

Canada – Nova Scotia

Offshore Petroleum Board

Review Report Summary

Dropped Riser Incident

Cheshire L-97 Exploration Well

**Shell Canada's Shelburne Venture Exploration
Drilling Project**

March 2016

22 June 2016

Table of Contents

1.0	Summary	2
2.0	Regulatory Framework	4
3.0	CNSOPB Incident Review	7
4.0	Review Findings	11
5.0	Decision Respecting a Return to Drilling	11
	Appendix I – Diagram of Riser.....	12
	Appendix II – Acronyms / Definitions	13

1.0 Summary

At 15:24 on Saturday, 05 March 2016, the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) was notified of an incident on the Stena IceMAX drillship that was drilling the Cheshire L-97 exploration well in the Canada-Nova Scotia offshore area for Shell Canada. After successfully securing the well and disconnecting to ride out heavy weather, the riser system (consisting of approximately 2100 metres of 21" diameter steel pipe and a lower marine riser package and affixed buoyancy modules) was dropped to the seafloor.

There were no injuries to any person. There was no discharge of either well fluids or synthetic oil based drilling fluids to the environment. Prior to the incident, the well had been secured with two barriers, a downhole plug, and the Blow-Out Preventer (BOP), as required by regulations administered by the CNSOPB. Both barriers remained intact for the full period of time during which drilling operations were suspended as a result of this incident.

Leading up to the weekend of Saturday, 05 March 2016, the crew of the Stena IceMAX received weather forecasts indicating worsening sea conditions approaching its location at the Cheshire L-97 Well. The worst conditions were forecast for the afternoon of the 5th.

Two days in advance the decision was made to secure the well, to prepare for disconnecting the riser system and to move away from the well to ride out the weather should vessel heave exceed the operational limits established for the Stena IceMAX. These limits are detailed in supporting documentation submitted to the CNSOPB in Shell Canada's application for authorization to drill exploration wells as part of its Shelburne Basin Venture Exploration Drilling Project.

Securing the well and disconnecting (or unlatching) requires a number of steps to prevent the discharge of well fluids and/or synthetic oil based drilling fluids to the environment. The first involves installing and testing a plug downhole from the wellhead called a Retrievable Test, Treat, and Squeeze (RTTS) packer. The second is activating the BOP by closing the blind shear rams. These steps provide the double-barrier required by the regulations administered by the CNSOPB to secure the well.

Then to secure the riser, the synthetic oil based drilling fluids within the riser are pumped to the drillship and replaced with sea water. This ensures that no drilling fluids are lost to the environment should the riser system need to be disconnected from the well at the Lower Marine Riser Package (LMRP), leaving the BOP in place at the wellhead.

On the morning of 05 March, with the well secured, and the forecast predicting lower sea states than predicted the day before, the crew of the Stena IceMAX was prepared to ride out the weather with the riser system attached. However, at mid-afternoon the vessel experienced a heave exceeding the established criteria necessitating a disconnect from the well, and the decision was made to immediately do so and move away from the BOP with the riser system attached to the vessel, a standard precaution.

The LMRP was successfully unlatched from the BOP at approximately 15:15. The vessel was moved slowly astern away from the well location to provide a safe distance between the BOP and the LMRP attached to the bottom of the riser.

This was a controlled and planned maneuver taken as a precaution to ride out heavy seas. The further vessel move was intentional creating more clearance between the LMRP and the seabed.

Air was intentionally added to fully retract the tensioners that hold the riser on the drillship to provide maximum clearance between the bottom of the LMRP and the BOP. In addition, the Riser Anti-Recoil System (RARS) was inactivated. In the heavy seas, the rise and fall of the riser began to differ from the heave of the vessel and in its fully retracted state, the tensioner system was unable to compensate for the difference causing the riser and LMRP to be released and drop to the sea floor.

The Local Incident Command System on the rig and in the Shell Halifax office was initiated. The CNSOPB and the Joint Rescue Coordination Centre were informed immediately.

No one was injured. No well fluids or synthetic oil based drilling fluid was released. The well was secured using two barriers. Vessel integrity was not impacted.

When weather permitted, a Remotely Operated underwater Vehicle (ROV) was launched from the drill ship. It inspected the BOP and reported no damage or integrity issues and that the BOP remained securely connected to the wellhead. The LMRP had landed approximately 22 metres from the BOP with the riser randomly coiled around the wellsite to a maximum distance of about 250 metres.

