# **CFerries Divisional Inquiry** DI-QCUM-10239



# INCIDENT INFORMATION

Incident Name:	Rescue Boat Fall During Man Overboard Drill
Worksite:	Queen of Cumberland
Location:	Swartz Bay Berth #4
Incident Date:	April 18, 2018
iSail Number:	226,156
IAR Number:	IAR-QCUM-4630

# **INVESTIGATION INFORMATION**

Panel Members:	Second Officer, BC Ferry & Marine Workers' Union Representative Manager, Safety Management System Director, Engineering Services Senior Master, Fleet Operations Senior Chief Engineer, Fleet Engineering Executive Director, Crewing Auditor, Operational Readiness
Interviewees:	Senior Master, <i>Queen of Cumberland</i> Senior Chief Engineer, <i>Queen of Cumberland</i> Chief Engineer, <i>Queen of Cumberland</i> Master, <i>Queen of Cumberland</i> (2) Mate, <i>Queen of Cumberland</i> (5) Engine Room Assistant, <i>Queen of Cumberland</i> Regional Terminal Manager, Swartz Bay Terminal Supervisor, Swartz Bay Loader, Swartz Bay Terminal Attendant, Swartz Bay Trades Helper, Swartz Bay Equipment Operator, Swartz Bay Deckhand, <i>Skeena Queen</i> (2) Operations Manager, Fleet Maintenance Unit (2) Trades Supervisor, Fleet Maintenance Unit Rigging Chargehand, Fleet Maintenance Unit Labourer (Rigging), Fleet Maintenance Unit (2)

Marine Superintendent, Southern Gulf Islands SEA Trainer, Swartz Bay SEA Manager, Little River SEA Manager (retired) Operational Trainer, Tsawwassen Manager, Asset Management, Swartz Bay

# APPROVAL BY CONVENING AUTHORITY

The Findings and Recommendations of the Investigation Panel are supported.

(Convening Authority's Signature) Executive Director Fleet Operations & Training September 20, 2018 (Date)

#### **Inquiry Overview**

On 18 April 2018 during rescue boat drills aboard the *Queen of Cumberland* (QCUM), the davit's wire rope failed and the boat fell to the water with two employees onboard. British Columbia Ferry Services (BCFS) convened a Divisional Inquiry to investigate.

The Divisional Inquiry panel's mandate was to investigate root cause and to identify safety deficiencies, with a focus on effectively and practicably reducing future risk. The panel did not have a mandate to assign fault.

The panel was ever mindful of the seriousness of this incident and in particular, the impacts to the two (2) injured employees. The panel acknowledges the incident's effect on employees throughout the fleet, both directly and indirectly.

Immediately following the incident, BCFS Fleet Operations assigned a Director to manage and support a fleet wide davit inspection and to address any immediate corrective actions that were required. The panel has supported the Director by sharing all pertinent draft findings as they became available.

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#### 1.0 Incident Overview

#### 1.1 Synopsis

On the day of the incident, during a routine drill, the line that secures the bow of the rescue boat to the side of the ship was adjusted (shortened in length). While retrieving the rescue boat from the waterline, the shortened length caused the rescue boat to be pulled (forward) out of plumb, beyond the operational limits of the davit. The wire rope (which the boat hangs from), was pulled from its sheave; it quickly became compromised and failed.

Multiple unsafe conditions (causal factors) have been identified and are included throughout this report.

# 1.2 Summary of Events

On 18 April 2018 at 12:30, the QCUM was tied up, propulsion shut down in Swartz Bay berth #4 for the normal mid-day layover (Figure 1). Two American Bureau of Shipping surveyors were aboard performing the vessel's annual inspection. A rescue boat drill was requested as part of the annual inspections. The vessel was laying in the berth with the starboard side to the berth dolphins providing open water on the port side of the vessel<sup>1</sup>.

At 12:44, from its davit, port side aft on the boat deck, the rescue boat was tilted (luffed) out and lowered to the waterline. The davit was controlled by the Davit Operator on the boat deck using the remote control device (Figure 2), connected by cord to the davit control box. There was a crew of two (2) in the boat. A painter (rope line) was attached to the bow of the boat and the other end ran to a cleat on the main car deck on the vessel's quarter. The descent of the boat took 32 seconds. Once the boat was in the water, the hook and the painter were released by the boat crew. At 12:46 the boat departed the vessel for a short turn around Swartz Bay. The davit remained in the luffed out position (Figure 3) with the davit falls (wire rope) and hook hanging about 2 metre (m) above the waterline.

At 12:49, the boat returned to a position under the davit falls<sup>2</sup> and the hook and painter were reattached to the boat. The Davit Operator on the boat deck initiated hoisting at 12:49:34, taking up the slack on the falls and raised the boat partially out of the water. At 12:49:52, the boat was lowered back to the waterline and the crew deployed boat hooks for fending off from the shipside.

At 12:50:13, the slack was taken up again and the boat rose out of the water to begin its ascent. The boat swung in and out, perpendicular to the ship side, as the crew fended off to get clear of the vessel's rubbing strake. The hoisting was stopped and started at 12:50:26. The boat cleared the rubbing strake at 12:50:27 and began a continuous lift with some swinging (pendulum) fore and aft that dampened out in the ascent.

At 12:50:49, the painter line became taut, causing the bow of the boat to slope down, and the davit falls wire rope parted. The boat dropped bow first to the waterline. The two crew members were thrown from the boat and were observed afloat in the water.

A recovery operation was immediately initiated to retrieve the boat crew from the water and to get ambulance service to the berth. Swartz Bay terminal employees (terminal and terminal work boat), *Skeena Queen* (SKEN) crew members (rescue boat) and QCUM crew members participated in the operation.

At 13:03:00, the two crew members were out of the water and onshore. Awaiting ambulances took them directly to hospital. Both employees suffered trauma, one with serious injuries including multiple broken bones and lacerations.

Upon immediate examination of the equipment, it was found that the davit falls wire rope had parted approximately 1.5 m from the hook end (Figure 4).

<sup>&</sup>lt;sup>1</sup> The QCUM is a double ended vessel. All shipboard directional orientations are based on the #1 end of the vessel being the forward end. At the time of the incident, the vessel had the #1 end into the berth.  $\frac{2}{2}$  For the second direction of the incident, the vessel had the #1 end into the berth.

<sup>&</sup>lt;sup>2</sup> Exact position undetermined.

#### **1.3 Recovery Actions** (timestamps from captured Closed-Circuit Television footage)

The overwhelming evidence received by the panel was that the immediate and recovery actions taken by both terminal and vessel crews were appropriate and well executed to the best of their abilities. The decisions that were made resulted in a successful recovery.<sup>3</sup>

Recovery action details, findings and a recommendation summary (lessons learned) are captured in Appendix C.

- 12:51:12 The first of three (3) life rings were thrown from the QCUM boat deck. The two crew members in the water were observed making their way to the rescue boat.
- 12:51:30 The SKEN was in the berth adjacent to the QCUM, and the QCUM Master called them directly by ship's radio in lieu of a Mayday call. The Master called the terminal, Emergency Services (911) and the Senior Master notified the Operations & Security Centre (OSC).
- 12:53:00 SKEN sounds three prolonged blasts on the ship's whistle.
- 12:54:00 SKEN rescue boat launched. Terminal Supervisor musters crew and launches terminal work boat.
- 12:54:50 Crew members (in water) holding on to rescue boat.
- 12:55:53 The Terminal Manager and Supervisor arrive at berth.
- 12:56:11 Terminal Work Boat arrives on scene.
- 12:56:26 SKEN rescue boat arrives on scene.
- 12:56:56 A terminal workboat crew member transfers (climbs into) the QCUM rescue boat.
- 12:57:17 Terminal management elect to lower berth #5 apron to the waterline to allow for easier injured crew transfer to shore.
- 12:59:25 Recovery net (parbuckle) in rescue boat deployed to assist.
- 13:00:30 First crew member recovered (into QCUM rescue boat). First ambulance arrives.
- 13:01:30 QCUM rescue boat at berth with first crew member. Second ambulance arrives at berth.
- 13:03:00 Second crew member (asks rescuers to keep him in water) and is slowly pulled to berth by SKEN rescue boat.
- 13:06:45 Fire and police arrive.

<sup>&</sup>lt;sup>3</sup> Potential improvements (lessons learned) have been included in the recommendations.

- 13:07:46 Third ambulance arrives.
- 13:10:30 First crew member (on stretcher) in ambulance.
- 13:11:00 Second crew member (on stretcher) in ambulance.
- 13:15:00 Ambulances depart terminal.

#### 1.4 Status of Vessel after Incident

The QCUM was immediately stood down from operations. WorkSafeBC was notified. Sailings were cancelled and the site was secured by RCMP. The davit area was cordoned off and monitored by RCMP until BCFS Safety representatives and a WorkSafeBC Occupational Safety Officer arrived on scene. The davit area remained cordoned and secured from all parties.

Transport Canada and the Transportation Safety Board were notified.

BCFS and WorkSafeBC investigations were initiated with two (2) additional WorkSafeBC Investigators onboard at 18:00 of 18 April.

On the morning of 19 April, a WorkSafeBC team (Safety Officers, Investigators and Professional Engineer) led an initial inspection of the davit with observation by BCFS and Original Equipment Manufacturer (OEM) representatives (Service Manager and Service Technician). It was determined that to safely and effectively complete testing and analysis, the davit would require removal from its Deck 6 position on the vessel.

WorkSafeBC determined that as part of their investigation, they would take possession of the davit and move it to a secure location in Richmond. Arrangements would be made for a third party engineering firm - specializing in technical investigation materials testing - to be contracted by WorkSafeBC, to inspect and test the davit components. The QCUM was re-positioned to the BCFS shipyard, FMU in Richmond, late in the evening of 19 April. The davit was removed from the vessel and secured in the WorkSafeBC exterior compound in Richmond on the morning of 20 April. Access to davit components (for inspection) was coordinated by WorkSafeBC on pre-determined dates, based on the results of initial tests to warrant further in-depth examination.

Immediately following the incident, the rescue boat was tied off in a gated area. It was retrieved by a crane truck and weighed (by digital scale on truck) at 635 kilogram (kg). The rescue boat was returned to the FMU Rescue Boat Centre for inspection and decommissioning.

The davit components underwent visual non-destructive testing and examination by Acuren<sup>4</sup> in Richmond, BC. for a total of three (3) days between 30 April and 30 May 2018. Attendees included: WorkSafeBC Investigator, WorkSafeBC Professional Engineer, Transportation Safety Board investigator, OEM technical representative (Palfinger Marine), BCFMWU and BCFS representatives. The conclusive results of the tests and examinations were shared.

The QCUM remained at FMU until returning to service 18 May 2018 with a newly installed *slewing* rescue boat davit type SCH 12-3.5R LV LA supplied by Palfinger Marine and approved by Transport Canada.

<sup>&</sup>lt;sup>4</sup> Acuren provides state-of-the-art non-destructive testing, inspection, engineering & rope access enabled industrial services throughout North America and the UK (www.acuren.com).

# **1.5** Sequence of Events (Extended Timeline - Safety Significant Events in red)

March 2014	1300H davit selected for <i>Queen of Capilano</i> (QCAP)and QCUM midlife upgrade davit upgrade (new BCFS standard for minor and intermediates/ included Polaris 5m rescue boat).
	Note: The larger 1800H model davit was originally proposed by the davit/rescue boat working group, however the project management team (Fleet Planning & Projects) selected the 1300H model based on davit weight installation considerations (lighter) and the number of persons required in the boat.
November 2014	QCUM davit receives Transport Canada type approval.
March 2016	New 1300H davit installed & commissioned at Esquimalt Graving Dock (shipyard).
	Senior Chief Engineer and FMU personnel receive davit orientation and training from davit manufacturer (OEM).
	Implementation of new asset (development of procedures) by vessel management.
	Davit not entered as new asset into Computerized Maintenance Management System (CMMS) Maximo.
	Maximo not providing relevant information – previous davit information including scheduled maintenance (auto-generated) routines and davit component specifications remain unchanged.
April 2016	QCUM enters service after midlife upgrade completion. Davit operating procedures not updated in QCUM Vessel Specific Manual (VSM).
	VSM procedures remain for previous davit.
	SEA <sup>5</sup> Training materials (which reference VSM) not updated.
June 2016	OEM service technician (drastically) modifies davit limit switch <i>counterweight</i> to a non-OEM off-set position to alleviate reported shuddering issue during rescue boat retrieval (at waterline) <sup>6</sup> (Figure 5).
August 2016	Rescue boat painter moved from stern to bow of rescue boat (in line with BCFS best practices).
December 2016	Rescue boat inspected and rescue boat hook replaced.

<sup>&</sup>lt;sup>5</sup> The BCFS SEA Training Program is responsible for the familiarization training of employees in their new job responsibilities.

<sup>&</sup>lt;sup>6</sup> Deemed to be related to painter line length not placing rescue boat directly underneath davit falls and wire rope engaging (rubbing) the limit switch counterweight.

April 2017 Davit receives annual service (FMU Riggers) – Maximo inaccuracies not noticed/mentioned. May 2017 ISM Audit – Post midlife upgrade changes in equipment noted missing from Maximo including operating instruction updates. It was noted that new equipment was not properly introduced. Davit was not specifically checked or mentioned. January 2018 Rescue boat bridle (webbing lifting straps) adjusted (lengthened) to attempt to address balance issue. 26 February 2018 Maximo auto-generates a work order for a davit service and wire rope replacement. The job plan details/specifications are for the previous davit, including different servicing requirements and wire specifications - Maximo inaccuracies not noticed/mentioned. QCUM vessel contacts FMU Rigging Shop directly (versus relying on Maximo process to send work order Rigging Shop) in order to expedite work as annual Class Inspection is approaching in April. 16 March 2018 FMU Rigging Shop receives Work Order - Maximo inaccuracies regarding wire specifications for the 1300H davit are not noticed/mentioned. 22 March 2018 Vessel visit by Marine Superintendent to investigate ongoing rubbing strake concern. SEA Trainer onboard and rescue boat painter length adjusted (during drill) to assist with alignment of rescue boat directly underneath wire falls on recovery (as per BCFS best practices) - ongoing/unresolved issue with painter alignment on QCUM. After adjustment and on recovery, rescue boat unable to reach top as painter became taut - dramatic shuddering/noise, felt/heard. Rescue boat lowered, safety pin had fallen out of hook - not reported. Equipment (davit and wire rope) not inspected for damage post incident. Painter readjusted by crew - no report/communication of incident to vessel crew. Incident not reported. 31 March 2018 FMU Rigging Chargehand prepares and cuts wire rope as per information listed in the Work Order. This incorrect wire rope is below OEM specifications.<sup>7</sup> Maximo inaccuracies not noticed/mentioned. Wire is sent to contractor (Western Equipment) for proof testing. 5 April 2018 FMU Rigging Shop Chargehand and two FMU Labourers visit QCUM in Swartz Bay and install new (below spec) wire rope during midday layover. Wire is not exercised (lowering and raising rescue boat to set/relax the wire) as per Rigging Shop best practices.

<sup>&</sup>lt;sup>7</sup> See *NOTE* page 43 (Section 2.12 Technical Analysis – Component Failures – Wire Rope Parting).

# Vessel Engineer does not review/sign work order. Maximo inaccuracies not noticed/mentioned.

12 April 2018	Rescue Boat Man	<b>Overboard Drill</b>	conducted	without incident.

#### 18 April 2018 Date of Incident

12:30 ABS Classification surveyors onboard for annual inspection and request to witness a Man Overboard Drill.

Appropriate deck crew assigned, Engine Room Assistant (ERA) arrives at davit per Emergency Duty Number (EDN), and is assigned as Painter Handler (as per local practice).

- 12:42 Painter Handler is instructed by the Mate to proceed to the main car deck to tend the painter line.
- 12:44 Rescue boat launched.
- 12:45 Painter Handler arrives on the main car deck and positions himself next to the painter cleat.

Painter Handler removes the painter from the cleat and pulls in some excess (slack) line.

- 12:46 Painter Handler ties two turns of painter back on the cleat (at shortened length) after receiving visual confirmation from a crew member above.
- 12:47 Painter Handler fully secures the painter back on the cleat, tidies the excess slack line with "daisy chain"<sup>8</sup> loops and stands-by for the rescue boat recovery.
- 12:49 Rescue boat returns, boat crew reattaches painter and hook.
- 12:50 Davit Operator starts recovery hoisting sequence and begins raising rescue boat.
- 12:50:49 As boat approaches deck level, the painter becomes taut and the bow of the boat began to slope down and the davit falls wire rope parted. The boat dropped bow first to the waterline. The two crew members were thrown from the boat and were observed afloat in the water. A recovery operation was immediately initiated.

Upon immediate examination of the equipment it was found that the davit falls wire rope had parted approximately 1.5 metres (m) from the hook end.

<sup>&</sup>lt;sup>8</sup> A traditional rope handling method of safely stowing excess line on deck (good seamanship practice).

#### 2.0 Factual Information & Analysis

#### 2.1 Training

#### **Operational Training**

The BCFS Operational Training department is responsible for the coordination of all operational training requirements for BCFS employees. Its mandate includes identifying training and familiarization requirements that are responsive to changes in external regulations, company policy, new vessels or equipment and performance gaps due to training.<sup>9</sup>

Rescue boat training delivered by BCFS takes place at the BCFS Operational Training Centre at FMU (classroom and practical). The following BCFS training courses are applicable to rescue boat operations:

#### **Restricted Proficiency in Survival Craft (RPSC)**

*This training course will prepare you for emergency situations, and meets Transport Canada regulations for "certificated" crew. This program is a combination of lecture and hands-on practice, and will require being outside in the elements.*<sup>10</sup>

The topics that will be covered include:

- Responding to emergencies
- Lifesaving appliances
- Deployment and operation of liferafts
- Rescue/Shepherd boats
- Man overboard recovery
- Helicopter rescues
- Post abandonment
- Hypothermia
- Communication during an emergency

The RPSC course is a Transport Canada requirement for any employee that is in a rescue boat. Transport Canada stipulates that 75% of entire crew (on minimum license) require the training. Levels are monitored by BCFS Crewing and Operational Training departments and are audited by Transport Canada. Transport Canada has accepted (grandfathered) a number of retired courses that have met standard.

As required, both the Coxswain and the Davit Operator met this criterion.

#### **Rescue/Shepherd Boat Operations**

*This training will provide participants with the essential knowledge for the safe and proficient operation of rescue boats to ensure compliance with search and rescue procedures.*<sup>11</sup>

Training includes BCFS best practices for launch and recovery procedures plus davit operations with a review of davit parts. This course is not a Transport Canada

<sup>&</sup>lt;sup>9</sup> From the Operational Training Academy website on the BCFS Intranet.

<sup>&</sup>lt;sup>10</sup> From the Operational Training Academy website on the BCFS Intranet.

<sup>&</sup>lt;sup>11</sup> From the Operational Training Academy website on the BCFS Intranet.

requirement but is a BCFS requirement for the rescue boat Coxswain position.<sup>12</sup> It is a supplemental course (added value) and meant to introduce employees to BCFS equipment, procedures and best practices.

There is an expectation, that upon completion of the course, employees would return to their vessels for further training (drill observation) with their vessel-specific fitted equipment. Information provided to the panel (including findings from BCFS Site Investigation SI-INS-9984) indicates this is not always the case and that content and thoroughness of delivery varies.

Additionally:

- The training centre is equipped with only one davit model/style (Schat Harding SPMOB slewing type).
  - $\circ$  There is no 1300H or other luffing models at the centre.
  - There are tidal limitations so rescue boat cannot always be launched.
- There is no Operational Training that is specific to (luffing style) davit models currently in the fleet (1300H/1800H/3400H).
- The training centre is equipped with a Polaris 5 m (current standard) and a Zodiac 6 m (non-standard) rescue boat.
- Best Practices for launch and recovery remain the same regardless of davit style.
- Course is on-demand.

Pertaining to the launch and recovery of the rescue boat, Fleet Operations policy<sup>13</sup> identifies that a Coxswain should be fully familiar with the operation of the boat, and be (as one of a number of options) a *Seaman with Bridge Watch* rating.

