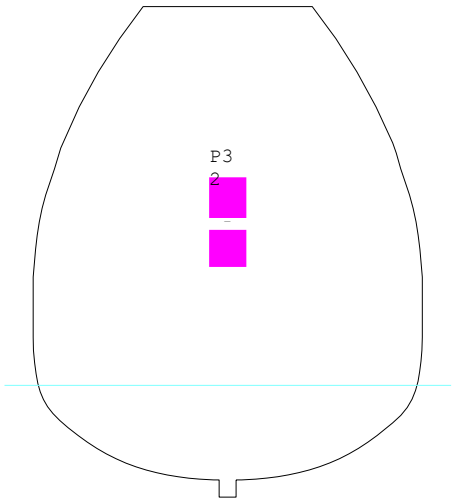

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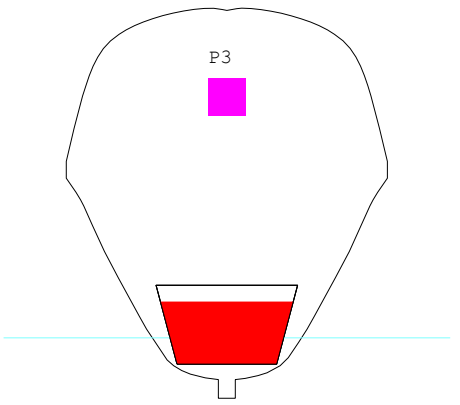

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LOADING CONDITION: LK3_B, Accident with passengers in CL, lightweight B

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
PERSON_1	P1	0.0940	0.0	0.900	0.000	1.370	0.00	1.000
PERSON_2	P2	0.0890	0.0	1.835	0.000	1.660	0.00	1.000
PERSON_3	P3	0.0720	0.0	5.100	0.000	1.680	0.00	1.000
PERSON_4	P4	0.0930	0.0	1.100	0.000	1.370	0.00	1.000
PERSON_5	P5	0.1300	0.0	1.700	0.000	1.370	0.00	1.000
PERSON_6	P6	0.0810	0.0	0.300	0.000	2.200	0.00	1.000
PERSON_7	P7	0.0810	0.0	1.100	0.000	1.370	0.00	1.000
SUBTOTAL		0.6400		1.643	0.000	1.550	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1119	75.0	5.117	0.000	0.298	0.00	0.860
TOTAL		0.7519		2.160	0.000	1.364	0.00	
Lightweight		2.5330		2.600	0.000	1.013		
Deadweight		0.7519		2.160	0.000	1.364		
Total weight		3.2849		2.499	0.000	1.093		

LOADING CONDITION: LK3_B, Accident with passengers in CL, lightweight B

FLOATING POSITION

Draught moulded	0.459	m	KM	1.32 m
Trim	-0.507	m	KG	1.09 m
Heel, PS=+	0.0	deg		
TA	0.713	m	GM0	0.23 m
TF	0.206	m	GMCORR	0.00 m
Trimming moment	-2	tf	GM	0.23 m

STABILITY CRITERIA

Loading condition: LK3_B, Accident with passengers in CL, lightweight B

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.023	mrad	0.853	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.033	mrad	0.850	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.010	mrad	0.895	NOT MET
Min. GZ > 0.2	0.200	0.120	m	1.014	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.186	OK
GM > 0.15 m	0.150	0.230	m	1.173	OK

VCG margin

Maximum VCG = 0.85 m
Actual VCG = 1.09 m
VCG reserve = -0.24 m

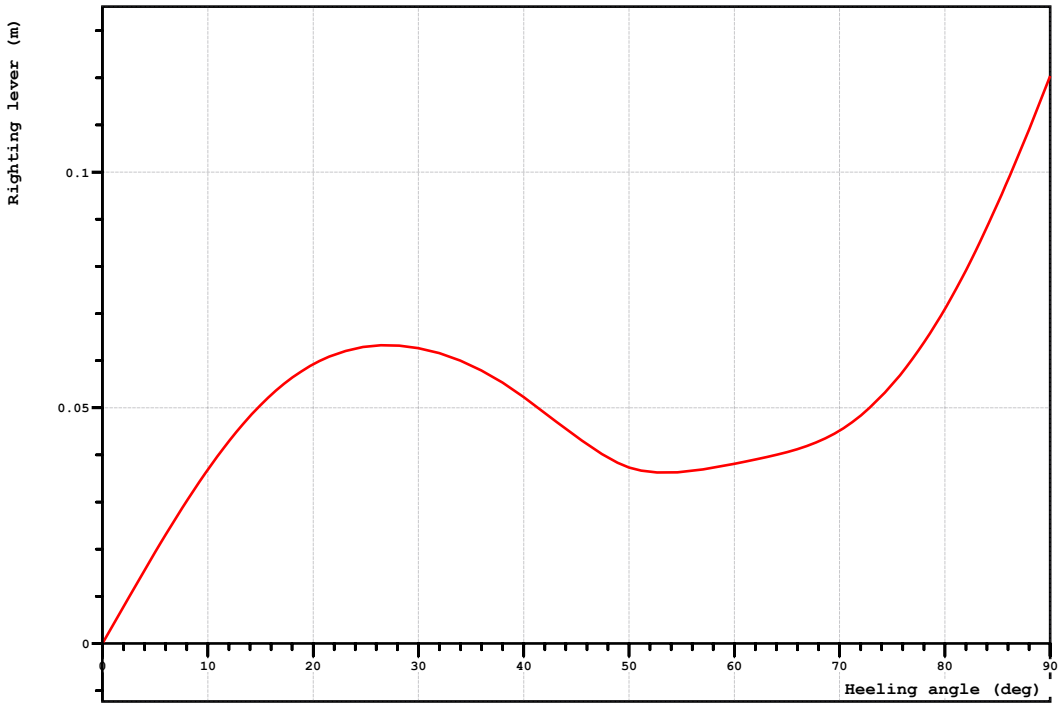
RELEVANT OPENINGS

Loading condition: LK3_B, Accident with passengers in CL, lightweight B

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	41.2	0.78
BB2	LOWER EDGE FORE	2.140	1.128	1.360	43.4	0.83
BB3	UPPER EDGE AFT	1.530	0.921	2.110	74.1	1.53
BB4	UPPER EDGE FORE	2.140	0.921	2.110	75.4	1.58
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	0.78
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	0.83
SB3	UPPER EDGE AFT	1.530	0.921	2.110	74.1	1.53
SB4	UPPER EDGE FORE	2.140	0.921	2.110	75.4	1.58

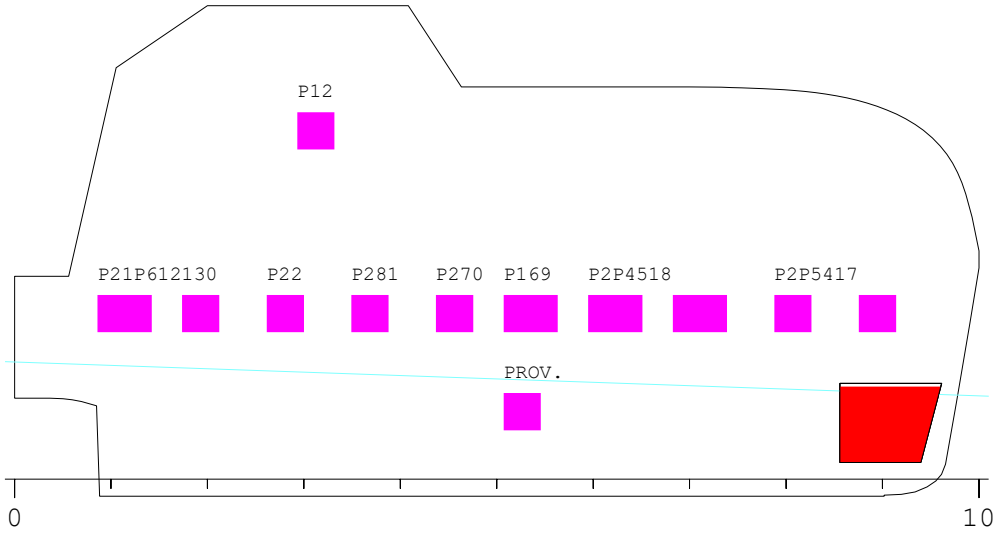
LOADING CONDITION: LK3_B, Accident with passengers in CL, lightweight B

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	0.000	0.000	0.0	0.000
5.0	0.115	0.019	0.001	0.0	0.000
10.0	0.227	0.037	0.003	0.0	0.000
15.0	0.334	0.051	0.007	0.0	0.000
20.0	0.433	0.059	0.012	0.0	0.000
30.0	0.609	0.063	0.023	0.0	0.000
40.0	0.755	0.052	0.033	0.0	0.000
50.0	0.875	0.037	0.041	0.0	0.000
60.0	0.985	0.038	0.047	0.0	0.000
70.0	1.073	0.045	0.054	0.0	0.000
80.0	1.148	0.071	0.064	0.0	0.000
90.0	1.214	0.120	0.081	0.0	0.000

LOADING CONDITION: LK4_A, Max. number of passengers, lightweight A



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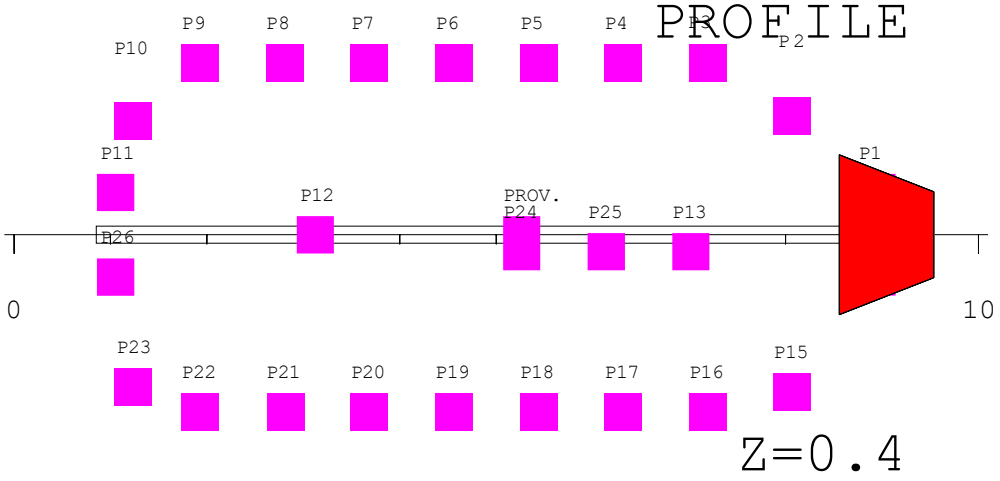

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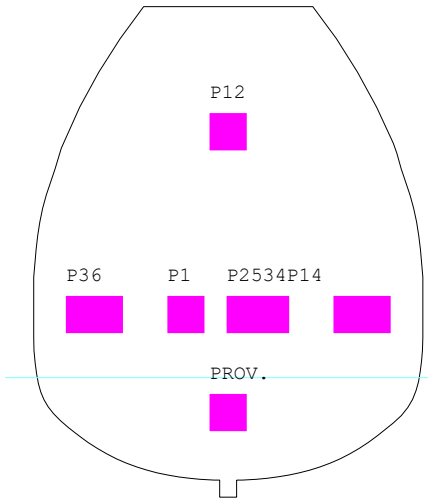

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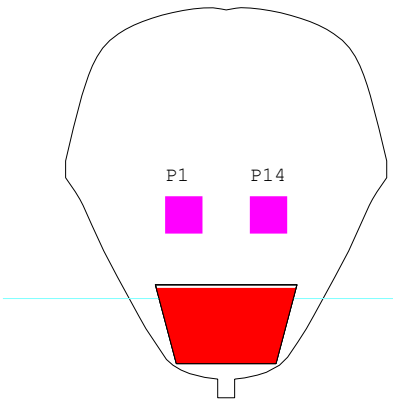

