Report 01-203

container vessel *Nicolai Maersk*

fatality during lifeboat drill

Auckland

13 February 2001

Abstract

At about 0750 on 13 February 2001, the crew were performing a lifeboat launching drill shortly after the vessel *Nicolai Maersk* arrived in Auckland. While attempting to return the port lifeboat from the boat deck level to its stow position, the davit winch motor repeatedly tripped on overload. In order to stow the lifeboat, the davit arms were raised by manually closing the contactor located in the lifeboat winch starter box one deck below, to operate the winch motor. Manual closing of the contactor had the effect of bypassing the safety stop limit switches. The davit arms were pulled hard up to their stops and both wire falls parted. The lifeboat dropped to the boat deck and then rolled overboard, falling some 16 metres to the sea and landing upside down. Of the 7 crew inside the lifeboat, one was fatally injured, 2 were seriously injured and 4 received minor injuries.

Safety issues identified included:

- bypassing of critical safety features through the use of non-standard operating procedures
- the limited understanding the crew had of the lifeboat retrieval apparatus and its associated circuitry
- the fitness for purpose of the lifeboat retrieval apparatus and its approval by the various administrations involved
- the design oversight of a simple failsafe device on the lifeboat davit that could have prevented the lifeboat falling when the wire falls parted.

Safety recommendations were made to the operator, the manufacturer and the director of the New Zealand Maritime Safety Authority to address the safety issues.

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

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courtesy of AXIS Intermodal

Nicolai Maersk

Contents

Figures

Abbreviations

Amp	Amperes
GRP	glass-reinforced plastic
IMO	International Maritime Organisation
ISM	International Safety Management
kg	kilogram(s)
kW	kilowatt(s)
MAIB	Marine Accident Investigation Branch (UK)
m	metre(s)
mm	millimetre(s)
SOLAS	Safety of Life at Sea
t	tonnes
UTC	universal time co-ordinated

Glossary

davit	launching apparatus for the lifeboat, comprising a structure fixed to the ship's deck and 2 hinged davit arms
draught	depth in water at which a ship floats
gross tonnage	a measure of the internal capacity of a ship; enclosed spaces are measured in cubic metres and the tonnage derived by formula
list	angle of tilt caused by internal distribution of weights
painter	quick-release rope attaching the bow of the lifeboat to the ship
port	left-hand side when facing forward
starboard	right-hand side when facing forward
trim	difference between the forward and aft draughts of a floating vessel

Data Summary

Vessel particulars:

Name:	*Nicolai Maersk*
Type:	container ship
Classification:	Lloyds Register of Shipping
Registered:	Denmark
Owner:	Aktieselkabet Dampskibsselskabet Svenborg and Dampskibsselskabet AF 1912 Aktieselskab
Operator:	A.P. Moller
Length:	198.6 m
Beam:	30.2 m
Tonnage (gross):	27 733 t
Tonnage (deadweight):	30 191 t
Summer draught:	11.032 m
Built:	by CSBC, Taiwan in July 2000
Propulsion:	one 28 762 kW Sulzer 7RTA84C diesel engine, driving a single fixed-pitch propeller

Date and time:	13 February 2001 at about 0750[1]	
Location:	Auckland, New Zealand	
Persons on board lifeboat:	crew:	7
Injuries:	crew:	1 (fatal) 2 (serious) 4 (minor)
Damage:	extensive to lifeboat	
Investigator-in-charge:	Captain Tim Burfoot	

[1] All times in this report refer to New Zealand Daylight Time (UTC + 13 hours) and are expressed in the 24-hour mode.

1. The Accident

1.1 Narrative

1.1.1 The *Nicolai Maersk* was a container ship trading on a liner service between ports in New Zealand and South East Asia. The vessel arrived at the Ferguson container terminal and berthed starboard side to, at about 0640 on Tuesday 13 February 2001.

1.1.2 A lifeboat drill[2] had been scheduled for soon after arrival at the berth. The drill was to involve launching the port lifeboat with 8 of its crew on board, manoeuvring the boat on the water and retrieving it. This opportunity was chosen to minimise disruption to the crew's daily working and sleep patterns, as most crew members were required to be awake for the ship's arrival.

1.1.3 The chief officer was in charge of the drill. While he was attending to arrival formalities and liaising with the shore stevedores to start cargo operations, the lifeboat crew prepared the lifeboat for launching.

1.1.4 At about 0715 the chief officer briefed the first officer on how the drill would proceed. Seven of the original 8 crew boarded the lifeboat while it was still in its stow position. The chief officer instructed the electrician to stay on the ship in case any equipment fault developed that required the electrician's expertise.

1.1.5 The boat was lowered from the stow position to boat deck level using the brake release control lever. The chief officer then tested the electric hoist winch to make sure it was operational[3]. The winch did not work.

1.1.6 The chief officer instructed the electrician to investigate why the winch did not work, while other crew started to wind the lifeboat back up using the manual winch handle. The electrician saw that the power source indicator light on the winch remote control unit was not lit, so he went down to the lifeboat winch starter box located one deck below in the compressor room. There he noticed that the circuit breaker had tripped. He reset the circuit breaker and pushed a button on the main contactor. Pushing this button resulted in the davit winch motor hoisting the boat for about one second before the circuit breaker tripped again.

1.1.7 On deck the crew were still manually winding the winch when the winch motor began running for about one second. They stopped winding while the chief officer went down to the compressor room to speak with the electrician. The chief officer pushed the button on the main contactor, but nothing happened, so he returned to the boat deck with the electrician. The crew resumed manually winding the boat to its stow position again while the electrician began to investigate further the cause of the malfunction.

1.1.8 The crew in the lifeboat were at that time captive in the lifeboat as it had been raised to a point between the boat deck and its stow position, making it hazardous for them to disembark.

1.1.9 It was a hot day and winding the lifeboat up was slow and physically hard work. The chief officer told the electrician to go back down to the compressor room and do whatever he had done last time to get the winch to hoist. Another crew member, who had a portable radio, went with the electrician to act as a communication link with the chief officer on deck.

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[2] The Safety of Life at Sea (SOLAS) regulations require that each lifeboat be launched with its assigned operating crew aboard and manoeuvred on the water at least once every 3 months.

[3] On a previous boat drill on another vessel the chief officer had experienced an event where the hoist winch had malfunctioned. On that occasion the boat had to be hand winched from the water to its stow position, which was a labour-intensive task. Since then he routinely tested the hoist winch before lowering the lifeboat to the water.

1.1.10 Back in the compressor room, the electrician reset the circuit breaker and pushed the button on the main contactor. The winch operated for about another second before the circuit breaker tripped again. On instruction from the chief officer, the electrician repeated the procedure several times. On deck, the lifeboat and its davit arms were moving up and inboard about half a metre each time.

