CANADA-NEWFOUNDLAND & LABRADOR
C-NLOPB
OFFSHORE PETROLEUM BOARD

ENQUIRY REPORT
ICE INCURSION INCIDENT *SEAROSE* FPSO
July 26, 2018

Prepared by:
Veronica Warren, C-NLOPB Safety Officer
Assisted by:
John Pennell, C-NLOPB Environmental Compliance Officer; and
Darrell Gover, C-NLOPB Environmental Compliance Officer

TABLE OF CONTENTS

1.0 INTRODUCTION

On March 29, 2017 an Iceberg, named berg 2017- 011 (berg 011), entered *SeaRose Floating Production Storage and Offloading Unit* (the *SeaRose*) Zone 1, with a forecasted drift Closest Point of Approach (CPA) of less than ¼ NM (0.25 NM), at which time in accordance with the Husky's *Ice Management Plan* EC-O-99-X-PR-00002-001 (IMP) the *SeaRose* should have disconnected and sailed to a safe area. The *SeaRose*, however, did not disconnect, but instead stayed on station with berg 011 passing through the ¼ NM (0.25 NM) Ice Exclusion Area and in close proximity to the *SeaRose*.

The IMP is a Husky Oil Operations Limited (Husky) plan developed to support normal operations during ice season. The plan also includes actions to take should ice become a threat to the *SeaRose* or any Mobile Offshore Drilling Unit (MODU) under contract by Husky. In an emergency situation the ice management process documented in the plan is to become integrated with Husky's emergency response systems.

The Newfoundland Offshore Petroleum Drilling and Production Regulations set requirements for an Operator's Management System, as well as, the documentation required to accompany an application for Authorization. The IMP is a contingency plan as specified in the *SeaRose FPSO Safety Plan – Part 1* (WR-0-99-X-PR-00003-001) and a component of Husky's management system.

Following the ice incursion incident on March 29, 2017, various meetings were held between Husky and the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) which discussed the circumstances surrounding the event.

The Chief Safety Officer issued a Notice of Non-Compliance and an Order to Husky, on April 7, 2017, to follow their *Ice Management Plan*, pursuant to section 193(1) of the *Canada-Newfoundland and Labrador Atlantic Accord Implantation Act (Accord Act).*

Husky launched their internal investigation into the incident, to which the report was submitted to the C-NLOPB on April 28, 2017. Upon review of Husky's internal investigation report the C-NLOPB decided to conduct an enquiry into the incident to determine more clearly the facts surrounding the ice incursion incident and determine if there were any contraventions of the *Accord Act* or associated Regulations. The enquiry commenced on May 9, 2017. The Enquiry report was provided to the C-NLOPB Assessment Team (Scott Tessier, Chair and CEO; Ed Williams, Vice Chair; Paul Alexander, Chief Safety Officer; Jeff O'Keefe, Chief Conservation Officer; Dave Burley, Director of Environmental Affairs; John Kennedy, Director of Operations; and Susan Gover, General Counsel.) to determine the next steps.

Authority and Jurisdiction

Husky is the owner and Operator for the *SeaRose* and is operating in the Canada-Newfoundland and Labrador Offshore Area under Authorization No.40020-020-OA08 issued by the C-NLOPB on March 31, 2015 in accordance with paragraph 138. (1)(b) of the *Accord Act*.

The *SeaRose* is an installation as defined by sub-section 1(3) of the *Newfoundland Offshore Petroleum Drilling and Production Regulations*, and sub-section 2(1) of the *Petroleum Installation Regulations,* and therefore, subject to the provisions respecting installations contained therein.

The *SeaRose* is also a Marine Installation or Structure as defined by section 205.001 of the *Accord Act* and is therefore a workplace which is subject to the requirements of Part III.1 of the *Accord Act*.

Enquiry Team

The C-NLOPB enquiry team consisted of:

- Veronica Warren, Safety Officer, Lead Investigator;
- John Pennell, Environmental Compliance Officer, Assistant Investigator; and
- Darrell Gover, Environmental Compliance Officer, Assistant Investigator

Enquiry Methodology

Before conducting interviews with relevant Husky and contracted staff, information that was already in the C-NLOPB's possession was collected and reviewed. Interviews were conducted between June 14, 2017 and November 16, 2017, a list of those interviewed is provided in Table 1.

A presentation was provided by the Marine Operations Specialist from Husky on August 25, 2017 to the enquiry team outlining the *Ice Management Plan*.

A warrant and assistance order was granted from Judge Pike, Justice of the Provincial Court of Newfoundland and Labrador, on September 21, 2017, to obtain evidence from the Husky offices located at 351 Water Street, St. John's, NL. This activity was carried out by the enquiry team with assistance from Dawn Higgins, Safety Officer, in accordance with the warrant on September 25 and 26, 2017.

The enquiry included interviews of key personnel, review of information seized from Husky under the authority of the warrant, information received from Provincial Aerospace Limited (PAL) under authority of a Production Order, review of Husky's investigation report and review of information obtained in the normal course of regulatory oversight prior to the enquiry.

Table 1: List of Interviewees

Date/Time	Position/Title	Employer	Additional Persons in the Interview
June 14, 2017	Captain *M/V Maersk Dispatcher*	Maersk Supply Service Canada Ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel Legal Counsel
June 15, 2017	Captain *M/V Atlantic Hawk*	Atlantic Towing ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel Legal Counsel
June 16, 2017	Operations Manager PAL Aerospace	Provincial Aerospace Ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel Legal Counsel
June 16, 2017	HSEQ Coordinator Drilling and Completions	Husky Oil Operations Ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel

June 21, 2017	Logistics Lead	Husky Oil Operations Ltd.	Veronica Warren, Darrell Gover– Enquiry Team Husky Legal Counsel
June 22, 2017	VP Drilling and Completion	Husky Oil Operations Ltd.	Veronica Warren, Darrell Gover – Enquiry Team Husky Legal Counsel
June 22, 2017	Senior Drilling Supervisor	Husky Oil Operations Ltd.	Veronica Warren, Darrell Gover-Enquiry Team Husky Legal Counsel
July 10, 2017	Marine Supervisor	Husky Oil Operations Ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel Legal Counsel
July 12, 2017	Ice and Environment Specialist	Provincial Aerospace Ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel Legal Counsel
July 21, 2017	Maintenance Manager	Husky Oil Operations Ltd.	Veronica Warren, John Pennell – Enquiry Team Husky Legal Counsel
July 21, 2017	Offshore Installation Manager	Husky Oil Operations Ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel
July 25, 2017	Deckhand	Husky Oil Operations Ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel
August 1, 2017	VP Operations	Husky Oil Operations Ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel Legal Counsel
August 7, 2017	Marine Operations and Services Manager	Husky Oil Operations Ltd.	Veronica Warren –Enquiry Team Husky Legal Counsel Legal Counsel
August 8, 2017	Production & Maintenance Manager	Husky Oil Operations Ltd.	Veronica Warren, John Pennell-Enquiry Team Husky Legal Counsel Legal Counsel
August 11, 2017	Senior VP Atlantic Region	Husky Oil Operations Ltd.	Veronica Warren, John Pennell – Enquiry Team Husky Legal Counsel Legal Counsel
November 9, 2017	Senior Electrical Engineer	Husky Oil Operations Ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel
November 16, 2017	Marine Coordinator	Husky Oil Operations Ltd.	Veronica Warren, Darrell Gover, John Pennell – Enquiry Team Husky Legal Counsel

2.0 FACTUAL INFORMATION

Description of Installation

The *SeaRose* is a double hulled ice strengthened D class tanker that is 271.5 m long, 46.0 m wide and 95,887 gross tonnes. As per standard tanker design, the accommodations, navigation bridge and engine room are located aft. It has 12 cargo tanks (1-6 port and starboard) with a total cargo capacity of 930,000 Barrels. There are wing tanks that carry ballast water located on the outboard side of and extending underneath each cargo tank to the centerline. The slop tanks and diesel bunkers are located in the aft part of the vessel.

The vessel was purpose built to extract hydrocarbons from the White Rose Field reservoir, carry out process separation and export the oil to shore via shuttle tankers. The vessel hull incorporates a turret, which is the interface between the subsea facilities and the topsides facilities. The turret is also the mooring point for the *SeaRose*, enabling it to weathervane around the turret while it is connected to the seabed by a nine line mooring system. A quick disconnect releasable buoy within the turret allows the *SeaRose* to move off station if required.

At the time of the incident there were 84 people onboard the *SeaRose* and between 343, 896 and 359, 524 barrels of crude onboard.

Environmental Conditions

At 1800 hrs, March 28, 2017 the support vessel, *M/V Maersk Dispatcher*, commenced monitoring berg 011. It was unable to take berg 011 under tow as weather and sea states were not favorable. At approximately 0300 hrs, March 29, 2017 conditions improved sufficiently and the M*/V Maersk Dispatcher* attempted a tow. Table 2 lists the environmental conditions in the White Rose Field, for March 28 – 29, 2017.

Table 2: Environmental Conditions

Date (2017)	Time (Hrs)	Wind Direction (Degrees)	Wind Speed (Knots)	Temperature (Celsius)	Significant Wave Height (Metres)	Visibility (Nautical Miles)
March 28	1800	310	45	-0.7	5.6	1
	1900	310	37	-0.6	-	1
	2000	310	42	-0.5	5.9	1
March 29	0000	280	40	-0.4	5.2	1
	0300	270	34	-0.6	4.7	1
	0600	280	30	-0.5	4.1	1

Berg 2017-011

Berg 011 was a tabular small sized iceberg that was sloped on one side. Its dimensions were estimated by the *SeaRose*'s Ice Observer to be 60m x 40m x 8m. The enquiry team calculated berg 011's mass to be roughly between 57,600 t to 68,400 t and estimated its draft to be 50 m (calculations are provided in Appendix 1 and based on IMP methodology). A picture of berg 011, taken from the *SeaRose*, is provided in Appendix 2.

According to the International Ice Patrol (IIP) Iceberg Shape and Classification System a small iceberg is 5 to15m in height and 15 to 60m in length. A Tabular iceberg is an iceberg with steep sides, a flat top and has a length-to-height ratio greater than 5:1 and a height to draft ratio of 1:5 (refer to picture 1).

Picture 1: Example of a Tabular Iceberg (IIP)

Initial Response and Reporting

Husky called Veronica Warren, C-NLOPB Duty Officer, at 0432 hrs on March 29, 2017 and advised that the Operator's onshore Regional Response Management Team (RRMT) had been mobilized because there was an iceberg with the potential to come close to the *SeaRose*. Table 3 lists the calls received by the C-NLOPB during the event.

Table 3: C-NLOPB Duty Call Distribution Emails

Date/Time	C-NLOPB Duty Call Distribution Emails
March 29, 2017 0432 hrs	HSEQ Coordinator Drilling and Completions from Husky called Veronica Warren, the C-NLOPB Duty Officer, to report that there was an iceberg with the potential to come close to the *SeaRose* and that the Operator's onshore Regional Response Management Team had been mobilized.
March 29, 2017 0448 hrs	Vice President Operations from Husky called Dan Chicoyne, the C-NLOPB Acting Chief Safety Officer, and reported that the subsea lines were flushed with seawater and that the *SeaRose* was able to disconnect in 15 minutes, if required, and that they were not sure if they would be able to manage the iceberg. Crew was mustered and he would keep him posted.
March 29, 2017 0542 hrs	Vice President Operations from Husky called Dan Chicoyne, the C-NLOPB Acting Chief Safety Officer, to report that they managed to maneuver the berg (medium sized) past the *SeaRose*. It came within 50-100m. They would continue to push it further with water cannons but felt the danger has passed and they did not plan to disconnect.
March 29, 2017 0605 hrs	HSEQ Coordinator Drilling and Completions from Husky called Veronica Warren, the C-NLOPB Duty Officer, and advised that the iceberg was outside the 500 m Zone.

Background

On Saturday March 25, 2017 a significant weather system was forecasted to bring a prolonged period of gale to storm force northwesterly winds over the Grand Banks starting Sunday March 26 and continuing until Tuesday March 28. Due to these winds, high seas and below normal temperatures, it was expected that there would be a southeastward progression of sea ice and icebergs toward the facilities in the Jeanne d'Arc Basin.

The ice flight on March 26, 2017 detected a total of 68 icebergs to the north of the facilities, which would be pushed toward the field by Tuesday March 28. The *SeaRose* Marine Supervisor stated in his interview that the bergs were approximately 90 to 120 NM away at that time and waves were forecasted to be 12 m significant with max wave height 18 to 19 m. The NRC Drift Model produced at that time (Figure 1) showed a southeast drift toward the operating facilities.

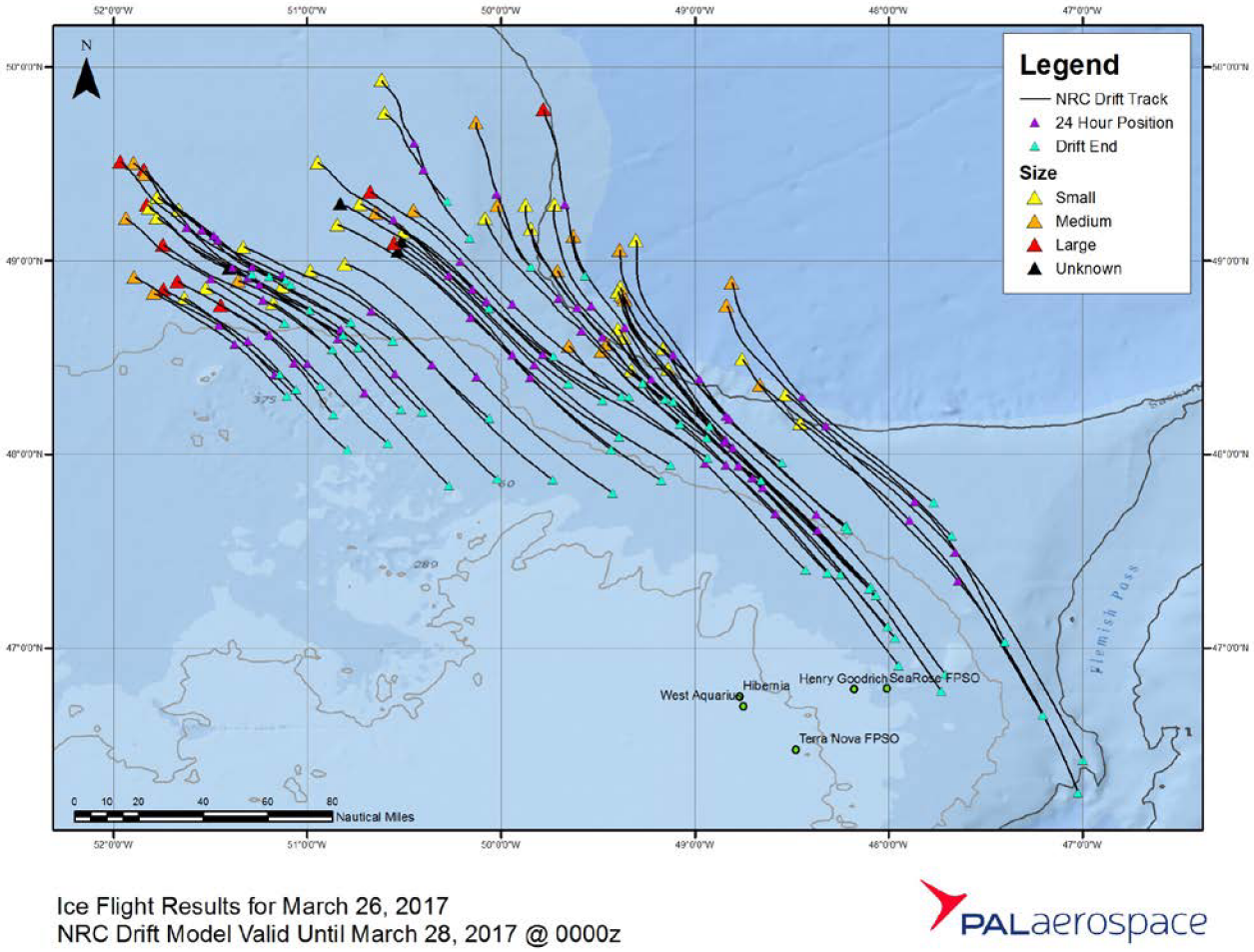


Figure 1: NRC Drift Model

In response to this prediction, Husky stood up a Non Standard Operation (NSO) team on March 27, 2017. The NSO team is used to enhance operations when circumstances indicate operations require more support than normal. In this incident, its goal was to increase the state of readiness and establish clear communications lines between operation and senior management. The NSO participated in ice management activities and kept updated with the ice situation in the field to help manage the ice risk to the *SeaRose* and *Henry Goodrich*.

Husky's Regional Response Management Team (RRMT) members had participated in an ice encroachment exercise to prepare for an ice encroachment event. On March 27 Husky's Emergency Management Advisor (identified as ERT Coordination) alerted the RRMT members of the heightened potential for RRMT activation due to the forecasted ice and iceberg encroachment into the White Rose field. He informed the RRMT of potential consequences for the team to be aware of in advance to enable them to provide support to the *Henry Goodrich* and *SeaRose* if necessary. He also advised them that the NSO team was preassembled to help support the facilities. (Email included in Appendix 3).

Provincial Aerospace Limited (PAL) is contracted by all Operators to coordinate ice management functions. PAL gathers ice information from reconnaissance flights, vessels, and ice observers onboard installations. Specifically they analyze, plot and prepare ice drift predictions to provide an overall picture of the ice situation on the Grand Banks. Since March 25, 2017, Husky had participated in joint ice calls, which included other Operators, as well as, dedicated ice calls that dealt solely with ice threats to the White Rose field. PAL also kept Husky informed between calls through Email which included information on icebergs that may affect the operation of *SeaRose* and *Henry Goodrich*.

As a number of icebergs were predicted to drift into the White Rose Field, the OIM reviewed and prepared the necessary checklists for possible disconnection. This was recorded in the Email below:

From: OIM *SeaRose*
Sent: Monday, March 27, 2017 2:07 PM
To: [redacted]
Subject: RE: Ice Management -Preparation

yup

From: [redacted]
Sent: Monday, March 27, 2017 1:48 PM
To: OIM *SeaRose*
Subject: Ice Management -Preparation

[redacted]

Can you confirm that we have reviewed/prepared the necessary checklists for disconnection (Marine and Production).

Thanks,
[redacted]

In further preparation, the *SeaRose* design limitation studies were reviewed. This was recorded in the Email below:

From: [redacted]
Sent: Monday, March 27, 2017 11:35 PM
To: OIM *SeaRose*; [redacted]
Cc: [redacted]
Subject: *SeaRose* Design Limits

Gents,

According to *SeaRose* Safety Plan Part 2 and other documents I have reviewed it states that the FPSO can withstand an Impact from a 100,000 the Iceberg at 0.5m/s. See also below excerpt from the Concept Safety Analysis further explaining how the forces to cause damage may be significantly greater depending on dissipation of energy from double hull design, mooring system, rotational impact etc.

With due regard to smaller icebergs as per Ice management plan and the report WR-HSE-RP-0151 Serviceability Conditions for Iceberg Impacts focuses on what conditions an impact with a smaller Iceberg could be permitted so as to avoid having to disconnect the FPSO. The formulated criteria was to avoid significant damage to the bow and only a small deformation to the vessel side. Icebergs of water line length less than 20 m together with Significant wave heights of 2.5 m are acceptable. Restricting the waterline length to less than 20 m minimizes the risk of an iceberg striking the bilge keels. See Figure 2a and 2b below;

With regard to pack ice, the *SeaRose* FPSO Operations manual states and is support by the report Analysis of Ice Loads:

* Mooring System to withstand Loadings resulting from sea ice conditions of an average 0.65m thickness at 10/10ths Coverage.

* FPSO Hull is ice Strengthened to Comply with DNV Baltic Ice Class 1A+ and can withstand 10/10ths of and average of 0.80 m thick sea ice

The FPSO hull will be designed to withstand an impact of a 100,000-t iceberg impacting at 0.5 m/s. This equates to a kinetic energy of approximately 15 MJ. In reality, however, the energy required to cause damage will be significantly greater than 15 MJ for a number of reasons:

- in designing the hull for 15 MJ there will be significant safety margins built in;
- the hull will be double-skinned so even if the outer skin is breached, significantly more energy would be required to breach the inner skin or seriously jeopardize vessel trim;
- only a portion of incident kinetic energy must be absorbed by the hull. The total incident kinetic energy in the errant ship (or iceberg) will be converted into a number of forms:
  - translational kinetic energy imparted to the FPSO (that is, the FPSO is made to move forward under the force of the impact);
  - rotational kinetic energy imparted to the FPSO (when the point of impact is off-centre the FPSO will be given a rotational impulse);
  - kinetic energy remaining with the iceberg/ship (only if it is brought fully to a standstill will all of the incident kinetic energy have been absorbed; oblique impacts will thus leave the iceberg/ ship with significant residual kinetic energy);
  - energy absorbed in damage to the iceberg/ship (crushing and local failure of the iceberg/ship near the point of impact will absorb energy);
  - energy absorbed in causing damage to the hull of the FPSO.

Only the last of the above categories is of interest when estimating likely damage to the FPSO. The other categories will account for a significant proportion of the incident kinetic energy, leaving less to cause hull damage to the FPSO.

In view of the above discussion, it is clear that in the majority of cases, only a fraction of the incident kinetic energy in an iceberg/errant ship will be absorbed in the form of hull damage. Conversely, to cause hull damage, the incident kinetic energy must in general exceed the nominal design value of 15MJ by a significant margin. Based on the above discussion, it has been subjectively assumed in the risk assessment that the incident kinetic energy must exceed 30MJ before excessive hull damage is likely.

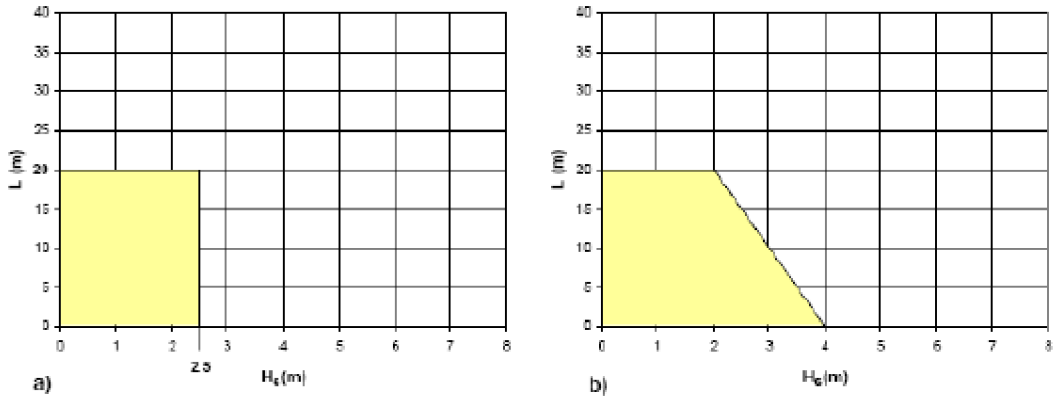
The derived frequencies (based on Appendix D) are presented in Table 7.2-1.

the northern subsea installations, or has a calculated CPA that intersects Zone 2 and is not being managed, will be designated as threatening ice.