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LOADING CONDITION: LK4_A, Max. number of passengers, lightweight A

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
P1	P1	0.0825	0.0	5.100	0.250	0.980	0.00	1.000
P2	P2	0.0825	0.0	4.600	0.732	0.980	0.00	1.000
P3	P3	0.0825	0.0	4.100	0.850	0.980	0.00	1.000
P4	P4	0.0825	0.0	3.600	0.850	0.980	0.00	1.000
P5	P5	0.0825	0.0	3.100	0.850	0.980	0.00	1.000
P6	P6	0.0825	0.0	2.600	0.850	0.980	0.00	1.000
P7	P7	0.0825	0.0	2.100	0.850	0.980	0.00	1.000
P8	P8	0.0825	0.0	1.600	0.850	0.980	0.00	1.000
P9	P9	0.0825	0.0	1.100	0.850	0.980	0.00	1.000
P10	P10	0.0825	0.0	0.700	0.700	0.980	0.00	1.000
P11	P11	0.0825	0.0	0.600	0.250	0.980	0.00	1.000
P12	P12	0.0825	0.0	1.780	0.000	2.060	0.00	1.000
P13	P13	0.0825	0.0	4.000	-0.100	0.980	0.00	1.000
P14	P14	0.0825	0.0	5.100	-0.250	0.980	0.00	1.000
P15	P15	0.0825	0.0	4.600	-0.732	0.980	0.00	1.000
P16	P16	0.0825	0.0	4.100	-0.850	0.980	0.00	1.000
P17	P17	0.0825	0.0	3.600	-0.850	0.980	0.00	1.000
P18	P18	0.0825	0.0	3.100	-0.850	0.980	0.00	1.000
P19	P19	0.0825	0.0	2.600	-0.850	0.980	0.00	1.000
P20	P20	0.0825	0.0	2.100	-0.850	0.980	0.00	1.000
P21	P21	0.0825	0.0	1.600	-0.850	0.980	0.00	1.000
P22	P22	0.0825	0.0	1.100	-0.850	0.980	0.00	1.000
P23	P23	0.0825	0.0	0.700	-0.700	0.980	0.00	1.000
P24	P24	0.0825	0.0	3.000	-0.100	0.980	0.00	1.000
P25	P25	0.0825	0.0	3.500	-0.100	0.980	0.00	1.000
P26	P26	0.0825	0.0	0.600	-0.250	0.980	0.00	1.000
PROVIANT	PROV.	0.1000	0.0	3.000	0.000	0.400	0.00	1.000
SUBTOTAL		2.2450		2.731	-0.011	0.994	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1418	95.0	5.122	0.000	0.343	0.00	0.860
TOTAL		2.3868		2.873	-0.010	0.955	0.00	
Lightweight		2.1410		2.594	0.000	0.936		
Deadweight		2.3868		2.873	-0.010	0.955		
Total weight		4.5278		2.741	-0.005	0.946		

LOADING CONDITION: LK4_A, Max. number of passengers, lightweight A

FLOATING POSITION

Draught moulded	0.594	m	KM	1.21 m
Trim	-0.201	m	KG	0.95 m
Heel, PS=+	-1.2	deg		
TA	0.694	m	GM0	0.26 m
TF	0.493	m	GMCORR	0.00 m
Trimming moment	-1	tf	GM	0.26 m

STABILITY CRITERIA

Loading condition: LK4_A, Max. number of passengers, lightweight A

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.029	mrad	0.751	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.049	mrad	0.771	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.020	mrad	0.846	NOT MET
Min. GZ > 0.2	0.200	0.276	m	1.022	OK
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.225	OK
GM > 0.15 m	0.150	0.263	m	1.060	OK

VCG margin

Maximum VCG = 0.75 m
Actual VCG = 0.95 m
VCG reserve = -0.20 m

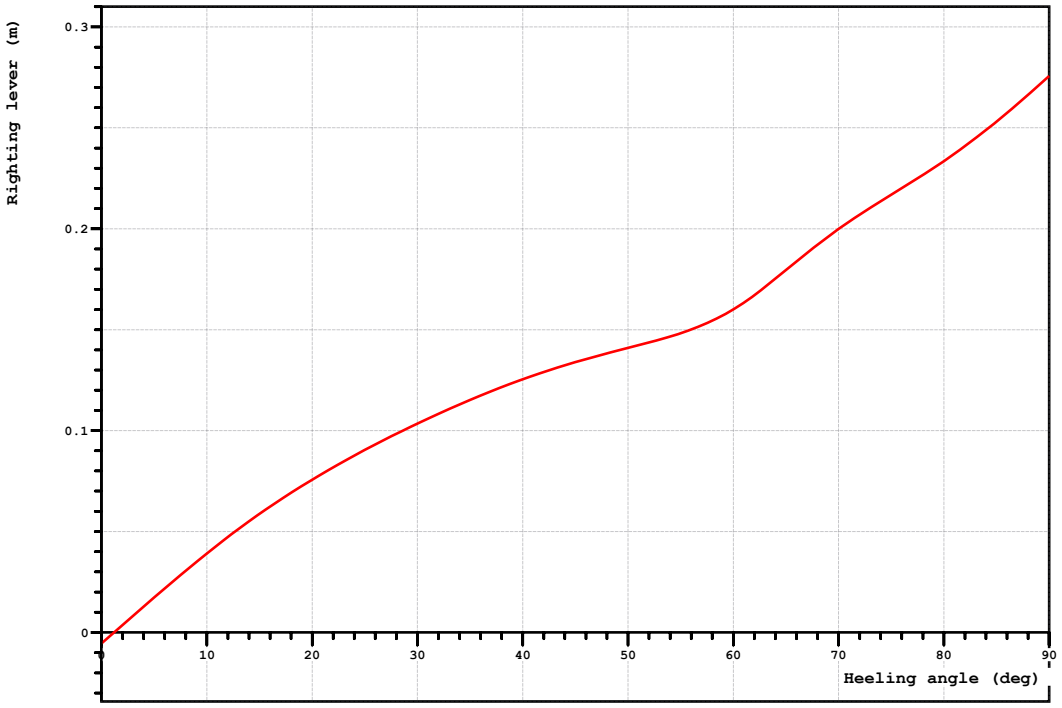
RELEVANT OPENINGS

Loading condition: LK4_A, Max Number of passengers, lightweight A

ID	Description	X m	Y m	Z m	Im.Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	-	0.74
BB2	LOWER EDGE FORE	2.140	1.128	1.360	-	0.76
BB3	UPPER EDGE AFT	1.530	0.921	2.110	-	1.49
BB4	UPPER EDGE FORE	2.140	0.921	2.110	-	1.51
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-36.8	0.70
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-37.5	0.72
SB3	UPPER EDGE AFT	1.530	0.921	2.110	-	1.49
SB4	UPPER EDGE FORE	2.140	0.921	2.110	-	1.51

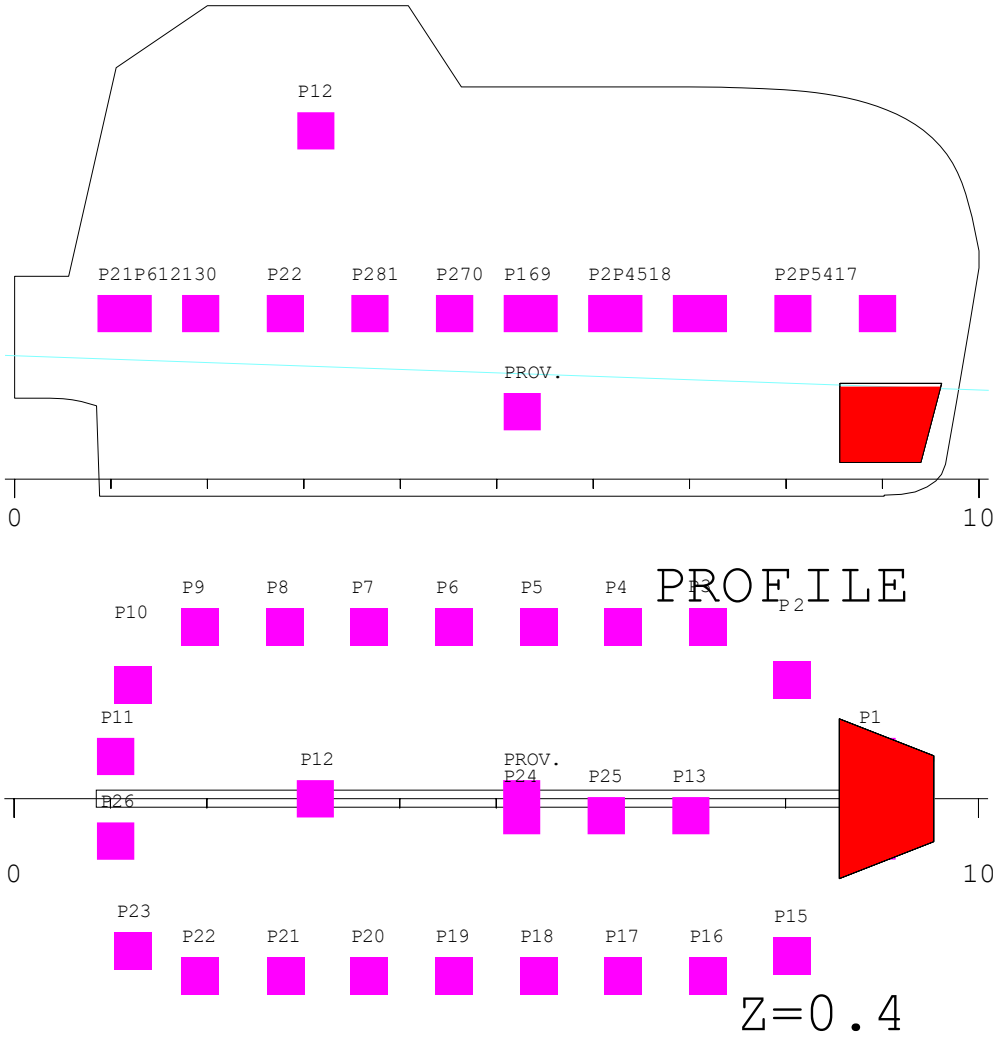
LOADING CONDITION: LK4_A, Max. number of passengers, lightweight A

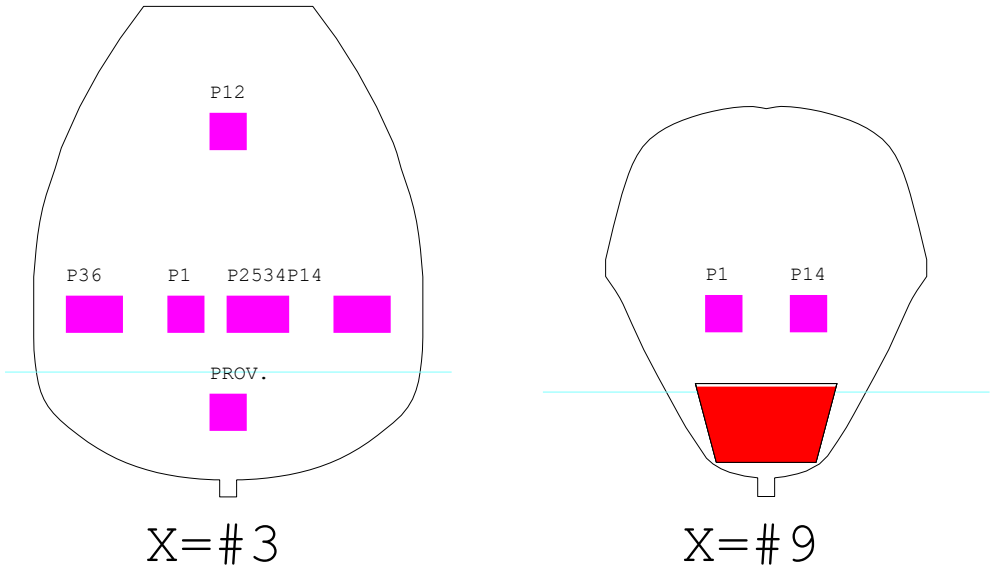
GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.005	0.000	0.0	0.000
5.0	0.105	0.017	0.001	0.0	0.000
10.0	0.209	0.039	0.003	0.0	0.000
15.0	0.309	0.059	0.007	0.0	0.000
20.0	0.404	0.076	0.013	0.0	0.000
30.0	0.581	0.103	0.029	0.0	0.000
40.0	0.738	0.125	0.049	0.0	0.000
50.0	0.869	0.141	0.072	0.0	0.000
60.0	0.982	0.160	0.098	0.0	0.000
70.0	1.091	0.200	0.130	0.0	0.000
80.0	1.166	0.233	0.167	0.0	0.000
90.0	1.222	0.276	0.212	0.0	0.000