1.1.11 As the lifeboat neared its stow position the circuit breaker did not trip and the winch continued to run smoothly while the electrician kept the button on the main contactor pressed in. On each of the davit arms there was a safety stop limit switch, the purpose of which was to stop the winch motor before the davit arms came hard up to their stops. The chief officer saw that the winch was still winding in past where the limit switches should have stopped the motor, so he immediately said "stop" several times into his radio.

1.1.12 In the compressor room, the electrician heard the chief officer say "stop" and took his finger off the contactor button, but not before the davit arms had come hard up on their stops and both wire falls parted.

1.1.13 When the wire falls parted, the davit arms and lifeboat fell outboard. The lifeboat did not pass free of the boat deck as it normally would, but landed on the edge of the boat deck with the davit arms on top of it. The boat teetered there momentarily and then rolled over the edge, falling some 16 m to the sea and landing upside down (see Figure 1 below).

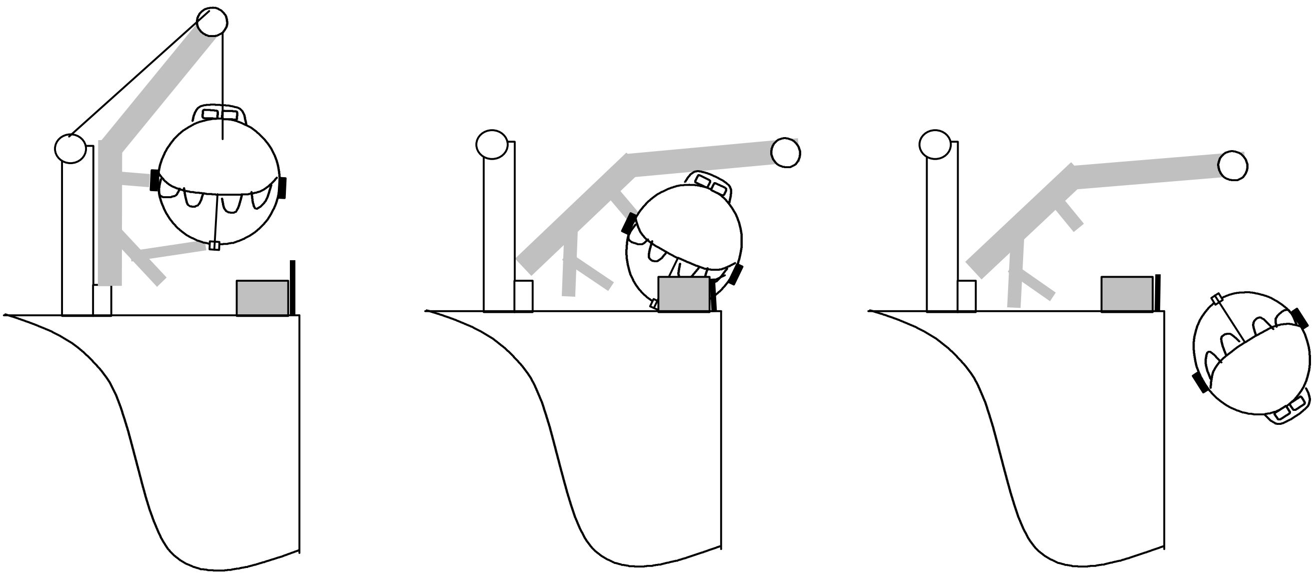


Figure 1
Simplified drawings showing accident sequence from left to right
(not to scale)

1.1.14 The lifeboat self-righted and remained attached to the ship by its painter. Ambulances were called and Auckland Harbour Control informed by radio. The port company pilot boat was nearby and assisted to take medics to the lifeboat. The lifeboat crew were transferred to the pilot launch, taken over to waiting ambulances and taken to hospital for treatment.

Analysis 1

1. It became apparent during interviews with the crew that, while they understood the basic procedure for launching and retrieving the lifeboat, no one spoken to was totally familiar with the launching apparatus, and in particular with the electrical circuitry associated with the retrieval system. The electrician had not seen a wiring diagram for the davit winch, nor did he refer to one before operating the winch from the deck below using the manual contactor button.

2. A more detailed description of the circuitry and the possible reasons why the winch motor cut out on overload is given and discussed in section 2 of this report, but in short, the effect of pushing the manual button on the main contactor overrode 2 important safety items; the first being the winch motor overload device and the second the safety stop limit switches. The limit switches were installed to prevent this very type of accident.

3. When the lifeboat was normally hoisted from sea level, the winch motor was at first hoisting the weight of the loaded lifeboat, the wire falls and the fall blocks, as well as overcoming any friction in the system. As the lifeboat was raised, the load on the winch motor reduced with the decrease in weight of the falls. As the fall blocks contacted the davit heads when the lifeboat reached about boat deck level, the load on the winch increased as it took up the weight of the davit arms as well. The further up and inboard the boat and davit arms reached, the more the load on the winch motor reduced as the movement progressively changed from upwards to laterally inboard. This was probably why the circuit breaker did not trip during the final moments before the accident. Without the limit switches to stop the electric winch motor, the motor pulled the davit arms hard up against the stops and applied sufficient force on the wire falls to part them before the chief officer could react, relay his message to the electrician, and the electrician respond by removing his finger from the contactor button.

4. The compressor room was relatively noisy, and it is possible that the electrician did not hear the chief officer's first request to stop.

5. Ideally the chief officer should at least have removed the crew from the lifeboat before attempting an untried and non-standard procedure to bring the lifeboat back to its stow position, but this would in itself have been a risky operation. His safest option would have been to continue winding the boat up by hand, disembark the crew, identify and fix the reason why the lifeboat winch was not performing normally, and then retest it.

1.2 Injuries and damage

1.2.1 One crew member was fatally injured. All crew members were strapped in with double shoulder and lap harnesses. They were all wearing hard hats and safety boots. The crew member who died was seated on the starboard side aft with his back to the outside of the boat. When the lifeboat fell to the boat deck and the davit arms landed on top of it, the upper stowing chock on the aft davit arm pierced the lifeboat's superstructure in the area where the deceased was sitting.

1.2.2 Two other crew members received serious injuries, including lacerations and fractures.

1.2.3 The remaining 4 crew members received minor cuts and bruises only.

1.2.4 The lifeboat was extensively damaged. The hull and topsides were damaged in several places, requiring major structural repairs. The internals of the boat were relatively intact. A centreline seat back dislodged from its securing at one end. This seat back contained the securing points for several shoulder and lap harnesses.

Analysis 2

1. The injuries to the deceased indicate that he died as a result of the intrusion into the cabin area of the aft davit arm upper stowing chock when the boat first fell to the boat deck. A blow to his upper back from the stowing chock probably caused unsurvivable injuries in the impact just before the lifeboat fell to the sea.

