OCS Report
BSEE 2013-01

Boom Hoist Wire Rope Line Failure Results in Fatality
High Island Area Block A557, Platform "A"
OCS-G 03484
16 August 2011

Gulf of Mexico OCS Region

U.S. Department of the Interior
Bureau of Safety and Environmental Enforcement
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New Orleans
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Gulf of Mexico
Off the Texas Coast

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Abbreviations and Acronyms

AEO	Acid Equipment Operator
API SPEC 2C	American Petroleum Institute Specification 2C
API RP 2D	American Petroleum Institute Recommended Practice 2D
BII	Branham Industries Inc.
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BSEE	Bureau of Safety and Environmental Enforcement
Cargotec	Cargotec USA, Inc.
CFR	Code of Federal Regulations
DBL	Design Breaking Load
DOI	Department of the Interior
EIPS	Extra Improved Plow Steel
EP	Extreme Pressure
ERT	Energy Resource Technology GOM, Inc.
GOM	Gulf of Mexico
HI	High Island (Leased Block)
IWRC	Internal Wire Rope Core
JSA	Job Safety Analysis
MMS	Minerals Management Service
MPG	Multi-Purpose Grease
M/V	Motor Vessel
OCS	Outer Continental Shelf
OEM	Original Equipment Manufacturer
OSM	Office of Safety Management
PCS	Platform Crane Services
RHRL	Right Hand Regular Lay
Seatrax	Seatrax, Inc.
SOP	Standard Operating Practice
WS	Working Strand

Executive Summary

Figure 1 (below) visually summarizes the overview and geography of the accident.

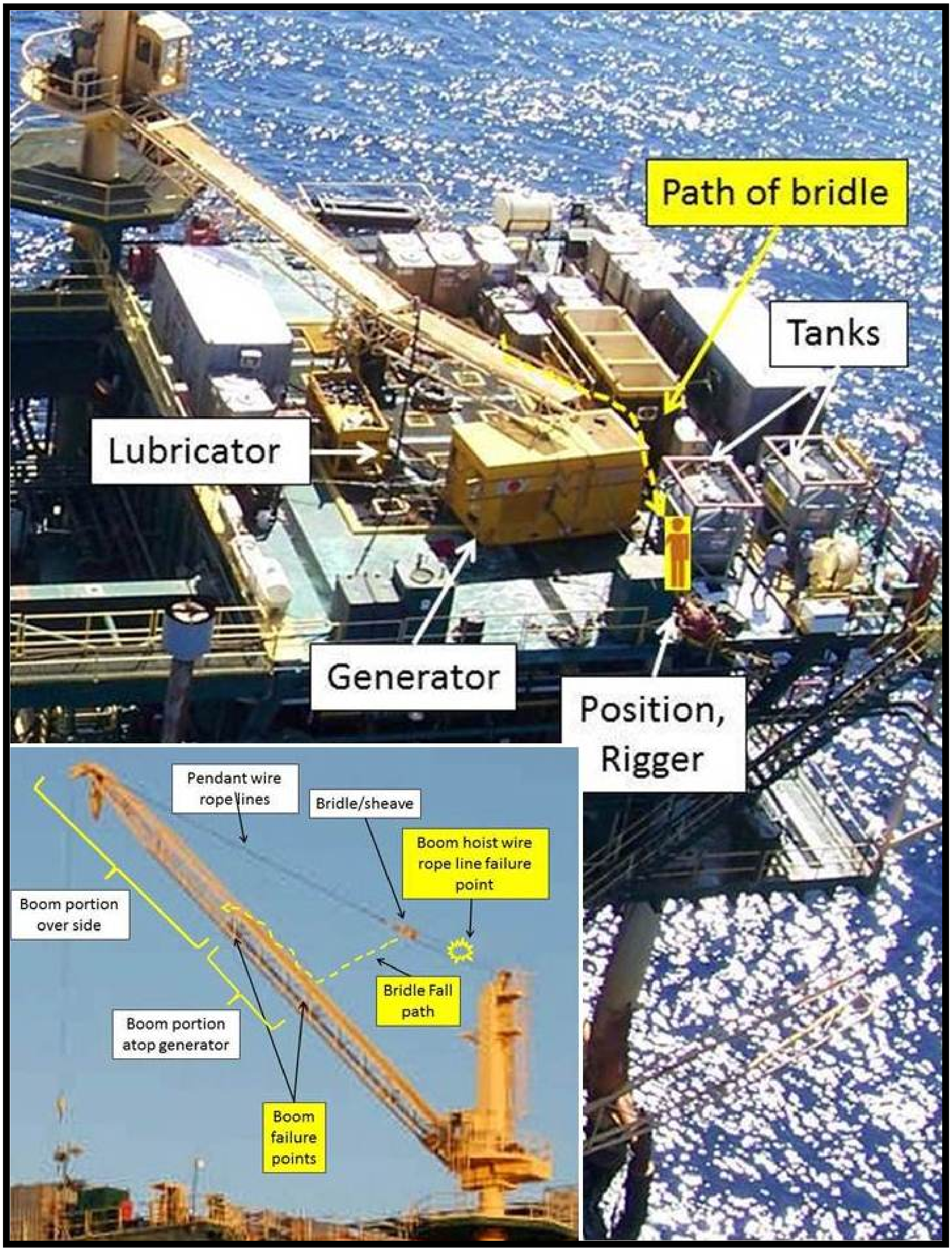

Figure 1 – Overview of accident

On 16 August 2011 at *approximately 0815 hours,* a fatal accident occurred on the offshore production platform, High Island A557 “A”, operated by Energy Resource Technology GOM, Inc. (ERT). Platform personnel were using the platform crane to move a rental generator from the platform onto a motor vessel. Two riggers were on deck close to the load, using tag lines to stabilize the lift. On the Platform deck in proximity to the generator were three tanks on the left side, and a barricaded lubricator attached to a wellhead, extending 14-ft above the deck, on the right side of the lift.

When the load was lifted, the crane’s boom hoist wire rope failed, the generator dropped to the deck, and the boom fell striking the generator. The boom subsequently broke into three sections; one section attached to the crane, the middle section resting on top of the dropped generator, while the nose section continued overboard. The crane’s main block hook subsequently disengaged releasing the connection between generator and boom nose.

The falling boom nose dragged the attached bridle/sheaves behind it as it fell overboard until its fall was arrested by the main load line and bridle pendant wire ropes. The 850-lb bridle/sheaves struck the fallen boom and pulled by the nose, ricocheted off of the end of the middle section, finally coming to rest against the platform toe-board. The rigger handling the left tag line was struck by the bridle and fatally injured.

A BSEE accident investigation Panel concluded that the **Causes** of the accident were as follows:

(1) The Crane’s boom hoist wire rope parted due to being weakened by internal and external corrosion, with loss of integrity, ductility and strength. The line was over four years old.

(2) The vicinity of the lift was constrained by other equipment which caused the rigger to be positioned in the path of the falling boom.

Probable Contributing Causes

(3) The crane’s corroded and damaged boom hoist wire rope was found to be systemically lacking internal lubrication; probably because of improper lubrication, application method, frequency, and an improper lubricant type.

(4) It is probable that the annual inspection of the crane conducted six months previous by a third party contractor did not include a comprehensive examination of the boom hoist wire rope.

(5) The positioning of other equipment in proximity to the lift, especially the 14-feet high (above the deck) lubricator, probably contributed to the decision to control the load with tag lines in the early stages of the lift.

(6) The positioning of tanks near the load probably caused the rigger stabilizing the load on the left side to be positioned in an unsafe location in the path of the falling boom.

(7) Moving the interfering equipment prior to the lift was probably not considered or discussed in the JSA, contributing to the improper positioning of the rigger.

Possible Contributing Causes

(8) The Operator had no company manual for crane operations. It is possible that an internal company policy for crane operations may have led to actions that could have prevented the incident.

(9) It is possible that the detachment of the main block hook from the load may have contributed by allowing the bridle to be pulled all the way to the railing, striking the rigger, rather than remaining atop the fallen boom.

(10) The crane's operator and those supervising the lift possibly did not give "special attention" to all of the crane's wire rope lines during the pre-use inspection as per the recommendations of API RP-2D.

Recommendation to BSEE

The Panel recommends BSEE consider issuing a Safety Alert describing the incident and recommending the operators take certain actions regarding lubrication and inspection of crane wire ropes, and positioning of equipment and riggers during lifts.

The Panel recommends BSEE consider initiating a study, coordinated with API, to see if wire rope lubrication data should be recorded in crane usage records.

Introduction

Authority

A fatal accident (the Accident) occurred on 16 August 2011 at approximately *0815 hours (hrs)* on Lease OCS-G 03484 (the Lease), High Island (HI) A557 Platform "A" (the Platform), operated by Energy Resource Technology GOM, Inc. (ERT or the Operator). The Accident occurred during crane operations to offload a rental generator from the Platform deck.

Pursuant to 43 U.S.C. 1348 (d), (1), and (2) and (f) [Outer Continental Shelf (OCS) Lands Act, as amended] and Department of the Interior (DOI) regulations 30 CFR 250, the Bureau of Safety and Environmental Enforcement (BSEE), formerly Bureau of Ocean Energy, Management, Regulation and Enforcement (BOEMRE), formerly the Minerals Management Service (MMS), is required to investigate and prepare a public report of this accident. By memorandum dated 22 August 2011 personnel were named to the investigative panel (the Panel), to include the following:

Glynn Breaux (Chair) – Chief, Office of Safety Management, Field Operations, GOM OCS Region
Jim Hail – Supervisory Inspector, Lake Jackson District, Field Operations, GOM OCS Region
Dr. Candi Hudson, PhD – Petroleum Engineer, Emerging Technologies Branch - BAST Section, BSEE, Herndon
Ross Laidig – Special Investigator, Investigations and Review Unit, BSEE
Craig Pohler – Field Engineer, Lake Jackson District, Field Operations, GOM OCS Region

Note: The Panel extends its appreciation to Jack Williams, Petroleum Engineer/Accident Investigator, Office of Safety Management, Field Operations, GOM OCS Region, for his technical editing of the Panel report and material contributions to the investigation, conclusions, and recommendations.

Background

The Lease covers approximately 5,760 acres and is located in HI Block A557, Gulf of Mexico, off the Texas coast (*see figure 2).* The Lease was purchased in Sale No. 47 on 23 June 1977, and issued to Amerada Hess Corporation and Marathon Oil Company with Amerada Hess Corporation becoming Lease owner and operator of record effective 1 January 1989. Amerada Hess Corporation assigned Energy Resource Technology, Inc. as Record Title Holder and Operator of Record on 1 April 2002. Energy Resource Technology, Inc. merged with Remington Oil and Gas Corporation effective 31 July 2006, with the corporation renamed Energy Resource Technology GOM, Inc. (ERT).

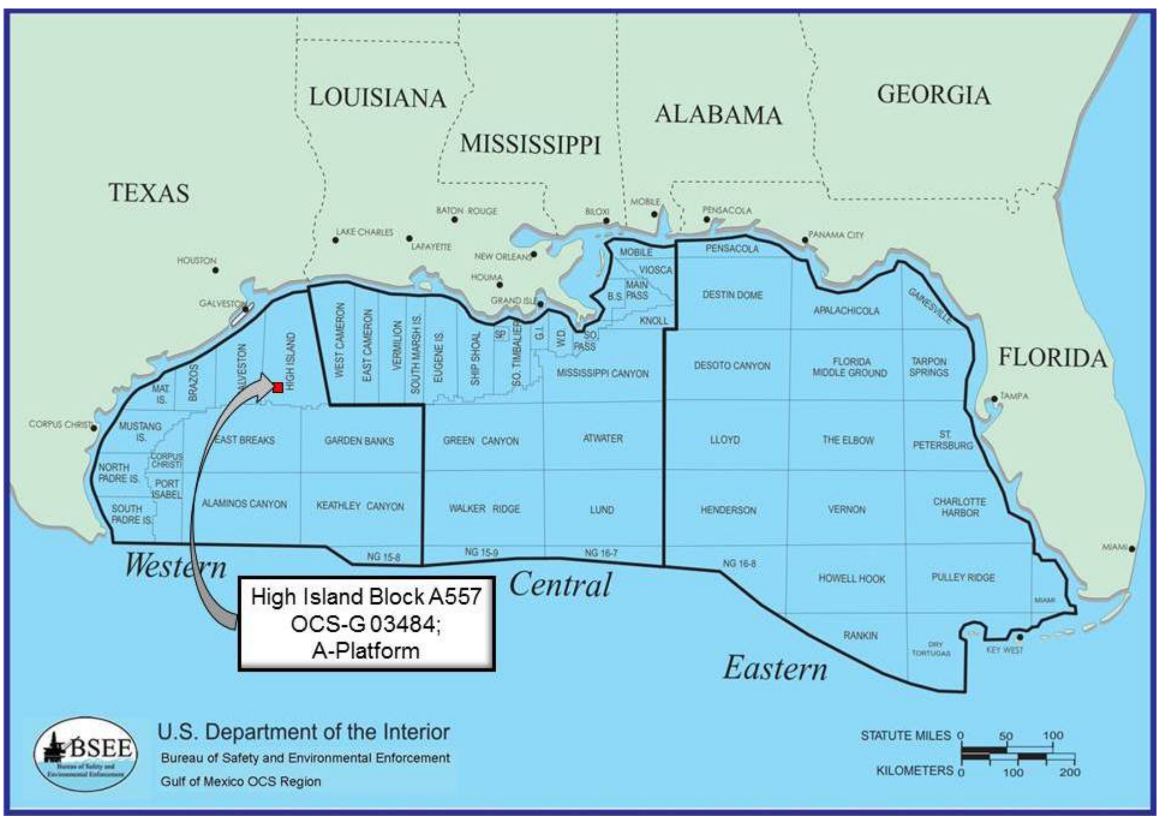

Figure 2 - Location of Lease OCS-G 03484, High Island Block A557 "A" Platform

The Platform, an 8-legged fixed structure, was installed on 1 January 1986 in approximately 235 feet (ft) of water, approximately 78 miles off the coast of Galveston, Texas. The Platform has two decks**,** with the main deck measuring approximately 75-ft x 160-ft. The main deck is split into three sections: living quarters, helideck and power generation section on the southern end, an open section for equipment storage in the center of the Platform, and the well bay area on the northern end of the Platform. A production process system is also located on the Platform (s*ee figure 3).*

Figure 3 - HI A557 "A" Platform

The platform was manned by personnel working either directly for ERT or under contract to them. Those employees located at the scene at the time of the Accident, included the crane operator who was a direct employee of ERT, and the "A" Operator and two riggers who were employees of Wood Group under contract to ERT. Also present was the acid equipment operator employed by Major Equipment and Remediation Services, Inc., contracted by ERT to perform well work on board the platform.

Findings

Relevant Platform Equipment

Equipment, Positioning

The key equipment positioned in the work area is shown in *figures 4 and 5*. The work deck space was occupied by the rental generator located immediately east of the well bay area. Two tanks (approximately 1,000 gallons each) were situated close to the generator, with these and other deck equipment limiting the work space on the north end of the Platform.

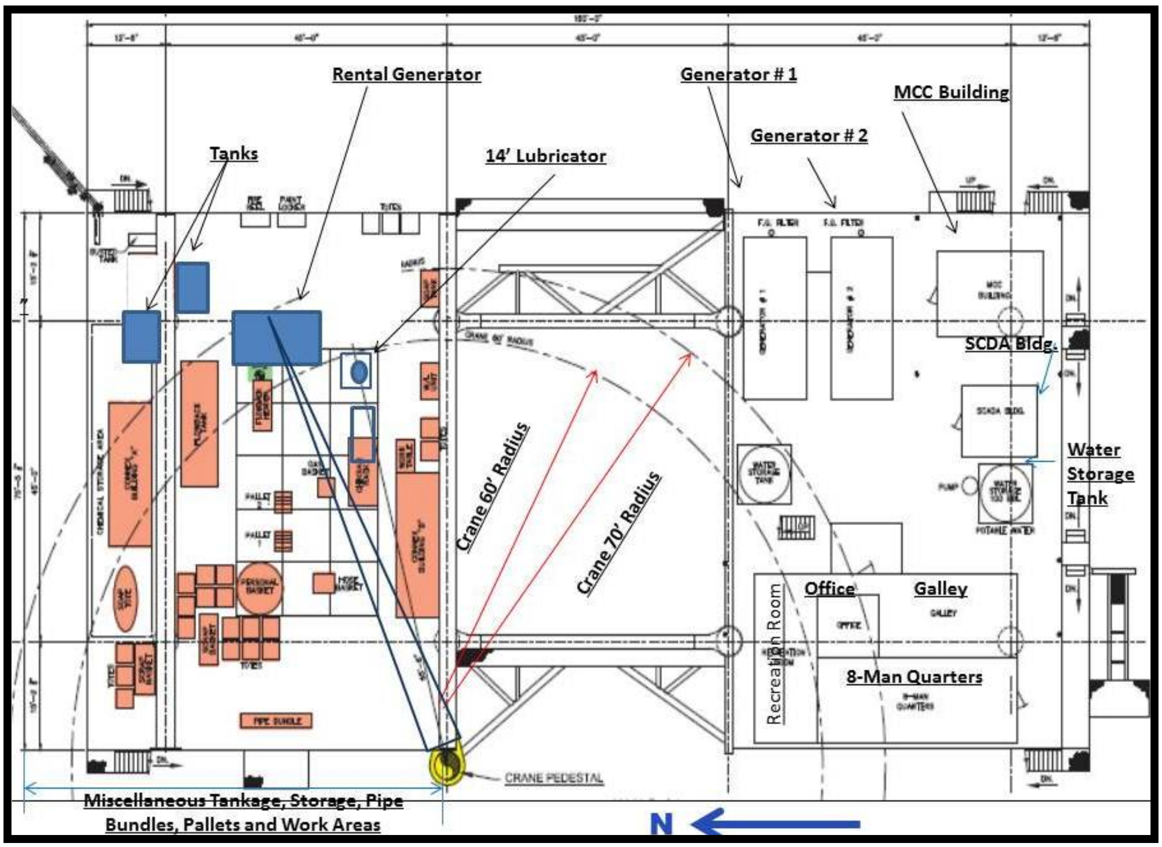

Figure 4 – Post accident schematic of the Platform's main deck *(after diagram, ERT)*

Also near the generator, a 30-ft long wireline lubricator was attached atop a well, extending approximately 14-ft above the deck. The lubricator was not guyed but was barricaded *(see figure 5*). The west side of the Platform's well bay area was almost wholly covered with material skids and other equipment.