5.6.1 SeaRose Serviceability Criteria

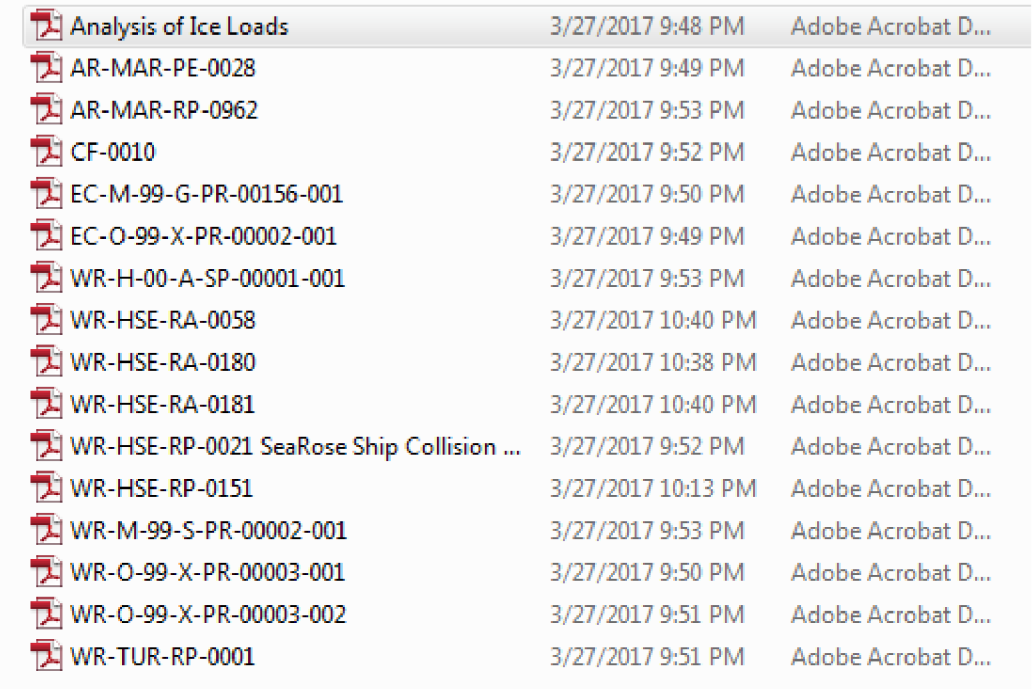
Criteria for maximum iceberg waterline length and significant wave height, that satisfy the serviceability condition, are illustrated in Figure 5-4. Figure 5-4 A illustrates the criterion in which icebergs of waterline lengths less than 20 m, together with significant wave heights less than 2.5 m, are acceptable. An alternative region is given in Figure 5-4 B in which the maximum significant wave height is increased for icebergs less than 20 m. Restricting the iceberg waterline length to less than 20 m minimizes the risk of an iceberg making contact with the FPSO bilge keel. Icebergs having waterline lengths less than 5 m were not considered in the analysis and do not pose a significant threat to the FPSO.

Figure 5-4 A & B - Criteria for combinations of L and H that satisfy the serviceability condition. Report # WR-HSE-RP-0151



Any ice that due to forecast conditions could be problematic and pose a hazard to Operations can be designated threatening ice by the tactical ice management team which is usually comprised of the FPSO OIM and Marine Supervisor, the Senior Husky Representative, and the Ice Observer.

There are several factors involved in threat analysis for tactical ice management. Figure 5-5 shows a typical threat analysis flow chart that lays out the thought and action processes as ice encroaches on the operations area. Refer to the Ice Management Reference Manual (EC-M-99-G-PR-00156-001) for further details on ice management methods.



Analysis of Ice Loads	3/27/2017 9:48 PM	Adobe Acrobat D...
AR-MAR-PE-0028	3/27/2017 9:49 PM	Adobe Acrobat D...
AR-MAR-RP-0962	3/27/2017 9:53 PM	Adobe Acrobat D...
CF-0010	3/27/2017 9:52 PM	Adobe Acrobat D...
EC-M-99-G-PR-00156-001	3/27/2017 9:50 PM	Adobe Acrobat D...
EC-O-99-X-PR-00002-001	3/27/2017 9:49 PM	Adobe Acrobat D...
WR-H-00-A-SP-00001-001	3/27/2017 9:53 PM	Adobe Acrobat D...
WR-HSE-RA-0058	3/27/2017 10:40 PM	Adobe Acrobat D...
WR-HSE-RA-0180	3/27/2017 10:38 PM	Adobe Acrobat D...
WR-HSE-RA-0181	3/27/2017 10:40 PM	Adobe Acrobat D...
WR-HSE-RP-0021 SeaRose Ship Collision ...	3/27/2017 9:52 PM	Adobe Acrobat D...
WR-HSE-RP-0151	3/27/2017 10:13 PM	Adobe Acrobat D...
WR-M-99-S-PR-00002-001	3/27/2017 9:53 PM	Adobe Acrobat D...
WR-O-99-X-PR-00003-001	3/27/2017 9:50 PM	Adobe Acrobat D...
WR-O-99-X-PR-00003-002	3/27/2017 9:51 PM	Adobe Acrobat D...
WR-TUR-RP-0001	3/27/2017 9:51 PM	Adobe Acrobat D...

Best Regards,
[redacted] Marine Superintendent - Marine Operations & Services

Atlantic Region |351 Water Street, Suite 107, St. John's, NL, A1C 1C2
Office: [redacted] Cell [redacted]
Email: [redacted] | Web: www.huskyenergy.com

(Emails are also provided in Appendix 3).

Due to the forecasted iceberg drift, on March 27, 2017, at approximately 1907 hrs, the OIM, began to shut down all wells other than CP1 and CP6 which are located in the Central Drill Centre (CDC) to reduce the *SeaRose* T_{Time} (total time to disconnect). This was completed by approximately 1030 hrs Tuesday, March 28, which brought the *SeaRose* T-time down to 2 hours and 40 minutes.

Husky also started to free up support vessels for ice management. Seven vessels were available to assist with ice management. Both the *M/V Maersk Dispatcher* and *M/V Atlantic Hawk* were assigned to the *SeaRose* ice management efforts during this incident.

The *SeaRose* Marine Supervisor, indicated that continuous watches were established in the crow's nest (bow of the *SeaRose*). This is because the visibility from the bridge windows, which is located aft, is restricted due to the topsides/plant structures blocking the forward view.

Late on the morning of March 28, 2017, the *M/V Maersk Dispatcher* was tasked to sail north to find and monitor a newly identified iceberg named berg 011. At 1800 hrs the *M/V Maersk Dispatcher* was positioned near berg 011 and began monitoring its track. The track of berg 011 for March 28, 2017, is provided in Figure 2. The *SeaRose* requested the *M/V Maersk Dispatcher* take berg 011 under tow. The vessel, however, was unable to carry out this request due to the weather conditions and sea states at the time.

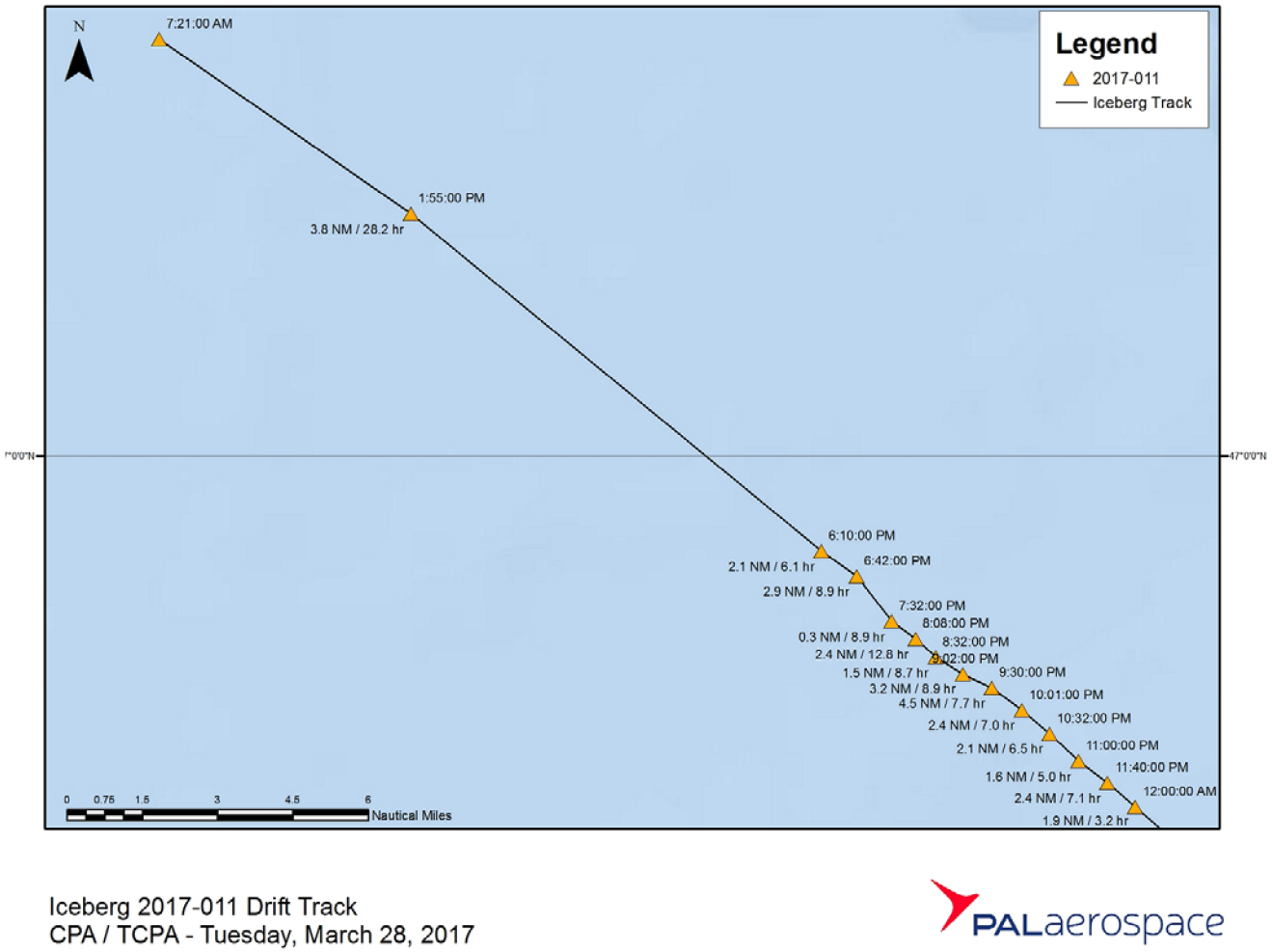


Figure 2: Drift Track of berg 011 for March 28, 2017 (IDNS Snapshot)

Berg 011 was also being monitored by the Officer of the Watch (OOW) on the bridge of the *SeaRose* who at 1930 hrs on March 28 recorded that berg 011 was approximately 10.9 NM from the *SeaRose* and getting closer.

Incident Description

The Enquiry team used the following sources of information:

- RRMT call Logs;
- *SeaRose* Key Events board (ECC);
- *SeaRose* ECC Debrief Report;
- *SeaRose* Manual Radar Plot(OOW Radar Plot);
- *SeaRose* Marine Log book;
- Ice Observer's Log (*SeaRose* Ice Observer);
- Maersk Captain's Log;
- *M/V Maersk Dispatcher*'s Log book;
- *M/V Atlantic Hawk* Log book; and
- C-NLOPB Duty Call Distribution Emails
- OICC Log book
- Interviews with key people.

At approximately 0145 hrs, Wednesday, March 29, 2017, the *SeaRose* OOW, conducted a manual radar plot showing that berg 011 had a Closest Point of Approach (CPA) of 0 NM with a Time of Closest Point of Approach (TCPA) of 0515 hrs. At this time berg 011 was 4.2 NM away from the *SeaRose* at a bearing of 346°T. Berg 011 was noted in the *SeaRose*'s Marine Log as having a "dangerous track" toward the *SeaRose*. The OIM was notified that berg 011 had changed course towards them. The *SeaRose* again contacted the *M/V Maersk Dispatcher* and requested it take berg 011 under tow. The Captain of the *M/V Maersk Dispatcher* responded that due to sea states and weather conditions the tow could not be performed safely. Around this time, the *SeaRose* also requested the *M/V Atlantic Hawk* return to the area and assist as required.

During this time, the *SeaRose* OOW actively tracked berg 011, and recorded berg 011's ranges, bearings, CPAs and TCPAs. The OOW utilized the aft marine radar and conducted manual radar plots.

During the 0200 hrs Joint Operator's Ice Call with PAL, Husky indicated that berg 011 was not discussed. PAL Ice Coordinator, who attended the ice call, however, indicated that berg 011was discussed. The OIM left the call early to check if the *M/V Maersk Dispatcher* had begun to take berg 011 under tow. On learning that no tow was underway the OIM called the Captain of the *M/V Maersk Dispatcher* via satellite phone to convey the seriousness of the current situation, and discussed the possibility of conducting a two vessel tow or using the water cannon. It was discovered through interviews that the OIM then spoke with the *SeaRose*'s night shift supervisory team to discuss the situation and they decided if berg 011 continued to be a threat they would call a muster between 0415 hrs and 0425 hrs in preparation for a possible disconnect.

At approximately 0230 hrs the *SeaRose* Marine Supervisor called the Marine Operations Manager onshore and informed him that berg 011 had turned toward the *SeaRose* and had a CPA of 0.

At this time, roughly 0230 hrs, the OIM, stood up the offshore Emergency Response Team (ERT) and commenced the first steps in the disconnect sequence. The OIM then sent a text message to the Vice President Operations and notified him of the change in the iceberg's CPA and actions taken up to that point. Following this text, there was a conference call between the Vice President of Operations, Production and Maintenance Manager, and the Marine Operations Manager (onshore NSO team) and the OIM offshore. The purpose of the call was to get a better understanding of what was happening offshore. It was decided that the situation offshore warranted mobilizing the RRMT to support the *SeaRose*. After this call, the Vice President of Operations called the Senior Vice President and advised him of the situation.

At approximately 0300 hrs, the Captain of the *M/V Maersk Dispatcher* informed the *SeaRose* Marine Coordinator (*SeaRose* OOW) that he would attempt to take the iceberg under tow as there had been an improvement in sea states and weather conditions. The *M/V Maersk Dispatcher*'s log book indicated seas, at this time, were approximately 5m with no record of visibility. Also, at this time, the OIM gave the one hour notice for the *SeaRose*'s main engines to be up and running in preparation for possible disconnect.

At approximately 0313 hrs the onshore Regional Response Management Team (RRMT) was activated. The NSO team was also on site and set up in a side room adjacent to the RRMT. The Senior Vice President arrived and joined the NSO team in the side room to keep abreast of the situation. At this time, the *SeaRose* OOW's radar plot indicated berg 011 was 2.4 NM from the *SeaRose* with a CPA of 0.2 NM and a TCPA of 0505 hrs.

At 0317 hrs the crew on the SeaRose called the OICC to inform them of the situation and discussed towing options. The OICC advised *SeaRose* to obtain updated positions every 30 minutes.

The NSO team was in contact with the Captain of the *M/V Atlantic Hawk* via satellite phone. The Captain had a radar lock on berg 011, the *M/V Maersk Dispatcher*, and the *SeaRose* and he provided play by play commentary of what he observed was happening with the *M/V Maersk Dispatcher*'s tow and berg 011's track.

The *M/V Maersk Dispatcher*'s log book indicated that at about 0340 hrs they were 2 NM downwind of berg 011 preparing to commence tow procedures with the *M/V Atlantic Hawk* standing by ready to assist. About 0350 hrs the *M/V Maersk Dispatcher* began to deploy its ice rope to take berg 011, now 2.1 NM from the *SeaRose*, under tow.

The *SeaRose* now had its main engines and propulsion system running to be able to sail away in the event it disconnected from the buoy. To further facilitate disconnection, at about 0400 hrs, the central drill centre (CP1 & CP6) had been flushed and shut-in, meaning that production was fully shut down with all subsea lines flushed of hydrocarbons. The *SeaRose* OOW's radar plot at 0415 hrs indicated berg 011 was roughly 1.25 NM away from the *SeaRose* at this time.

According to the *SeaRose*'s Emergency Command Center (ECC) debrief record the ECC team referred to the *SeaRose FPSO Hazard-based Emergency Response Scenarios* (*HaBERS*) WR-0-00-X-PR-00005-001 (Rev E8), specifically, the scenario for Vessel Collision Avoidance (Appendix 4). The emergency response process outline in the IMP for icebergs is not included in the HaBERS manual. This is further discussed in section 3.0.

At approximately 0420 hrs the *SeaRose* Ice Observer was called to the bridge and began tracking berg 011 using the *SeaRose*'s ice radar. At this time both the *SeaRose's* OOW and the *SeaRose*'s Ice Observer actively tracked berg 011 plotting roughly every 15min.

According to the *SeaRose* Emergency Command Centre (ECC) key events board at about 0424 hrs the OIM activated a General Platform Alarm (GPA) mustering all crew which was completed within 5 minutes. The *SeaRose*'s OOW, Ice Observer, Helmsman, and two crewmembers in the crow's nest were exempt from the muster as they continued to assist with the situation. Concurrently, the *M/V Maersk Dispatcher* had deployed 1200 m of ice rope, and begun encircling berg 011, which was now about 0.957 NM from the *SeaRose* with a CPA of 0 NM.

About 0432 hrs, the disconnect sequence was paused at step 5 which is the last step before flooding the Quick Connect Disconnect (QCDC) Room. During the interview with the OIM, it was indicated that this is the natural pause in the sequence. Proceeding beyond this step, the intent would be to disconnect from the buoy and sail away. This brought the *SeaRose*'s $T\text{-}_{\text{Time}}$ down to 15 minutes.

At about 0432 the HSEQ Coordinator Drilling and Completions, from the RRMT, called the C-NLOPB Duty Officer, Veronica Warren and advised that there was an iceberg with potential to come close to the *SeaRose* so the RRMT was mobilized.

At 0440 hrs the communications onboard the *SeaRose* were restricted to emergency communications only. At this time, the OIM called the RRMT/NSO and requested to speak to the Vice President of Operations or the Production and Maintenance Manager.

At about 0448, RRMT/NSO Vice President Operations called Dan Chicoyne, the C-NLOPB Acting Chief Safety Officer, and reported that the subsea lines were flushed with seawater and that the *SeaRose*

was able to disconnect in 15 minutes, if required. He indicated that they were not sure if they would be able to manage the iceberg. Crew were mustered and he would keep him posted.

About this time, the OIM called the RRMT/NSO and advised he was preparing to flood the QC/DC space but maintained hold at step 5. The Dispatcher's tow hook up was estimated to be completed in 10 minutes. Disconnect from the buoy could be achieved in 15 minutes. The *SeaRose* would hold on station.

At about 0452 hrs the *M/V Maersk Dispatcher's* log book indicated that the messenger line had been recovered. *SeaRose*'s Ice Observer recorded that berg 011 was now about 0.6 NM from the *SeaRose*.

At about 0458 hrs the RRMT/NSO, Production and Maintenance Manager called the OIM and advised that the *M/V Maersk Dispatcher*'s tow was starting to take some weight. At 0502 hrs the RRMT/NSO, Vice President of Operations advised the OIM that the berg was under tow.

The *SeaRose* Marine Supervisor was getting information from the *M/V Maersk Dispatcher*, via radio, regarding the status of the tow and relayed it to the OIM. At 0504 hrs the OIM advised the RRMT/NSO that there was no tow line on the berg and it was expected to be 10 minutes before hook up.

The RRMT Call Logs showed that there were several discussions between the RRMT/NSO and the *SeaRose* regarding if berg 011 was under tow.

The RRMT Call Logs indicated that at approximately 0505 hrs the OIM advised the RRMT/NSO that berg 011's CPA was approximately 0 , there was no tow line on the berg, and he needed to continue with the disconnect sequence. The RRMT/NSO, Vice President of Operations requested that he wait a minute so they could check the status of the tow with the *M/V Atlantic Hawk*. At this time the *SeaRose* OOW's radar plot indicated that berg 011 was 0.37 NM from the *SeaRose*.

The RRMT Call Logs indicated that about 0508, the OIM called the RRMT/NSO and indicated that the *SeaRose* must continue with the disconnect sequence. The RRMT/NSO, Vice President of Operations asked him to wait 5 minutes as the *M/V Maersk Dispatcher* was preparing to pull in slack; tension was expected in 5-6 min, hold for now, they would contact the *M/V Atlantic Hawk* and call the OIM back in a few minutes. The *M/V Maersk Dispatcher*'s logbook indicated that, at this time, the other end of the iceberg rope was on deck and being connected to the tow wire.

The RRMT Call Logs indicated that about 0510 hrs RRMT/NSO, Production and Maintenance Manager advised tension on the berg had started. At 0512 hrs the OIM advised the RRMT/NSO that there was no tension on the tow rope and requested to speak to the Vice President of Operations. The *SeaRose* Ice Observer recorded berg 011 at about 0.32 NM from the *SeaRose* and radar contact with berg 011 was being lost. The *SeaRose* now begun to rely on the ranges provided from the visual watch from the crew on the forecastle (bow).

At 0514 the OIM indicated to the RRMT/NSO that he felt he needed to open the QCDC valves which is the next step in disconnect sequence. The RRMT/NSO, Production and Maintenance Manager requested that the OIM wait a few more minutes.

Due to the proximity of berg 011 to the *SeaRose*, the *M/V Maersk Dispatcher*'s Captain indicated in his interview with the enquiry team he only paid out approximately 100 m of tow wire before he applied tension. Normally 500 m of tow wire would have been paid out, but because of berg

011's proximity to the *SeaRose* he only used 100 m. This meant there was a greater possibility of the tow rope slipping off the berg.