2. The dislodgement of one end of the centreline seat back containing a number of harnesses was a consequence of several crew members being strapped to the seat back when the boat impacted the water upside down. It is unlikely the centreline seat back was designed to withstand such forces.

3. Under the circumstances the minimal injuries sustained by the other crew members were a tribute to the robust design of the lifeboat, and the fact that they were restrained by lap and shoulder harnesses, and wearing hard hats and safety boots.

1.2.5 Damage to the ship was confined to the broken wire falls and damage to handrails on the boat deck. Some minor cracking of welds in the stowing chocks on the davit arm was noted, but the davit structure as a whole was intact. The lifeboat falls were 18 mm diameter 18 x 7 strand, stainless steel wire ropes.

Analysis 3

1. The wire ropes were in good condition, showing no signs of corrosion and with minimal wear. Examination of the broken ends of the falls showed they had failed in overload. The breaks in the individual bunches of wire strands in the aft fall were staggered, which suggested that pull from the winch had been exerted on this wire fall marginally before the forward one, with a slower build-up of forces resulting in progressive failure.

2. The break in the forward fall was cleaner with all strands breaking at virtually the same place. This was consistent with the rigging arrangement, where the forward fall had to span a greater distance and follow more sheaves between the head of the davit and the winch. With the progressive failure of the aft fall, the pull from the winch built up quickly, resulting in an instantaneous failure of the forward fall.

3. Both wire ropes failed where they roved around their respective fall blocks. Wire strength is known to diminish in a radius.

1.3 Post-accident testing

1.3.1 Following the accident the parted wire falls were removed from the davit, the circuit breaker switched on, and the winch tested using the remote control unit. The winch operated normally, as did the safety stop limit switches.

1.3.2 Several months after the accident, the repaired lifeboat was returned to the ship and an operational test carried out in Auckland. The lifeboat was loaded with 546 kg to simulate the 7 persons in the lifeboat at the time of the accident.

1.3.3 The lifeboat davit successfully raised the lifeboat twice without the circuit breaker tripping. After the initial high starting current the observed current across the motor windings settled at 17 Amps, increased to 19.5 Amps when the winch motor began lifting the weight of the davit arms as well, and then progressively reduced to 14.5 Amps as the davit arms neared their stow position. The rated maximum continuous current for the motor was 25 Amps.

2. Lifeboat and its Launching Apparatus

2.1 Lifeboat

2.1.1 The lifeboats on the *Nicolai Maersk* were manufactured by FR. Fassmer Gmbll and Company in Germany. They were 7.44 m in length and rated to hold 34 persons.

2.1.2 The lifeboats were of the totally enclosed type constructed in glass-reinforced plastic (GRP) with the space between the seats, hull and canopy liner filled with polyurethane buoyancy foam, which provided the boats with enough buoyancy to remain upright and afloat, even if holed below the waterline.

2.1.3 The lifeboats were connected to the falls by 2 hooks that could be released simultaneously from the driver's position, even with load on the hooks.

2.1.4 The dry weight of the lifeboat and its equipment was 3400 kg and together with 34 persons at 75 kg each, had a potential all-up davit load for lowering of 5950 kg.

2.2 Lifeboat davit

2.2.1 SOLAS regulations state that all lifeboats and rescue boats must be manoeuvred on the water with their assigned operating crew at least once every 3 months.

2.2.2 The *Nicolai Maersk* was a relatively new ship, and had been approved by both the classification society and the flag state administration. SOLAS requirements for lifeboat davits were for the davit to be capable of "recovering the lifeboat with its crew". SOLAS did not specify a minimum rate of recovery. The Lloyds Register of Shipping Provisional Rules for Launch and Recovery Appliances for Survival Craft and Rescue Boats required the davit to be "capable of power recovery of the survival craft with its crew (i.e. 2 or 3 persons) at a minimum speed of 0.08 m/s. . .".

2.2.3 The davit was manufactured by Dongwoo Machinery and Engineering Company Limited in South Korea. It was a twin-arm hinged gravity davit designed to launch the lifeboat by gravity alone with the ship listed up to 20 degrees either way and/or with up to 10 degrees of positive or negative trim.

2.2.4 The davit consisted of a main structure fixed to the deck of the ship and 2 davit arms that hinged about a pivot point close to deck level. Each end of the lifeboat was suspended from the head of a davit arm through a quick-release lifting point. During the initial swinging out of the davit arms, the lifeboat remained suspended from the head of the davit arms. When the davit arms extended out to the limit of their travel the lifeboat was suspended above the water, clear of the ship's side. From that point the davit arms remained stationary and the lifeboat lowered on the wire falls (see Figure 1).