LOADING CONDITION: LK4_B, Max. number of passengers, lightweight B





LOADING CONDITION: LK4_B, Max. number of passengers, lightweight B

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
P1	P1	0.0825	0.0	5.100	0.250	0.980	0.00	1.000
P2	P2	0.0825	0.0	4.600	0.732	0.980	0.00	1.000
P3	P3	0.0825	0.0	4.100	0.850	0.980	0.00	1.000
P4	P4	0.0825	0.0	3.600	0.850	0.980	0.00	1.000
P5	P5	0.0825	0.0	3.100	0.850	0.980	0.00	1.000
P6	P6	0.0825	0.0	2.600	0.850	0.980	0.00	1.000
P7	P7	0.0825	0.0	2.100	0.850	0.980	0.00	1.000
P8	P8	0.0825	0.0	1.600	0.850	0.980	0.00	1.000
P9	P9	0.0825	0.0	1.100	0.850	0.980	0.00	1.000
P10	P10	0.0825	0.0	0.700	0.700	0.980	0.00	1.000
P11	P11	0.0825	0.0	0.600	0.250	0.980	0.00	1.000
P12	P12	0.0825	0.0	1.780	0.000	2.060	0.00	1.000
P13	P13	0.0825	0.0	4.000	-0.100	0.980	0.00	1.000
P14	P14	0.0825	0.0	5.100	-0.250	0.980	0.00	1.000
P15	P15	0.0825	0.0	4.600	-0.732	0.980	0.00	1.000
P16	P16	0.0825	0.0	4.100	-0.850	0.980	0.00	1.000
P17	P17	0.0825	0.0	3.600	-0.850	0.980	0.00	1.000
P18	P18	0.0825	0.0	3.100	-0.850	0.980	0.00	1.000
P19	P19	0.0825	0.0	2.600	-0.850	0.980	0.00	1.000
P20	P20	0.0825	0.0	2.100	-0.850	0.980	0.00	1.000
P21	P21	0.0825	0.0	1.600	-0.850	0.980	0.00	1.000
P22	P22	0.0825	0.0	1.100	-0.850	0.980	0.00	1.000
P23	P23	0.0825	0.0	0.700	-0.700	0.980	0.00	1.000
P24	P24	0.0825	0.0	3.000	-0.100	0.980	0.00	1.000
P25	P25	0.0825	0.0	3.500	-0.100	0.980	0.00	1.000
P26	P26	0.0825	0.0	0.600	-0.250	0.980	0.00	1.000
PROVIANT	PROV.	0.1000	0.0	3.000	0.000	0.400	0.00	1.000
SUBTOTAL		2.2450		2.731	-0.011	0.994	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1418	95.0	5.122	0.000	0.343	0.00	0.860
TOTAL		2.3868		2.873	-0.010	0.955	0.00	
Lightweight		2.5330		2.600	0.000	1.013		
Deadweight		2.3868		2.873	-0.010	0.955		
Total weight		4.9198		2.732	-0.005	0.985		

LOADING CONDITION: LK4_B, Max. number of passengers, lightweight B

FLOATING POSITION

Draught moulded	0.630	m	KM	1.19 m
Trim	-0.201	m	KG	0.98 m
Heel, PS=+	-1.4	deg		
TA	0.730	m	GM0	0.20 m
TF	0.529	m	GMCORR	0.00 m
Trimming moment	-1	tf	GM	0.20 m

STABILITY CRITERIA

Loading condition: LK4_B, Max. number of passengers, lightweight B

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.022	mrad	0.741	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.038	mrad	0.764	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.016	mrad	0.844	NOT MET
Min. GZ > 0.2	0.200	0.241	m	1.026	OK
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.230	OK
GM > 0.15 m	0.150	0.204	m	1.039	OK

VCG margin

Maximum VCG = 0.74 m
Actual VCG = 0.98 m
VCG reserve = -0.24 m

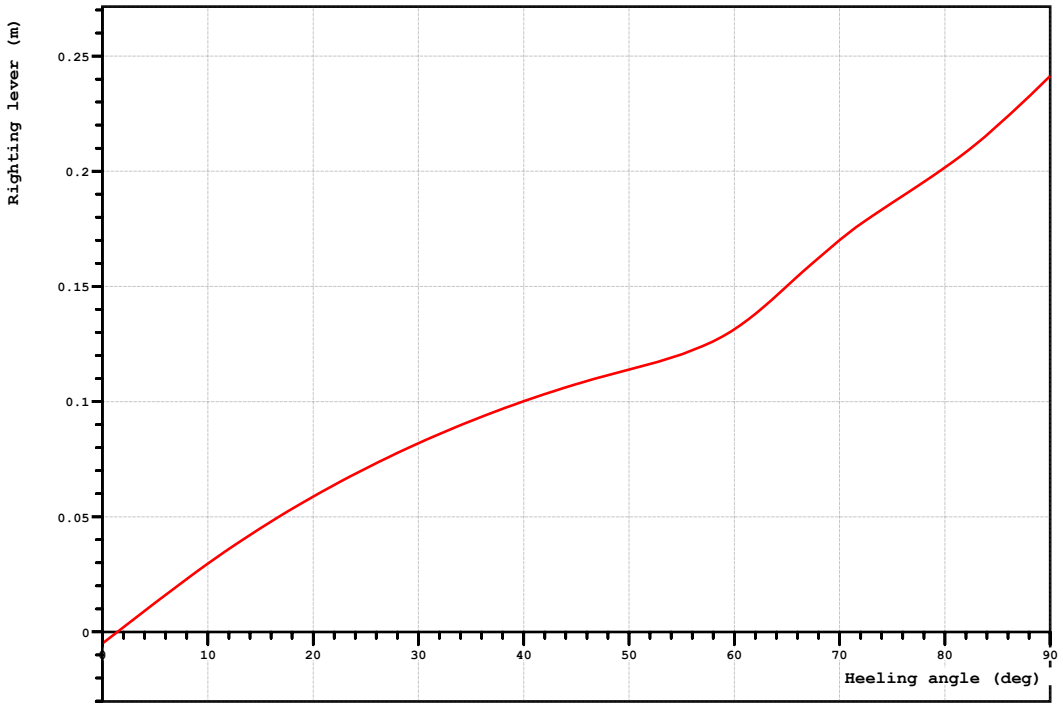
RELEVANT OPENINGS

Loading condition: LK4_B, Max number of passengers, lightweight B

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	-	0.71
BB2	LOWER EDGE FORE	2.140	1.128	1.360	-	0.73
BB3	UPPER EDGE AFT	1.530	0.921	2.110	-	1.46
BB4	UPPER EDGE FORE	2.140	0.921	2.110	-	1.48
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-34.5	0.66
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-35.3	0.68
SB3	UPPER EDGE AFT	1.530	0.921	2.110	-	1.46
SB4	UPPER EDGE FORE	2.140	0.921	2.110	-	1.48

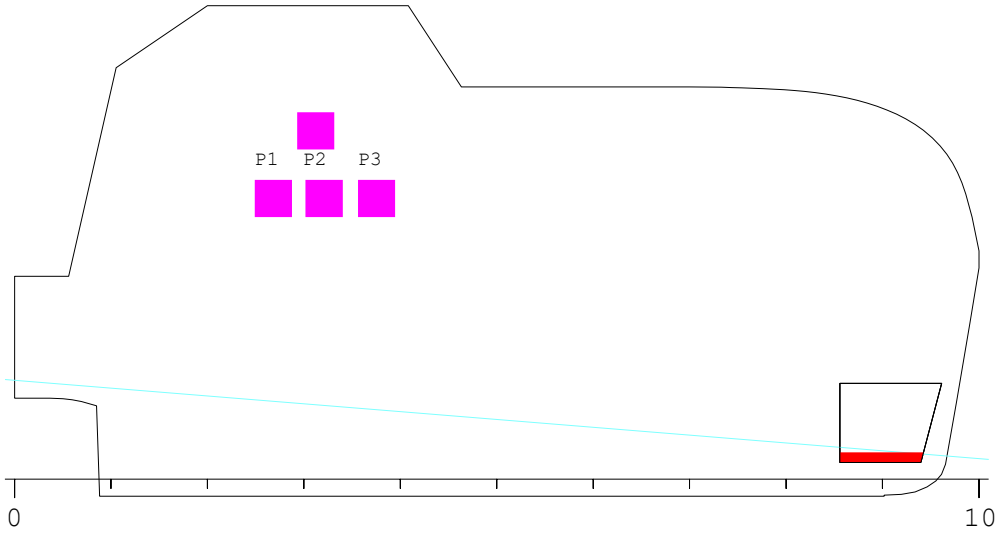
LOADING CONDITION: LK4_B, Max. number of passengers, lightweight B

GZ CURVE

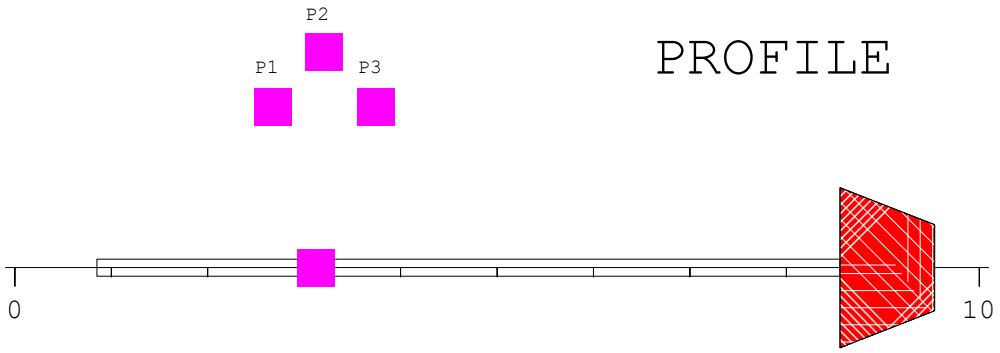


HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.005	0.000	0.0	0.000
5.0	0.103	0.013	0.000	0.0	0.000
10.0	0.206	0.030	0.002	0.0	0.000
15.0	0.305	0.045	0.005	0.0	0.000
20.0	0.400	0.059	0.010	0.0	0.000
30.0	0.579	0.082	0.022	0.0	0.000
40.0	0.737	0.100	0.038	0.0	0.000
50.0	0.872	0.114	0.057	0.0	0.000
60.0	0.987	0.131	0.078	0.0	0.000
70.0	1.097	0.170	0.104	0.0	0.000
80.0	1.172	0.202	0.137	0.0	0.000
90.0	1.226	0.241	0.175	0.0	0.000

