

Fatal accident in connection with the operation of an A-frame based launch and recovery system (LARS) used for ROV operations

Safety Flash Published on 10 April 2008 Generated on 24 January 2025 IMCA SF 07/08

During the process of docking in a floating dock, an ROV crew consisting of seven persons was working on an ROV spread inside the hangar on the port side of the vessel.

What happened?

This work was mainly to undock the ROV from the tether management system (TMS) unit and to cut out and re-terminate a 50-70m section of the umbilical on the ROV winch.

Prior to the incident, the ROV had been separated from the TMS and both units were resting on the base platform in the hangar, with the TMS located just underneath the docking head which was situated 2.5m above the top of the TMS. The ROV was located adjacent to the TMS towards the port side of the hangar.

A total power black out occurred onboard the vessel due to lack of cooling water supply to the auxiliary engines. At this time the TMS unit made a sudden and significant vertical upward movement (of approximately 2.5m) until it was stopped by the docking head overhead. The ROV senior supervisor was standing on top of the TMS with the aim of assisting with the pull-out of the umbilical. He was thus trapped between the TMS and the docking head and subjected to a massive force of 13.7 tonnes, resulting in his death.

At the time of the accident, the ROV supervisor was standing on a small service platform on the side of the TMS facing the accommodation and he was thrown clear, landing on the base platform, with no apparent injuries.

The other ROV crew members were located in the following positions:

- One person was strategically located between the ROV/TMS and the accommodation operating the remote control for the LARS system.
- One person was located on the ROV winch deck on top of the ROV hangar, adjusting the position of the transversal crane to keep it well clear of the LARS system.
- Two persons were located on the inboard side of the TMS, pulling out slack on the umbilical from the umbilical winch.
- One ROV trainee was observing the operation from a safe position near the centre of the hangar.

The accident was sudden and the witnesses of the tragedy estimated the time it took for the uncontrolled and rapid spooling of the winch to be in the order of 2-3 seconds.

Facts and Observations from the Investigation

There was no offshore manager (OM) assigned onboard after the vessel's departure from its last port.

The ROV crew had allegedly obtained, from the bridge, permission to work at heights.

There were no indications that the ROV crew members were not wearing the correct PPE for this type of operation.

The ROV crew was working on the ROV spread during the de-ballasting of the floating dock.

Relevant crew allegedly knew that a power black out would take place during the dry docking process, although the exact timing of this black out and the permanent loss of 440 VAC was not known to some key personnel beforehand.

The accident occurred at the same time as the power black out. The ROV winch spooled in the umbilical instantly and in an uncontrolled manner, lifting the TMS module vertically up towards the docking head, causing the fatality.

The ROV supervisor was standing on top of the TMS with the aim of assisting the pull-out of the umbilical of which about 5m had been slacked off when the incident occurred. He was trapped and his body subjected to a massive force of 13.7 tonnes between the TMS and the docking head.

Due to power cut the operation of the emergency stop had no effect.

It is anticipated that the task of spooling off (approximately 50m) of umbilical in order to re-terminate had to be completed prior to docking – this may have led to time pressure.

It has been noted that assistant ROV supervisor was in process of lashing down the TMS at the time of the incident.

Technical Errors and Corrective measures

Testing and trouble shooting have confirmed that there were serious technical discrepancies on the LARS system resulting in a chain of events having a direct effect on the accident.

The mechanisms with effect, cause and corrective measures are presented below. It was noted that all of the six mechanisms described below had to occur simultaneously for the erratic winch behaviour to occur.

1. The isolation valve fails to close:

Effect: The motor remains open to hydraulic power.

Cause: Incorrect wiring.

1. Corrective measure:

- Wiring done according to original drawing;
- The valve is hardwired into the emergency stop circuit (de-energising).

2. The bypass valve fails to open:

Effect: Potentially full pressure differential over the motor with failure on the isolation valve, thus enabling the motor to produce maximum torque.

Cause: An error in the motor controller (HNC) software fails to de-energise the bypass valve when an emergency stop is triggered, while operating the winch from the radio remote or the operator panel.

Corrective measure: Software for motor controller updated. Bypass valve will be de-energised as originally intended when the winch is rotating during an emergency stop.

3. The brake fails to engage within reasonable time:

Effect: The brake cannot stop winch motion within reasonable time.

Cause: The main controller (PC104) software will not engage the brake until a brake engage request is given from the motor controller (HNC) software. The motor controller software will not give such a request in all situations.

Corrective measure:

- Software for motor controller updated. Brake on command (de-energising) will be provided immediately in case of an emergency stop;
- Software for main controller updated. Brake on command (de-energising) will be provided immediately in case of an emergency stop, independent of the motor controller;
- Brake control is hardwired into the emergency stop circuit (de-energising).

4. The displacement (swivel angle) of the motor is sufficient to create winch pull:

Effect: The motors had a displacement creating torque so that the winch could pull in.

Cause: To avoid the load from dropping during a normal emergency stop, the displacement of the motors is set at a fixed value. As long as the isolation valve is closed as it should be in case of an emergency stop, the winch can only give a static torque and cannot hoist any load as the supply of high pressure oil is cut by the isolation valve. When the bypass valve opens, there will be no significant pressure differential over the motor and the winch's ability to also create a static torque will be lost.

Corrective measure: None. Displacement is required to prevent the load from dropping during an ordinary emergency stop. Investigations regarding alternatives ongoing. This is to be tested at the implementation of a coming release of new motor controller software.

5. The winch has a speed signal different from the control signal for zero:

Effect: Winch hoisting for a longer period of time after an emergency stop.

Cause: In the original motor controller software, the brake did apply quickly at an emergency stop at zero speed, but not when the speed was different than zero.

Corrective measure:

- As for 1.3.3.

6. Hydraulic power is available:

Effect: Winch motion possible.

Cause:

- Pumps do not instantly stop rotating, due to rotation inertia;
- Hydraulic energy is stored in accumulators;
- Hydraulic energy is stored in the system due to the flexibility of pipes, hoses and the oil itself.

Corrective measure: A valve on the accumulator will be installed to cut the connection to the main line, and relieve the energy into the return line. The valve will be hardwired into the emergency stop circuit (de-energising).

The following summarises the applied measures:

- Wiring of isolation valve corrected to comply with original drawing.
- Isolation valves hardwired into the emergency stop circuit.
- Brake control valve hardwired into the emergency stop circuit.
- Main controller software updated to request brake on upon an emergency stop.
- Motor controller software updated to request brake on upon an emergency stop.
- Motor controller software updated to de-energise bypass valve upon an emergency stop.

The applied measures of the introduction of modifications to the software and electronic hardware will minimise the probability of any failure to engage the brake, or failure to close the isolation valve, during an emergency stop. The duration of any significant dynamic winch pull will also be minimised as the bypass valve short-circuits the hydraulic motor shortly after an emergency stop.

Further, the following measure will be applied at a later stage due to lead time of components:

- The accumulator will be cut off from the main line, and the stored high pressure oil will be discharged to tank through a hydraulic valve being hardwired into the emergency stop circuit.

Company's Conclusion

The combination of technical and human error had resulted in an unfortunate breach of barriers causing the fatality. Apart from the technical issues identified, there were several examples of human error including:

- Management/supervision
- Communication
- Culture
- Compliance

- Task planning
- Barriers

These issues are to be focused on by the company.

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