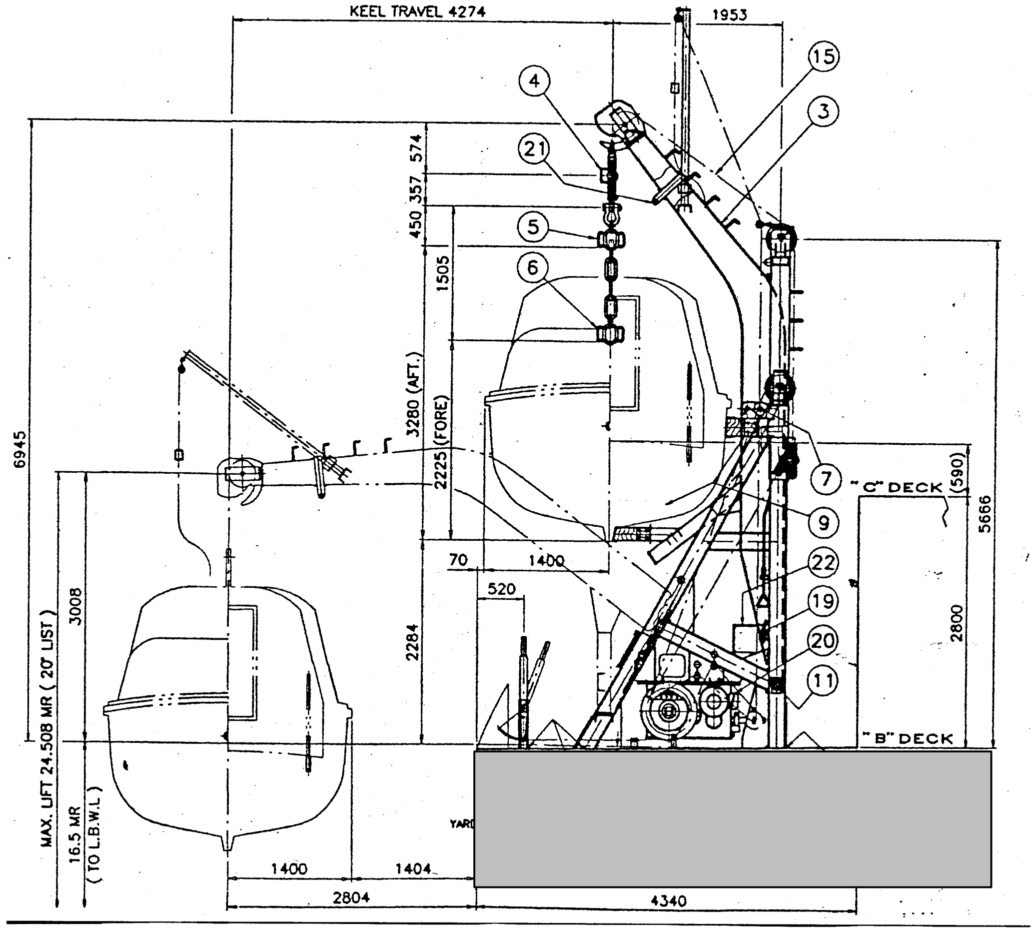


Figure 2
General arrangement of lifeboat davit

Number	Description	Number	Description
3	Davit arm	4	Fall block fitted over suspension horn
5	Suspension chain	6	2nd suspension chain
7	Cradle stopper	9	Stowing chock
11	Davit arm pivot pin assembly	15	Wire rope fall
19	Proximity limit switch	20	Hoist winch
21	Hanging off pendent		

2.2.5 During the whole launching and retrieval procedure the movement of the lifeboat and davit arms was controlled by 2 wire falls connected via a purchase arrangement of sheaves and blocks to a double wire rope drum. The wire rope drum was connected through a reduction gearbox to a brake for lowering, and an electric winch motor for raising. The brake was controlled either from one of 2 levers on the boat deck, or by a remote cable from within the lifeboat. The hoist winch was operated from a remote control unit on a wandering lead plugged in to the ship's supply on the boat deck. The hoist winch was rated by the manufacturer to raise the boat from the water to its stow position with a maximum of 2 persons on board only.

Analysis 4

1. The Commission is of the opinion that a minimum of 3 crew members was required to safely operate the lifeboats, one to drive, and one at each end to connect the falls. The launching apparatus should have been rated for at least that number. The operator appeared to have recognised the minimum practicable number of crew was 3, because the Deck Operating Manual on board contained a note "**Note!** The winch motor will lift the lifeboat with a maximum of three persons on board". The operator said it had based this note on SOLAS requirements, but it was not established if it was aware this exceeded the manufacturer's rating for the hoist winch when writing the Deck Operating Manual.

2. The rationale given by the crew for putting 7 persons in the lifeboat was to let a maximum number of crew experience the full drill. Apart from the 3 persons required to operate the lifeboat, the others probably would have gained little value from the drill, and were exposed to unnecessary risk.

3. The actual load on the hoist motor was difficult to calculate accurately, but indications were that in raising the weight of the boat with 7 crew, allowing for about 80% efficiency due to friction, the electric hoist motor would have been well within its maximum rating. This was confirmed during the operational test conducted in Auckland after the lifeboat had been repaired and returned to the ship.

4. The winch manufacturer was asked what factor restricted the hoist operation to 2 persons in the boat, but did not respond to that specific question. Whatever the limiting factor was, both the classification society and the flag state administration had approved a lifeboat installation that effectively could not meet the requirements of SOLAS while complying with the manufacturer's instructions.

2.2.6 The normal procedure for raising the lifeboat was to use the winch motor to pull the davit arms and lifeboat inboard until the safety stop limit switches cut the winch motor out shortly before the davit arms reached their stops. From this point the davit arms had to be wound against their stops using the manual winch handle. It was normal procedure to test the correct operation of the safety stop limit switches while the boat was being raised, but before the davit arms reached the point where the limit switches would normally cut out motor operation.

Analysis 5

1. Post-accident testing confirmed the limit switches were able to function correctly if their function had not been bypassed. An instruction to test the limit switches can be found on most lifeboat installations. This is almost without doubt done every time, as most mariners are aware of the consequences of an unserviceable limit switch. The chief officer could have tested the limit switches for correct operation even though the winch motor was only running intermittently for about one second each time. Had he done so, he would have observed the winch motor running when it shouldn't have been. It is likely that he missed this important check because of the unusual procedure being followed to raise the lifeboat, and his haste owing to the pressure he was under to attend to the cargo work and other routine duties.

2.2.7 When the lifeboat was in its stowed position, the wire falls and the winch brake were the primary method used to prevent the lifeboat and davit arms from falling outboard. There were 3 other mechanisms contributing to the overall security of the system:

1. The fall blocks that were attached to the lifeboat lifting points each fitted over a suspension horn welded directly to the davit head. If the wire fall parted, or the winch brake failed, the lifeboat would hang from the davit heads on these horns instead of falling directly to the deck. These alone would not prevent the davit arms from falling outboard.

2. There were 2 cradle stopper hooks between the fixed structure of the launching apparatus and the davit arms. When engaged, these 2 cradle stoppers would prevent the davit arms from swinging outboard. Between the suspension horns and the cradle stoppers, the wire fall could part or slack back and the lifeboat would remain in its stowed position.

3. Wire lashings known as “gripes” were placed around the lifeboat securing it back against the fixed structure. The gripes were only put in place when the launching apparatus was not in use.

2.2.8 The cradle stoppers were designed to fall naturally in the open position. To close them and secure the davit arms the crew had to physically push the operating rod up and secure it with a pin.

Analysis 6

1. When the davit arms were pulled hard up against the stops by the winch motor during the accident sequence, they were not automatically secured by the cradle stoppers.

2. It would have been a relatively simple engineering feat to design the cradle stoppers so that they were self-latching. Had this been the case, both wire falls could have parted and the davit arms and lifeboat would have remained in the stowed position. The accident would not have happened. This is an example of a basic safety feature that should be mandatory on all lifeboat installations of this type.

