



Australian Government
Australian Transport Safety Bureau

Unintentional release of the freefall lifeboat from *Aquarosa*

Indian Ocean | 1 March 2014



Investigation

ATSB Transport Safety Report
Marine Occurrence Investigation
307-MO-2014-002
Final – 20 May 2015

Cover photo: Australian Transport Safety Bureau (ATSB)

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Publishing information

Published by: Australian Transport Safety Bureau
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Addendum

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Safety summary

What happened

On 1 March 2014, *Aquarosa* was transiting the Indian Ocean en route to Fremantle, Western Australia, when its freefall lifeboat was inadvertently released during a routine inspection. A ship's engineer, the only person in the lifeboat at the time, was seriously injured in the accident.

About 5 hours after its release, the ship's crew recovered the lifeboat and resumed the voyage. On 8 March, the ship berthed in Kwinana, near Fremantle, and the injured engineer was transferred to hospital.

What the ATSB found

The ATSB found that when the lifeboat on-load release was last operated before the accident, it was not correctly reset. Consequently, when the engineer operated the manual release pump to inspect the equipment, the incorrectly-reset release tripped unexpectedly. The simulation wires, designed to hold the lifeboat during a simulated release, failed and the lifeboat launched.

The investigation found that although there was an indicator to show that the hook was in the correct position, there was nothing to indicate that the tripping mechanism was correctly reset. It was also found that the design and approval process for the lifeboat's simulated release system had not taken into account effects of shock loading on the simulation wires.

What's been done as a result

Aquarosa's shipboard procedures were revised shortly after the accident. Changes included the introduction of a requirement to notify the officer of the watch before entering the lifeboat. Notices were posted at the on-load release hydraulic pump positions, stating that the pumps must not be operated without the master's permission.

Via a circular, *Aquarosa's* managers, V.Ships, notified all ships in its fleet of the accident and its internal investigation findings. The circular also required the masters of all ships fitted with the same type of on-load release, to similarly revise the instructions for its operation and resetting. In addition, masters were required to review the simulation wire maintenance and inspection regime.

On 17 March 2014, the ATSB contacted V.Ships, the ship's flag State (Malta), Bureau Veritas, the lifeboat manufacturer, the International Association of Classification Societies and the Australian Maritime Safety Authority (AMSA) and advised them of the ATSB's preliminary findings. The parties were asked to identify ships equipped with similar freefall lifeboat arrangements and to advise operators of those ships to take safety action to prevent a similar accident.

In response, AMSA informed its surveyors of the accident and the ATSB's preliminary findings, and asked them to pay particular attention to these issues during flag and Port State inspections.

Safety action by the manufacturer included placing alignment marks on the release segment of new on-load releases mechanisms, to indicate when they are correctly reset. A lock-out 'maintenance pin' is also being provided for all new on-load releases to ensure the release cannot trip while maintenance is being performed.

Safety message

When designing and certifying equipment such as on-load release systems for lifeboats, all facets of the equipment's possible operation, use and environment must be taken into account and allowed for. Only then can fully comprehensive instructions be documented, enabling seafarers and others to safely use and maintain the equipment under all conditions.

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The occurrence

On 25 February 2014, the 190 m long bulk carrier *Aquarosa* (Figure 1) departed Singapore in ballast, bound for Fremantle, Western Australia (WA).

On the morning of 1 March, the ship was in the Indian Ocean about 450 miles¹ north-northwest of Dampier, WA. The deck crew were washing the ship's holds in preparation for a pre-loading grain survey scheduled at Fremantle. The second engineer, third engineer, electrical engineer, trainee engineer and supernumerary chief engineer² were completing routine weekly checks of the safety equipment.

Figure 1: *Aquarosa*



Source: ATSB

At about 1100,³ the third engineer and the supernumerary chief engineer went to the freefall lifeboat. After confirming that the simulation wires were connected (two wire slings connected to the lifeboat to prevent an actual launch) they removed the on-load release safety pin, which was attached by a short lanyard to the entry door, and entered the lifeboat. Once inside, they carried out a general inspection of the lifeboat's machinery and equipment. When the checks were completed, they left the lifeboat and remained on the embarkation platform just forward of the lifeboat. The electrical engineer had arrived and was working adjacent to the funnel, forward of the embarkation platform, conducting emergency battery checks.

As the third engineer and supernumerary chief engineer exited the lifeboat, the second engineer entered. During recent maintenance in Singapore, the second engineer had noted that the lifeboat release system hydraulics appeared to be losing oil and he wanted to personally confirm that all was in order. He checked the area around the main hydraulic pump and noticed a sheen of oil. After topping up the reservoir with oil, he decided to pressurise the system and identify any obvious oil leaks. He was standing between the passenger seats and had to lean across the coxswain's seat to manually operate the pump.

At about 1118, after operating the pump handle three or four times, the second engineer felt the lifeboat shudder and move. He looked toward the entry door and saw that the lifeboat had begun to move down the launching rails. Realising that the lifeboat had been released and there was no time to escape, he sat down in a seat and attempted to fit the seatbelt.

As the lifeboat moved down the launching rails, the simulation wires parted and the lifeboat was launched.⁴ The engineers nearby saw the lifeboat launch. The third engineer and the electrical

¹ A nautical mile is 1,852 m.

² The supernumerary chief engineer was representing *Aquarosa's* new owners, who were to take ownership at the end of the current voyage.

³ All times referred to in this report are local time, Coordinated Universal Time (UTC) + 8 hours.

⁴ At that time, the ship was in position 13° 26.8' S 114° 36.2' E.

engineer hurried to the bridge to raise the alarm, leaving the supernumerary chief engineer to keep the lifeboat in sight.

On the bridge, the officer of the watch was alerted by the engineers. He immediately activated the ship's general alarm and made an emergency announcement over the public address system. He began to slow and turn the ship and contacted the engine room to ensure an engineer was present for manoeuvring.

The master and chief mate, walking along the starboard side of the main deck approaching the accommodation, heard the general alarm and the announcement. They looked astern and could see the lifeboat. The master went directly to the bridge while the chief mate went aft to begin mustering the crew to respond to the emergency.

After about 10 minutes, the crew keeping a lookout noticed that the lifeboat was underway and heading toward the ship.

At 1132, the master sent a distress alert via satellite. He then reported the accident to the Australian Maritime Safety Authority's (AMSA) Rescue Coordination Centre (RCC).

Aquarosa was manoeuvred to allow the lifeboat to approach its stern. The wind was about 15 knots, the sea state was moderate and there was a 1.5 m swell. Those conditions made manoeuvring and securing the lifeboat difficult. Ropes were thrown to the lifeboat in an attempt to secure it but the second engineer was unable to grab them. One of the ropes fouled the lifeboat's propeller and the lifeboat lost propulsion.

At 1240, the ship's fast rescue boat was launched to assist the recovery operation. The lifeboat was towed around the ship and finally made fast to the starboard side of the ship adjacent to the midships accommodation ladder. A pilot ladder was deployed but the second engineer could not climb it. He had suffered injuries to his left leg and abrasions to his face and forehead.

At 1425, the midships accommodation ladder was lowered and the second engineer was assisted onto its bottom platform. It was then raised and the second engineer was helped on board the ship and taken to the ship's hospital for assessment and treatment. Medical advice was requested through the RCC and subsequently obtained.

At 1459, the master cancelled the distress alert.

Meanwhile, the operation to manoeuvre the lifeboat under the davit at the ship's stern and recover it continued. By 1630, the lifeboat was secure in its cradle and the voyage was resumed.