As required, the rescue boat Coxswain met these criteria.

# SEA Training

The BCFS SEA training program is responsible for the familiarization training of employees in their new job responsibilities.

SEA provides a standardized and consistent education and clearance process across all terminal and vessel positions at BCFS. SEA Managers manage content and SEA educators (trainers). All SEA training is delivered by SEA trainers who are BCFS operational staff (i.e. deckhands, terminal attendants, deck officers, engineers, etc.) SEA trainers attend train-the-trainer sessions to learn how to effectively deliver SEA training.<sup>14</sup>

# **SEA Training Content**

Content Update Process (typical/preferred):

• Senior Master or Senior Chief Engineer contact the relevant (departmental) SEA Manager and notify of a new asset.

<sup>&</sup>lt;sup>12</sup> BCFS Fleet Operations Policy 07.50.090 "Rescue Boat and Fast Rescue Craft Operations."

<sup>&</sup>lt;sup>13</sup> BCFS Fleet Operations Policy 07.50.090 "Rescue Boat and Fast Rescue Craft Operations."

<sup>&</sup>lt;sup>14</sup> From the pamphlet on the SEA website on the BCFS Intranet.

- SEA Manager schedules a SEA Trainer to attend refit (for major asset installations).
- SEA Trainers will contact SEA Manager directly (for minor assets).

The SEA Manager was not contacted regarding the QCUM 1300H davit installation.

The SEA training materials (related to the QCUM 1300H davit) were not updated with the relevant 1300H model information when the davit was installed.<sup>15</sup>

- The VSM was not updated with the relevant 1300H davit model information.
  - $_{\odot}$   $\,$  there were no reference materials available for SEA trainers.
- The 1300H davit is not referenced in SEA training materials (SEA website).
- The previous (slewing) davit remains the primary reference.
- Trainers did not use the SEA website for training because the information was not relevant.

# **SEA Trainers**

- SEA trainers familiarized themselves with the QCUM 1300H davit by reading the OEM manual, and asking questions when the OEM tech was on board.
- SEA trainers did not receive formal training for the QCUM 1300H davits.

# QCUM SEA Training

The information provided to the inquiry regarding the operation of the 1300H davit panel, indicates there were likely inconsistent levels of training.

- Some crew members received davit and rescue boat operations training in detail while others reported limited detail.
- Some crew members had opportunities in the form of hands on usage, others did not.
- SEA training on the operations of the 1300H davits was required but SEA trainers were not required to perform evaluations regarding crew knowledge of davits or rescue boat operations.
- Davit operations were not considered a critical requirement to obtain clearance so crew knowledge was not evaluated.16
  - No formal evaluation of crew knowledge/comprehension.
  - Training did not include an internal review of the davit.
  - Training focused on usage (local practices) versus Standardized Operating Procedures and BCFS best practices.
- The Painter Handler received SEA training to gain clearance as an ERA.
  - The Painter Handler did not recall any Emergency Duty Number (EDN) or muster duty training for Man Overboard.
  - The Painter Handler did not recall any additional training/direction regarding the tending of the painter line.

<sup>&</sup>lt;sup>15</sup> SEA Training website content on the BCFS Intranet.

<sup>&</sup>lt;sup>16</sup> Update at time of report - Davit operations are now considered a critical requirement for clearance.

# **BCFS Rigging Shop Training & Experience**

BCFS Rigging Shop Supervisors (Chargehands) complete a basic, written and practical exam (facilitated by the FMU Trades Supervisor) covering wire terminology, rigging techniques, BCFS policy & processes and general safety.

BCFS Rigging Shop Labourers (helpers) require no specialized training prior to assisting in the rigging shop.

Preventive maintenance and servicing of the 1300H davits require specialized training and certification by the OEM. Certification is a two (2) day practical course with a focus on electrical, mechanical and rigging requirements. In addition, the course shows how to safely operate the davit in accordance with the OEM manual and provides direction to complete the required yearly inspections.<sup>17</sup>

• 12 January 2016 - Six (6) FMU employees receive certification from the OEM.<sup>18</sup>

# **Operational Readiness Exercises Training & Regulatory Drills**

**Operational Readiness Exercises Tier I** drills provide each watch on each vessel with an expanded drill opportunity once every 5 years, in which case the vessel is taken out of service for 2 days for major vessels or 1 day for minor vessels to allow the ships' crew an opportunity to have extensive training and familiarization, both alongside, and at sea. The Tier I drills are led by the Operational Readiness team, assisted by outside contractors.

• QCUM – February 2012 and February 2017.

**Operational Readiness Exercises Tier II** drills provide each watch on each vessel with an expanded drill opportunity once per year and in most cases this will consist of a 3-4 hour period blocked into the vessel schedule. The expanded drill will be led by the vessel senior supervisors and supported by the Safety, Security & Environment Department, specifically a company representative and an outside contractor.

• QCUM – March 2018.

**Operational Readiness Exercises Tier III** drills are weekly/monthly regulatory drills; these are handled entirely by shipboard crew.

• QCUM – 2017 and 2018 Drill Report (Log) complete.<sup>19</sup>

<sup>&</sup>lt;sup>17</sup> The previous OEM (Schat Harding) completed the servicing and yearly inspections.

<sup>&</sup>lt;sup>18</sup> The certification was to expire in January 2018, however a 6-month extension was granted until August 2018.

<sup>&</sup>lt;sup>19</sup> QCUM VSM 08.02.01.010A Appendix "Emergency Preparedness Drills – Schedules."

# 2.2 Policy & Procedures

BCFS operational policy & procedures are controlled digitally in an application called eFleet.

#### Relevant Davit and Rescue Boat Policy & Procedures (at time of incident)

BCFS Operations Policy identifies the requirement for organizational structure and responsibilities, procedures and resources needed to provide compliance with mandatory requirements, i.e. all ships, all terminals, all the time. These policies provide direction for all BCFS personnel. Nothing contained in these policies supersedes rules, regulations or orders of a higher authority.<sup>20</sup>

#### Fleet Operations Manual

07.50.90 Rescue Boat and Fast Rescue Craft Operations 10.20.10.070 Rescue Boats 10.20.10.090 Davits

"The Senior Master shall liaise with the Senior Chief Engineer to ensure that all davits are serviced in accordance with the manufacturer's recommendations and the relevant articles in the Fleet Maintenance Manual."<sup>21</sup>

# **Fleet Maintenance Standards**

V2.03.9240 Rescue Boat Station Equipment V2.03.0000 Vessel Maintenance Documentation

"Vessels are complex in design and function. Essential documents that describe the design, function and maintenance needs of the vessel and its installed system must be readily accessible for use by shipboard personnel".<sup>22</sup>

# VSM

The primary source for site-specific written operational procedures on board vessels, are as (controlled) articles in the VSMs.<sup>23</sup> Procedures may also be posted by machinery/equipment and may also be stored in equipment manual *binders* onboard vessels.

8.01.180	Launch and Recovery of Rescue and Shepherd Boats
10.050	Vessel Inspections
10.160	Rescue Boat and Davit Maintenance
10.190	Routines and Planned Maintenance Schedule

"The Chief Engineer is responsible to the Senior Chief Engineer for ensuring that all the vessel's planned maintenance procedures are carried out."<sup>24</sup>

• The QCUM 1300H procedures were posted on the side of the davit.

<sup>&</sup>lt;sup>20</sup> BCFS Operations Policy Manual 01.010 "BCF Operations Policy."

<sup>&</sup>lt;sup>21</sup> BCFS Fleet Operations Policy 10.20.10.090 "Davits."

<sup>&</sup>lt;sup>22</sup> BCFS Fleet Maintenance Standards Policy V2.03.0000 "Vessel Maintenance Documentation."

<sup>&</sup>lt;sup>23</sup> BCFS Operations Policy Manual 01.010 "BCF Operations Policy."

<sup>&</sup>lt;sup>24</sup> QCUM VSM 10.190 "Routines and Planned Maintenance Schedule."

- Procedures were based on the OEM manual.
- Procedures do not reference BCFS modifications including: cradles, selflaunch terminology and use of davit controls.
- An OEM manual was available on board.<sup>25</sup>
- VSM article 8.01.180 "Launch and Recovery of Rescue and Shepherd Boats" was not up to date.
  - $\circ$  The article was not updated when the new 1300H davit was installed.
  - The information in the article at the time of the incident references the previous (slewing) davit.

<sup>&</sup>lt;sup>25</sup> OEM manuals are typically onboard / available for reference and are often utilized for routine operations, training and familiarization.

# 2.3 Safety Reporting & Deficiencies (March 2016 – 18 April 2018)

Specific references to items related to davit and rescue boat operations from March 2016 to 18 April 2018 (date of incident).

**ALERTs** (All Learning Events Reported Today).

ALERT-QCUM-7999 (March 22, 2018).

- "Davit not luffing out far enough for boat to clear rubbing strake".
- Status: *Not Resolved* (investigation for fix still underway).

ALERT-QCUM-6734 (June 23, 2016).

- "Rescue Boat Davit (New): No barrier to protect feet when luffing davit back in".
- Status: Resolved.

# **Initial Assessment Reports**

None

# **Operations Safety Log Corrective Actions**

ACTION-QCUM-7359 (August 25, 2016).

- Corrective Action Request.
- Status: Closed-Sighted (Painter relocated to bow of rescue boat).

Toolbox Meeting<sup>26</sup> Minutes (references/notes in minutes)

- April 12, 2018 Engineering to change angle of bars along rubbing strake.
- February 13, 2018 New bridal on boat, still tippy, longer davit head would be better.
- December 12, 2017 "Davit still a concern".27
- November 28, 2017 "Davit still a concern".28
- March 03, 2017 Operational Readiness Drills, possibly switch ERA and 3rd in emergency until crew properly certified.
- February 20, 2017 Auditor sends 07.050.090/ exposure suits.
- October 31, 2016 ALERT-6734 Closed (Resolved).
- September 29, 2016 Paint work around rescue boat davit complete.
- August 24, 2016 Rescue boat davit slewing and foot danger need cord for davit remote control.
- August 30, 2016 Painter. Rescue boat checklists to be used prior to daily inspection.
- July 18, 2016 Platform ladder. Rescue boat davit re: foot danger.
- July 06, 2016 Painter location (stern to bow).
- June 23, 2016 Slewing in and foot dangers ALERT-6734 submitted.

<sup>&</sup>lt;sup>26</sup> A formal *watch* safety meeting to review/discuss/communicate safety issues. Held once *per watch*, per month.

<sup>&</sup>lt;sup>27</sup> No further details given. Likely related to identified bridle or rubbing strake concerns.

<sup>&</sup>lt;sup>28</sup> No further details given. Likely related to identified bridle or rubbing strake concerns.

# Site Safety Committee<sup>29</sup> Minutes (references/notes in minutes)

February 21, 2018 – Possible ALERT for rescue boat davit and issues around launching issue (*No ALERT submitted*).

- January 09, 2018 ALERT to be submitted regarding rescue boat deployment and the rubbing strake issue (*No ALERT submitted*).
- December 11, 2017 Discussion of boat launching issues.
- August 30, 2017 Davit reinforcement done in refit.
- October 21, 2016 Pinch points, additional signage and davits.
- August 30, 2016 Rescue boat painter relocated to the bow.
- July XX<sup>30</sup>, 2016 Pinch points for ALERT-QCUM-6734.
- June 23, 2016 Pinch points, ALERT-QCUM-6734.

# Drill Reports<sup>31</sup>

- January 7, 2018 Man Overboard boat was lowered multiple times and corrective actions were explained.
- February 12, 2018 Man Overboard new bridal connected to falls... crew still need to be careful... boat will tilt and could cause someone to fall.
- February 27, 2018 Man Overboard rescue boat discussed in great detail about self-launch and safety of painter line.
- March 17, 2018 Man Overboard rescue boat discussed in great detail about self-launch and safety of painter line.

# Master's End of Shift Handover Report<sup>32</sup>

- April 1-6, 2018 ALERT submitted lack of sufficient clearance at rubbing strake.
- November 18-23, 2017 OSC reports loose bolts on *Salish Raven* (RAV) davit (shared learnings from similar davit for reference).
- June 11-16, 2017 Davit leaked hydraulic oil on deck and windows, Engineering fix.
- July 2-10, 2016 Painter attachment point relocated from stern to bow in rescue boat (Figure 30).
- June 9-16, 2016 ALERT on davit (pinch point).

# Safety Deficiencies & Reporting - Items of Note

Information provided to the inquiry panel has indicated:

March 2016 - From the initial rescue boat launches using the QCUM's newly installed 1300H davit, crew members became aware that the rescue boat would have difficulty clearing the rubbing strake on launch and recovery.

<sup>&</sup>lt;sup>29</sup> A formal *worksite* safety meeting to review/discuss/communicate safety issues. BCFMWU and BCFS employees colead and attend. Held once per month.

<sup>&</sup>lt;sup>30</sup> Not discernable.

<sup>&</sup>lt;sup>31</sup> Documented notes following drills.

<sup>&</sup>lt;sup>32</sup> Communication tool for next shift/watch.

- 20 months later (November 2017), the first notation of "davit concerns" was posted in a Toolbox meeting.
- 24 months later (March 2018), ALERT-QCUM-6766 was submitted: "Davit not luffing out far enough to clear rubbing strake".

June 2016 - From the initial launches using the new 5 m Polaris rescue boat, crew members became aware that the positioning of the lifting straps (bridle) caused the boat to tip dramatically forward (in the bow).

- 22 months later (January 2018), an adjustment to the bridle was made
  - 1 month later (February 2018) a notation that the "adjustment was not satisfactory" was posted in the Toolbox minutes.
  - No ALERTs were submitted.

June 2016 - Three months after the new davit and rescue boat were installed, an OEM service technician (Palfinger Marine) was called for a reported issue with the rescue boat retrieval (at waterline).<sup>33</sup> To alleviate the issue, the service technician (drastically) modified the davit's safety limit switch *counterweight* to a non-OEM *off-set* position (Figure 5 and 6) which would allow the rescue boat to be retrieved when not directly underneath the davit head.

- Senior Chief Engineer and Senior Master recalled (during interviews) there was an issue with the limit switch not allowing the boat to be raised (while at the water line) unless it was directly under the falls.
- No ALERT was submitted.
- No specific documentation for the modification was found on the vessel. A reference to an OEM service visit was found in the Engineering Log. Handwritten notes in a (requested) Palfinger Marine Service Report (17 June 2018), reference the technician's modification.
- OEM technician did not communicate (or was not aware of) the potential consequences to operators.
- No written indication that the system was tested for safe operation of the limit switch (outside of working limits) immediately following the adjustment.
- Although the limit switch counterweight is not specifically designed (or specified) by the OEM to act as a wire rope falls *angle limiting* safety device, it was reported to have acted this way prior to the modification.<sup>34</sup>

August 2016 - When the rescue boat painter was first repositioned at the bow of the rescue boat, the crew became aware the painter could (still) not be used according to BCFS best practices (alignment under the wire falls) because the cleat's position wouldn't allow the painter to be at the required length for both launch and recovery.

• This was never reported/documented. No ALERTs were submitted. No service request or work order.

<sup>&</sup>lt;sup>33</sup> Deemed to be related to painter line length not placing rescue boat directly underneath davit falls and wire rope engaging (rubbing) the limit switch counterweight.

<sup>&</sup>lt;sup>34</sup> Post-incident investigation testing of the QCUM's davit's limit switch counterweight, for engagement at excessive  $(>20^\circ)$  wire rope falls angles, was not completed as this is not a specified OEM design characteristic for operations.

June 2017 - Interviewee recalls that there was a davit hydraulic leak that sprayed oil on the deck and windows.

- Speculation that a cap may have been replaced incorrectly causing the hydraulic oil to spray (*this information remains unconfirmed*).
- No documentation or notation found on vessel.
- No ALERT was submitted.

January 2018 – Site Safety minutes: "ALERT to be submitted regarding rescue boat deployment and the rubbing strake issue".

• No ALERT submitted.

February 2018 – Site Safety Minutes: "Possible ALERT for Rescue Boat davit issues around launching issue".

• No ALERT submitted.

March 2018 – Twenty-three months after the new davit and rescue boat were installed and eighteen months after the painter was relocated to the bow, an attempt was made to adjust and set the painter length (for best practice recovery positioning) resulting in an unreported safety event/incident.

- A Man Overboard Drill was conducted with the SEA Trainer, Watch Master and Marine Superintendent in attendance. The painter was un-cleated, adjusted in length (shortened) and re-cleated so the rescue boat would be directly under the wire falls at the waterline (as per BCFS best practices). During the recovery, as the boat approached the deck edge, the painter became taut and pulled the rescue boat forward (rescue boat crew member/interviewee indicated a 25 – 40 degree angle), forcing the boat to a grinding halt with significant vibration and sound (the rescue boat crew communicated with the Davit Operator to stop). The rescue boat hung bow down for 15 – 20 seconds before being lowered again.
  - The painter was re-adjusted to its original position (but not marked).
  - When the rescue boat reached the waterline, a crew member noticed the rescue boat hook safety pin had slipped out of its position.
  - The Marine Superintendent and Watch Master did not recall the incident and/or recall the incident as being significant (i.e. sound, angle of rescue boat, crew communication).<sup>35</sup>
  - No documentation or notation found on vessel.
  - No ALERT submitted regarding the event.
  - The equipment was never checked for damage.

22 March 2018 – ALERT submitted for insufficient clearance at rubbing strake.

- ALERT-QCUM-7999.
- "Davit not luffing out far enough for boat to clear rubbing strake".
- Status: Not Resolved.

<sup>&</sup>lt;sup>35</sup> There were numerous people on the Sun Deck engaged in multiple conversations during the launch and recovery.

March 2016 – 18 April 2018 - Information provided to the panel indicates there were other events (incidents) over the 2 year period after installation, involving issues with the davit and rescue boat recovery.

- Limit switch engaging *at the waterline*.
- Limit switch *not engaging* at the top.
- Limit switch *not engaging* at the top and wire falls being pulled up into sheave.

No documentation (or notation) could be found on the vessel regarding these events and there were no ALERTs or Initial Assessment Reports submitted.

# 2.4 Crew/Worker Fatigue

The information provided to the inquiry panel indicates that crew/worker fatigue was not a contributing factor in this incident.

# 2.5 QCUM Davit History

In September 2011, with a mind on standardization and in view of a number of significant upcoming projects, including: minor vessel midlife upgrades (~2012-2016); major vessel midlife upgrades (~ 2014-2019); and new vessel construction (~2015-2020), BCFS formed a Rescue Boat & Davit Fleet Standardization Working Group to develop and implement a new rescue boat and davit standard. A Request for Expression of Interest, RFEOI 02-02-2012, was released, and Noreq (davits) and Polaris (rescue boats) were the manufacturers selected to comprise the standard.

The selected Noreq<sup>36</sup> davit series – Noreq Pivoting Davit Single-arm (NPDS) 1300H, 1800H, 3500H, 4000H, 6000H - met the latest IMO/SOLAS regulations, LSA Code and TC regulations. The NPDS series differed significantly in design from previous BCFS davit models in that the davits launched by tilting outboard (luffing) instead of swinging (slewing) (Figure 31). Additionally, the working components of the new davits (winch, wire, sheaves, etc.) were enclosed (protected) and hidden from view.

In 2014/15, during the *Spirit of Vancouver Island* (SOVI) planned refit, the first two 3500H davits were installed on a major vessel. This was followed by a single 3500H davit on the *Northern Adventure* (NADV).

Soon after the installation, a concern was brought forward from the SOVI deck crew regarding balance issues while crews were completing their regular inspections of the rescue boat in its stowed position. Noreq technicians and BCFS Engineering employees, worked together to address the concern by adding two custom "cradles" - one *fore* and one *aft* - under the rescue boat keel (Figure 7). With the oversight of the OEM, the inclusion of custom cradles became a BCFS practice for all Noreq davit installations, even though this was a deviation from OEM installation guidance and supporting documentation (Figure 8).

In 2015, the *Spirit of British Columbia* (SOBC) was fitted with two 3500H davits and more recently, two 1800H davits were installed during the 2018 midlife upgrade.