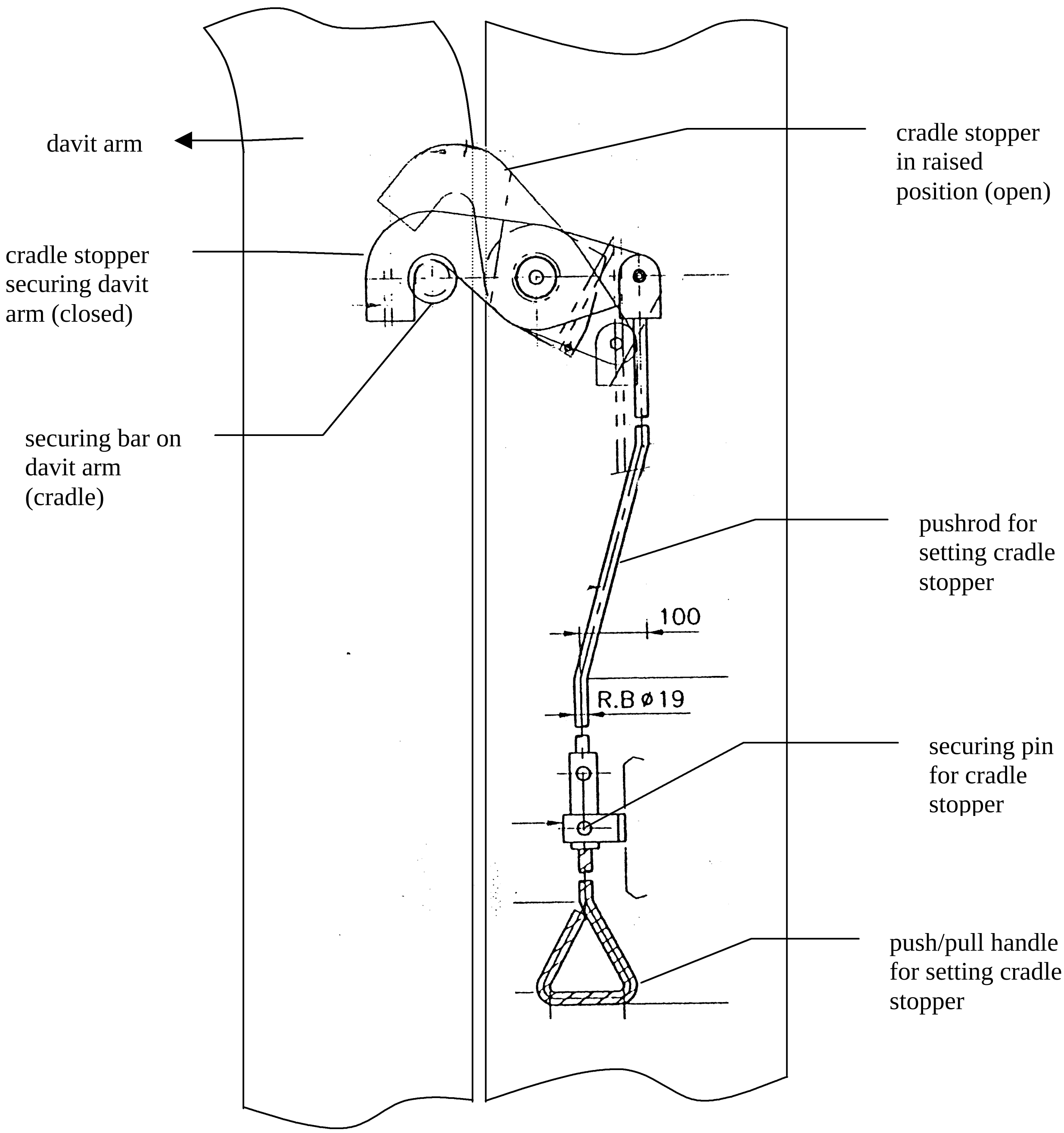


Figure 3
Drawing of cradle stopper

2.3 Electrical system

2.3.1 The port and starboard lifeboat winch starters had identical control circuits contained in a common cabinet in the compressor room. A wiring diagram has been included as Appendix A to this report.

2.3.2 Each motor supply was protected by a circuit breaker that was also used as an isolator, and an emergency stop isolator via a shunt trip coil. The motor was controlled by relay logic and switched on and off by a contactor. A motor heater could be selected to keep the winch motor dry and above freezing temperature when not in use. The heater system consisted of a low-voltage supply that was connected across one of the winch motor field windings.

2.3.3 A remote control unit on a wandering lead was plugged in near each lifeboat. This control unit had a power indication light and 2 pushbuttons, one for "Hoist" and one for "Emergency Stop".

2.3.4 When the heater was selected “Off”, the hoist motor followed the command from the control unit; depress the hoist button and the hoist motor would operate.

2.3.5 When the heater was selected “On” and the hoist pushbutton was depressed, the heater would immediately turn off, but there would be a 5-second delay before the hoist motor operated. When the hoist pushbutton was released, the hoist motor would stop, but there would be a 5-second delay before the heater re-energised.

2.3.6 If the circuit breaker had tripped or been manually switched off, the heater would not work regardless of the heater selection switch.

Analysis 7

1. Following the accident it was noted that the heaters had been selected “On” for both port and starboard winch motors. The circuit breakers for both winch motor supplies were in the “Off” position, and this was consistent with the instructions contained in the Deck Operating Manual. Using this procedure the motor heaters would never have been in operation except when the circuit breaker was turned “On” during a drill. The heaters being selected “On” would then have been a hindrance owing to the 5-second delay it would have caused when trying to hoist the lifeboat at a critical time during recovery. The way the control panel was set up indicated the crew were not familiar with this feature.

2. There are 3 possible reasons the winch motor did not operate when first tested: the circuit breaker had not been switched on or reset after the previous drill some months before; or the last operator pressed the emergency stop at the end of the previous lifeboat drill; or whoever depressed the hoist pushbutton did not hold it down long enough to allow the heater circuitry logic to complete its 5-second cycle; or any combination of the 3.

3. It was feasible that once the electrician had reset the circuit breaker below, had he gone back to the boat deck and pressed the hoist pushbutton on the remote for more than 5 seconds, the hoist winch might have operated.

4. Even with the electrician holding the contactor closed manually from down below, the emergency stop pushbutton on the remote control unit on the boat deck would have immediately tripped the circuit breaker and stopped the winch motor. Anyone standing on the boat deck could have used this method to stop the winch once it became apparent the safety limit stop switches were not going to work.

2.3.7 The circuit breaker had a thermal trip device that would trip if the motor current exceeded the trip curve. The trip characteristic of a typical circuit breaker is roughly hyperbolic and follows an “inverse-time” curve, which means the greater the current level above the trip point, the shorter the time required to trip the circuit breaker. Typical curves would trip a 40-Amp circuit breaker if the current exceeded the nominal current by 1.5 times for 1.5 minutes.

2.3.8 The circuit breaker could also be manually operated to isolate the controls and motor for maintenance. A shunt trip coil was fitted, which could be electrically activated by the emergency stop button on the remote control on the boat deck to remotely trip the circuit breaker, which would completely isolate power to the motor and controller. The circuit breaker was intended to protect the motor wiring, equipment and cables from damage.