On 6 March, *Aquarosa* anchored off Fremantle to complete the grain pre-loading survey. The second engineer was recovering well from his injuries, his left knee was still swollen and had regained some mobility. The master and second engineer discussed his condition and, as he was not able to safely board a launch, they agreed that he would wait until the loading port, in about a week's time, for a medical assessment.

As the cargo hold cleanliness did not meet the required standards for loading grain the agent then made arrangements for the ship to berth in Kwinana and for shore side assistance and equipment to finish cleaning the holds.

On 8 March, after berthing in Kwinana, the second engineer was transferred to a hospital. The medical assessment revealed a fractured left kneecap and he was hospitalised until he was able to travel home.

Context

Aquarosa

At the time of the accident, *Aquarosa* was registered in Malta and classed with Bureau Veritas. The ship was owned by Aquarosa Shipping, Copenhagen, and managed by V.Ships, USA.

Aquarosa had a crew of 21 Indian and Sri Lankan nationals. A supernumerary chief engineer was also on board, representing the ship's new owners in preparation for taking it over at the end of the current voyage.

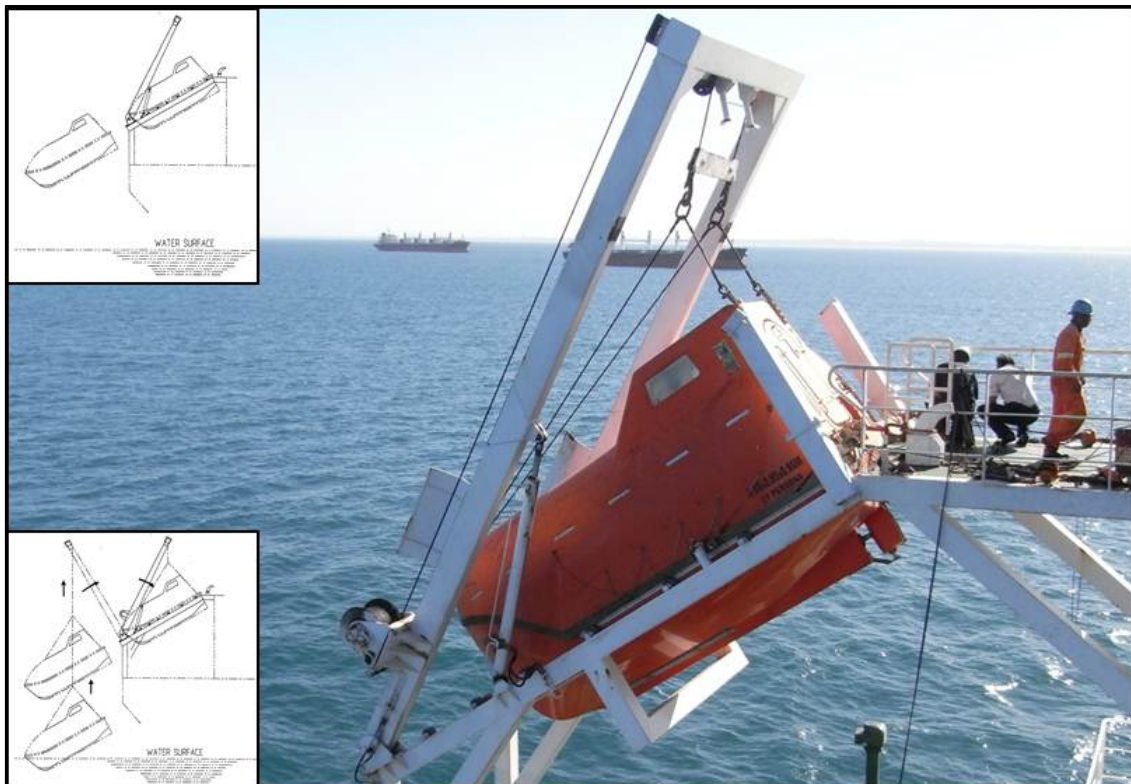
The master held an Indian master's certificate of competency. He had 22 years of seagoing experience and had been sailing as master for 18 months. He had worked for V.Ships for 3 years and had been on board *Aquarosa* for 5 months.

The second engineer had 12 years of seagoing experience and held a United Kingdom Class II engineer's certificate of competency. He had worked for V.Ships for 4 years and had joined *Aquarosa* about 1 month before the accident. It was his first assignment as second engineer.

Freefall lifeboat

Aquarosa was fitted with a Jiangsu Jiaoyan Marine Equipment Company (JJMEC), model JY-FN-5.80, twenty-seven person fibre-reinforced plastic freefall lifeboat that was manufactured in November 2009. The lifeboat was 5.80 m long, had a beam of 2.55 m and weighed 5,460 kg⁵ with a full passenger and stores load (Figure 2).

Figure 2: *Aquarosa*'s freefall lifeboat (insets show launch and recovery)



Source: ATSB (photo and annotations) and *Aquarosa*'s master (drawings)

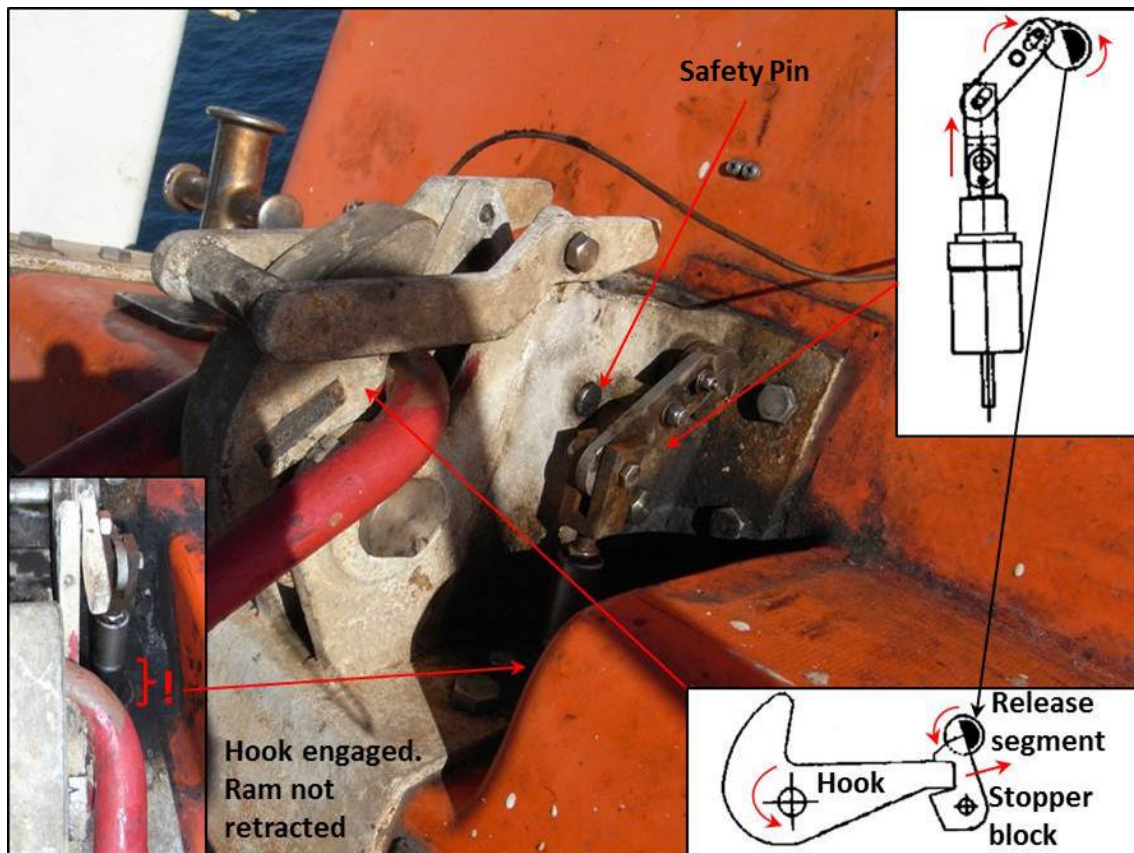
⁵ As stated on the lifeboat's nameplate, in contrast to the 5,844 kg stated in its 'Operation and maintenance manual'.