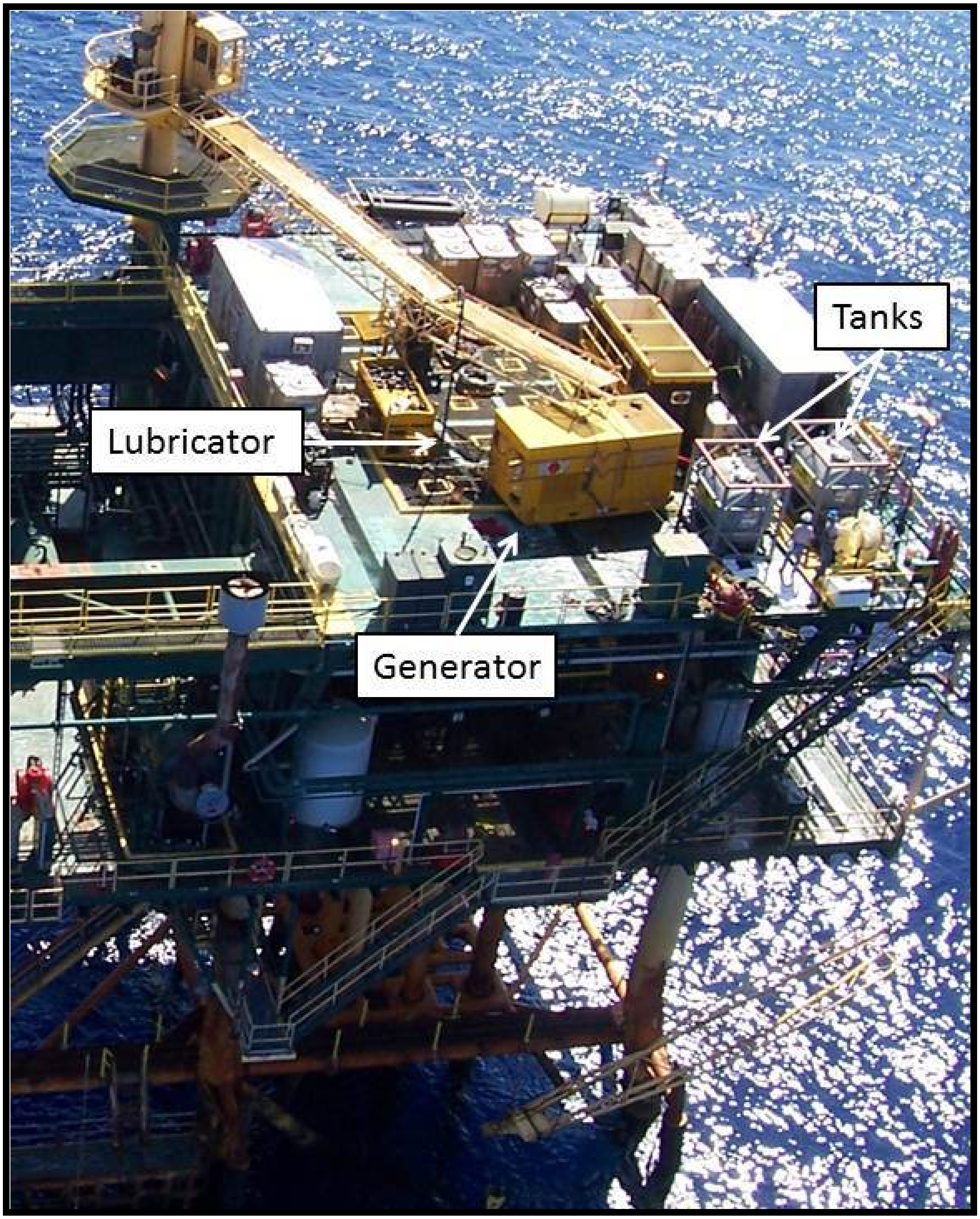

Figure 5 - Position of key lift and deck equipment elements, post-accident

The Crane

ERT became operator of the Platform on 1 April 2002, with the Platform's SeaKing Model 1400 crane (the Crane) already installed (*see figures 3, 6)*. According to Seatrax, Inc. (Seatrax) the Crane was manufactured in 1990 by Branham Industries, (BII), the licensee of SeaKing at that time. BII declared bankruptcy in 1992, and the SeaKing intellectual property rights were transferred from BII to Seatrax. Seatrax, however, stated that the Crane's manufacturing records were not transferred to Seatrax, or could no longer be found. The Crane was located on the west side of the well bay area, on top of the Platform leg which joins the well bay area and the open middle section.

Figure 6 – SeaKing Model 1400 Crane on Platform

The Crane consisted of a pedestal fitted with walkways and ladder access to the cab, and ladder access to the top of the pedestal. The Crane's cab, located to the left of the boom, was enclosed and fitted with controls and monitoring gauges to operate the engine and winch motors used to raise and lower the boom, main load and auxiliary load hoist systems. The cab was fitted with a load indicator, located at the feet of the Crane operator, and a boom radius indicator located just outside the cab on the operator's right side.

The Crane's boom was approximately 100-ft long and consisted of five sections of approximately 20-ft each. The boom was constructed of steel lattice work, bolted together by four bolts located at the corners of each section. The boom was connected to the Crane's gantry by the boom suspension system in a pendant and bridle configuration *(see figure 7).*

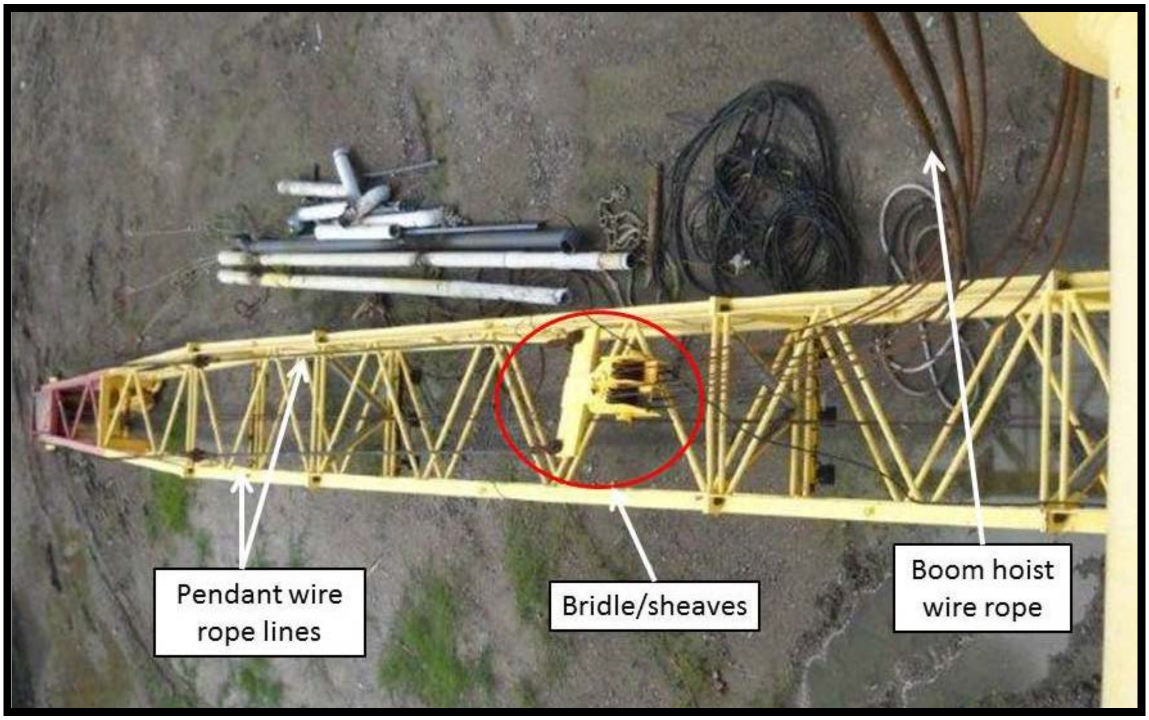

Figure 7 - SeaKing 1400 "pendant and bridle" boom suspension *(not actual crane)*

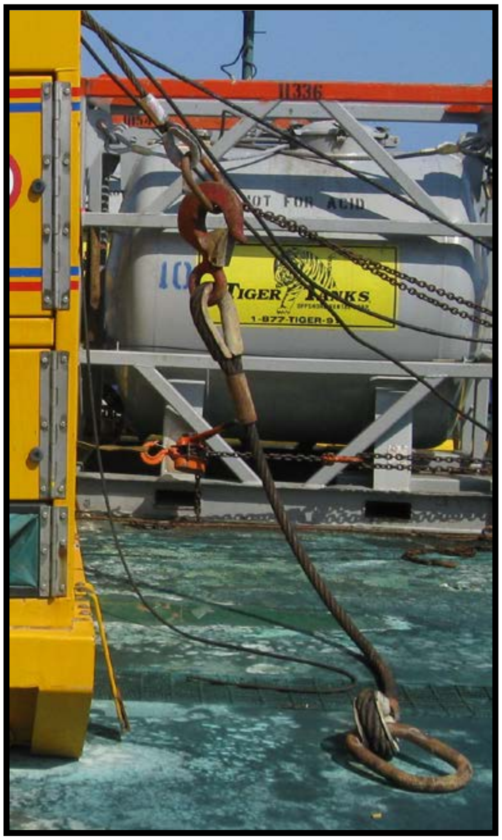

Figure 8 – Hook and stinger

The Crane was de-rated to lifting a maximum of 40,872 pounds (lbs) using the main load line, and a maximum of 12,198 lbs using the auxiliary line (fast line). The generator lift in this case was apparently within the design safety factor used for cranes, though it exceeded the rating (*see table 1, pg. 36*).

Each hook, as supplied by the manufacturer, was fitted with a safety latch of the manufacturer's design which was spring loaded to automatically close, but which could be "latched," and also positively locked with bolt and nut, secured with cotter pin. The load's rigging was attached to the stinger - a short wire rope and hook that simplified connecting the load to the Crane's hoist line by reducing rigger interaction with the main block hook (*see figure 8; see p. 32 for detailed description of rigging components*).

The Crane boom lifting/lowering system consisted of a winch and drum in the rear of the gantry. The boom hoist wire rope, *(see figure 9)* rose vertically from the drum to the top of the Crane's gantry, where the line passed through the four gantry sheaves and the four-sheave bridle. The bridle was secured to the nose of the boom by means of two fixed-length pendant wire ropes, each fitted with a poured socket at each end. The total weight of the bridle was approximately 850 lbs.

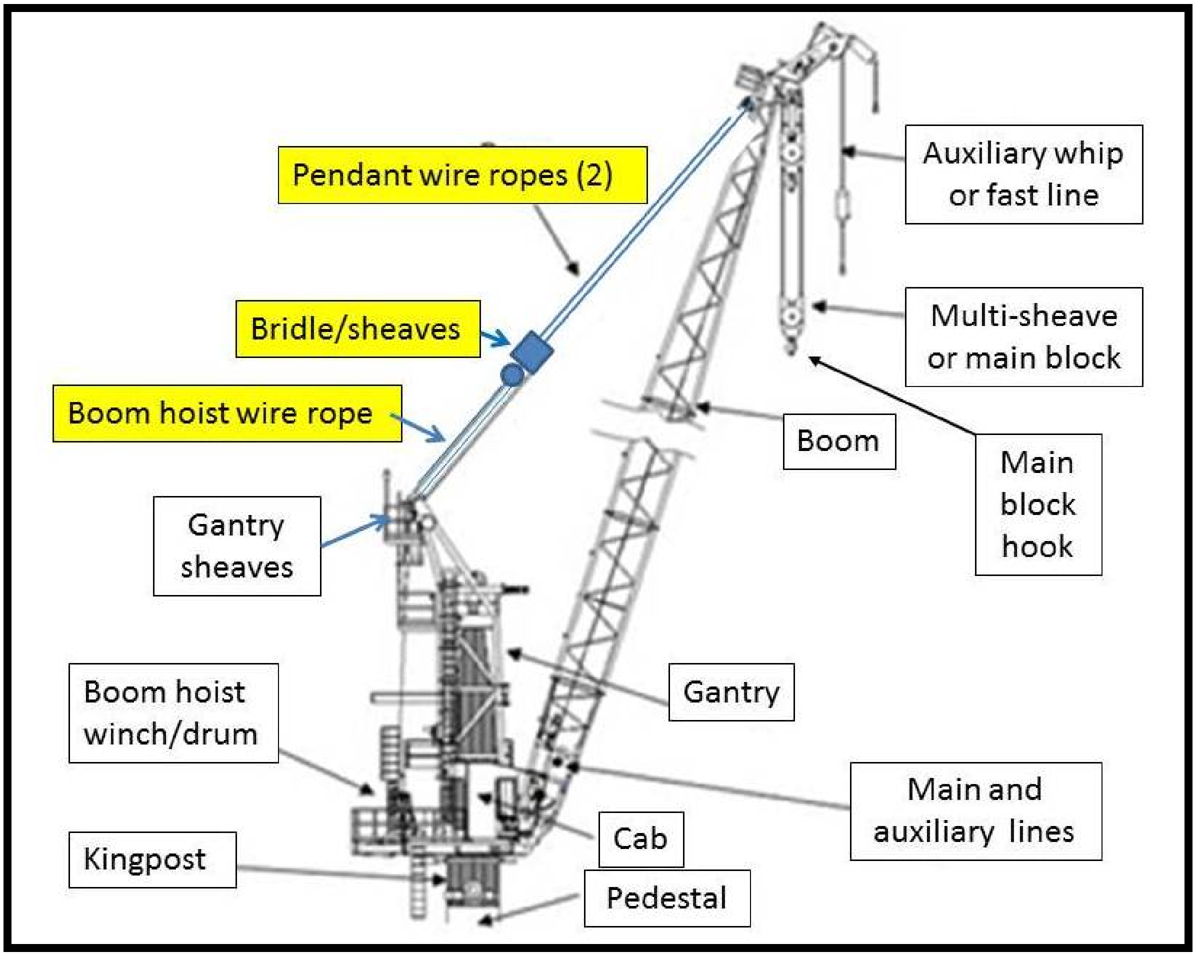

Figure 9 - Boom hoist wire rope, bridle/sheaves, pendant wire ropes *(after definitions provided in API Spec 2C)*

The Crane was refurbished in 2002 at which time it was de-rated, with the Crane capacities being reduced on the static and dynamic load charts to the values shown in *table 1, pg. 36*.

The Crane was routinely used by ERT on an almost daily basis for short periods of time, with the Crane used mainly to load and unload storage containers, grocery boxes and similar items. Also, a piece of production well equipment for cutting paraffin, the lubricator, weighed 400 to 500 lbs and was located within the Platform's well bay area. The lubricator was moved by the Crane from well-to-well on a near-daily basis.

The Crane's load lines ran internally within the structure of the boom. Of the two lifting line system (the main load line and the auxiliary line or fast line), the auxiliary line was the more utilized. When not in use, the Crane's boom was stored on its cradle, located on the opposite corner of the open section of the Platform.

The Crane's boom was located approximately 14-ft above the main deck when in its cradle, and its tip could extend to over 100-ft above the deck during operations. When stored in its cradle, the elevated portion of the boom suspension system was more than 30-ft above the main deck.

The Crane's Boom Hoist Suspension

In October 2006 the boom hoist wire rope and auxiliary line were replaced. The boom hoist wire rope construction was changed from the 0.750-in, 6x19 Design Breaking Load (DBL) 58,800 lbs, to 0.750-in, 6x26 DBL 58,800 lbs. No other components within the Crane's boom suspension system were noted as being changed. On 8 March 2007, ERT personnel identified a "flat spot" on the Crane's boom hoist wire rope, and following a third-party inspection, the wire rope was recommended for replacement on 15 March 2007.

The replacement boom hoist wire rope was manufactured in Korea with a Mill Test Certificate / Certificate of Inspection date of 22 March 2006, and installed on 20 April 2007. The Mill Test Certificate / Certificate of Inspection indicates 14,000-ft of 0.750-in nominal diameter (0.773-in actual diameter), 6 x 26 working strand (WS) with an internal wire rope core (IWRC), graded extra improved plow steel (EIPS) with a right hand regular lay (RHRL). The nominal breaking strength was 58,800-lbs with an actual strength of 61,238-lbs. The nominal tensile strength was 262,000 pounds per square inch (psi) with an actual tensile strength of 274,840 psi, a nominal torsion of twenty one with an actual torsion of thirty-eight.

According to ERT, during their investigation they discovered that the incorrect boom hoist wire rope certification was issued to the Platform in April of 2007, and after further discussions with the line supplier, they received the correct boom hoist wire rope certification for HI A557 "A".

Well Work Prior to the Accident

ERT hired a third party acid equipment operator (AEO) to perform the acid flow-back on well A8 on the Platform in order to stimulate well production and improve overall well performance. The acid flow-back operation entailed pumping the acid down the well and returning the acid back to associated acid equipment on the Platform.

On 14 August 2011 the acid equipment was offloaded from the *M/V Karla F*, a vessel chartered by ERT from Gulf Offshore Logistics, to the Platform without incident; with several acid tanks remaining on board the *Karla F*. As with prior equipment offloading, the *Karla F* positioned itself on the west side of the platform.

The acid flow-back operation required the installation of a gas buster tank, acid tote tanks, an iron basket, a separator choke manifold, several containers and other tankage such as the well flow-back tanks (*see figure 4, p. 7*). As is typical of the acid jobs performed on the Platform, acid tanks remained on the *Karla F* in order to minimize movement of the acid itself. The acid job was completed for the Platform's Well A8 on 15 August 2011.

Arrival and Installation of the Rental Generator

In May 2011 a failure of generator #2, one of two generators aboard the Platform, required the rental and installation of a back-up rental generator. The back-up rental generator was transported from Freshwater City, Louisiana via the *M/V Jacob Gerald*, a vessel chartered by ERT from Gulf Offshore Logistics, and off-loaded using the Crane from the vessel onto the Platform on 26 May 2011. The Crane Operator, assisted by the A-Operator, performed the lift assisted by a rigger who was not on the Platform during the 16 August 2011 incident.