The first intermediate class vessels that required new davits (midlife upgrade) were the QCAP and the QCUM (sister ships) which would require a smaller davit model than major vessels. The larger 1800H model davit was originally proposed by the davit/rescue boat working group, however the project management team (Fleet Planning & Projects) selected the 1300H model based on davit weight installation considerations (lighter) and the number of persons required in the boat.

In May 2015, the QCAP was fitted with a single 1300H davit and in November 2015, the QCUM was similarly fitted with a single 1300H davit. Following the new installation practice, both davits were fitted with cradles.

In May 2017, the *Salish Orca* (ORC) (followed shortly after by the *Salish Eagle* [EAG] in June and the RAV in July) became the first new-build BCFS vessels to be fitted with Noreq davits. The Salish class vessels were fitted with (two) 1300H davits each, along with the Polaris Seamaster 166R rescue boats to maintain the company's standard. All of the davits were fitted with cradles.

<sup>&</sup>lt;sup>36</sup> A number of mergers and acquisitions amongst global davit manufacturers have influenced the naming (branding) of BCFS davits which is confusing. In 2013, Schat Harding and Noreq AS merged and in 2016, Palfinger acquired Harding.

# 2.6 QCUM Davit Installation & Configuration

The QCUM underwent a midlife upgrade in the winter of 2015/16 at Esquimalt Graving Dock in Esquimalt, BC. The replacement of the vessel's Schat Harding Man Overboard (slewing style) davit with the NPDS 1300H (luffing style) davit was part of the midlife upgrade project.

The design specification for the installation was prepared by BCFS Fleet Technical, which included drawings and documentation prepared and submitted for approval by American Bureau of Shipping Classification Society in 2015.

The Project Management Office issued detailed work specifications for the installation of the davit by Palfinger Marine Canada (OEM) in March 2015 as part of Refit / Capital Project awarded to Esquimalt Graving Dock. The scope of services required Palfinger Marine to install the davit assembly, provide rescue boat supports, install Light-emitting diode floodlights and connect the davit to the vessel's electrical system.

Training of a number of QCUM crew, including the Senior Chief Engineer and maintenance technicians was provided by the contractor (Palfinger) as well as representatives from Harding International prior to the vessel entering regular operations after the refit.

Following successful testing and commissioning of new vessel assets, it is normal practice to review the installation and update record drawings that reflect the actual layout. These updates were completed for the QCUM 1300H davit by BCFS Fleet Technical following the midlife upgrade in 2016.

# 2.7 Davit System – Technical Overview

The system is a rescue boat and launching davit arrangement. The QCUM is fitted with one such arrangement, as required by *Life Saving Equipment Regulations* C.R.C., c. 1436, section 52. By definition "rescue boat"<sup>37</sup> means a vessel designed to be used for rescuing persons in distress and marshalling survival craft.

#### **Primary Elements of the Approved and Commissioned Installation:**

The new davit and rescue boat system was installed and commissioned 17 March 2016.

- Hydraulic pivoting (tilting) davit, Harding NPDS 1300H, serial no. 144375:
  - Hoisting/lowering speed of 18 m/minimum.
  - 480V / 3ph / 60Hz power supply.
  - An independent integrated hydraulic system of 70 litres capacity with one position type accumulator and maximum. Working pressure of 240 bar.
  - Pushbutton remote control, 5 buttons: tilt out, tilt in, lower (2-step speed control), hoist (2-step speed control) and emergency stop.
  - Plunger type Schmersal limit switch Model TQ 700-11S, normally open type, AC-15V/DC-13V, activated by the lifting of a counter weight, the bottom of which is about 350 mm from the centre of the head sheave when the davit is tilted out.
  - Pull force is noted at 88 N ( $\pm$  15 %).
  - Davit sheave diameter is nominally 200 mm.
  - Davit sheave and falls are centred on frame 17A port side aft.
  - Height from waterline to the boat deck is 10.69 m (maximum draft)
  - Height from boat deck to head sheave top when stowed is 3.00 m.
  - Davit pivot radius to outer radius of the head sheave is 2.88 m.
  - In the tilted out position the centre of the head sheave is 2.5 m above the plane of the boat deck.
  - Boat release hook connection point is at 2.2 m outboard from the davit foot hinge pins or 1.8 m from shipside (fishplate) when davit base is fully tilted at 67 degrees.
- Hydraulic hoisting/lowering winch, Brevini BWF38 1500-I/1.5/SD12-01/31.2:
  - Winch drum (non-grooved) 185 mm length, 198 mm diameter (nominally 200 mm) connected to the hydraulic motor through a planetary reduction gear unit with a 31.2 ratio.
  - Nominal Line Pull at the top (4th) layer of wire rope wrap is 1500 kg; at 2 layers of wrap the Line Pull is 18.2 kN or 1856 kg.

<sup>&</sup>lt;sup>37</sup> Although there is an international requirement for ro/ro passenger vessels in SOLAS Ch-III Reg.26.3.1 "At least one of the rescue boats on a ro–ro passenger ship shall be a fast rescue boat approved by the Administration," there is not a Canadian requirement for a "fast" rescue boat. Many of the same features apply to both rescue boats and fast rescue boats.

<sup>&</sup>lt;sup>38</sup> The Harding NPDS 1300H Technical Datasheet states the winch to be BW 1350. Brevini renamed this winch in the 2014 catalogue to the BWF 1500.

- Calculation of pulling force at three (3) layers as provided by Palfinger Technical Support is 17.74 kN.39
  - Drum rotation is clockwise.
  - negative multidisc brake.
- Wire rope davit falls:
  - 10 mm, 35x7, galvanized, non-rotating.
  - 27 m length with stainless steel duplex eye on one end only, brazed and tapered at other end.
  - A Limit Switch Activator (stop ring) fitted immediately above the duplex eye that will lift the davit limit switch counterweight if the eye approaches the davit head (Figure 23).
  - $_{\odot}$   $\,$  To include angle range for operation of falls 20° Port/Starboard and 10° Fore/Aft.
- On/Off Load Release Hook type RRH.15 Harding serial no. 15R1536.
- Web Sling Assembly, Polaris 4 Leg Web Bridle, serial no. 122089-01:
  - $_{\odot}$  2 inch, 2 ply slings, 2 Fwd legs 60-1/2 inches, 2 Aft legs 45 inches.
  - $_{\odot}$   $\,$  Stainless Steel Link Top End to which the release hook can attach.
- Rigid Rescue Boat Type Polaris 166R/SeaMaster:
  - 5.02 m length, 1.98 m beam.
  - $\circ$  9 person capacity (limited to 6 persons by approved LSA plan).
  - 60 HP Mercury outboard engine, 119 kg.
  - $\circ$  Boat weight fully fueled and equipped is nominally 635 kg.40
- Painter system consisting of:
  - Floatline, MFP, 3/4 inch, Orange, rope with an eye at one end.
  - A tie-off cleat on the vessel atop of the bulwarks close to frame 8A at the boat deck level at an elevation of 4 m above the waterline.
  - A toggle release arrangement in the Rescue Boat securing the Painter rope to the Samson post of the self-righter at the aft end of the boat.

Safe Working Loads or Working Load Limits (as converted to kgs) for this davit and boat system not including the wire rope falls is as follows:

<sup>&</sup>lt;sup>39</sup> If we have 250 bar pump pressure (system pressure) due to internal losses in the system, in best case we will have theoretical 220 +/- bar max at the winch. That will give us a pulling force of approx. 1809kg on the third layer. In reality, it will very likely be less due to friction and losses. From Palfinger Marine Technical Support Americas - May 29, 2018.

<sup>&</sup>lt;sup>40</sup> For the purpose of this technical report nominal values are used instead of actual (known) values to make it clear that calculated results are representative only.

- 1300 kg Davit
- 1200 kg Winch (per F.E.M. 1.001, M5 designation)
- 1683 kg Wire rope 35x7, 10 mm (as per the Test Certificate) 1530 kg Release Hook
- 1360 kg Web Sling Assembly
- The LSA Code requires that a Safety Factor of 6 be applied to the load bearing elements of launching appliances.
- The lowest Safe Working Loads or Working Load Limit determines the maximum load to which the davit system can be operated.

#### Noted Deviations from the Installation as Commissioned:

Strikethroughs in item # 3 indicate the *previous* or originally specified numbers.

- 1. OEM Limit Switch Counterweight 20 June 2016: [Harding Service report] OEM (drastically) modifies the Limit Switch Counterweight to correct a shuddering problem when hoisting. *The service report suggests that the arrangement of the counterweight at the time of the incident (with both support wires connected to the forward side of the davit head sheave) was made at this time (Figure 5 and 6).*
- 2. BCFS Painter 27 July 2016: Relocation of the vessel tie off point for the painter from the sun deck to the main car deck. A new cleat installed on the vessel atop of the bulwark 0.23 m aft of frame 35A port side aft, 2.0 m above car deck level. At the same time, the securing arrangement of the Painter in the rescue boat was changed from the stern to the bow. The Painter toggle release which was on the Samson post at the aft of the boat (Figure 30) was now made through the forward port D ring used to anchor one leg of the web sling assembly.
- 3. BCFS Web Sling Assembly February 2018: New web slings installed with adjusted lengths. 2 Forward legs <del>60-1/2</del> 57 inches, 2 Aft legs <del>45</del> 51 inches. As a result it is calculated that the web assembly Link Top End could be about 6 inches (150 mm) higher when suspended from the hook.
- BCFS Wire Rope 5 April 2018: Wire rope davit falls: 35x7 19x7 10 mm wire rope, 27 30.5 m length; Wire Rope Working Load Limit of 1683 kg 1000 kg (Test Certificate) and a Minimum Breaking Load of 72.90 kN or 7434 kg.

#### 2.8 Davit System – Functional Overview:

The Rescue Boat and Davit System performs a dual purpose (Figure 22). In the event of a vessel evacuation from the Marine Evacuation Systems (a system of evacuation slides and life rafts), the rescue boat is used to tow loaded life rafts away from the vessel. In this function it may be referred to as a "shepherd boat." Also, in the event of a man overboard from the vessel, the rescue boat can be rapidly deployed with crew to rescue and recover persons from the water. In this function it may be referred to as a Man Overboard boat. In the busy near coastal waters of British Columbia, rescue boats are often deployed from BCFS fleet vessels to rescue persons in distress from other vessels.

The davit is designed for rapid deployment of the rescue boat with a minimal crew requirement. This includes self-launch capability by which the boat crew, normally two (2) persons, board, deploy the davit and lower the boat to the waterline and then release from the falls without any assistance from the other vessel crew. This self-launch function is less commonly used (on some vessels) and was not the mode of operation at the time of this incident. The technical aspects of self-launch functions will not be addressed herein. Rescue boat davits are to be capable of launching the rescue boat from the stowed position in not more than five minutes.<sup>41</sup>

In dormant mode, the rescue boat rests on cradles (Figure 7 – previously referenced in section 2.6)<sup>42</sup> with the top end link of the four point bridle attached to the release hook. Slack is taken up on the bridle but only very light tension is maintained on the hook in this normal, stowed position, which runs contrary to OEM recommended full tension.

The deployment cycle of the davit system in which all the Primary Elements are subjected to the load consists of these operations:

- 1. Raise boat from cradle.
- 2. Tilt to outboard position (luffing the davit).
- 3. Lower boat to waterline.
- 4. Hoist boat to the fully retrieved position.
- 5. Tilt to inboard position.
- 6. Lower boat to the cradle.

In all these operations the force of the Load (boat and boat occupant's weight) is translated to the davit structure by:

- The wire rope.
- Two (2) 200 mm diameter sheaves.
- The 200 mm diameter winch drum.

Once the davit has tilted (luffed) to the outboard position, the Load (rescue boat and occupants) are lowered or raised by turning the winch drum to pay out or reel in a length of wire rope.

<sup>&</sup>lt;sup>41</sup> Lloyd's Register Rules and Regulations - Code for Lifting Appliances in a Marine Environment, July 2017 - Chapter 3 Launch and Recovery Appliances for Survival Craft and Rescue Boats - 1.3.2 (a).

<sup>&</sup>lt;sup>42</sup> OEM documentation recommends that the boat should *not* rest on supports but rather should be continuously suspended from the release hook while the boat is held static in position by two lashing straps.

- The secured end of the 27 m long wire rope is attached to the winch drum by a wedge lock.
- It is important to maintain continuous tension on the wire rope such that the wire spools off and back onto the drum in an orderly manner to avoid snarling or sudden side slippage of an outer turn off an inner turn on the winch drum.
- When the hook is in the fully retrieved position, there will be three (3) layers of turns on the drum with a 10 mm diameter wire rope.
- In addition to having sufficient strength and safety factor for the Working Load Limit of the davit, the wire rope is intended to be sufficiently flexible to conform to the circumferences of the winch drum and the sheaves.
  - Wire rope to drum diameter ratio is 20:1 (Class minimum is 16:1).
  - Wire rope to sheave diameter ratio is 20:1 (Class minimum is 12:1).

The winch drum orientation within the davit is parallel to the shipside so that the tension on the wire rope remains in the same continuous vertical plane throughout the tilting and lowering or hoisting operations.

- When the davit is tilted up and outboard at 67.5°, the winch drum becomes close to horizontal with the davit head sheave.
- The travel of the wire rope coming off the 200 mm diameter winch drum is from the inboard side of the drum and runs over top of a 200 mm diameter sheave making a 45° turn, runs over top of the 200 mm diameter davit head sheave making a 67.5° turn into the vertical falls.
- There is a steel rope guard integral to the davit head sheave bearing support with minimal clearance from the outer diameter of the sheave.
  - With the davit in the tilted position the rope guard is oriented parallel to the vertical falls and
  - Would act to prevent a hanging wire rope from coming out of the sheave if the hook were carried out and away from the ship. e.g. in very heavy weather.
- The entire run of the wire rope from winch to the davit head sheave is enclosed in the davit casing and not visible to the operators.
  - $\circ$   $\;$  The rope guard is also positioned slightly inside the casing.

The nominal full speed of the winch when hoisting is 0.31 m per second.

- The winch is two-speed and will switch from slow speed to the full speed with further depression of the hoist button on the control.
- The difference between high-speed and low-speed (18.65 m/min versus 18.2 m/min<sup>43</sup>) is negligible.

The wire rope falls are to travel vertically through a distance of about 12 m from the davit head to just above the waterline.

• It is a requirement<sup>44</sup> that "falls are to be of sufficient length to enable the survival craft or rescue boat to reach the water with three full turns remaining

<sup>&</sup>lt;sup>43</sup> Harding Commissioning report, March 16, 2016.

<sup>&</sup>lt;sup>44</sup> Lloyd's Register Rules - Code for Lifting Appliances - Chapter 3, 1.9.7.

on the winch drum with the ship in her lightest sea-going condition and listed 20° in the adverse direction".

- The thimble end of the wire rope is attached directly to the Release Hook.
- The hook carries the full weight of the boat via the top end link of the web sling assembly.
  - $\circ$   $\;$  The hook design allows release under load.
  - The boat crew can release the hook at the waterline without having to get slack in the davit falls.

The painter system is intended to keep the rescue boat in position beneath the davit falls for both hook release and hook reconnection. It is also an aid to keep the rescue boat in fore and aft alignment as it is both ascending and descending.

- The painter is tied off to a cleat on the vessel.
- The positioning of the cleat is to create a suitable angle for the painter to act effectively in bringing the rescue boat into position under the falls while also allowing enough slack in the line for the rescue boat to fully recover to the boat deck without any tension on the painter.
- The rescue boat propeller thrust is set opposite to the resistance of the painter to bring the boat into a steady position under the falls.
- The painter remains connected to the rescue boat for the hoisting operation.
- Any adjustment of painter length during boat operations is to be managed from the boat.
- The toggle arrangement in the rescue boat allows for a rapid release of the painter.
- The painter rope must be able to float upon the water to be easily retrieved and to avoid being drawn into the vessel's propeller(s).

The limit switch (and counterweight) provides over hoist protection to prevent the hook block from running into the davit head sheave (Figure 23 and 6). The LSA Code (6.1.2.7) infers no additional requirements on the function of the limit switch other than to "cut off the power before the davit arms<sup>45</sup> reach the stops in order to prevent overstressing the falls or davits."

The OEM manual does not clarify that the function of the limit switch is bypassed when hoisting in "dead ship"<sup>46</sup> conditions.

<sup>&</sup>lt;sup>45</sup> The term "davit arm" is in reference to lifeboat davits with davit arms on roller tracks.

<sup>&</sup>lt;sup>46</sup> OEM uses term "dead ship". BCFS uses term "self-launch."

# 2.9 BCFS Maintenance and Asset Management

#### Maintenance Management Overview

BCFS maintenance management is defined in policy as Fleet Maintenance Standards. The primary objectives of maintenance management are:

- lower predictable ship and terminal maintenance costs.
- more effective maintenance processes "best practices".
- better "replace" versus "repair" decisions.
- lower emergency repair costs.
- longer asset life with a proactive preventive maintenance program.

The Fleet Maintenance Standards provide employees with company-wide standards for vessel condition and maintenance requirements. Fleet Maintenance Standards applies to the entire vessel, including any vessel structures, systems or equipment that can affect the safety, reliability and value of operations if they fail or perform below standard. Maintenance "standards" have been set in the *Canada Shipping Act (CSA 2001) and Regulations* and are administered by Transport Canada. Statutes for health, safety, and environmental protection also set standards for maintenance. These are obligations under the law and shall be complied with at all times.<sup>47</sup>

Roles and responsibilities are outlined in the Fleet Maintenance Standards, including that every employee has a role in maintenance management - through observation, identification and reporting. Senior Engineering management is responsible for ensuring that vessels are in a condition of full "operational readiness" when deployed into operations.<sup>48</sup>

# Asset Management Overview (Vessel)

As described in the BCFS Engineering Administration Manual, Job Plans and Preventive Maintenance Schedules are under the responsibility of the Senior Chief Engineer. Requirements and resources are drawn from technical literature such as OEM equipment manuals and drawings.<sup>49</sup> Equipment-specific needs brought forward by the crew may also be included. Administrative tasks can be and are often delegated to the Chief Engineer.

Information provided to the inquiry panel indicated that the usual timeframe for updates of new equipment (assets) in the Maximo database is normally in the order of six (6) months following refit or capital projects such as a midlife upgrade.

Assets are meant to be formally assigned a new asset number (tag) and updated in the BCFS CMMS Maximo, with name plate data, maintenance information and relevant approvals. Each vessel has a specific master equipment list of assets and locations in Maximo.

<sup>&</sup>lt;sup>47</sup> FMS Article V2.01.010 "Introduction."

<sup>&</sup>lt;sup>48</sup> FMS Article V2.01.020 "Roles and Responsibilities."

<sup>&</sup>lt;sup>49</sup> BCFS Engineering Administration Manual V3.03.30.010 "Duties and Responsibilities of Officers and Crew."

Corresponding Planned Maintenance Routines, Job Plans and Bill of Materials are then updated (these also include key parts and accessories that are associated with the new equipment).

When changes are required (made) to critical equipment aboard a vessel, the appropriate updates are added to the VSM. This task is the responsibility of the Senior Master and the Senior Chief Engineer. Ship specific routines detail step by step inspection and operational procedures that are accessible by all crew members.

As described in the BCFS Fleet Operations Manual, checks are performed by operational crew at regular intervals. Operational crews play a significant role in their contribution to safe and reliable operations through active participation in identifying, reporting and - integrating through teamwork - improvements to assets and overall fleet maintenance standards.

Vessel assets are (and need to be) uniquely identified so that any employee can report problems and performance history can be tracked. Each vessel has a specific master equipment list of assets and locations in Maximo.

#### CMMS

As mentioned previously, the primary CMMS application utilized by asset managers at BCFS is *Maximo*.

Maximo is used throughout BCFS to help integrate the activities of various personnel. It is a tool to augment work, inventory, purchasing and asset management processes to help create a more efficient maintenance organization from the bottom up.<sup>50</sup>

Basic Information concerning equipment specifications, major inspections and adjustments, as well as routine checks are linked to critical assets through Maximo.