LOADING CONDITION: LK5_A, Maritime rescue in hatch, lightweight A



PROFILE



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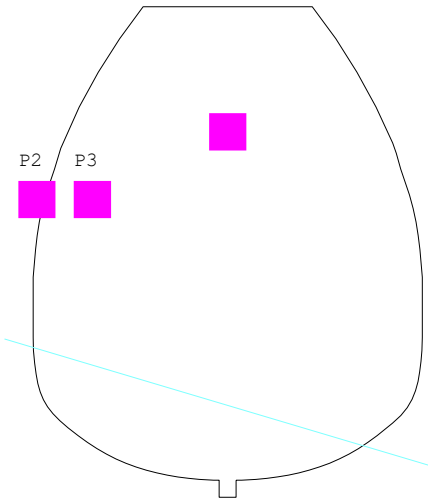

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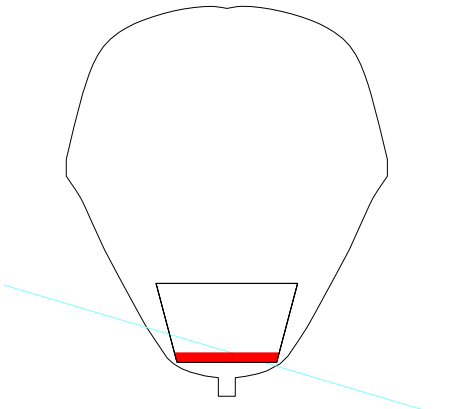

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LOADING CONDITION: LK5_A, Maritime rescue in hatch, lightweight A

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
P1	P1	0.0825	0.0	1.530	0.800	1.660	0.00	1.000
P2	P2	0.0825	0.0	1.830	1.128	1.660	0.00	1.000
P3	P3	0.0825	0.0	2.140	0.800	1.660	0.00	1.000
P4		0.0825	0.0	1.780	0.000	2.060	0.00	1.000
SUBTOTAL		0.3300		1.820	0.682	1.760	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.0149	10.0	5.096	0.000	0.130	0.00	0.860
TOTAL		0.3449		1.962	0.652	1.689	0.00	
Lightweight		2.1410		2.594	0.000	0.936		
Deadweight		0.3449		1.962	0.652	1.689		
Total weight		2.4859		2.506	0.091	1.041		

LOADING CONDITION: LK5_A, Maritime rescue in hatch, lightweight A

FLOATING POSITION

Draught moulded	0.336	m	KM	1.42 m
Trim	-0.444	m	KG	1.04 m
Heel, PS=+	16.6	deg		
TA	0.558	m	GM0	0.38 m
TF	0.114	m	GMCORR	0.00 m
Trimming moment	-1	tf	GM	0.38 m

STABILITY CRITERIA

Loading condition: LK5_A, Maritime rescue in hatch, lightweight A

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.004	mrad	0.607	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.008	mrad	0.661	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.004	mrad	0.779	NOT MET
Min. GZ > 0.2	0.200	0.155	m	0.996	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.257	OK
GM > 0.15 m	0.150	0.377	m	1.268	OK

VCG margin

Maximum VCG = 0.61 m
Actual VCG = 1.04 m
VCG reserve = -0.43 m

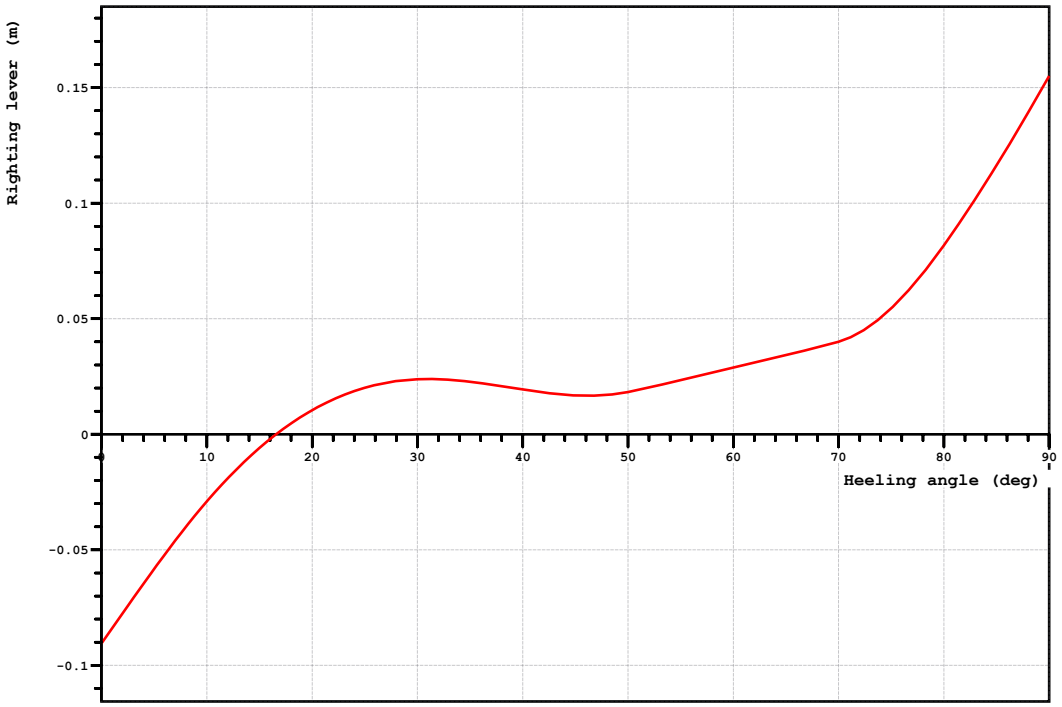
RELEVANT OPENINGS

Loading condition: LK5_A, Maritime rescue in hatch, lightweight A

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	47.9	0.54
BB2	LOWER EDGE FORE	2.140	1.128	1.360	49.6	0.59
BB3	UPPER EDGE AFT	1.530	0.921	2.110	79.3	1.32
BB4	UPPER EDGE FORE	2.140	0.921	2.110	80.3	1.36
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	1.18
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	1.23
SB3	UPPER EDGE AFT	1.530	0.921	2.110	79.3	1.32
SB4	UPPER EDGE FORE	2.140	0.921	2.110	80.3	1.36

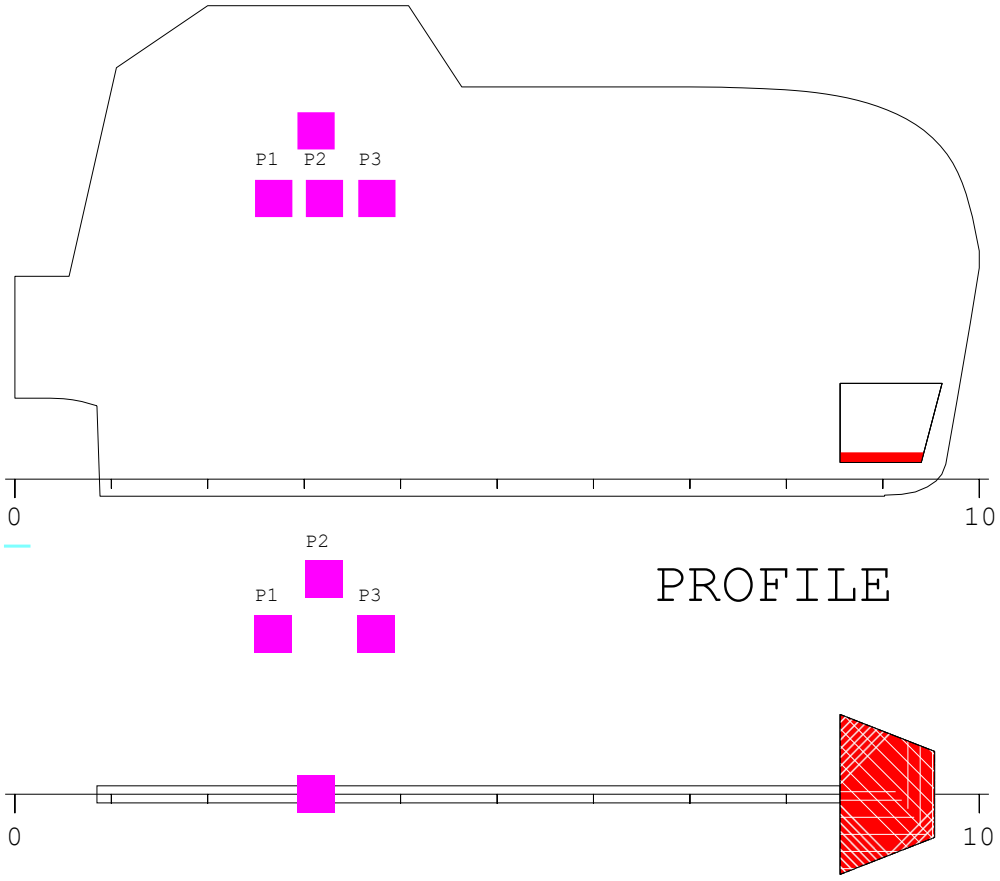
LOADING CONDITION: LK5_A, Maritime rescue in hatch, lightweight A

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.091	0.000	0.0	0.000
5.0	0.123	-0.058	-0.006	0.0	0.000
10.0	0.241	-0.029	-0.010	0.0	0.000
15.0	0.351	-0.006	-0.012	0.0	0.000
20.0	0.451	0.010	-0.011	0.0	0.000
30.0	0.623	0.024	-0.008	0.0	0.000
40.0	0.758	0.019	-0.004	0.0	0.000
50.0	0.874	0.018	-0.001	0.0	0.000
60.0	0.975	0.029	0.003	0.0	0.000
70.0	1.049	0.040	0.009	0.0	0.000
80.0	1.122	0.082	0.019	0.0	0.000
90.0	1.196	0.155	0.039	0.0	0.000

LOADING CONDITION: LK5_B, Maritime rescue in hatch, lightweight B



PROFILE

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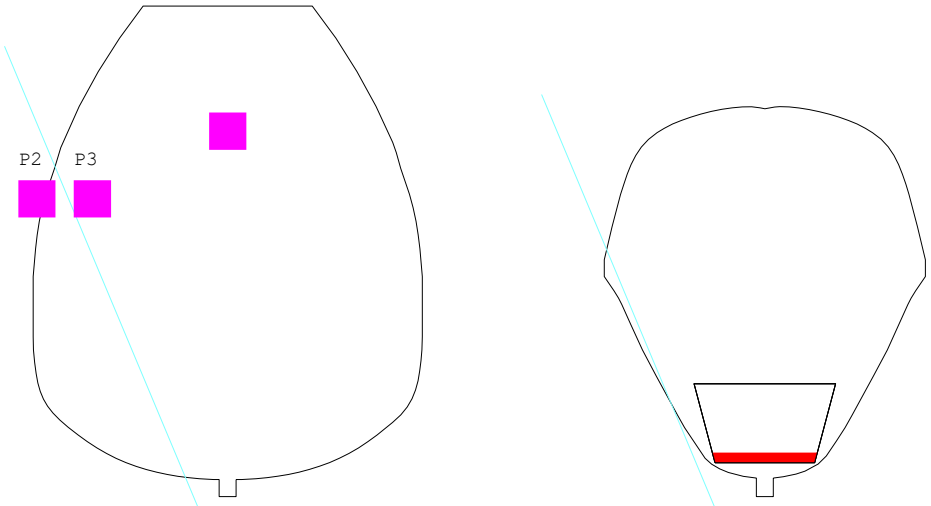