The RRMT Call Logs indicated that the OIM called the RRMT/NSO about 0515 hrs and advised that berg 011 was 100 yards (91 m) from the bow. The RRMT/NSO, Production and Maintenance Manager requested the OIM to standby for further instructions. At this time, the OIM announced to the crew to brace for impact, this is in accordance with the *HaBERS* Vessel Collision Avoidance scenario for objects with a CPA of less than 500 m and TCPA of less than 15 minutes. At 0518 hrs the OIM called the RRMT/NSO again and advised that berg 011 was approximately 50 m from the *SeaRose* coming down the starboard side and he expected an impact shortly.

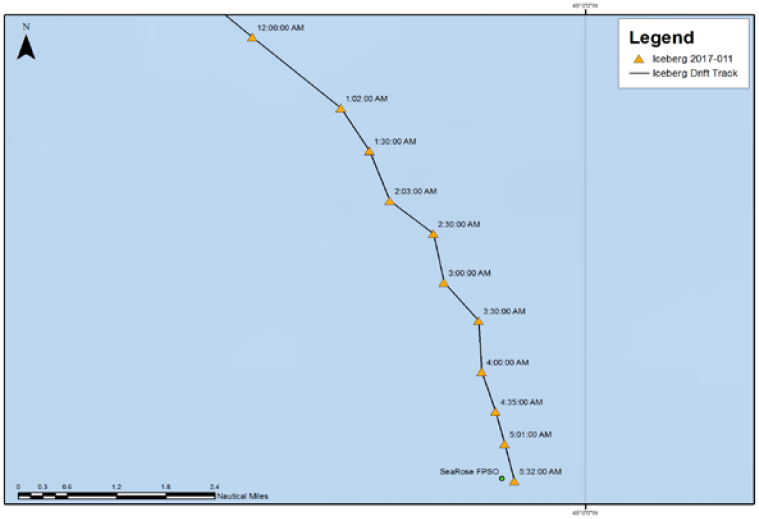
The *M/V Maersk Dispatcher*'s log book indicated that at 0520 hrs the ice rope slipped over berg 011 and the tow was lost. The RRMT Call Logs indicated that at this time the *SeaRose*'s heading was 009° T and pivoted to keep its bow pointed toward berg 011. Berg 011 was thought to have snagged a riser/mooring chain as it appeared to stop. The *SeaRose* reported to the RRMT/NSO that there was no indication of tension change on the risers and moorings.

The OIM made a PA announcement about 0522 hrs that berg 011 was passing on the starboard side. The Captain of the *M/V Atlantic Hawk* indicated during his interview that he monitored berg 011 as it drifted past the *SeaRose*. At that time, he also indicated that the *SeaRose* requested, the *M/V Atlantic Hawk* to try to establish a tow or use the water cannon if necessary to deflect berg 011 away from the *SeaRose*.

At approximately 0540 hrs berg 011 had gone past the *SeaRose* and continued to drift in a southerly direction. The *SeaRose* muster stood down about 0542 hrs.

At 0542 hrs the RRMT/NSO, Vice President of Operations from Husky called Dan Chicoyne, the C-NLOPB Acting Chief Safety Officer, to report that they managed to maneuver the berg (medium sized) past the *SeaRose*. It came within 50-100m. They would continue to push it further with water cannons but felt the danger had passed and did not plan to disconnect.

At 0605 hrs the HSEQ Coordinator Drilling and Completions from the RRMT called Veronica Warren, the C-NLOPB Duty Officer, and advised that the iceberg was outside the 500 m zone.



Iceberg 2017-011 Drift Track
March 29, 2017

PALaerospace

Figure 3: Drift Track of berg 011 for March 29, 2017 (IDNS Snapshot)

Sequence of Events

The enquiry team used the following sources of information to construct and corroborate a sequence of events as provided in Appendix 5: (interview statements not included)

- RRMT call Logs
- *SeaRose* Key Events board
- *SeaRose* Manual Radar Plot
- *SeaRose* Marine Log book
- Ice Observer's Log
- *M/V Maersk Dispatcher* Captain's Log
- *M/V Maersk Dispatcher*'s Log book
- Husky's Investigation Report
- *M/V Atlantic Hawk* Log book
- PAL IDNS
- Husky's Presentation
- OICC Log book

3.0 DISCUSSION/ANALYSIS

Onshore Ice Coordination Center

The Grand Banks Operators participate in a Joint Ice Management regime which details a set of procedures that are designed to coordinate all ice management functions, including ice detection, monitoring and management between all facilities operating on the Grand Banks. This is described in Husky's *Grand Banks Joint Ice Management Strategy* (EC-M-99-G-PR-001SS-001) (Rev E2) (Joint Strategy). One of the main strategies of the Joint Strategy is to coordinate ice management functions through an Onshore Ice Coordination Centre (OICC). The OICC is operated by PAL under contract. In the Joint Strategy it is the responsibility of the OICC to coordinate strategic and tactical ice management functions between all offshore facilities.

The primary goal of the OICC is to provide timely advice on ice management operations for each facility. The OICC is to be familiar with the content and approach taken in all Operators' IMPs and where possible should coordinate ice management activities from the perspective of those plans. The enquiry team, note that an Email sent to Husky from the PAL at 0036 March 29 (Appendix 3), provided information on berg 011's CPA. It showed berg 011 had a CPA of 1.9 NM. Commentary within the Email, see below excerpt, advised that berg 011 would pass to the east of the *SeaRose*.

> From: PAL Ice Coordinator
> Sent: Wednesday, March 29, 2017 12:36 AM
> To: Company Man - HGR [redacted] Weatherman *SeaRose*; Ice Weatherman - HGR; OIM *SeaRose*; MarineSuper *SeaRose*; Night Company Man - HGR
> Cc: [redacted] Drilling Superintendent - HGR; [redacted] (White Rose)
> Subject: Iceberg update @ 0035
>
> Good evening,
> 2017-007 is passing east of HGR and west of *SeaRose*. 2017-011 will pass east of both facilities. The leading patch of sea ice will also pass to the east of both facilities.

Name	Size	Shape	Time Stamp	Range	Bearing	CMG	SMG	Ref Facility	CPA	TCPA	Source	Tow	Tow Hdg	Bollard Pull	Flow Rate	Comments
Sealce1	Unknown	Unknown	29-03-2017 02:46:00	6.7	16.9	150.3	1.7	SeaRose	4.8	2.8	Maersk Detector	N				
2017-011	Medium	Tabular	29-03-2017 02:30:00	6.1	340.2	141.9	1.8	SeaRose	1.9	3.2	Maersk Dispatcher	N				
2017-007	Small	Wedge	29-03-2017 00:45:00	2.3	228.4	154.8	1.4	SeaRose	2.2	0.5	Atlantic Hawk	Y	310.0		1400.0	

Regards,

PALaerospace
[redacted] Ice Coordinator
[redacted] palaerospace.com

There was a Joint Operator's Call at 0200 on March 29, 2017, where it is unclear if berg 011 was discussed. Husky indicated that berg 011 was not discussed. PAL, however, indicated that it was discussed.

At about 0317 hrs the *SeaRose* called the OICC to advise of berg 011's closing CPA and discussed towing options. The OICC advised *SeaRose* to obtain updated positions every 30 minutes.

At 0324 hrs, another Email (Appendix 3) was sent to Husky from PAL providing an updated CPA of 0.1 NM for berg 011. This CPA is within the ¼ NM Ice Exclusion Area and showed that berg 011 was on a potential collision course with the *SeaRose*. Commentary within the Email, see below excerpt, stated "2017-011 will pass east of the *Henry Goodrich*, at present it will pass slightly to the east of *SeaRose* …"

From: PAL Ice Coordinator
Sent: Wednesday, March 29, 2017 3:24 AM
To: Company Man - HGR; [redacted] Weatherman *SeaRose*; Ice Weatherman - HGR; OIM *SeaRose*; MarineSuper *SeaRose*; Night Company Man - HGR
Cc: [redacted] Drilling Superintendent - HGR; [redacted] (White Rose)

Subject: Iceberg update @ 0325

Good morning,

2017-007 is passing east of HGR and west of *SeaRose*. 2017-011 will pass east of the *Henry Goodrich*, at present it will pass slightly to the east of *SeaRose* it will pass. 2017-012 will pass east of both facilities. 2017-014 will pass west of both facilities, and the leading patch of sea ice will also pass to the east of both facilities.

Name	Size	Shape	Time Stamp	Range	Bearing	CMG	SMG	Ref Facility	CPA	TCPA	Source	Tow	Tow Hdg	Bollard Pull	Flow Rate	Comments
Sealce1	Unknown	Unknown	29-03-2017 04:41:00	5.5	41.2	145.6	1.5	SeaRose	5.4	0.9	Maersk Detector	N				
2017-014	Medium	Unknown	29-03-2017 04:33:00	16.6	292.4	170.4	0.9	SeaRose	14.1	9.7	Maersk Cutter	N				
2017-012	Small	Unknown	29-03-2017 04:30:00	7.3	87	161.7	1.7	SeaRose	7	-1.2	Scotian Sea	N				
2017-011	Medium	Tabular	29-03-2017 05:30:00	2.6	349.4	172.1	1.3	SeaRose	0.1	2	Maersk Dispatcher	N				
2017-007	Small	Wedge	29-03-2017 00:45:00	2.3	228.4	154.8	1.4	SeaRose	2.2	0.5	Atlantic Hawk	Y	310.0		1400.0	

Regards,

PALaerospace
[redacted] Ice Coordinator
[redacted] palaerospace.com

In addition to the Joint Strategy, each Operator has its own IMP that interfaces with the Joint Strategy. Each Operator is to define what threatening ice is, what their ice management zones are, and what actions are to be employed as ice enters each zone. Husky's IMP identifies these aspects for the *SeaRose* as well as for any MODU under contract by Husky. The IMP is designed to support normal operations during ice season and also details actions to be taken in an emergency situation.

The risks associated with sea ice and/or icebergs were assessed by Husky in the following documents/studies and used by the enquiry team in their analysis:

- *White Rose Development Iceberg Risk for FPSO and Shuttle Tankers*, C-Core Report Number 01-C15, June 2001;
- *White Rose Iceberg Collision Risk*, WR-HSE-RP-0022, 2002;
- *Serviceability Conditions for Iceberg Impacts: White Rose Project Final Report,* WR-HSE-RP-0151, 2006;
- *SeaRose Ship Collision Analysis* , WR-HSE-RP-0021, 2006; and
- *Structural and Mooring Limitations of the SeaRose in Ice*, WR-O-00R-CL-00002-001, 2008.

The IMP does not make reference to the above documents/studies with exception of the *Serviceability Conditions for Iceberg Impacts*. These documents/studies provide information related to the *SeaRose* hull design limits, mooring limits, and the probability of a successful iceberg tow. The IMP, however, speaks to the Serviceability Condition which states that icebergs with a maximum waterline length of less than 20 m in significant wave heights of less than 2.5 m were deemed acceptable. Restricting the iceberg waterline length to less than 20 m minimizes the risk of an iceberg making contact with the *SeaRose's* bilge keel.

Husky's IMP has three geographical ice zones created around the *SeaRose* to dictate actions to be taken to ensure the safety of personnel, equipment and the environment. See Figure 4.

Zone 1: Ice Alert Safety Buffer – Quick Departure to designated safe area. (T_{Time} x D_s) + 0.25NM (Ice Exclusion Area)

Zone 2: Reaction securing of operations and preparation for departure of Offshore Facility to designated safe area from well / work site. (T_{Time} x D_s)

Zone 3: Ice Monitoring Tracking, Management and Forecasting. (Extends outside Zone 2 and has no fixed width)

T_{Time} is the total time required for suspending operations, securing the well/working site and preparing the Offshore Facility to disconnect from the well/work site, evacuate the personnel (if required) or move the facility to a safe area.

D_s is the iceberg drift speed calculated by using the greater of the mean ice speed calculated for the previous three observations or hours or the mean historical ice speed reported for the operating area of 0.51 knots.

The IMP indicates that during ice season when a MODU is present, coordination of ice management activities is conducted from the MODU for the field assets. Ice management activities, for this incident, should have been coordinated from the MODU (*Henry Goodrich*). It is the Ice Observer's role to review the OIM's T_{Time} calculations, calculate, communicate and record ice Zones, advise when ice enters the Zones, and give one hour notice prior to ice entering Zone 2. There was no record, however, that the *Henry Goodrich* Ice Observer had performed these duties. Husky also employed one Ice Observer on the *SeaRose*

who was working dayshift. During this incident the *SeaRose* Ice Observer was off shift and not present on the bridge until approximately 0420 hrs when he was called to the bridge.

About 2345 hrs, March 28, 2017, the *SeaRose* OOW recorded berg 011 as being 6.3 NM away from the *SeaRose* with a CPA of 2.2 NM and a TCPA at 0500 hrs on March 29. This CPA is intersecting Zone 2. There was, however, no record that it was recognized or conveyed to the OIM that berg 011's CPA intersected Zone 2. Figure 4 below shows the *SeaRose* Ice Zones (not to scale) as calculated by the enquiry team using data derived from Husky's records (Refer to Appendix 1 for Zone calculations for berg 011). Zone 2 was calculated by the enquiry team to be 3.12 NM using the last $T\text{-}_{Time}$ provided of 2 hours and 40 minutes and a berg speed of 1.2 kt (Appendix 1).

The enquiry team has determined, around this time, berg 011 was in Zone 3 with a CPA that intersected Zone 2. This means berg 011 was on track B, as shown in Figure 5, and when it reaches the outer edge of Zone 2 the actions identified in Table 4 are to be taken. Those actions are:

- Initiate suspension of operations in the Northern, Southern, SWRX and North Amethyst Drill Centers. (This was completed on March 28)
- Suspension of operations in the Central Drill Center will be at the discretion of the offshore ice management team (Wells CP1 and CP6 are not offline at this time but would need to be completed when ice reaches the edge of Zone 2). The composition of the offshore ice management team is not defined in the IMP but is believed to consist of the *SeaRose* OIM, Ice Observer, and the Marine Supervisor.

At 0145 hrs the OIM gave instructions to shut in the two remaining wells, CP1 and CP6, both located within the central drill centre, to reduce the *SeaRose*'s T_{Time}. This was in accordance with the IMP as the iceberg has not yet reached Zone 2. The OIM also instructed the control room to proceed to and hold at step five of the disconnect sequence.

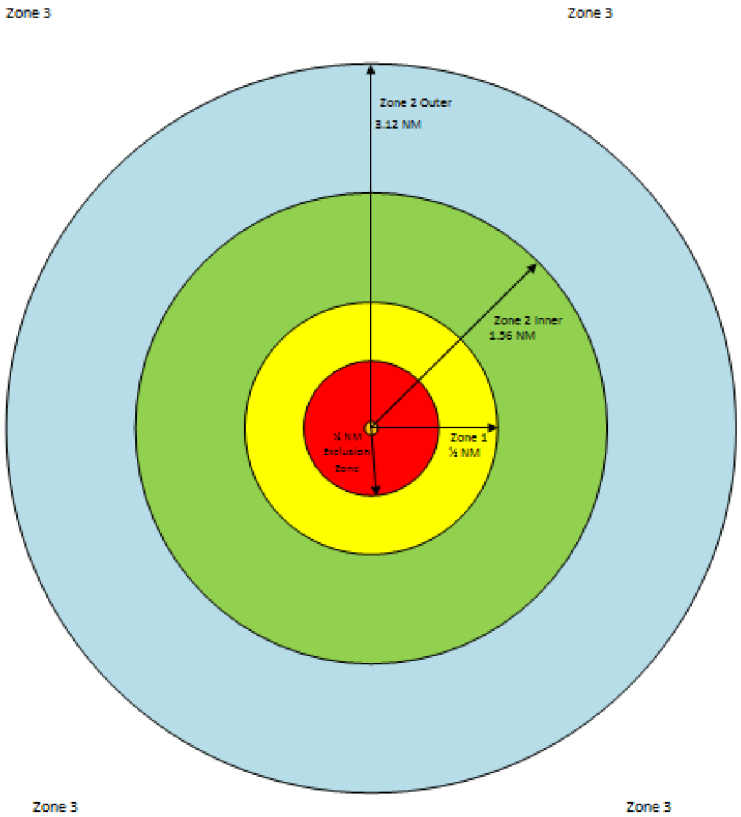


Figure 4: FPSO Ice Zone

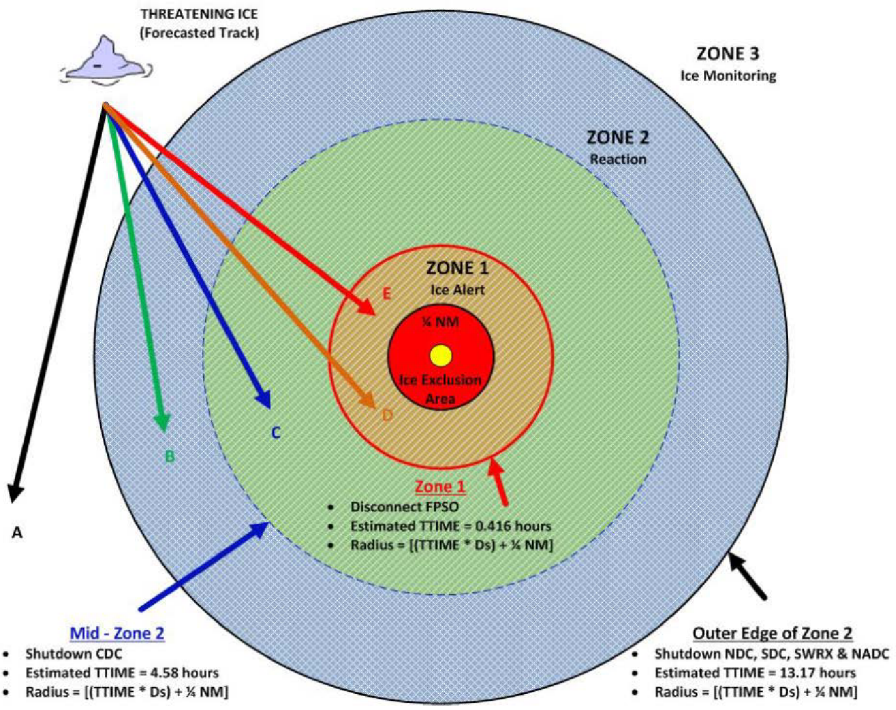


Figure 5: Iceberg Forcasted Track

Table 4: *SeaRose* Ice Response Procedure Base on Iceberg Track (IMP)

FPSO Ice Response Procedures		
Track	**Threat**	**Action**
	Monitor Ice	
A	The ice has a forecasted drift CPA within Zone 3 but **outside** Zone 2.	1. The ice will be closely monitored. 2. Ice management procedures may be employed at the discretion of the ice management team.
	Production Shutdown	
B	The ice has a forecasted drift CPA within Zone 2 but **outside** the T_{Time} for the Central Drill Center [Mid-Zone 2]	Threatening Ice reaches edge of Zone 2: 1. Initiate suspension of operations in the Northern, Southern, SWRX and North Amethyst Drill Centers. 2. Suspension of operations in the Central Drill Center will be at the discretion of the offshore ice management team.
C	The ice has a forecasted drift CPA within Mid-Zone 2 but **outside** Zone 1	Threatening Ice reaches edge of Zone 2: 1. Initiate suspension of operations in all Drill Centers. 2. Decision to initiate the disconnect sequence will be at the discretion of the offshore ice management team.
	Disconnect Sequence	
D	The ice has a forecasted drift CPA within Zone 1 but **outside** the *Exclusion Area* (1/4 Nm)	Threatening Ice reaches edge of Zone 2: 1. Initiate suspension of operations in all Drill Centers Threatening Ice reaches edge of Zone 1: 1. Initiate disconnect sequence and continue until the QCDC Valves are closed (Step 4). 2. Closely monitor the ice threat situation. 3. If conditions improve such that the threat is alleviated (ice management, weather), further disconnect operations will cease. 4. If conditions worsen complete the disconnect sequence and sail the FPSO clear of the threat.
E	The ice has a forecasted drift CPA within the Zone 1 *Exclusion Area* (1/4 Nm)	Threatening Ice reaches edge of Zone 2: 1. Initiate suspension of operations in all Drill Centers. Threatening Ice reaches edge of Zone 1: 1. Initiate disconnect sequence and continue until the riser buoy is released. 2. Sail the FPSO clear of the threat

The IMP indicates that the OIM should be notified one hour prior to berg 011 entering Zone 2. There was no record that this notice had been provided.

At 0245 hrs the *SeaRose* OOW's manual radar plot showed that berg 011 was 3.0 NM away from the *SeaRose* with a CPA of 0.7 NM and a TCPA of 0500 hrs. At this point, using the *SeaRose* OOW's radar plots, the enquiry team calculated that berg 011 had entered Zone 2. The CPA now intersected Mid-Zone 2. This meant berg 011 was on path C as defined in Figure 5 and actions outlined in Table 4 above were to be taken. According to the IMP when threatening ice entered Zone 2 the *SeaRose* was to initiate suspension of operations in all Drill Centers. This was commenced by the OIM earlier as stated above at approximately 0145 hrs. There was no record, however, that it was recognized by the Ice Observer, OOW or OIM that berg 011 had entered Zone 2.

Figure 5 and Table 4 above are based on threatening ice entering each zone. During interviews varying understandings of threatening ice were given. The IMP, however, defines Threatening Ice as: "Any ice that exceeds the design tolerances of the Offshore Facility and/or its associated equipment, including icebergs of sufficient size and draft that could potentially threaten subsea assets, such as, the North Drill Center (NDC) gas injection flow line/umbilical and the northern subsea installations or has a calculated CPA that intersects Zone 2 and is not being managed." There is no explanation of what is meant by "being managed" as stated in the definition of threatening ice, but, the IMP does broadly define Ice Management as any action to detect, collect information on, actively manage, monitor or track ice and it also defines Active Ice Management as any action to tow, deflect, or ice break. The enquiry team believes that in the context of threatening ice, as defined above, "being managed" is taken to mean Active Ice Management. In the view of the enquiry team berg 011 was threatening ice as its CPA intersected Zone 2 and was not being actively managed.