The rental generator was positioned on the northeast side of the Platform, to the east side of the well bay area. ERT reported (in their High Island A-557A Crane Incident Investigation Report, dated 20 April 2012), that this location had been used in the past when a rental generator was required for specific projects onboard the Platform. No issues were encountered in the offload and installation of the rental generator from the *M/V Jacob Gerald* onto the Platform. From its installation on 26 May 2011 until the incident, the rental generator remained in place.

The ERT Production Foreman stated the ERT Crane Operator told him that he did not have any problems when he set the generator in its location on 26 May 2011, and both stated they had no concerns specific to the lift to remove the generator on 16 August 2011. The Crane Operator stated that they did not move the generator after it was wired up, and he and the "A" Operator said they did not notice any fraying, kinks, etc., with the crane's lines prior to the Accident.

Personnel Working on Lift – 16 August 2011

ERT's Production Forman arrived at the Platform on 3 August 2011. He stated that he had been overseeing operations at the Platform since 2007, and had received both crane and rigger training. The Crane Operator, an ERT employee, was also considered the Lead Operator and arrived at the Platform on 10 August 2011. He stated he first began working on the Platform in 2001, and received his first crane qualification credentials in 1995, which he maintained to present time.

Also arriving on 10 August 2011 was the "A" Operator and a summer intern roustabout; both of Wood Group contract company. The "A" Operator had been working on the Platform for nearly three years, and he stated he also received rigger and crane operator qualification credentials. ERT reported that the summer intern (Rigger 1) had worked at the Platform over the course of the prior three months, and was later employed during the generator lifting operation.

Rigger 2, who was employed with Wood Group for approximately three months prior to the incident, also arrived at the Platform on 10 August 2011. Rigger 2 had been working on two other ERT platforms prior to transferring to the Platform. Rigger 2 was supervised by the Crane Operator and the "A" Operator. ERT reported that the Crane Operator reviewed Rigger 2's API RP 2D rigger's qualification credentials.

Preparing for the Lift

According to personnel onboard, on the morning of 16 August 2011, the *Karla F* arrived to the Platform at approximately *0600 hrs*. The Crane Operator instructed the vessel to stand by, not wanting to back load the rental generator and remaining acid equipment until all Platform personnel involved in performing the lift were fully prepared.

Following the usual round of morning checks, a Job Safety Analysis (JSA) meeting, led by the Crane Operator, was held for the work activities related to loading equipment onto the *Karla F*. The JSA document was prepared on 14 August 2011 and used on the days of the 15th and 16th. Those attending the JSA meetings included the Crane Operator, "A" Operator, Rigger 1, Rigger 2, and the third-party AEO. The JSA's focus for back-loading the boat included potential hazards centered on elevated loads, tag lines, pinch points, loads shifting, and proper rigging.

The Crane Operator stated that on 16 August 2011 they discussed additional hazards, since there was quite a bit of extraneous equipment lying around. According to statements, this discussion was to insure all involved knew exactly what was out there, and the escape routes. He also indicated that he told people to verify where they were based on the location of equipment. He said there were no questions from anyone about their role in the lift. The Crane Operator said the plan was to lift the generator above the height of the lubricator, and then swing the load over to the left to insure clearing the lubricator.

ERT reported that the Crane Operator and "A" Operator had determined that since the rental generator was the heaviest lift, it would be the first lift undertaken. Also, because the generator had been lifted onto the Platform by the Crane utilizing essentially the same personnel less than three months prior, no specific discussions were undertaken about the weight of the rental generator or the distance from the center line of the Crane's pedestal to the rental generator's location on the Platform. From statements and documents, there is no indication that the option of clearing the lift area by laying down the lubricator or by moving the tanks was discussed.

Need for Tag Lines, Personnel Positioning

The lift was planned to be accomplished without removing the lubricator or relocating the tanks. The lift package of the generator was designed with only a single central point pad eye for a lift load that weighed in excess of 21,000-lbs *(see figure 10)*. Under certain circumstances, a single point lift can be more unstable than one using four points. The instability can include static (weight distribution inequities) and dynamic (tendency to swing and/or spin) factors.

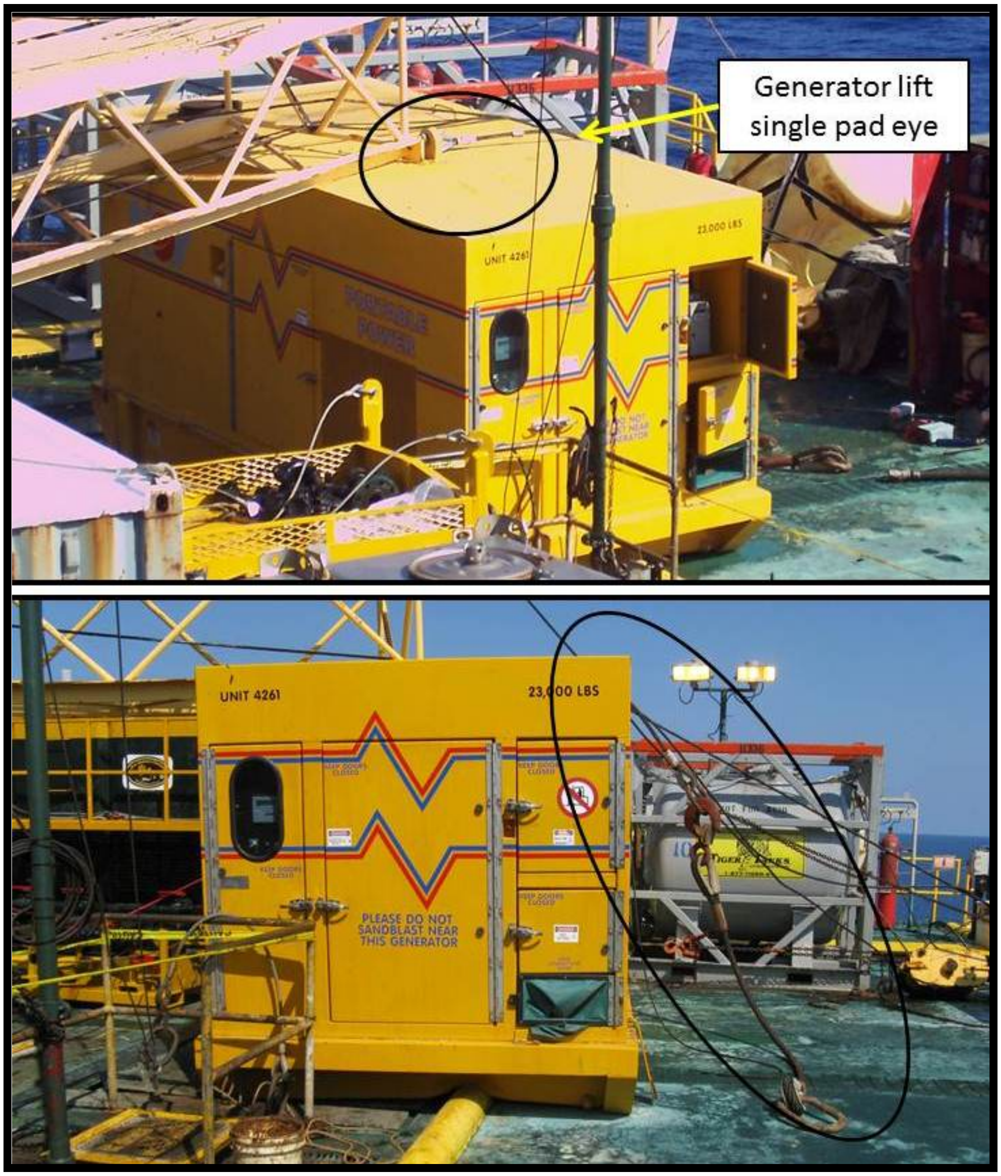

Figure 10 - Generator lift point and rigging, post-accident

The lift was planned using two men to stabilize the load with tag lines. The "A" Operator stated that the purpose of the tag lines was to secure the lift, and the Platform riggers generally put a tag line on every load that was lifted. He stated that it was easier for the crew on the boat to catch the lift if it was not swinging, and the same was true on the Platform. The Crane Operator stated they used the tag lines to control any swing in the load that might occur when the load was first lifted.

From observations, the lubricator *(see figure 11)* would not be able to withstand contact from the load without risk of damage. Any such contact would risk toppling and subsequent damage to the well head, Platform equipment, and personnel. No statements or documents indicated a reason for keeping the lubricator rigged up rather than removing it from the wellhead and laying it down while the lift was in progress.

Figure 11: Proximity of lubricator to lift

The location of both the tanks and the lubricator, and the attachment of the tag lines, also limited the positioning of the men manning the tag lines *(see figures 12, 13 and 14)*.

The two tanks to the north of the generator, and the decision to attach the tag line to the northeast corner of the generator, prevented Rigger 2, holding the tag line on that end of the lift load, from taking a position clear of the line of the boom. No statements or documents indicated that re-positioning the tanks was considered to allow Rigger 2 greater safety by positioning himself to the north of the boom line. There were no indications that the potential of boom hoist wire rope failure was considered in the positioning of Rigger 2.

The lubricator barricade location and the decision to attach the other tag line to the southwest corner of the generator similarly limited the initial position of the "A" Operator and required him to negotiate the barricade with his tag line. No information was gathered as to the reasons the tag lines were attached as they were.

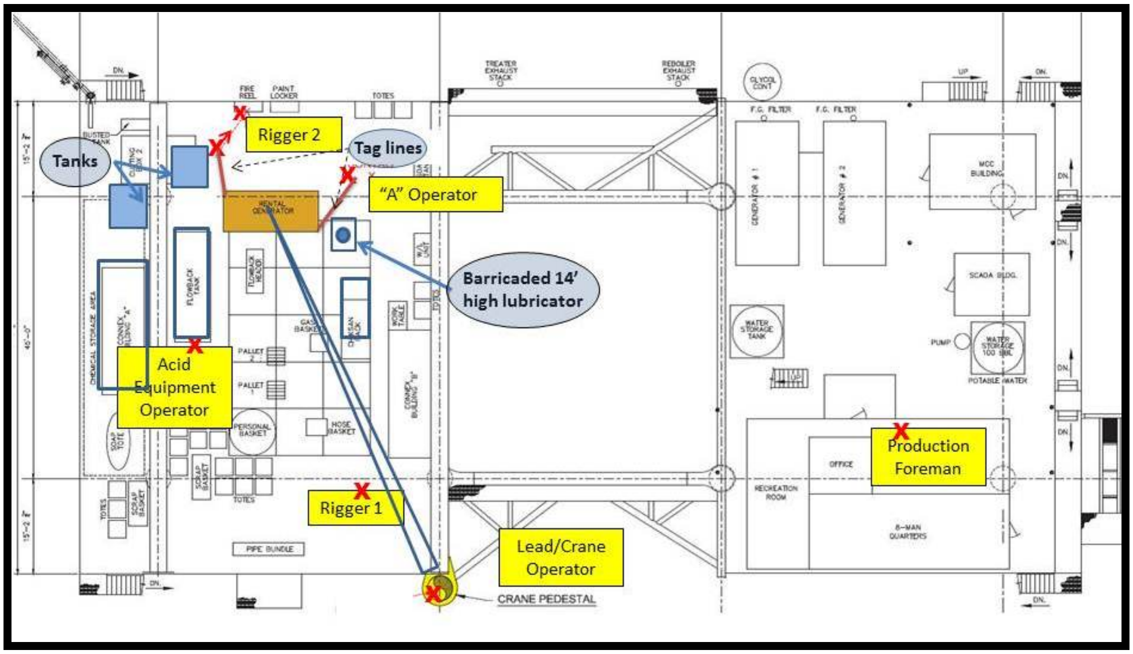

Figure 12: Positioning of personnel and equipment during lift

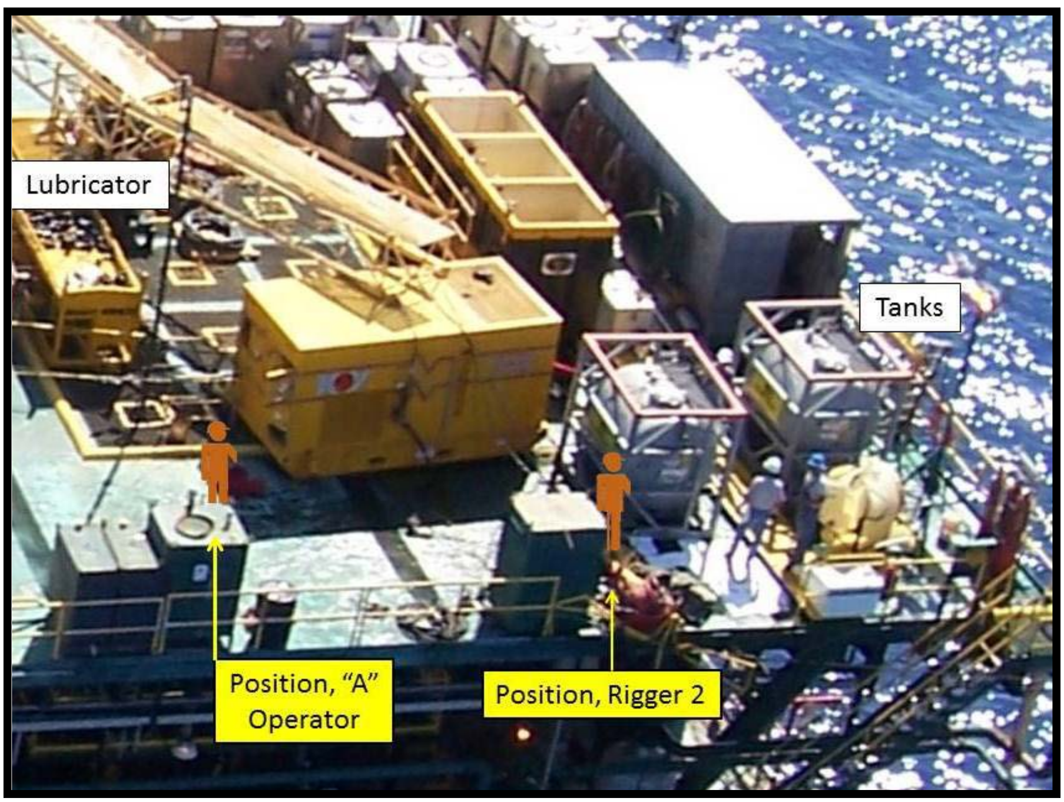

Figure 13 - Position of riggers, equipment

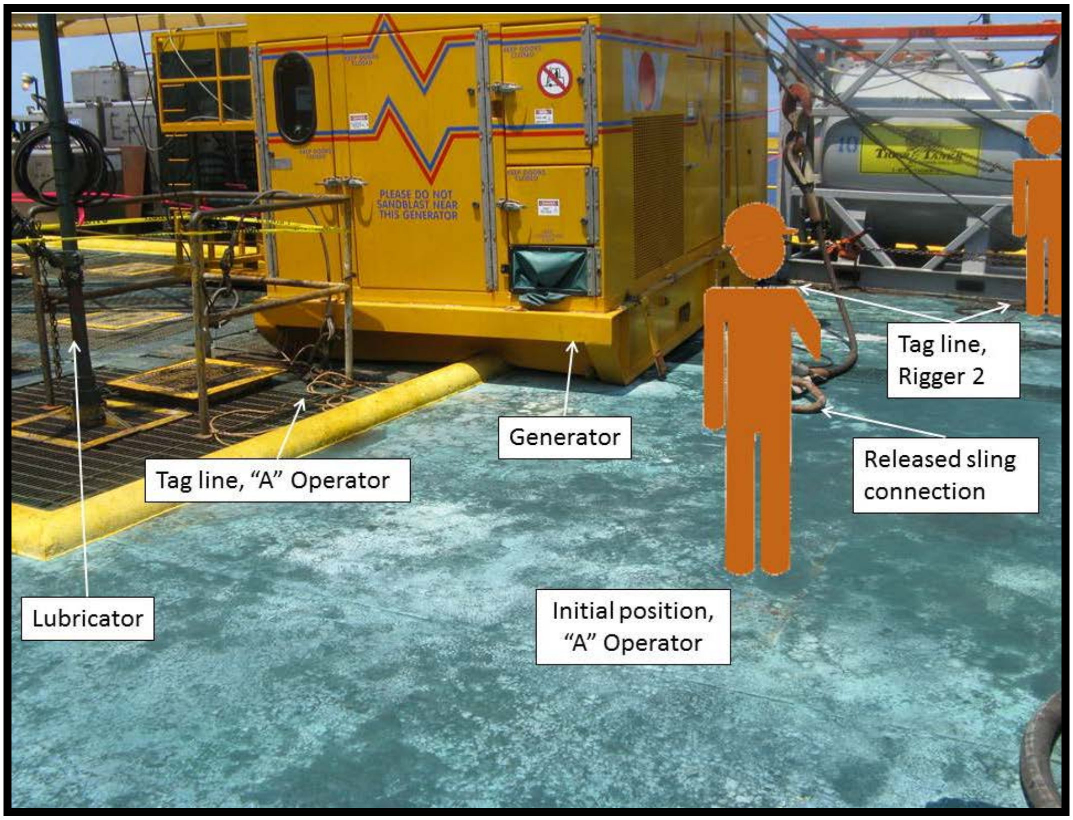

Figure 14 – Position of riggers, equipment, tag lines

The Lift

On the morning of 16 August 2011, based on information from the National Data Buoy Center for HI A595 (the nearest available data point), the wind speed at *0800 hrs* was directed south at 4.7 meters/second or 9.1 knots, with wind gusts at 5.6 meters/second or 10.9 knots. The wind speed at *0830 hrs* was also directed south at 4.5 meters/second or 8.7 knots, with wind gusts at 5.4 meters/second or 10.5 knots.

Rigger 1 hooked up the rental generator to the Crane, but took no other part in the lifting operation. The third-party AEO was preparing his remaining acid equipment for back loading. ERT's Production Foreman was not involved with the lift, and was in the Platform's quarters and galley during the lift. The Crane Operator conducted the pre-use inspection and stated that he saw nothing abnormal.