The lifeboat was housed in a JJMEC, JYF55 launching appliance (A-frame davit and winch) which included provision for the controlled lifting and lowering of the lifeboat into and out of the launching frame.

Under normal, ready for use, conditions, the freefall lifeboat was positioned with its side rails sitting on rollers on the ramp section of the launching appliance. The lifeboat was retained solely through ring links fitted between a fixed hook on the ship and the on-load release on the lifeboat (Figure 3 and Figure 4).

Once passengers were safely seated with seatbelts fastened, the coxswain would use the hand-operated hydraulic pump to actuate the lifeboat's on-load release, allowing the lifeboat to move down the ramp and freefall to the water, clear of the stern of the ship (Figure 2, inset - top left).

Figure 3: Freefall lifeboat on-load release



Source: ATSB (photo and annotations) and *Aquarosa's* master (drawings)

Release system

The lifeboat on-load release system comprised the on-load release (JJMEC model JX-4) located at the stern of the lifeboat, the hook hydraulic activating cylinder and two hand-operated pumps. One pump was adjacent to the coxswain's position. The second, emergency pump to be used in case the coxswain's pump failed, was located within arm's reach of the aft-most port-side seating position.

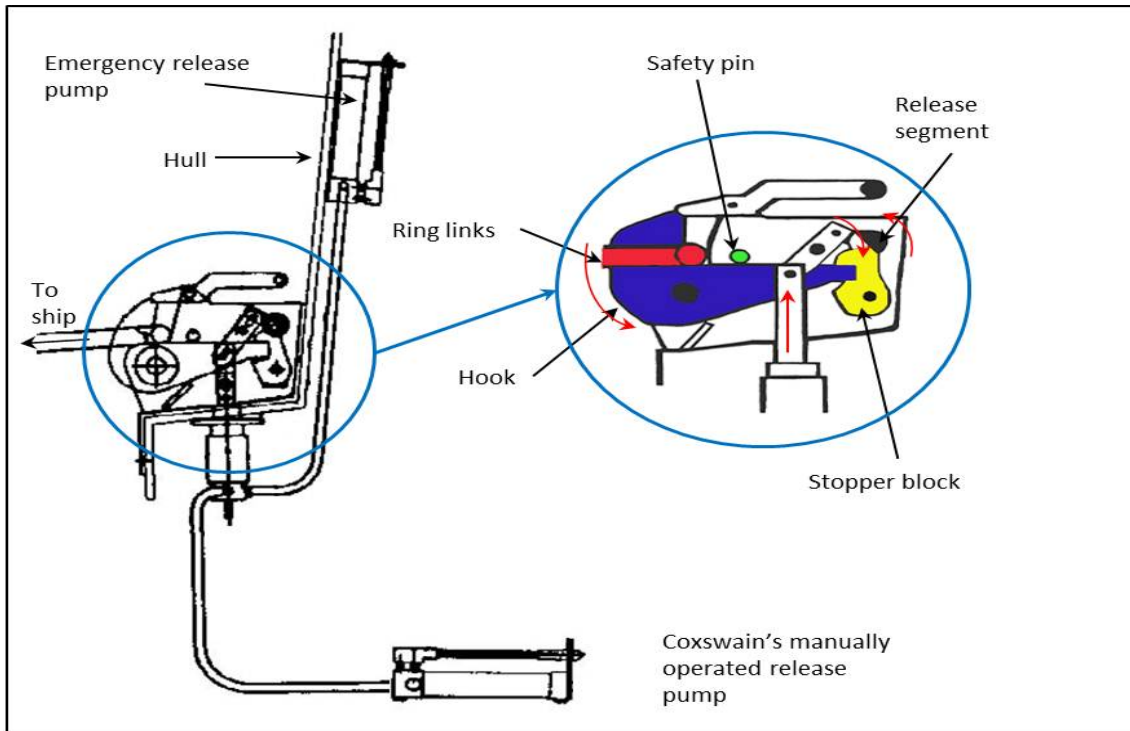
A safety pin was fitted (Figure 3 and Figure 4) through the on-load release's cheek plates and sat over the tail of the hook to prevent the hook from opening and the unintentional release of the lifeboat. The on-load release could still trip but the hook could not rotate far enough for the ring links to be let go, thus preventing the launch of the lifeboat. The pin was attached by a lanyard to the entrance door of the lifeboat, such that the pin had to be removed before the door could be opened. Therefore, its removal could not be forgotten in an emergency.

The hook device's operating manual stated that 10–12 operations of the hydraulic pump handle were required to trip the on-load release and release the lifeboat. This operation of the pump extended the activating cylinder ram which released the stopper block via a series of linkages. The hook was then free to rotate and release the ring links connecting the lifeboat to the ship.

The pump also had a small valve on its body which, when opened, allowed the oil to return to the pump's oil reservoir. This valve had to be closed for the system to actuate the hook. The valve was, therefore, normally left in the closed position ready for use.

Resetting the on-load release and securing the lifeboat in place required the ring link to be positioned over the hook and then rotating it until its tail engaged in the stopper block. An alignment mark, on the side of the hook (Figure 6 and Figure 7), provided a visual confirmation that the hook was in the correct position. The release segment then had to be rotated into position, locking the stopper block in place, by opening the valve on the pump and the activating cylinder ram retracting. Once the on-load release was reset, the hydraulic pump's valve was closed. This locked the oil in the system and the linkages in position.

Figure 4: Freefall lifeboat hook release system



Source: *Aquarosa's* master with annotations by ATSB

Simulated release of a freefall lifeboat

A freefall lifeboat is required to be launched or lowered to the water every 3 months.⁶ In recognition of the unacceptably high number of accidents with lifeboats in which crew were being injured, *simulated* launches of freefall lifeboats at intervals not exceeding 6 months were permitted.

The International Maritime Organization (IMO) circular titled 'Measures to prevent accidents with lifeboats',⁷ incorporates a previous circular on the 'Guidelines for simulated launching of freefall

⁶ The International Convention for the Safety of Life at Sea, 1974, as amended (SOLAS) - Regulation III/19.3.3.

⁷ International Maritime Organization 2009, MSC.1/Circ.1206/Rev.1, IMO, London.

lifeboats'.⁸ Any lifeboats, davits and associated equipment such as on-load release systems are required to be in full compliance with the IMO's Life-Saving Appliances (LSA) Code.

Simulation systems

'Simulated launching is a means of training the crew in the freefall release procedure of freefall lifeboats and in verifying the satisfactory function of the freefall release system without allowing the lifeboat to fall into the sea.'⁹ Therefore, a simulation system must be designed to allow for the release of the freefall lifeboat from its housed position without actually launching the lifeboat into the sea.

Shock loading

All designs of lifeboat launch simulation equipment need to stop the moving lifeboat before it is launched clear of the ship. Therefore, regardless of the system employed, the design must take into account the forces required to stop the lifeboat once it is released.

Shock loading is a sudden, or unexpected, load imposed upon a system and it can be many times the static loads arising from the general weight of the components. The three factors that govern the magnitude of the shock load are the:

- mass involved - in this case the vector component of the lifeboat's mass that is acting down the launching ramp
- speed of the mass at impact; governed by how far the lifeboat travels before being stopped, and
- the stiffness of the stopping device, which governs the cushioning effect and impact duration.