According to the RRMT First Person Contact Form, the first person to arrive in the Emergency Response Center (351 Water St.) was the Vice President of Operations who signed into the RRMT at 0313 hrs. He contacted the *SeaRose* and advised the OIM that the RRMT was stood up and requested a status update. The *SeaRose* reported that the facility was shut in and "the keys were in hand ready for disconnect". At this time berg 011 was approximately 2 NM away from the *SeaRose* and was approaching with a speed of 1.2 kt. Its CPA was 0 and was maintaining a steady bearing. The *SeaRose* advised that they planned to swing to 000 ° T and then go astern upon disconnection. At this time the wind speed was 24 kt and the wave height varied between 4.0 m to 6.5 m. The *M/V Maersk Dispatcher* was preparing for a tow and the *M/V Atlantic Hawk* was standing by to assist as required. The enquiry team calculated that berg 011 was in Zone 2 and almost to Mid-Zone 2 with a CPA that intersected the ¼ NM (0.25 NM) Ice Exclusion Area. Berg 011 was on path E in accordance with Figure 5. There was no record that it was recognized that berg 011 was in this zone.

The enquiry team calculated (Appendix 1) that Zone 1 was 0.5 NM from the *SeaRose*. According to radar ranges provided, berg 011 entered Zone 1 sometime between 0450 hrs and 0500 hrs. The recorded CPA remained at about 0 NM meaning berg 011 was still on track E as shown in Figure 5. In accordance with the IMP when threatening ice enters Zone 1 on track E (which is a berg with a CPA that intersects the ¼ NM (0.25 NM) Ice Exclusion Area the *SeaRose* was to:

- Initiate disconnect sequence and continue until the riser buoy is released.
- Sail the *SeaRose* clear of the threat

The *SeaRose*, however, remained connected. There was no evidence provided to the enquiry team to indicate that it was recognized at approximately 0500 hrs berg 011 entered Zone 1 on path E (Figure 5). It was noted that the OIM was receiving conflicting information as to whether berg 011 was under tow or not. This is further discussed in the Analysis of the RRMT Call Logs section of this report.

During the OIM's interview, he indicated that since the speed of berg 011 had decreased he felt it would not have done significant damage to the vessel. The *SeaRose* was designed to withstand the expected impact with very little structural damage. The *SeaRose* was designed to withstand an impact of 15 MJ, which is equivalent to an iceberg of 100,000 tonnes traveling at 1 kt. It is noted by the enquiry team that this information does not appear in the IMP. The *SeaRose* design limitation is further discussed in the Potential Consequence section of this report.

The enquiry team calculated (Appendix 1) berg 011's drift speed to be 1.12 kt using the methodology in the IMP. The *SeaRose* OOW recorded berg 011's drift speed had reduced to 0.75 kt. This is not in keeping with the drift speed calculation outlined in the IMP.

The enquiry team noted that the IMP was not utilized by the *SeaRose*'s ECC. The *SeaRose* ECC utilized the *HaBERS* scenario (flowchart) for Vessel Collision Avoidance (Appendix 4) which does not provide direction on actions required as an iceberg enters the ice zones. This scenario also does not provide direction to disconnect the *SeaRose* from the buoy. Upon review of the *HaBERS*, the enquiry team noted that there is no scenario for iceberg threats.

There are several observations identified by the enquiry team related to the IMP. The key observations are listed below:

- *HaBERS* only references the IMP in the Scope, but rather than referencing the IMP, a specific scenario should be added for iceberg collision avoidance;
- The IMP does not include guidance on the probability of a successful tow. This information exists in the *White Rose Development Iceberg Risk for FPSO and Shuttle Tankers* (C-CORE report 01-C15, June 2001) and from experience towing icebergs in the intervening period, should be included in the IMP; and
- The IMP should be updated to clarify the roles and responsibilities of all key personnel with respect to ice management,
    - The IMP does not contain specific duties for the *SeaRose* Marine Supervisor (Master Mariner) as outlined by *SeaRose Development Plan 2001.01* conditions in relation to the role of the Master Mariner for marine matters as follows:
        - Condition 29: The command structure for the FPSO clearly require that in making decisions in relation to marine matters, the Offshore Installation Manager must seek the advice of the Master Mariner.
        - Condition 30: The Master Mariner on board the FPSO shall maintain an Official Log-Book and the List of the Crew as if the FPSO were a ship. In addition, if not one and the same person, the Master Mariner shall record in the Official Log- Book all recommendations made to the Offshore Installation Manager on marine matters.
        - Condition 31: The procedures should provide that initiation of the actual disconnection of the vessel shall be under the command of the Master Mariner.
    - This is further reinforced in the *SeaRose FPSO Safety Plan - Part 1* WR-0-99-X-PR-00003-001 (Rev E8) indicates that the OIM seeks advice of the Marine Supervisor (Master Mariner) when making decisions in relation to marine matters. Additionally the OIM transfers over the responsibility for the installation to the Master Mariner (Marine Supervisor) when disconnect is required, and
    - The IMP does not contain ice management duties for the Officer on Watch. The *Canada Shipping Act 2001 requires* a licensed Officer of the Watch (OOW) to be responsible for maintaining a proper watch, including a 24 hour radar watch while at sea.

Regional Response Management Team (RRMT)

The function of the RRMT is described in Husky's *Incident Coordination and Response Management Plan* (EC-M-99-X-PR-00003-001) (Rev E7) (ICRMP). The RRMT is to provide the necessary support and coordination required by the Incident Response Team on the *SeaRose* to deal with the immediate emergency and in the longer term management of consequences resulting from the emergency.

The response process is modeled from the Incident Command System (ICS). The Husky's RRMT organization chart is provided below in Figure 6.

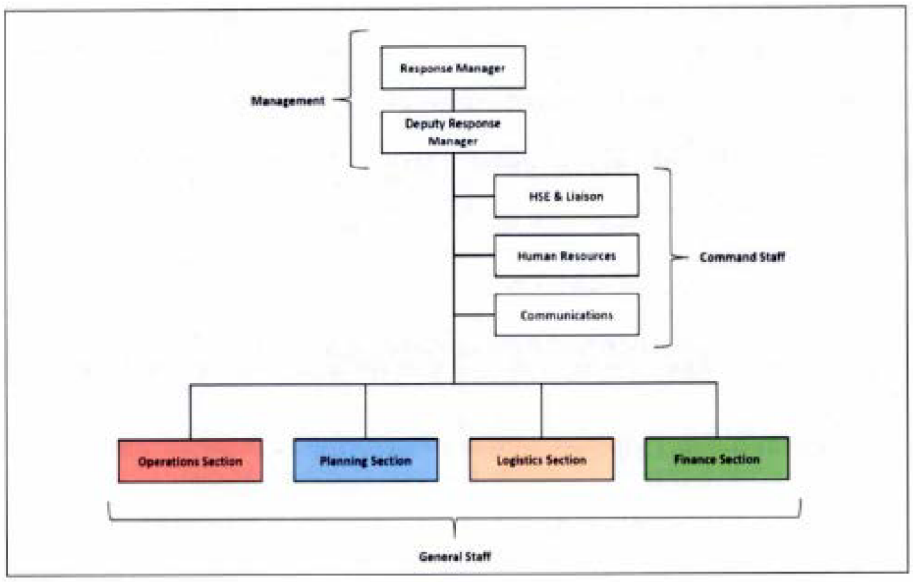


Figure 6: RRMT Structure

The ICRMP speaks to emergencies that develop over time and require consultation before an emergency is declared. Often there is a common escalation process, as provided below:

- Situation emerges-discussion with Onshore Management;
- Situation expands-discussions result in declaration of an alert;
- Situation becomes an emergency–declared an emergency.

The escalation process described above was followed during this event. There were discussions between onshore management and the *SeaRose* OIM several days in advance and eventually the discussions led to the declaration of an emergency in the early morning hours on March 29, 2017.

Husky's emergency response uses a two phase approach, (1) reactive phase and (2) proactive phase. During the reactive phase of an emergency response the RRMT is to act in a support capacity and does not take command of the response. It is the responsibility of the *SeaRose*'s Incident Response Team (Offshore Emergency Response Team) to deal directly with the emergency. The proactive phase, on the other hand, is lead by the RRMT (Onshore Emergency Response Team) and is geared toward strategic long term planning.

According to the ICRMP, Husky's ICS based process consists of a standard management hierarchy that is flexible. Their ICS includes the ability to select and form temporary management hierarchies to control a number of items including communications. The RRMT has the ability to expand to any size and configuration that is necessary to respond to the situation. Expansion under an ICS system, however, occurs is a systematic manner with additional personal or expert teams being incorporated into the

command structure under one of the Section Chiefs. The ICRMP indicates that expansion occurs under the appropriate Section Chief.

In the early morning of March 29, 2017, berg 011 was considered a threat when it changed track to intercept the *SeaRose*. Roughly 1 hour after berg 011 changed track onshore management and the *SeaRose* OIM declared an emergency and stood up the RRMT. The Vice President of Operations, who was also the RRMT Response Manager, decided that the NSO team (Production and Maintenance Manager, the Marine Operations Manager and the Logistics Lead) should join the response. Shortly after the RRMT stood up, the Senior Vice President arrived, to keep abreast of the situation and went into the side room with the NSO team.

Table 5: RRMT check in March 29, 2017

Role/Position	Check-In Time
Response Manager	3:33
Emergency Coordinator (Deputy Response Manager)	3:32
HSE & Regulatory Advisor	3:36
Offshore Liaison (D&C)	3:42
Offshore Liaison (Sub-Sea)	3:34
Offshore Liaison (FPSO)	3:44
Onshore Logistics Coordinator	3:53
Human Resources Manager	3:38
Public Affairs Manager	3:37
Data Recorder	3:36
I.T. Support	3:48

One of the key features of Husky's RRMT includes management by objectives. Objectives were established and prioritized by the Response Manager and Deputy Response Manager who had overall command of Husky's RRMT response. These objectives are to be attainable within the working time frame allotted by the incident and are to be specific and limited to immediate needs. The general staff (Section Chiefs) is responsible to execute them and the Deputy Response Manager is responsible to check periodically to ensure the Section Chiefs are working in accordance with these objectives.

The RRMT records show that the following response objectives were set.

- Maintain POB safety during operations
- Ice management procedures being executed to isolate or eliminate integrity of hull
- Protect for discharges (*SeaRose* shut in)
- Contacted Duty person C-NLOPB

The single point of contact with the *SeaRose* for emergency response communications was the Operation Section Chief. The NSO team, primarily the Vice President of Operations (also a member of the RRMT) and the Production and Maintenance Manager used the Operation Section Chief to relay information to the OIM and/or used his phone directly to communicate with the OIM. There was, however, no indication that the NSO team were operating under an ICS command and reporting structure as it appears that the only interaction they had with the RRMT was directly using the Operations Section Chief's phone or requesting that he relay the information to the OIM.

Enquiry Team Analysis of RRMT Call Log

The RRMT call logs are not verbatim records, as confirmed by the Operations Section Chief. While he did not capture everything, he tried to capture, as much as possible, and they reflect the essence of the conservations.

At approximately 0430 hrs communications between RRMT (onshore) and the *SeaRose* ECC (offshore) increased with calls occurring every few minutes. The *SeaRose* relayed information provided by the *M/V Maersk Dispatcher* to the RRMT on berg 011's range, CPAs, TCPAs and the status of the tow. The RRMT/NSO advised the OIM on the status of the tow as reported by the Captain of the *M/V Atlantic Hawk.*

The *SeaRose*'s OIM called the RRMT/NSO at 0440 hrs and requested to speak with the Production and Maintenance Manager and the Vice President of Operations. At about 0448 hrs the OIM advised the RRMT/NSO that the *SeaRose* had 15 minutes to disconnect and move. The enquiry team take this to mean the *SeaRose*'s T_{Time} was 15 minutes. The OIM advised that berg 011 had a CPA of 0.1 NM and TCPA of 0514 hrs, and that he was preparing to flood QCDC room, but was holding at step 5 for now. He also communicated that the *M/V Maersk Dispatcher* was hooking up the tow which was expected to begin in approximately 10 minutes. The enquiry team note that at this time, the *SeaRose* OOW's radar plot positioned berg 011 with a bearing of 001° T and a distance of 0.7 NM from the *SeaRose*. Using information provided from the OIM, the tow was to commence at 0458 hrs at which time berg 011 would be 0.54 NM away.

At 0458 hrs the RRMT/NSO Production and Maintenance Manager advised the OIM that the *M/V Atlantic Hawk* reported that the *M/V Maersk Dispatcher*'s tow had started to take some weight. Again at 0502 hrs the OIM received call from the RRMT/NSO, Vice President of Operations, advising that the *M/V Atlantic Hawk* reported that berg 011 was under tow. The enquiry team note that this was a critical time as berg 011 was entering Zone 1. The IMP states that if threatening ice reaches the edge of Zone 1 the *SeaRose* must disconnect and sail to a safe area.

At this time, the OIM had also received updates on the *M/V Maersk Dispatcher*'s tow from the *SeaRose* Marine Supervisor who was in communication with the *M/V Maersk Dispatcher*. About 0504 hrs, the OIM responded to the RRMT/NSO that the *M/V Maersk Dispatcher* had not established the tow and estimated it would take another 10 minutes. The enquiry team note that at this time berg 011 was in Zone 1 and in 10 minutes it would be in the ¼ NM (0.25 NM) Ice Exclusion Area. The RRMT/NSO, Vice President of Operations, requested the OIM to wait a minute so they could consult the *M/V Atlantic Hawk*. Shortly after this the RRMT/NSO told the OIM that the *M/V Atlantic Hawk* reported the tow was on. From review of the *M/V Maersk Dispatcher*'s Log book it was determined that no tow was established at this point. Since berg 011 was not under tow and entered Zone 1 with a forecasted CPA to come within the ¼ NM Ice Exclusion Area the IMP requires the *SeaRose* to disconnect and sail to a safe area.

Between 0505 hrs and 0510 hrs the RRMT call logs continue to show discussions between the OIM and RRMT/NSO with respect to whether a tow was established or not. The enquiry team note that at 0505 hrs the *SeaRose* Ice Observer recorded berg 011 at a distance of 0.37 NM, which is nearing the ¼ NM (0.25 NM) Ice Exclusion Area. At 0508 hrs the call log indicated the OIM felt he was at the point the disconnect sequence needed to be resumed. The RRMT/NSO, Vice President of Operations, requested the OIM to wait five minutes as they expected tension would be applied in 5 to 6 minutes and that they would confirm this with the *M/V Atlantic Hawk*. The enquiry team note that the 0508 hrs entry in the *M/V Maersk Dispatcher*'s log book indicated that the end of the tow rope was retrieved on deck and was commencing connecting the tow wire.

Between 0510 hrs and 0515 hrs RRMT call logs continue to show confusion as to the status of the tow. The OIM believed there was no tow and advised the RRMT/NSO the CPA was still 0, whereas, the RRMT/NSO claimed that the tow was just starting. The OIM repeated that he wanted to resume the disconnection sequence. The RRMT/NSO continued to request a delay in the disconnect sequence as they were waiting for clarification from the *M/V Atlantic Hawk* regarding the *M/V Maersk Dispatcher*'s tow. The enquiry team note that at 0510 berg 011 was 0.32 NM from the *SeaRose* which was the last recorded radar range. At 0511 hrs the radar contact was lost with berg 011. The OIM then relied on visual estimations of distances provided from the crew on the forecastle. The crew on the forecastle had difficulty estimating distances as they did not have range finding equipment, no point of reference, and there was low visibility from fog and darkness.

Two minutes after radar contact was lost with berg 011, at 0513 hrs, the distance of berg 011 as provided from the forecastle was 200 yards (0.098 NM) from the bow. At this point the OIM was still talking to the RRMT/NSO about continuing with disconnection, even though the time needed to disconnect was greater than the TCPA of berg 011. The enquiry team note that the radar antenna is located aft on the *SeaRose* and that the bow is about 225 m away, meaning the *SeaRose* OOW and Ice Observer ranges are about 0.12 NM greater than the actual distance of the berg from the bow. Without correcting for the difference in the distance between the bow and radar antenna the berg is closer to the bow than expected. When the visual ranges were provided from the bow, berg 011 appeared to have moved a significant distance in three minutes. This is because the visual from the bow does not include the additional distance to the aft radar antenna; as well as their inability to take accurate ranges visually without proper equipment and poor visibility conditions.

At 0515 hrs, the OIM advised the RRMT/NSO that they expected impact in two minutes as berg 011 was 55 yards (50 m) from the *SeaRose*. At 0520 hrs the OIM advised the RRMT/NSO that the *M/V Maersk Dispatcher* lost the tow and that they were altering the *SeaRose*'s heading by swinging its stern (rear) to the port side (left) as fast as rudders would allow keeping its bow (front) pointing toward berg 011. The enquiry team note that this action is consistent with normal seamanship practice and the *HaBERS* Vessel Collision Avoidance scenario. At 0551 hrs, the OIM advised that berg 011 had passed by the *SeaRose* and the muster was stood down.

When questioned by the enquiry team, members of the NSO indicated that the *M/V Atlantic Hawk* was strategically positioned at 0.2 NM away from the *SeaRose* with visibility of the *M/V Maersk Dispatcher*'s tow progression and of berg 011 in relation to the *SeaRose*. It was stated that the Captain of the *M/V Atlantic Hawk* had a radar lock on berg 011, the *M/V Maersk Dispatcher*, and the *SeaRose* and provided a play by play commentary of what he observed. It was indicated that prior to the tow being initiated, the *M/V Atlantic Hawk* reported that berg 011's CPA was opening but would pass in close proximity. Knowing this and the belief that the *M/V Maersk Dispatcher* was about to place berg 011 under tow, a high degree of confidence was put on the Captain's information.

When questioned by the enquiry team, the OIM stated that the decision to stay connected to the buoy was his. He was receiving information from the bridge team onboard the *SeaRose* which differed from that of onshore. Several times he expressed his awareness of the situation to the best of his ability to ensure everyone was aware of what was going on. At the critical moment, he believed that the *M/V Maersk Dispatcher* had established a tow and the berg was no longer a threat. He also indicated that at no point did he feel pressured from onshore to stay connected. Further discussion of this is provided in the *SeaRose* Emergency Command Structure section below.

Also the OIM indicated that since the speed of the berg had decreased he felt it would not do significant damage to the vessel. His primary concern was structural damage as he believed impact would not cause loss of life or environmental damage. The enquiry team does not have evidence that berg 011's energy calculation was conducted during the incident and note that the RRMT call logs do not indicate that there were discussions regarding impact pressures and risk to the hull structure.

The *M/V Atlantic Hawk* monitored berg 011 as it drifted past the *SeaRose*. The Captain of the *M/V Atlantic Hawk* indicated during his interview that after the *M/V Maersk Dispatcher* lost the tow, the *SeaRose* requested the *M/V Atlantic Hawk* to try to establish a tow or use its water cannon to deflect berg 011 away from the *SeaRose*. The OIM (as recorded in the RRMT call log) and Ice Observer (as recorded in his log) stated that the *M/V Atlantic Hawk* would use the water cannon to give berg 011 a push. The *SeaRose* ECC Debrief Report also stated that the *M/V Atlantic Hawk*'s water cannon was effective in moving the berg further to the starboard side (right side). When interviewed, however, the Captain of the *M/V Atlantic Hawk* indicated he only monitored berg 011 until it past the *SeaRose*, he did not use the water cannon, as he stated, if he applied the water cannon there was a risk of pushing berg 011 into the *SeaRose*.

SeaRose Emergency Command Structure

The *SeaRose FPSO Emergency Response Plan* WR-O-OO-X-PR-00017-001 (Rev E4) (ERP) provides the framework of organizational responsibility and lines of communications in the event of an incident. In this plan it is stated that the Incident Commander, the OIM is in overall command of the offshore emergency response organization and has responsibility for all strategic and tactical decisions required to control emergencies on or in the vicinity of the *SeaRose* to ensure the safety of personnel, environment and the facility. It also specifies that ongoing management of an incident will be in accordance with the *HaBERS*. The enquiry team note that there is no iceberg emergency scenario in *HaBERS. HaBERS* does refer to the IMP in the scope section for an iceberg collision.

The *SeaRose* Offshore Emergency Command Center (ECC) includes:

- Incident Commander - OIM
- Communications Operator - Marine Supervisor
- Incident Coordinator - Production Supervisor
- Scribe - MMSC
- Engineering Support - Chief Engineer
- Electrical Support - Electrical Coordinator
- Muster Captain - Maintenance Supervisor
- Control Room Operator - On-shift CCRO
- Control Room Operator - Off-shift CRO
- Ballast Control- Marine Coordinator / Technician
- ICSS Support - ICSS Tech

The Communications Operator (*SeaRose* Marine Supervisor) is responsible to make all external communications during an incident. He was communicating with the *M/V Maersk Dispatcher* and providing tow status updates to the OIM. Through review of the *SeaRose*'s ERP, communications with field assets (i.e. the *M/V Atlantic Hawk*) should go through the Communication Operator onboard the *SeaRose*. However, in this case, the *M/V Atlantic Hawk* was communicating primarily with the NSO team onshore who then relayed information to the OIM. During the interview with the Captain of the *M/V Atlantic Hawk* he said he only had short conversations with the *SeaRose* as he primarily communicated with Husky onshore personnel.

Communications between the *SeaRose* Marine Supervisor and the *M/V Maersk Dispatcher* provided reliable information on the progression of the tow. This is evident as the information in *M/V Maersk Dispatcher*'s log book matches the tow information the OIM was reporting to the RRMT/NSO from the *SeaRose* Marine Supervisor.

As stated above, when questioned about disconnecting, by the enquiry team, the OIM replied that the decision to stay connected to the buoy was his. He was receiving information from the bridge team onboard the *SeaRose* which differed from the information provided from the RRMT/NSO onshore. Several times he expressed his awareness to the best of his ability to ensure everyone was aware of what was going on. At the critical moment, he believed that *M/V Maersk Dispatcher* had established a tow and was no longer considered a threat. The OIM further stated that this was premature as it was later established that the *M/V Maersk Dispatcher* had not yet initiated its tow. When the tow was initiated, the time it would take to disconnect was greater than the time needed for the iceberg to reach the *SeaRose*. He also indicated that at no point did he feel pressured from the RRMT/NSO to stay connected.

As stated above, the *SeaRose* ECC used the Vessel Collision Avoidance *HaBERS* flow chart in lieu of the IMP. There was no indication that the OIM provided direction to the ECC to consult the IMP in order for the ECC to provide the necessary support and advice. Without this support the OIM may not have received guidance as to actions to take in accordance with the IMP and may have been attempting to perform these duties himself when he should focus on making the necessary decisions.