ERT reported that shortly before *0800 hrs* on 16 August 2011, ERT's Crane Operator instructed the *Karla F* that the Platform personnel should prepare for the back loading operation, and the vessel should be maneuvered to the northwest side of the Platform. The Crane Operator started the Crane and brought the Crane's boom up over the handrails and sling stations on the opposite side. Rigger 1 and Rigger 2 connected the stinger master link to the main load block hook while the "A" Operator stated he watched to ensure that it was secure and "latched."

The Crane Operator lowered the main block with stinger attached and the "A" Operator, and Rigger 2 made up the rental generator's rigging single sling master link to the stinger's hook. The "A" Operator stated he observed the stinger hook to be "latched." The Crane's main block was raised and boom height adjusted to bring hook, stinger, and generator sling into a vertical position above the generator.

The "A" Operator stated the latches on those types of hooks were made to spring-load shut on their own, but he checked to ensure the hook "latch" mechanism was engaged. Depending on interpretation, this can infer the activation of a lever which holds the latch edge in contact with the hook. This "latching" lever is designed to ensure metal-metal contact only. It does not constitute a positive, safety, or locking mechanism.

The main block hook was engaged to the stinger on the other side of the tool building, and the Crane Operator did not see it connected; although he indicated that when he picked it up he could see the hook and it appeared to be properly rigged and latched. *(Note: neither of the Crosby hooks apparently had the lever in the "latched" position after the accident, see figure 29, pg. 34).*

According to normal lift procedures, after the load was connected to the Crane and immediately before the lift itself commenced, the Crane Operator checked the crane's radius indicator (a measurement of the horizontal distance between the crane's pedestal and the tip of the boom), which he stated read approximately 58 feet.

The Crane Operator stated that when he first started coming up with the generator, he watched the weight indicator to make sure it was working, and stated the load measured approximately 20,000 lbs. He also stated he had considered the rigging's weight when calculating the lift.

Two tag lines had been installed on opposite corners (NE and SW corners) of the rental generator to steady the load. The "A" Operator and Rigger 2 stepped back from the load while holding the taglines. At that time, Rigger 1 walked back towards the Crane while the AEO continued to secure his equipment.

According to accounts, during the lift the Crane Operator was receiving signal instructions from the "A" Operator. At this time Rigger 2 was out of the line of sight of the Crane Operator, obstructed by the rental generator.

Boom Hoist Wire Rope Failure and Boom Separation

The "A" Operator stated the rental generator was then lifted approximately 10 to 12-ft above the Platform deck. The Crane Operator stated that although he had checked his radius indicator prior to initiating the lift, during the lift itself he did not look at either the weight indicator or the radius indicator.

According to statements, no unusual noises or movements were heard or felt by the Crane Operator or the "A" Operator at the Platform's main deck level when the load was lifted. The Crane Operator then proceeded to boom up, raising the angle of the boom; thereby raising the rental generator. At that moment the Crane Operator heard a loud "pop" and the rental generator fell to the Platform deck.

The Crane Operator stated he immediately assumed that the Crane's main load wire rope had broken, but then realized the Crane's boom was also falling. The "A" Operator stated that when the boom hoist wire rope broke, the rental generator package had not been raised above the top of the wire line lubricator on the south side of the deck, indicating the generator was no higher than 14-ft above the deck when it fell.

The "A" Operator stated he was about to tell Rigger 2 to release his tag line when he heard the pop, looked up and saw the rental generator falling. He stated he turned to run and saw out of the corner of his eye that Rigger 2 also seemed to be preparing to run. The "A" Operator ran SE, toward the catwalk. When he heard the generator hit the deck he turned to check on Rigger 2; but when the Crane boom hit the generator, the "A" Operator turned back around again and ran.

When the falling boom struck the generator, the impact caused the boom to separate into three sections. The “nose” consisting of the sheaves and the top two 20-ft sections of the boom broke completely free and fell overboard off the platform. The center 20-ft section of the boom lodged atop the generator, partially connected by the top structural bolts to the rest of the boom which remained attached to the Crane *(see figure 15 and 19).*

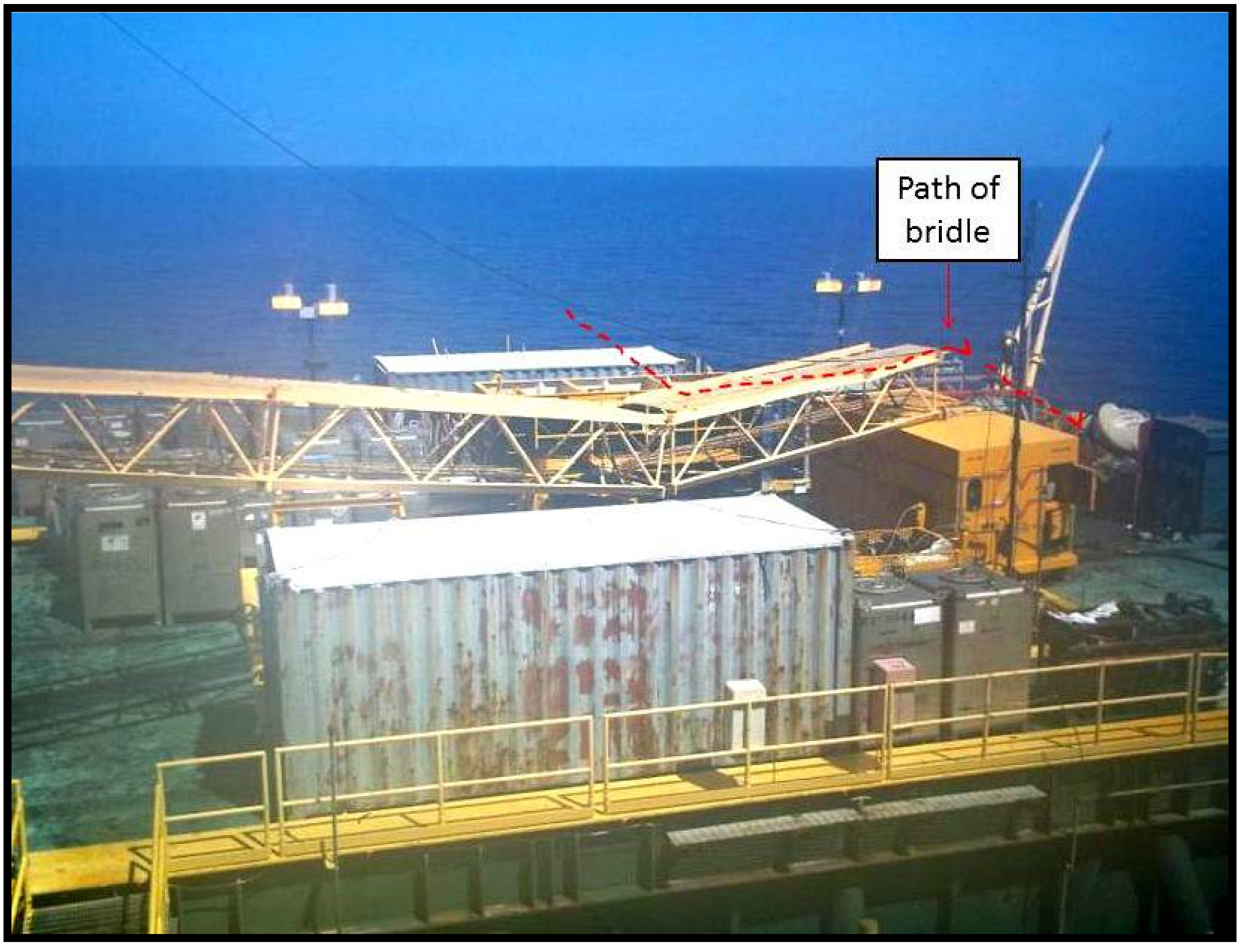

Figure 15 – Separated boom atop the rental generator

The Crane’s nose boom sections were still attached to the bridle by the two fixed pendant wire ropes. As these nose sections fell overboard, the bridle followed. It struck the middle section of the boom atop the generator, and, pulled by the pendants, was dragged off the broken boom end by the falling nose boom sections.

The portion of the boom hoist wire rope that was still reeved to the boom hoist drum remained looped over the gantry sheaves while the parted end dropped and came to rest hanging near the

Crane cab. The section of the boom hoist wire rope pinned to the gantry dead end connection unspooled behind the bridle, following the bridle to its final position *(see figure 16).*

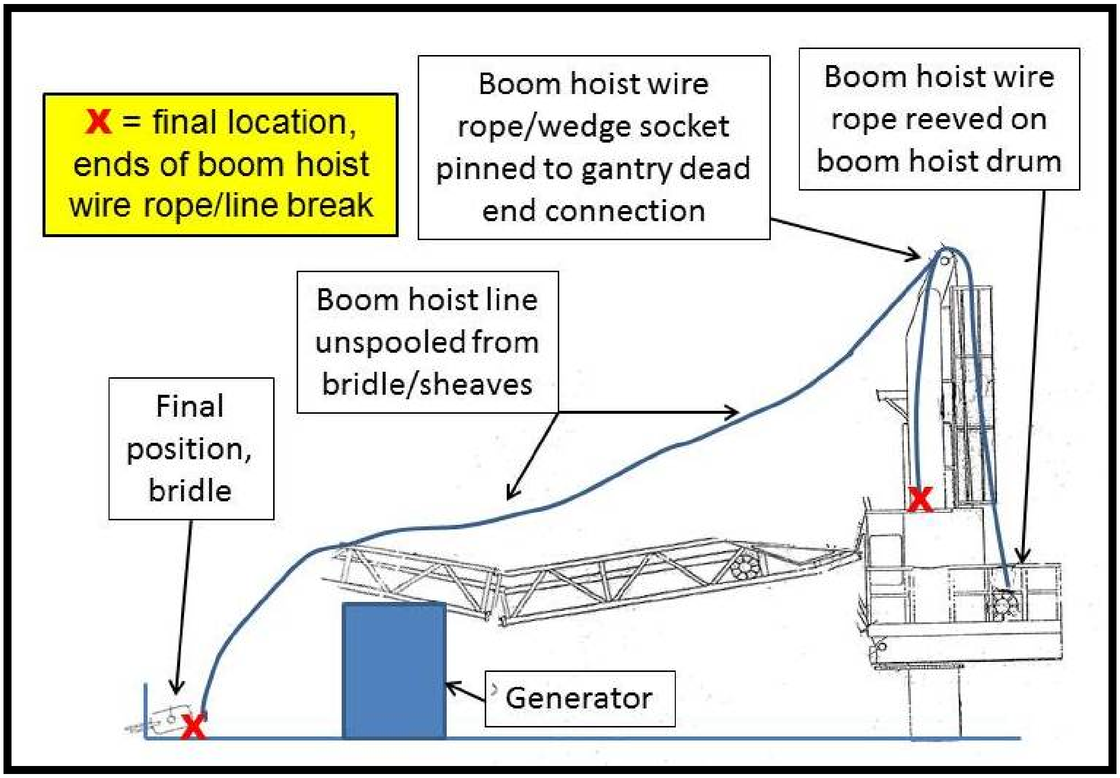

Figure 16 –Representation of final configuration of boom hoist wire rope after break

The 850-pound bridle then struck Rigger 2 and pinned him against a fire hose reel (s*ee figure 17*). After action ceased, the "A" Operator yelled to Rigger 2 but he did not answer. The AEO immediately attended to the victim by checking for a pulse, but did not find one; with the Production Foreman doing the same and getting the same results.

Figure 17 – Final location of bridle

The two (2) "nose" boom sections that separated from the remainder of the boom landed on the handrail on the east side of the platform, breaking the handrail from the Platform, and continued overboard. The fall of the overboard boom sections was finally arrested by the main load line running inside the boom lattice, and the two pendant wire ropes attached to the bridle which caught against equipment on the Platform toe-board. This prevented the suspended boom sections from falling into the Gulf waters (s*ee figure 18*).

