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Assessment Of The MODU *Rowan Gorilla I* Capsize And Sinking

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ABSTRACT

The *Rowan Gorilla I* was a Mobile Offshore Drilling Unit (MODU) fabricated in Mississippi by the Marathon Le Tourneau Shipyard, and completed in 1983. The jack-up spent its first 5 years following completion off the east coast of Halifax, Nova Scotia involved in drilling activities for several clients. After remaining dormant for several months due to a decline in offshore activity in the fall of 1988 the decision was made to relocate the unit.

On route to the North Sea, the unit, in tow by the tugboat *Smit London*, encountered unfavourable weather. The rig was down by the stern allowing waves to board the working deck. Green water reduced stability and compromised the water tight integrity of the deck. The following seas caused shock loading of the tow wire eventually leading to failure. The rig with stern facing the waves suffered severe impact loading for which it was not designed. Oscillating motions of the three 154 meter truss legs caused local hull fracturing resulting in ingress of water. The crew abandoned the rig after which it was observed to capsize and sink.

The marine casualty can be attributed to a combination of factors which include the design of the rig, regulatory standards, personnel experience, and negligence. The sequence of events leading up to the loss was not anticipated by either party involved in the tow. It is evident that better planning and closer adherence to recommendations prior to departure may have resulted in a different outcome.

The report to follow will outline the incident prologue and account, briefly discuss contributing factors, and outline the severity of loss, loss prevention and impact of the disaster. While conclusions have been included, enough detail is provided for the reader to execute their own assessment and draw relevant conclusions.

1 INTRODUCTION

The *Rowan Gorilla I* was a self-elevating MODU, or jack-up, fabricated in 1983 by the Marathon Le Tourneau Shipyard in Mississippi. The unit was designed and constructed in accordance with multiple standards which included the U.S. Coast Guard Regulations for MODUs, the American

Bureau of Shipping (ABS) Rules for Building and Classing Offshore Drilling Units, as well as the United Kingdom Department of Energy (DEN) Regulations for Offshore Installations. Upon completion the jack-up was certified by the U.S Coast Guard.

The *Rowan Gorilla I* was roughly 90 meters long, 89 meters wide, and 9 meters deep with a triangular hull design. The rig was equipped with three independent 154 meter legs of truss construction, as can be seen in below. The unit was owned and operated by Rowan Companies Inc. with homeport in Houston, Texas.

Figure 1-1: *Rowan Gorilla I* Profile [1]

2 MARINE CASUALTY

2.1 Incident Prologue

Following completion of the *Rowan Gorilla I* in 1983, Rowan Companies Inc. arranged to transport the rig to eastern Canada to engage in drilling activities. A survey was completed by a representative from J.K Tynan International Marine Surveyors to assess critical aspects of the upcoming transit and determine a suitable towing arrangement. Multiple recommendations were made concerning the tow which was consistent with the unit's operation manual. The surveyor recommended a tow vessel with a minimum continuous brake horsepower (BHP) of 20,000. The two vessels selected had a combined BHP of 21,760. The survey also recommended the retrofit of a temporary breakwater to the forward part of the rig. This recommendation was neglected and departure from Belle Chasse, Louisiana to Halifax, Nova Scotia took place on December 12th, 1983.

A week into the voyage on December 19th, a tow wire parted in rough weather. The MODU took on a trim by the stern where minor damage occurred from wave impact. Only days later the tow again encountered adverse conditions of roughly 40-50 knot winds and 4.5 meter swells where once again a tow wire parted. The busted wire allowed the unit to rotate into an unfavourable orientation where the aft end faced the oncoming waves. This resulted in boarding waves leading to damage of the shale shaker, numerous objects on deck, and the discovery of fractures on port and starboard bulkheads of the respective thruster rooms. Water was noted to ingress as the 154 meter legs moved with the waves. In addition, numerous voids and tanks were found to contain water, some of which was thought to have entered through damaged deck vents. The 154 meter legs, while stowed in transit condition roughly 4 meters below the hull, were lowered an additional 4 meters in an attempt to dampen the severe motions of the legs.