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X=#9

LOADING CONDITION: LK5_B, Maritime rescue in hatch, lightweight B

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
P1	P1	0.0825	0.0	1.530	0.800	1.660	0.00	1.000
P2	P2	0.0825	0.0	1.830	1.128	1.660	0.00	1.000
P3	P3	0.0825	0.0	2.140	0.800	1.660	0.00	1.000
P4		0.0825	0.0	1.780	0.000	2.060	0.00	1.000
SUBTOTAL		0.3300		1.820	0.682	1.760	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.0149	10.0	5.096	0.000	0.130	0.00	0.860
TOTAL		0.3449		1.962	0.652	1.689	0.00	
Lightweight		2.5330		2.600	0.000	1.013		
Deadweight		0.3449		1.962	0.652	1.689		
Total weight		2.8779		2.524	0.078	1.094		

LOADING CONDITION: LK5_B, Maritime rescue in hatch, lightweight B

FLOATING POSITION

Draught moulded	-0.263	m	KM	1.37 m
Trim	-0.184	m	KG	1.09 m
Heel, PS=+	67.2	deg		
TA	-0.170	m	GM0	0.27 m
TF	-0.355	m	GMCORR	0.00 m
Trimming moment	-1	tf	GM	0.27 m

STABILITY CRITERIA

Loading condition: LK5_B, Maritime rescue in hatch, lightweight B

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.000	mrad	0.615	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.000	mrad	0.669	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.000	mrad	0.788	NOT MET
Min. GZ > 0.2	0.200	0.110	m	1.005	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.266	OK
GM > 0.15 m	0.150	0.272	m	1.216	OK

VCG margin

Maximum VCG = 0.62 m
Actual VCG = 1.09 m
VCG reserve = -0.48 m

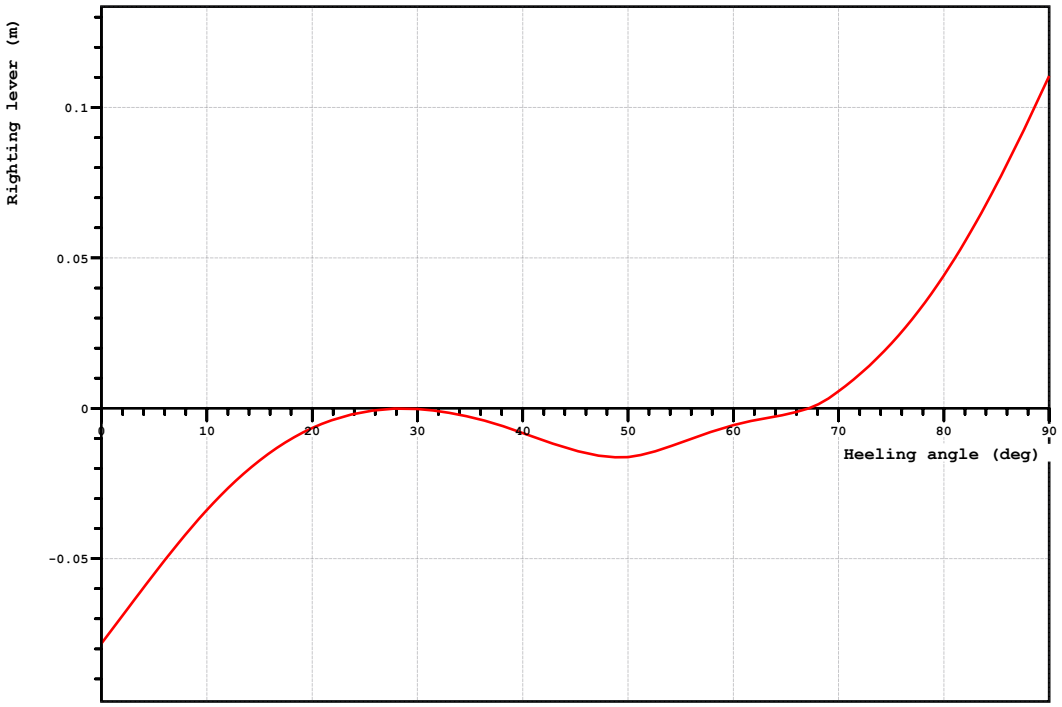
RELEVANT OPENINGS

Loading condition: LK5_B, Maritime rescue in hatch, lightweight B

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	44.8	-0.29
BB2	LOWER EDGE FORE	2.140	1.128	1.360	46.6	-0.27
BB3	UPPER EDGE AFT	1.530	0.921	2.110	77.0	0.19
BB4	UPPER EDGE FORE	2.140	0.921	2.110	77.9	0.21
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	1.79
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	1.80
SB3	UPPER EDGE AFT	1.530	0.921	2.110	77.0	0.19
SB4	UPPER EDGE FORE	2.140	0.921	2.110	77.9	0.21

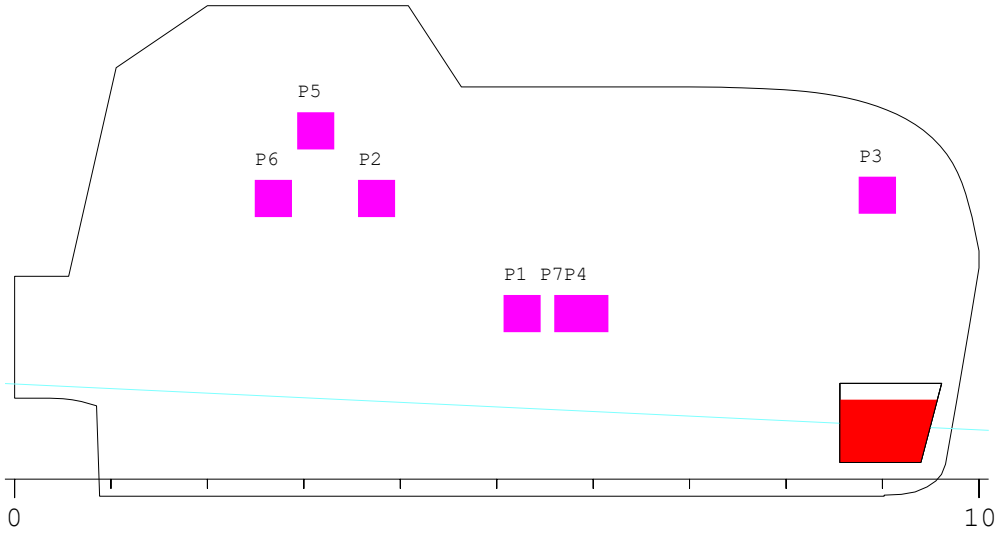
LOADING CONDITION: LK5_B, Maritime rescue in hatch, lightweight B

GZ CURVE

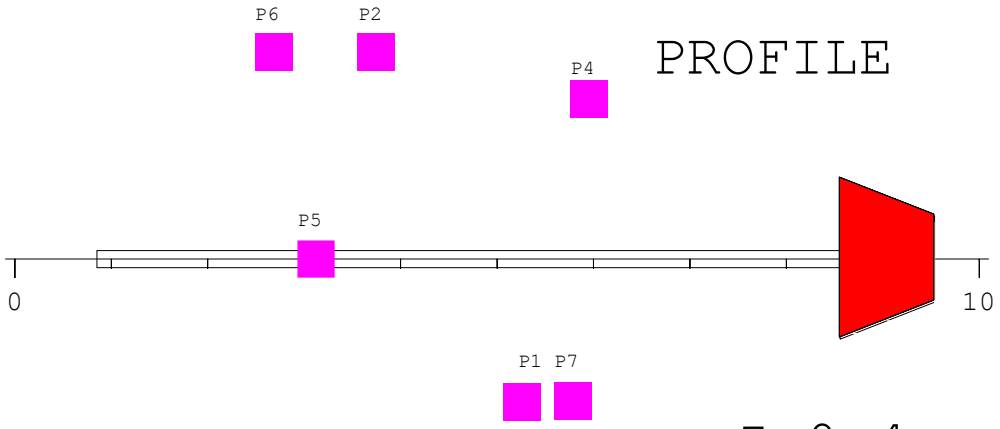


HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.078	0.000	0.0	0.000
5.0	0.118	-0.055	-0.006	0.0	0.000
10.0	0.233	-0.034	-0.010	0.0	0.000
15.0	0.341	-0.017	-0.012	0.0	0.000
20.0	0.441	-0.007	-0.013	0.0	0.000
30.0	0.615	0.000	-0.013	0.0	0.000
40.0	0.755	-0.008	-0.014	0.0	0.000
50.0	0.872	-0.016	-0.016	0.0	0.000
60.0	0.981	-0.006	-0.018	0.0	0.000
70.0	1.060	0.006	-0.018	0.0	0.000
80.0	1.135	0.044	-0.014	0.0	0.000
90.0	1.205	0.110	-0.001	0.0	0.000

LOADING CONDITION: LK6_A, Accident, alt. placement, lightweight A



PROFILE



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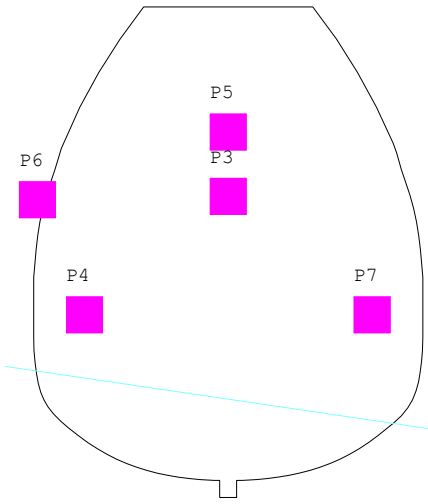

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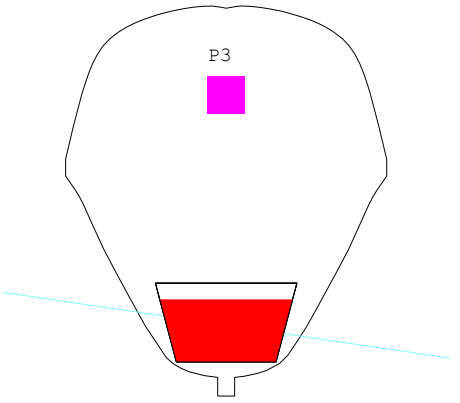

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LOADING CONDITION: LK6_A, Accident, alt. placement, lightweight A

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
PERSON_1	P1	0.0940	0.0	3.000	-0.850	0.980	0.00	1.000
PERSON_2	P2	0.0890	0.0	2.140	1.128	1.660	0.00	1.000
PERSON_3	P3	0.0720	0.0	5.100	0.000	1.680	0.00	1.000
PERSON_4	P4	0.0930	0.0	3.400	0.850	0.980	0.00	1.000
PERSON_5	P5	0.1300	0.0	1.780	0.000	2.060	0.00	1.000
PERSON_6	P6	0.0810	0.0	1.530	1.128	1.660	0.00	1.000
PERSON_7	P7	0.0810	0.0	3.300	-0.850	0.980	0.00	1.000
SUBTOTAL		0.6400		2.779	0.191	1.459	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1119	75.0	5.117	0.000	0.298	0.00	0.860
TOTAL		0.7519		3.127	0.162	1.286	0.00	
Lightweight		2.1410		2.594	0.000	0.936		
Deadweight		0.7519		3.127	0.162	1.286		
Total weight		2.8929		2.733	0.042	1.027		

LOADING CONDITION: LK6_A, Accident, alt. placement, lightweight A

FLOATING POSITION

Draught moulded	0.422	m	KM	1.33 m
Trim	-0.268	m	KG	1.03 m
Heel, PS=+	8.4	deg		
TA	0.556	m	GM0	0.31 m
TF	0.288	m	GMCORR	0.00 m
Trimming moment	-1	tf	GM	0.31 m

STABILITY CRITERIA

Loading condition: LK6_A, Accident, alt. placement, lightweight A

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.012	mrad	0.697	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.021	mrad	0.726	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.009	mrad	0.815	NOT MET
Min. GZ > 0.2	0.200	0.173	m	1.000	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.224	OK
GM > 0.15 m	0.150	0.305	m	1.182	OK