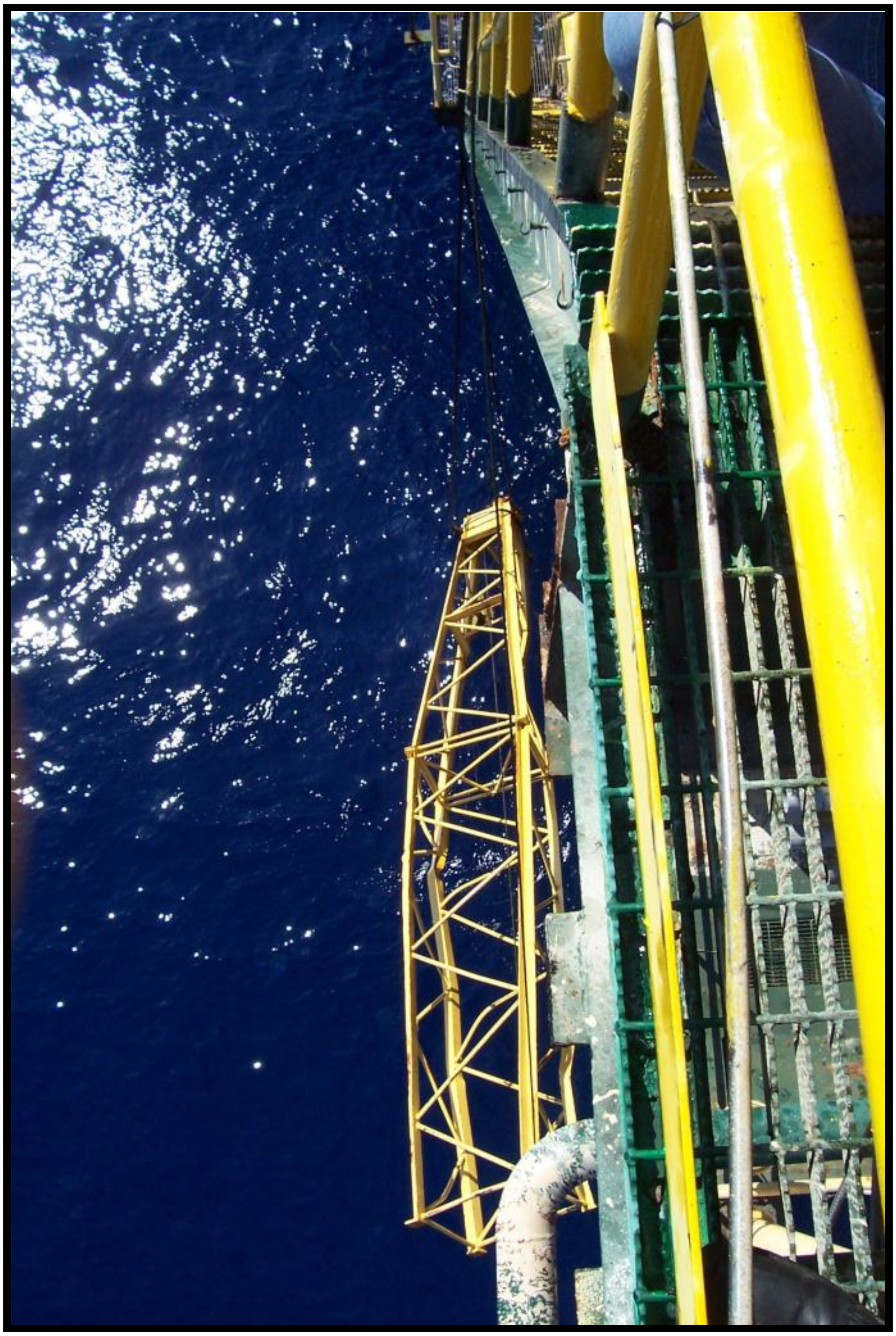

Figure 18 – Separated boom section suspended overboard the Platform

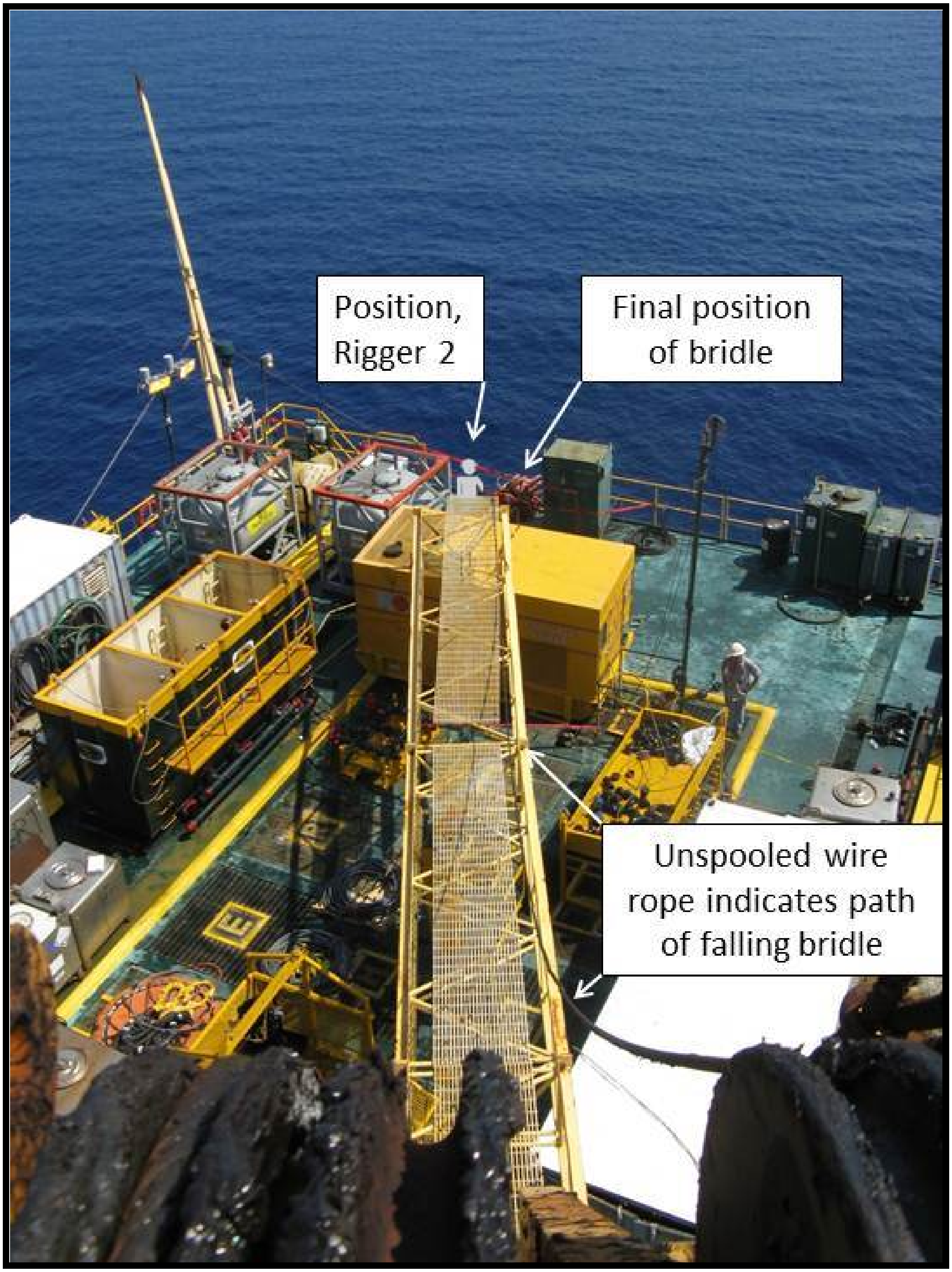

Figure 19 - Boom location after failure, and bridle/sheave path

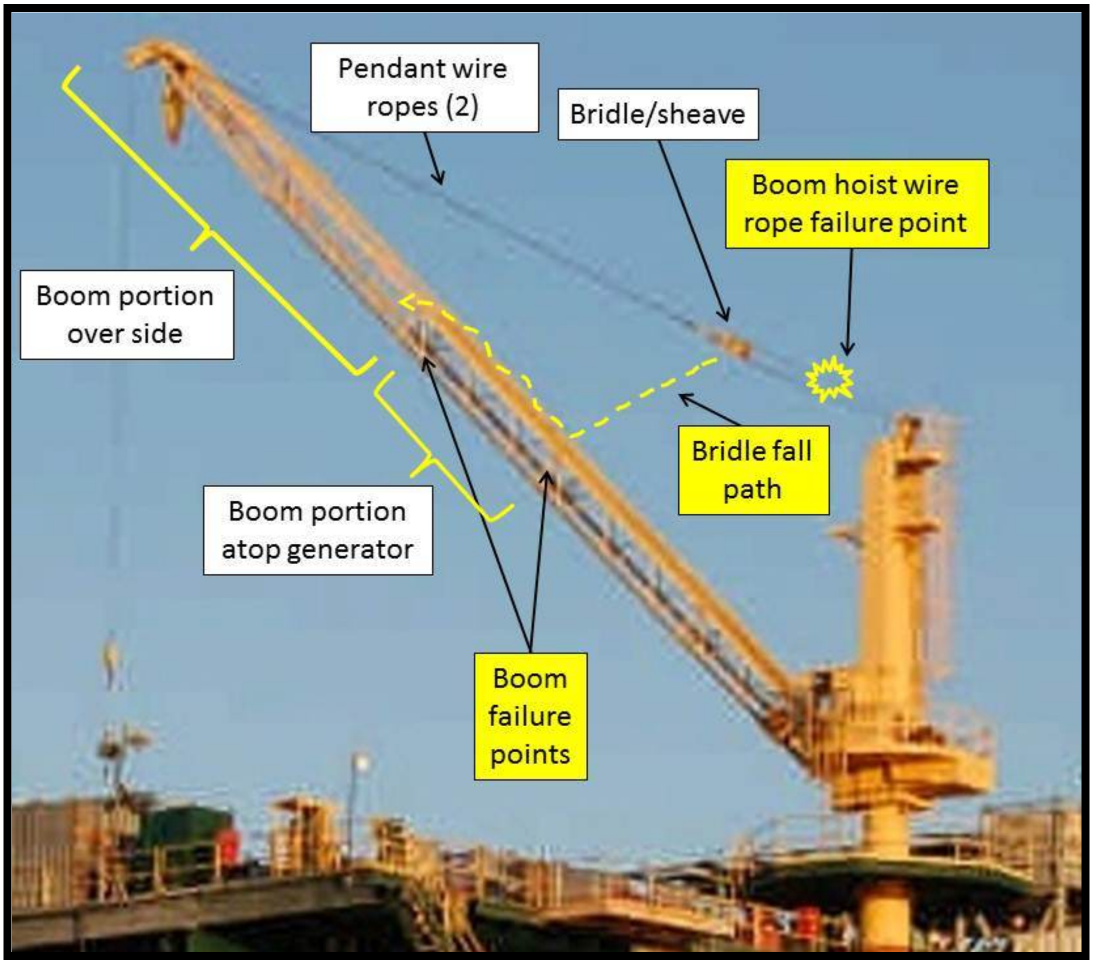

Figure 20 - Crane and failure points

Figure 19 shows the positioning of Rigger 2 in line with the fall path of boom and the track of the falling bridle. *Figure 20* illustrates the approximate location of the failure of the boom hoist wire rope. It also identifies the sectioning of the boom upon impact with the generator and the path followed by the falling bridal.

Post-Accident Events

ERT reported that the activities from the time the stinger was connected to the rental generator until the AEO checked the pulse of Rigger 2 was approximately 2-3 minutes. As an immediate precaution following the incident, the Production Foreman, who was in the living quarters during the entire lift operation, instructed all persons on board the Platform to go inside the accommodations and await further instructions. At approximately *0825 hrs*, ERT used their established emergency response practice to advise onshore personnel of the incident; the Production Foreman contacted the Production Superintendent, who was located onshore, at approximately *0830 hrs*.

ERT reported that subsequent to their conversation, at approximately *0840 hrs,* the Production Superintendent contacted the Operations Manager for ERT, who then contacted the Vice President of Shelf Operations and the Regulatory Manager. The Regulatory Manager, having received the necessary information to properly and sufficiently communicate the incident, immediately notified BSEE by contacting the on-call Lake Jackson District representative at approximately *0845 hrs*. The Regulatory Manager then notified the Houston United States Coast Guard (USCG) Petty Officer on duty at approximately *0850 hrs*, and then advised the Operations Manager that the Lake Jackson District Inspectors were en route to the Platform with their helicopter flight to another nearby platform being diverted to this Platform.

The Crane's upper boom sections and lines were secured to the Platform in order to prevent them from falling into the Gulf waters, and attempts were made to lift the bridle from Rigger 2. Because both the bridle pendant wire ropes and the main load line were supporting the two overboard sections of the crane's boom, ERT had to call a construction crew from another facility to assist in the lengthy process. A temporary hand railing was installed at the Platform in areas that had been damaged in the incident, and rigging was attached to support the load.

This allowed Rigger 2 to be extracted and prepared for transport off the Platform. Rigger 2 was taken by helicopter, departing the Platform at approximately *1653 hrs* and arrived at Shoals Airfield in Galveston at approximately *1732 hrs* where he was pronounced deceased.

Safety Stand-Down

ERT reported that their immediate response to the incident was to stop all crane usage company-wide in the GOM, pending further understanding of the incident. This safety stand-down order was issued on the day of the incident at the direction of the ERT Operations Manager. He e-mailed all ERT Production Foremen at approximately *1000 hrs*, and followed up with telephone calls to each Foreman individually to ensure they received the message. ERT subsequently ordered its third-party Inspectors to perform a heavy lift inspection of every crane in the GOM, regardless of how recently those cranes had been inspected. ERT required completion of this mandatory "heavy lift" inspection prior to re-starting a crane's operation. As per ERT, no major mechanical issues were discovered on any other ERT cranes in connection with the GOM-wide safety stand-down.

BSEE Post Accident Onsite Investigation

Two BSEE Inspectors arrived by helicopter on the Platform approximately 30 minutes after the incident occurred. Upon arrival, platform personnel conducted a safety briefing cautioning the Inspector about trip hazards on the Platform deck as a result of the Crane boom falling. The Inspectors took initial statements and conducted a survey of the site. The senior Inspector reported he found the following conditions:

- The boom hoist wire rope was broken and the line was unspooled down the length of the fallen boom.
- The boom lattices were damaged, and part of the boom was hanging overboard supported by the boom hoist pendant wire ropes and by the main load line which prevented that section of the boom from falling into the Gulf.
- The end of the auxiliary line was parted, unraveled, and the auxiliary ball was missing.
- The main load block hook had become disconnected from the rigging stinger.
- The boom hoist wire rope appeared to have a large amount of thick grease on portions of the wire rope.
- There appeared to be external rust, corrosion, fraying and kinks on the boom hoist wire rope.

The Inspector stated that he examined the wire rope ends at the break point and there appeared to be evidence of corrosion on the inside of the boom hoist wire rope. The Inspector took photographs of the Platform, accident site, Crane, and wire ropes to supplement photographic documentation later made available from other sources. Selected photographs from various sources are shown in *figures 21-25* to illustrate the condition of the boom hoist wire rope after the accident.

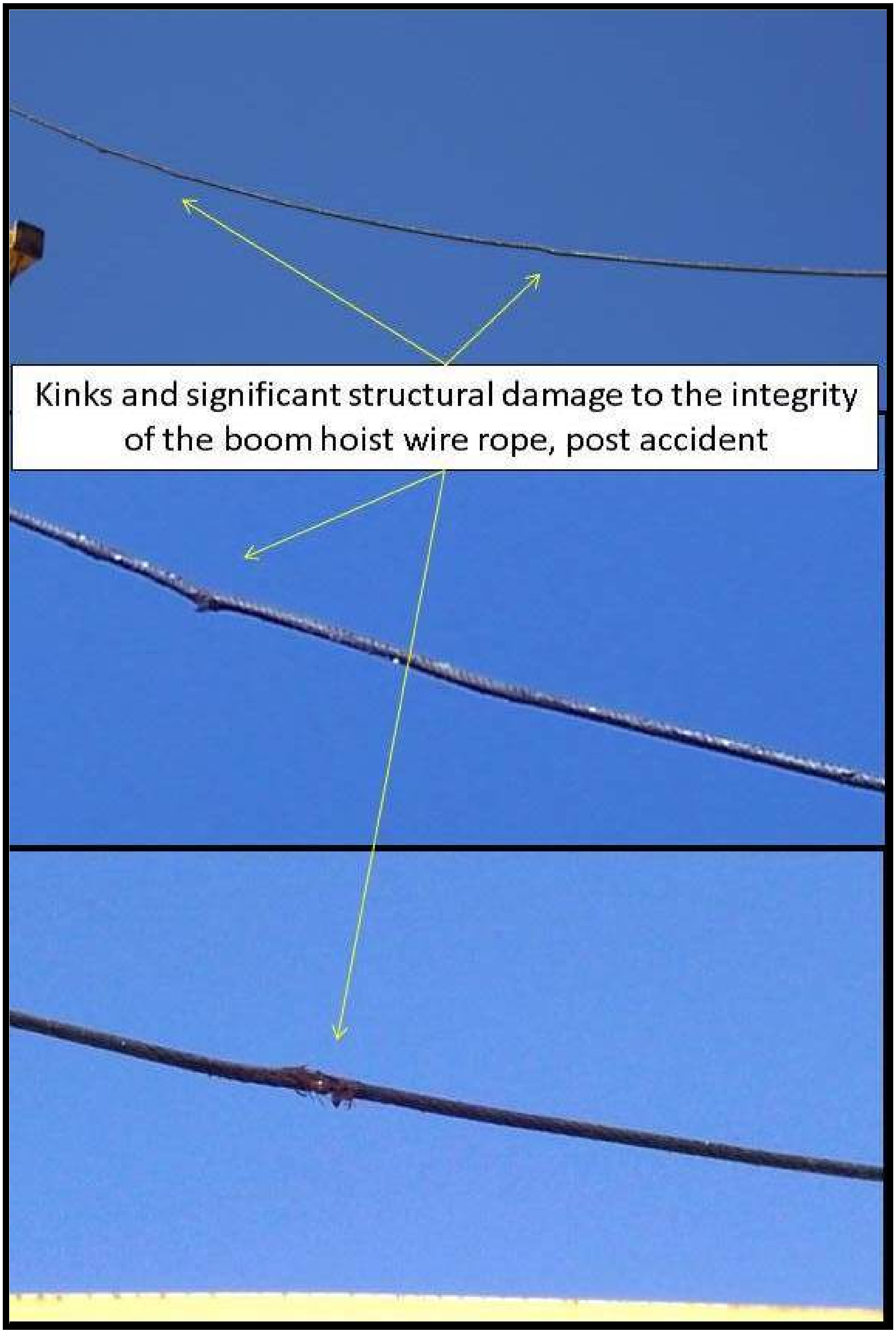

Figure 21 – Middle section of boom hoist wire rope, post-accident

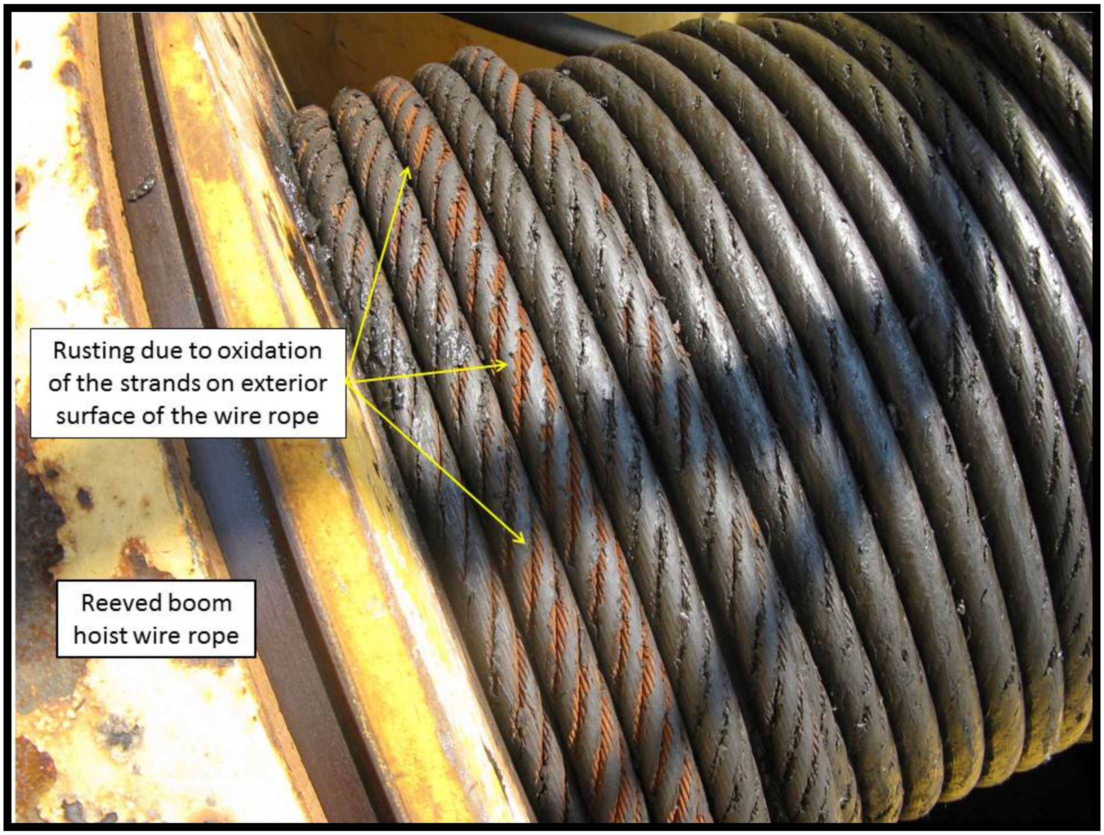

Figure 22 – Reeved drum of boom hoist wire rope, evidence of external strand corrosion

Figure 23 – Corroded boom hoist wire rope, wedge socket, pinned to gantry dead end connection

Figure 24 – End section of failed boom hoist wire rope

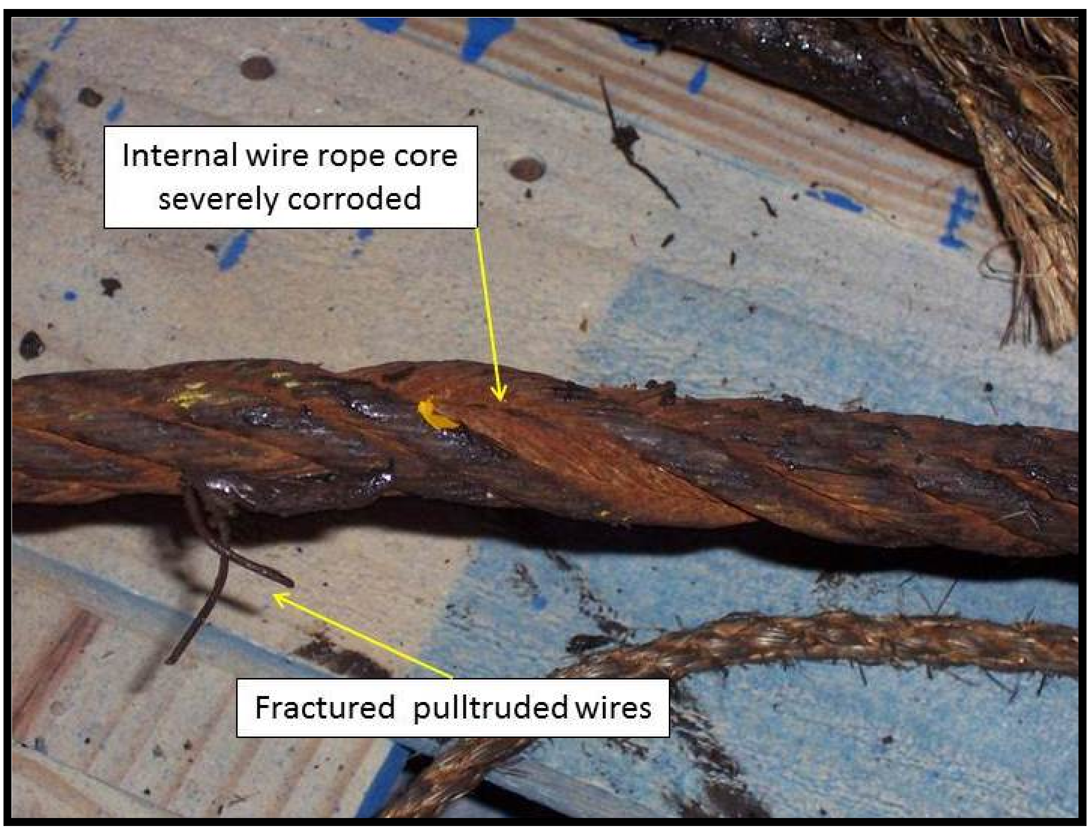

Figure 25 – Section of failed boom hoist wire rope with evidence of severe oxidative corrosion to the core

The BSEE Inspector and a BSEE Production Engineer returned to the Platform on 26 August 2011. More photographs were taken and another review was made for the purpose of requesting additional information from ERT.