Berg 011 Tow

The *SeaRose* had first requested the *M/V Maersk Dispatcher* take berg 011 under tow at approximately 1800 hrs on March 28, 2017. The *M/V Maersk Dispatcher* could not do this due to high sea states and poor visibility. As berg 011 got closer, the *SeaRose* continued to request a tow. At 0145 hrs berg 011 changed course and had a drift CPA of 0. The OIM was notified and asked the *SeaRose* OOW to contact the *M/V Maersk Dispatcher* and request again to take berg 011 under tow. The Captain of the *M/V Maersk Dispatcher* again advised that conditions were not suitable to attempt a tow.

About 0215 hrs the OIM left the 0200 hrs ice call to check if the *M/V Maersk Dispatcher* had begun to take berg 011 under tow. On learning that no tow was underway the OIM called the Captain of the *M/V Maersk Dispatcher* via satellite phone to convey the seriousness of the current situation, and discussed the possibility of conducting a two vessel tow or using the water cannon. Shortly after this call the Captain of the *M/V Maersk Dispatcher* agreed to attempt a tow as weather conditions and sea states were improving. Berg 011 at this time was approximately 3.5 NM from the *SeaRose*, and about to enter Zone 2, with a CPA of <0.1 NM and a TCPA of 0500 hrs.

The *M/V Maersk Dispatcher*'s log book indicated that at about 0340 hrs they were positioned 2 NM downwind of berg 011 preparing to commence tow procedures and at 0350 hrs they started deploying the ice rope. The *SeaRose* OOW had calculated the TCPA of berg 011 to be between 0500-0515 hrs. According to the document, *White Rose Development Iceberg Risk for FPSO and Shuttle Tankers* (C-CORE report 01-C15, June 2001), it takes about 4 hours to get a berg under tow. In this situation, berg 011 was estimated to reach the *SeaRose* in 1 to 1.5 hours; it was approximately 1.8 NM from the *SeaRose*. The Captain of the *M/V Maersk Dispatcher* stated that he deployed the ice rope rather than the ice net, even though the net has a higher success rate of achieving a tow, because of time constraints to establish the tow.

About 0430 hrs the *M/V Maersk Dispatcher* had 1,200 m of tow rope in the water and begun manoeuvring the vessel around berg 011. At this time the *M/V Maersk Dispatcher* logged berg 011 at 0.86 NM from the *SeaRose*. The enquiry team calculate this to be in Mid Zone 2. The *M/V Maersk Dispatcher* connected the tow wire to the tow rope and started paying out the tow wire about 0508 hrs. The enquiry team calculate that berg 011 was now in Zone 1 and according to the IMP the *SeaRose* was to disconnect and sail to a safe area.

It was not until about 0514 hrs when the *M/V Maersk Dispatcher* commenced applying tension on the tow wire with 100 m of tow wire paid out. Berg 011 was just inside the ¼ NM (0.25 NM) Ice Exclusion Area. The Captain of the *M/V Maersk Dispatcher* indicated that he would have preferred to pay out 500 m of wire to weigh down the rope but due to the proximity to the *SeaRose* they only paid out 100 m. As tension was applied the ice rope slipped over berg 011. It was recorded in the *M/V Maersk Dispatcher's log book that at* 0520 hrs the tow was lost. As stated previously, radar contact with berg 011 had been lost and visual distances were being relayed to the OIM by personnel on the forecastle (bow). The visual distance provided at this time was 200 yards (0.098 NM). At this point, the *SeaRose* would not have time to disconnect and sail away before berg 011 reached its CPA.

4.0 INCIDENT CONSEQUENCES

Actual Consequences

Berg 011 did not make contact with the *SeaRose* or subsea infrastructure. There were no injuries, no environmental damage, and no damage to the *SeaRose* or subsea assets.

Potential Consequences

Impact with *SeaRose*:

According to *The SeaRose Ship Collision Analysis*, the *SeaRose's* hull is designed to withstand the impact of a 100,000 tonne iceberg colliding at 0.5 m/s (1 kt). This corresponds to a kinetic energy of approximately 15 MJ. According to the study the kinetic energy required to cause damage to the hull leading to loss of containment would exceed 30 MJ. This is because; in reality the total kinetic energy of the colliding object required to cause considerable damage will be significantly greater than 15 MJ for a number of reasons:

- In designing the hull for 15 MJ there are significant safety margins built in;
- The hull is double-skinned so even if the outer skin were breached, significantly more energy would be required to breach the inner skin or seriously jeopardize vessel trim; and
- Only a portion of incident kinetic energy would be absorbed by the *SeaRose* in the form of hull damage. The total incident kinetic energy of the colliding iceberg would be converted into a number of forms.
    - translational kinetic energy imparted to the *SeaRose* (that is, because the *SeaRose* and its associated mooring system is compliant, it will tend to move away from the colliding vessel under the force of the impact);
    - rotational kinetic energy imparted to the *SeaRose* (when the point of impact is off centre the *SeaRose* will be given a rotational impulse);
    - kinetic energy remaining with the iceberg or ship (only if it is brought fully to a standstill will all of the incident kinetic energy have been absorbed; oblique impacts will thus leave the iceberg or ship with significant residual kinetic energy);
    - energy absorbed in causing damage to the colliding iceberg or ship (crushing and local failure of the iceberg or ship near the point of impact will absorb considerable energy); and
    - energy absorbed in causing damage to the hull of the *SeaRose*.

The kinetic energy of berg 011 was calculated by the enquiry team (Appendix 1) using the formula contained in The *SeaRose Ship Collision Analysis*; was estimated to be less than 15 MJ. This study states that the damage to the *SeaRose*'s hull would have been unlikely.

The Serviceability Criteria, incorporated in the IMP limit icebergs to waterline lengths of 20 m or less with a maximum wave height of 2.5 m so as to minimize the risk of contact with the bilge keels. Berg 011's water length exceeded these conditions as did the wave heights at the time. If berg 011 had made contact with a bilge keel some damage would have occurred. The enquiry team is not able to specify the amount of damage or the significance of the damage.

The enquiry team have little information to assess the impact on personnel resulting from berg 011 colliding with the *SeaRose*.

Impact with Subsea:

With a draft estimated to be 50 m, berg 011 had the potential to contact the hog bends of risers in its path as the hog bends have depths ranging from 46 to 56 m. If a riser was damaged there would be the possibly of loss of residual hydrocarbon left after flushing. The volume lost would not be significant and would disperse readily given the conditions at the time. Even if the *SeaRose* disconnected, the risk of berg 011 contacting one of the risers would not change significantly.

5.0 MEDIA RELEASES

Relevant media coverage of the event is included in Appendix 6.

6.0 FINDINGS

Principal Findings

1. Husky did not follow its *Ice Management Plan*, which identifies actions to be taken when icebergs are present in or near the White Rose Field. Of particular note was their failure to follow section 5 of the *Ice Management Plan*, which specifies actions to be taken when an iceberg is encroaching on the *SeaRose*, including when disconnection is required.

2. Husky Senior Management did not ensure that Husky's *Ice Management Plan* was followed, as evidenced by their failure to support the OIM's desired course of action to disconnect when berg 011 entered Zone 1 with a CPA that intersected the ¼ NM Ice Exclusion Area.

3. The OIM did not disconnect in accordance with the *Ice Management Plan* when berg 011 reached the edge of Zone 1 with a forecasted drift CPA that intersected the ¼ NM Ice Exclusion Area.

Contributing Factors to the Principal Findings

1) Husky's *Ice Management Plan* is not fully incorporated into their emergency response process as evident by:

a) The *Ice Management Plan* is designed to support normal operations during ice season for both the *SeaRose* and the MODU, but also, details actions to be taken in emergency situations as when ice becomes threatening to the facility. The inclusiveness of the plan, unless familiar with the plan, makes finding the emergency response process related to threatening ice, cumbersome, as unnecessary information needs to be sorted through in order to obtain the pertinent emergency actions.
b) The *SeaRose* ECC team uses a document called *Hazard-based Emergency Response Scenarios* (*HaBERS*) as a guide during emergencies and training, as it outlines actions to be taken for the management of predetermined incident scenarios. It is noted that there is no iceberg emergency scenario in *HaBERS*. *HaBERS* directs personnel to the *Ice Management Plan* for potential iceberg collision; which as stated above is cumbersome unless familiar with the plan. The ECC team being accustomed to using *HaBERS* defaulted to the Vessel Collision Avoidance scenario (used for vessels) which does not reference actions to be taken as icebergs enter zones with particular tracts and does not direct the OIM to disconnect;
c) Key personnel do not have specific duties outlined in the *Ice Management Plan*, specifically, the *SeaRose* OOW and Marine Supervisor. However, during the incident these are the people the OIM relied on. The *SeaRose* Marine Supervisor is responsible to provide advice to the OIM on all marine matters and is to assume command of the SeaRose when disconnection is required. If individuals taking actions during an incident do not have specific duties or know what functions to carry out(in accordance with a specific plan) during the emergency scenario it could create indecision and confusion; and
d) No record that the Ice Observer onboard the *Henry Goodrich* was carrying out his/her duties in accordance with the *Ice Management Plan*. As evident by:
    i) No record that the *Henry Goodrich*'s Ice Observers calculated the *SeaRose*'s ice zones and communicated them to the OIM;
    ii) No record that the *Henry Goodrich*'s Ice Observer gave the OIM 1 hour notice of berg 011 entering Zone 2;
    iii) No record that berg 011's drift speed and CPA's were calculated by the *Henry Goodrich*'s Ice Observers using the formulas provide in the *Ice Management Plan* and communicated to the OIM; and
    iv) No record that the *Henry Goodrich*'s Ice Observers reviewed the OIMs $T_{\text{-Time}}$ calculations.

2) No record that the *SeaRose* OIM or the onshore personnel recognized when berg 011 entered the zones in order to employ the actions as required in the *Ice Management Plan*, as evident by:
a) RRMT call logs, which are discussions between the OIM and onshore staff, do not include information about berg 011 entering the *SeaRose* ice zones;
b) The *SeaRose* ECC key events board, which is where key events are logged during an emergency, did not include information about berg 011 entering the *SeaRose* ice zones;
c) The *SeaRose* bridge Marine Log book did not include information about berg 011 entering the *SeaRose* ice zones;
d) No evidence provided from interviews with personnel about berg 011 entering *SeaRose* ice zones, with exception of the ¼ NM Ice Exclusion Zone; and
e) Emails to Husky from the Onshore Ice Coordination Center (PAL) identified berg 011 as one of the bergs in the area and that the berg would pass slightly to east. The CPA of berg 011 was listed as being 1.9 NM (one email) and 0.1 NM (another email). These CPAs intersect the *SeaRose* ice zones, including the ¼ NM (0.25 NM) Ice Exclusion Area.

3) The *Ice Management Plan* does not clearly define threatening ice or when it is reasonable to conduct a tow, as evident by:
   a) The *Ice Management Plan* defines threatening ice in terms of design tolerance of the *SeaRose* and its associated equipment. The *Ice Management Plan* however, does not provide information on the *SeaRose* design tolerances other than that of the bilge keels. The OIM was requested on March 27 to read the *SeaRose* design limitation documents prior to the incident as Husky has conducted several studies that outline design limits for the *SeaRose*'s hull and moorings;
   b) The *Ice Management Plan* defines threatening ice in terms of an iceberg having a CPA that intersects Zone 2 and is not being managed. There is no clear explanation of what is meant by being managed; and
   c) There is no information provided regarding the estimated amount of time required to achieve a tow. There is a separate study called the *White Rose Development Iceberg Risk for FPSO and Shuttle Tankers,* C-CORE report 01-C15, June 2001, which states the estimated amount of time needed for a tow is 4 hours. In this event, when the decision was made to attempt a tow, berg 011 was estimated to reach the *SeaRose* in 1.5 hrs.

4) The situational awareness of the *SeaRose*'s OIM included inaccurate information regarding berg 011's position as well as its tow status, as evident by:
   a) At the time berg 011 entered Zone 1 the OIM received several confirmations from the RRMT/NSO that berg 011 was under tow. Despite the OIM's assertion that he was receiving conflicting information from *M/V Maersk Dispatcher*, the RRMT/NSO continued to confirm the tow was established;
   b) The *M/V Maersk Dispatcher* advised the *SeaRose* at 0448 hrs that they expected a tow in 10 minutes; however, the timeline shows that when this was up, the *M/V Maersk Dispatcher* advised the *SeaRose* they needed another 10 min;
   c) Berg 011's range was provided using the ship's radar. The ship's radar antenna is positioned roughly 225 m aft of the bow. This means berg 011 was closer than reported by the *SeaRose* OOW. When range information switched from radar information to visual information berg 011 was closer than expected;
   d) Crew stationed on the Forecastle/crow's nest did not have access to equipment to use to take accurate range and bearings. Meaning information about berg 011's position was not precise; and
   e) When the *M/V Maersk Dispatcher* lost the tow, the *SeaRose* requested the *M/V Atlantic Hawk* to use its water cannon. Records show that the *SeaRose* OIM and crew believed the *M/V Atlantic Hawk* had used its water cannons to increase berg 011's CPA. However, during the interview with the Captain of the *M/V Atlantic Hawk* indicated he had not used the water cannons on berg 011 for fear it would push it closer to the *SeaRose*.

5) The RRMT/NSO stood up to support the OIM but it contributed to miscommunication and confusion during the incident, as evident by:
   a) The NSO not operating within the RRMT under a proper Incident Command System's command and reporting structure as outlined in *the Incident Coordination and Response Management Plan*. Meaning the NSO directly communicated with OIM instead of through the RRMT;

b) The NSO were communicating with infield resources. Communications with field resources (i.e. the *M/V Atlantic Hawk*) should go through the Communication Operator (*SeaRose* Marine Supervisor) in accordance with the *SeaRose Emergency Response Plan*.
c) The *Ice Management Plan* was not referred to in the RRMT to help ensure the response was in accordance with the procedure; and
d) The RRMT/NSO provided inaccurate information to the OIM about the *M/V Maersk Dispatcher*'s tow, at the critical moment when berg 011 had reached the edge of zone 1.

6.0 CLOSING REMARKS AND CONCLUSION

In this incident the contingency plan, contained within the *Ice Management Plan* was not adhered to. This is the first time an iceberg had encroached the *SeaRose*'s Zone 1 as in all previous situations they actively managed the icebergs successfully. With the learning's from this incident Husky is now in a position to review the incident and determine which aspects of their *Ice Management Plan* worked and which did not.

Alleged Contraventions of Statutes for C-NLOPB Assessment Team consideration:

1) Husky did not follow its *Ice Management Plan*, which identifies actions to be taken when icebergs are present in or near the White Rose Field. Of particular note was their failure to follow section 5 of the *Ice Management Plan*, which specifies actions to be taken when an iceberg is encroaching on the *SeaRose*, including when disconnection is required.

Husky's *Ice Management Plan* is a required part of their Management System pursuant to Section 5 of the *Newfoundland Offshore Petroleum Drilling and Production Regulations,* which states the Operator is required to manage risks associated with identified hazards, this includes icebergs. Husky, therefore, contravened section 18 of the *Newfoundland Offshore Petroleum Drilling and Production Regulations* by not ensuring compliance with their Management System. Not following the regulations is a contravention of subsections 194 (1)(a)&(e) of the *Accord Act.*

2) Husky Senior Management did not ensure that Husky's *Ice Management Plan* was followed, as evidenced by their failure to support the OIM's desired course of action to disconnect when berg 011 entered Zone 1 with a CPA that intersected the ¼ NM Ice Exclusion Area.

The following senior management members present during the incident response were the Senior Vice President and Vice President Operations who are corporate officers of Husky Oil Operations Limited and are obligated under section 205.036 to take all reasonable measures to ensure the corporation complies with the provisions of Part III.1 of the *Accord Act*. These senior management members breached this obligation by failing to follow the *Ice Management Plan* contrary to the operator's duty under section 205.012 of the *Accord Act* to take all reasonable measures to ensure the health and safety of all employees and other individuals at its workplace.

3)The OIM did not disconnect in accordance with the *Ice Management Plan* when berg 011 reached the edge of Zone 1 with a forecasted drift CPA that intersected the ¼ NM Ice Exclusion Area.

The *SeaRose* Installation Manager (OIM) did not follow the *Ice Management Plan* which is a part of the Management System as required in Section 5 of the *Newfoundland Offshore Petroleum Drilling and Production Regulations*. The OIM's failure to comply with the *Ice Management Plan* was a breach of his responsibility under section 193.2(1) of the *Accord Act* and a failure to ensure the safety of the installation and the persons at it, contrary to the OIM's duty under section 193.2(2) of the *Accord Act*.

APPENDIX 1

Berg 011 Drift Speed Calculation

@ 0245 Range is 3.0 NM
@0215 Range is 3.5 NM
@0145 Range is 4.2 NM

$D_s = D/T$
$= (4.2\ NM - 3.0\ NM)/ 1h$
$= 1.2\ Kt$

Zone Calculations

Zone 2= $D_s \times T_{Time}$
$= 1.2\ Kt \times 2.6\ h$
$= 3.12\ NM$

Mid Zone 2 = ½ Zone 2
= ½ (3.12 NM)
= 1.56 NM

Zone one = $D_s \times T_{Time}$ + ¼ NM Ice Exclusion Area
= 1.2 Kt x .25 h + .25 NM
= 0.55 NM

It is noted that as the icebergs drift speed or the *SeaRose*'s T_{Time} changes so does the zones sizes. The ¼ nautical mile Ice Exclusion Zone is constant.

Berg 011 Draft Calculation

$D = 3.781\ x\ L^{0.63}$
D = Draft (m)
L = Length (m)

$D_{Berg\ 011} = 3.781 * (60\ m)^{0.63}$
$= 50\ m$

Berg 011 Mass Calculation

According to Husky's Ice Reference Manual there are several different ways to calculate iceberg mass if the above-water dimensions are known. The enquiry team used two methods as detailed below:

$M = 3\ x\ LWH$
M = Mass (T)
L = Length (m)
W = Width (m)
H = Height (m)

$M_{Berg\ 011} = 3*60m*40m*$
= 57,600 tonnes

Another method to calculate Iceberg Mass is as follows:

$M = 7.12\ x\ L\ x\ W\ x\ H\ x\ Sf$
7.12 = Ratio of the density of glacial ice to sea water
M = Mass (T)
L = Length (m)
W = Width (m)
H = Height (m)
Sf = Shape factor
Tabular and Blocky 0.50

$M_{Berg\ 011} = 7.12*60m*40m*8m*0.5$
= 68,400 tonnes

Pinnacle and wedge 0.25
Dry-dock 0.15
Dome 0.41

Berg 011 Kinetic Energy

Kinetic energy is a function of both the mass and velocity of the colliding vessel. This formula is also used to determine the impact energy of a colliding iceberg.

E = ½(m/1000)kv2
E = impact energy (MJ)
M = vessel mass (tonnes)
V = vessel speed (m/s) = 0.514 x (speed in knots)
k = hydrodynamic added mass constant
= 1.1 for head-on (powered) impact
= 1.4 for broadside (drifting)

Kinetic energy for berg 011 with a velocity of 1.2 kt and using the masses calculated above as 57,600 t and/or 68,400 t.

$E_{Berg\ 011}$ = ½ *(57,600t/1000) * 1.1 * (1.2kt * 0.514m/s)^2
= 12 MJ

$E_{Berg\ 011}$ = ½ *(68,400t/1000) * 1.1 * (1.2kt * 0.514m/s)^2
= 14 MJ

Berg 011's energy was estimated to be between 12-14 KJ

APPENDIX 2

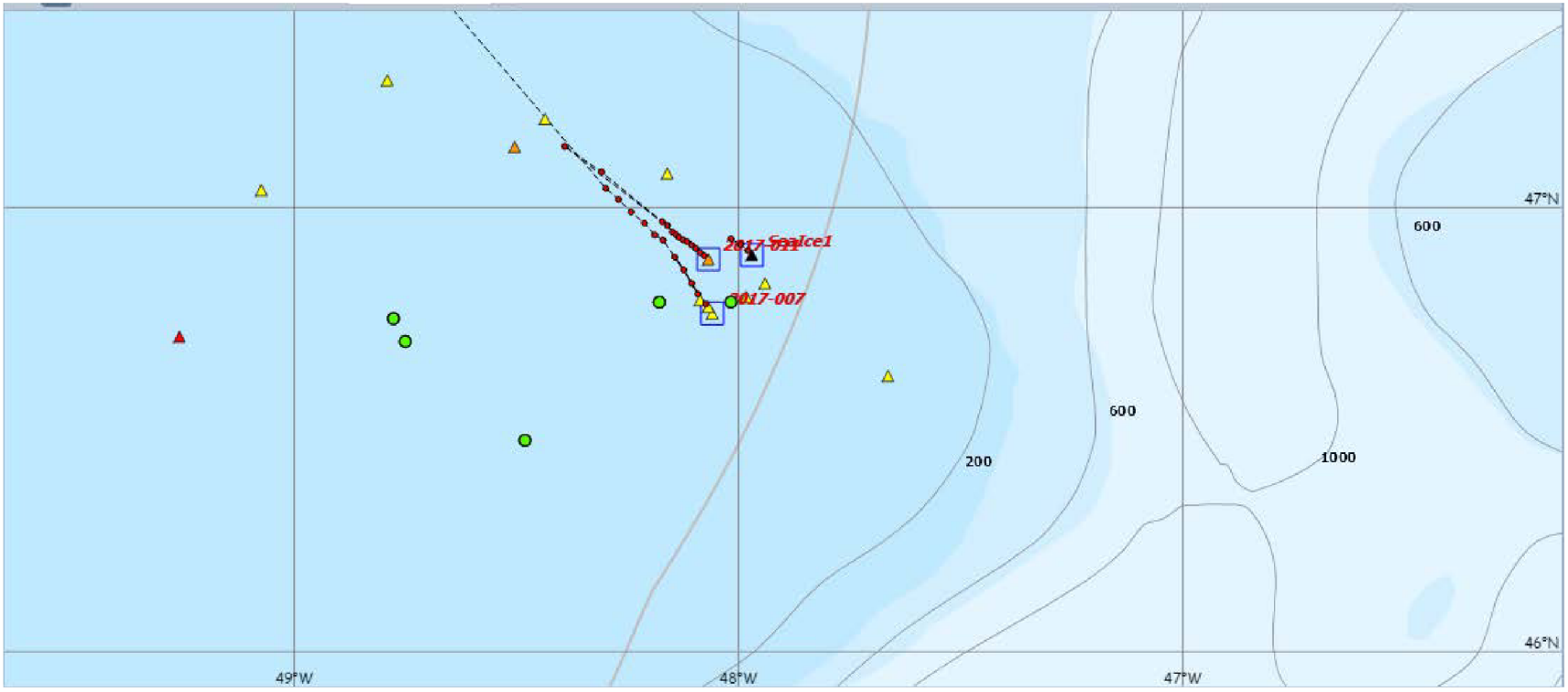
Berg 011 (Taken from *SeaRose* at 0525 hrs March 29, 2017)

APPENDIX 3

From: PAL Ice Coordinator
Sent: Wednesday, March 29, 2017 12:36 AM
To: Company Man - HGR; [redacted] Weatherman *SeaRose*; Ice Weatherman - HGR; OIM *SeaRose*; MarineSuper *SeaRose*; Night Company Man - HGR
Cc: [redacted] Drilling Superintendent - HGR; [redacted] (White Rose)
Subject: Iceberg update @ 0035

Good evening,

2017-007 is passing east of HGR and west of *SeaRose*. 2017-011 will pass east of both facilities. The leading patch of sea ice will also pass to the east of both facilities.