Despite the weather and damage sustained, the rig successfully arrived in Nova Scotia under tow by the two tugboats. During the crossing, a total of 3 tow wires had parted and the MODU had suffered

notable damage. Documentation from the Coast Guard classed the damage as minimal. No reports were filed dictating any casualty or structural failure had occurred by any party.

Before engaging in her maiden drilling operation, extensive work was completed to repair fractures in bulkheads and shell plating. Testimonials from the person in charge of the MODU indicated that the oscillating legs contributed to and/or amplified the problem were otherwise disregarded. Additionally, the correlation between rig orientation and induced damage was never drawn i.e. the majority of damages were sustained with the rigs stern facing the waves. No engineering study was commissioned or conducted to determine the exact cause of the fractures or mitigate future risk of similar damages. The *Rowan Gorilla I* went on to operate offshore Canada for multiple clients from 1983 onwards.

2.2 Incident Account

After the *Rowan* had remained dormant for several months due to a decrease in offshore activity in the fall of 1988 (5 years following its arrival), the high maintenance costs forced the decision to re-locate the unit to a more active region outside of eastern Canada. Noble Denton and Associates Inc. was contracted to survey the rig prior to departure. The recommendations were consistent with the U.S. Coast Guard (certifying authority) approved operation manual. The survey provided information on towing arrangement, stability, water tight integrity, securing equipment on deck and dangerous motions under tow. In addition, it was recommended the tow be performed by a tug of 22,000 continuous horsepower, and take place in good weather with receipt of an agreeable long range forecast. This survey, unlike the one performed by J.K Tynan International Marine Surveyors, had no mention of a breakwater being required.

In further preparation for the tow, Marine Safety Office (MSO) Boston conducted an examination with no outstanding deficiencies noted. ABS also completed hull, load line and drydock equivalent surveys with no outstanding deficiencies. Given the possibility of a contract to move the unit to the North Sea, Smit Tak was contacted to secure towing services. With only a weeks' notice, the rig superintendent in charge of the jack-up stated compliance with the departure recommendations from Noble Denton. All equipment required to engage in drilling operations was properly secured and any items requiring protection were relocated. All four of the enclosed lifesaving capsules were removed from their davits and stowed elsewhere. Upon inspection by the Canadian Coast Guard, it was noted that lifesaving capsules had been removed without Coast Guard permission. Two of the four capsules were re-connected to their davits prior to departure.

The M/V Smit London tugboat arrived in Halifax on December 6th 1988. The towing vessel and equipment was considered to be in excellent order. The captain admitted to having never towed MODUs across the Atlantic as a captain, but had done so as a mate. A certificate of approval for the tow was issued by Noble Denton. Stability was assessed for the ocean transit and was in accordance with Coast Guard requirements. While Noble Denton recommended at least 15 riders, 26 personnel were selected.

Forecasts received on the *Smit London* indicated a 36 hour window of fair weather required for the departure. It was assumed the tug would monitor weather and advise accordingly. There was however no discussion between the tug and *Rowan Gorilla I* about the Noble Denton instruction of long range forecasting.

Departure from Halifax took place December 8th, 1988. At this point the final destination was still undecided between the North Sea and Trinidad. While the first week of the voyage was unexciting, on December 13th a winter storm generated 60 knot winds and swells of over 12 meters. The pitch and roll of the rig resulted in the legs being lowered to storm condition, roughly 8 meters below the hull.

This was consistent with the leg location on the initial voyage to Halifax which helped to minimize stresses and dampen motions. The cruel wind and waves resulted in severe oscillations of the rig's legs which transferred enormous stresses to the surrounding hull as the waves impacted the stern and rear quarters. Due to an approaching storm with estimates of 50-65 knot winds, the tow course was altered in an attempt to avoid the system.