Currently in Maximo:

- All maintenance work and refit projects are controlled by work orders that track labour and materials used, and estimate the total cost of work completed.
- Many automated preventive maintenance routines for critical systems have been designed on ships (and on the terminals) and are triggered automatically.

A CMMS such as Maximo is capable of managing assets throughout their lifecycle from procurement, implementation, training and maintenance to disposal. Fleet Engineering is responsible for ensuring that the CMMS application (Maximo) is a reliable and current source for technical information.<sup>51</sup>

<sup>&</sup>lt;sup>50</sup> From the web based training and reference tool UPK on the BCFS Intranet.

<sup>&</sup>lt;sup>51</sup> BCFS Engineering Administration Manual V3.03.20.010 "Fleet Engineering."

# 2.10 QCUM Maintenance and Repair Records

Appendix E details the maintenance work instructions and schedules that were in place at the time of the incident and the work that was performed based on those instructions.
### 2.11 QCUM Asset Management and Maintenance

When the vessel completed its 2016 midlife upgrade, the asset records were not updated to represent the changed configuration of the vessel in the Maximo system.

- A new asset record (and number) did not get created for the Harding NPDS 1300H davit.
- Standard Job Plan 9210-QCUM-M2-8 remained assigned to the old asset number 2729, the former Schat Harding Man Overboard davit that was replaced in 2016.
- OEM specific work instructions for the new model for inspection, service and testing of davit components such as wire, sheave, limit switch or multi-filament polypropylene painter line were not entered into Maximo.
- Work orders with obsolete Job Plans and Bill of Materials continued to generate for QCUM-9240 Rescue Boat Station equipment.
- The wire rope change out maintenance done on 5 April 2018 was performed to instructions written for the old davit removed in the 2016 midlife upgrade.
  - The wire rope fitted was specified for the old davit and was of a lower tensile strength than the wire rope specified for the new davit.
  - Harding 1300H davit specifies a 10 mm 35x7 wire. This item was not inventoried with an approved part number in Maximo. Instead, 10 mm 19x7 Wire (item 025574) was installed on the davit.

When the vessel completed its 2016 midlife upgrade, the Preventative Maintenance (QCUM-9240-PM-1) and Job Plan (9240-BCF-SJ-10) for monthly maintenance inspections of the Rescue Boat station was not re-activated.

Fleet Maintenance Standards policy<sup>52</sup> provides no guidance on the following aspects of the maintenance of this system:

- Determination and documentation of the Working Load Limit<sup>53</sup> of the davit.
- The selection and proof testing criteria for wire rope falls that are to be fitted to a rescue boat davit, including the determination of Working Load Limit to be assigned to the wire rope.
  - The proof testing requirement for wire rope for rescue boats is 2.5 x Working Load Limit (Safe Working Load) Life Saving Equipment Regulations crc1436.

### Work Order QCUM.54061 - Davit, Rescue Boat, Annual inspection

### Overview

Work Order QCUM.54061 dealt with the annual service of the davit. It was autogenerated in Maximo as a planned maintenance routine and available to the Engineering Department for review and planning on 26 February 2018.

• Engineering approved the work order and assigned the work to DPM<sup>54</sup> for planning. It was moved from the planning status to an approved status, which

<sup>&</sup>lt;sup>52</sup> FMS Article V2.03.9240 "Rescue Boat Station Equipment."

<sup>&</sup>lt;sup>53</sup> Or Safe Working Load

ensured visibility of the work order to the Maintenance Planner at DPM for further action.

- The Maintenance Planner at DPM took ownership of the work order on 16 March 2018 by DPM and assigned the work to the Supervisor at the Rigging Shop for further action and planning by the shop.
- The Supervisor was notified by the Planner, who accordingly scheduled the work, printed a hardcopy of the work order and posted it on the assigned clipboard as is customary at the Rigging Shop.
- DPM Operational Managers and Supervisors conducted weekday operational meetings where the upcoming maintenance work was discussed prior to deploying work crew onsite.
- The Supervisor mobilized his Chargehand and crew to attend the work on 5 April 2018. Accordingly, the Chargehand called the vessel to confirm their arrival during the brief afternoon layover on that date.
- The Chargehand prepared 100 feet of OEM supplied 10 millimetre diameter. 19X7X1RWC wire (Item 025574) and sent it to Western Equipment for testing the wire to proof load (4410 lbs) on 21 March 2018. (This would have been the correct action for the previously installed davit).
- The Chargehand and two (2) labourers performed the work on 5 April 2018, which included removal of the old wire and installation of the new wire. Upon leaving the site, the Chargehand provided a hardcopy of the work order to the Chief Engineer who reviewed the copy and filed it in the appropriate folder in the Engine Room.
- Due to the short length of the turnaround time for the vessel and crew change, the co-ordination of a trial of lowering and hoisting of the rescue boat (exercising the wire) without occupants was not performed or communicated with the Engineering department.
- The Work Order was updated with closing comments on 12 April 2018.

### Asset Workflow Details

- Planned Maintenance Routine QCUM-9240-00-PM-20 was revised in 2016 to coincide with the annual service interval for the newer Harding 1300H davit rather than the previous setting of a 25 launch interval for the Schat Harding Man Overboard davit.
- The standard job plan 9210-QCUM-M2-8 was attached to the older asset the former Schat Harding Man Overboard davit that was replaced in 2016. Specific instructions pertaining to new equipment model for inspection, service and testing of davit components such as wire, sheave, limit switch or multi-filament polypropylene floating painter line were not appropriate. A new asset such as the Harding 1300H Davit would normally be assigned a new asset number (tag) and updated in the CMMS Maximo system.
- The Harding 1300H davit used 10mm 35x7 wire WLL 1.88MT. This item was not inventoried with an approved part number in Maximo. Instead, 10 mm 19x7 Wire (item 025574) WLL 1MT was actually used on this davit.<sup>55</sup> Technical specifications for the 10 mm 35x7 wire was not found in CMMS.

<sup>&</sup>lt;sup>54</sup> Acronym for *Deas Pacific Marine* now known as Fleet Maintenance Unit (FMU).

<sup>&</sup>lt;sup>55</sup> See *NOTE* page 43 (Section 2.12 Technical Analysis – Component Failures – Wire Rope Parting).

- The painter attached to the rescue boat was 3/4" x 600' multi-filament polypropylene double braid orange/black tracer. This item was not inventoried with an approved part number in Maximo.
- Referring to the common inventoried item of 10 mm 19x7 wire used on Schat Harding Man Overboard davits, the Rigging Shop Chargehand prepared the (incorrect) wire.
- The Chargehand did not have access to the computer network and referred to a hardcopy of the work order posted at the Rigging Shop.
- The scope of annual service intended to be performed on the davit as perceived by the Riggers did not correspond with the expectation of the vessel's Chief Engineer. The scope and methodology of the service performed differed from a similar annual service performed by the Rigging department on the vessel on 12 April 2017.
- Based on the request on the work order, the Chief Engineer relied on the Rigger's capacity to perform the service and receive a complete annual davit service report from the Chargehand similar to April 2017. This was not forthcoming.
- It was felt by the Chargehand and Maintenance Crew that limited time was available between callouts and worksites to perform lengthy updates and work comments prior to, and immediately following the work. Handwritten copies of work order reports were typically scanned or copied and then uploaded into Maximo with assistance from peers and supervisors. Access to desktop workstations was mostly remote from their routine work locations.
- Despite being a critical maintenance routine, supervisors were not clear on the necessity to test the rescue boat (critical machinery adjustment or maintenance) immediately after work was performed by maintenance personnel, and prior to departure from Swartz Bay.
- Vessel crew accessing the Rescue Boat Station for routine inspection were required to use Fall Protection. Detailed examination of concealed<sup>56</sup> elements on the davit structure was not conducted during these checks.
- Routine inspections performed by crew such as weekly or monthly checks were done using paper checklists drawn from VSM. Vital information on state of the equipment observed from these checks of equipment condition was not updated in Maximo.
- The process for "on-boarding" a new asset did not involve an up to date instruction manual that involved the functional relationship of the new equipment with the existing structure, in this case the Rescue Boat Station components.
- Asset updates immediately following upgrades of critical equipment as part of refit/capital projects were not performed within the intended timeframe prior to entering operations. The same was noted of updates in the VSM concerning the davit upgrade.
- Live integration of day to day transactions between ship and shore were at times not synchronized as a result of network issues. On several occasions, vessel crew and shore side personnel relied on conventional means of communication to augment maintenance and purchasing functions initiated using Maximo.
- Engineers entered critical data concerning day to day routines on a unique Access based Engine Room Watchlog. These updates mostly concerned critical

<sup>&</sup>lt;sup>56</sup> The component parts of Harding luffing davits are enclosed (hidden from view) by metal covers.

asset data and were performed at every watch in a detailed fashion. No way of linking these data to Maximo records existed, which made queries for data more cumbersome.

- Managing change in CMMS procedures across multiple departments fleet wide is a time consuming process. Between initial rollout of a newer version of Maximo, subsequent training and implementation, the time taken is typically several months. Many users are not aware of added features in order to extract full functionality out of the newer version of Maximo.
- Maximo was relied on as the primary means of communication between ship and shore personnel concerning the planned maintenance routine for annual service of the davit.
- A written process for "on-boarding" an asset from initiation through project planning and full functionality in operations was not evident in CMMS.
- There was no written clarification on the necessity to test the rescue boat (critical machinery adjustment or maintenance) immediately after work was performed and prior to departure from Swartz Bay.
- An understanding of the scope of annual service needed to be clarified by the originator of the work order and the maintenance crew performing the work. In this case, an updated job plan for annual service may have provided proper clarification.

### 2.12 Technical Analysis – Component Failures

### Wire Rope

The found condition of the parted wire rope falls after the accident was as follows:

- The wire rope was parted approximately 1.5 m from the release hook thimble end.
- There were several exterior wire strands broken and an apparent flattening of the wire rope approximately 0.5 m before the break.
- Microscopic examination of the wire rope artifacts by Acuren (WorkSafeBC contracted Professional Engineering firm) at the region of the parted strands revealed fracture due to crushing of individual wires (Figure 28).
- No corrosion, fatigue or wear was determined as possible causes of the failure.
- Sufficient lubrication between wires was evident.

The wire rope was 19x7 10 mm 1960 wire rope, galvanized, non-rotating and pregreased. It was accompanied by a Certificate of Test from Western Equipment dated 21 March 2018 and overwritten with an "install" date of 5 April 2018.

- The wire rope was the final length from a 305 m spool in the FMU Rigging Shop (spool Certificate # HC171922 was on file in the shop).
  - $\circ$   $\;$  It is the most common davit wire rope in the fleet.
  - It is inventory item 025574 and is listed on the Bill of Materials for the Job Plan "9210-QCUM-M2-8 Davit, Man Overboard, Annual".
  - $_{\odot}~$  It is given a Working Load Limit of 1000 kg (1 MT) which is stamped on the ferrule at the thimble end (Figure 29).
  - $_{\odot}$   $\,$  It is proof load tested at Western Equipment at two (2) x Working Load Limit.  $^{57}$
- It is noted that the wire rope for the same davit model on the Salish class vessels is ordered direct from the OEM and is:
  - 35x7, 2160 tensile grade.
  - Delivered cut to length and ready for proof testing at Western Equipment.
  - Bagged and labelled for Salish Class vessels in the FMU Rigging Shop.
  - $_{\odot}$  Stamped with a Working Load Limit of 1000 kg (1 MT).
- It is noted that the Harding NPDS 1300H Technical Datasheet specifies 10 mm, 35x7 wire rope but does not state a tensile grade.
  - 35x7 wire rope is also available in 1960 tensile grade.
- It is not clear how the assignment of the Working Load Limit, as stamped on the wire rope falls before fitting to davits, is determined and managed by the contractor (Western Equipment).

<sup>&</sup>lt;sup>57</sup>The maximum working load for which equipment is designed and specified for safe use by the manufacturer. This number is much less than the breaking force that would actually cause the equipment to fail or yield.

The wire rope was fitted to the QCUM davit 5 April 2018 during midday layover.

- The work order used and charged for this work was QCUM.54061.
- The wire rope fitted matched what was specified on the work order as item 025574.
- Although the wire rope removed is laid out on the deck beside the wire rope to be installed, it was not observed during this change out that there was any difference in the wire rope types:
  - 10 mm 35x7 removed.
  - $\circ$  10 mm 19x7 installed.
- There was no examination of the removed wire rope it was carried back to the FMU site and discarded to recycling.
- There was no checklist for verification of actions during the change out.
- There was no cross check of wire rope Working Load Limit stamp and certificate with the load carried by the wire, i.e., the rescue boat.

At the time of the break, the wire rope had been exercised for just the second time since installation on 5 April 2018.

- The davit was not test operated under load, e.g., lowering/raising of the rescue boat, 5 April 2018 due to insufficient time after completing the wire change.
- The new wire was exercised under load lowering and hoisting for a Man Overboard Drill 12 April 2018. There was nothing unusual reported or observed from this event that might alter the condition of the wire rope.

It is most likely that the wire rope was undamaged immediately before the 18 April accident and capable of enduring a tensile loading up to 72.9 kN.

### Wire Rope Parting

As there is some variation in witness accounts of the relative orientation of the davit/boat system at the instant of the wire parting, the most likely orientation is as follows:

- The stop ring on the davit falls approaching the underside of the limit switch counterweight with a separation distance of approximately 1 m.
  - In a normal retrieval the hoist is stopped with the stop ring almost touching the limit switch. In this position the rescue boat deck should be roughly level with the boat deck.
  - $_{\odot}$   $\,$  The distance from the rubbing strake to the boat deck is 8.65 m.
  - At maximum retrieval rate of 0.31 m/second, the minimum retrieval time is 28 seconds to cover the distance from rubbing strake to boat deck without slowing or stopping.
  - From the closed-circuit television footage there is 25 seconds from the boat coming off the rubbing strake to the parting of the wire rope.
  - The 3 second difference would be approximately 1 m of wire rope travel.

- The measured distance from the centre of the davit head sheave to the underside of the limit switch counterweight is approximately 400 mm.
  - If the stop ring is 3 seconds or 1 m below the limit switch counterweight at the time of parting then the total distance to the centre of the davit head sheave is about 1.4 m.
- The measured distance from the stop ring to the position of the break in the wire rope is approximately 1450 millimetres (from the evidence collected from the scene).
- Therefore, the wire rope parting occurs at very close proximity to the centre of the davit head sheave (this is also where the rope guard is located).

The mechanism of the wire rope parting must have involved more than one factor:

- The winch does not impart enough line pull (tension) to break the wire rope.
  - $_{\odot}$  The minimum breaking strength of the fitted 19x7 10 millimetre wire rope was 72.90 kN.
  - $_{\odot}$  The maximum line pull of the winch, estimated at less than 18 kN  $^{58}$ , is insufficient to break the wire rope.
- The davit load does not impart enough tension to break the wire rope.
  - The translated force of the boat weight on the wire rope varies from:
    - 8 kN (minimum) when vertical with the sheave.
    - 19 kN if as much as 43° off vertical with the sheave.
  - Alternatively, the strain on the Painter would also be over 15 kN.
- It is therefore expected that the wire rope suffered sufficient damage to reduce its effective tensile strength to a value near to or below 20 kN.

It is most likely that the wire rope was heavily damaged during the final second before the parting via the double actions of:

(a) Riding up and over the edge of the sheave and incurring breaks to some of the outer wire strands and then;

(b) Colliding with the sheave rope guard with increased momentum (>0.3 m/s due to increased radius of travel) and side force of about 15 kN.

*NOTE:* Whether the installation of the OEM-specified (35x7) wire rope would have prevented this failure is undetermined.

Although the limit switch counterweight is not specifically designed (or specified) by the OEM to act as a wire rope falls angle limiting safety device, it was reported to have acted this way prior to the OEM technician modification in June 2016 (Figure 5 and Section 2.4 – Safety Deficiencies and Reporting).<sup>59</sup>

<sup>&</sup>lt;sup>58</sup> This value has been provided by Palfinger Technical Support based on calculations. The actual maximum line pull to a stalled condition has not yet been tested for this winch after the incident.

<sup>&</sup>lt;sup>59</sup> Post-incident investigation testing of the QCUM's davit's limit switch counterweight, for engagement at excessive  $(>20^\circ)$  wire rope falls angles, was not completed as this is not a specified OEM design characteristic for operations.

### **Davit Head Sheave and Rope Guard**

Examination of the davit head sheave and rope guard:

- The electrical continuity limit switch function was confirmed okay.
- Davit sheave was disassembled.
  - $\circ$   $\;$  The stainless steel pin was found to be in good shape.
  - The davit bearing assembly was noted to be in working shape and spinning freely.
- Wire rope imprints were noted upwards of the sheave groove on the side wall and over the edge.
  - It was discovered that there was a thick galvanized layer on the surface. of the sheave, therefore a microscopic examination would not be effective.
  - The galvanic coating was determined to be "too flaky" to derive estimations of the force imparted to create the imprints.
- An estimation of the maximum wire rope angle was measured by making a line pull over the top of the davit head sheave to a contact marking on the davit head cover plating.
  - The angle was determined to be 43° off the vertical.

### Davit Loading and Working Load Limit or Safe Working Load

IMO Resolution MSC.81(70), 8.1.5 requires that "a winch intended for use with a rescue boat is capable of recovering the rescue boat with the number of persons for which it is to be approved and its equipment or an equivalent mass at a rate of not less than 0.3 m/s."

- The type approval certificate TC 095.060.020 for 5 m Polaris 166R/Seamaster Rescue Boat states:
  - Total weight of 1252 kg
  - A 9 person boat
- The approved Life Saving Plan for QCUM states:
  - $\circ$  A 6 person rescue boat
  - The estimated total boat weight will be 1122 kg if based on the latest LSA Code standard person weight of 82.5 kg
  - $_{\odot}$  The boat weight is greater than the 1000 kg (1MT) Working Load Limit  $^{60}$  stamped on the wire rope falls ferrule (Figure 29)

<sup>&</sup>lt;sup>60</sup> Working Load Limit. The maximum working load for which equipment is designed and specified for safe use by the manufacturer. NOTE: This number is *much less than* the breaking force that would actually cause the equipment to fail or yield.

### Painter (rescue boat line – typically attached to bow)

The Multi-filament Polypropylene, 3/4 inch floating line "painter" is subject to elongation under load. The amount of the elongation can vary depending on age and the amount of stress to which it has been subjected.

The geometry (setup) of the painter attachment arrangement was problematic. The position of the cleat on the aft port bulwarks did not allow for the correct length of the painter to be used for both the rescue boat recovery, as well as to allow for the rescue boat to be hoisted to the davit while maintaining a perpendicular angle to the fall wire. The vessel attachment point, the cleat aft on the car deck, was 4 m of elevation above the waterline and 7 m above the cleat position when the boat is fully retrieved (Figure 9).

- If the painter were considered to be of constant length (no stretching) a boat that is in position under the falls at the water line will:
  - have slack in the line at the same elevation as the cleat, and
  - will be pulled forward as it approaches the boat deck.
- If the painter can stretch it will act like a spring. A boat that is in position under the falls at the water line with the painter taut will:
  - o scillate coming out of the water relative to how much tension was put on the Painter by the reversing of the boat's engines;
  - continue to oscillate against the spring action of the Painter as it is hoisted up the ship side;
  - be pulled forward as it approaches the boat deck as the amount of tension to stretch the painter increases.

Through testing of the same painter line as fitted on the QCUM it has been determined that:

• 20 kN of pulling force would stretch the Painter about 1.1 m.

The established position for the painter line to be secured on the cleat had no markings.

- The painter had two separate bands of black electrical tape tied to the line at the lengths of 16.5 m<sup>61</sup> and 21 m.
- Neither of these markings was used as the position for where the painter was to be secured to. The established length of the painter for the position in which it had been secured was not marked or communicated to other crew members.

The OEM operational limits that are specified for the wire falls are 10° fore/aft and 20° port/starboard. These limits can be easily affected by the handling of the painter; however the potential consequences of exceeding these angles are not stated by the OEM.

<sup>&</sup>lt;sup>61</sup> The 16.5 m tape had recently been removed or had fallen off, leaving the unfaded (original) orange colour of the line.