Rigging and Crosby Hook

The generator was connected to the Crane using a linear combination of rigging. The single central pad eye of the lift was secured to the generator's wire rope single sling by a shackle and master link. The sling was then connected to a Crosby hook at one end of another wire rope lifting line, the "stinger." The other end of the stinger was then connected to the main block's Crosby hook.

Thus the entire rigging system had seven different elements before considering the Crane components. These were: (1) the generator's single lift pad eye; (2) generator rigging shackle; (3) generator wire rope sling; (4) sling master link; (5) stinger's Crosby hook; (6) wire rope stinger; (7) stinger master link; which was connected to the Crosby main load block hook with PL latch *(see figures 25, 26 and 27).*

Both the main block hook and the stinger hook used on the lift were Crosby models with PL hook latch. The PL hook latch is spring loaded to close automatically when the load is in slack condition with the spring loading designed to inhibit releasing when the load is correctly positioned. The PL hook latch has a lever that when activated insures metal-to-metal contact between the leading edge of the latch and the hook body. However, this does not constitute a "positive locking" mechanism.

For positive locking, the PL safety latches were designed so that a bolt and nut with cotter pin can be inserted to "lock" the latch in a closed position, preventing any inadvertent disengagement of the hook during lifting operations (so long as the hook is oriented and used in proper manner).

According to the manufacturer, "locking" this system is particularly important during dynamic lifting operations, when the load and lifting equipment can experience sudden movements and shocks which could allow a system to disengage, possibly allowing loads and/or lifting devices to fall.

Figure 26 – Stinger hook attached to the generator rigging

After the incident, the stinger's Crosby hook remained attached to the generator rigging (*see figure 26*), but the Crane's main block hook became detached from the master link on the other end of the stinger (*see figures 27, 28*).

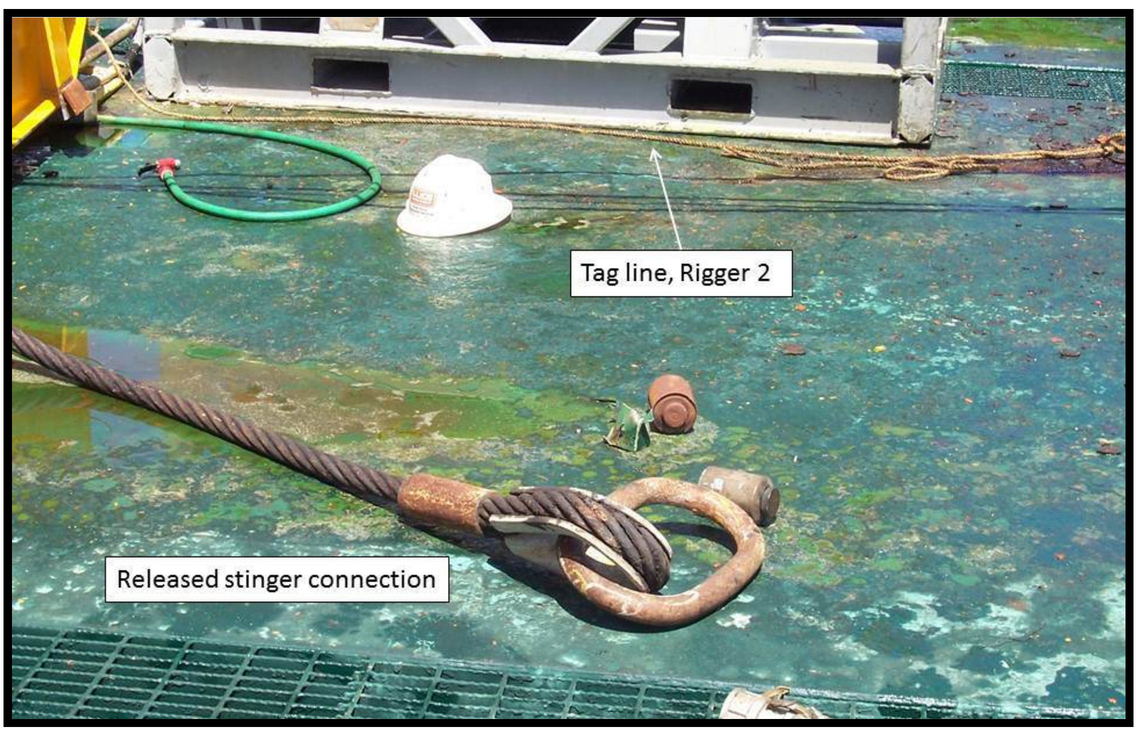

Figure 27 – The stinger detached from the Crane's main hook

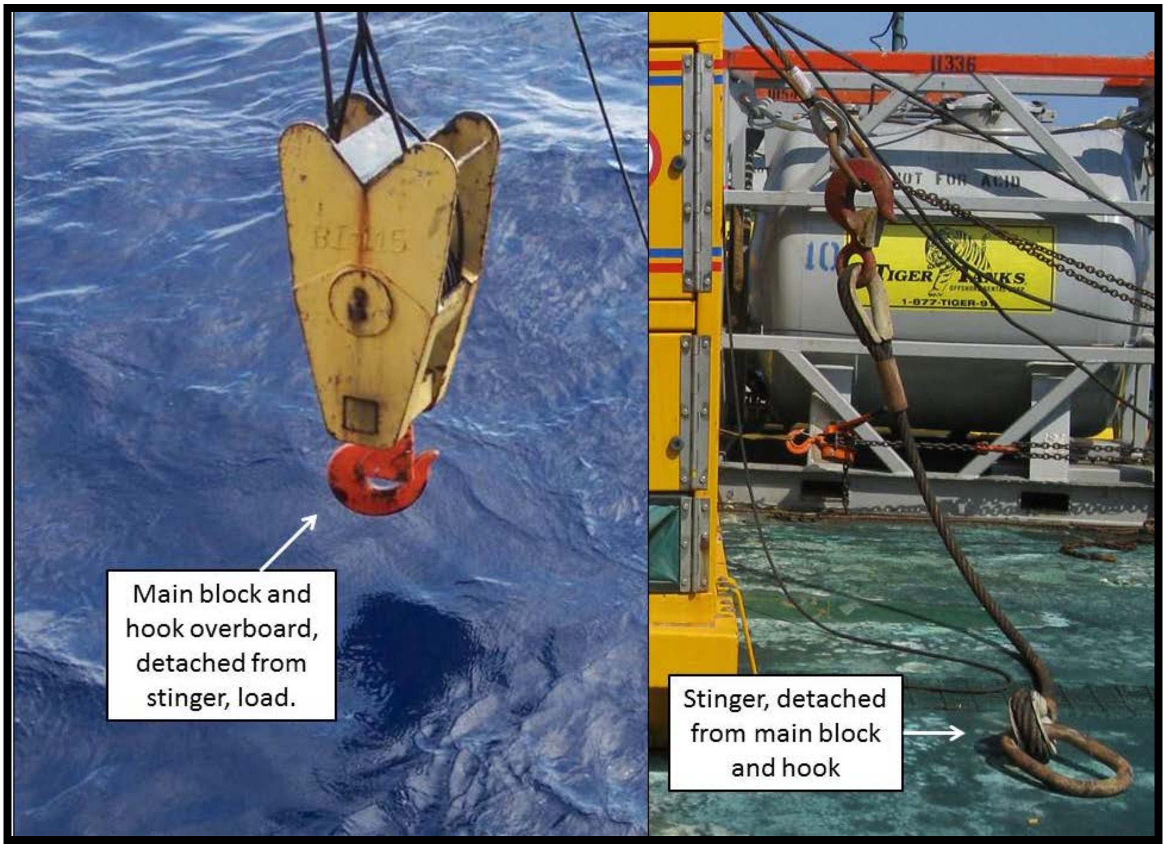

Figure 28 - Main hook detached from stinger/sling

Statements from the Crane Operator and "A" Operator were received that both the Crosby hooks PL latches were "latched" or "locked." However photographs taken immediately post-accident indicate neither hook had the latching lever engaged (*see figure 29*).

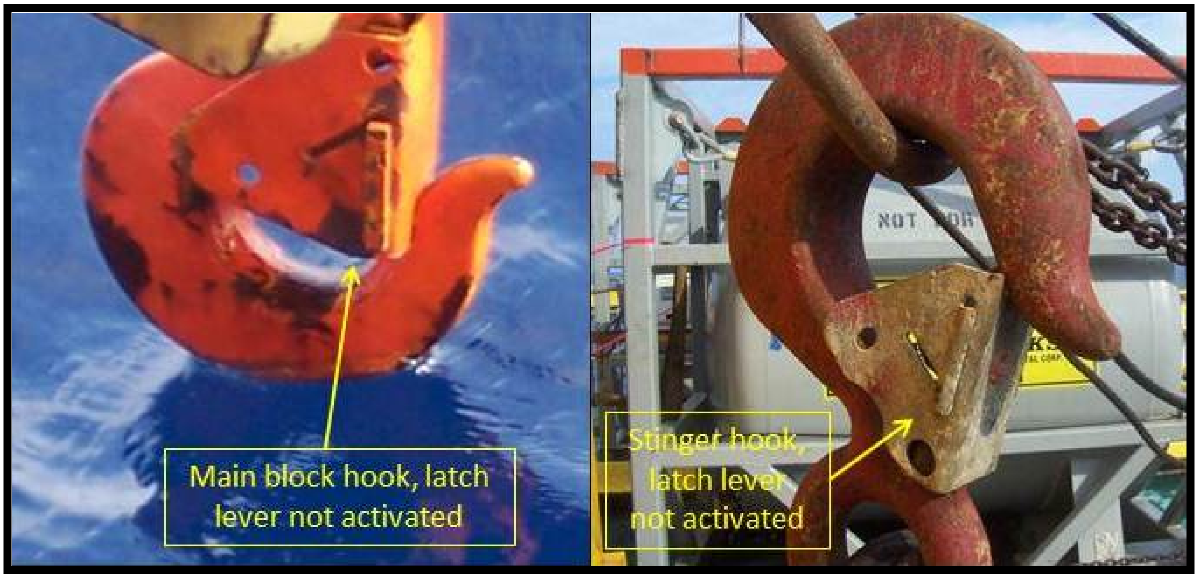

Figure 29 – Crosby hooks post-Accident, "latching" levers not engaged

Cargotec's 2011 Hook Inspection Report dated 11 February 2011, the most recent annual inspection prior to the incident, indicated the safety latch for the main load block hook was in "good" condition. The inspection also indicated that the fasteners, sheaves, dead end connection, pin condition and overall condition of the main load block were "good".

Though ERT did not have a written policy or manual for crane operations, ERT reported that their personnel were supposed to follow API RP 2D guidelines. When lifting personnel RP 2D recommends the hook safety latch to be locked and isolated by a bolt and nut with cotter pin to ensure the latch does not open. No locking bolt and nut with cotter pin was used on the rental generator lift because personnel were not lifted. The Crosby Group LLC, manufacturer of latch, provided literature warning against of a number of improper procedures that could cause a hook with latch not secured by a locking bolt and nut to disengage.

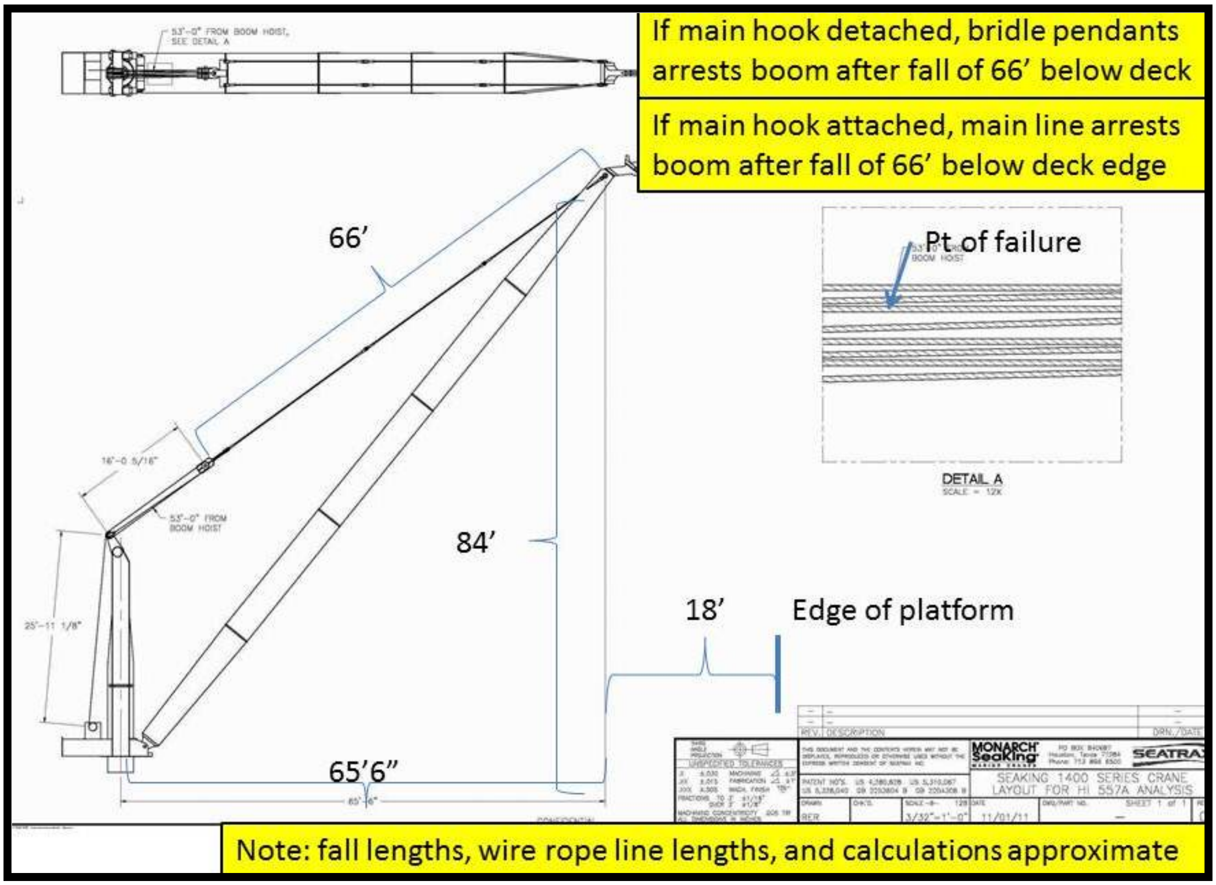

Figure 30 – Diagram: components, wire rope, edge of platform *(base diagram from ERT)*

The ERT report discussed the possibility that if the hook had not detached from the sling, the nose of the boom would have remained anchored to the generator, and thus may not have fallen overboard far enough to pull the bridle sheaves into the railing. However, diagram measurements reviewed by the Panel indicate that even if the main load hook had remained attached to the generator, the bridle would likely have still been pulled all the way to the railing, striking Rigger 2 *(see figure 29*), absent the main load line being snagged or kinked in the boom lattice or sheaves in some manner.

SeaKing Model 1400 Static Load Chart

Prior to ERT's purchase of the Platform and while the Platform was being operated by Amerada Hess, in April 2002 the crane underwent a major refurbishment at which point a reduced load capacity was allocated to the Crane. The reasons for the load chart reduction by Amerada Hess remain unknown to ERT; however, upon ERT's purchase of the Platform and at all times thereafter, ERT personnel uniformly stated they have only used the reduced load chart when conducting Crane lifting operations. According to statements, upon purchase of the Platform, all available information regarding the Platform and Crane was forwarded to ERT; including the Crane manual, data books and limited Crane refurbishment information.

The values from the SeaKing Model 1400 Static Load Chart, acquired from the Crane's cab, is outlined below *(see table I)*:

Table I – SeaKing Model 1400 Static Load Chart			
Radius (Feet)	**2-Part Capacity (Pounds)**	**4-Part Capacity (Pounds)**	**Auxiliary Capacity (Pounds)**
20	25920	40872	12198
25	25920	38125	12198
30	25920	33922	12198
35	25920	30884	12198
40	25920	28527	12198
45	25920	26598	12198
50	24955	24955	12198
55	23508	23508	12198
60	22200	22200	12198
65	20990	20990	12198
70	19849	19849	12198

75	18753	18753	12198
80	17680	17680	12198
85	16607	16607	12198
90	15502	15502	12198
95	14309	14309	12198
100	12859	12859	12198

The Static Load Chart on the Platform at the time of the incident identified the following five factors:

1. Working radius is measured from main hook to centerline of rotation;
2. Static rated loads are to be used only for lifts to or from stationary platforms;
3. Rated loads are GROSS Loads, and the 850 pound main block and 350 pound overhaul ball must be deducted in order to determine the net load;
4. Main drum cable is 0.750-in diameter, Flex-X19, 1,100 ft;
5. Auxiliary drum cable is 0.75-in diameter, Flex-X19, 350 ft;

Crane Load Capacity

At the time of the lift, the rental generator contained a ¾ tank of diesel fuel, and when brought back to shore after the incident it weighed 21,800 lbs. In addition to the rental generator, the lift on 16 August 2011 also included the weight of the main block (850 lbs) and overhaul ball (350 lbs) and stinger weights, etc. (400 lbs). Therefore, the total weight of the load was estimated at 23,400 lbs.

The original lift radius, calculated by a crane third-party company (Sparrows Offshore LLC) that was hired by ERT and sent to the post-accident site, was 65 ft and 6-in, with the lift radius at the time of the incident calculated at 63 ft and 7-in. Both measurements were from the main hook to centerline of rotation.

Utilizing the lift radius measurement of 65-feet and 6-inches and the Crane's static load chart's 4-Part Capacity, the maximum Crane capacity at the time of the lift equates to between 20,990 lbs and 19,849 lbs *(see Table 1).* Given the working radius of the Crane and the total weight of the load, the Crane was at approximately 118% of the capacity when the lift was undertaken.