Any increase in mass, speed or the stiffness of the stopping device, will increase the magnitude of the shock load.

Aquarosa's lifeboat launch simulation system

On board *Aquarosa*, the simulation system consisted of securing points on the port and starboard quarters of the lifeboat. Wire slings (simulation wires) were attached to these points and secured to eye plates that were welded onto the lifeboat launching frame's deck (Figure 5). When the lifeboat was in its stowed position (secured via the release hook and links) the simulation wires were slack.

When the on-load release was tripped, the lifeboat should (as per the design) move 150–200 mm down the launch ramp. At this point, the slack in the simulation wires would be taken up and the lifeboat would be stopped. The lifeboat would then be repositioned using the A-frame davit and the on-load release reset.

Figure 5: A new simulation wire



Source: ATSB

The manufacturer's 'Freefall Lifeboat Operation & Maintenance Manual' and shipboard procedures required the simulation wires to be disconnected while the ship was at sea. Entry into the lifeboat, other than for emergency purposes, could not take place until the wires were securely in place.

⁸ International Maritime Organisation 2004, MSC/Circ.1137, *Guidelines for simulated launching of freefall lifeboats*, IMO London

⁹ International Maritime Organization 2009, MSC.1/Circ.1206/Rev.1 Appendix to Annex 2 - *Guidelines for simulated launching of freefall lifeboats*, IMO, London.

Safety analysis

The accident

On 1 March 2014, *Aquarosa* was at sea in the Indian Ocean when its freefall lifeboat was inadvertently launched during a routine inspection.

The second engineer had entered the lifeboat, noted the oil level was low in the coxswain's release pump and topped it up. He then attempted to pressurise the system, by operating the hand pump, to check for leaks. He believed that it was safe to operate the pump three or four times, well short of the expected 10–12 pumps normally required to trip the on-load release. However, the on-load release tripped after only four pumps. The two simulation wires, in place to prevent a launch, failed and the lifeboat fell into the sea with the second engineer on board.

The on-load release had tripped unexpectedly because it did not properly reset when last operated. When the lifeboat was housed on completion of maintenance in the previous port, the activation cylinder ram had not fully retracted. This condition was not apparent because of a cover (Figure 7) fitted over the release mechanism and the lack of an indicator for the release linkage, which prevented a person being able to see that the ram had not fully retracted.

Therefore, the second engineer did not have sufficient information to deduce that the low oil level in the coxswain's operating pump was, in fact, not low because the oil remained in the ram and had not returned to the pump. Checking for leaks, by operating the hydraulic pump, was an action that was well intentioned but all of the risks had not been fully considered.

On-load release reset indication

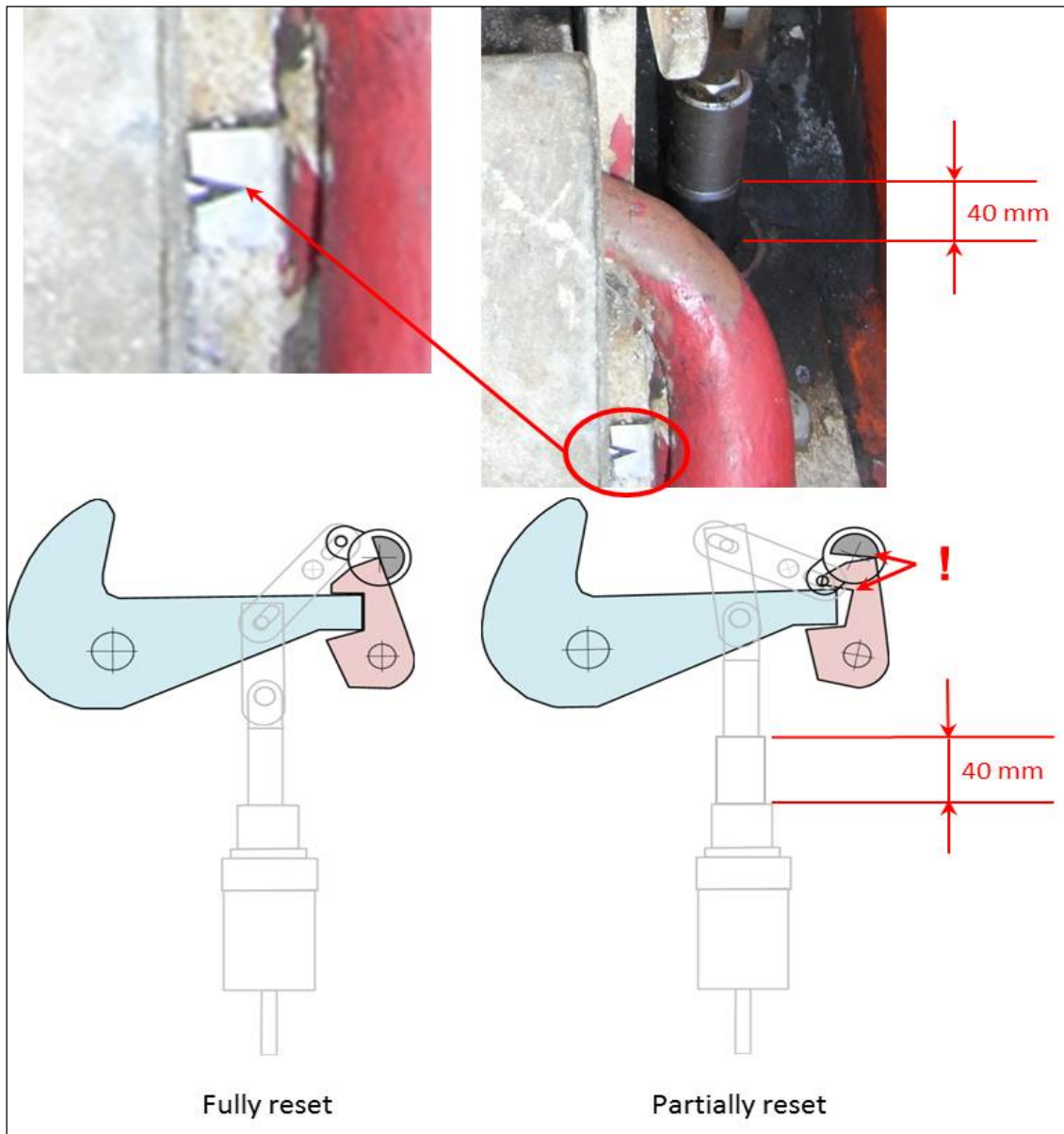
When ATSB investigators attended *Aquarosa*, the on-load release was tested without the lifeboat being launched. The cover over the on-load release's mechanism was removed and the hydraulic system was operated from the coxswain's seat while minimal load was placed, by hand, on the hook to determine the point of tripping. It was noted, during testing, that the hydraulic ram did not always retract fully without manual intervention. When this occurred, it was still possible to reset the on-load release with the hook alignment arrows aligned, and lock it in place. This was confirmed in a number of subsequent tests.

The distance between the hook's pivot point and the stopper block was such that the hook's alignment arrows (Figure 6) could indicate that the hook was in the correct position despite its tail remaining a few millimetres out of position. In this position the hook's tail did not allow the stopper block to fully return and the release segment would catch on the top face, locking both in a partially reset position with the ram still extended by about 40 mm. The hydraulic pump recirculation valve was then closed, effectively locking the system in a partially reset state. When subsequently tested, four operations of the hand pump were sufficient to trip the on-load release.

The shaft for the release segment had a tab welded to its shoulder (Figure 7, inset - top right) to limit the travel when tripping. There was no mark on the body of the on-load release to align with the tab and confirm that the release segment was properly reset.