Flooding was soon detected during a routine tank sounding; the only way to assess the condition of tanks was sounding tubes on the main deck. Fractures and a cyclic spray of water were witnessed in numerous tanks as the rig was pounded by waves. The hull had begun to fracture locally and propagate throughout, resulting in the flooding of storage tanks at the stern of the rig. The enormous drag of the MODU as it clambered through the waves resulted in the decision to turn and ride with the seas.

An attempt at executing repairs while in tow by means of installing plates over cracks in the tanks was halted by the now routine breaking waves over the stern of the rig, resulting in water running into the tanks. The same seas prevented the crew from checking tank covers as it was no longer safe to go on deck. The following seas were causing immense cyclic loading on the tow wires; tow wire gauges were reported to fluctuate between 0 and 280 metric tons as the tow encountered 12 meter waves. Cargo had come loose and was now sliding across the main deck.

After days of abuse, the tow line from the tug broke while the 26 risers on the rig struggled to control the flooding. By December 15th, the captain of the *Smit London* noticed the MODU was severely trimmed by the stern and warned the rig superintendent of the imminent danger of sinking. As a series of waves approximately 15 – 18 meters high pounded the rig, the remaining cargo was extricated and the stern hung below the seas. The crew was ordered to abandon the rig and only hours later, the *Rowan Gorilla I* was observed capsizing on its aft legs. The position was noted to be approximately 30º 56'N, 52º 47'W, in roughly 4900 meters of water. Figure 2-1 shows the relative location of the casualty.

Figure 2-1: Location of Rowan Gorilla I Disaster

(Credit: Google Maps)

3 MARINE CASUALTY ASSESSMENT

With the events leading up the casualty considered, major influential factors which resulted in the sinking of the *Rowan Gorilla I* can effectively be assessed. The sections to follow will briefly discuss how the rig design, personnel experience, and regulatory standards all played a unique role in the incident.

3.1 Design of the *Rowan Gorilla I*

The belief that the greatest loads and stresses on the legs of the rig occur while in an elevated condition is inaccurate. There is no evidence that any of the damage to the *Rowan Gorilla I* occurred while operating in the raised condition. Evidence does however exist to support that leg stresses during transit are more severe. Marathon Letourneau, who designed the jack-up, claimed that this view was considered during the design but it is unclear whether or not this is true. If it was considered, the design was still inadequate given the events that unfolded.

The deck layout, designed to carry cargo and equipment on an otherwise unprotected deck, proved to be an unwise design given the severe loading due to waves boarding the rig. This green water reduced stability as well as dislocated the majority of the deck cargo, creating numerous downflooding points. The damage caused by the moving cargo was extensive; therefore the forces from both the water on deck and shifting cargo were underestimated. Locations of downflooding points are indicated by the shaded black circles and squares in Figure 3-1.

The only means of sounding tanks that could not be entered were sounding tubes on deck, and given the deck was unsafe for personnel in severe conditions, no secondary means of assessing the contents of the tanks existed. In spaces that the crew could physically enter, flooding was controlled however given the notable trim by the stern of the rig, clearly an unknown amount of inaccessible space had taken on water.

Lastly, while the rig was designed with a bilge pump system, it was never intended to act as a ballast pump system. It was therefore inadequate and unable to handle the flooding of numerous compartments.