VCG margin

Maximum VCG = 0.70 m
Actual VCG = 1.03 m
VCG reserve = -0.33 m

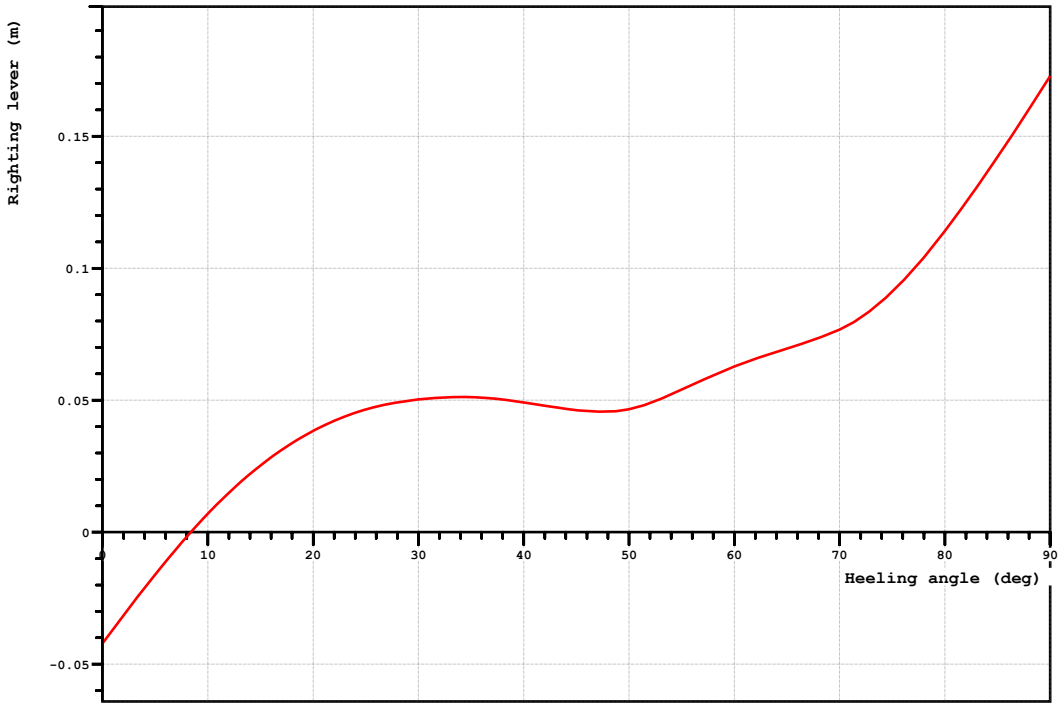
RELEVANT OPENINGS

Loading condition: LK6_A, Accident, alt. placement, lightweight A

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	47.6	0.70
BB2	LOWER EDGE FORE	2.140	1.128	1.360	47.9	0.73
BB3	UPPER EDGE AFT	1.530	0.921	2.110	79.3	1.47
BB4	UPPER EDGE FORE	2.140	0.921	2.110	79.0	1.50
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	1.02
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	1.05
SB3	UPPER EDGE AFT	1.530	0.921	2.110	79.3	1.47
SB4	UPPER EDGE FORE	2.140	0.921	2.110	79.0	1.50

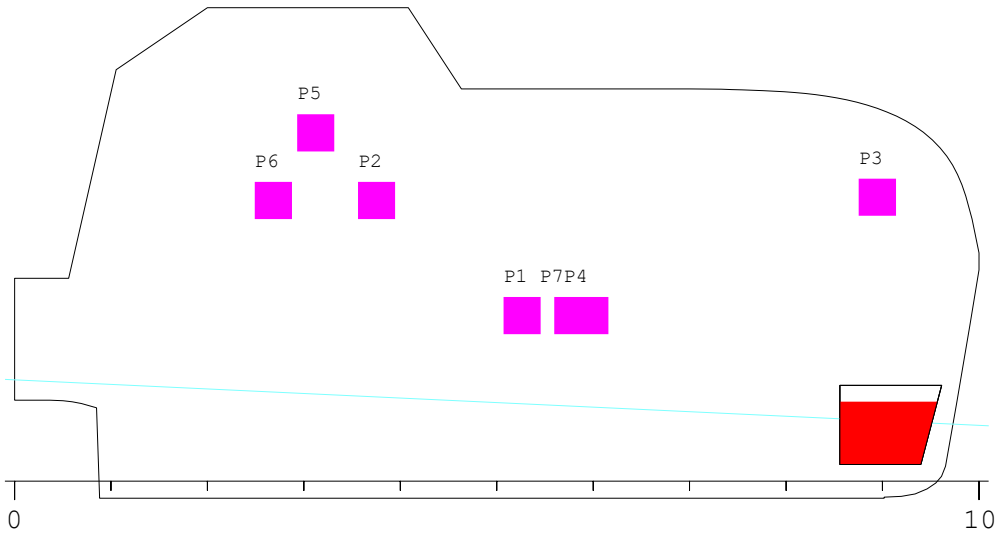
LOADING CONDITION: LK6_A, Accident, alt. placement, lightweight A

GZ CURVE

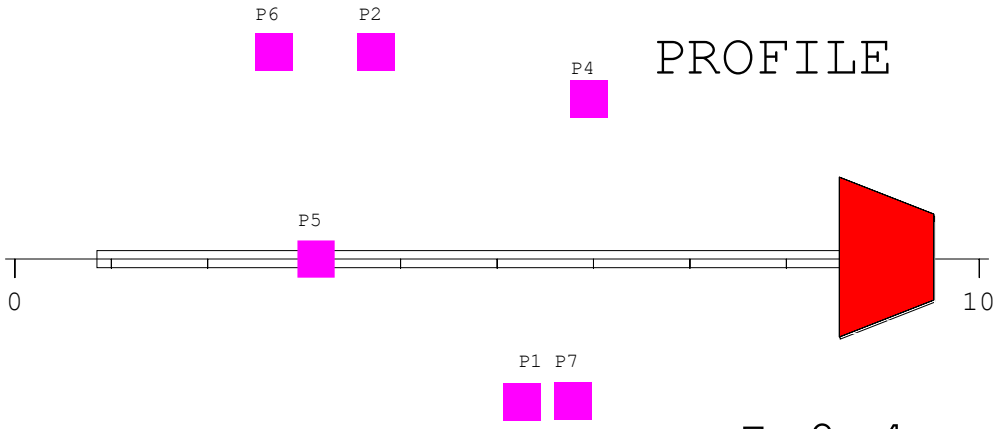


HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.042	0.000	0.0	0.000
5.0	0.115	-0.016	-0.003	0.0	0.000
10.0	0.227	0.007	-0.003	0.0	0.000
15.0	0.332	0.025	-0.001	0.0	0.000
20.0	0.429	0.038	0.001	0.0	0.000
30.0	0.600	0.050	0.009	0.0	0.000
40.0	0.742	0.049	0.018	0.0	0.000
50.0	0.860	0.047	0.026	0.0	0.000
60.0	0.973	0.063	0.036	0.0	0.000
70.0	1.056	0.077	0.048	0.0	0.000
80.0	1.133	0.114	0.064	0.0	0.000
90.0	1.200	0.173	0.089	0.0	0.000

LOADING CONDITION: LK6_B, Accident, alt. placement, lightweight B



PROFILE



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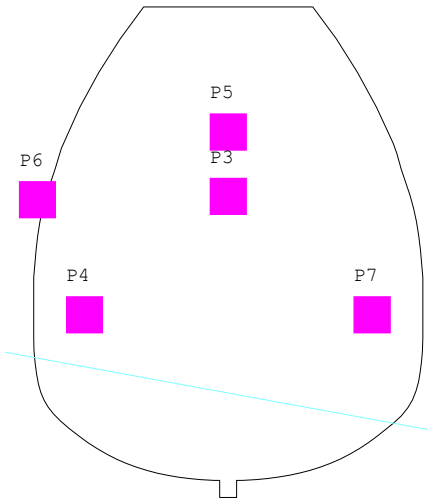

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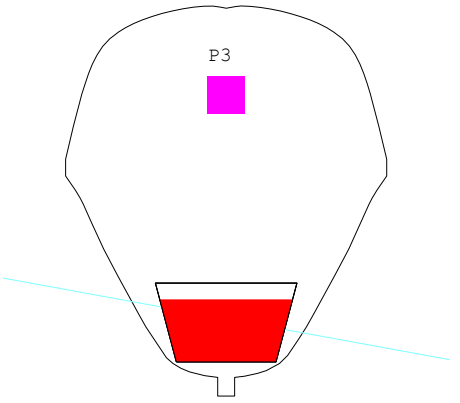


X=#9

LOADING CONDITION: LK6_B, Accident, alt. placement, lightweight B

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
PERSON_1	P1	0.0940	0.0	3.000	-0.850	0.980	0.00	1.000
PERSON_2	P2	0.0890	0.0	2.140	1.128	1.660	0.00	1.000
PERSON_3	P3	0.0720	0.0	5.100	0.000	1.680	0.00	1.000
PERSON_4	P4	0.0930	0.0	3.400	0.850	0.980	0.00	1.000
PERSON_5	P5	0.1300	0.0	1.780	0.000	2.060	0.00	1.000
PERSON_6	P6	0.0810	0.0	1.530	1.128	1.660	0.00	1.000
PERSON_7	P7	0.0810	0.0	3.300	-0.850	0.980	0.00	1.000
SUBTOTAL		0.6400		2.779	0.191	1.459	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1119	75.0	5.117	0.000	0.298	0.00	0.860
TOTAL		0.7519		3.127	0.162	1.286	0.00	
Lightweight		2.5330		2.600	0.000	1.013		
Deadweight		0.7519		3.127	0.162	1.286		
Total weight		3.2849		2.721	0.037	1.075		

LOADING CONDITION: LK6_B, Accident, alt. placement, lightweight B

FLOATING POSITION

Draught moulded	0.456	m	KM	1.30	m
Trim	-0.265	m	KG	1.08	m
Heel, PS=+	10.4	deg			
TA	0.588	m	GM0	0.22	m
TF	0.324	m	GMCORR	0.00	m
Trimming moment	-1	tf	GM	0.22	m

STABILITY CRITERIA

Loading condition: LK6_B, Accident, alt. placement, lightweight B

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.006	mrad	0.695	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.010	mrad	0.727	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.004	mrad	0.818	NOT MET
Min. GZ > 0.2	0.200	0.131	m	1.007	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.235	OK
GM > 0.15 m	0.150	0.222	m	1.147	OK