2.3.9 Additional to the circuit breaker was a motor overload device that was a thermally operated trip unit that when activated stopped the winch motor from operating. The motor overload could be selected to either "Manual" or "Auto" reset. If selected to "Manual", the motor overload device could be reset by pushing a button directly on the motor overload unit in the control cabinet. If selected to "Auto" the motor overload automatically reset once the thermal trip device cooled down. This device was designed only to protect the winch motor from damage during an overload. The overload device could be adjusted to trip at between 18 and 30 Amps. On the *Nicolai Maersk*, it was set at 25 Amps. Such devices are typically set to trip if motor current exceeds its maximum full current by approximately 200% for one minute.

2.3.10 Two proximity-type safety stop limit switches were installed on the davit. Normally these automatically stopped the motor contactor from operating when the davit arms came within a preset distance from their stops.

Analysis 8

1. The way the protection circuitry was set up meant that in the event of a high electrical load on the hoist motor, the motor overload would trip before the circuit breaker; however, pushing the manual button on the contactor would force the motor to run regardless of its overload protection having tripped. This had the potential to damage the hoist motor, but in this case the current being drawn was sufficient to trip the circuit breaker as well. By repeatedly resetting and operating the winch motor the crew risked causing permanent damage to electrical components.

2. With the motor heater selected "On" a low-voltage current was supplied to one phase winding of the winch motor. Normally when the hoist button was depressed on the remote control, the heater was disconnected and there was a delay of 5 seconds before the hoist motor would operate. This feature was built in to avoid potential damage to the motor.

3. By manually closing the contactor in the lifeboat winch starter box, the circuitry logic was bypassed. This resulted in both main current and current from the heater supplying the motor at the same time, which together with the normal operating load caused the circuit breaker to trip on over-current.

3. Crew and Shipboard Management

3.1 The *Nicolai Maersk* had a crew of 19 including the master, comprising 4 Danish officers, 2 Danish deck cadets, 12 Filipino officers and ratings, and one Polish rating.

3.2 The chief officer was Danish. He had been at sea for about 15 years, 10 of which as chief officer. He held a Danish Class 1 Master certificate and had been sailing on the *Nicolai Maersk* for about 3 months at the time of the accident.

3.3 The electrician was Filipino and had worked ashore for about 12 years as an assistant mechanic. He had been at sea for about 7 years in the capacity of mechanic and electrician. It could not be established if he held an electrical qualification.

3.4 The ship had entered an International Safety Management (ISM) system, which was reviewed as part of the investigation, along with the plans and documentation for the lifeboats and their davits. A copy of the lifeboat launching and retrieval instruction placard supplied to the ship by the manufacturer has been included as Appendix B.

Analysis 9

1. The ISM system on the ship was generally sound and indicated a good level of control and monitoring of the ship's day-to-day business. Specific anomalies to do with the operation of the lifeboat launching apparatus have been mentioned earlier in this report. Some of those anomalies may have been related to the standard of documentation supplied to the ship by the davit manufacturer.

2. English was the command language chosen for the *Nicolai Maersk*. The written instructions and the instruction placards provided with the lifeboat launching apparatus did include English, but the standard was poor. This made the launching procedure difficult to understand. The instructions had been deciphered and corrected in the operator's deck operating manual, but the instruction placards displayed near the apparatus were still those supplied by the manufacturer.

3. An example was, instruction number 4 for hoisting included the caution "*when turn in the life boat davit, to shift clutch lever to lower direction*". When lowering the lifeboat using the clutch lever, it would normally be raised. The instruction was intended to tell the operator to ensure the clutch lever was not raised while hoisting. During testing after the accident, one crew member was observed to misunderstand this instruction and do the opposite.

4. The ambiguities in the instructions are not considered to have contributed to this accident, but represented an unnecessary risk to safe operation of the lifeboat davit.

Analysis 10

1. A disproportionate number of the deaths and serious injuries that occur each year on ships happen during drills involving life-saving craft. The Marine Accident Investigation Branch of United Kingdom (MAIB) recently published a safety study, Review of Lifeboat and Launching Systems' Accidents. The review concluded with the following recommendation to the International Maritime Organisation (IMO):

   "The IMO should undertake a study on the present value, need, and desirability of lifeboats. Reported accidents worldwide should be examined with regard to the specification of lifeboat launching systems.

   If it concludes that lifeboat launching systems are necessary, the study should be extended to give consideration to formulating the requirements for safe lifeboat launching systems. Such requirements would seek to introduce integrated systems which:

   - have common operating procedures independent of the manufacturer
   - can be readily understood by non-technical persons
   - will reliably perform tasks, which include lowering and deployment for training purposes
   - will perform safely under the control of operators with minimum experience and training."

2. For reasons outlined in this report, the Commission considers that the fourth bullet point includes the need for the integrated systems to have built-in failsafe defences against common human and equipment failure.

3. If the IMO fully implements the safety recommendation submitted by MAIB, the future design and construction of launching apparatus should become more robust and failsafe, so not only could the frequency of training be reduced, but the risk to crew when using such equipment would be significantly less.

4. Until such time as better launching systems become a requirement, ship masters should consider adopting procedures that minimise the risk to crew, while still complying with current regulations.

5. Of the currently available life-saving craft and their launching systems, some are safer than others. In the interim, ship owners, classification societies and flag states should adopt a risk management approach to crew safety when approving and purchasing life-saving equipment for new buildings.

4. Findings

Findings and safety recommendations are listed in order of development and not in order of priority.

4.1 The port lifeboat had 5 more crew members than the recommended 2 on board when the accident occurred, but that alone should not have caused the circuit breaker for the winch motor to repeatedly trip when raising the lifeboat.

4.2 When operating the winch motor by manually pushing its main contactor from a control box located one deck down, the crew bypassed the relay logic and allowed dual voltage from the single phase heater and 3-phase mains to be connected to the motor windings at the same time, causing the circuit breaker to trip.

4.3 By using non-standard operating procedures to raise the lifeboat to its stow position, the crew unknowingly bypassed the motor overload trip, the safety limit stops and the motor heater relay logic, which was a significant factor contributing to the accident.

4.4 A combination of the crew not being familiar with all normal aspects of the launching apparatus, and an element of haste, probably influenced the crew’s decision to deviate from standard operating procedures.

4.5 The emergency stop function on the remote control unit was functional and could have prevented the accident, if used.

4.6 Had the design of the cradle stopper securing devices on the lifeboat davit been self-latching, the lifeboat would not have fallen when the wire falls parted, which would have saved the life of one crew member and prevented injury to 6 others.

4.7 By not being rated by the manufacturer to retrieve more than 2 persons in the lifeboat, the lifeboat installation did not comply with SOLAS regulations. While this did not in itself cause the accident, it potentially increased the risk of the operation.

4.8 The current SOLAS regulations governing the design, construction and use of survival craft and their launching installations do not provide an acceptable level of safety for those required to use them.

4.9 There is a growing indication worldwide that accidents during training with survival craft at sea are causing a disproportionate number of deaths and serious injuries, and that the SOLAS regulations are in need of review.