Name	Size	Shape	Time Stamp	Range	Bearing	CMG	SMG	Ref Facility	CPA	TCPA	Source	Tow	Tow Hdg	Bollard Pull	Flow Rate	Comments
Sealce1	Unknown	Unknown	29-03-2017 02:46:00	6.7	16.9	150.3	1.7	SeaRose	4.8	2.8	Maersk Detector	N				
2017-011	Medium	Tabular	29-03-2017 02:30:00	6.1	340.2	141.9	1.8	SeaRose	1.9	3.2	Maersk Dispatcher	N				
2017-007	Small	Wedge	29-03-2017 00:45:00	2.3	228.4	154.8	1.4	SeaRose	2.2	0.5	Atlantic Hawk	Y	310.0		1400.0	

Name	Size	Shape	Time Stamp	Range	Bearing	CMG	SMG	Ref Facility	CPA	TCPA	Source	Tow	Tow Hdg	Bollard Pull	Flow Rate	Comments
Sealce1	Unknown	Unknown	29-03-2017 02:46:00	10.7	53.2	150.3	1.7	Henry Goodrich	10.6	0.8	Maersk Detector	N				
2017-011	Medium	Tabular	29-03-2017 02:30:00	7.4	38.1	141.9	1.8	Henry Goodrich	7.1	1	Maersk Dispatcher	N				
2017-007	Small	Wedge	29-03-2017 00:45:00	5.1	107.1	154.8	1.4	Henry Goodrich	3.8	-2.5	Atlantic Hawk	Y	310.0		1400.0	

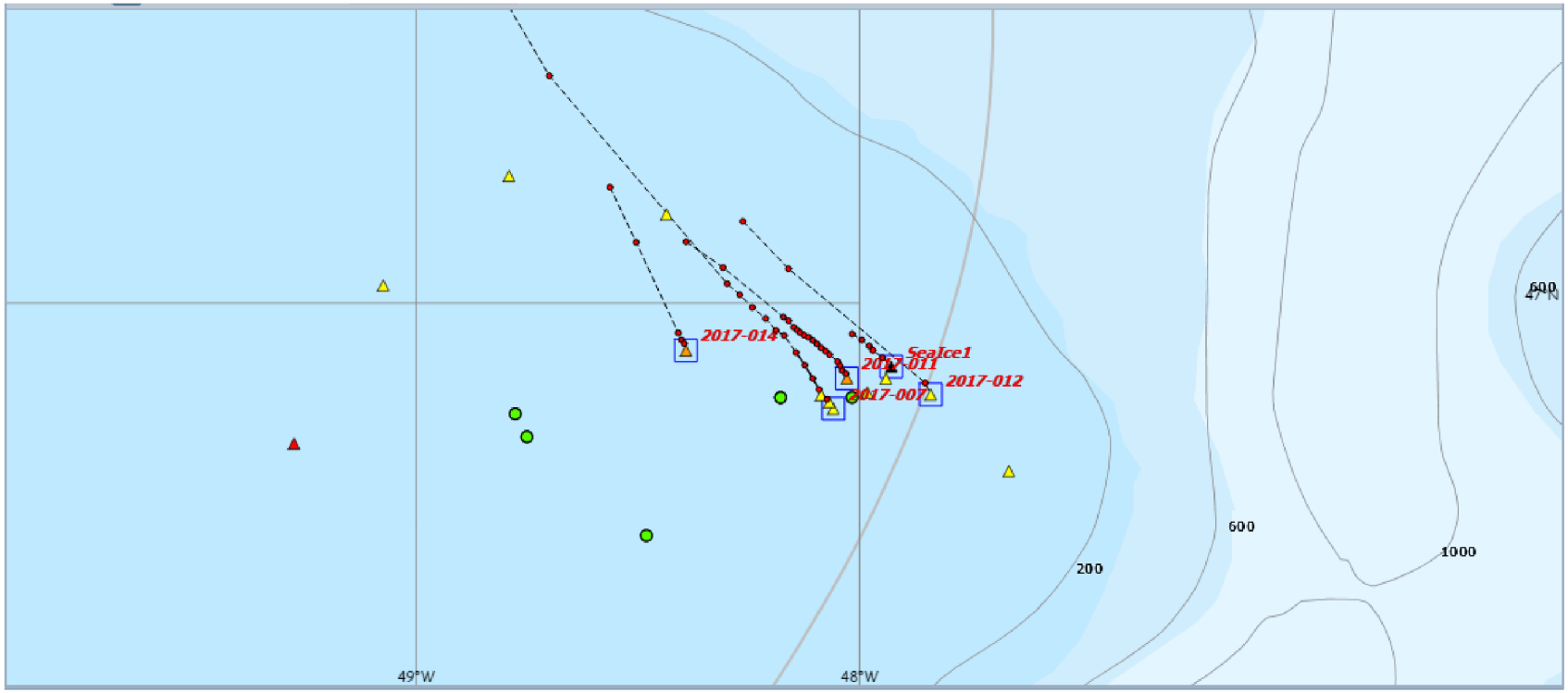
Regards,

PALaerospace
Ice Coordinator
palaerospace.com

From: PAL Ice Coordinator
Sent: Wednesday, March 29, 2017 3:24 AM
To: Company Man - HGR; [redacted] Weatherman *SeaRose*; Ice Weatherman - HGR; OIM *SeaRose*; MarineSuper *SeaRose*; Night Company Man - HGR
Cc: [redacted] Drilling Superintendent - HGR; [redacted] (White Rose)
Subject: Iceberg update @ 0325

Good morning,

2017-007 is passing east of HGR and west of *SeaRose*. 2017-011 will pass east of the *Henry Goodrich*, at present it will pass slightly to the east of *SeaRose* it will pass. 2017-012 will pass east of both facilities. 2017-014 will pass west of both facilities, and the leading patch of sea ice will also pass to the east of both facilities.



Name	Size	Shape	Time Stamp	Range	Bearing	CMG	SMG	Ref Facility	CPA	TCPA	Source	Tow	Tow Hdg	Bollard Pull	Flow Rate	Comments
Sealce1	Unknown	Unknown	29-03-2017 04:41:00	5.5	41.2	145.6	1.5	SeaRose	5.4	0.9	Maersk Detector	N				
2017-014	Medium	Unknown	29-03-2017 04:33:00	16.6	292.4	170.4	0.9	SeaRose	14.1	9.7	Maersk Cutter	N				
2017-012	Small	Unknown	29-03-2017 04:30:00	7.3	87	161.7	1.7	SeaRose	7	-1.2	Scotian Sea	N				
2017-011	Medium	Tabular	29-03-2017 05:30:00	2.6	349.4	172.1	1.3	SeaRose	0.1	2	Maersk Dispatcher	N				
2017-007	Small	Wedge	29-03-2017 00:45:00	2.3	228.4	154.8	1.4	SeaRose	2.2	0.5	Atlantic Hawk	Y	310.0		1400.0	

Name	Size	Shape	Time Stamp	Range	Bearing	CMG	SMG	Ref Facility	CPA	TCPA	Source	Tow	Tow Hdg	Bollard Pull	Flow Rate	Comments
2017-014	Medium	Unknown	29-03-2017 04:33:00	10.8	306	170.4	0.9	Henry Goodrich	7.6	8.5	Maersk Cutter	N				
Sealce1	Unknown	Unknown	29-03-2017 04:41:00	11.1	67.8	145.6	1.5	Henry Goodrich	10.8	-1.6	Maersk Detector	N				
2017-012	Small	Unknown	29-03-2017 04:30:00	13.9	88.4	161.7	1.7	Henry Goodrich	13.3	-2.4	Scotian Sea	N				
2017-011	Medium	Tabular	29-03-2017 05:30:00	6.7	67.2	172.1	1.3	Henry Goodrich	6.4	1.3	Maersk Dispatcher	N				
2017-007	Small	Wedge	29-03-2017 00:45:00	5.1	107.1	154.8	1.4	Henry Goodrich	3.8	-2.5	Atlantic Hawk	Y	310.0		1400.0	

Regards,

PALaerospace
Ice Coordinator
palaerospace.com

From: OIM *SeaRose*
Sent: Monday, March 27, 2017 2:07 PM
To: [redacted]
Subject: RE: Ice Management -Preparation

yup

From: [redacted]
Sent: Monday, March 27, 2017 1:48 PM
To: OIM *SeaRose*
Subject: Ice Management -Preparation

[redacted]

Can you confirm that we have reviewed/prepared the necessary checklists for disconnection (Marine and Production).

Thanks,
[redacted]

From: [redacted]
Sent: Monday, March 27, 2017 11:35 PM
To: OIM *SeaRose* [redacted]
Cc: [redacted]
Subject: *SeaRose* Design Limits

Gents,

According to *SeaRose* Safety Plan Part 2 and other documents I have reviewed it states that the FPSO can withstand an Impact from a 100,000 the Iceberg at 0.5m/s. See also below excerpt from the Concept Safety Analysis further explaining how the forces to cause damage may be significantly greater depending on dissipation of energy from double hull design, mooring system, rotational impact etc.

With due regard to smaller icebergs as per Ice management plan and the report WR-HSE-RP-0151 Serviceability Conditions for Iceberg Impacts focuses on what conditions an impact with a smaller Iceberg could be permitted so as to avoid having to disconnect the FPSO. The formulated criteria was to avoid significant damage to the bow and only a small deformation to the vessel side. Icebergs of water line length less than 20 m together with Significant wave heights of 2.5 m are acceptable.
Restricting the waterline length to less than 20 m minimizes the risk of an iceberg striking the bilge keels. See Figure 2a and 2b below;

With regard to pack ice, the *SeaRose* FPSO Operations manual states and is support by the report Analysis of Ice Loads:

* Mooring System to withstand Loadings resulting from sea ice conditions of an average 0.65m thickness at 10/10ths Coverage.
* FPSO Hull is ice Strengthened to Comply with DNV Baltic Ice Class 1A+ and can withstand 10/10ths of and average of 0.80 m thick sea ice

The FPSO hull will be designed to withstand an impact of a 100,000-t iceberg impacting at 0.5 m/s. This equates to a kinetic energy of approximately 15 MJ. In reality, however, the energy required to cause damage will be significantly greater than 15 MJ for a number of reasons:

- in designing the hull for 15 MJ there will be significant safety margins built in;
- the hull will be double-skinned so even if the outer skin is breached, significantly more energy would be required to breach the inner skin or seriously jeopardize vessel trim;
- only a portion of incident kinetic energy must be absorbed by the hull. The total incident kinetic energy in the errant ship (or iceberg) will be converted into a number of forms:
  - translational kinetic energy imparted to the FPSO (that is, the FPSO is made to move forward under the force of the impact);
  - rotational kinetic energy imparted to the FPSO (when the point of impact is off-centre the FPSO will be given a rotational impulse);
  - kinetic energy remaining with the iceberg/ship (only if it is brought fully to a standstill will all of the incident kinetic energy have been absorbed; oblique impacts will thus leave the iceberg/ ship with significant residual kinetic energy);
  - energy absorbed in damage to the iceberg/ship (crushing and local failure of the iceberg/ship near the point of impact will absorb energy);
  - energy absorbed in causing damage to the hull of the FPSO.

Only the last of the above categories is of interest when estimating likely damage to the FPSO. The other categories will account for a significant proportion of the incident kinetic energy, leaving less to cause hull damage to the FPSO.

In view of the above discussion, it is clear that in the majority of cases, only a fraction of the incident kinetic energy in an iceberg/errant ship will be absorbed in the form of hull damage. Conversely, to cause hull damage, the incident kinetic energy must in general exceed the nominal design value of 15MJ by a significant margin. Based on the above discussion, it has been subjectively assumed in the risk assessment that the incident kinetic energy must exceed 30MJ before excessive hull damage is likely.

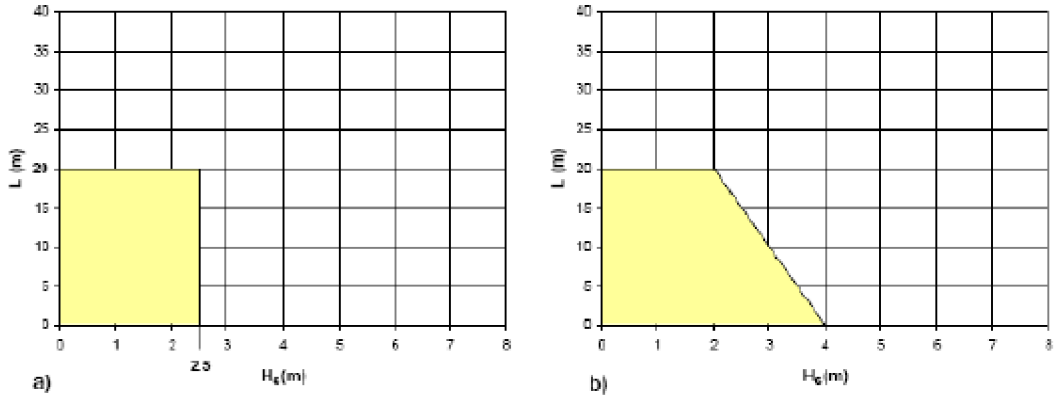
The derived frequencies (based on Appendix D) are presented in Table 7.2-1.

the northern subsea installations, or has a calculated CPA that intersects Zone 2 and is not being managed, will be designated as threatening ice.

5.6.1 SeaRose Serviceability Criteria

Criteria for maximum iceberg waterline length and significant wave height, that satisfy the serviceability condition, are illustrated in Figure 5-4. Figure 5-4 A illustrates the criterion in which icebergs of waterline lengths less than 20 m, together with significant wave heights less than 2.5 m, are acceptable. An alternative region is given in Figure 5-4 B in which the maximum significant wave height is increased for icebergs less than 20 m. Restricting the iceberg waterline length to less than 20 m minimizes the risk of an iceberg making contact with the FPSO bilge keel. Icebergs having waterline lengths less than 5 m were not considered in the analysis and do not pose a significant threat to the FPSO.

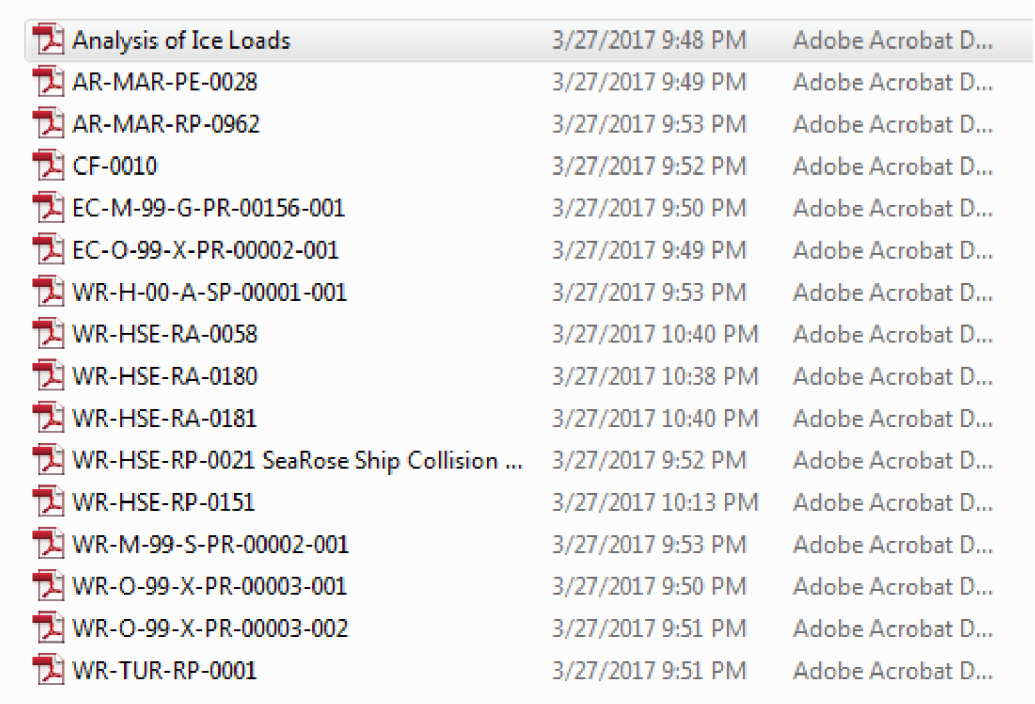
Figure 5-4 A & B - Criteria for combinations of L and H that satisfy the serviceability condition. Report # WR-HSE-RP-0151



Any ice that due to forecast conditions could be problematic and pose a hazard to Operations can be designated threatening ice by the tactical ice management team which is usually comprised of the FPSO OIM and Marine Supervisor, the Senior Husky Representative, and the Ice Observer.

There are several factors involved in threat analysis for tactical ice management. Figure 5-5 shows a typical threat analysis flow chart that lays out the thought and action processes as ice encroaches on the operations area. Refer to the Ice Management Reference Manual (EC-M-99-G-PR-00156-001) for further details on ice management methods.

References below as they are two large to send.



Analysis of Ice Loads	3/27/2017 9:48 PM	Adobe Acrobat D...
AR-MAR-PE-0028	3/27/2017 9:49 PM	Adobe Acrobat D...
AR-MAR-RP-0962	3/27/2017 9:53 PM	Adobe Acrobat D...
CF-0010	3/27/2017 9:52 PM	Adobe Acrobat D...
EC-M-99-G-PR-00156-001	3/27/2017 9:50 PM	Adobe Acrobat D...
EC-O-99-X-PR-00002-001	3/27/2017 9:49 PM	Adobe Acrobat D...
WR-H-00-A-SP-00001-001	3/27/2017 9:53 PM	Adobe Acrobat D...
WR-HSE-RA-0058	3/27/2017 10:40 PM	Adobe Acrobat D...
WR-HSE-RA-0180	3/27/2017 10:38 PM	Adobe Acrobat D...
WR-HSE-RA-0181	3/27/2017 10:40 PM	Adobe Acrobat D...
WR-HSE-RP-0021 SeaRose Ship Collision ...	3/27/2017 9:52 PM	Adobe Acrobat D...
WR-HSE-RP-0151	3/27/2017 10:13 PM	Adobe Acrobat D...
WR-M-99-S-PR-00002-001	3/27/2017 9:53 PM	Adobe Acrobat D...
WR-O-99-X-PR-00003-001	3/27/2017 9:50 PM	Adobe Acrobat D...
WR-O-99-X-PR-00003-002	3/27/2017 9:51 PM	Adobe Acrobat D...
WR-TUR-RP-0001	3/27/2017 9:51 PM	Adobe Acrobat D...

Best Regards,

[redacted]Marine Superintendent - Marine Operations & Services

Atlantic Region |351 Water Street, Suite 107, St. John's, NL, A1C 1C2
Office: [redacted] Cell: [redacted]
Email: [redacted]| Web: www.huskyenergy.com

From: ERT Coordination on behalf of ERT Coordination [redacted]
To: [redacted]
Cc:
Subject: Hightened potential for Ice and Iceberg Encroachment into White Rose Field and Rig Operating Location
Date: Monday, March 27, 2017 7:11:00 PM
Importance: High

Good Evening Everyone,

Current and projected weather and sea conditions offshore are creating a heightened potential for pack ice and iceberg encroachment into the Operating area of the *SeaRose* FPSO and the *Henry Goodrich*.

A Non Standard Operations team has been convened and mitigation/preparations and encroachment monitoring activities are in place/underway.

The opportunity for RRMT activation is heightened and for that reason I wish to identify some potential consequences for the team in be aware of in advance so that all are prepared.

HGR Response Support:

1. If the HGR moves it's anchor mooring, it will be by emergency anchor release i.e. separating from anchors and chains at the rig end, ultimately dropping the chains to the sea floor

2. With the high sea states emergency towing assistance from supply vessels may not be effective and the rig will likely be required to maneuver under its own thruster power until sea states calm

3. In high sea states and with the rig maneuvering under thrusters, Helicopters will not be able to land on the rig (i.e. any MedEvac situation that should arise would have to be a winching operation) and because of sea states helicopters will have limited on site time because refueling opportunities/locations are limited.
SeaRose FPSO Support:

1. The *SeaRose* is shutting in and depressurizing systems in preparation for potential disconnect from the Turret. If disconnect is required, the *SeaRose* will also be maneuvering under he own propulsion because of the sea conditions.

2. Once off the turret buoy the *SeaRose* will have to make way to a port of refuge (i.e. anchorage in Conception, Placentia or St. Mary's Bay).

3. As with the HGR the *SeaRose* FPSO cannot receive helicopters (i.e. any MedEvac situation that should arise would have to be a winching operation) and because of sea states helicopters will have limited on site time because refueling opportunities/locations are limited.