### 3.0 Safety Significant Events

### 3.1 Davit not assigned an asset number

When the QCUM's davit and rescue boat system was updated during its midlife upgrade in 2016, a new asset number was not assigned.

*Unsafe Act: The* Refit Team failed to ensure an asset number was created and added, along with the required maintenance plans.

*Unsafe Act:* Incoming QCUM Senior Chief Engineer did not identify that a new asset number was required.<sup>62</sup>

*Unsafe Condition:* Policies and procedures exist, however understanding and adoption is not fully realized or consistently checked to ensure adherence.

*Unsafe Condition:* Resource allocation and lack of consistency. Job planners were in place to assist vessel managers with asset management tasks. These positions have been reduced in number (or are no longer present), so process lacks continuity and tasks are not consistently being completed.

**Root Cause:** Lack of adequate quality assurance (process), quality control (confirmation) and focused oversight of safety critical assets (equipment).

### 3.2 Maximo records not updated

When the QCUM's davit and rescue boat system was updated during its midlife upgrade in 2016, the asset records were not updated to represent the change, so Maximo information was not providing relevant information.

- Job plans (for the previous davit) remained unchanged.
- OEM work instructions, inspection parameters, service and testing details for davit components (wire, sheave, limit switch, painter) remained unchanged.
- Work orders with obsolete job plans and Bill of Materials continued to generate.

*Unsafe Act:* Incoming QCUM Senior Chief Engineer did not identify that records would need to be updated.

*Unsafe Condition:* Policies and procedures exist, however understanding and adoption is not fully realized or consistently checked to ensure adherence.

*Unsafe Condition:* Resource allocation and lack of consistency. Job Planners were in place to assist vessel managers with asset management tasks. These positions have been reduced in number (or are no longer present), so process lacks continuity and tasks are not consistently being completed.

**Root Cause:** Lack of adequate quality assurance (process), quality control (confirmation) and focused oversight of safety critical assets (equipment).

<sup>&</sup>lt;sup>62</sup> At the time of the midlife upgrade, the QCUM Senior Chief Engineer was retiring and the new one was being on boarded.

### 3.3 Vessel Specific Manual procedures not updated

When the QCUM's davit and rescue boat system was updated during its midlife upgrade in 2016, VSM article 08.01.180 "Launch and Recovery of Rescue and Shepherd Boats" was not updated with the new davit model's operating procedures.

*Unsafe Act:* The QCUM Senior Master did not identify that article would need to be updated.

Unsafe Condition: Davit and rescue boat procedures remained present for the previous davit.  $^{\rm 63}$ 

Unsafe Condition: SEA Training materials (which reference VSM) were not updated.

**Root Cause:** Lack of adequate quality assurance (process), quality control (confirmation) and focused oversight of safety critical assets (equipment).

### **3.4 OEM technician modifies limit switch counterweight**

20 June 2016, an OEM service technician (Palfinger Marine) was called for a reported issue with the rescue boat retrieval (at waterline).<sup>64</sup> To alleviate the issue, it appears the service technician (drastically) modified the davit's safety limit switch *counterweight* to a non-OEM *off-set* position (Figure 5 and 6) which would allow the rescue boat to be retrieved when not directly underneath the davit head.<sup>65</sup>

*Unsafe Act:* The OEM technician modified the limit switch counterweight outside of OEM specifications.

*Unsafe Condition:* No physical indicator or limiting device (for excessive angles) is provided by the davit design to alert operators (crew). In addition, the OEM 10° fore and aft operational limits are stated, however the potential consequences (and warning) of exceeding those angles are not stated for operators.

*Unsafe Condition:* Lack of awareness (both OEM technician and BCFS employees) of potential consequences to making adjustments to safety critical assets (equipment) creating an unforeseeable risk for davit operators.

*Unsafe Condition:* Lack of communication from OEM pertaining to the potential consequences of exceeding stated operational angle limits.

**Root Cause:** Lack of adequate quality assurance (process), quality control (confirmation) and focused oversight of modifications to safety critical assets (equipment and procedures).

<sup>&</sup>lt;sup>63</sup> OEM operating procedures for the davit were available on the davit itself, however they were basic and did not reflect additional BCFS (non-OEM) equipment modifications (cradles) and BCFS best practices.

<sup>&</sup>lt;sup>64</sup> Deemed to be related to painter line length not placing rescue boat directly underneath davit falls and wire rope engaging (rubbing) the limit switch counterweight.

<sup>&</sup>lt;sup>65</sup> Handwritten notes in a (requested) Palfinger Marine Service Report (17 June 2018), reference the technician's modification.

### 3.5 Rescue boat painter length adjusted

22 March 2018, the rescue boat painter length was adjusted (during drill) to assist with alignment of rescue boat directly underneath wire falls on recovery (as per BCFS best practices). After adjustment and on recovery, the rescue boat was unable to reach the top as the painter became taut. On becoming taut, crew members reported there was dramatic shuddering (felt) and a metallic noise (heard). The rescue boat was lowered and when at the waterline, rescue boat crewmembers noticed the rescue boat safety pin had fallen out of the hook. The painter was re-adjusted to its previous (longer) length.

*Unsafe Act:* Post incident; davit equipment (davit sheave and wire rope) was not inspected for damage.

Note: The wire rope involved in this incident was replaced (5 April 2018) prior to the incident on 18 April 2018. It was recycled (disposed) at FMU.

*Unsafe Act:* Post incident; there was no documentation, reports (ALERTs or Initial Assessment Report) or informal communication with crews regarding the painter length adjustment and its (negative) effects.

*Unsafe Condition:* Lack of awareness (both OEM technician and BCFS employees) of potential consequences to making adjustments to safety critical assets (equipment) creating an unforeseeable risk for davit operators.

Unsafe Condition: Lack of awareness regarding post-incident inspections and reporting.

**Root Cause:** Implementation (and oversight) of installation modifications and procedure (development) for safety critical assets is inadequate.

### 3.6 Inaccurate work order received

Maximo auto-generated a work order for the davit service and wire change. The information (and specifications) was for the previous davit and did not apply to the new 1300H davit. Vessel engineering sent the work order directly to the Rigging Shop to expedite the process, thus circumventing an existing quality assurance step.

*Unsafe Act:* QCUM vessel engineering did not review and recognize that the incorrect information was in the Job Plan and circumvented a quality assurance step.

*Unsafe Act:* FMU Rigging Shop did not recognize that incorrect wire specifications were listed in the Job Plan.

*Unsafe Condition:* An overreliance on trust. Employees assume the information in Maximo is accurate and that processes are in place to ensure its accuracy.

*Unsafe Condition:* Existing quality assurance steps are not enforced and even when followed, may have limited effectiveness (lack of subject matter expertise involvement in process).

**Root Cause:** Lack of adequate quality assurance (process), quality control (confirmation) and focused oversight.

### 3.7 Incorrect wire rope prepared<sup>66</sup>

The FMU Rigging Shop Chargehand measured, cut and prepared the incorrect wire for the wire rope replacement. Prior to installation, the wire was sent offsite to a contracted company (Western Equipment) for proof testing.

*Unsafe Act:* The Rigging Shop Chargehand did not identify the incorrect wire rope specification in the Work Order.

*Unsafe Condition:* The Rigging Shop Chargehand was new to the *supervisory* position and although trained and certified by the OEM, had limited practical experience with the 1300H davit (in a supervisory role).

*Unsafe Condition:* An additional quality assurance step was not in place to review "safety critical" work orders for accuracy.

*Unsafe Condition:* An overreliance on trust. Employees assume the information in Maximo is accurate and that processes are in place to assure its accuracy.

**Root Cause:** Lack of adequate quality assurance (process), quality control (confirmation) and focused oversight.

### 3.8 Incorrect wire rope installed<sup>67</sup>

5 April 2018, the FMU Rigging Shop Chargehand and two FMU Labourers visited the QCUM in Swartz Bay and installed the new (below specification) wire rope during midday layover.

*Unsafe Act:* The Chief Engineer and Rigging Shop Chargehand did not review the work order and identify the incorrect wire rope specification in the work order.

Unsafe Act: Vessel engineering did not review (inspect) the completed work or sign the completed work order prior to the Rigging Shop team leaving the vessel.

*Unsafe Condition:* An overreliance on trust. Employees assume the information in Maximo is accurate and that processes are in place to assure its accuracy.

Unsafe Condition: Existing quality assurance steps are not followed.

**Root Cause:** Lack of adequate quality assurance (process), quality control (confirmation) and focused oversight.

<sup>&</sup>lt;sup>66</sup> See *NOTE* page 43 (Section 2.12 Technical Analysis – Component Failures – Wire Rope Parting).

<sup>&</sup>lt;sup>67</sup> See *NOTE* page 43 (Section 2.12 Technical Analysis – Component Failures – Wire Rope Parting).

### 3.9 Rescue Boat painter length adjusted during Man Overboard Drill

While tending to the painter during the Man Overboard Drill, the Painter Handler removed the painter from its set position and monitored the launch. When the painter was re-secured, its length had been shortened by approximately 3.5 m from its previous length.

The painter line attached to the rescue boat was too short to allow the wire rope falls to remain at a perpendicular angle to the davit head while being hoisted on recovery. This caused the rescue boat to move forward (towards the fixed cleat on the vessel) while being hoisted until it reached approximately 1.5 m from its home position beneath the davit.

*Unsafe Act:* The Painter Handler adjusted (shortened) the painter line length from its previously set position.

*Unsafe Condition:* The Painter Handler assigned to tend the painter line had never been trained to do so, had received no formal instructions and did not fully understand their role when tasked to tend the painter (the painter was not meant to be removed from the cleat).

*Unsafe Condition:* The painter line had been marked with separate bands of black electrical tape at distances of 16.5 m and 21 m; however, neither location was the appropriate length (Figure 27).

*Unsafe Condition:* The painter cleat (location) was not suitable for following BCFS practices (i.e. allowing alignment of the rescue boat to be directly underneath the wire falls at the waterline *and* allowing the rescue boat to reach the top on recovery) (Figure 9).

*Unsafe Condition:* Vessel crew members (including supervisors) were not aware of the potential consequences of allowing the adjustment of a piece of safety critical equipment.

*Unsafe Condition:* The OEM 10° fore/aft operational limits are stated, however the potential consequences (and warning) of exceeding those angles are not stated for operators.

**Root Cause:** Implementation (and oversight) of installation and procedure development (control) and training for safety critical assets is inadequate.

### 3.10 Wire rope failure (technical)

The wire rope of the rescue boat davit failed under load during hoisting as a result of the wire rope strands parting from mechanical damage.

The wire rope suffered mechanical damage to the outer strands when it made heavy contact with the sheave outer edge and the sheave rope guard located above the sheave (Figure 10). The wire rope came out of the sheave groove due to a substantial side pull at an angle exceeding 40°, well outside of operational limits (Figure 11).<sup>68</sup> The OEM design of the davit head assembly did not allow for the angle of the wire falls to exceed 10° in the fore and aft direction. The wire rope came under tension exceeding the minimum breaking load as reduced by the mechanical damage.<sup>69</sup>

*Unsafe Condition:* The attached painter was too short and imparted excessive tension on the wire rope as it was stretched by the pull of the davit winch as the rescue boat neared the fully retrieved position (Figure 11).

*Unsafe Condition:* The determination of the painter cleat positioning did not anticipate and mitigate the risk of the painter being tied off at too short a length.

*Unsafe Condition:* No physical indicator or limiting device (for excessive angles) is provided by the davit design to alert operators (crew).

*Unsafe Condition:* The OEM 10° fore and aft operational limits are stated, however the potential consequences (and warning) of exceeding those angles are not stated for operators.

**Root Cause:** The OEM design of the davit sheave arrangement (and guard) did not anticipate and mitigate against the risk of a wire jam.

<sup>&</sup>lt;sup>68</sup> Determined to be 43° off vertical.

<sup>&</sup>lt;sup>69</sup> See *NOTE* page 43 (Section 2.12 Technical Analysis – Component Failures – Wire Rope Parting).

### 4.0 Conclusions

### 4.1 Findings as to Cause, Contributing Factors and Risk

- The panel concludes from this inquiry (and learnings from recent investigations<sup>70</sup>), that there is an overreliance on trust that employees (at all levels) are experienced and knowledgeable enough to make appropriate decisions regarding the configuration management<sup>71</sup> and maintenance of safety critical assets (equipment) and their operation (procedures).
- 2. There are compounding factors contributing to a "skill erosion" within the fleet, including: a significant demographic shift with accelerated retirements, an influx of new and relatively inexperienced employees (and supervisors), insufficient training requirements (rescue boat training is not mandatory for all deckhands), employee movement (fluidity) in the fleet, a reduced (traditional) oversight role of Marine and Engineering Superintendents and finally, equipment diversity and change.
- 3. There is a lack of "ownership", governance and control of safety critical assets. Engineering crews maintain davits, but do not operate them. Deck crews operate davits, but do not maintain them. This gap was highlighted by interviewee comments noting their area of focus and observations were always "hook up" (Engineering) or "hook down" (Deck).<sup>72</sup> The formalized communication between the two departments – specifically related to quality assurance and quality control of assets – is insufficient.
- 4. Safety critical assets (equipment) lack a strict quality assurance framework and documented approval process in regards to procedure development/assessment, monitoring and training. (e.g. a lack of crew awareness of the potential implications of painter adjustments led to an unsafe act, the consequences of which were not previously appreciated)
- 5. The introduction of *modifications* to safety critical assets (and procedures) lack a strict quality assurance framework and documented approval process (e.g. the introduction of cradles, inconsistent procedure development and risk assessment, painter adjustments, inconsistent (non-OEM) terminology in procedures)
- 6. The supervision of contractors (both internal and external) is insufficient and would benefit from additional (updated) quality assurance and quality control measures, including formalized documentation updates from contractors. (e.g. OEM technician modification to limit switch counterweight, FMU incorrect wire rope installation)
- 7. In regards to configuration management, the relationship between the safety critical equipment OEM and BCFS is insufficient. (i.e. implementation guidance, procedure development and assessment, training & curriculum development, monitoring of maintenance processes, and usage)

<sup>&</sup>lt;sup>70</sup> Site Investigation SI-INS-9984 "Rescue Boat Recovered Using Incorrect Lifting Eye."

<sup>&</sup>lt;sup>71</sup> Establishing and maintaining the consistency of an asset (all aspects) throughout its entire lifecycle.

<sup>&</sup>lt;sup>72</sup> Rescue boat hook. "hook up" = The davit. "hook down" = The rescue boat hook and rescue boat equipment.

### 4.2 Other Findings (Items of Note)

- 1. The terms BCFS "best practices" and BCFS "standards" were heard repeatedly by the panel but lack a formal documentation, quality assurance and quality control framework, which leads to interpretation and deviation.
- 2. Information provided to the panel indicates the BCFS practice of tasking (operational employees in particular) to be part of "working groups" above and beyond their regular duties produces less than optimum results and is difficult to sustain.
- 3. Information provided to the panel indicates varying degrees of acknowledgement that there were safety issues with the 1300H davit.

The consensus from interviewees who worked directly with the davit was that:

- The enclosed design (that protected components) also hid them from view for ease of inspection.
- The gravity-fed slewing davits were simpler, preferred and more trustworthy.
- The davit model's size (arm length) and /or installation introduced an issue with hitting the rubbing strake during the launch and recovery procedure, due to the close proximity to the side of the vessel.
- The rescue boats were not very stable with the current bridle arrangement.
- Although there were a number of references and notes found in safety briefing minutes regarding issues with the rubbing strake, there was only one (1) ALERT submitted over a 2-year period.

The consensus from interviewees who did not work directly with the davit was that more time and experience was required for the crew to feel more comfortable with the new equipment, and expressed belief that "peculiarities" existed, but that there weren't any significant safety issues.

- 4. Information provided to the panel indicates the QCUM crew found the 1300H davit operation "awkward" in regards to the rubbing strake contact issue. Crews were required to deviate from BCFS best practices in order to make the operation work.
  - Drills, familiarization, and hands-on training became focused on modifying procedures versus reinforcing (drilling) BCFS best practices for safety.
  - Procedural modifications to BCFS best practices eventually became 'normal' operating procedures due to Operational Drift.<sup>73</sup>
- Information provided to the panel indicates varying levels of comfort and adoption with hazard reporting tools/processes such as ALERTs, Toolbox and Site Safety Committees and Initial Assessment Reports. Past (negative) experiences<sup>74</sup> were the leading cause for non-usage/lack of engagement.
- 6. Information provided to the panel indicates that worksite SEA Training content, delivery and effectiveness can vary considerably.

<sup>&</sup>lt;sup>73</sup> A safety industry expression describing the risk of erosion of baseline procedures and practices if left unmonitored and unenforced. Eventually these become (are assumed to be) how things are supposed to be operating (i.e. the new baseline).

<sup>&</sup>lt;sup>74</sup> Supervisor interactions and/or satisfaction with resolution of concern.

- 7. Closed-circuit television cameras showing rescue boat station activities were extremely helpful to investigators and should be considered for all vessels.
- 8. Maintenance Crew from the Rigging department accessed details of the work from a paper copy obtained through a maintenance planner or supervisor. Access to critical asset data through a handheld or portable device may make the planning of work more efficient and reliable for the Chargehand and his crew. The use of new technologies (e.g. asset barcodes and barcode scanning tools) could trigger alarms to assist. In addition, a more efficient process of routine checks to critical equipment performed by ship crew could use relevant tools and features that interface with newer versions of Maximo. This would improve the efficiency and reliability of the maintenance process.
- 9. The current regime of process change accompanying improvised systems to deliver mission critical functions is largely motivated by the need for enhanced safety through continual improvement. In keeping with these cycles of change, the CMMS at BCFS has evolved through several upgrades in the last 10 years. Newer tools and measures aimed at achieving objectives of safety and reliability by identifying and combining parallel processes could help reduce paperwork by saving time and effort. This could translate into more time and resources dedicated to the practice of safety critical and real time maintenance functions.
- 10. Several critical assets in rotation throughout the fleet such as evacuation slides, liferafts and rescue boats are not tracked with unique asset numbers as they move between worksites.
- 11. Information provided to the panel indicates the OEM's davit maintenance and servicing certification training, received by FMU employees was limited (brief).
- 12. FMU is ISO 9001:2015<sup>75</sup> certified under Lloyd's Register Quality Assurance. All functions within the facility completed a transition audit to new standards in 2018 under the oversight of certified Lloyd's Register Quality Assurance Auditors. Under the ISO program, there are policies and specific procedures established including a System Improvement Request process for handling any non-conformances or deficiencies reported in the normal course of business. Any issue related to the execution of services, including emerging issues identified in this report (procedural or otherwise) would necessarily be included under the quality improvement processes. At the time of this report, the internal processes are already under review and Service Improvement Request appropriate to the circumstances created. Service Improvement Requests are logged and tracked and are subject to internal and external review and audit.
- 13. Although not a contributing factor in this incident, information provided to the panel indicates it is challenging for Deck Officers to manage (be aware of) competency levels of deck crew while in operation, due in part to adequacy of administrative tools and crew fluidity in the fleet.
- 14. Environmental conditions (weather and tide) on the date of the incident were moderate and determined to not be a contributing factor (Appendix D).

<sup>&</sup>lt;sup>75</sup> The international standard that specifies requirements for a Quality Management System.

### 5.0 Recommendations

### 5.1 Review davit design and operator warnings

The design of the davit head assembly and the absence of warnings to operators of potential consequences of exceeding wire falls operational angles should be addressed directly by the davit OEM.

## 5.2 Assign specific/dedicated<sup>76</sup> operational resources to manage safety critical assets

In order to reduce future risk, the preponderance of evidence provided to the panel has identified the management of safety critical<sup>77</sup> operational tasks and related assets (equipment) as the primary safety deficiency for BCFS to address.

There were examples of appropriate and reasonable levels of training, certification, policy, employee action, drills, inspections, procedures and processes, however; the panel cautions that safety critical tasks (procedures) and equipment require a higher standard of "asset management" than is currently in place.