While the design of the on-load release system allowed the reset position of the hook to be visually confirmed, it did not allow for visual confirmation that the release segment and mechanism had been correctly reset. Consequently, the hook device could appear to be properly reset when it actually was not.

Figure 6: On-load release partial reset.



Source: ATSB

On-load release trip prevention

The LSA Code requires that:

The launching appliance shall be arranged so as to preclude accidental release of the lifeboat in its unattended stowed position. If the means provided to secure the lifeboat cannot be released from inside the lifeboat, it shall be so arranged as to preclude boarding the lifeboat without first releasing it.¹⁰

To comply with the requirement, a safety pin (Figure 4) was fitted through the on-load release which stopped the hook from rotating and releasing the ring link. The pin was attached to the boarding door via a short lanyard, such that the pin had to be removed to allow the door to open

However, once the safety pin is removed to access the lifeboat for inspection or maintenance, there is no protection from an inadvertent opening of the on-load release.

¹⁰ Chapter IV, Section 6.1.4.5.

After the accident, *Aquarosa's* managers required a second (maintenance) safety pin to be fabricated. The maintenance pin was to be used in the on-load release in place of the safety pin for operations other than an emergency launch or simulated launch.

As a result of the accident, the lifeboat's manufacturer decided to supply all new lifeboats with a maintenance pin. The pin's purpose and correct use is stated on an instruction plate to be mounted near the on-load release.

Risk controls

In submission to the draft report, the Australian Maritime Safety Authority (AMSA) indicated its concern that the maintenance pin did not have a safety interlock (the safety pin had a lanyard). Therefore, if the maintenance pin was inadvertently left in, it could prevent the launching of the lifeboat in an emergency. Once the on-load release hook was tripped, the boat's weight would come onto the pin, making it very difficult, if not impossible, to remove.

While AMSA's concern is valid, the issue needs to be considered in the context of the risk reduced by the maintenance pin. The pin reduces the risk of an accident whenever the lifeboat is entered for maintenance and inspection. Routine weekly or fortnightly safety checks, maintenance and repairs, surveys and inspections result in a high exposure to risk, which should be reduced.

Although interlocks or engineering risk controls are preferable to procedural controls, reliance on the latter is part of any system. In the case of *Aquarosa's* lifeboat, disconnection of the simulation wires whilst at sea relied on a procedural control. Similarly, engaging the safety pin after exiting the lifeboat also relied on following a procedure. Therefore, a procedural control intended to ensure that the maintenance pin is replaced by the safety pin should be no less effective.

It is also worth noting that the adverse consequences of the maintenance pin being left in, or leaving the simulation wires attached, are the same. The resultant risk from both of these undesirable situations is, therefore, equivalent. Notwithstanding this, procedural controls to avoid these situations must be robust and, where possible, engineering controls preferred. Inexpensive solutions are often available, such as the safety pin lanyard arrangement on board *Aquarosa*.

The submission on behalf of the ship's flag State (Malta) noted that the safety benefit of a maintenance pin, if properly managed, outweighed the risks it introduced. The submission also indicated a concern about the use of wires, both as a part of a simulation system and as an appropriate risk reduction measure to stop the unintentional launching of a freefall lifeboat.

On board *Aquarosa*, before the occurrence, an equivalent, alternative arrangement to the safety pin had not been provided to prevent inadvertent tripping of the freefall lifeboat's on-load release during routine operations, such as inspections and maintenance.

Failure of the simulation wires

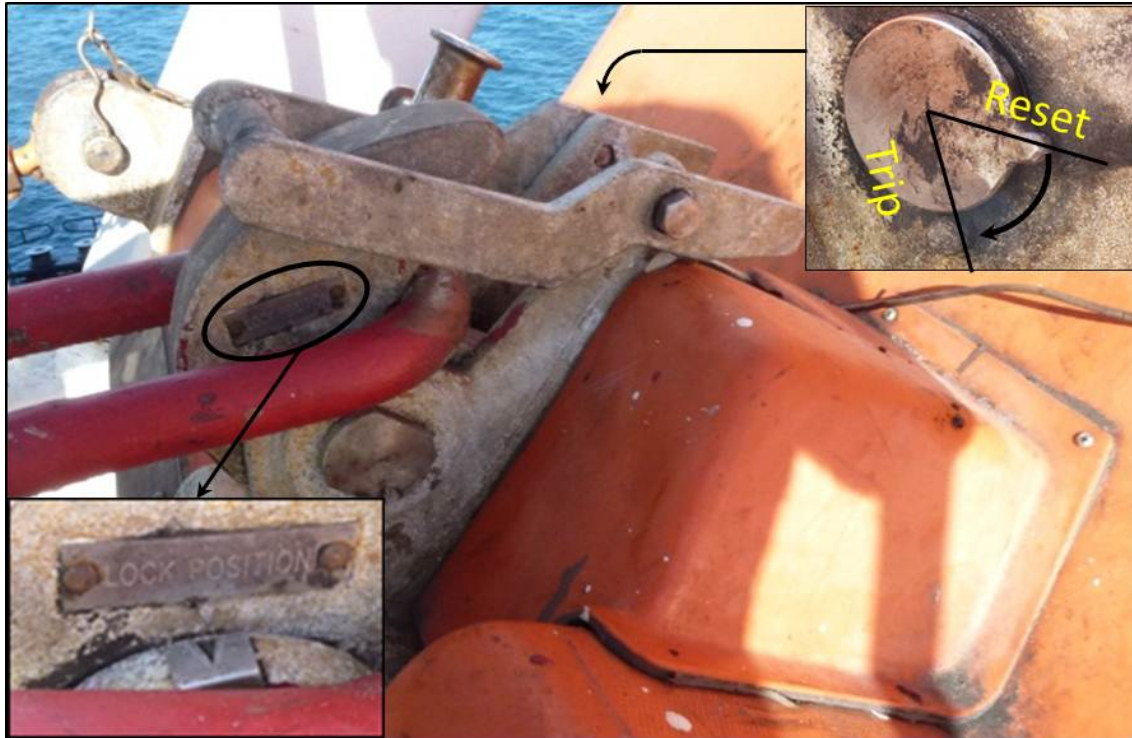
Aquarosa's freefall lifeboat simulated launching arrangement relied on two wire slings to prevent the lifeboat from launching after the on-load release had been operated.

Analysis of the failed wire slings by the ATSB indicated that their failure was consistent with gross overload. There was no evidence to indicate that the failure was the result of a defect, damage or corrosion.

The simulation system on board relied on two simulation wires, acting in parallel and an equal distribution of energy between them. Therefore, it was important for each component of both wires to be identical, including the wires themselves, their mounting points and other parts. If this were not the case, uneven loading during simulation could overload one wire, resulting in its failure. This, in turn, would place the entire load on the remaining wire, which could then also fail.

The simulation wires were intended to stop the lifeboat's motion and were used, primarily, under shock loading conditions. Further, the lifeboat's operation and maintenance manual stated that maintenance on the release hook and system was to be carried out after a simulated release, once the boat's weight was being held by the wires.

Figure 7: On-load release and indicators



Source: ATSB

Wire rope

As a wire rope ages through normal use, its strength and flexibility decreases. The individual strands within a wire rope bed themselves in and the elasticity of the rope reduces by 20–25 per cent.¹¹

Aquarosa's lifeboat simulation wires had been shock loaded on multiple occasions during the ship's life when conducting drills and demonstrations for Class or Port State Control inspections. There were no records available to indicate if, or when, the wires had been replaced, suggesting that they could have been fitted when the lifeboat was first installed. Therefore, by 1 March, the elasticity of the wires may have been reduced by up to 25 per cent with a resultant reduction in their ability to absorb a shock load.