The CNSOPB immediately began its review of the incident. Shortly after the incident, two of its senior advisors (including an Operational Safety Officer) were on site for a complete review of the incident, and to gather pertinent information. The CNSOPB established an internal review team and contracted independent experts (Aberdeen Drilling Management) to assist in its review.

Shell assembled an independent investigation team composed of Shell and Stena representatives outside of the local organization who were dispatched to the IceMAX.

The CNSOPB's internal review team constantly monitored the Shell investigation. Its review included the questioning of findings, seeking further clarifications, requesting additional actions, numerous meetings and additional site visits.

The CNSOPB's goals for reviewing an incident such as this are to ensure that the cause or causes of an incident are properly investigated and identified. Then, the focus shifts to making sure that both the operator and the CNSOPB learn all it can from the incident, noting any areas for which corrective actions are necessary along with other areas that could be improved to help prevent similar incidents in the future. Additionally, the CNSOPB determines if additional regulatory actions are required, and what steps an operator would need to take in order to demonstrate to the satisfaction of the CNSOPB that operations could resume safely.

2.0 Regulatory Framework

2.1 CNSOPB Authority

The CNSOPB was established in 1990 by the proclamation of the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*, S.C. 1988, c.28 by the Government of Canada, and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act*, S.N.S. 1987, c. 3 by the Province of Nova Scotia.

The CNSOPB is an independent body responsible for the regulation of petroleum activities in the Canada-Nova Scotia Offshore Area on behalf of the federal and provincial governments.

2.2 Legislative and Regulatory Considerations

Section 140 of the Accord Act (federal version) requires an entity undertaking any activity related to exploring, drilling, producing, conserving, processing or transporting petroleum in the Canada-Nova Scotia Offshore Area to have a prior authorization issued by the CNSOPB.

Exploratory drilling activities must comply with the *Nova Scotia Offshore Petroleum Drilling and Production Regulations*. The CNSOPB, in conjunction with the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) have jointly issued *Drilling and Production Guidelines*, the purpose of which is to provide assistance to interested parties in understanding the requirements of the aforementioned regulations and how those requirements can be met.

These regulations specifically require an operator to have both an authorization for the overall drilling program, and a well approval for each well that is to be drilled.

Applications for drilling program authorizations and associated well approvals require submission to the CNSOPB of an environmental assessment; an environmental protection plan; safety plan; emergency response / contingency plans; spill response plan; financial documentation; benefits plan; and a Certificate of Fitness for the drilling installation that is issued by a recognized Certifying Authority.

Certifying Authorities are designated under the *Nova Scotia Offshore Certificate of Fitness Regulations* to conduct examinations of the design, construction, transportation and installation or establishment of such installations as drill ships so as to issue a Certificate of Fitness. Such certificates state that an installation complies with the relevant regulations, is fit for purpose, and can be operated safely and without polluting the environment. In the case of the Stena IceMAX, the Certifying Authority is DNV GL.

In addition, a declaration is required from the operator stating that equipment and installations are fit for their intended purposes; that operating procedures are appropriate; and that personnel are qualified and competent for their employment. The drilling program authorization application furthermore describes the equipment and procedures to be used for the drilling of the wells. The well approval

application details the actual well design, drilling fluids to be used, and the proposed total depth of the well.

As part of the regulatory framework, the CNSOPB, in conjunction with the National Energy Board and the C-NLOPB has established *Offshore Waste Treatment Guidelines* (OWTG) and the *Offshore Chemical Selection Guidelines* (OCSG). These guidelines were developed to minimize the potential environmental impact of activities. They outline which discharges are prohibited, and what treatments are required for certain permitted discharges.

The drilling program authorization was issued to Shell Canada on 19 October 2015 and includes a plan to drill one well on Exploration Licence (EL) 2426 and one well on EL 2424. The well approval for the Cheshire L-97 well was issued on 20 October 2015.

2.3 Incident Response Protocol

Upon notification of an incident, an officer is assigned to the file to lead the CNSOPB's incident response and follow-up. This lead officer assembles a technical team of people with expertise in the specifics of the operations affected by the incident.

For the dropped riser incident, this included in-house engineering, safety and environmental specialists, and outside contracted technical specialists (Aberdeen Drilling Management) to supplement CNSOPB expertise. Shortly after the incident, the assigned lead officer, and the CNSOPB's drilling engineering specialist, were dispatched to the Stena IceMAX to gather facts and relevant information.