The wire rope used in main load line and boom hoist systems utilizes a design factor that can be calculated from API Specification for Offshore Pedestal Mounted Cranes, Specification 2C, Sixth Edition, March 2004. Essentially these lines have a safety factor of 2.5 times the vertical design coefficient or 5.0, whichever is greater than the hoist system. Therefore, the lift was theoretically limited by the Crane design factors, not the load line wire rope design limits.

Lack of an ERT Crane Operation and Maintenance Manual

Communications with ERT indicated that they did not have a separate written policy or manual for operation of cranes specifying procedures, use of tag lines, positioning of riggers, pre-use crane inspection. The Operator also had no internal methodology to insure the annual inspections by third parties comprehensively checked all components of the crane.

However, the Operator's representatives stated that it was their practice to follow all API 2C/2D requirements. ERT reported that they required the same from all their contractors and subcontractors.

ERT communicated that the Crane's lifting history consisted of routine operations typical for an offshore platform crane. A typical week's usage was documented as less than 10 hours/month and therefore the Crane was categorized as "Infrequent Usage" by API RP 2D. Typical platform Crane usage consisted of:

- Movement of the wire line lubricator from one wellhead to another for routine paraffin scrapping procedures;
- Offloading a vessel every 1-2 weeks (typically including a grocery box, palletized supplies - such as valves, 550 gallon tote tanks of processing chemicals) and hooking up water and diesel hoses;
- Every few months, as needed, construction gang boxes and welding/cutting machinery would be brought aboard for needed routine repair work; and
- Approximately once a year, a routine buffered acid injection would occur on the platform for one or more wells. Acid would be pumped into the wells via high pressure hoses from a tied-up vessel and typically only flow-back equipment and tanks would be brought onboard before later being offloaded to the vessel.

Although ERT lacked a company-specific crane operation and maintenance manual, they described managing their crane lifting operations, crane inspections and certification of lifting equipment on the Platform as follows:

- Compliance with API RP 2D formed the basis of ERT's control of lifting operations and the maintenance, inspection and certification of its lifting equipment;
- Lifting equipment operators were required to complete initial API RP 2D training before being allowed to operate the lifting equipment, with regular refresher training and assessment as per the requirements of API RP 2D;
- Other members of a lifting team were required to complete API RP 2D training before being allowed to participate in lifting operations, with regular refresher training and assessment as per the requirements of API RP 2D;
- Lifting equipment operators' training and certification records are the subject of regular audits by regulatory authorities;
- All lifting operations are based on the Safe Operating Practices (SOP) described in API RP 2D;
- The regular upkeep of lifting equipment was checked through pre-use inspection and maintenance by ERT employees and/or ERT contractors' employees; all qualified lifting equipment operators as defined under API RP 2D;
- Annual maintenance, inspection and certification of lifting equipment is undertaken by ERT-approved third-party contractors who are qualified API RP 2D inspectors. Inspection and certification are conducted pursuant to the requirements of API RP 2D. Monthly or quarterly inspections are also conducted by third-party contractors depending on the API RP 2D requirements defined by usage hours.
- Documentation of lifting equipment usage records is undertaken in accordance with the requirements of API RP 2D, with additional inspections conducted when lifting equipment usage exceeds or could exceed stated usage limitations.

History of the Crane's Maintenance and Inspection

Maintenance chronology of the Crane, as provided by ERT, is detailed in Table II below.

Table II - ERT's Crane Maintenance Summary		
Date	**Service Provider**	**Issue**
April 26, 2002	SonBeck Int'l	Inspected gantry sheaves
May 24, 2002	Marine Crane	Mechanic noted the boom cable was "smashed" about 50' from the end. Cable was cut and spooled back on winch.
April 2, 2003	Marine & Mainland	Boom cable needed greasing.
August 10, 2003	Marine & Mainland	Greased boom and aux cable. Suggested changing aux line due to shock loading.
December 31, 2003	Marine & Mainland	Replaced aux cable and load tested.
April 13, 2004	Marine & Mainland	Removed wedge socket from boom hoist cable and replaced it with wedge socket.
September 18, 2006	Marine & Mainland	Identified issue with aux cable (flat spotted and identified too short for service) and boom hoist cable identified to have broken wires in strands.
October 14, 2006	Marine & Mainland	Changed out aux cable and boom cable (Korean cable).
March 15, 2007	Marine & Mainland	Found knick in boom hoist cable (crane remained in service).
April 20, 2007	Marine & Mainland	Replaced boom hoist cable (Korean cable).
April 22, 2007	Marine & Mainland	Noted during annual inspection that all sheaves on crane needed replacing.
May 25, 2007	Marine & Mainland	Replaced bad sheaves on load block.
May 26, 2007	Marine & Mainland	Replaced pendant lines, bridle sheaves, gantry sheaves, boom point sheaves.
November 9, 2007	Marine & Mainland	Replaced main cable.
April 16, 2008	Marine & Mainland	Cut off dead ends from boom rope, load block and aux line and readjusted wedge sockets on all; lubricated all.
March 18, 2009	Platform Crane Service, Inc.	Adjusted brake band on aux winch, pull tested aux line to 8,800 lbs.
February 19, 2010	Cargotec USA, Inc.	Inspected and lubed wire rope on main and aux.
February 21, 2010	Cargotec USA, Inc.	Inspected wire rope, cut dead ends, lubed boom hoist rope, bridle, gantry and sheave inspection.
July 20, 2010	Cargotec USA, Inc.	Removed/replaced pendant lines.
February 12, 2011	Cargotec USA, Inc.	Aux and boom cable dead ends cut and wedge sockets adjusted.
February 13, 2011	Cargotec USA, Inc.	Main cable dead ends cut and wedge sockets adjusted.

As indicated in the table above, the boom hoist wire rope was changed in October 2006, and again in April 2007. The reason for the change in October 2006 was because the boom hoist wire rope was found to have broken wires in strands; and the reason for the change in April 2007 was because of a kink.

Failure Analyses Boom Hoist Wire Rope

ERT submitted the Crane's wire rope lines, including the failed boom hoist wire rope, for laboratory analyses. A testing protocol was developed by Pellow Engineering Services et.al., and initial evaluation began at Stress Engineering Services, Inc. Testing was conducted by other specialty companies including Holloway Houston, Inc., Houston Metallurgical Laboratory, Inc., and A&M Technical Services, Inc.

The subsequent Pellow report, *"HI A-557 A Offshore Crane Incident – Failure Analysis Boom Hoist Wire Rope (February 2012),"* noted the analyses employed various tests using visual, optical, scanning electron microscopic (SEM) observations, EDS chemical composition analysis, torsion, ultimate breaking strength and tensile strength. These analyses noted evidence of severe corrosion, structural material integrity loss, absence of any lubrication in internal segments of the failed boom hoist wire rope, and incomplete lubrication penetration throughout the wire rope.

Among other analyses, ultimate breaking strength tests were conducted on eight samples of the boom hoist wire rope. These samples were tested to destruction. Testing found that the breaking strength of the boom hoist wire rope near the drum (most prime condition) was over 56,000 lbs, compared to a nominal breaking strength of new, unused wire rope of almost 59,000 lbs. The breaking strength of samples taken 8-ft either side of the location of the Accident failure point were approximately 15,400 lbs on one side of the break, and 26,000 lbs on the other side of the break. This represents up to a 75 percent reduction in wire rope strength.

The reasons the boom hoist wire rope strength was reduced at least 75 percent in localities is identified in the report. The report noted the following conditions:

"…the end of the boom hoist wire rope with the wedge socket and attached to the bale/yoke is severely corroded and lacks evidence of any remaining lubrication…"

The report further notes that laboratory examination of the boom hoist wire rope found the following: *"… severe pitting corrosion on the external and internal wires of the outer strands and IWRC; pre-existing wire fatigue breaks that have been distorted subsequent to breaking; and partial cuts/crushing in several outer wires. Microscopic inspection reveals that many of the damaged and broken wires were caused from previously broken wires lying across other wires as the wire rope operated through the sheaves … prior to the wire rope breaking.*

"…it is evident that severe, pitting corrosion exists throughout the wire rope strands and the IWRC. There is evidence of only a small amount of lubrication on the center strand of the IWRC.

"Normally, as a wire rope operates through the sheaves and on/off the drum, the lubricant wears off of the contact areas of the outer wires. As this occurs, a light surface corrosion (iron oxide) will form on the exposed outer wire surfaces. When this is observed during regular visual inspection, this is an indication that the wire rope should be re-lubricated…

"Along both lengths of this broken boom hoist wire rope, there are areas of doglegs and damage, but it is not possible to determine if this existed prior to the failure or during recoiling… subsequent to the failure. However, two areas with multiple broken wires from fatigue are evident along the length of the 99' block side wire rope. At 35' from the break there is an area displaying crushing and broken wires protruding from the inside of the wire rope… At 81' from the wire rope break, there is an area showing a kink with broken and "snagged" wires… These wire breaks from the outer and inner layers of strand wires have previously broken in fatigue and or corrosion…

"Along the lengths of both [segments of] *boom hoist wire ropes, there is inconsistency in the amount of black, asphaltic lube that is on the wire rope surface. In some areas, this thick, black lubricant covers the outer wires and fills the valleys between the strands… while other areas show no lubrication whatsoever… Regardless of the amount of lubricant on the outer surface of these wire ropes, the internal layers of strand wires, and most of the IWRC wires, are void of any lubrication and contain severe, pitting corrosion."*

The report concludes: " … *Corrosion has dramatically damaged all wires throughout the boom hoist wire rope, especially near the field breaking location. This damage has resulted in decreased wire rope diameter; worn wires in heavily corroded locations; loss of cross-sectional* *steel area, reduced ductility of the wires; reduced strength of the wires; and reduced overall strength of the wire rope. In summary, severe corrosion is the underlying cause for the boom hoist wire rope breaking…"*

"The severe pitting corrosion of the wires has established notching and stress risers in the grain boundaries of the metallurgical structure of the wires…

"Aside from significantly reducing the wire strengths and ductility … this pitting corrosion has established sites for the initiation of premature fatigue breaks. Wire fatigue breaks normally develop in a boom hoist wire rope toward the end of its useful service life; however the onslaught of this severe pitting corrosion has dramatically decreased the fatigue life of this wire rope.

"…The severe pitting corrosion is the result of this wire rope operating in salt water atmosphere (NaCL)… Other trace elements discovered… are insignificant and are not a noticeable contributing factor to the development of the pitting corrosion.

"Lack of proper lubrication, both internally and externally, has allowed the onset of severe pitting corrosion…."

Other wire ropes associated with the Crane were also examined and their condition was reported as follows:

- Pendant wire ropes – "…*No broken wires were discovered in these pendant wire ropes during the visual investigation, although there is corrosion on the outer wire surfaces..".*
- Main load line wire rope – "…*There are no noticeable broken wires or damaged areas…"*
- Auxiliary load line wire rope – "…*The outside end shows a total break of the wire rope which reportedly occurred subsequent to the boom hoist wire rope breaking. Visual observation reveals both tensile and shear wire breaks along with advanced surface corrosion…"*

The analyses and testing also found the following: "…*It was discovered that there was no evidence of chemical attack other than the chlorides from the salt water which resulted in severe* *iron oxide corrosion. Specifically, no evidence of H2S was discovered in any of the wire rope samples…"*

Crane Pre-Use Inspections

From information provided by the Operator, the pre-use inspection of the Crane was performed and documented as per standards in API RP 2D, prior to the first crane use of the day, prior to or during each change in crane operator, and then as the Qualified Crane Operator or Qualified Inspector deems necessary during the day for extended operations.

According to statements, ERT personnel routinely performed a pre-use visual walk-around of the Crane and lifting equipment, including examining components such as boom, turn-tables, lines and sheaves, in order to spot visible changed conditions since last use, or obvious hazardous conditions. These pre-use visual inspections were conducted at deck level, and did not afford the Platform personnel a close view of equipment at height, such as the Crane's boom or boom hoist wire ropes between the gantry and bridle sheaves.

ERT's pre-use inspections were conducted daily from January 2005 through August 2011. Pertinent wire rope issues excerpted from the ERT Daily Pre-Use Inspection Forms are summarized below (*see table III):*

Table III – Summary of ERT's Daily Pre-Use Crane Inspection Reports

Date	**Pertinent Cable Issues**
October 2006	The boom and fast line cables were replaced.
March 2007	The boom cable was greased.
April 2007	The boom cable was replaced.
August 2007	The fast line was repaired and the winch checked.
October 2007	A semi-annual crane inspection was performed.
December 2007	The cable lines were inspected with no flaws.
April 2008	Annual crane maintenance of the crane was performed.
May 2008 – July 2011	There is no mention of crane related maintenance/deficiencies.
August 16, 2011	The incident occurs, and the crane is taken out-of-service pending boom repair.

The Crane Operator stated that he and other crane operators performed daily pre-use inspections on the Crane, which entailed a visual inspection of the boom, balls and attaching hardware; checking the controls, the function of the crane, the wire ropes, the engine components and hydraulics, and any leaks. When a pre-use inspection was conducted, they used a paper form that listed each of the items to be checked, and they kept an electronic copy of each completed form on the computer for their records. They also kept a copy of the form inside the cab of the Crane.

According to statements, when a different person was assigned to operate the Crane, then the new crane operator would usually go back over the checklists previously completed by his predecessor (s). The Crane Operator stated that he conducted the pre-use inspection on the day of the incident and saw nothing abnormal.

Based on monthly hours of operation, the Crane was categorized as "Infrequent Usage" by ERT. Usage categories are defined by API RP 2D, Section 4.1.1 Crane Usage Categories (s*ee table IV*):

Table IV – API RP 2D Crane Usage and Inspection Requirements		
Category	**Usage**	**Inspection Required**
Infrequent	0 to 10 hours per month	• Pre-Use Inspection • Annual Inspection
Moderate	10 to 50 hours per month	• Pre-Use Inspection • Quarterly Inspection • Annual Inspection
Heavy	50+ hours per month	• Pre-Use Inspection • Monthly Inspection • Quarterly Inspection • Annual Inspection

Crane Infrequent Usage - API RP 2D Section 4.1.1.1 includes the following recommendations:

"…Infrequent Usage applies to those cranes that are used for 10 hours or less per month, based on the averaged use over a quarter. These cranes are subject to a Pre-Use Inspection and an Annual Inspection. Crane usage should be reviewed on a periodic basis by the Crane Owner to ensure proper inspection intervals.

"Note: Special attention should be given to wire rope on these cranes during pre-use inspections" [emphasis added].

BSEE Inspection of HI A557 A-Platform

Two BSEE Inspectors conducted an annual production sampling inspection on 11 July 2011. One Inspector stated he noticed the Platform's normal generator skid had the generator portion missing, and was told by Platform personnel that they had problems with the generator and had to send it in. The Inspectors performed a standard visual inspection of the Crane and witnessed testing of the anti-two blocks, boom hoist limitation, emergency engine shut-off and swing brake; the latter used to verify that the brake prevented the boom from rotating.

As per normal BSEE procedure, the Inspectors reviewed the Crane's paperwork such as documentation of the pre-use inspections, annual inspections, and the frequency of usage due to the pre-use inspections; which they later described as being in compliance.

Annual Crane Inspections

In October 2006, the boom hoist wire rope and auxiliary lines were replaced, with the boom hoist wire rope construction changed from the 0.75-in, 6x19 DBL 58,800 lbs to 0.75-in, 6x26 DBL 58,800 lbs. The reasons why the construction of the boom hoist wire rope was changed were unknown to ERT. The wire rope replacement was ordered by a third-party crane inspection company (Marine & Mainland), with no other components within the Crane's boom wire rope system being changed as noted by the inspection reports.

On 8 March 2007 ERT personnel identified a "flat spot" on the Crane's boom hoist wire rope. The boom hoist wire rope was inspected and recommended for replacement by Marine & Mainland on 15 March 2007. The boom hoist wire rope was replaced on 20 April 2007 by Marine & Mainland, with the replacement boom hoist wire rope manufactured in March 2006. This 2007 boom hoist wire rope was in place on the Crane at the time of the Accident. This new boom hoist wire rope construction was 0.75-in, 6x26 DBL 58,800 lbs.

On 22 April 2007, Marine & Mainland performed an annual inspection; with the replacement boom hoist wire rope passing the inspection, but the Crane's sheave arrangements failed the inspection. Pertinent to API RP 2D inspection requirements, the boom hoist wire rope diameter was measured as 0.752-in. The Crane's sheaves along with its pendant lines were replaced with all Crane lines lubricated on 25 May 2007 by Marine & Mainland.

In October 2007, pursuant to the requirements of API RP 2D, the Crane underwent a "heavy lift" inspection, performed by Marine & Mainland. As part of the heavy lift inspection, the Crane's weight indicator was verified and the boom hoist wire rope diameter was measured at 0.752-in.

ERT reported they completed a drilling program for the Platform in late 2007 and early 2008. During this program, a jack-up drilling rig was positioned over the Platform wells, and the Crane was used more frequently. This resulted in ERT's commissioning a "heavy use" inspection performed by Marine & Mainland on 15 January 2008. The inspection report states that as part of this inspection all Crane wire rope lines were lubricated, and the boom hoist wire rope diameter was measured at 0.750-in.

The 2008 annual inspection of the crane was completed on 16 April 2008, by Marine and Mainland. The Crane passed all parts of the inspection, except the load cell, which was subsequently re-charged. The inspection report states that as part of the 2008 annual inspection all Crane wire rope lines were lubricated, the dead-end was cut off the boom hoist wire rope, the socket was reattached, the crane was in "good" condition and the wire rope condition was "OK". At the time of this annual inspection, the boom hoist wire rope diameter was measured at 0.752-inches.

Due to the higher usage and pursuant to the requirements of API RP 2D, the Crane underwent a quarterly inspection in November 2008. The quarterly inspection was completed by a third-party crane inspection company (Platform Crane Services – PCS) on 23 November 2008. The Crane passed all parts of the inspection, although it was noted that the boom hoist wire rope was not spooling properly. This was corrected by removing and re-spooling the boom hoist wire rope. At the time of this quarterly inspection, the boom hoist wire rope diameter was measured at 0.755-in. API RP 2D sets forth a number of criteria which could require line replacement due to incorrect spooling; however, no indication was given in the quarterly inspection report of the presence of any such criteria.

The 2009 annual inspection of the Crane was completed on 17 March 2009 by PCS. The Crane passed the inspection and the boom hoist wire rope was rated to 26,598 lbs at a 30-ft boom radius.