5. Safety Recommendations

5.1 On 30 August 2001 the Commission recommended to the managing director of A P Moller that he:

5.1.1 circulate a memo to all company vessels describing the circumstances of this accident, and the lessons learned as outlined in this report (038/01)

5.1.2 ensure the operating instructions for all survival craft and their launching appliances on all company vessels are correct, easily understandable by the crew, and clearly understood by the crew. Instructions should include a note not to deviate from standard operating procedures before fully assessing the consequences of doing so (039/01)

5.1.3 liaise with the lifeboat davit manufacturer to establish the reason for limiting the winch capacity to the lifeboat plus 2 persons, and bring the installations on all company vessels fitted with them up to SOLAS compliance standards. (040/01)

5.2 On 6 September 2001 the managing director replied, in part:

5.2.1 **038/01:** This item has already been complied with. We have sent 2 telexes to the entire fleet covering these points. The first, cph74763 sent on 19 February, describes the incident, consequences and findings with regard to the full functionality of the equipment and resulting dangers of incorrect operational procedures. The second, cph17546 sent on 1 March 2001 is a procedure for [man-over-board] and lifeboat drills – precautions on launching and recovery, which [inter alia] specifies the need to establish work place instructions and risk analysis.

5.2.2 **039/01:** After the accident, all vessels were contacted to check, and revise where necessary, the launching procedures and instructions for their vessel. Once completed, the instructions were sent to this office for control and monitoring. This process was completed in the middle of April. Instructions concerning deviation from standard operating procedures are covered in our compliance with 038/01.

5.2.3 **040/01:** We have on 31 August, after careful study of all material from the davit manufacturer and shipyard, sent a communication to the manufacturer explaining the apparent lack of compliance with SOLAS requirements and requesting that all future installations be in compliance. As yet no reply has been received. On receipt, this will be forwarded to [the Commission]. The relevant persons within our organisation have been made aware of the possibility of inconsistencies between davit manufacturers and SOLAS requirements.

5.3 On 30 August 2001 the Commission recommended to the managing director of Dongwoo Machinery and Engineering Company Limited that he:

5.3.1 critically review the design of the company's survival craft launching apparatus and ensure that they:

- can be readily understood by non-technical persons
- will reliably perform tasks, which include lowering and deployment for training purposes
- will perform safely under the control of operators with minimum experience and training
- so far as is practicable, are failsafe
- are accompanied by clear, unambiguous instructions in English. (041/01)

5.4 On 30 August 2001 the Commission recommended to the Director of Maritime Safety that he:

5.4.1 Submit a copy of report 01-203 to the Maritime Safety Committee of IMO to support the work and initiatives now being conducted by both the Marine Accident Investigation Branch and the Maritime and Coastguard Agency of the United Kingdom, regarding the safety of lifeboats and lifeboat drills.

Any review conducted by IMO should consider reported accidents worldwide, with particular emphasis on lifeboat/rescue boat launch and recovery systems.

In addition, the review should consider standardised and integrated systems which:

- Have effectively common operating systems and procedures independent of the manufacturer
- Can be readily understood by non-technical persons
- Will reliably perform the tasks required, including routine testing, with maximised safety
- Can be operated safely under the control of operators with minimum experience and training. (042/01)

5.5 On 5 September 2001 the Director of Maritime Safety replied, in part:

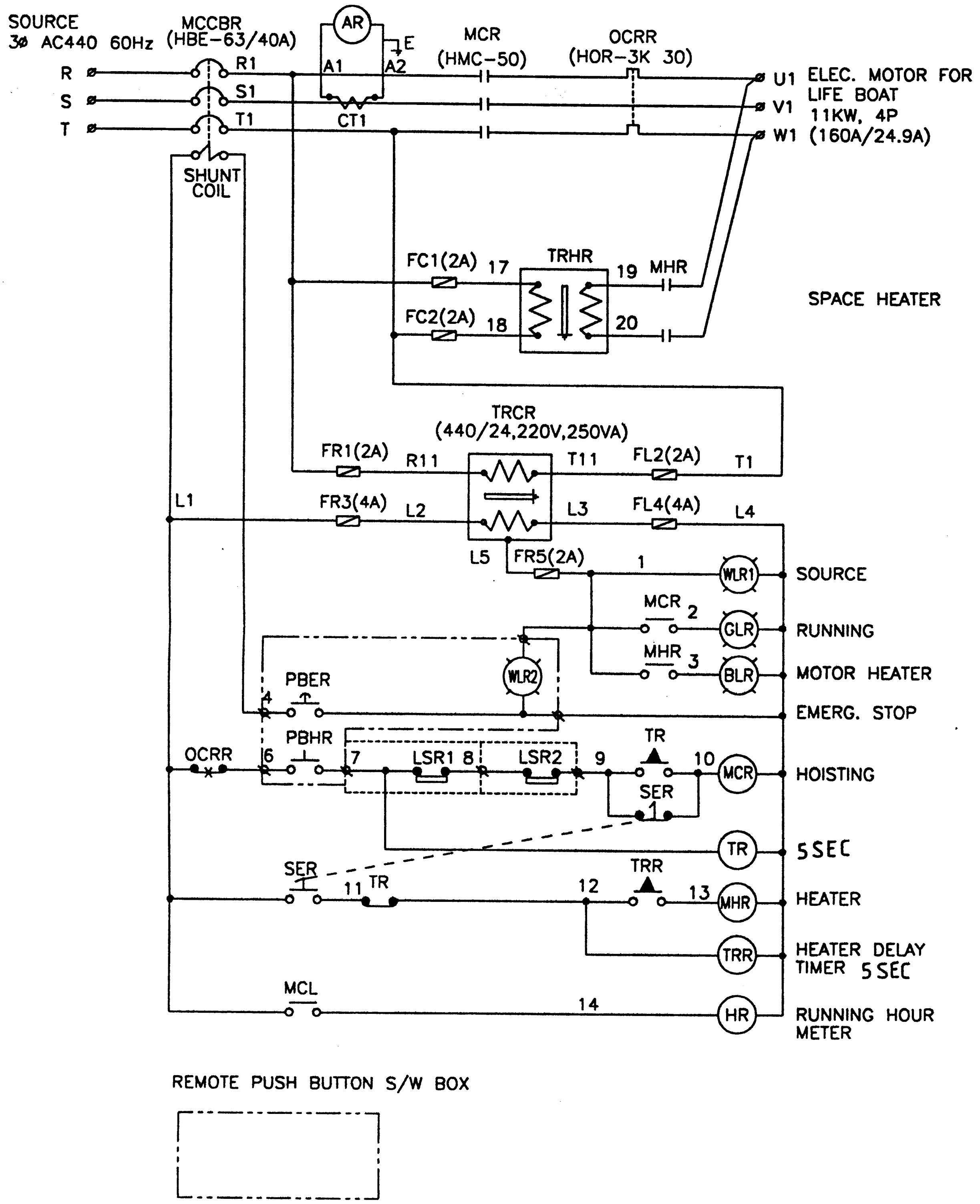
5.5.1 The recommendation is acceptable to the Maritime Safety Authority.