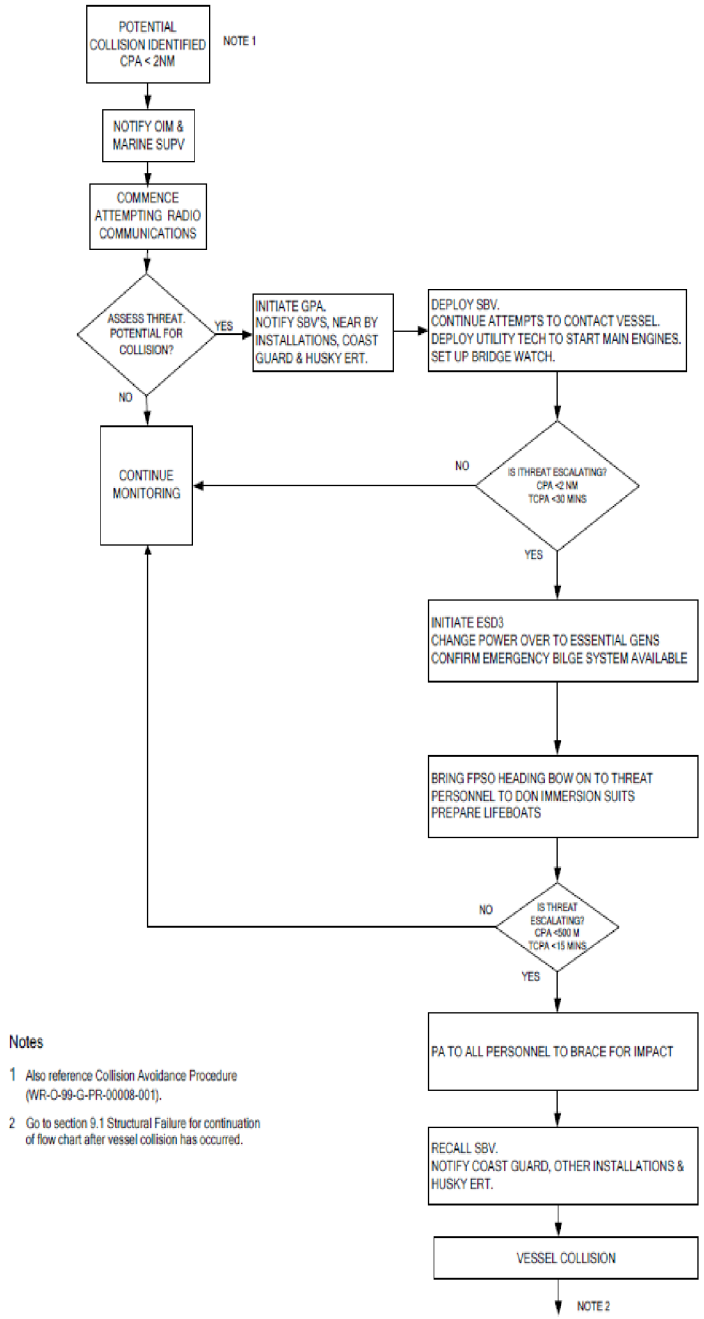
Ice encroachment activations and exercise covering these scenarios have recently been exercised by the RRMT. That coupled with the pre-assembled support of the NSO Team currently active means that all aspects of a response activation, notifications and the development/implementation of a response can be successfully coordinated and managed by the RRMT.

I will keep everyone informed of situation updates as they become available over the next 24hours.
Cheers,

[redacted]
Emergency Management Advisor
Husky Energy, Atlantic Region
Office: [redacted]
Mobile

APPENDIX 4

9.15 Vessel Collision Avoidance



Notes

1 Also reference Collision Avoidance Procedure (WR-O-99-G-PR-00008-001).

2 Go to section 9.1 Structural Failure for continuation of flow chart after vessel collision has occurred.

APPENDIX 5

Record	Time	Date	Source
Onshore Marine Operations Manager initiated the Atlantic Region Nonstandard Operations process (NSO) the team was formed at 1600 hrs.	4:00:00 PM	27-Mar	Husky Investigation Report Timeline
The *SeaRose* began to shut down all wells other than CP1 and CP6 which are located in the Central Drill Centre (CDC).	7:07:00 PM	27-Mar	Husky Investigation Report Timeline
Vessels started arriving in the field.	8:00:00 AM	28-Mar	Husky Investigation Report Timeline
The shutdown was complete. This brought the *SeaRose* T-time down to 2 hrs and 40 minutes. At this point, berg 011 had a CPA of 3.8 NM and a TCPA of 28 hrs.	10:30:00 AM	28-Mar	Husky Investigation Report Timeline
The NSO team then attended a briefing by PAL, which indicated 7 icebergs of interest, bergs 004 up to 010. Berg 011 had not been assigned a number by PAL at this point.	11:30:00 AM	28-Mar	Husky Investigation Report Timeline
Dispatcher commenced monitoring berg 011.	6:00:00 PM	28-Mar	Dispatcher Logbook Timeline
The *M/V Maersk Dispatcher* was dispatched to monitor a newly identified target that was now labeled berg 011.	6:00:00 PM	28-Mar	Husky Investigation Report Timeline
On the *SeaRose* berg 011 was recorded on a manual radar plot, with a bearing of 330 ° T and distance of 10.9 NM from the *SeaRose*.	7:30:00 PM	28-Mar	Husky Investigation Report Timeline
Bearing 330° T Range 10.9 NM.	7:30:00 PM	28-Mar	*SeaRose* Manual Radar Plot
Another ice briefing was provided which did not identify any specific threats to the *SeaRose* or *Henry Goodrich*. Follow up e-mail after the 8:00 PM ice flight/NSO meeting that berg 011 had a CPA of 4.5 NM.	8:00:00 PM	28-Mar	Husky Investigation Report Timeline
Bearing 332° T Range 10.0 NM	9:00:00 PM	28-Mar	*SeaRose* Manual Radar Plot
The OIM requested the *M/V Maersk Dispatcher* to take berg 011 under tow. Due to 5 to 7 m significant wave heights and poor visibility, the Captain of the *M/V Maersk Dispatcher* was unable to complete the request.	10:00:00 PM	28-Mar	Husky Investigation Report Timeline

Record	Time	Date	Source
The OIM also instructed HGR Ice Observer and the *SeaRose* Marine Supervisor to ask *M/V Maersk Dispatcher* for a single or two boat tow if required and conditions allowed for a tow to take place.	10:20:00 PM	28-Mar	Husky Investigation Report Timeline
Bearing 335° T Range 7.6 NM.	10:45:00 PM	28-Mar	*SeaRose* Manual Radar Plot
Bearing 337° T Range 7.1 NM.	11:15:00 PM	28-Mar	*SeaRose* Manual Radar Plot
Marine coordinator (*SeaRose* OOW) calculated berg 011 CPA 1.2 NM, TCPA Not Calculated.	11:15:00 PM	28-Mar	Husky Investigation Report Timeline
Bearing 339° T Range 6.3 NM CPA 2.2 NM @ 0500 hrs.	11:45:00 PM	28-Mar	*SeaRose* Manual Radar Plot
Marine coordinator (*SeaRose* OOW) calculated berg 011 CPA 2.2 NM, TCPA 0545 hrs. The *SeaRose* requested the *M/V Maersk Dispatcher* to take berg 011 undertow. At this time, *M/V Maersk Dispatcher* Captain indicated that berg 011 could not be taken under tow safely, due to poor visibility and sea conditions, which, by the *SeaRose* log indicated seas were between 5 m to 7 m and fog.	11:45:00 PM	28-Mar	Husky Investigation Report Timeline
Berg 011 CPA 1.9 NM TCPA 3.2 hrs.	12:00:00 AM	29-Mar	PAL IDNS
Seven vessels were in field.	12:00:00 AM	29-Mar	Husky Investigation Report Timeline
Bearing 344° T Range 5.3 NM CPA 2.3 NM @ 0450 hrs.	12:45:00 AM	29-Mar	*SeaRose* Manual Radar Plot
Marine coordinator (*SeaRose* OOW) calculated berg 011 CPA 2.3 NM TCPA 0435 hrs.	12:45:00 AM	29-Mar	Husky Investigation Report Timeline
Berg 011 CPA 2.0 NM TCPA 4.0 hrs.	1:02:00 AM	29-Mar	PAL IDNS
Bearing 347° T Range 4.8 NM.	1:15:00 AM	29-Mar	*SeaRose* Manual Radar Plot
Marine coordinator (*SeaRose* OOW) did not calculate for berg 011 CPA or TCPA.	1:15:00 AM	29-Mar	Husky Investigation Report Timeline
Berg 011 CPA 0.7 NM TCPA 3.3 hrs.	1:30:00 AM	29-Mar	PAL IDNS
Bearing 346° T Range 4.2 NM CPA 0.0 NM @ 0515 hrs.	1:45:00 AM	29-Mar	*SeaRose* Manual Radar Plot

Record	Time	Date	Source
The Marine Coordinator (*SeaRose* OOW) completed another range and bearing and calculated a CPA of 0 NM and the TCPA of 3.5 hrs (~0515). At which time, 0145 hrs, the OIM gave instruction to shut in the two remaining wells, CP1 and CP6.	1:45:00 AM	29-Mar	Husky Investigation Report Timeline
The *SeaRose* made another request to the *M/V Maersk Dispatcher* to take berg 011 under tow. The Captain of the *M/V Maersk Dispatcher* provided the same response that sea states and weather conditions were such that the operation could not be performed safely.	1:47:00 AM	29-Mar	Husky Investigation Report Timeline
The *SeaRose* directed the *M/V Atlantic Hawk* to leave berg 012 and head towards the *SeaRose*.	1:50:00 AM	29-Mar	Husky Investigation Report Timeline
Berg 011 has changed course and now on dangerous track *M/V Atlantic Hawk* was requested to return to *SeaRose.* *M/V Maersk Dispatcher* advised tow not possible (approximate time).	1:50:00 AM	29-Mar	*SeaRose* Logbook Timeline
M/V Maersk Dispatcher Captain called to bridge by the First Officer to speak with *SeaRose* concerning towing berg 011. Captain informed the *SeaRose* it was too foggy to deploy rope or net as it would be too foggy to pick up other end. At the time could not see water from bridge or stern roller Berg 011 was 3.7 NM from *SeaRose.* Approximate dimensions of berg 011- L: 90 m W: 30 m H: 8 m. Winds NW 22 to 27 kt, Seas: 5 m significant Vis: Dense fog.	2:00:00 AM	29-Mar	Maersk Captain Timeline

Record	Time	Date	Source
March 29 0200 hrs to 0340 hrs. *SeaRose* call the Captain of the *M/V Maersk Dispatcher* about the possibility of a tandem tow with the *M/V Atlantic Hawk*. Spoke with Captain of *M/V Atlantic Hawk* concerning tandem tow. We decided against due to visibility sea state and the proximity of the two vessels to conduct this tow. Too much risk. Fog dissipated enough to see water. Still only seeing approximately 10 to 15 m past the stern roller. Decided to deploy iceberg rope. Decided against the net as this would mean more gear in the water and increase the chance of fowling in a thruster or propeller with the poor visibility. Net would have taken longer to deploy as towing speed would have been less than 2 kt to prevent the net from twisting. Decided to deploy the entire rope (1,200 m) as we had to make a wider sweep around the iceberg due to the poor visibility. Did not want to get in a situation where we were chasing the other end of the rope. Iceberg distances from *SeaRose*: 0230 hrs 3.2 NM, 0300 hrs 2.6 NM, 0330 hrs 2.1 NM.	2:00:00 AM	29-Mar	Maersk Captain Timeline
Early morning joint ice call attendance from Husky included the *SeaRose* OIM, The *Henry Goodrich* company man, the Vice President of Operations and the Marine Operations Manager. The ice call lasted from 0200 hrs until roughly 0230 hrs. During the ice call, the course change of berg 011 was not raised.	2:00:00 AM	29-Mar	Husky Investigation Report Timeline (page 11)
Berg 011 CPA 0.0 NM TCPA 3.1 hrs.	2:03:00 AM	29-Mar	PAL IDNS
M/V Atlantic Hawk, tasked by *SeaRose* to proceed to position of berg 011 to assess for possible tow.	2:05:00 AM	29-Mar	Hawk Logbook Timeline
The *SeaRose* directed the *M/V Atlantic Hawk* to make way towards berg 011.	2:05:00 AM	29-Mar	Husky Investigation Report Timeline
M/V Atlantic Hawk was requested to attend berg 011 and assess possible tow.	2:05:00 AM	29-Mar	*SeaRose* Logbook Timeline
Bearing 348° T Range 3.5 NM CPA <0.1 NM @0500 hrs.	2:15:00 AM	29-Mar	*SeaRose* Manual Radar Plot

Record	Time	Date	Source
The *SeaRose* OIM left the ice call to discuss having berg 011 taken under tow with the Captain of the *M/V Maersk Dispatcher*, including the possibility of taking berg 011 under a two boat tow. The Captain of the *M/V Maersk Dispatcher* and *M/V Atlantic Hawk* discussed the request to undertake berg 011 in a two vessel tow and both agreed it was unsafe, due to sea states and low visibility at that time. The wells were shut-in and treated with methanol	2:15:00 AM	29-Mar	Husky Investigation Report Timeline
Berg 011 CPA 1.6 NM TCPA 2.3 hrs	2:30:00 AM	29-Mar	PAL IDNS
The Marine Supervisor on shift on the *SeaRose* called the Marine Operations Manager and informed him that berg 011 had turned towards the *SeaRose* and had a CPA of 0 NM. After speaking with the Captain of the *M/V Maersk Dispatcher*, the OIM woke up the offshore management team and the Emergency Response Team (ERT) to discuss the situation. They decided to provide one hour notice for main engines, to begin preparations to disconnect from the buoy and to sound the GPA at 0415 if things had not improved. The OIM then went to the Control Room and gave directions to prepare to initiate the disconnect sequence and hold at the completion of step 5. After speaking with the offshore management team and ERT, the OIM then notified the VP Operation, Production and Maintenance Manager and Marine Operations Manager, of the change in the iceberg CPA and the steps that had been taken, namely shutting in CP1 and CP6, flushing the CDC and emergency preparations.	2:30:00 AM	29-Mar	Husky Investigation Report Timeline
Berg 011 3.2 NM from the *SeaRose.*	2:30:00 AM	29-Mar	Maersk Captain Timeline
Bearing 351° T Range 3.0 NM CPA 0.7 NM @ 0500 hrs.	2:45:00 AM	29-Mar	*SeaRose* Manual Radar Plot
Bearing 349° T Range 2.65 NM	3:00:00 AM	29-Mar	*SeaRose* Manual Radar Plot
The *M/V Maersk Dispatcher*'s Captain informed the *SeaRose* Marine Coordinator (*SeaRose* OOW), after another request to tow berg 011, that he would attempt to take the iceberg under tow. The Captain of *M/V Maersk Dispatcher* indicated that the improvement in visibility allowed him to attempt the tow.	3:00:00 AM	29-Mar	Husky Investigation Report Timeline
Berg 011 CPA 0.1 NM TCPA 2.0 hrs	3:00:00 AM	29-Mar	PAL IDNS

Record	Time	Date	Source
1 hour notice to main engines was given.	3:00:00 AM	29-Mar	*SeaRose* Logbook Timeline
Berg 011 distance from *SeaRose* 2.6 NM.	3:00:00 AM	29-Mar	Maersk Captain Timeline
It was decided that the onshore Regional Response Management Team (RRMT) would be activated. The VP Operations called the Senior Vice President - Atlantic Region (SVP) and relayed the situation.	3:13:00 AM	29-Mar	Husky Investigation Report Timeline
Page 1, (Source RRMT First Contact Form) Out going call from RRMT to *SeaRose*. Vice President of Operations called to find out status of situation. Facility was shut-in, circulating COC with water, 20 minutes. Heading 324° T d, blocks on for disconnect, keys in hand for disconnect. Focus- Berg 011, 2 NM @ 1.2 kt. 0355 hrs 352° T @ 1.5 kt CPA 0 NM. Bearing steady. TCPA to ¼ zone 0500 hrs. Coming 000° T & plan to go astern. POB 84. Wind Direction: 300° T, Wind Speed: 24 kt, Wave Height: 4.0/6.5 m. Dispatcher - tow, Hawk- standby, 0515hrs before.	3:13:00 AM	29-Mar	RRMT
Bearing 350° T Range 2.4 NM CPA 0.2 NM @ 0505 hrs.	3:15:00 AM	29-Mar	*SeaRose* Manual Radar Plot
M/V Atlantic Hawk standing by berg 011 to assist *M/V Maersk Dispatcher* as needed.	3:15:00 AM	29-Mar	Hawk Logbook Timeline
The Marine Coordinator (*SeaRose* OOW) completed another manual range and bearing of berg 011 and estimated a CPA of 0.7 NM and a TCPA of 1 hour and 50 minutes. The *M/V Atlantic Hawk* arrived at the position of berg 011. While visibility remained poor, the Captain was able to monitor the iceberg visually and by radar. The Vice President of Operations and RRMT members began arriving at the ERC.	3:15:00 AM	29-Mar	Husky Investigation Report Timeline
SeaRose called the OICC regarding closing CPA of berg 011. OICC was advised that at present vessel crew deemed single vessel tow as unsafe. Option for two vessel tow was being looked at based on drift model run of bergs in the area. OICC advised *SeaRose* crew to obtain updated positions every 30 minutes.	3:17:00 AM	29-Mar	OICC Log Book
Berg 011 CPA 0.9 NM TCPA 1.6 hours	3:30:00 AM	29-Mar	PAL IDNS

Record	Time	Date	Source
Berg 011 distance from *SeaRose* 2.1 NM.	3:30:00 AM	29-Mar	Maersk Captain Timeline
Telelink text the RRMT members at 0330 hrs.	3:30:00 AM	29-Mar	Husky Investigation Report Timeline
Senior Vice President arrived ERC.	3:35:00 AM	29-Mar	Husky Investigation Report Timeline
Vessel 2 NM down wind of berg 011.	3:40:00 AM	29-Mar	Maersk Captain Timeline
Vessel 2 NM downwind of berg 011.	3:40:00 AM	29-Mar	Dispatcher Logbook Timeline
The main engines were running and the *SeaRose* had propellers going astern and took a heading of 000 ° T. The *M/V Maersk Dispatcher* was positioned to start paying out the tow rope, 2 NM downwind of berg 011.	3:40:00 AM	29-Mar	Husky Investigation Report Timeline
Bearing 352° T Range 1.8 NM.	3:45:00 AM	29-Mar	*SeaRose* Manual Radar Plot
Commenced deploying the rope. High flyer buoy and strobe lights attached.	3:50:00 AM	29-Mar	Maersk Captain Timeline
Rope in water paying out.	3:50:00 AM	29-Mar	Dispatcher Logbook Timeline
M/V Maersk Dispatcher deployed its tow rope to take berg 011 under tow.	3:50:00 AM	29-Mar	Husky Investigation Report Timeline
SeaRose main engines running clutched in and up to speed.	3:54:00 AM	29-Mar	*SeaRose* Logbook Timeline
Stop Crude Oil Wash pump 5P/S 135/270 m^3 6P/S 12676 m^3/12850 m^3.	3:55:00 AM	29-Mar	*SeaRose* Logbook Timeline
Berg 011 CPA 0.1 NM TCPA 1.0 hrs.	4:00:00 AM	29-Mar	PAL IDNS
Berg 011 position 1.38 NM from *SeaRose.*	4:00:00 AM	29-Mar	Maersk Captain Timeline

Record	Time	Date	Source
M/V Maersk Dispatcher preparing for tow berg 011.	4:00:00 AM	29-Mar	Dispatcher Logbook Timeline
Flushing of the central drill centre was completed fully. Onshore RRMT largely assembled.	4:00:00 AM	29-Mar	Husky Investigation Report Timeline
Bearing 351° T Range 1.25 NM.	4:15:00 AM	29-Mar	*SeaRose* Manual Radar Plot
M/V Maersk Dispatcher informed to tow to southeast if successful.	4:15:00 AM	29-Mar	*SeaRose* Logbook Timeline
Ice Observer *SeaRose* called to bridge at 0410 hrs by OIM, berg 011 60 m x 40 m x 8 m. *SeaRose* engaged main engines alerting Ice Observer to problem. TCPA 0500 hrs @1/4 NM, TCPA 0514 hrs @ 0.75 NM. GPA sounded with berg 011 2 NM from *SeaRose.*	4:20:00 AM	29-Mar	Ice Observer Timeline
The GPA (General Platform Alarm) was activated and the crew mustered in 5 minutes.	4:24:00 AM	29-Mar	Husky Investigation Report Timeline
GPA Disconnect.	4:24:00 AM	29-Mar	*SeaRose* Key Events Timeline
Rope deployed (1,200 m)	4:25:00 AM	29-Mar	Maersk Captain Timeline
Iceberg rope connected to tow wire.	4:25:00 AM	29-Mar	Dispatcher Logbook Timeline
M/V Maersk Dispatcher's tow rope was fully deployed.	4:25:00 AM	29-Mar	Husky Investigation Report Timeline
Range 0.957 NM, Bearing 353 ° T CPA 0. *M/V Maersk Dispatcher* attempting to get net.	4:26:00 AM	29-Mar	Ice Observer Timeline
Disconnect sequence started.	4:26:00 AM	29-Mar	*SeaRose* Key Events Timeline
M/V Atlantic Osprey requested to take pass on port side.	4:27:00 AM	29-Mar	*SeaRose* Logbook Timeline

Record	Time	Date	Source
Full Muster and GPA silenced.	4:29:00 AM	29-Mar	*SeaRose* Key Events Timeline
Bearing 354° T Range 0.9 NM.	4:30:00 AM	29-Mar	*SeaRose* Manual Radar Plot
Manoeuvring vessel around berg 0.11 Iceberg distance from *SeaRose* 0.86 NM	4:30:00 AM	29-Mar	Maersk Captain Timeline
Begin coming around on berg 011 to wrap rope.	4:30:00 AM	29-Mar	Dispatcher Logbook Timeline
Range 0.91 NM, Bearing 354 ° T CPA 0, TCPA ¼ NM @ 0500 hrs.	4:30:00 AM	29-Mar	Ice Observer Timeline
March 29, 0430 hrs and 0530 hrs Four lines of communication were established which were: • the first was between the *SeaRose* OIM and the VP Ops and the Production and Maintenance Manager, via the ERC and ERT phones; • the second was between the *SeaRose* Marine Coordinator and the Captain of the *M/V Maersk Dispatcher* on VHF radio; • the third was between the Captain of the *M/V Atlantic Hawk* and the SVP, Marine Operations Manager and Logistics Lead, all of whom were located in meeting room RM829 at 351 Water Street, via the *M/V Atlantic Hawk* satellite phone and the Logistics Lead's cell phone; and • the fourth was between the SVP, Marine Operations Manager and Logistics Lead in RM829 and the VP Ops and the Production and Maintenance Manager. The VP Ops and the Production and Maintenance Manager moved between the ERC and RM829 to relay information being received from the *M/V Atlantic Hawk* to the OIM of the *SeaRose*.	4:30:00 AM	29-Mar	Husky Investigation Report Timeline