Safety critical asset management should consider the lifecycle of an asset to include:

- Assessment
- Procurement
- Installation
- Implementation (operationalization)
- Policy & Procedures (development and assessment)
- Training
- Documentation Control (governance)
- Maintenance and Service Plan development
- Quality Assurance (process)
- Quality Control (confirmation)
- Audit

This holistic approach to safety critical asset management - which is recommended - requires dedicated operational resources<sup>78</sup> to effectively control these defined assets through each stage of their lifecycle and to have the appropriate authority (and resources) to enforce set standards.

The panel notes the BCFS common practice of creating Working Groups (made up of operational employees with regular duties) to support and manage operational initiatives. The panel emphasizes this working group approach would lack effectiveness for the scope of this recommendation as long term sustainability needs to be ensured through dedicated resources with ownership.

# OPI:Fleet OperationsOwner:Executive Director, Fleet Operations & TrainingManager:Vice President & Chief Operating Officer

<sup>&</sup>lt;sup>76</sup> Not assigned to other operational or regular duties or to other assignments/initiatives.

<sup>&</sup>lt;sup>77</sup> Safety critical, includes higher potential for: injury (serious/fatality), damage to equipment (damage/loss) and impacts to the environment.

<sup>&</sup>lt;sup>78</sup> A Manager or Director level position. The resource will require operational experience.

### 5.3 Conduct an assessment of safety critical asset (systems) management

Review existing equipment/systems and identify those that are safety critical. The review should be consistent with Recommendation 5.1 in that it should establish clear authority and process for configuration management<sup>79</sup> of safety critical assets.

The assessment should be documented.

OPI:EngineeringOwner:Director, Engineering ServicesManager:Executive Director, Engineering

### 5.4 Conduct a risk assessment of the launch and recovery of rescue boats

Addressing the findings from this inquiry (and those of recent investigations<sup>80</sup>), conduct a risk assessment of the launch and recovery of rescue boats. The scope should include (but not be limited to):

- the continued use of luffing style davits
- rescue boat launch and recovery procedures (by worksite)
- the use/management of the painter and the positioning of the painter cleat
- training requirements for related EDN duties
- alternative rescue boat stowage and launching locations

# OPI:Safety, Health & EnvironmentOwner:Executive Director, Safety, Health & EnvironmentManager:Vice President & Chief Operating Officer

### 5.5 Improve emergency scene management at terminals (including drills)

The Incident Command System has been adopted and is often utilized by terminals, however information provided to the panel indicated that the scene would have benefited from an On Scene commander. On Scene Command is an important aspect of emergency management and it should be understood *and* practiced.<sup>81</sup>

Increase the level of Incident Command training for Terminal Supervisors, Managers and Superintendents and include drills. Consider including as a competency.

# OPI:Terminal OperationsOwner:Executive Director, Catering & Terminal OperationsManager:Vice President & Chief Operating Officer

<sup>&</sup>lt;sup>79</sup> A consistency of standard throughout an asset's lifecycle.

<sup>&</sup>lt;sup>80</sup> Site Investigation SI-INS-9984 "Rescue Boat Recovered Using Incorrect Lifting Eye."

<sup>&</sup>lt;sup>81</sup> Review Appendix C for lessons learned.

### 5.6 Conduct an assessment of water rescue preparedness at terminals

The crewmember recovery was successful; however interviewees indicated that additional training and drilling would be of benefit.<sup>82</sup>

Review and assess the training and drill preparedness of terminals for water rescues/recoveries using existing equipment and employee competencies.<sup>83</sup>

Review and assess Terminal Operations Level II Policy and Level III Procedures for persons in the water response and recovery plans. This should include the use of equipment required to safely remove someone from the water (e.g. work boat man overboard recovery, boat hooks). The assessment should consider how to get someone to an extraction point and what extraction points are suitable for recovery.

Terminal/vessel communications and protocols (for ceasing loading/unloading operations during an incident) should be included in the assessment.

The assessment should be documented.

# OPI:Terminal OperationsOwner:Executive Director, Catering & Terminal OperationsManager:Vice President & Chief Operating Officer

### 5.7 Improve Operational Training related to the launch and recovery of rescue boats

Incorporating the findings from this inquiry (and those of recent investigations<sup>84</sup>), improve the BCFS Operational Training component related to the launch and recovery of rescue boats by providing resources for the following:

- Increased availability of rescue boat training courses (i.e. Rescue Boat/Shepherd Boat, RPSC)
- Increased number of qualified rescue boat instructors
- Additional training facility development in centralized and satellite locations<sup>85</sup>

OPI:TrainingOwner:Director, Operational TrainingManager:Executive Director, Fleet Operations & Training

<sup>&</sup>lt;sup>82</sup> Review Appendix C for lessons learned.

<sup>&</sup>lt;sup>83</sup> Consider the use of the detailed rescue timeline and Closed-Circuit Television video footage for the development of water recovery/rescue training content.

<sup>&</sup>lt;sup>84</sup> Site Investigation SI-INS-9984 "Rescue Boat Recovered Using Incorrect Lifting Eye."

<sup>&</sup>lt;sup>85</sup> Training facility asset/equipment upgrades must match current vessel equipment

### 5.8 Conduct an audit of SEA Training processes

Implement a formal audit of SEA Training processes to provide the basis and rationale for improvements. The scope should include, but not be limited to:

- Content updates (especially new equipment/assets)
- Content quality control (accuracy and consistency)
- Content delivery (consistency)
- Trainee evaluation (post-training comprehension)
- Trainer qualifications (capabilities)
- Specialized safety critical training positions

## OPI:Internal AuditOwner:Executive Director, Internal AuditManager:Vice President & Chief Financial Officer

### 5.9 Conduct an assessment of FMU quality assurance processes (safety critical)

In relation to Recommendation 5.1, implement a formal review and audit of the quality assurance processes<sup>86</sup> related to the management of safety critical assets at FMU. Areas of focus to include: Rigging Shop, Life Raft Centre, Rescue Boat Centre.

The assessment should include recommendations to update existing (or create new) FMU Level 3 Standard Operating Procedures (Section 6). The assessment should be documented.

OPI:	FMU & Supply Chain
Owner:	General Manager, FMU & Supply Chain
Manager:	Vice President & Chief Operating Officer

## 5.10 Develop and enforce new governance and quality assurance processes in the CMMS

In relation to Recommendation 5.1, allocate sufficient resources and authority to improve the governance and enforce user adherence to quality assurance processes of the BCFS CMMS.

The scope should include (but not be limited to): procurement, maintenance & service plan development, quality assurance, quality control and audit.

OPI:	Engineering
Owner:	Director, Engineering Services
Manager:	Executive Director, Engineering

<sup>&</sup>lt;sup>86</sup> ISO 9001: 2015 processes already in place.

## 5.11 Issue a joint<sup>87</sup> communication regarding the importance of reporting safety events

Recognizing that implementation of resolves pursuant to safety reporting ultimately rests with BCFS, the importance of sustaining an active and effective reporting culture (especially in regards to safety critical assets and operational tasks) is a joint responsibility between the Executives of BCFMWU and BCFS. Issue a joint communication to foster continued support of active safety reporting.

OPI:Safety, Health & EnvironmentOwner:Executive Director, Safety, Health & EnvironmentManager:Vice President & Chief Operating Officer

<sup>&</sup>lt;sup>87</sup> BCFMWU and BCFS.

### Appendix A – Images

Figure 1 – 1300H davit remote control device



**Figure 2** – QCUM 1300H davit in 'luffed' out position





Figure 3 – QCUM parted davit wire rope (with hook assembly)

**Figure 4** – Image shows QCUM limit switch counterweight (cable) modification. Arrow indicates where cable *should* be connected to allow limit switch to hang directly underneath sheave (i.e. 1 cable on either side of sheave).



**Figure 5** – Image shows *Queen of Capilano* (QCAP) 1300H davit with *correct* OEM limit switch arrangement (i.e. 1 cable on either side of sheave)





Figure 6 – QCUM davit installation with non-OEM davit cradles (davit is luffed out)

Figure 7 – 1300H OEM Operation and maintenance manual<sup>88</sup>



**Figure 8** – QCUM profile illustration showing davit location and rescue boat at waterline and at full hoist on recovery<sup>89</sup>



PORT OUTBOARD PROFILE

<sup>&</sup>lt;sup>88</sup> Harding Operation and maintenance manual NPDS-DOC-OMM-002-01 Rev 01.

<sup>&</sup>lt;sup>89</sup> BCFS General Arrangement drawings.

**Figure 9** – QCUM Davit *Sheave Head Assembly* images showing sheave abrasions and upper sheave guard contact.



Figure 10 - Free Body parameters used in the estimation of forces on wire rope and the sheave



**Figure 11** – Painter length before and after the incident. Arrows indicate end of daisy chain and significant difference in length, past the cleat. (Incident occurred at 12:50:52)



### Figure 12 Moment before Davit Failure 18 April, 2018

Closed-Circuit Television footage of QCUM at Swartz Bay Terminal. Camera view is in the direction of Berth #4 and #5. Frame captured just before the rescue boat drops.



### Figure 13 Rescue Boat 18 April, 2018

Retrieved by BCFS crane truck and weighed at 635 kg on 18 April 2018.



### Figure 14 Rescue Boat Davit 19 April, 2018

After lockouts had been removed, the OEM service technician pressurized the accumulator system to luff the davit inboard and back level on to the deck from the outboard position it was in at the time of failure.



### Figure 15 Davit Casing Upper 19 April, 2018

Upper Inspection cover opened. Noted a paint chip mark on the idler sheave.



### Figure 16 Davit Casing Lower 19 April, 2018

Lower Inspection cover opened. Wire rope still on the winch drum. Noted the falls loosely coiled to right side of drum, deformed profile of wire rope across the upper length.



### Figure 17 Winch Drum 19 April, 2018

The drum showed normal wear.



### Figure 18 Wire Rope 19 April, 2018

Inspection of wire rope (falls) along the entire length, unwound from drum and laid out on deck. 10mm rotation resistant 19x7 wire rope was in use, the chafing mark was evident to approximately 48 inches from the severed end.



### Figure 19 Wire Rope 19 April, 2018

10mm rotation resistant 19x7 wire rope was in use, the chafing mark was evident to approximately 48 inches from the severed end.



### Figure 20 Upper Sheave 19 April, 2018

Upper sheave was intact and moved freely.





Figure 21 – 1300H Davit / Polaris rescue boat arrangement (QCAP)

Figure 22 – 1300H Davit/Rescue Boat Components


## Figure 23 – OEM procedures posted on 1300H Davit



Figure 24 – Limit Switch Activation Switch



Figure 25 - 'Luffed' out position of the NPDS 1300H Davit at time of the incident<sup>90</sup>



<sup>&</sup>lt;sup>90</sup> OEM illustrations.

**Figure 26** – Painter markings (orange indicates less Ultra Violet damage where tape was removed – date unknown).



## Figure 27 – Wire rope microscopic analysis (samples)

Sufficient lubrication between wires was evident, with several marks in close proximity across a section of wires indicated crushing.



The galvanized coating of the wires was undisturbed over the majority of the surface examined – no surface corrosion noted.



Ends had fractured (or sheared) at nearly the same length within the strand. Corrosion, fatigue or wear ruled out as probable causes. Wire was "galled" or crushed on the surface.



Figure 28 – QCUM wire rope falls *ferrule* 



**Figure 29 –** *Previous* **QCUM R/B stern painter arrangement** (*with Sun Deck cleat*)









- Davit: Manufacture
- Drawing reference
- Application
- Safe Working Load ( SWL)
- Trim/ List conditions
- Max Lowering/ Hoisting speed
- Total height of Davit
- Total weight of Davit
- : Noreq Hydraulic Pivoting Davit : 10014 NPDS 1300H : Rescue Boat Handling : 1300 Kg : 10\*/ 20\* : 18 m/ min : 3009 mm : 1110 Kg

<sup>&</sup>lt;sup>91</sup> OEM illustrations.

# Appendix B – Technical Cause Analysis

SCENARIO Calculated Results	Units											
Seconds before Wire Rope Break	Seconds	0	1	2	3	4	5	6	7	8	9	10
Davit Falls - Angle off Vertical	Degrees	43	41	38	35	31	28	25	22	19	17	15
Rescue Boat elevation off boat deck	m	0.00	-0.23	-0.47	-0.74	-1.03	-1.32	-1.63	-1.95	-2.27	-2.58	-2.90
Tension on Falls Wire Rope	kN	19.0	17.3	15.3	13.8	12.2	11.3	10.6	9.9	9.4	9.1	8.9
Tension on Painter	kN	14.3	12.5	10.3	8.6	6.8	5.7	4.8	4.0	3.2	2.8	2.4
Side Force on Wire Rope at Sheave	kN	13.0	11.3	9.4	7.9	6.3	5.3	4.5	3.7	3.1	2.7	2.3
Side Force (Max) at Max Line Pull	kN	15.3										

Harding NPDS 1300H Davit								
PAINTER: MFP Floatline, 3/4" Pull Tests								
TECHNICAL DATA								
057097 Floatline, MFP, 3/4 In, Orange								
Minimum Breaking Load (MBL) 11,000 lbs	49035	N						
20% MBL	9807	N						
Test Pull, 28 May, 2018 at FMU	Tension A	pplied	Ro	pe Leng	th	Elongat	ion	
Length of Rope stretched: ~ 60 ft	kN	kg	ft	in	m	stretch	%	
Spliced Eye configuration	0		59	10	17.59	0.00		
	5	510						
20% MBL	10	1020	62	10	18.47	0.88	5.0%	
	15	1530	64	6	18.96	1.37	7.8%	
	20	2039	65	9	19.33	1.74	9.9%	
	25	2549	67	4	19.80	2.21	12.5%	
	30	3059	68	5	20.11	2.52	14.3%	
Test Pull, 28 May, 2018 at FMU	TensionApplied		Rope Length			Elongation		
Length of Rope stretched: ~ 30 ft	kN	kg	ft	in	m	stretch	%	
Bowline Eye configuration	0		29	6	8.67	0.00		
	5	510						
20% MBL	10	1020	30	4	8.92	0.24	2.8%	
	15	1530	32	7	9.58	0.91	5.2%	
	20	2039	33	2	9.75	1.08	6.1%	
	25	2549	33	6	9.85	1.18	6.7%	
	30	3059	34	2	10.05	1.37	7.8%	
Extrapolated @ 20 kN for a 54 ft rope presuming linear function	on:							
stretch factor m/kN for 30 ft	0.054	m/kN	30					
stretch factor m/kN for 60 ft	0.087	m/kN	60					
stretch factor m/kN for 54 ft	0.080	m/kN	54					
old painter 10% for loss of tension	0.088	m/kN						

Queen of	Cumberland (QCUM) Recovery Ac	tions (Timeline from SWB CCTV, QCU	M logbook and interviews)	
Legend:	ALARP			
	Caution			
	Awareness required			
	Action required			
Timo	Event	Commente	l aarnina Evant	Dick
				NOVI
	Davit wire rope parts and rescue	Two crew in boat, both have (PPE): Helmets, anti-exposure suits and	At present, all PPE worked as designed - Life jackets deployed - no head injures - suits giving	-
12.50.52	boat (RIB) falls to waterline	life jackets	floatation	PPE effectiveness good
12.50.55	Unit 8 radios that an incident has happened	(Unit 8) at loaders position hears and sees an incident happen and makes radio statement of event	Begins the Terminal response process	Not confirmed what was stated on the radio call, but all hear there was an issue
12.51.12	ERA deploys life ring	Life ring deployed with line	Care was shown when deploying	Training working
12.51.12	Life deployed from boat deck	Life ring deployed	Care first	Training working
12.51.20	Line ring deployed	Life ring deployed from car deck	Lowered to water line	Training working
12.51.39	Line ring deployed	No line	Care was shown when deploying	Training working
		QCUM radio call that men are in the		Not confirmed if slow bell was
12.52.00	QCUM radio call	water	Awareness to vessels in the bay	issued, Tower SOP to do so
			C/E reports he heard a loud bang so went on deck to see what	
12.52.00	Chief Engineer (C/E) on car deck	Reviews situation	happened	C/E input into situation
12.52.10	Crew member drags other crew member to rescue boat (QCUMB)	One crew member tows crew member to rescue boat , not clear if persons are in the water	Life jackets deployed, suits giving floatation, helmets in place	Self rescue initiated by one crew member. Common sense or training? Crewmembers not available for interview/confirmation.
	Skeena Queen (SKEN) sound	Three blasts on whistle and Stop	SKEN stops traffic prepares to	Rescue boat deployed with PPE (helmets, jackets). Crew missing anti-exposure suits - reasoning behind no suits was acknowledged
12.53.00	signals	Traffic	launch rescue boat	as saving time to get boat away.
12.53.04	QCUM OFA on car deck	Equipment and OFA shows up on QCUM deck	OFAs, we do not know what direction was given or at what point the recovery point information was given to them	Crew training working as they were fully equipped with first aid equipment
12.53.12	Life ring goes into the water	Life ring deployed other side of rescue boat	Care shown when deploving	Training kicking in
				QCUM plan to remove persons from dock 3 pontoon, this was changed
				by Terminal Manager and Regional Terminal Manager. Past experience knew that the anron could be
12.53.18	Terminal Attendant	Terminal Maintenance in video runs towards dock 3	In order to change plan, from Dock 4 pontoon to dock 5 ramp	lowered into the water and is a better way of recovery.