The reduction in elasticity as a result of the wire's age and use, would make it stiffer, reducing its ability to provide a cushioning effect. The reduced cushioning effect would mean a further increase in the magnitude of the shock load.

Depending on the type of wire rope used, the elastic limit¹² of the material is 55–65 per cent of the failure strength.¹³ In *Aquarosa's* installation, the shock load was less than the failure load of the wire. However, it was in excess of both the safe working load and the elastic limit. Therefore, each simulated release subjected the simulation wires to permanent, cumulative damage.

¹¹ Values taken from the article *Understanding shock loads* as published in TD&T, Volume 49 No. 2 (Spring 2013) which had been adapted from the paper *Understanding shock loads*, Delbert L. Hall.

¹² The point at which a greater load will start to cause permanent deformation and damage to the wire rope.

¹³ Values taken from *Shock Loading*, H & H Specialities, South El Monte CA 91733.

Manufacturer's calculations

The lifeboat, davit and the on-load release were manufactured by the same company. As part of the design process, calculations were made as to the forces in the simulation wires and hoisting wire. However, those calculations did not take into account the shock load imposed on the simulation wires, nor on the lifeboat and launching frame mounting points.

Installation

When correctly installed, the lifeboat operation and maintenance manual stated that once the on-load release tripped, the lifeboat should travel a maximum of 150–200 mm. A travel distance of 150 mm requires simulation wires with a length of 600 mm.¹⁴

However, the simulation wires fitted were about 700 mm long. Further, an additional shackle had been attached to the wire. The effective length of the wires, therefore, allowed the lifeboat to travel about 400 mm - twice the designed maximum distance, before being stopped. As a result, the speed of the lifeboat when arrested was much greater, with a proportional increase in the magnitude of the shock load imposed on the simulation wires.

The wire rope used for the simulation wires was a rotation-resistant wire; the outer lay was right hand and the inner lay was left hand.¹⁵ The use of an extra shackle meant that when the boat's travel down the ramp was arrested, a twist of about 90° was forced into the wires. Good practice requires that 'care should be taken to avoid inducing a twist into the rope during handling and installation'.¹⁶ Further, the short distance (about 360mm) between the two simulation wire swages meant that the twist unevenly loaded the inner and outer lays of the wire rope due to the differing lay directions, reducing the wire's breaking strain.

There were no records found on board for the maintenance, inspection or the purchase of replacement simulation wires and shackles. This suggests that the extra shackles and the 700 mm simulation wires were fitted when the lifeboat was installed on the ship. This serious irregularity was not detected during maintenance, inspections or surveys.

In summary, the simulation wires in use at the time of the accident were longer than required and were not installed as per the manufacturer's design guidance. Therefore, once the on-load release was tripped, the freefall lifeboat travelled significantly further than it was designed to during simulation with a proportional increase in the shock loads placed on the wires.

Suitability of wire rope

Many engineering solutions are available for stopping the lifeboat in simulation system designs. One such, widely used, solution is to use wire slings to arrest the movement and absorb the impact. When wire rope slings are made by folding the ends of the rope over thimbles and swaging, the effective stiffness is now substantially different from that of the wire rope. The eyes are relatively flexible but permanently deform when loaded, so that the stiffness increases each time the wire sling is loaded. The doubled portion under the swage sleeves are at least twice as stiff as the wire itself. This means that as a wire sling is repeatedly shock loaded, the probability of exceeding the breaking strength of the wire rope increases.

The ship's flag State expressed concern about the use of wire rope in freefall lifeboat simulation systems. It does not consider that wire rope is suitable because of the shock loading and because internal corrosion can often remain undetected.

While the use of wire rope is not prohibited by regulation, a large number of wire rope manufacturers specify that it should never be used in shock loading situations. Contrary to this

¹⁴ Length supplied by JJMEC for the manufacture of replacement simulation wires.

¹⁵ Refer to Appendix B for more information.

¹⁶ Wire rope users' manual – fourth edition.

guidance, the simulation system for *Aquarosa*'s freefall lifeboat used wires that were repeatedly subjected to shock loads.

Approval and survey

Before installation on board, equipment must undergo an approval process by a Recognized Organization (RO) on behalf of the flag State. The approval process confirms that the equipment was manufactured in accordance with the relevant regulations and is fit for the purpose for which it is going to be used.

In *Aquarosa*'s case, the RO was the ship's classification society, Bureau Veritas (BV). The lifeboat, davit and fittings had undergone this process and certificates had been issued by BV in October 2009. Inspections after installation on the ship at the time of building and at subsequent annual surveys did not identify that the installation was not in accordance with the manufacturer's specific requirements.

The process and procedures followed by BV should have ensured that the use to which an item of equipment would be put was considered when giving approval. Bureau Veritas approved the simulation wires for 'maintenance and testing'. However, the approval procedures took into account the lifeboat's static weight, but not the shock loading that would be experienced during 'testing'.

Lifeboat and on-load release documents

The SOLAS mandated *Instructions for on-board maintenance*¹⁷ and MSC.1/Circ.1206/Rev 1¹⁸ require all appropriate documentation for the maintenance and adjustment of lifeboats, launching appliances and associated equipment to be available on board. Where possible, the documentation is to be illustrated and should be easily understood. Further, all personnel undertaking inspections, maintenance and adjustment of lifeboats, launching appliances and associated equipment are to be fully trained and familiar with these duties.

The manufacturer's manuals available on board *Aquarosa* related to lifeboat operations were 'Final Drawing' and 'Freefall Lifeboat Operation & Maintenance Manual'. Neither manual gave information on the resetting of the on-load release, the alignment marks for the hook, or the required checks to ensure that proper resetting was complete.

The ATSB also identified inconsistencies in the documents in relation to the weight values for the lifeboat, which differed from the value stated on the nameplate (see Appendix A). Both the nameplate and the manuals gave the boat's weight but did not indicate that it also included the fuel and stores in that value. Similarly, there were significant inconsistencies across various documents with respect to the length and diameter of simulation wires and the name used by the manufacturer to identify them (see Appendix C).

The manufacturer had not provided any guidance for simulation wire maintenance or replacement requirements, and the ship's planned maintenance system did not contain any reference to the simulation wires or any other lifting equipment. The ship's Cargo Register contained information only for its four cargo cranes.

¹⁷ Chapter III, Part B, Section 5, Regulation 36.

¹⁸ Paragraph 2.3.3.2.

Findings

From the evidence available, the following findings are made with respect to the inadvertent release of *Aquarosa's* freefall lifeboat and associated failure of the lifeboat launch simulation wires on 1 March 2014. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance.

A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing factors

- When the on-load release was last reset before the accident, it was not noticed that the release segment had not properly reset.
- **While the design of the on-load release system allowed the reset position of the hook to be visually confirmed, it did not allow for visual confirmation that the release segment and mechanism had been correctly reset. Consequently, the hook device could appear to be properly reset when it was not. [Safety issue]**
- **An equivalent, alternative arrangement to the safety pin had not been provided to prevent inadvertent tripping of the freefall lifeboat's on-load release during routine operations, such as inspections and maintenance. [Safety issue]**
- All the risks had not been fully considered before the on-load release system hydraulic activation pump was operated to check for leaks.
- The simulation wires fitted at the time of accident were longer than required and had not been installed as per the manufacturer's design guidance. Therefore, once the on-load release was tripped, the lifeboat travelled significantly further than it was designed to during a simulated release with a proportional increase in the shock load placed on the wires.
- **The manufacturer's calculations did not take into account the shock load imposed on the simulation wires or the lifeboat and launching frame mounting points. [Safety Issue]**
- **The Recognized Organization's process for the approval of the simulation wires for 'maintenance and testing' had not taken into account the shock loading that would be experienced during testing. [Safety issue]**

Other findings

- The manufacturer's documents contained inconsistencies in relation to the specifications of both the lifeboat and the simulation wires.
- There was no guidance in the manufacturer's documents or in the ship's planned maintenance system for simulation wire maintenance or replacement.