This technical team closely monitored the investigation by performing ongoing detailed reviews of draft investigation reports, requesting clarifications, identifying deficiencies, and challenging conclusions until the team was satisfied that the:

- incident itself was well understood, and that its description was complete and accurate.
- investigation properly considered the facts and information gathered by the CNSOPB's technical team.
- root cause(s) and contributing factors were correctly identified.
- corrective action(s) were identified and implemented to correct the root cause(s).

The CNSOPB review team followed-up to make sure all corrective actions had been properly and fully implemented. The team also must determine if further or future regulatory actions or changes are required.

Given that operations were suspended as a result of the incident, the CNSOPB team determined any additional regulatory reviews that needed completion and any additional assurances that were required from the Operator, before consideration could be given to resuming operations and under what, if any, restrictions.

In addition, as with any incident, the Chief Safety Officer (CSO) was kept apprised throughout the investigation and review, as the CSO must ultimately provide a recommendation as to whether operations are safe to resume.

3.0 CNSOPB Incident Review

As the responsible regulatory authority, the CNSOPB duty officer was notified immediately of the dropped riser incident on the Stena IceMAX. On Saturday, 05 March 2016, the duty officer was the CNSOPB's Chief Safety Officer. He immediately notified the Director, Operations/Health Safety and Environment, who in turn notified the CEO.

It was confirmed that no one was injured and there was no spill of well fluids or synthetic oil-based drilling fluid to the environment as a result of the dropped riser incident. The duty officer continued to monitor the situation during the weekend. The executive team met to discuss the incident first thing Monday morning, 07 March 2016, and designated a lead officer and an incident review team.

The review team met with Shell officials on Monday, 07 March 2016, in the operator's Halifax office. They reviewed the incident report, the damage to equipment, and were given an explanation of known vessel / BOP / Riser condition at that time and confirmed well integrity.

Two key members of the CNSOPB team travelled to the Stena IceMAX on 08 March 2016. The CNSOPB's Advisor Drilling and its Advisor Facilities, who is also an Operational Safety Officer, spent two days on the drillship. This first visit to the facility included interviews with key personnel on board, examination of damage, review of processes and procedures, collecting of reports and evidence, and further assurance of well integrity confirming that the dropped riser did not impact the BOP or wellhead.

The CNSOPB representatives were given full access to the drillship, spending time in the moonpool area inspecting damaged equipment and taking evidence photographs. Separate in-depth interviews were conducted with the Offshore Installation Manager (OIM), and other key personnel including the Senior Subsea Engineer, Senior Toolpush, Dynamic Positioning (DP) Operators, and Safety Officers. The CNSOPB officers met with the ROV crew (Remotely Operated underwater Vehicle) to review a survey of the seabed taken after the incident confirming well integrity, that the BOP was not impacted, and the location of the dropped riser.

These interviews gathered accounts of the event from different operational aspects including weather conditions, position of crew members, and actions taken before, during and after the incident. Follow up interviews were conducted to ask questions of clarification and to gather equipment information.

This first-hand site survey and interviews confirmed for the CNSOPB that there was no ongoing threat to the environment, drillship, its personnel, or well integrity. The CNSOPB representatives were informed of the discharge of BOP fluids, the loss of nine buoyancy modules (one recovered within days), and that some additional buoyancy modules were loosened as the riser dropped to the sea floor and could pose a low risk of disconnecting.

Before the CNSOPB representatives departed the Stena IceMAX, officials with the Certifying Authority, DNV GL, arrived on board. Their Scope of Work was discussed and the CNSOPB Advisors shared their initial observations. It was determined conditions would be imposed on the Stena IceMAX that would restrict its ability to return to drilling operations.

Therefore, DNV GL, as the independent Certifying Authority and the governing Class Society, would examine all new equipment needed and all repairs on the drillship. The Certificate of Fitness would be amended by the Certifying Authority until such time as the rig was again considered "Fit for Purpose".

On return to shore, the CNSOPB Advisors reviewed their notes and observations. Procedures were reviewed to ensure consistency of what was learned during the interviews offshore and the regulatory filings provided in the supporting documents for the drilling program authorization and well approval applications. The CNSOPB engaged independent, outside, world-class expertise in deep-water drilling to provide additional support. Aberdeen Drilling Management worked with the CNSOPB in the review of the incident, the work procedures, the investigation report and an assurance plan that CNSOPB required from Shell Canada, to determine whether drilling can be safely resumed, and, if so, under what conditions.