# Appendix C – Recovery Actions

12.55.30     Terminal work boat crewed     Cew mustered at terminal work     Terminal work to and T/A from foot land     One person with training de trainining de tranining de training de tranining de training de traini	Time	Event	Comments	earning Event	Risk
12.56.36   Terminal work boat crewed   Supervisor   and T/A from foot land   training de tread training de training de tread de training de			Crew mustered at terminal work boat directed by Terminal	Ferminal Maintenance worker, 1.5	One person has PCOC (TM), one person with Catering vessel
12.54.50   RB side of the QCUM rescue boat   Hanging on     12.54.50   RB side of the QCUM rescue boat   Hanging on     12.55.17   Crew member hanging on to crew member sogether on one crew member helping out the many crew in water   Tarining de the qCUM rescue boat     12.55.17   Crew member moves to similar side port side   Both crew member together on one crew member helping out the many crew in water     12.55.18   Terminal Manager   dock 4   manager goes to head of success to review the generation other     12.55.18   Terminal Manager   dock 4   manager goes to head of success success to head of success to head of success success to head of success to head of success to head of success success to head of success to head of success success success to head of success success success success success to head of success success success success to head of terminal head of term	12.54.00	Terminal work boat crewed	Supervisor	and T/A from foot land	training
Two crew in water hanging on to the QCUM rescue boat     Two crew in water hanging on the QCUM rescue boat     Hanging on trained in the water.     Itemnioal in trained in the water in trained in traine in traine in trained in trained in trained in trained in trained					Training does include removal from
12.55.17   Terminal more thanging on to crew members were on each side of the QCUM mescue boat   Hanging on the real member moves to similar side port side   Plane required to been handed to the QCUM mescue boat   Hanging on the real member moves to similar side port side   Plane required to been handed to the QCUM mescue boat   Terminal member moves to similar side port side   Plane required to been handed to the QUEAL   Plane required to the QCUM member moves to similar side port side   Doe to the moves to similar side port side   Doe term member moves to similar side port side   Doe term member moves to similar side port side   Doe term member moves to similar side port side   Doe term member moves to the situation   Crew member helping out the been handed to the move the move of scene by crew, rew   Doe term mail to the water, not trained to the move to the move of scene by traw, rew   Doe term move the peovery by the move of scene site site to the move of scene site side to the move of scene site side to the move of scene site site site site to the move of scene site site site site site site site sit					the water via stern using engine
12.54.50   RB side of the QCUM   The QCUM rescue boat   Hanging on   Tanadin and the provision of the provision of the member helping out the been hanging on the been hanging on the been hanging and the member helping out the been hanging out tide   Inclease team and the helping out the been hanging on the been hanging on the been hanging out tide   Inclease team and the helping out the been hanging out the been hanging on the been hanging out tide   Inclease team and the helping out the been hanging out the been hanging out the been hanging out tide   Inclease team and the helping out the been hanging out the been hanging out the been hanging out tide   Inclease team and the helping out the been hanging out the been hanging to the team and the been hanging to the team and the been of the dock 4.   Note team the helping out the been hanging to the team and vessels side, the predict hand vessels side, the predict hand vessels side, the predict hand vessels side, the man and vessels side, the man and vessels side, the man way from persons in the water.   Inclease team and vessels side, the rescue the team and vessels side, the man way from persons in the water.   Intendent the teace team and vessels side, the rescue team and vessels side, the rescue team and vessels side, the rescue team and transfers to the and vessels side, the rescue team and team and vessels side, the rescue team and		Two crew in water hanging on to	Crew members were on each side of		Flare. Terminal staff not drilled or
12.55.17   Crew member moves to similar side port side   Doth crew member sogether on other   One crew member helping out the mindent   Deen hamp heredent     12.55.17   Crew member moves to similar side port side   Dott crew member helping out the port side   Dott crew member helping out the here hamp   Dotte rem here hamp     12.55.53   Terminal Manager   Dock 4   Not equipy process from the water, not trained to process   Dock equipy from crew from the water, not trained to process   Dock equipy from crew from the water, not trained to process   Dock equipy from crew from the water, not trained to from crew from the water, not trained to from the pointen and vessels side, from crew from the pointen and releases it the mater and releases it the mat	12.54.50	RIB side of the QCUM	the QCUM rescue boat	Hanging on	trained in recovery methods
12.55.17     Crew member moves to similar side     Both crew members together on other     One crew member helping out the incident     Frequend to incident       12.55.53     Terminal Manager     dock 4     manager goes to head of recovery process     Suggested response to review the peter th incident     Note elem hand greater th incident       12.55.11     Terminal Manager     duck response to the situation     Suggested response to review the deployed for presonal removal     greater th incident       12.56.11     Terminal work boat on scene     Quick response to the situation     complete task, no pre drint?     Ch       12.56.26     Skeena Queen RIB on scene     Quick response to the situation     complete task, no pre drint?     Ch       12.56.26     Skeena Queen RIB on scene     Quick response to the situation     terminal boat assisting keeping RIB     recovery to member it       12.56.30     Skeena Con     Review of Scene XO     Review of Scene XO     Con       12.56.30     South Coast on scene     Quick response to rew of scene XO     Review of Scene XO     Codentrian of the water       12.56.30     Repoind Terminal Work boat transfer     Terminal work boat transfer     Could remove the water     Transfer     Transfer       12.5					Crew in water figuring out what is
12.55.17   Crew member moves to similar side port side anager goes to head of suggested response to review the deployed a greater th. Note stern that manager   Description   Description <thdescription< th="">   Description   Description&lt;</thdescription<>					required for self rescue, could have
12.55.13     Terminal Manager     Terminal manager goes to head of Suggested response to review the deployed a genetic mut the deported a genetic mut trained to do dock 4     Note state     Note state     Note state     Note state     Note state     Repeared mut trained to genetic mut the deported of personal removal ferminal S from the water, not trained to meaw term of the meak is the water, not trained to do dock 4     Note state     Note state     Note state     Note state     Note state     Review of scene State     Review of scene State     Review of scene State     Note state     Campo scene complete task, no pre failing     (1)       12.56.26     Skeena Queen RIB on scene     Quick response to the situation complete task, no pre failing     (1)     (1)       12.56.26     Terminal work boat transfer     Between RIB and sessiting keeping RIB recovery B     Review of scene State     Steena complete task, no pre failing     (1)       12.56.26     Terminal Work boat transfer     Between RIB and sessiting keeping RIB     Fermiored RIB     Ferminal Manager     Steena complete task, no pre state     Steena complete       12.56.30     Terminal Work boat transfer     Do protoch sistit transfers to     Termis RIB     Transfer R     Transfer R       12.55.30     Terminal Manager and Regional     Corbin fail transfer R	12.55.17	Crew member moves to similar side	Both crew members together on to bort side	One crew member helping out the other	been hampered by shock from the incident
12.55.53     Terminal Manager     Terminal Manager     Terminal Manager     Terminal Manager     Mode of equipped for personal removal removere removal removal removal removal removere removal removal remov					Note: terminal boat was quickly
12.55.53 Terminal Manager dock 4 tecovery process greater th.   12.55.11 Terminal Manager Mot equipped for personal removal from the water, not trained to for more work from the water, not trained to the network from the water is the water of the network from persons in the water transfer is the more the more transfer is the more transfer is the more the network from persons in the water. greater th.   12.56.26 Skeena Queen RIB on scene Quick response to the situation complete task, no pressing keeping RIB recovery be away from persons in the water. Skeena crew or scene or crew or scene Skeena crew or scene or crew or scene or sc			Terminal manager goes to head of	Suggested response to review the	deployed and response time was
Instruction     Not equipped for personal removal from the water, not trained to complete task, no pre drained to remnial work boat on scene     Terminal Solution     Remnal Solution terminal to from the water, not trained to terminal boat assisting keeping KB     Terminal Solution     Steena contact Solution     Steena contacot Solution Solution     Steena contact Solution </td <td>12.55.53</td> <td>Terminal Manager</td> <td>dock 4 II</td> <td>ecovery process</td> <td>greater than Skeena Queen RIB</td>	12.55.53	Terminal Manager	dock 4 II	ecovery process	greater than Skeena Queen RIB
12.56.11   Terminal work boat on scene   Quick response to the situation   from the water, not trained to   from crew     12.56.15   Ferninal work boat on scene   Quick response to the situation   Review of scene by crew, crew   Refena cr     12.56.26   Skeena Queen RIB on scene   Skeena crew on scene   Between RIB and vessels side, terminal boat assisting keeping RIB   Cerovery between RIB and vessels side, terminal boat assisting keeping RIB   Charge was     12.56.26   Terminal Work boat transfer   Reminal Attendant transfers to terminal boat assisting keeping RIB   Catering)     12.56.20   Terminal Work boat transfer   QCUM RIB to assist crew in water   Tends to painter and releases it.   Incident C.     12.56.30   South Coast on scene   QCUM RIB to assist crew in water   Tends to painter and releases it.   Incident C.     12.56.30   South Coast on scene   QCUM RIB to assist crew in water   Tends to painter and releases it.   Incident C.     12.56.31   Fouth Coast on scene   Cound for ensuring suggested observations in contact.   No clear In.     12.56.30   South Coast on scene   Cound for ensuring suggested observations in contact.   No clear In.     12.56.30   South Coast on scene   Cound for ensuring suggested observations in contact.   N				Vot equipped for personal removal	Terminal Staff taking directions
12:56.11   Terminal work boat on scene   Quick response to the situation   complete task, no pre drill?   (1)     12:56.12   Skeena Queen RIB on scene   Quick response to the situation   Review of scene by crew, crew   Skeena crew     12:56.26   Skeena Queen RIB on scene   Skeena crew on scene   away from persons in the water   Charge wa     12:56.26   Terminal Work boat transfer   Amen work   Amen work   Charge wa     12:56.30   Terminal Work boat transfer   Amen work   Creating)   Creating)     12:56.30   Terminal Work boat transfer   Amen work   Creating)   System no     12:56.30   South Coast on scene   PCLIM RIB to assist crew in water   Tends to painter and releases it   Incident Co     12:56.30   South Coast on scene   PCE is worn   Cood change of plan as removal   Incident Co     12:56.31   Ferminal Manager and Regional   Terminal Manager and Regional   Creating   Suggested observations in contact   No clear Ir     12:57.17   Crew on QCUM walk to dock 4   Cood change of plan as removal   This type   Suggested observations in contact   No clear Conton     12:57.17   Crew on QCUM walk to dock 4   Crew from QCUM go to he			48	from the water, not trained to	from crew member in the water
12.56.26   Skeena Queen RIB on scene   Skeena crew of scene by crew, crew scene   Between RIB and vessels side, scena crevery by terminal boat assisting keeping RIB recovery by terminal boat assisting keeping RIB recovery by terminal boat assisting keeping RIB recovery by terminal boat away from persons in the water   Transfer is member ha way from persons in the water   Skeena crew on scene   Skeena crew on scene   Skeena crew on scene   Skeena crew of scene by crew, crew scene by crew, crew is way from persons in the water   Skeena crew of scene by terminal boat assisting keeping RIB recovery by terminal boat cransfer is member ha work boat transfer   Transfer is member ha work boat transfer is member ha way from persons in the water   Transfer is member ha work boat transfer is member ha way from persons in the water   Transfer is member ha work boat transfer is member ha way from persons in the water   Transfer is member ha work boat transfer is member ha water   Incident Co system of syst	12.56.11	Terminal work boat on scene	Quick response to the situation	complete task, no pre drill?	(1)
12.56.26   Skeena Zugeen RIB on scene   between RIB and vessels side, terminal boat assisting keeping RIB recovery b away from persons in the water   Skeena Zuge wa     12.56.26   Skeena Queen RIB on scene   Skeena crew on scene   between RIB and vessels side, terminal boat assisting keeping RIB   Recovery b away from persons in the water   Charge wa     12.56.36   Terminal Work boat transfer   Cound RIB to assist crew in water   Tends to painter and releases it   Transfer is when work     12.56.30   South Coast on scene   Do phone, giving direction, ensuring   Suggested observations in contact   System to the period observations in contact   Secne Con System to system to system to system to system to the portoon would be the rescue from the portoon would be the from the portoon would be the from to the water   This type the secue to the system to system to system to the system to t			4	Review of scene by crew, crew	
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12.56.26   Skeena Queen RIB on scene   Skeena crew on scene   away from persons in the water   charge water     12.56.26   Terminal Work boat transfer   Skeena Queen RIB on scene   Skeena crew on scene   Transfer is ween work     12.56.56   Terminal Work boat transfer   QCUM RIB to assist crew in water   Tends to painter and releases it   Transfer is ween ween ween ween ween ween ween wee			+	terminal boat assisting keeping RIB	recovery but at this point the in
12.56.56   Terminal Mork boat transfer   Terminal Attendant transfers to Mem work   Terminal Member ha when work     12.56.56   Terminal Work boat transfer   QCUM RIB to assist crew in water   Tends to painter and releases it   Incident C     12.56.30   Terminal Superintendent, Regional Terminal Superintendent, South Coast on scene   On phone, giving direction, ensuring   Suggested observations in contact   Incident C     12.56.30   South Coast on scene   PPE is worn   Suggested observations in contact   No clear Ir     12.56.30   Forminal Manager and Regional   PPE is worn   Kith OSC / EOC   Scene Con     12.55.31   Forminal Manager RTM) Southern   Change of plan for removal from the pontoon would be   This type     12.57.17   Islands   Lock 4 pontoon to ramp dock 5   can be lowered into the water   In place ar     12.57.17   Crew on QCUM walk to dock 4   Crew from QCUM go to help   n/a   Present place ar     12.57.17   Crew on QCUM walk to dock 4   Crew from QCUM go to help   n/a   Present place ar     12.57.17   Crew on QCUM walk to dock 4   Crew from QCUM go to help   n/a   Present place ar     12.57.17   Terminal Manager Southern   Discres clan act clan clan be lowered in	12.56.26	Skeena Queen RIB on scene	Skeena crew on scene	away from persons in the water	charge was not apparent
12.56.56   Terminal Work boat transfer   Attendant transfers to QCUM RIB to assist crew in water   Tends to painter and releases it   member he when work     12.56.30   Terminal Work boat transfer   QCUM RIB to assist crew in water   Tends to painter and releases it   Incident C     12.56.30   South Coast on scene   On phone, giving direction, ensuring   Suggested observations in contact   No clear In     12.56.30   South Coast on scene   PPE is worn   Egood change of plan as removal   Incident C     12.55.30   South Coast on scene   PPE is worn   Kith OSC / EOC   Scene Con     12.55.17   Terminal Manager and Regional   Terminal Manager (RTM) Southern   Incident Co   Scene Con     12.57.17   Terminal Manager and Regional   Canbe of plan for removal from   Info   Inst type     12.57.17   Terminal Manager and Regional   Crew on QCUM walk to dock 4 pontoon to ramp dock 5   can be lowered into the water   In place at     12.57.17   Crew on QCUM walk to dock 4   Crew from QcUM go to help   n/a   Present place at     12.57.17   Terminal Manager Southern   Terminal Manager Southern   Doc discussion as berth 5 ramp   Present place at					Transfer is good. Terminal staff
12.56.56   Terminal Work boat transfer   Terminal Attendant transfers to QCUM RIB to assist crew in water   Tends to painter and releases it   when work (Catering)     12.56.30   Terminal Work boat transfer   QCUM RIB to assist crew in water   Tends to painter and releases it   Incident C     12.56.30   South Coast on scene   On phone, giving direction, ensuring suggested observations in contact   System no system no system no with OSC / EOC   System no system no system no system no with OSC / EOC     12.55.31   South Coast on scene   PPE is worm   Good change of plan as removal from the pontoon would be from the pontoon to ramp dock 5   And     12.57.17   Crew on QCUM walk to dock 4   Dock 4 pontoon to ramp dock 5   And   And   And     12.57.17   Crew on QCUM walk to dock 4   Crew from QCUM go to help   n/a   Na   And   And   And     12.57.17   Terminal Manager Southern   Crew from QCUM go to help   n/a   And   And   And					member has taken part in drills
12.56.56   Terminal Work boat transfer   Terminal Attendant transfers to QCUM RIB to assist crew in water   Tends to painter and releases it   (Catering)     12.56.30   Terminal Work boat transfer   QCUM RIB to assist crew in water   Tends to painter and releases it   the rescue system no     12.56.30   South Coast on scene   On phone, giving direction, ensuring   Suggested observations in contact   No clear Ir     12.55.30   South Coast on scene   PPE is worn   Mith OSC / EOC   Scene Con     12.55.17   Terminal Manager and Regional   Change of plan as removal   This type     12.57.17   Islands   Can be lowered by ladders. Dock 5 apron   hoc. Farmi     12.57.17   Islands   Can be lowered into the water   In place at     12.57.17   Islands   Can be lowered into the water   In place at     12.57.17   Terminal Manager and Regional   The from the pontoon would be   Phoce at     12.57.17   Islands   Crew from QCUM go to help   n/a   Act of the water   In place at     12.57.17   Terminal Manager and Regional   Terminal Manager and Regional   This type   In place at   In place at     12.57.17   Terminal Manager Southern					when working on the ships
12.56.56   Terminal Work boat transfer   QCUM RIB to assist crew in water   Tends to painter and releases it   the rescue     12.56.30   Regional Terminal Superintendent,   On phone, giving direction, ensuring   Suggested observations in contact   No clear Ir     12.56.30   South Coast on scene   PPE is worn   Mith OSC / EOC   Scene Con     12.56.31   Ferminal Manager and Regional   Change of plan as removal   From the pontoon would be   No clear Ir     12.55.31   Terminal Manager and Regional   Change of plan for removal from   Mith OSC / EOC   Scene Con     12.55.17   Islands   Crew on QCUM walk to dock 4 pontoon to ramp dock 5   n/a   In/a   No. Terminal Manager and Regional     12.57.17   Islands   Crew on QCUM walk to dock 4   Dontoon to ramp dock 5   n/a   In/a   In/a     12.57.17   Terminal Manager Southern   Acted from to clear Ir   n/a   In/a   In/a   In/a     12.57.17   Terminal Manager Southern   Acted Terminal Manager Southern   Acted Terminal Manager Southern   In/a   In/a   In/a     12.57.17   Terminal Manager Southern   Acted Com QCUM go to help   In/a   In/a   In/a			Terminal Attendant transfers to		(Catering) and has knowledge of
12.56.30   South Coast on scene   Incident C     12.56.30   South Coast on scene   On phone, giving direction, ensuring suggested observations in contact No clear Ir Terminal Manager and Regional Terminal Manager (RTM) Southern Change of plan for removal from the pontoon would be throw would be throw alk to dock 4 pontoon to ramp dock 5   Good change of plan as removal from the pontoon would be throw alk to dock 4 pontoon to ramp dock 5   This type throw how alk to dock 5     12.57.17   Crew on QCUM walk to dock 4   Crew from QCUM go to help   n/a   n/a     12.57.17   Terminal Manager Southern   Crew from QCUM go to help   n/a   n/a   n/a     12.57.17   Terminal Manager Southern   Crew from QCUM go to help   n/a   n/a   n/a     12.57.17   Terminal Manager Southern   Discuss of change of plan for the water for for the water for the water for the water fo	12.56.56	Terminal Work boat transfer	QCUM RIB to assist crew in water	Tends to painter and releases it	the rescue boat
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Regional Terminal Superintendent, On phone, giving direction, ensuring Suggested observations in contact   No clear Ir     12.56.30   South Coast on scene   PPE is worn   with OSC / EOC   Scene Con     12.56.31   South Coast on scene   PPE is worn   with OSC / EOC   Scene Con     12.57.17   Terminal Manager (RTM) Southern   Change of plan as removal from the pontoon would be from the pontoon would be hampered by ladders. Dock 5 apron hoc. Terminal Manager (RTM) Southern   Hondoon to ramp dock 5   n/a     12.57.17   Islands   Crew on QCUM walk to dock 4 pontoon to ramp dock 5   n/a   n/a   n/a     12.57.17   Terminal Manager Southern   Crew from QCUM go to help   n/a   n/a   Present pla     12.57.17   Terminal Manager Southern   Discuss of an and change of plan for the water   n/a   n/a     12.57.17   Iterminal Manager Southern   Discuss of an an be lowered into the water   n/a   p/a     12.57.17   Terminal Manager Southern   Discuss of an and change to dock 5   n/a   p/a   p/a     12.57.17   Terminal Manager Southern   Discuss of an an change to dock 5   n/a   p/a   p/a					system not formally implemented.
12.56.30 South Coast on scene PPE is worn with OSC / EOC Scene Con   12.56.30 South Coast on scene PPE is worn dood change of plan as removal Scene Con   Terminal Manager and Regional Terminal Manager (RTM) Southern Change of plan for removal from the pontoon would be This type   12.57.17 Islands Crew on QCUM walk to dock 4 Crew from QCUM go to help n/a n/a   12.57.17 Terminal Manager and Regional This type from the pontoon would be n/a   12.57.17 Islands Crew on QCUM walk to dock 4 Crew from QCUM go to help n/a n/a   12.57.17 Terminal Manager and Regional Terminal Manager Southern Discuss of a be lowered into the water n/a   12.57.17 Terminal Manager Southern Discuss of a be lowered into the water n/a		Regional Terminal Superintendent,	On phone, giving direction, ensuring	Suggested observations in contact	No clear Incident Command/On
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Terminal Manager and Regional   This type     Terminal Manager (RTM) Southern   Change of plan for removal from   hampered by ladders. Dock 5 apron   hoc. Terminal     12.57.17   Islands   dock 4 pontoon to ramp dock 5   can be lowered into the water   n/a     12.57.17   Crew on QCUM walk to dock 4   Crew from QCUM go to help   n/a   n/a     12.57.17   Terminal Manager and Regional   Erew from QCUM go to help   n/a   present plance are to help   present plance are to help     12.57.17   Terminal Manager and Regional   Erew from QCUM go to help   n/a   present plance are to help				sood change of plan as removal	
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12.57.17 Crew on QCUM walk to dock 4 Crew from QCUM go to help n/a   Terminal Manager and Regional Present pla   Terminal Manager Southern 6000 discussion as berth 5 ramp   12.57.44 relands	12.57.17	Islands	dock 4 pontoon to ramp dock 5	can be lowered into the water	in place and drill to it. (2)
Terminal Manager and Regional Present place   Terminal Manager Southern Good discussion as berth 5 ramp   12 57 44 Telands	12.57.17	Crew on QCUM walk to dock 4	Crew from QCUM go to help	a/r	n/a
Terminal Manager Southern     Good discussion as berth 5 ramp     through dc       12 57 44     Telande     Discusse plan and channe to dock 5     can be lowered to the water     as too may		Terminal Manager and Regional			Present plan of bringing MOB out
		Terminal Manager Southern		Good discussion as berth 5 ramp	through dock 4 pontoon changed
	12.57.44	Islands	Discuss plan and change to dock 5 (	can be lowered to the water	as too many hazards with ladders

i				
Time	Event	Comments	Learning Event	Risk
		Did unit 7 receive direction for this?	Was the ambulance on route or	Unit 7 was loading and trying to
12.59.34	Unit 7 opens section of Main gates	Was it loading at the time?	communicated out on radio?	help
				Terminal Work boat not equipped
		T/A was not trained in MOB		with MOB recovery net. Seems
	Terminal Attendant in QCUM	recovery net but deploys the unit	MOB recovery net simple to operate	MOB or recovery of persons from
	rescue boat deploys MOB recovery	to assist getting crew member out	but should be trained and practiced	water not drilled or trained for this
12.59.25	net	of water	with	event.
			n	
12.99.52	kamp is lowered into the water	Kamp is set for recovery of persons	was ramp rully lowered?	what is the SWL for the apron?
		One MOB crew in QCUM rescue		
		boat, crew member self rescued		MOB net proved very useful as
	One crew member is out of the	with help using the recovery net as	Time in water was 9 minutes 13	ladder and worked well with an
13.00.13	water	a ladder to gain access to the RIB	seconds	injured person with assistance
				Gates opened, security should be
				formed at this point, if ICS had
		T/A opens gates barriers still in		been set up this would now be a
13.00.18	T/A opens gates	place	Gates open	key control point
			If T/M had been the on site	
			incident commander then was	
			appropriate, however interviews	Under ICS, on site commander
			confirmed that no formal I/C was on	should remain away from the scene
13.00.30	T/M	T/M at top of ramp	scene (just ad hoc)	to direct events
				T/A training should have caution
				on using pike poles for holding onto
			Things to note: Pike pole has a	persons in the water - very sharp
13.00.38	Barriers raise on dock 5	T/A takes pike pole to waters edge	very sharp point	points on the end
				SKED training only talks very
				shortly on removing someone from
				the water using the SKED. It is a
				complicated operation and only
			SKED was bought but not equipped	really trained for in the Northern
		Note C/E and Engineer has	for water extraction. Note that	routes for rescue boat transfer and
13.00.38	C/E attends dock 5 with engineer	stretcher (SKED)	SKED can be used in the water.	not recovery from the water
				It should be noted that all the
				small boat operations were done
				well as there were numerous
	QCUM RIB being assisted to the	Terminal work boat pushing QCUM	Good job by Terminal work boat	hazards in the water plus the two
13.01.04	ramp by Terminal work boat	RIB towards dock 5 ramp	crew	crew members