At the time of the inspection, the boom hoist wire rope diameter was measured at 0.743-in, a decrease from the previous year, and the condition was noted as “good”. The Wire Rope Inspection Report also identified the line diameter measurements from the previous year.

The 2010 annual inspection of the Crane was completed on 24 February 2010 by a third-party crane inspection company (Cargotec USA, Inc. - Cargotec). The Crane passed the inspection, although it was noted that the certification tag for one of the pendant wire ropes was missing.

At the time of this annual inspection, the boom hoist wire rope diameter was measured at 0.78-in, an increase from the previous year, and the condition was noted as “good”. The inspection report states that the dead end of the boom hoist wire rope was cut off and all crane lines were lubricated; however, the Wire Rope Inspection Report did not identify the line diameter measurements from the previous year.

In July 2010, both of the Crane’s boom pendant wire ropes were replaced, as the certification for one of the lines was missing (as noted during the 2010 annual inspection). Replacement of the pendant wire ropes was completed on 20 July 2010 by Cargotec.

The 2011 annual inspection of the Crane was completed on 13 February 2011 by Cargotec. The Crane passed inspection and at the time of this inspection the boom hoist wire rope diameter was measured at 0.781-in. The inspection report states that the dead end of the boom hoist wire rope was cut off and all lines were lubricated.

The 2011 inspection report specifically noted that each of the Crane’s boom and sheaves (including the condition of all boom bolts), and all wire rope and hooks (including the boom hoist wire rope and the condition of line lubrication) were “OK”, with no items on the Crane being identified for repair or replacement. The individual Wire Rope Inspection Report characterized the boom hoist wire rope as “good”.

Through correspondence with Cargotec, the Cargotec Inspector indicated that the 2011 inspection checked for corrosion of the Crane’s wire ropes including internal corrosion. The company reported the inspector did so by turning the winch and inspecting the wire rope as the line came off the drum, stopping periodically for closer inspection, then repeated as the line went back on the drum. He also reportedly removed external strands from the dead end section that was cut more closely to inspect the core.

Upon review of the 2011 annual inspection report, ERT noted the Platform slings had not been inspected by Cargotec. ERT required Cargotec to return to the Platform to conduct a separate wire rope inspection that addressed the slings, with the inspection completed on 11 March 2011. In this separate report Cargotec noted "terminal rust" with two of the approximate ten slings on the Crane, with none relating to the Crane's boom or boom hoist wire rope.

A summary of the Annual Crane Inspections with pertinent boom hoist wire rope diameter data is outlined (*see table V*):

Table V - Annual Inspection of Boom Hoist Wire Rope Diameter Changes

Inspection Company	Date	Diameter (Inches)
Marine Mainland	April 22, 2007	0.752
Marine Mainland	October 25, 2007	0.752
Marine Mainland	16 April 2008	0.752
Platform Crane Services, Inc.	November 23, 2008	0.755
Platform Crane Services, Inc.	March 17, 2009	0.743
Platform Crane Services, Inc.	February 24, 2010	0.780
Cargotec USA, Inc./PCS	February 13, 2011	0.781

The measurement of the Crane's boom hoist wire rope diameter increased from both the 2009 to 2010 and 2010 to 2011 annual inspections. API RP 2D gives criteria for the measurement of reductions in line diameter, but not for diameter increases. Pursuant to API RP 2D, extensive external or internal permanent corrosion is viewed as a criterion for line replacement; however, no such corrosion was identified at the time of any annual inspections of the Crane. Additionally, the 2010 Crane Inspector did not indicate the previous year's wire rope diameter on their 2010 Wire Rope Inspection Report and therefore may not have noticed the nearly five percent (5%) increase in diameter from 0.743-in to 0.780-in from the previous year.

The Crane Operator stated that he believed he was present for the February 2011 inspection. He thought he saw them with a gauge tool on the fast line but did not recall seeing it used on the other lines. The Crane Operator said he believes one of the Cargotec inspectors climbed up on the boom and looked at the pendant wire ropes, but he did not see him looking at the other lines.

The Crane Operator stated that the Cargotec inspectors used a checklist, and the inspections included stripping the paint off the crane ball and magnum-flushing the cracks. The Crane Operator said the Cargotec inspectors looked at the Crane's wire rope on several occasions, but he could not tell how they gauged it. He stated that he saw the inspectors lubricate the Crane lines during their annual inspections. He indicated that if personnel onboard the Platform saw an issue with the lines in between third-party inspections, and thought wire ropes needed lubrication, then they did it themselves. However, the last time any Platform personnel recalled lubricating Crane lines was in 2010.

The "A" Operator stated that the Crane's lines were lubricated every annual inspection by the third-party inspectors. He stated that the lines would be lubricated by Platform personnel on an as-needed basis between inspections. However, he stated he had never lubricated Crane lines himself, nor had he ever seen anyone other than crane mechanics for Cargotec do it during annual inspections.

The "A" Operator stated that he had been in close proximity to inspectors during annual inspections of the Crane, but he was usually involved in other duties and did not closely monitor their activities. He stated he believes the inspectors looked at the lines closely, and he recalled that they ran a gauge down the fast line which was unspooled over hand rails down the side of the platform, but he did not see the gauge used on other lines.

The "A" Operator stated that he recalled seeing an inspector on the boom looking at pendant wire ropes because a JSA was performed and he thought he saw them using a gauge on the pendant lines. However, he did not recall if he was on site for the last annual inspection, and stated he was unsure whether this memory was of the 2010 or February 2011 annual inspection.

Correspondence from Cargotec stated that the inspector who conducted the annual inspection in February 2011 took measurements of the diameter of the boom hoist wire rope using dial calipers at the drum, before and after the sheave, between the winch and first gantry sheave, before the first bridle sheave and after the fourth bridle sheave. Additionally, the Cargotec correspondence noted the inspector examined the boom hoist wire rope by turning the winch and inspecting as the line came off the drum, stopping periodically for closer inspection, and then repeated the examination as the wire rope was spooled back on the drum. It was stated that he also tacked external strands off the dead end section that was cut to more closely inspect the core. Cargotec noted that the inspector walked out on the boom to examine the wire rope and take measurements at sheaves.

ERT Crane Personnel Qualifications

The Crane Operator received qualification for Crane Operator/Rigger Training on 24 February 2010, which expires on 24 February 2014. ERT reported that the Crane Operator had been employed by ERT for over nine years, was first crane qualified in 1995 and was Lead Operator of the crane since ERT purchased the Platform in 2002.

The “A” Operator stated that he was also a certified crane operator and rigger, and ERT Report reported that the “A” Operator had been working regularly on the Platform in the same capacity for over three years.

ERT reported that Rigger 2 had been employed by Wood Group approximately three months at the time of the incident, and had arrived on the Platform on 10 August 2011 and completed API 2D Rigger qualification.

The Crane Operator stated that everyone was trained to complete his role in the lift. He knew that the “A” Operator was qualified and had worked with Rigger 2 only a couple times; moving equipment and clearing equipment before the acid work.

Third-Party Inspector Qualifications

API RP 2D, Section 4.1.2.5 states the following: “*The Annual Inspections shall be performed once every twelve months. A Qualified Inspector shall perform this inspection and it applies to all cranes regardless of usage category.*”

According to API RP 2D,[1] Section 2.43, a "Qualified Inspector" is a ***"****person so designated by the employer who by reason of appropriate experience and training, has successfully completed classroom-type training on crane maintenance and troubleshooting; on hoist troubleshooting and overhaul; and on the structural aspects of offshore cranes, which gives a knowledge of structurally critical components and critical inspection areas."* The minimum training requirements are outlined in API RP 2D Appendix A2.

Additionally, individuals recognized by regulatory authorities ("Authorized Surveyors" or "certifying authorities") may conduct inspections of cranes pursuant to this edition, provided they meet the requirements of Appendix A2. With successful completion of this minimum training supplemented with requalification at a minimum of every four years, the inspector is considered qualified to perform the "Initial", "Pre-use", "Monthly", "Quarterly", and "Annual" inspections. The scope of these inspections is outlined in 4.1.2. It is not a requirement for a Qualified Inspector to also be a "Qualified Crane Operator."

As previously noted, the most recent complete inspection of the Platform's Crane prior to the Accident was by a Cargotec-employed Qualified Inspector in February 2011.[2] Cargotec reported that at the time of this inspection their inspector was a Qualified Inspector per the standards of API RP 2D, Section 2.43, and had been so qualified since April 2006. Cargotec reported that he had successfully completed Platform Crane Services, Inc.'s "Crane Inspector Seminar," which covered crane maintenance, troubleshooting, hoist, and overhaul; and had many years of hands-on experience inspecting cranes.

The Cargotec inspector had a certification card that identified him as an "Inspector for Marine Service" and "Man Riding Winches" that expired in July 2011, and a certification for a MacGregor Hydramarine Manrider Winch Service Course as a service technician for manrider winches in September 2008.

Cargotec reported that they considered their inspector to be a fully Qualified Inspector at the time of his February 2011 inspection of the Crane, based on his experience conducting inspections and his completion in April 2006 of the Crane Inspector Seminar (a requirement of API RP 2D).

[1] The 30 CFR § 250.108(a) states that, "All cranes installed on fixed platforms must be operated in accordance with The American Petroleum Institute's Recommended Practice for Operation and Maintenance of Offshore Cranes, API RP 2D (as incorporated by reference in §250.198)."
[2] A brief follow-up inspection of the slings was also conducted in March 2011.

It was written that the reason that he did not re-qualify for this course within four years was because at the time that he completed his training the additional qualification was only required every five years.

However, this was an erroneous understanding as API RP 2D, Fifth Edition states that requalification is to be renewed every four years, as does 30 CFR 250.108. Therefore, at the time of his February 2011 inspection of the Crane, the Cargotec Inspector had technically exceeded the time requirement for requalification by a few months.

SeaKing Crane Operation and Maintenance Manual

The SeaKing Crane Operation and Maintenance Manual recommends procedures that should be employed with this equipment. Excerpts are quoted below.

Lifting Loads

Page 1-1 Introduction of the manual: *"Even though the machine may appear capable of lifting loads greater than those listed on the load rating charts, never exceed the loads and/or conditions stated on these plates."*

Page 1-8 Capacity Rating Section: *"Manufacturer's ratings should never be exceeded. The stipulations pertinent to these ratings should always be carefully observed. If required conditions are not present, the full standard capacity ratings cannot be used and ratings must be adjusted downward to compensate for special hazards."*

Wire Rope Replacement

Page 1-3: *"A fully comprehensive and precise set of rules cannot be given for determination of exact time for rope replacement since many variable factors are involved. Safety in this respect depends largely upon the use of good judgment by competent maintenance personnel in evaluating rope strength in a used rope after allowance for deterioration disclosed by inspection…."*

"Boom hoist ropes should be inspected near dead end for breaks in heart of rope not visible from outside caused by vibrations."

"When replacing ropes, do not weld ends to seize them as this can cause premature failure. This is especially critical on the boom hoist dead end…."

Wire Rope Lubrication Excerpts

Page 5-1: *"The story of lubrication is: the correct lubricant, the right quantity, the right time and the proper application."*

Page 5-2 of the Lubrication Chart – Boom and Associated Equipment:

Interval Hours	Description	Number of Points	Lube Type	Qty.
8	Bridle Block Sheaves	1	MPG	6 shots
40	Gantry Sheaves	1	MPG	6 shots

"NOTE: MPG = Multi-Purpose Grease with an EP (extreme pressure) additive, and it must have a high resistance to water washout. Use Shell Darina #2 or equal."

Page 6-1 Reeving General Suggestions: *"Lubrication of wire rope is a must. Rust freezes the wires and strands of a wire rope, prevents them from working smoothly and causes the rope to break. In addition, dry wires and strands rub together and prematurely destroy the rope. Lubrication prevents rust and destructive internal abrasion."*

Page 6-2: *"Wire ropes are lubricated by the wire rope manufacturer but protection must be continued in the field. Lubricant must penetrate to the inside of rope to get a film of oil between the strands. It can be applied either hot or cold, depending on its penetrating quality. Refer to a local oil company engineer to find the best lubricant and application to fit your needs. There is no set rule on how often to lubricate wire ropes; it depends on service conditions. However, experience would indicate a good interval to be every 100 hours or less. Exposure to salt air may require more frequent lubrication."*

Lubricant Used

The Crane Operator stated that he saw the inspectors lubricating the Crane's lines during the annual inspection. He stated that if Platform personnel identified an issue with the lines in between annual inspections, they lubricated the lines themselves. He stated that he thought the last time Platform personnel on his hitch lubricated the lines was sometime last year.

The "A" Operator stated that he believed the lines were lubricated during annual inspections or by Platform personnel more frequently if the need was identified. He stated he had never lubricated the lines himself, nor had he ever seen anyone other than CargoTec Crane Mechanics lubricate them during annual inspections. He also stated he did not know what kind of lubricant was used on the lines.

The Crane Operator stated that the lubricant used on the lines was thick grease similar to wheel bearing grease, axle grease, or general purpose grease. He was not sure how the grease can was marked and stated he was unsure if the lubricant used was in fact wire rope lubricant. He stated the lubricant on the lines was what the inspectors used during the annual inspections because the Platform personnel asked the inspectors to leave what remained and it was then marked for use on the Crane's lines.

Neither Operator nor third party contractor's annual (or quarterly) inspection check list (s) , nor Operator's pre-use inspection forms, etc., recorded the specifics of the Crane's wire-rope lubrication, including date, methodology, personnel involved, amount of lubrication, brand and type of lubricant applied. API RP-2D does not address recording this information, nor do BSEE or USGC regulations require this information to be recorded.

Conclusions

The Accident

On 16 August 2011 at approximately *0815 hours*, the Platform personnel were using the Platform Crane to move a rental generator from the Platform onto a vessel. Two riggers were on deck, close to the load, using tag lines to stabilize the load. The lift weight was approximately 23,400 lbs or approximately 118 percent of the Crane's rated capacity. On the Platform deck in proximity to the generator were three tanks on the left side, and a barricaded lubricator attached to a wellhead, extending 14-ft above the deck, on the right side of the lift.

When the load was lifted, the Crane's boom hoist wire rope failed, the generator was dropped to the deck and the boom fell, striking the generator. The boom subsequently broke into three sections. One section remained attached to the crane, the middle section came to test on top of the generator, while the nose section continued overboard after breaking off completely from the rest of the boom. The main block hook detached when the hook assembly struck the generator, releasing the connection between the generator and the nose of the boom.

The falling boom nose dragged the attached bridle/sheaves and main load line behind it as it fell overboard, until its fall was arrested by the main load line and bridle pendant wire ropes. The 850-lb bridle struck the fallen boom and pulled by the nose, ricocheted off of the end of the middle section, finally coming to rest against the Platform toeboard. The rigger handling the left tag line was hit by the bridle and fatally injured.

Cause of Fatality

(1) The Crane's boom hoist wire rope parted due to being weakened by internal and external corrosion; with loss of integrity, ductility and strength. The advanced extent of this corrosion was visually evident when examined post-accident, and was confirmed by laboratory analyses. The line was over four years old.

(2) The vicinity of the lift was constrained by other equipment which caused the rigger to be positioned in the path of the falling boom.

Probable Contributing Causes

(3) The Crane's corroded and damaged boom hoist wire rope was found to be systemically lacking in internal lubrication, probably because of improper lubrication application, methodology, frequency, and improper lubricant type.

(4) The annual Crane inspection performed six months prior by an independent third party reported the lines to be "OK," and did not identify corrosion of the wire ropes. However, when examined after the accident, the boom hoist wire rope (and others) were found to have extensive corrosion that was obvious and advanced. It is probable that the annual inspection of the Crane conducted six months previous by a third party contractor did not include a comprehensive examination of the boom hoist wire rope.

(5) The positioning of other equipment in proximity to the lift, especially the 14-feet high (above the deck) lubricator, probably contributed to the decision to control the load with tag lines in the early stages of the lift.

(6) The positioning of tanks near the load probably caused the rigger stabilizing the load on that side to be positioned in an unsafe location in the path of the falling boom.

(7) The JSA probably did not address the best positioning of the riggers in the event of a boom hoist wire rope failure, or question the need for tag line control in the initial stage of the lift. Moving the interfering equipment prior to the lift was probably not discussed.

Possible Contributing Causes

(8) The Operator had no internal company manual or guidelines for Crane operations specifying procedures, use of tag lines, positioning of riggers, and pre-use crane inspections. Also, there were no internal Operator policies to insure the annual inspections by third parties comprehensively checked all components of the Crane. It is possible that an internal company policy for crane operations may have led to actions that prevented the incident.

(9) When the load fell, the main hook connecting boom and load detached from the stinger. This prevented the generator from anchoring the boom nose and thus limiting its fall overboard. It is possible that this may have contributed to the severity of the consequences of the Accident by allowing the bridle to be pulled all the way to the railing striking the rigger, rather than remaining atop the fallen boom.

(10) The Crane Operator and those supervising the lift possibly did not give special attention to the Crane's lines during the pre-use inspection as per the standards of API RP-2D.

Recommendations

Safety Alert

It is recommended that BSEE consider issuing a Safety Alert to operators that includes these elements:

1. *A brief description of the accident;*
2. *A summary of the causes; and*
3. *List the following recommendations to operators and their contractors:*

- Operators should review their methods of crane wire rope inspections to insure a full and comprehensive examination as per the standards of API RP-2D, in addition to:
    - Third party crane inspections should be cross-checked and verified by Operator personnel and procedures.
    - Coats of heavy grease on the crane cables should be removed during inspections so that the external and internal integrity of the lines to be examined.
    - Special attention should be given to indications of changing wire rope diameters (both increasing and decreasing).
    - Wire ropes should be lubricated with the proper original equipment manufacturer recommended lubricants, using recommended methodology, to insure full penetration by the lubricant.
- Operators should review the geography of equipment location prior to making a lift. Removing or relocating obstructing equipment prior to a lift in the interest of safety should be strongly considered.
- Operators should review the positioning of riggers using tag lines for all emergency contingencies.

The Panel recommends that the BSEE consider initiating a study, coordinated with API, to examine if wire rope lubrication data (date, personnel, method, type lubricant, etc.) should be recorded in crane records. The study should address whether requiring the recording of such data could result in improved maintenance with the possibility of fewer failures.