Aberdeen Drilling Management has decades of experience in offshore drilling, particularly in the North Sea. It has built a global reputation in a range of support services including technical audits, project and operational management, technical mentoring, and is called on as an Independent Expert Witness under different International Rules of Arbitration.

The CNSOPB did not just limit its work to the detailed and thorough review of reports and findings. CNSOPB representatives also examined replacement equipment as it arrived in the province including a review of procedures and a visit to the facility used for welding the high pressure piping damaged during the incident.

During the initial stages of its investigation into the incident, CNSOPB staff determined that, as a direct consequence of the loss of the riser system, there was an associated loss of BOP control fluid. This fluid, which is used to operate the BOP, is pumped from a mixing unit located on the drill ship to the BOP on the seafloor through small diameter supply and return conduit lines that are attached to the riser string.

BOP control fluid consists of 86% water, 10% glycol and 4% Erifon HD 603HP. Erifon HD603 is a water based fluid specifically formulated for use in high-pressure BOP control systems. The fluid is designed to prevent valves within the BOP from sticking which could otherwise occur due to its infrequent use, and it improves BOP system life.

With the loss of the riser system, the BOP control fluid contained in the supply and return conduit lines connected to the riser has been lost in its entirety. This fluid remains either within the conduit lines attached to the riser on the seabed, or has been discharged to the sea. The volume of BOP control fluid loss was calculated as follows: 37,446 litres water, 4,354 litres of glycol and 1,742 litres of Erifon HD 603HP.

BOP control fluid is routinely discharged each time the BOP is function tested. Such testing is required pursuant to regulation. Additionally, the full volume of BOP control fluid is discharged when the BOP is retrieved to surface at the end of each well, and at any time the BOP needs to be retrieved for maintenance or repair. This is consistent with global drilling practices. Discharges of BOP control fluids are contemplated in the Environmental Protection Plan submitted to, and accepted by the Board. In authorizing such discharges, an assessment of the constituent components in BOP control fluid was carried out to determine permissibility against criteria set out in the Board's *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands* (OCSG). This assessment concluded that all constituents are acceptable for use and discharge.

During the CNSOPB's review of this incident, it was determined that the Environmental Protection Plan filed by Shell Canada for this drilling program did not contemplate all batch BOP control fluid discharges that will occur, and other unplanned batch discharges that may occur, during the drilling of a well. A revised Environmental Protection Plan has now been submitted and accepted by the CNSOPB.

Meetings between the CNSOPB team and key personnel from the operator continued through March, April, May and June. Drafts of the investigation report from the operator were reviewed and challenged with further clarifications required. In late April, another visit was made to the Stena IceMAX by senior CNSOPB staff to examine the repair work and speak with offshore personnel.

The Stena IceMAX returned to the wellsite early in June to conduct ROV surveys, retrieve six loosened buoyancy modules and test the repaired and new equipment. The CNSOPB Advisor Drilling visited the drillship to witness the testing of equipment and procedures. This inspection included officials from the Certifying Authority and the Operator. The CNSOPB Advisor also interviewed senior drilling personnel to review the latest procedures, training and forecast protocols. Once again the Advisor was given full access to the drillship. This included a review of the repaired and replaced equipment and an explanation of how repairs and replacements were completed.

The operator was required to provide an Assurance Report to satisfy the CNSOPB that processes and procedures are in place, and the Stena IceMAX is fit to return to operations.

It was only after key questions were answered, challenges were addressed, and assurances were completed, that the CNSOPB determined whether and under what conditions operations would or could resume.

3.1 Assurance Report

The CNSOPB technical review team identified the necessity for the operator to provide an Assurance Plan (with supporting documentation) in addition to a final investigation report. The objective of the Assurance Plan is for the operator to demonstrate to the satisfaction of the CNSOPB that operations can be safely resumed on the Cheshire L-97 well. It is based on the lessons learned from the incident and incorporates the corrective actions taken in response to those learnings. Assurance was required around the following key aspects of the incident:

1. Equipment – That all repaired and replacement equipment is certified, installed, commissioned, tested and compliant.
2. Procedures – That procedures and operational criteria are reviewed and amended, where applicable, with specific focus on updated disconnect procedures and the use of weather forecasting.
3. Training and competency – That people are trained and fully aware of changes to procedures, their roles and responsibilities, and are specifically aware of weather related disconnect criteria. In addition, disconnect drills and simulations are conducted to ensure that personnel in positions critical to the disconnect process are fully conversant with revised procedures.
4. Risk Management – That a review of the incident investigation findings and learnings related to equipment, work procedures, and personnel competency be conducted to ensure risks are ALARP (as low as reasonably practicable).