Approved for publication 5 September 2001

Hon. W P Jeffries
Chief Commissioner

Appendix A

Wiring diagram for lifeboat winch starter



Symbol	Name	Description
MCCBR	Moulded case circuit breaker	HBE-63/40A
MCR	Magnetic contactor	HMC-50, 220V
OCRR	Over current relay	HOR-3K 30
AR	AC A Meter	O-50A, 50:5, 60T
CT1	Current Transformer	100:5, 5VA
TRCR	Transformer	440/220V,24V, 250V
TRHR	Transformer	440/18, 25, 30, 300VA
FR1, 2, 5, FC1, 2	Fuse	DIAZED 2A
FR3, FR4	DO	DIAZED 4A
WLR1, GLR, BLR	Pilot lamp	30Ø 24V
LSR1, LSR2	Proximity switch	PRL30 15AC
PBHR, PBER	Push button switch	25Ø 1a1b, 6A
SER	Selector switch	30Ø 2a2b, 6A
MHR	Magnetic contactor	HMX-22, 220V
TR	Timer relay	
TRR	Timer relay	
HR	Running meter	220V

Appendix B

Copy of lifeboat davit operating instruction placard

LIFE BOAT DAVIT OPERATING INSTRUCTION(救生艇架操作指示)

A. THE LOWERING OF THE LIFE BOAT (放下救生艇)

1) DRAW OUT A TOGGLE PIN AT BRAKE LEVER OF THE WINCH. (将绞车刹车的止动销拉开。)
2) RELEASE AN ARM STOPPER. (松开止动棒。)
3) RELEASE LASHING LINE AFTER DISCONNECTING SLIP HOOKS. (将拉绳滑钩松开。)
4) EMBARKATE (登艇。)
5) PULL CONTINUOUSLY REMOTE CONTROL WIRE WHICH IS SUSPENDED FROM THE DAVIT IN THE LIFE BOAT UNTILL THE LIFE BOAT REACHES ON THE WATER. (在救生艇驾驶舱内拉动钢丝手环，遥控放下救生艇。)
   (OR INSTALLATION OF BRAKE LEVER, TO RELEASE THE BRAKE LEVER DIRECTLY ON BOAT DECK.)
   (或直接在救生甲板控制绞车放艇。)

• CAUTION • (注意)
   OPERATE SLOWLY DURING TURN OUT. (在操作期间，应将速度放慢以避免意外。)

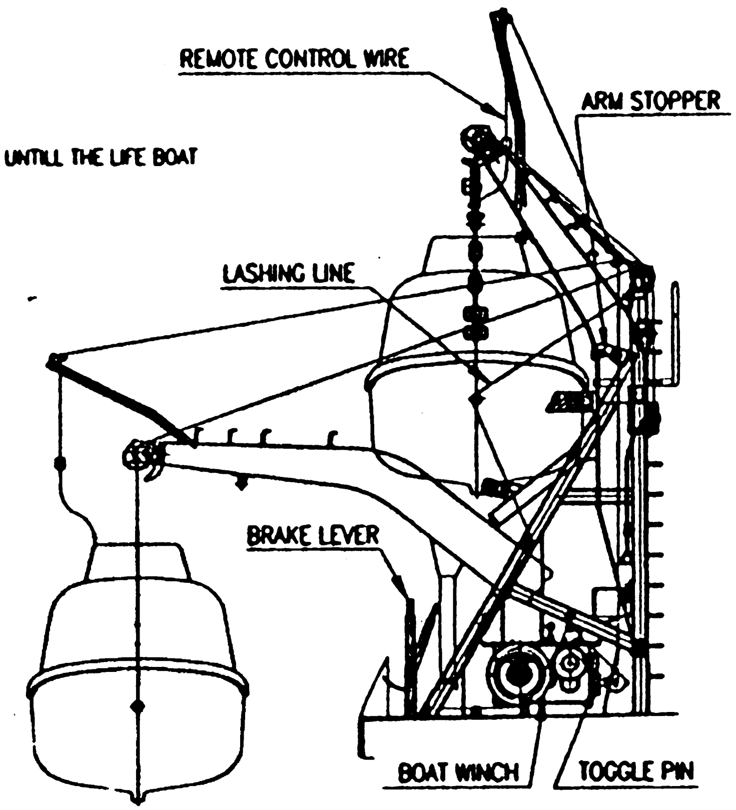
6) WHEN THE LIFE BOAT REACHES ON THE WATER, TO RELEASE THE REMOTE CONTROL WIRE AND THE RELEASE HOOK OF THE LIFE BOAT.
   (当救生艇到达海面时，松开钢丝手环并操作脱钩。)
7) FREE THE LIFE BOAT FROM THE RELEASE HOOK. (操作救生艇离开船边。)

B. THE HOISTING OF THE LIFE BOAT (收回救生艇)

1) RESET A TOGGLE PIN AT THE BRAKE LEVER OF THE WINCH. (将绞车的刹车止动销装上。)
2) HOOK TWO(2) SUSPENSION BLOCKS UP TO THE FWD & AFT HOOKS OF THE LIFE BOAT.
   (在救生艇前后将吊钩挂好。)
3) TURN STARTER MAIN SWITCH ON. (启动主开关。)
4) TURN OR PUSH BUTTON SWITCH ON FOR THE HOISTING WINCH.
   (按下按钮控制绞车收回救生艇。)
   (THE DAVIT IS ABLE TO HOIST THE BOAT TOGETHER WITH TWO(2) PERSONS EMBARKATED.)
   (艇架可收回救生艇和 2 人。)

• CAUTION • (注意)
   WHEN TURN IN THE LIFE BOAT DAVIT, TO SHIFT CLUTCH LEVER TO LOWER DIRECTION.
   (当使用艇架收回救生艇 / 救助艇时，需将离合器置于低速位置)

5) WHEN LIMIT DEVICE IS IN ACTION, TO REWIND USING MANUAL HANDLE UNTILL STOWING POSITION LIMITED.
   (当到达限位器时，需手动操作使救生艇 / 救助艇复位。)
6) SECURE AN ARM STOPPER. (将止动棒复位。)
7) CONNECT SLIP HOOKS ON LASHING LINE AND TO SECURE TURNBUCKLE.
   (固定钢索并收紧。)
8) STARTER MAIN SWITCH OFF. (关闭总开关。)



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