Time	Event	Comments	Learning Event	Risk
13.01.18	Terminal Supervisor on scene	QCUM RIB now powers its way to dock 5 ramp, reason for the delay is that the MOB net rope is in prop but boat is propelled to the dock ok	Noted that T/A is in control of the RIB. T/S has Floatation device on.	Good boat handling skills here by terminal staff member
13.01.31	QCUM OFA on scene	QCUM OFA on scene from video - we are assuming that the Terminal OFA is also on his way	T/A OFA has blue jump bag and both are wearing Floatation device	Good PPE control at this point for those on the ramp
13.01.24	One ambulance and BC Ambulance Supervisor van at ticket booth	Ticket booth CCTV timestamps	Vehicles give direction as to where to go	Terminal has good practice in this as this is common place for terminals to receive emergency vehicles
13.01.51	SKEN RIB towing crew member	SKEN RIB had problems with their recovery net as they could not move it from one side of the boat to the other	Skeena crew did try to change sides for their MOB recovery nets but could not attach it to the side they needed. Crew decided (with direction from crewmember in water) to tow the crew member to dock 5 ramp	SKEN RIB towed in a safe and controlled (slow) manner. One crew member holding on to the man in the water while in direct contact with the RIB operator. This appeared to work well.
13.02.52	Ambulance Number 1 arrives	Ambulance backs up and attendants proceed to scene	PPE was worn by attending crew	It did not seem like there was someone to report to or give a situation report , Scene requires On scene command
13.02.27	Ambulance Number 2 arrives	T/M talks to ambulance attendant	Situation report	Good
13.02.52	Foot passenger walkway opened	Walk way opened up	It is assumed this was opened up for ambulance stretcher due to the wheels	No security / passenger control at this point as now all gates are open
13.02.56	SKEN RIB leaves MOB at apron	SKEN RIB delivers MOB at ramp fingers	Recovery has no plan	Terminals should have a plan and drill for this type of operation
13.03.03	A lot of people on the ramp	There were a lot of people on the ramp. Security duty is not assigned for the ramp or foot passenger walk way.	A lot of people on the ramp and apron.	Securing the scene is a big part of managing a situation and ensuring everyone's safety. Due to the amount of people attending, this adds complication and it is un clear who is in charge or what the plan is (was). (3)
	Crew member in the water	Last crew member is removed from	C/E is held from falling in water by another person - has hold of his belt, it was reported that the C/E had problems removing crew	Removing someone from the water should be planned for. Specific training and drills should be considered. The anti exposure
13.03.51	SKEN RIB returns	ure water by ure c/E SKEN RIB returns to vessel	Left site and returned to vessel	suits were noted as very neavy. observation only

Strends scene with extends scene with evaluation report evaluation reportShould be noted that all persons attending should be controlled for their own safety of MOB personnel and safety of MOB personnelera time taken at ticket no commentbeservation onlybestration reportobservation onlycara time taken at ticket no commentbeservation onlybestration reportbeservation onlycara time taken at ticket no commentbeservation onlybestration reportbeservation onlycara time taken at ticketbeservation onlycara time taken at ticketbeservation onlycara time taken at ticketbeservation onlyfine department membersbeservation onlyfine department membersbeservationfine department membersbeservationfine department membersbeservation onlyfine department membersbeservationfine department membersbeservationfine department membersbesenger walk way - allows forber loaded on tobesenger walk wayber in ambulance andclose of video observationsclose of video observations	Event		Comments	-earning Event	Risk
era time taken at ticketno commentobservation onlyno commentobserved that the main part of the ramp surface is not good for whee stretchers. Walk way is used.stretchers are bought to function well on the ramp.observed that the main part of the ramp surface is not good for whee stretchers. Walk way is used.era time taken at ticketbeservation onlyfinc department membersobservation onlyfire department memberspre worn by personsfire department membersprefed?fire department membersprefed?fire department membersprefed?fire department membersprestionfire department memberspresticed before?fire departmentpre	QCUM S/Master and crew member Senior r attends	Senior r another	naster attends scene with crew member	f ICS was followed I/C in charge vould aive situation report	Should be noted that all persons attending should be controlled for their own safety and consideration and safety of MOB personnel
e stretchers are bought to fine taken at ticketObserved that the main part of th ramp surface is not good for whee stretchers. Walk way is used.era time taken at ticketEunction well on the ramp.observation only stretchers. Walk way is used.fine department membersPPE worn by personsObservation only observation onlyfire department membersEood planning would have briefed?Opservation only opserationscenePPE worn by personsCood planning would have briefed?aised with multiple personsHas this been accounted for / per actionOpservationber on stretcherStretcher is used on the foot passenger walk waySurface is different on foot passenger walk way - allows for the wheels to functionber loaded on toAmbulance bought onto ramp close of video observationsControl at the scene required for this operationber in ambulance andCose of video observationsControl at the scene required for	Fire department at ticket booth booth	CCTV ca booth	amera time taken at ticket	io comment	observation only
era time taken at ticket   deservation only     fire department members   beservation only     fire department members   PPE worn by persons     present   Cood planning would have     aised with multiple persons   Has this been accounted for /     practiced before?   Cood planning would have     practiced before?   Deferation     ber on stretcher   Stretcher is used on the foot     ber loaded on to   Dessenger walk way     ber in ambulance and   Control at the scene required for     ber in ambulance and   close of video observations	Stretchers are bought down to Ambulan the scene	Ambulan the scer	ice stretchers are bought to the	Wheels on the stretchers did not unction well on the ramp.	Observed that the main part of the ramp surface is not good for wheel stretchers. Walk way is used.
fire department membersAppear to have not been met or briefed?t scenePPE worn by personsbriefed?is scenecood planning would have confirmed this was a safe operationaised with multiple personsHas this been accounted for / perationGood planning would have confirmed this was a safe operationaised with multiple personsEacticed before?Coof planning would have confirmed this was a safe operationber on stretcherStretcher is used on the foot passenger walk waySurface is different on foot passenger walk way - allows for the wheels to functionber loaded on toAmbulance bought onto ramp close of video observationsControl at the scene required for this operation	Ambulance and RCMP at Ticket CCTV car booth booth	CCTV car booth	mera time taken at ticket		observation only
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ber on stretcher   Surface is different on foot     ber on stretcher   Stretcher is used on the foot     ber loaded on to   passenger walk way     ber loaded on to   Ambulance bought onto ramp     ber in ambulance and   close of video observations	Apron is raised on apron	Apron is ra on apron	ised with multiple persons	4as this been accounted for / practiced before?	Good planning would have confirmed this was a safe operation
ber loaded on to Control at the scene required for Ambulance bought onto ramp this operation ber in ambulance and close of video observations	Crew member on stretcher Crew men	Crew men	ther on stretcher	stretcher is used on the foot aassenger walk way	Surface is different on foot passenger walk way - allows for the wheels to function
ber in ambulance and close of video observations	Crew mer Ambulance on ramp ambulanc	Crew mer ambulanc	mber loaded on to	Ambulance bought onto ramp	Control at the scene required for this operation
	Ambulance leaves ramp leaves	Crew me leaves	mber in ambulance and	close of video observations	

See recommendation summary next page.

Queen of	Cumberland (QCUM) Recovery Actions (Timeline from SWB CC	rv, QCUM logbook and interviews)
-		
Legend:	ALAKP	
	Caution	
	Awareness required	
	Action required	
Summary		
RISK	What happened	<b>Recommendation Summary</b> (formal recommendations found in main body of DI report)
1 (specific)	Terminal Work boat taking directions from crew member in the water. Terminal work boat crew (if trained for recovery of persons in the water) would have had the knowledge and tools to recover the crew members with out prompt.	Terminal work boat operations should be reviewed. Person in the water recovery procedure for training and drills. Terminal should also review the level of boat training for terminal staff along with scheduling drills to maintain the skill sets required.
2 (specific)	This type of plan should not be ad hoc. Terminals should have a plan in place and drill to it.	TSM's should be reviewed for response plans for persons in the water and how to recover them , this should include use of tools , locations and equipment required to safely remove someone from the water. The main review should consider how to tow/or get someone to an extraction point and what extraction points are suitable
3 (specific)	The scene would greatly benefit from an on scene commander as there was no on scene command	Terminal to review emergency scene management. The ICS system is in place for terminals however a review for management levels is recommended. (Supervisors, Managers, Superintendents). On scene command is very important for emergency management and should not only be trained for but practiced. A good example for this system is the one used by the vessels for fire management as it includes very clear direction as to how the scene should be managed.
RISK	What happened	Recommendations
4 (all)	Awareness would be raised if above recommendations are realized.	Training material for entering a rescue boat should be reviewed: for example how best to enter the rescue boat if you are in the water and what are your options? Should also include the removal or loosening of PPE.
5 (all)	Cautionary notes should be reviewed along with the recommendations.	Should be reviewed along with the recommendations. There may already be safe working practices in place that can assist in planning for events.
6 (all)	General observations from the incident.	Learning events either good or bad that are worth noting

# Appendix D – Environmental and Tide Data<sup>92</sup>

# Sidney (#7260)

## Predicted Hourly Heights (m)

Date												Но	ur											
PDT	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2018/04/18	2.1	2.1	2.2	2.4	2.6	2.8	2.9	2.8	2.6	2.1	1.5	1.0	0.6	0.5	0.6	0.9	1.3	1.8	2.2	2.6	2.8	2.9	2.8	2.6

20 (M	018-04-18 /ednesday)						
Time	Hei	ght					
PDT	(m)	(ft)					
00:32	2.1	6.9					
06:05	2.9	9.5					
12:56	0.5	1.6					
21:02	2.9	9.5					

<sup>&</sup>lt;sup>92</sup> Environment Canada

## **Appendix E - Maintenance Work Instructions and Schedules**

The QCUM has the following preventative maintenance/job plans for the 9240 (location) Rescue Boat Station:

**QCUM-9240-PM-1** Rescue Boat Station Equipment, Test and Examine, Monthly 9240-BCF-SJ-10 Monthly Rescue Boat Station Equipment, Test and Examine Task 10 Confirm the deck department equipment checks have been completed. Task 20 Inspect the davit reference the Rescue Boat/Davit Maintenance Schedule. Task 40 Inspect the boat hull for damage.

Task 50 Inspect the rescue boat pontoons for adequate air pressure.

Perform a performance test on the davit hook stop limit switch.

Test by manually engaging the switch trip with a pike pole prior to raising the hook under power.

Hook should be disconnected from the boat for the test or the boat released from the cradle.

**QCUM-9240-00-PM-10** Rescue Boat and Release Hook Annual .Service 9240-BCFC-A-1 Rescue Boat Annual Service

Task 10 Rescue boat, remove, install loaner rescue boat.

Remove ship's rescue boat and replace with loaner boat.

Fill out the BCFS notice of change to lifesaving appliance and fire fighting/ safety equipment form.

Phone ship's Senior Chief Engineer to make arrangements for exchange.

2 LSA personnel to truck and trailer loaner boat to arranged location. Exchange boats.

Drop off ship's rescue boat at garage.

Task 20 Outboard engine, service.

Replace spark plugs, replace fuel filter, service fuel tank and system where applicable and change leg oil.

Remove leg and inspect/ replace shifter pins, replace water pump, change zincs, drain the carburetor.

Check battery specific gravity, top up with mineral free water, load test the batteries, barrel test engine with special propeller.

Corrosion inhibit engine, check boat electrical and lights, and test boat/motor in the river.

Task 30 Rescue boat, service.

Test tubes, test inflation and pressure relief valves. Check hull for damage, cracks and water ingress. Check attachments - tubes to hull etc. Check electrical.

Check off rescue boat check list - Transport Canada form. Check lifting gear bridle, check test certificate for date.

Wash boat, apply boat dressing and test run.

Task 40 Rescue boat, regulatory survey.

Arrange for regulatory survey of boat.

Sign off BCFC rescue boat equipment check off list. Sign off BCFC inflatable boats service report.

Complete annual test of rescue boat davit limit switches and document. Service reports and certificates to be sent to Senior Chief Engineer.

**9210**<sup>93</sup>-**QCUM-M-8** Davit, Man Overboard, Annual (last modified 20 October 2016 10:56 PM) Task 10 RIG.

Check condition of wires for damage. Replace as required, 90 feet.

Wire gets replaced every 2 years, check when last changed.

Check gripe lines for slackness and tighten as necessary. Check rotation of sheave in lower block.

Grease all lubrication points.

Damaged grease nipples should be replaced immediately. There should be no paint on the nipples.

A red circle should be painted around the nipple to facilitate location during maintenance.

Do not over-lubricate the nipple on the brake mechanism! There is a possibility of contaminating the brake linings.

Grease Nipple Locations:

- 4 on the circumference at the base.
- 2 on the slewing gear.
- 1 on the winch.

Task 100 SERX.

Check electrical fittings for corrosion and water tightness.

Check for corrosion and damage on the winch gear train and bearings. Inspect brake linings for wear.

Winch manual brakes function tested, direct and remote control. Complete function test of the davit, with special attention to limit switches and safety devices.

Bill of Materials in Job Plan:

Item 025574 : ROPE, WIRE, ROTATION RESISTANT, GALVANIZED, 10MM DIA. RHOL 1960N/MM2, MBL 62.7KG, SWL 1 TONNE, FOS 6:1, 19X7X1RWC, 1000FT REEL, NEEDS TO BE STORED INDOORS

Item 022175 : OIL, MEROPA 150, CHEVRON 277210-783, 15.9 KG PAIL Item 041826 : GREASE, DELO EP 2, CHEVRON 235208-642, 397 GR CARTRIDGE

## 9210-QCUM-M2-8 Davit, Man Overboard, Annual.

Task 100 SERX.

NOTE: check with bridge; only proceed with this work order when you're at 24 launches. Will need to make a purchase requisition for this service, using the work order number as reference. We will receive certification, which is then stored in the certificates binder.

- Arrange for service to the ship to perform the following activities for the 25 Launch inspection.
- Check electrical fittings for corrosion and water tightness.
- Check for corrosion and damage on the winch gear train and bearings.
- Inspect brake linings for wear. Refer to manual #41 for procedure.
- Winch manual brakes function tested, direct and remote control.
- Complete function test of the davit, with special attention to limit switches and safety devices.
- Check condition of wires for damage.
- Replace as required, 90 feet.
- Check gripe lines for slackness and tighten as necessary.
- Check rotation of sheave in lower block.

<sup>&</sup>lt;sup>93</sup> The 9210 coding for this Job Plan is incorrect. It should be 9240.

- Grease all lubrication points.
  - Do not over-lubricate the nipple on the brake mechanism. There is a possibility of contaminating the brake linings.
  - Grease Nipple Locations:
    - 4 on the circumference at the base.
    - 2 on the slewing gear.
    - 1 on the winch.

### Maximo Work Order Records

Work orders issued against the rescue boat davit system since the new davit system was installed in 2016:

Date Created	<u>WO Number</u>	<u>Type</u>	<u>Job Plan</u>
2016-MAY-21	QCUM.49677	PM/INSP	9240-BCFC-A-1
2016-AUG-16	QCUM.50043	REPAIR	New painter Line
2016-OCT-29	QCUM.50396	PM/INSP	9210-QCUM-M2-8
2016-NOV-04	QCUM.50420	PM/INSP	[see notes below]
2017-APR-05	QCUM.51477	PM/INSP	[see notes below]
2017-MAY-21	QCUM.51915	PM/INSP	9240-BCFC-A-1
2017-JUN-28	QCUM.52274	PM/INSP	9210-QCUM-M2-8
2017-DEC-13	QCUM.53648	PM/INSP	9240-BCFC-A-1
2018-FEB-26	QCUM.54061	PM/INSP	9210-QCUM-M2-8

Notes:

QCUM.50420 is a manually generated work order with a user selected "Preventative Maintenance/Inspection" work type and shows completed 5 February 2017 but was created 4 November 2016. It has the same description as QCUM.51477 "Davit, Rescue Boat, Service; Hook, Winch/Hydraulics." QCUM.50420 also has an "originating work order/service request" which is QCUM.50396. There is no Job Plan for this work order.

QCUM.51477 "Davit, Rescue Boat, Service; Hook, Winch/Hydraulics" is the entire extent of the information on this work order. This is a manually created work order. There is no Job Plan. An "originating work order/service request" is identified as QCUM.50420.

Job Plan 9210-QCUM-M2-8 is for the old davit. This was acknowledged 4 November 2016. The work orders that have been generated by QCUM-9240-00-PM-20 (QCUM.52274 and QCUM.54061) have been set to complete. Work order QCUM.52274 generated after QCUM.51477 was used for the April 2017 davit service. QCUM.52274 was completed with no action taken and referred back to the April work. QCUM.54061 generated 26 February 2018 and was the work order used to do the wire rope change out.

## Appendix F - Glossary

Term	Acronym
All Learning Events Reported Today	ALERT
British Columbia Ferry & Marine Workers' Union	BCFMWU
British Columbia Ferry Services Inc.	BCFS
Computerized Maintenance Management System	CMMS
Engine Room Assistant	ERA
Emergency Duty Number	EDN
Fleet Maintenance Unit	FMU
International Maritime Organization	IMO
Kilogram	kg
Knot	kN
Life Saving Appliance	LSA
Metre	m
Northern Adventure	NADV
Original Equipment Manufacturer	OEM
Operations & Security Centre	OSC
Queen of Capilano	QCAP
Queen of Cumberland	QCUM
Restricted Proficiency in Survival Craft	RPSC
Safety of Life at Sea	SOLAS
Salish Eagle	EAG
Salish Orca	ORC
Salish Raven	RAV
Skeena Queen	SKEN
Spirit of British Columbia	SOBC
Spirit of Vancouver Island	SOVI
Standardized Education and Assessment	SEA
Vessel Specific Manual	VSM