VCG margin

Maximum VCG = 0.70 m
Actual VCG = 1.08 m
VCG reserve = -0.38 m

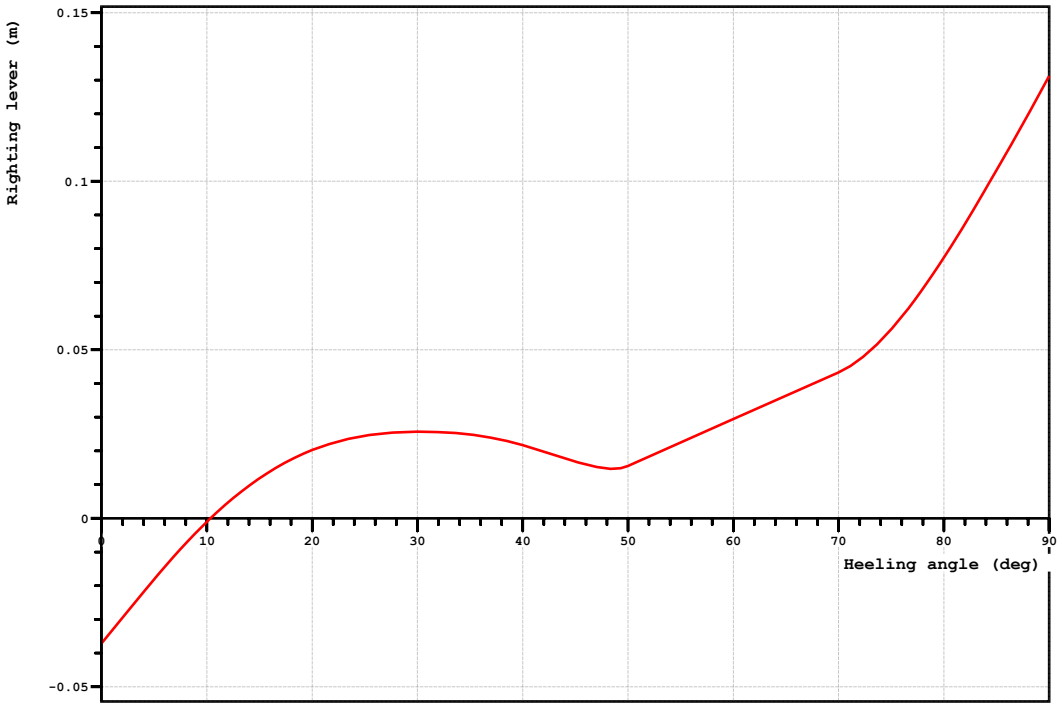
RELEVANT OPENINGS

Loading condition: LK6_B, Accident, alt. placement, lightweight B

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	44.5	0.62
BB2	LOWER EDGE FORE	2.140	1.128	1.360	45.1	0.65
BB3	UPPER EDGE AFT	1.530	0.921	2.110	76.9	1.39
BB4	UPPER EDGE FORE	2.140	0.921	2.110	76.7	1.42
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	1.02
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	1.05
SB3	UPPER EDGE AFT	1.530	0.921	2.110	76.9	1.39
SB4	UPPER EDGE FORE	2.140	0.921	2.110	76.7	1.42

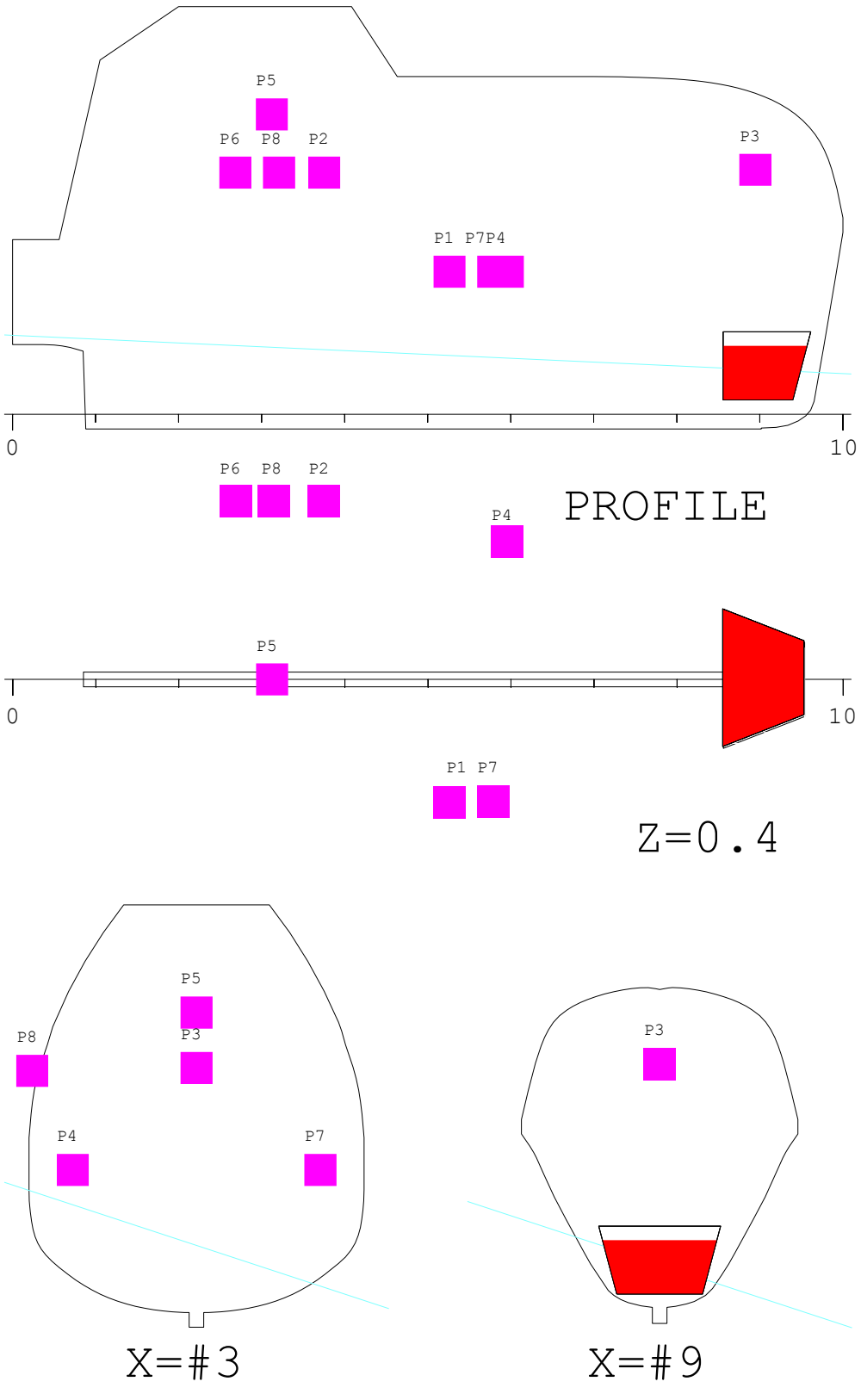
LOADING CONDITION: LK6_B, Accident, alt. placement, lightweight B

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.037	0.000	0.0	0.000
5.0	0.113	-0.018	-0.002	0.0	0.000
10.0	0.222	-0.001	-0.003	0.0	0.000
15.0	0.326	0.012	-0.003	0.0	0.000
20.0	0.423	0.020	-0.001	0.0	0.000
30.0	0.596	0.026	0.003	0.0	0.000
40.0	0.741	0.022	0.007	0.0	0.000
50.0	0.863	0.016	0.010	0.0	0.000
60.0	0.979	0.029	0.014	0.0	0.000
70.0	1.067	0.043	0.020	0.0	0.000
80.0	1.143	0.077	0.031	0.0	0.000
90.0	1.207	0.131	0.049	0.0	0.000

LOADING CONDITION: LK7_A, Accident, alt. placement, maritime rescue, lightweight A



LOADING CONDITION: LK7_A, Accident, alt. placement, maritime rescue, lightweight A

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
PERSON_1	P1	0.0940	0.0	3.000	-0.850	0.980	0.00	1.000
PERSON_2	P2	0.0890	0.0	2.140	1.128	1.660	0.00	1.000
PERSON_3	P3	0.0720	0.0	5.100	0.000	1.680	0.00	1.000
PERSON_4	P4	0.0930	0.0	3.400	0.850	0.980	0.00	1.000
PERSON_5	P5	0.1300	0.0	1.780	0.000	2.060	0.00	1.000
PERSON_6	P6	0.0810	0.0	1.530	1.128	1.660	0.00	1.000
PERSON_7	P7	0.0810	0.0	3.300	-0.850	0.980	0.00	1.000
PERSON_8	P8	0.0825	0.0	1.830	1.128	1.660	0.00	1.000
SUBTOTAL		0.7225		2.671	0.298	1.482	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1119	75.0	5.117	0.000	0.298	0.00	0.860
TOTAL		0.8344		2.999	0.258	1.323	0.00	
Lightweight		2.1410		2.594	0.000	0.936		
Deadweight		0.8344		2.999	0.258	1.323		
Total weight		2.9754		2.707	0.072	1.045		

LOADING CONDITION: LK7_A, Accident, alt. placement, maritime rescue, lightweight A

FLOATING POSITION

Draught moulded	0.388	m	KM	1.33 m
Trim	-0.251	m	KG	1.04 m
Heel, PS=+	18.2	deg		
TA	0.514	m	GM0	0.28 m
TF	0.263	m	GMCORR	0.00 m
Trimming moment	-1	tf	GM	0.28 m

STABILITY CRITERIA

Loading condition: LK7_A, Accident, alt. placement, maritime rescue, lightweight A

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.002	mrad	0.600	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.005	mrad	0.654	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.003	mrad	0.773	NOT MET
Min. GZ > 0.2	0.200	0.157	m	1.002	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.265	OK
GM > 0.15 m	0.150	0.283	m	1.177	OK

VCG margin

Maximum VCG = 0.60 m
Actual VCG = 1.04 m
VCG reserve = -0.44 m

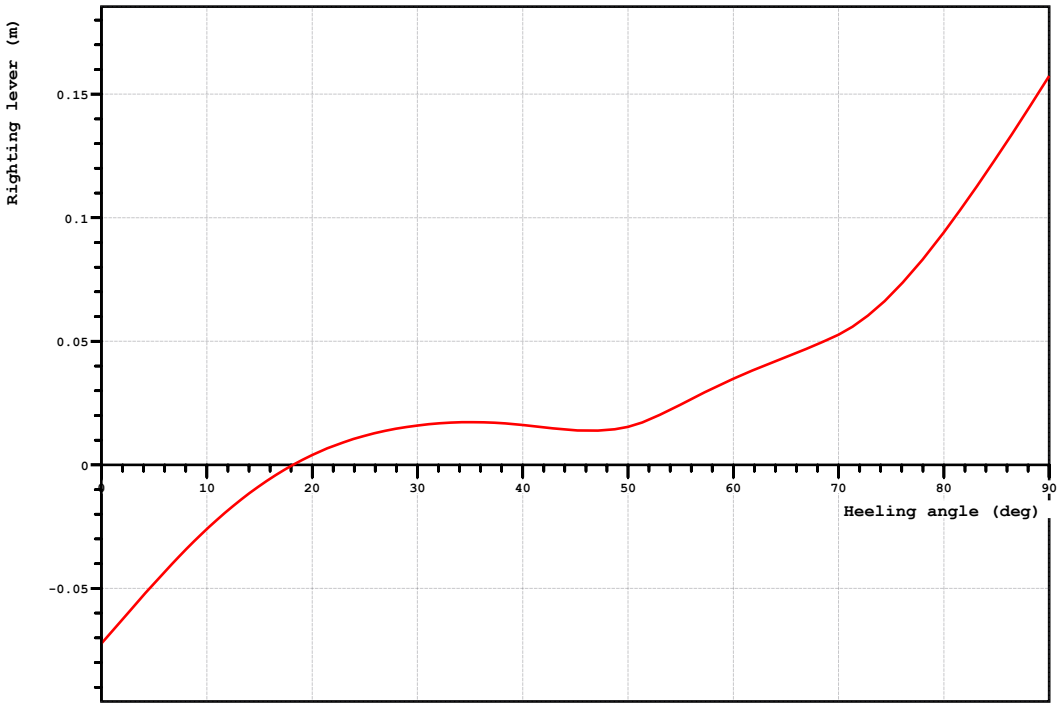
RELEVANT OPENINGS

Loading condition: LK7_A, Accident, alt. placement, maritime rescue, lightweight A

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	46.6	0.49
BB2	LOWER EDGE FORE	2.140	1.128	1.360	47.2	0.52
BB3	UPPER EDGE AFT	1.530	0.921	2.110	78.6	1.27
BB4	UPPER EDGE FORE	2.140	0.921	2.110	78.4	1.30
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	1.20
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	1.22
SB3	UPPER EDGE AFT	1.530	0.921	2.110	78.6	1.27
SB4	UPPER EDGE FORE	2.140	0.921	2.110	78.4	1.30