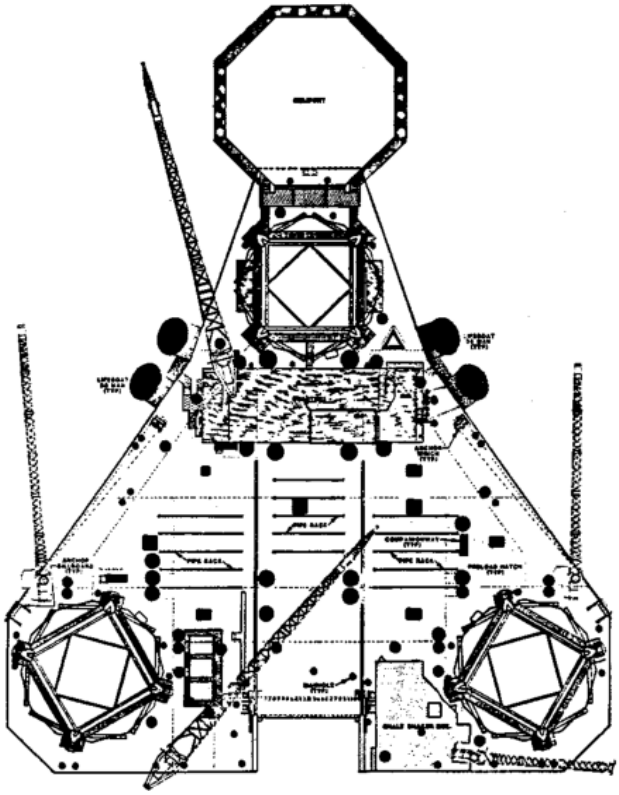

Figure 3-1: Location of *Rowan Gorilla I* Downflooding Points [1]

3.2 Regulatory Standards

In addition to issues with the actual design of the jack-up, there is evidence which may indicate that stability standards developed by the U.S. Coast Guard may be inadequate for jack-ups in conditions other than raised. While the stability requirements see the application of 70-100 knot winds in intact conditions, this does not account for any dynamic effects induced by the wind and wave action.

Adherence to the regulatory standards resulted in a jack-up that was not compliant with realistic sea conditions it would encounter. This is further reinforced by the fact that prior to departure the rig was perfectly compliant with the U.S. Coast Guard Operation Manual (which included stability requirements) and was issued a certificate to sail by Noble Denton.

3.3 Personnel Experience

While the rig design and regulatory standards played a role in the casualty, so did lack of experience of the personnel involved. The captain of the *Smit London* tug boat was unfamiliar with towing jack-up rigs as a master and in an attempt to avoid severe weather, navigated with the seas. The following seas induced intense cyclic loading of the tow wire, resulting in failure. The tension indicator was fluctuating between 0 and 280 tons throughout the tow indicating severe shock loading. In addition, the following seas exposed the stern of the rig to intense impact loading. The low freeboard compared to the huge waves provided the rig no protection from the elements. If the rig had to of remained in a position with its bow into the seas, some of the water that covered the deck may have been discarded. If temporary breakwaters were installed as recommended originally on the tow to Halifax, loading could have been reduced significantly. Additionally, it no one was aware that the stern of the rig shouldn't have been exposed to the seas.

The decision to tow the rig across the North Atlantic in the heart of winter was risky regardless, but an alternative means of transit may have been considered such as a heavy lift vessel (HLV). Given the owners extensive towing experience, it was ignored that on the initial tow to Halifax, serious damage was sustained on the same crossing.

During the tow, it was recommended by Noble Denton that long range forecasting be used to monitor and avoid harsh weather. Rowan Companies Inc. relied on Smit Tak to take this responsibility however the *Smit London* only received data from weather services with 36 hour accuracy. The individuals involved could have been more diligent in planning the transit.

3.4 Casualty Summary

Given the contributing factors discussed above, the immediate cause of the casualty was the unanticipated and uncontrolled downflooding into a large but unknown number of interior voids and tanks. This resulted in loss of stability leading to capsize, and loss of positive buoyancy leading up to the sinking. The fracturing from the severe weather conditions and oscillations of the legs both compromised the structural integrity of the rig, and allowed the ingress of water. This flooding reduced the freeboard of the rig, and further exposed the main deck to waves and green water. Green water, while reducing stability also compromised the watertight integrity of the deck. Damage to tank vents, access hatches, and fittings caused by hydrostatic pressures from water on deck, along with shifting cargo effectively created extensive downflooding points.