Safety issues and actions

Depending on the level of risk of the safety issue, the extent of corrective action taken by the relevant organisation, or the desirability of directing a broad safety message to the marine industry, the ATSB may issue safety recommendations or safety advisory notices as part of the final report.

Lack of visual indication for the resetting of the release segment

Number:	MO-2014-002-SI-01
Issue owner:	Jiangsu Jiaoyan Marine Equipment Company
Operation affected:	Freefall lifeboat operations
Who it affects:	All ships with this type of on-load release arrangement

Safety issue description:

While the design of the on-load release system allowed the reset position of the hook to be visually confirmed, it did not allow for visual confirmation that the release segment and mechanism had been correctly reset. Consequently, the hook device could appear to be properly reset when it was not.

Proactive safety action taken by Jiangsu Jiaoyan Marine Equipment Company

Action number: MO-2014-002-NSA-010

The manufacturer has written to ship owners and ship yards notifying them of the potential problem with the resetting of the on-load release. The letter also advises how to reset the on-load release properly to avoid it being partially reset.

All new on-load releases now include a marker to show that the release segment has rotated to the fully reset position.

Proactive safety action taken by *Aquarosa's* managers, V.Ships

Action number: MO-2014-002-NSA-011

The cheek plate of the on-load release on board *Aquarosa* was marked so as to give visual indication when the release segment was in the correct position.

The cover, over the linkages and hydraulic ram, is also to be left off allowing access to the ram to assist it retracting.

Current status of the safety issue

Issue status: Adequately addressed

Justification: The letter sent by the manufacturer should raise awareness with organisations that currently use this model of on-load release. The addition of the marker to show that the release segment is fully reset should reduce the likelihood of an inadvertent release on ships that receive the modified on-load release.

On-load release safety pin

Number:	MO-2014-002-SI-02
Issue owner:	Jiangsu Jiaoyan Marine Equipment Company
Operation affected:	Freefall lifeboat maintenance, testing and inspection
Who it affects:	All ships with this type of on-load release arrangement

Safety issue description:

An equivalent, alternative arrangement to the safety pin had not been provided to prevent inadvertent tripping of the freefall lifeboat's on-load release during routine operations, such as inspections and maintenance.

Proactive safety action taken by Jiangsu Jiaoyan Marine Equipment Company

Action number: MO-2014-002-NSA-012

All new freefall lifeboats will be supplied with a maintenance pin and instruction plate, which will be mounted on the outside of the lifeboat near the on-load release.

ATSB comment in response

While the maintenance pin reduces the risk of an inadvertent launch during maintenance, leaving the pin in can prevent lifeboat launch in an emergency. The control for this introduced risk is procedural instead of an engineering control.

ATSB safety recommendation to Jiangsu Jiaoyan Marine Equipment Company

Action number: MO-2014-002-SR-003

Action status: Released

The Australian Transport Safety Bureau recommends that Jiangsu Jiaoyan Marine Equipment Company takes safety action to fully address the issue by providing controls that ensure the freefall lifeboat maintenance pin is replaced by the safety pin after its use.

Proactive safety action taken by *Aquarosa's* managers, V.Ships

Action number: MO-2014-002-NSA-013

An additional pin was fabricated by *Aquarosa's* crew so that it could be fitted before entering the lifeboat for any purpose other than launching it.

Shipboard procedures have been implemented which require tool box meetings to be held before entry into the lifeboat to carry out maintenance. These procedures include details of the checks to be made prior to any lifeboat maintenance being carried out. The master's permission is now required before the lifeboat release system hand pumps are operated and warning signs have been placed at the pump locations stating this requirement.

Aquarosa's managers have shared the details of the accident within their group and with industry colleagues through safety forums.

ATSB comment in response

While the maintenance pin reduces the risk of an inadvertent launch during maintenance, leaving the pin in can prevent lifeboat launch in an emergency. The control for this introduced risk is procedural instead of an engineering control.

ATSB safety recommendation to V.Ships

Action number: MO-2014-002-SR-004

Action status: Released

The Australian Transport Safety Bureau recommends that V.Ships takes safety action to fully address the issue by providing controls that ensure the freefall lifeboat maintenance pin is replaced by the safety pin after its use.

Current status of the safety issue

Issue status: Partially addressed

Justification: The proactive safety action taken reduces the likelihood of an inadvertent launch. However, replacing the maintenance pin with the safety pin is reliant on the instruction plate and associated procedural controls instead of a control that positively ensures that it is replaced. An engineering control or interlock, such as that used for the safety pin, to ensure the maintenance pin is replaced by the safety pin, could be an equivalent arrangement.

ATSB safety advisory notice to all manufacturers of freefall lifeboats and operators of ships fitted with freefall lifeboats

Action number: MO-2014-002-SAN-005

The Australian Transport Safety Bureau advises that all manufacturers of freefall lifeboats and operators of ships fitted with freefall lifeboats should review their on-load release and associated instructions manuals to ensure that crew entering the lifeboat for inspection and maintenance are not exposed to an increased risk due to the removal of the safety pin from the on-load release.

Simulation wire calculation

Number:	MO-2014-002-SI-03
Issue owner:	Jiangsu Jiaoyan Marine Equipment Company
Operation affected:	Freefall lifeboat operations
Who it affects:	All ships with this type of launch simulation system

Safety issue description:

The manufacturer's calculations did not take into account the shock load imposed on the simulation wires or the lifeboat and launching frame mounting points.

Proactive safety action taken by Jiangsu Jiaoyan Marine Equipment Company

Action number: MO-2014-002-NSA-014

Jiangsu Jiaoyan Marine Equipment Company has not advised of any action taken to calculate the shock loads imposed on the simulation system or the mounting points.

However, the instruction manuals have been updated to include a requirement for the fitting of two of the four lifting slings as an extra safety measure. The expected travel of the boat during a simulated launch has been reduced from 150–200 mm to 50 mm.

Boats fitted with 'new type' on-load releases will be fitted with a turnbuckle arrangement, in place of the wire slings, that will be loosened to allow for a travel of 10 mm during a simulated launch. The reduction in the distance travelled will considerably reduce the shock loads imposed on the simulation system.

ATSB safety recommendation to Jiangsu Jiaoyan Marine Equipment Company

Action number: MO-2014-002-SR-006

Action status: Released

The Australian Transport Safety Bureau recommends that Jiangsu Jiaoyan Marine Equipment Company takes safety action to address the lack of calculation of the shock loads imposed on the simulation wires. Further, the suitability of the materials used to make up the simulation system and how they dissipated the forces imposed on them should also be assessed.

Current status of the safety issue

Issue status: Partially addressed

Justification: While the action taken will reduce the likelihood of a failure of the simulation system by reducing the shock loads imposed on it, it has not addressed the lack of knowledge as to the forces involved when conducting a simulated launch and whether the equipment used is suitable for the intended task.

ATSB safety advisory notice to all manufacturers of freefall lifeboats

Action number: MO-2014-002-SAN-007

The Australian Transport Safety Bureau advises that all manufacturers of freefall lifeboats should calculate all of the forces that will be imposed on their simulation system. Further, the suitability of the materials used to make up the simulation system and the dissipation of forces imposed on them should also be assessed.