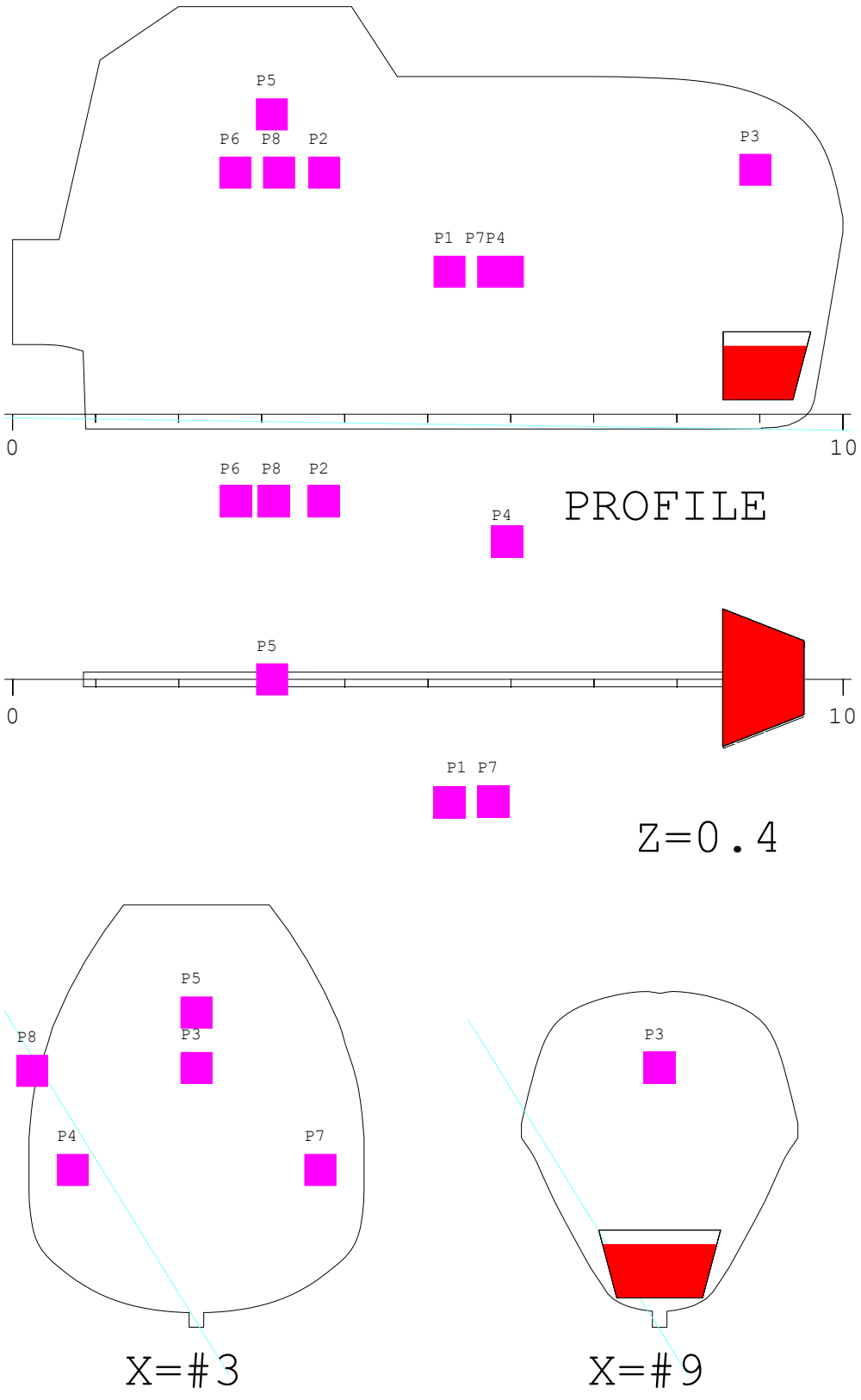
LOADING CONDITION: LK7_A, Accident, alt. placement, maritime rescue, lightweight A

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.072	0.000	0.0	0.000
5.0	0.115	-0.048	-0.005	0.0	0.000
10.0	0.227	-0.026	-0.008	0.0	0.000
15.0	0.332	-0.009	-0.010	0.0	0.000
20.0	0.429	0.004	-0.010	0.0	0.000
30.0	0.601	0.016	-0.008	0.0	0.000
40.0	0.743	0.016	-0.005	0.0	0.000
50.0	0.862	0.015	-0.003	0.0	0.000
60.0	0.976	0.035	0.002	0.0	0.000
70.0	1.059	0.053	0.009	0.0	0.000
80.0	1.135	0.094	0.022	0.0	0.000
90.0	1.202	0.157	0.043	0.0	0.000

LOADING CONDITION: LK7_B, Accident, alt. placement, maritime rescue, lightweight B



LOADING CONDITION: LK7_B, Accident, alt. placement, maritime rescue, lightweight B

NAME	DESCRIPTION	MASS t	FILL %	LCG m	TCG m	VCG m	FRSM tm	DENS t/m3
CONTENTS= (RHO=1.000)								
PERSON_1	P1	0.0940	0.0	3.000	-0.850	0.980	0.00	1.000
PERSON_2	P2	0.0890	0.0	2.140	1.128	1.660	0.00	1.000
PERSON_3	P3	0.0720	0.0	5.100	0.000	1.680	0.00	1.000
PERSON_4	P4	0.0930	0.0	3.400	0.850	0.980	0.00	1.000
PERSON_5	P5	0.1300	0.0	1.780	0.000	2.060	0.00	1.000
PERSON_6	P6	0.0810	0.0	1.530	1.128	1.660	0.00	1.000
PERSON_7	P7	0.0810	0.0	3.300	-0.850	0.980	0.00	1.000
PERSON_8	P8	0.0825	0.0	1.830	1.128	1.660	0.00	1.000
SUBTOTAL		0.7225		2.671	0.298	1.482	0.00	
CONTENTS=Diesel Oil (RHO=0.860)								
FUEL_TANK		0.1119	75.0	5.117	0.000	0.298	0.00	0.860
TOTAL		0.8344		2.999	0.258	1.323	0.00	
Lightweight		2.5330		2.600	0.000	1.013		
Deadweight		0.8344		2.999	0.258	1.323		
Total weight		3.3674		2.699	0.064	1.090		

LOADING CONDITION: LK7_B, Accident, alt. placement, maritime rescue, lightweight B

FLOATING POSITION

Draught moulded	-0.044	m	KM	1.29 m
Trim	-0.045	m	KG	1.09 m
Heel, PS=+	58.3	deg		
TA	-0.021	m	GM0	0.20 m
TF	-0.066	m	GMCORR	0.00 m
Trimming moment	0	tf	GM	0.20 m

STABILITY CRITERIA

Loading condition: LK7_B, Accident, alt. placement, maritime rescue, lightweight B

CRITERIA	REQ	ATTV	UNIT	MAXKG	STAT
Area under GZ curve up to 30 deg	0.055	0.000	mrad	0.608	NOT MET
Area under GZ curve up to 40 deg.	0.090	0.000	mrad	0.662	NOT MET
Area under GZ curve between 30 and 40 deg	0.030	0.000	mrad	0.780	NOT MET
Min. GZ > 0.2	0.200	0.119	m	1.009	NOT MET
Max. GZ at an angle > 25 deg.	25.000	90.000	deg	1.268	OK
GM > 0.15 m	0.150	0.204	m	1.143	OK

VCG margin

Maximum VCG = 0.61 m
Actual VCG = 1.09 m
VCG reserve = -0.48 m

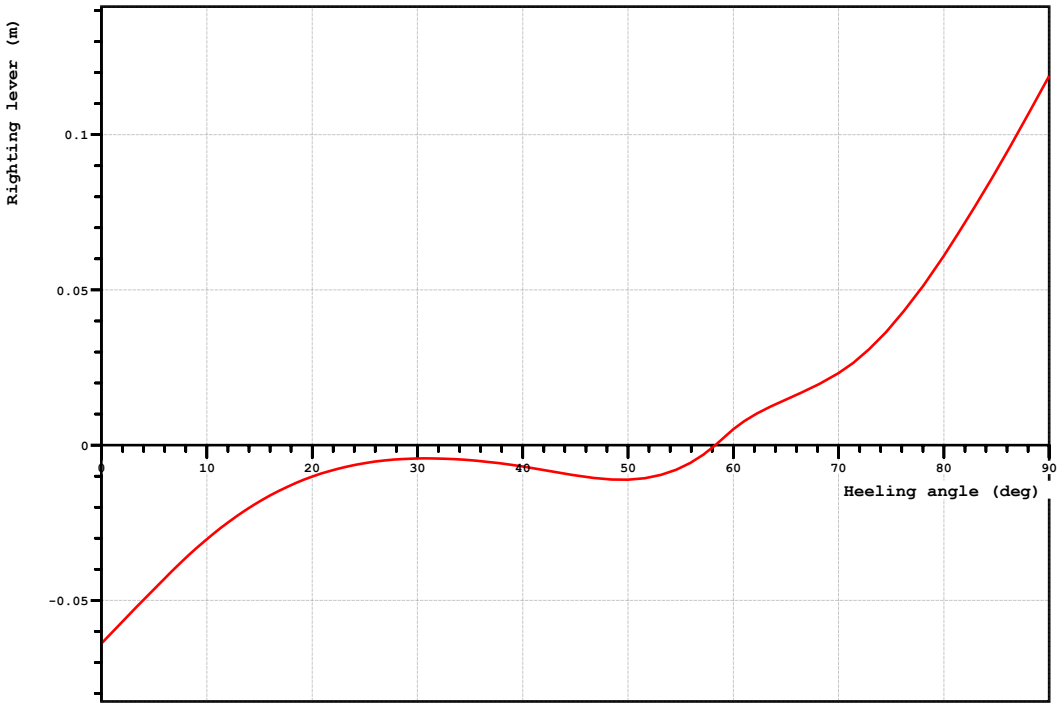
RELEVANT OPENINGS

Loading condition: LK7_B, Accident, alt. placement, maritime rescue, lightweight B

ID	Description	X m	Y m	Z m	Im. Angle deg	Ht. to WL m
BB1	LOWER EDGE AFT	1.530	1.128	1.360	43.5	-0.21
BB2	LOWER EDGE FORE	2.140	1.128	1.360	44.3	-0.21
BB3	UPPER EDGE AFT	1.530	0.921	2.110	76.3	0.36
BB4	UPPER EDGE FORE	2.140	0.921	2.110	76.2	0.36
SB1	LOWER EDGE AFT	1.530	-1.128	1.360	-	1.71
SB2	LOWER EDGE FORE	2.140	-1.128	1.360	-	1.71
SB3	UPPER EDGE AFT	1.530	0.921	2.110	76.3	0.36
SB4	UPPER EDGE FORE	2.140	0.921	2.110	76.2	0.36

LOADING CONDITION: LK7_B, Accident, alt. placement, maritime rescue, lightweight B

GZ CURVE



HEEL deg	KN m	GZ m	AREA mrad	FSMOM tm	DGZ m
0.0	0.000	-0.064	0.000	0.0	0.000
5.0	0.112	-0.046	-0.005	0.0	0.000
10.0	0.222	-0.030	-0.008	0.0	0.000
15.0	0.326	-0.018	-0.010	0.0	0.000
20.0	0.423	-0.010	-0.011	0.0	0.000
30.0	0.596	-0.004	-0.013	0.0	0.000
40.0	0.743	-0.007	-0.013	0.0	0.000
50.0	0.865	-0.011	-0.015	0.0	0.000
60.0	0.981	0.005	-0.016	0.0	0.000
70.0	1.069	0.023	-0.014	0.0	0.000
80.0	1.145	0.061	-0.007	0.0	0.000
90.0	1.209	0.119	0.009	0.0	0.000