4 SEVERITY OF LOSS

Once the seas had subsided, all 26 personnel were safely rescued from the lifesaving capsule by the *Smit London*, with aid from a Canadian Forces Long Range Search and Rescue Aircraft, known as an *Aurora*, shown in Figure 4-1. While the lifesaving capsule had no exterior light, the *Aurora* eliminated the area, allowing the *Smit London* to remain in close courters prior to and during the rescue. Transfers from the life capsule to the tug lasted roughly an hour. There were no injuries to the crew aside from minor seasickness.

Figure 4-1: Canadian Forces Aurora SAR Aircraft

(Credit: www.airforce-technology.com)

Environmental loss was minimal considering the *Rowan Gorilla I* had not been active in months. It is unknown what the volume of fluids or contaminates onboard at the time of the sinking actually was. The estimated value of the unit at the time of the loss was in excess of USD $90 million.

5 LOSS PREVENTION

Before either departure took place, the *Rowan Gorilla I* received an inspection certificate. This indicated that the unit was fit for ocean transit. It was apparent following the initial tow to Halifax that the structural integrity of the unit was comprised during the voyage. These damages were repaired however the cause was not clearly defined. Even though the physical issues, i.e. fractures, were addressed, the problem causing the damage was not isolated.

The legs were said to contribute to the stress cracking of the bulkheads and tank plating, however this was not confirmed by any form of engineering analyses or study. It was stated that the legs may have exceeded design limitations but there were no means of verification. The cause(s) of the structural damage were never pinpointed (or mitigated), so when the unit went to sea for transit to the North Sea, it risked suffering the same damage that was repaired following the first tow to Halifax.

The towing wire, although relatively new, was never strength tested and received only a visual inspection prior to use. Given the tow wire failed during transit, more care could have been taken in certifying the equipment prior to departure.

6 IMPACT

The marine casualty effectively drew attention to the design codes and regulations in which the vessel was designed and operated according to. This is indicative of a need for more comprehensive analysis methods that account for joint motions of coupled structures and thus stresses that one imposes on the other.

The minimum credentials required to be considered a mariner may not be conservative enough considering the events that unfolded. The selection of key personnel as well as verification of experience and competence could be more thoroughly investigated. It is clear by the actions and demeanour of the *Rowan Gorilla I* crew during the disaster, that formal emergency training is critical in ensuring the safety of crew at sea.

7 CONCLUSION

The *Rowan Gorilla I* capsized and sank on December 15th, 1988, roughly 500 nautical miles Southwest of Halifax, Nova Scotia. The immediate cause of the casualty was the uncontrolled downflooding of a number of interior voids and tanks. This resulted in loss of stability and positive buoyancy leading up to the sinking. Many factors effectively contributed to the loss, namely the rig design, inadequate regulatory standards, lack of experience throughout the parties involved as well as potential negligence.

It can be seen from the study that no single contributing factor resulted in the loss of the *Rowan Gorilla I*. The unfortunate series of events that unfolded could not have been anticipated by either party. Noble Denton, ABS and the U.S. Coast Guard performed inspections, examinations and surveys prior to departure and found no deficiencies, indicating that the tug, MODU, and towing arrangement were fit for departure.

The severity of loss was largely economic as the 26 personnel aboard the MODU escaped with their lives. The disaster could have been a lot worse if it wasn't for the lifesaving equipment, formal emergency training of individuals aboard the rig, recommendations from the captain of the tug, as well as timely decision to abandon the rig made by the rig superintendent.

The casualty portrays the fact that minimum requirements dictated by regulatory standards may not be adequate, even the best designs can have unanticipated issues, and the human factor i.e. experience and decisions made play a huge role in the outcome of any operation, especially in times of distress. Unfortunately there are many unknowns as well as conflicting information, however many lessons can be learned to avoid future disasters.

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