In the months following the incident, the CNSOPB required the operator to work through a list of actions that needed to be completed as the CNSOPB determined whether operations could resume. All actions were tracked and confirmed completed before determination of whether drilling could resume.

The following are an example of some of the changes made as the operator worked through the Assurance Plan for the CNSOPB:

- The procedure is changed so that the Riser Anti-Recoil System (RARS) is not to be reset in transition phase
- That riser tensioners are to be maintained in compensating mode at all times
- Rig offsets are to be calculated and used during disconnect operations to improve recoil performance & accelerate LMRP offset from lower BOP
- Testing be conducted to verify the revised disconnect procedures
- There be documentation of structured weather decision-making meetings
- Training be conducted for the revised disconnect procedures
- Additional workshops & training sessions for revised/new procedures
- Additional specialist sessions be held with specific subject-matter experts
- Desktop exercises/drills in disconnect procedures be held on a regular basis
- Verification that there is crew readiness and understanding of procedures, roles and responsibilities through disconnect testing

These corrective actions occurred over months and included verification of completion by CNSOPB staff.

4.0 Review Findings

The investigation identified two key contributing factors to the incident on 05 March 2016: The heave of the vessel and the inability of the riser tensioner system to compensate for the difference in movement between the riser and the vessel with the tensioner system in a fully retracted position and with the Riser Anti-Recoil System (RARS) inactive.

Shortly after the LMRP had successfully disconnected from the well, as a precaution to maximize the clearance between the BOP and the riser, the tensioner system was deliberately and fully retracted. In this retracted position, the tensioner riser system was unable to compensate the relative motion between the heaving vessel and the downward motion of the riser -- ultimately causing the riser and the lower marine riser package to release as the drillship was moving away from the well.

5.0 Decision Respecting a Return to Drilling

With the completion of the investigation into what happened and why, the identification of corrective actions, and the completion of all action items addressed in the Assurance Plan, the CNSOPB has permitted Shell Canada to resume drilling its Cheshire L-97 exploration well, under the following condition:

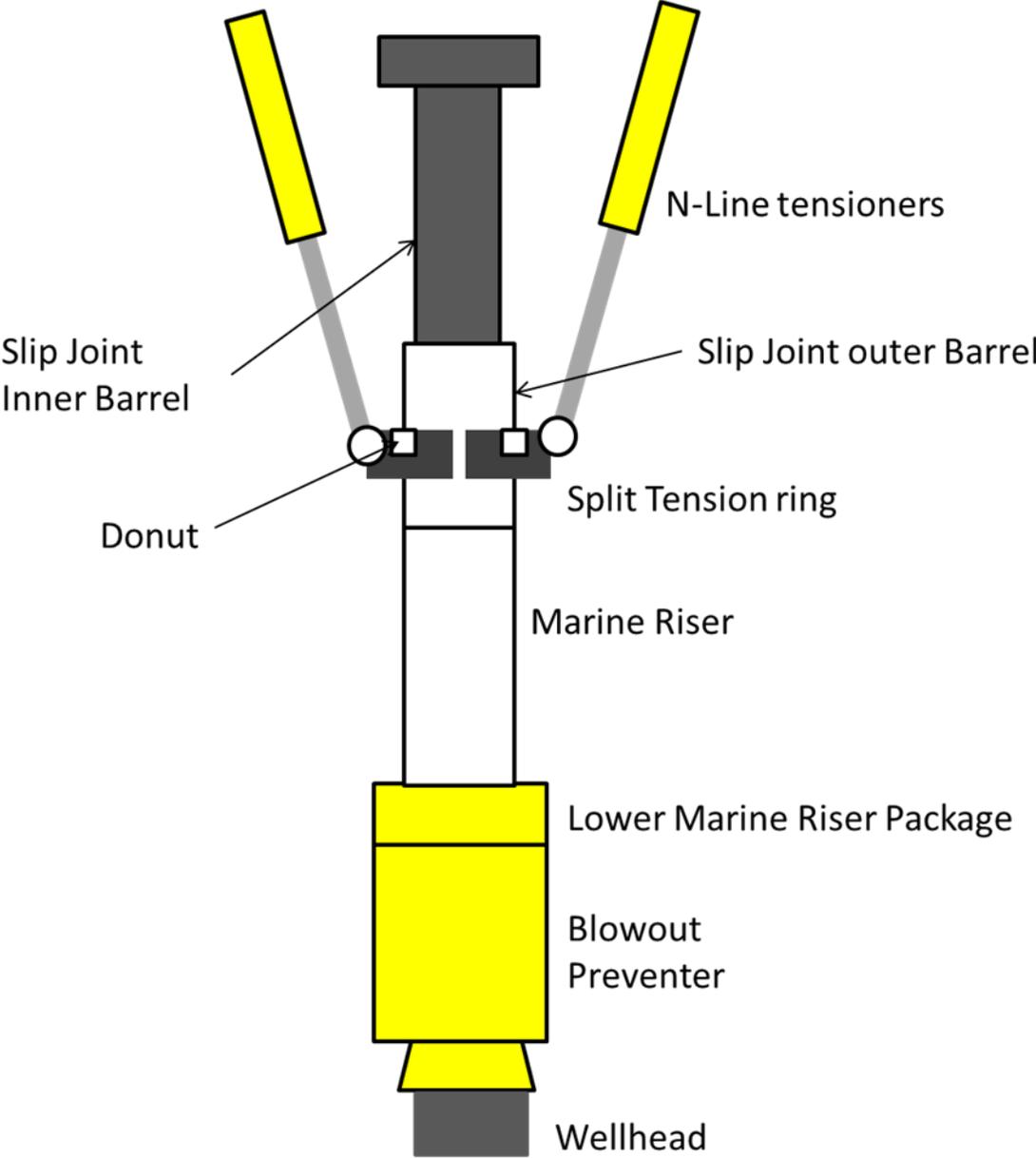
The disconnect criteria, based on vessel heave, is reduced to five metres.

Prior to the occurrence of the incident, the disconnect criteria was eight (8) metre heaves. Shell Canada in its Assurance Plan determined that a revised disconnect criteria of seven (7) metre heaves should be applied. However, the CNSOPB has determined that until such time as it is satisfied from a risk perspective, a further restriction to five (5) metre heaves should be applied.

The CNSOPB continues to review the investigation and assurance reports, while considering whether any further or future regulatory actions are required. Its findings and lessons learned will be shared with the International Regulators' Forum (IRF), a group of 12 regulators of health and safety in the global offshore oil and gas industry which exists to drive improvements in health and safety in the sector through collaboration on joint programs and information sharing.

The CNSOPB continues to review the fate of the dropped riser. The decision will take into account the results of this investigation, regulatory compliance, safety and environmental considerations, and potential impacts to other users of the sea.

Appendix I – Diagram of Riser



Appendix II – Acronyms / Definitions

Acronym	Meaning
BOP	Blow out preventer
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
DP	Dynamic Positioning is a computer-controlled system to automatically maintain a vessel's position and heading by using its own propellers and thrusters.
DNV GL	The independent Certifying Authority.
DPO	Dynamic Positioning Operator
LMRP	Lower marine riser package is the upper section of a two-section subsea BOP stack consisting of a hydraulic connector, annular BOP, flex joint, riser adapter, jumper hoses for the choke, kill and auxiliary lines, and subsea control pods. This interfaces with the lower subsea BOP stack.
OIM	Offshore Installation Manager is the most senior manager on the drillship.
RARS	Riser Anti-Recoil System is used to help slow or dampen the force of the recoil action of the riser tensioner system during disconnect
Riser	A riser is an assembly of pipes used to support the drillhead and transfer produced fluids from the wellbore to the drillship or to transfer injection fluids or control fluids to the wellbore.
ROV	Remotely Operated underwater Vehicle
Soft Hang-Off	A soft hang-off is when the riser is unlatched from the wellhead and held by the tensioner system below the drillship.
SSE	Subsea Engineers are responsible for the design and installation of equipment and structures below the surface of the sea.
SSSE	Senior Subsea Engineer
STP	Senior Tool Pusher – supervises drilling operations on an oil rig
TP	Tool Pusher