Simulation wire approval by a recognized organization

Number:	MO-2014-002-SI-04
Issue owner:	Bureau Veritas and the International Association of Classification Societies
Operation affected:	Freefall lifeboat operations
Who it affects:	All ships with this type of launch simulation system

Safety issue description:

The Recognized Organization's process for the approval of the simulation wires for 'maintenance and testing' had not taken into account the shock loading that would be experienced during testing.

Response to safety issue by Bureau Veritas

Action number: MO-2014-002-NSA-015

Bureau Veritas advised that:

Equipment approval was made by Bureau Veritas on behalf of the French Maritime Authority (MED Equipment). As per Bureau Veritas procedure, Bureau Veritas will transmit the report on this accident to the French Maritime Authority when released.

ATSB safety recommendation to Bureau Veritas

Action number: MO-2014-002-SR-008

Action status: Released

The Australian Transport Safety Bureau recommends that Bureau Veritas takes safety action to address the lack of procedures governing the approval and certification process, so that all aspects of a piece of equipment's use is considered prior to certifying.

Response to safety issue by the International Association of Classification Societies

Action number: MO-2014-002-NSA-016

The International Association of Classification Societies advised that, in accordance with its procedures, it had no comment to offer. The response indicated that the Permanent Secretariat would forward its reply to Bureau Veritas for its information.

ATSB safety advisory notice to all Recognized Organizations and the International Association of Classification Societies

Action number: MO-2014-002-SAN-009

The Australian Transport Safety Bureau advises that all Recognized Organizations and the International Association of Classification Societies should consider the safety implications when certifying simulation systems that are subject to forces that have not been calculated. Further, the materials and components used to make up the simulation system should be assessed for suitability and safety under all intended conditions of use.

Current status of the safety issue

Issue status: Not addressed

Justification: At the time of publication of this report, no safety action has been taken by the issue owners.

General details

Occurrence details

Date and time:	1 March 2014 – 1118 (UTC + 8 hours)		
Occurrence category:	Accident		
Primary occurrence type:	Equipment failure		
Injuries:	Fatal: Nil	Serious: 1	Minor: Nil
Damage:	Minor damage to the lifeboat and two failed simulation wires		
Location:	450 miles north-northwest of Dampier, Western Australia		
	Latitude: 13° 26.80' S	Longitude: 114° 36.20' E	

Ship details

Name:	<i>Aquarosa</i>
IMO number:	9506708
Call sign:	9HA2201
Flag:	Malta
Classification society:	Bureau Veritas
Ship type:	Bulk carrier
Builder:	Yangzhou Guoyu Shipbuilding, China
Year built:	2010
Owner(s):	Aquarosa Shipping, Copenhagen
Operator:	Falcon Maritime
Manager:	V.Ships, USA
Gross tonnage:	33,005
Deadweight (summer):	56,723.99 t
Summer draught:	12.80 m
Length overall:	189.99 m
Moulded breadth:	32.26 m
Moulded depth:	18.00 m
Main engine(s):	Wartsila 6RT-Flex50B
Total power:	9,480 kW at 110 rpm
Speed:	14 knots

Sources and submissions

Sources of information

On 6 March 2014, investigators from the Australian Transport Safety Bureau (ATSB) attended *Aquarosa* while the ship was at anchor off Fremantle, Western Australia. The master and directly involved crew members were interviewed and each provided their account of the accident.

Photographs of the ship, its equipment and copies of relevant documents were obtained, including log books, statutory certificates, reports, manuals and procedures. Further information was supplied by Bureau Veritas and Jiangsu Jiaoyan Marine Equipment Company.

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Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the master and directly involved crew of *Aquarosa*, V.Ships, Jiangsu Jiaoyan Marine Equipment Company (JJMEC), the Australian Maritime Safety Authority (AMSA), the International Association of Classification Societies, the flag State (Malta) and Bureau Veritas (BV).

Submissions were received from JJMEC, AMSA, International Association of Classification Societies flag State and BV. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Appendices

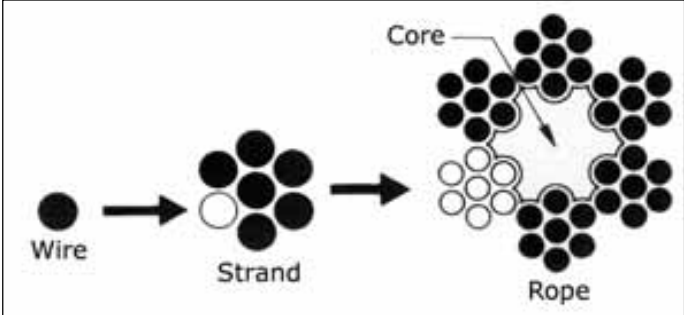
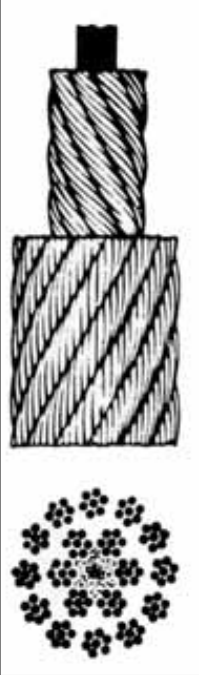
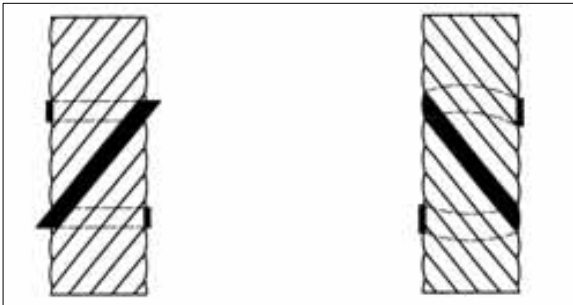
Appendix A – Table of values

	Values from JJMEC lifeboat manuals	Value used for the calculations by JJMEC	
Lifeboat weight	(a) 3435.0 kg	(e) 2752.0 kg	
Crew weight	(b) 2227.5 kg		
Total weight	(c) 5844.0 kg		Lifeboat's nameplate – 5460 Kg
Davit SWL	(d) 5606.5 kg		

Note

- (c) \neq (a) + (b) as given in the manual.
- (b) – The table used 27 persons with an average weight of 82.5 kg (2227.5 kg) but due to the date of manufacture the average weight of 75 kg (2025 kg) was used to arrive at the total weight as noted on the nameplate.
- (c) – The lifeboat weight as stated in the manual is greater than the davit SWL (d). It is also greater than the value given on the nameplate affixed to the lifeboat.
- (e) – The manufacturer, in correspondence, gave this value as the empty lifeboat weight which does not match the lifeboat weight given in the manual.

Appendix B – Wire rope nomenclature

Construction of a wire rope	Rotation resistant wire rope
 <p>Wire → Strand → Rope</p> <p>Core</p>	
Rope lay	
 <p>a) z (right lay) b) s (left lay)</p>	<p>Source: A. Noble & Sons</p>

Appendix C – Simulation wire rope lengths and diameters

Rope length and dimension	Source
500 mm x 18 mm	As given in the Aft Lashing Unit manual supplied by the manufacturer
600 mm x 16 mm	As given by the manufacturer for new wires
700 mm x 14 mm	As removed from the lifeboat
800 mm x 14 mm	As supplied to Class for approval

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Notifications 1800 011 034

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Investigation

ATSB Transport Safety Report

Unintentional release of the freefall lifeboat from Aquarosa
Indian Ocean, 1 March 2014

307-MO-2014-002

Final – 20 May 2015