Record	Time	Date	Source
Log page 28, Call Berg of concern #11, Detector trying to attach rope to move. *SeaRose* mustering. Communications Call C-NLOPB (Vice President of Operations or Production and Maintenance Manager) (source [redacted]) Update by OIM, have mustered, started disconnect sequence, monitoring berg 011. _____ _____ log page 29, Outgoing call from RRMT to C-NLOPB Duty Officer. Activation of ERT to aid in ice management of berg 011 with a closing CPA. Vessels in area have been mobilized to aid in situation. Will call back to give update. (Source RRMT HSE & Liaison Officer).	4:30:00 AM	29-Mar	RRMT
Log page 27, incoming call from OIM indicating they have a Full Muster, step 5 disconnect sequence. Sitting there waiting. @0430 Ghrs 354° T 0.9 NM CPA of ¼ at 0500 *SeaRose* (source section chief).	4:32:00 AM	29-Mar	RRMT
The disconnect sequence was held at step 5. To complete the disconnect sequence from this step requires approximately 15 minutes. OIM called RRMT to communicate this. Berg 011 0.9 NM TCPA 28 min.	4:32:00 AM	29-Mar	Husky Investigation Report Timeline
Disconnect sequence paused at 5.	4:32:00 AM	29-Mar	*SeaRose* Key Events Timeline
Berg 011, CPA 0.1 NM TCPA 0.9 hrs.	4:35:00 AM	29-Mar	PAL IDNS
Range 0.89 NM, Bearing 359 ° T, CPA 0.	4:35:00 AM	29-Mar	Ice Observer Timeline
M/V Maersk Dispatcher circling berg 11 with rope. *M/V Atlantic Osprey* coming to stern.	4:37:00 AM	29-Mar	Ice Observer Timeline
Vice President of Operations contacted the Acting Chief Safety Officer and relayed the situation to him.	4:37:00 AM	29-Mar	Husky Investigation Report Timeline
Bearing 359 ° T, Range 0.8 NM.	4:40:00 AM	29-Mar	*SeaRose* Manual Radar Plot

Record	Time	Date	Source
Log page 28, Incoming call from *SeaRose* (OIM) called to speak to Vice President of Operations and Production and Maintenance Manager. They agreed to call back on the red phone. (source Section Chief).	4:40:00 AM	29-Mar	RRMT
Range 0.81° T, Bearing 359 NM, CPA 0. Connecting rope.	4:40:00 AM	29-Mar	Ice Observer Timeline
Communications disabled.	4:40:00 AM	29-Mar	*SeaRose* Key Events Timeline
log page 18, Outgoing Call to *SeaRose* Vice President of Operations called *SeaRose* Hold at 7 (Source unknown).	4:43:00 AM	29-Mar	RRMT
Vice President of Operations called OIM to discuss status.	4:43:00 AM	29-Mar	Husky Investigation Report Timeline
Range 0.75 NM, Bearing 001° T.	4:45:00 AM	29-Mar	Ice Observer Timeline
The Marine Operations Managers, Logistics Lead, the SVP moved into a room separated (Room 829) from the ERC. At this point they were receiving regular up date from *M/V Atlantic Hawk* regarding the relative position of berg 011 and the status of the tow on *M/V Maersk Dispatcher*.	4:45:00 AM	29-Mar	Husky Investigation Report Timeline
M/V Atlantic Osprey inform on port quarter	4:45:00 AM	29-Mar	*SeaRose* Logbook Timeline
Continue log page 18, OIM called have 15 minutes to disconnect and move. Berg 011 may pass at 0.1 NM. *SeaRose* CPA 0.15 miles 0514 ETA (starboard side) (recorded by unknown source in RRMT) _____ log page 25, Incoming Call from *SeaRose* OIM preparing to flood QC/DC space . *SeaRose* maintain hold at step 5 *M/V Maersk Dispatcher* hooking up. TCPA is 10 minutes. Disconnect is 15 minutes. SeaRose will hold on station. Vice President of Operations and Production and Maintenance Manager in attendance during call at ERC. (Recorded by Dave Wilkie)	4:48:00 AM	29-Mar	RRMT

Record	Time	Date	Source
The OIM called, advised the iceberg had slowed down, travelling at 0.75 kt and the TCPA was now 26 minutes and reinforced the status of the disconnect sequence and indicated he would need 15 minutes to disconnect and move the *SeaRose*. At this point *M/V Maersk Dispatcher* had 1,200 m of ice rope paid out and berg 011 encircled and was in the process of recovering the messenger line.	4:48:00 AM	29-Mar	Husky Investigation Report Timeline
Bearing 001° T, Range 0.7 NM CPA 0.15 NM TCPA 0514 hrs.	4:50:00 AM	29-Mar	*SeaRose* Manual Radar Plot
Range 0.7 NM, Bearing, 002° T.	4:50:00 AM	29-Mar	Ice Observer Timeline
Messenger line retrieved.	4:52:00 AM	29-Mar	Maersk Captain Timeline
Messenger line grapneled.	4:52:00 AM	29-Mar	Dispatcher Logbook Timeline
The messenger line was retrieved by *M/V Maersk Dispatcher*.	4:52:00 AM	29-Mar	Husky Investigation Report Timeline
March 29 between 0452 hrs and 0500 hrs The *M/V Atlantic Hawk* was now positioned just outside the *SeaRose*'s safety zone monitoring the progress of the tow and the position of berg 011 and was reporting back continuously to RM829 via the Logistics Lead's cell phone. The SVP, Logistics Lead and Marine Operations Manager all indicated that at this time *M/V Atlantic Hawk* reported that it appeared there was tension on the ice rope and that the heading of the iceberg was such that it appeared it would be a close pass, within 0.1-0.18 NM, but that the separation distance between the *SeaRose* and berg 011 was opening up. On the basis of the information coming from the *M/V Atlantic Hawk*, the SVP informed the VP Ops that disconnection was not required.	4:52:00 AM	29-Mar	Husky Investigation Report Timeline
Range 0.6 NM, Bearing 004° T, TCPA 0515 hrs (Range 0.58 NM, Bearing 004° T, CPA 0, TCPA 0514 hrs – Attempting to connect-Source Dispatcher) Messenger landed connecting to tow wire.	4:55:00 AM	29-Mar	Ice Observer Timeline

Record	Time	Date	Source
log page 24, Incoming Call *SeaRose* 0450 hrs 001° T @0.7 NM CPA 0.15 NM, TCPA 1/4 NM 0514 hrs 3/4 kt Starboard side approach (Source Section Chief RRMT).	4:55:00 AM	29-Mar	RRMT
Higher flier on deck.	4:57:00 AM	29-Mar	Dispatcher Logbook Timeline
Berg 011 was at the outer edge of Zone 1, 0.48 NM away from the *SeaRose*. However, the berg had been fluctuating between a CPA of 0 NM and 1.6 NM since 0210 hrs, The change in bergs 011 speed and the fluctuation in the CPA as it approached Zone 1, affects the T_{Time}.	4:57:00 AM	29-Mar	Husky Investigation Report Timeline
log page 23, Outgoing Call to *SeaRose* OIM . Production and Maintenance Manager to OIM update from Detector (actually Dispatcher) starting to take some weight now (Source Section Chief RRMT)	4:58:00 AM	29-Mar	RRMT
Bearing 004° T, Range 0.4 NM.	5:00:00 AM	29-Mar	*SeaRose* Manual Radar Plot
Range 0.5 NM, Bearing 004° T. S- Band to SP, Radar Range 1.5 NM SP on S-Band, Messenger on deck, estimated tension 0515 hrs to 0520 hrs.	5:00:00 AM	29-Mar	Ice Observer Timeline
March 29 between 0500 hrs and 0515 hrs. There was a series of communications between the OIM and the VP Ops and the Production and Maintenance Manager regarding the status of the tow line. Over a period of 15 minutes the VP Ops and Production and Maintenance Manager received information from the *M/V Atlantic Hawk* via the SVP and Marine Operations Manager and relayed this to the OIM. *M/V Atlantic Hawk* reported that the tow line was connected and that tension should be on in 5-6 minutes. However, the *M/V Maersk Dispatcher* was reporting to the *SeaRose* that tension on the tow wire had not yet been established.	5:00:00 AM	29-Mar	Husky Investigation Report Timeline
Berg 011 CPA 0.1 NM TCPA 0.4 hrs.	5:01:00 AM	29-Mar	PAL IDNS
Log page 22, Outgoing Call to *SeaRose* (OIM) Vice President of Operations called (*SeaRose*) to advise berg 011 in under tow (Source Section Chief RRMT).	5:02:00 AM	29-Mar	RRMT

Record	Time	Date	Source
Continue log 18, Incoming Call from OIM *SeaRose* No tow line on berg 011 10 min before hooked up to berg 011 (source in RRMT unknown).	5:04:00 AM	29-Mar	RRMT
Log page 21, Incoming Call form *SeaRose* OIM CPA approximately 0 NM no tow line on berg 011 OIM to start next step in sequence. Vice President of Operations to check on status with *M/V Atlantic Hawk* and return call in 1 minute. (Source Section Chief RRMT) _____ Continue log 18, unknown if Incoming/Outgoing call to/from RRMT. Tow is on as per *M/V Atlantic Hawk*. Tension on line 5/6 min. Need to start sequence as per OIM. Slow moving berg (source in RRMT unknown pg18).	5:05:00 AM	29-Mar	RRMT
Range 0.37 NM, Bearing 003° T.	5:05:00 AM	29-Mar	Ice Observer Timeline
Log page 20, Incoming call from *SeaRose* OIM at point now that must start sequence . Vice President of Operations must wait 5 minutes getting ready to pull in slack. Tension in 5-6 minute hold for now [redacted] to talk to *M/V Atlantic Hawk* and return call to OIM in few minutes. (Source RRMT Section Chief)	5:08:00 AM	29-Mar	RRMT
Other end of rope connected to tow wire. Commence paying out tow wire.	5:08:00 AM	29-Mar	Maersk Captain Timeline
Other end of iceberg rope on deck connecting to tow wire.	5:08:00 AM	29-Mar	Dispatcher Logbook Timeline
Continue log page 18, Unknown if Incoming/Outgoing call To/From RRMT OIM no tension on rope. As per Production and Maintenance Manager tension on berg 011 started. Berg 011 is now 100 yards from bow. (Source in RRMT unknown)	5:10:00 AM	29-Mar	RRMT
Range 0.32 NM, radar loosing contact because of angle. Connect up wire, tension eta 10 mins= 0520 hrs.	5:10:00 AM	29-Mar	Ice Observer Timeline

Record	Time	Date	Source
Target lost on radar visual watch in forecastle.	5:11:00 AM	29-Mar	Ice Observer Timeline
log page 19, Incoming Call from *SeaRose* OIM CPA = 0 NM no tension on the rope need to speak to Vice President of Operations(Source RRMT Section Chief).	5:12:00 AM	29-Mar	RRMT
200 yards (0.098 NM) berg 011 on bow head on.	5:13:00 AM	29-Mar	Ice Observer Timeline
Continue log page 19, OIM states that he feels we need to open QC/DC vales now Production and Maintenance Manager states need a few minutes time. (Source Section Chief RRMT)	5:14:00 AM	29-Mar	RRMT
Commence applying tension to rope with 100 m of tow wire out. Would have preferred 500 m of wire out to weigh down the rope but due to proximity to *SeaRose* decided to commence applying tension. No time to pay out 500 m of wire.	5:14:00 AM	29-Mar	Maersk Captain Timeline
Coming up on tension.	5:14:00 AM	29-Mar	Dispatcher Logbook Timeline
M/V Maersk Dispatcher had recovered its messenger, hooked the tow wire to the rope, paid out 100 m of tow wire and began applying tension to the tow rope.	5:14:00 AM	29-Mar	Husky Investigation Report Timeline
15 T of tension on tow rope.	5:14:00 AM	29-Mar	Husky presentation
Continue log page 18, OIM – 50 m starboard side impact 2 minutes. (Unknown source in RRMT) _____ Continue log page 19, OIM States Berg 100 yards from bow. Production and Maintenance Manager standby for further instructions. (Source Section Chief RRMT)	5:15:00 AM	29-Mar	RRMT
Tension coming on wire. Dispatcher Heading 050° T.	5:15:00 AM	29-Mar	Ice Observer Timeline
Brace for impact P/A.	5:16:00 AM	29-Mar	*SeaRose* Key Events Timeline

Record	Time	Date	Source
The OIM reported that berg 011 was 50 m from the *SeaRose* and as a precaution he would inform the crew to brace for impact. This distance was an estimate provided by personnel located in the crow's nest on the bow of the *SeaRose*.	5:18:00 AM	29-Mar	Husky Investigation Report Timeline
continue log page 19, OIM 50 m coming down starboard side expect impact shortly. (Source Section Chief RRMT)	5:18:00 AM	29-Mar	RRMT
log page 17, Unknown if Incoming/Outgoing call To/From RRMT Lost tow berg 011 on starboard side. *SeaRose* heading 009° T swinging starboard. Snagged a riser/chain. Putting Cannon. From safety perspective okay. Risers 7, 8 and 9 moorings 1, 2 and 3. (Unknown Source in RRMT) _____ log page 16, (0523) Outgoing Call from RRMT to *SeaRose* Approximately 50 m heading 009° T lost the tow (*M/V Maersk Dispatcher*). *SeaRose* swinging to starboard as quickly as rudders will allow. Put cannon on berg (*M/V Atlantic Hawk*). Checking ALLURS for tension / no indication of change. Risers 7, 8 and 9 moorings 1, 2 and 3 at risk. (Source RRMT Section Chief)	5:20:00 AM	29-Mar	RRMT
Rope slipped over berg 011 – lost tow.	5:20:00 AM	29-Mar	Maersk Captain Timeline
Lost tow/rope slipped over berg 011. *SeaRose* informed.	5:20:00 AM	29-Mar	Dispatcher Logbook Timeline
The tow lasted 6 minutes the tow rope slipped off the iceberg.	5:20:00 AM	29-Mar	Husky Investigation Report Timeline
March 29 between 0520 hrs and 0551 hrs. The bridge team, employing heading control, turned the *SeaRose* to starboard i.e. swinging the aft of the *SeaRose* away from berg 011 as it moved down its side.	5:20:00 AM	29-Mar	Husky Investigation Report Timeline
Commenced retrieving rope.	5:22:00 AM	29-Mar	Maersk Captain Timeline

Record	Time	Date	Source
Began recovery of tow wire and iceberg rope.	5:22:00 AM	29-Mar	Dispatcher Logbook Timeline
Berg 011 passing starboard side P/A.	5:22:00 AM	29-Mar	*SeaRose* Key Events Timeline
Continue log 17, Moving Starboard side slowly moving (Source Unknown RRMT).	5:25:00 AM	29-Mar	RRMT
M/V Maersk Dispatcher lost tow.	5:25:00 AM	29-Mar	Ice Observer Timeline
M/V Atlantic Hawk coming to use water cannon. Berg 011 moving S turning clockwise. (Vis Ob.)	5:26:00 AM	29-Mar	Ice Observer Timeline
Continue log 17, Couldn't establish tow. Berg past 50 m of *SeaRose.* (Unknown Source in RRMT)	5:27:00 AM	29-Mar	RRMT
Backed out of disconnect sequence.	5:27:00 AM	29-Mar	*SeaRose* Key Events Timeline
Log page 15, Incoming Call From *SeaRose* (OIM) D Class cannot re-establish tow, *M/V Atlantic Hawk* to give it a push with water cannon. CPA was 50 m, actually 10 m now, get logistics involved as soon as all is clear. (Source Section Chief RRMT)	5:29:00 AM	29-Mar	RRMT
Contacted *HGR* Ice to check other targets.	5:30:00 AM	29-Mar	Ice Observer Timeline
Berg 011 CPA 0.1 NM TCPA 0.1 hrs	5:32:00 AM	29-Mar	PAL IDNS
Iceberg rope on deck.	5:33:00 AM	29-Mar	Dispatcher Logbook Timeline
Log page 2, Unknown incoming/outgoing call berg 011 gone past (Source RRMT unknown).	5:40:00 AM	29-Mar	RRMT
Muster Stood Down.	5:42:00 AM	29-Mar	Ice Observer Timeline
Stand down.	5:44:00 AM	29-Mar	*SeaRose* Key Events Timeline
Log page 14, Outgoing Call to *SeaRose* Status at present time: OIM busy now will call back later. (Source Section Chief)	5:49:00 AM	29-Mar	RRMT

Record	Time	Date	Source
Log page 13, Incoming Call *SeaRose* OIM Iceberg passed on starboard side, past CPA, Stood down, start normal operations, to keep communications locked down for an hour or so, Riser pressure okay, doesn't look like there is damage, send flight as per normal, inspect risers before return to normal operations. RRMT: Any Other Threats? *SeaRose*: No. RRMT: making plans for riser inspection later. Board to be notified call on blue phone for 1509 if needed. (Source Section Chief RRMT)	5:51:00 AM	29-Mar	RRMT
The *SeaRose* OIM called the ERC and indicated that berg 011 had passed its CPA.	5:51:00 AM	29-Mar	Husky Investigation Report Timeline
log page 2, (unknown incoming/outgoing) *SeaRose* stood down. (Source unknown RRMT)	5:55:00 AM	29-Mar	RRMT
Rope recovered.	6:00:00 AM	29-Mar	Maersk Captain Timeline
Iceberg rope recovered.	6:00:00 AM	29-Mar	Dispatcher Logbook Timeline
Stop Main engines Numbers 1 and 2.	8:40:00 AM	29-Mar	*SeaRose* Logbook Timeline

APPENDIX 6

Husky Energy

NEWS RELEASE
Calgary, Alberta
January 17, 2018

Husky Energy to Suspend *SeaRose* Operations

Husky Energy will begin taking steps to suspend operations of its *SeaRose* floating production, storage and offloading vessel (FPSO) and associated production facilities offshore Newfoundland and Labrador.

This is being undertaken to comply with an order received today from the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB), related to an iceberg management incident that occurred in March 2017.

"We could have and should have responded differently according to the pre-existing plan, and we will learn from this incident. We will work with the C-NLOPB and take the actions necessary to satisfy the regulator," said CEO Rob Peabody.

The suspension of operations will take place in a safe, controlled and environmentally prudent manner, while maintaining the integrity of the installation.

Husky will undertake all steps necessary to comply with the directives of the C-NLOPB. A number of measures have already been put in place to further improve ice management operations.

The safety of personnel and the protection of the environment remains Husky's number one priority.

Current production from the *SeaRose* FPSO is approximately 27,000 barrels of oil per day (Husky working interest, before royalties).

Updates will be provided as available.

Investor and Media Inquiries:

Mel Duvall, Manager, Media & Issues
403-513-7602

Rob Knowles, Manager, Investor Relations
587-747-2116

Husky Energy

NEWS RELEASE
Calgary, Alberta
January 26, 2018

Husky Energy to Resume *SeaRose* Operations

The Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) today announced it has lifted the notice to suspend operations for the *SeaRose* floating production, storage and offloading (FPSO) vessel and associated facilities.

The January 17, 2018 C-NLOPB notice to suspend operations resulted from an incident in March 2017 where Husky Energy departed from its agreed Ice Management Plan by not disconnecting the vessel and sailing away when an iceberg entered its quarter-mile exclusion zone.

"We could have and should have responded differently according to the pre-existing plan, and have learned from this incident," said CEO Rob Peabody. "We will apply these lessons and share the learnings broadly in the region and across the company.

"Our engagement with the C-NLOPB was constructive and cooperative. We share the same objective. The safety of our people and the protection of the environment is our first priority and in this case we let ourselves down."

In conjunction with the C-NLOPB, a series of actions have been taken to ensure this type of incident cannot happen again, including:

- A comprehensive review of Husky's ice management and emergency response plans has been conducted, and further improvements have been made and implemented. The emergency response plan reinforces that the *SeaRose* FPSO must be disconnected if a threatening iceberg enters the 0.25 nautical mile ice exclusion area and that there can be no exceptions.
- Husky completed an emergency response drill, observed by the C-NLOPB, industry partners and the offshore facilities certifying authority.
- Management has met with employees onshore and offshore to communicate the changes being made and to reinforce that procedures must be followed with no exceptions.
- Organizational changes include the appointment of Trevor Pritchard as Senior Vice President, Atlantic Region. He was previously the Company's head of safety, overseeing operational integrity and ensuring a safe work environment. Pritchard will report directly to Chief Operating Officer Rob Symonds.

"Trevor Pritchard is well known to many in Newfoundland and Labrador. He has previously led the business and under his leadership the *SeaRose* FPSO established a solid track record for safety and reliability," said Peabody. "I'm very pleased he has agreed to move from his previous position leading Process and Occupational Safety for the whole of Husky to return to a province where I know he has strong ties.

"Under Trevor's leadership we look forward to resuming production, continuing our exploration in both the Jeanne d'Arc and Flemish Pass basins and progressing the West White Rose project to first production in 2022."

The March 2017 incident did not result in any product release or environmental impact.

The safe and controlled resumption of operations is expected to take approximately three days. The *SeaRose* FPSO was producing approximately 27,000 barrels of oil per day (Husky working interest, before royalties) prior to the suspension of operations.

Media and Investor Inquiries:

Mel Duvall, Manager, Media & Issues
403-513-7602

Rob Knowles, Manager, Investor Relations
587-747-2116

FORWARD-LOOKING STATEMENTS

Certain statements in this news release are forward-looking statements and information (collectively "forward-looking statements") within the meaning of applicable Canadian securities legislation, Section 21E of the United States Securities Exchange Act of 1934, as amended, and Section 27A of the United States Securities Act of 1933, as amended. The forward-looking statements contained in this news release are forward-looking and not historical facts.

In particular, forward-looking statements in this news release include, but are not limited to, references to: the expected timing of first production at the West White Rose project; and the expected duration of the resumption of operations.

Although the Company believes that the expectations reflected by the forward-looking statements presented in this news release are reasonable, the Company's forward-looking statements have been based on assumptions and factors concerning future events that may prove to be inaccurate. Those assumptions and factors are based on information currently available to the Company about itself and the businesses in which it operates. Information used in developing forward-looking statements has been acquired from various sources, including third party consultants, suppliers and regulators, among others.

Because actual results or outcomes could differ materially from those expressed in any forward-looking statements, investors should not place undue reliance on any such forward-looking statements. By their nature, forward-looking statements involve numerous assumptions, inherent risks and uncertainties, both general and specific, which contribute to the possibility that the predicted outcomes will not occur. Some of these risks, uncertainties and other factors are similar to those faced by other oil and gas companies and some are unique to the Company.

The Company's Annual Information Form for the year ended December 31, 2016 and other documents filed with securities regulatory authorities (accessible through the SEDAR website www.sedar.com and the EDGAR website www.sec.gov) describe risks, material assumptions and other factors that could influence actual results and are incorporated herein by reference.

New factors emerge from time to time and it is not possible for management to predict all of such factors and to assess in advance the impact of each such factor on the Company's business or the extent to which any factor, or combination of factors, may cause actual results to differ materially from those contained in any forward-looking statement. The impact of any one factor on a particular forward-looking statement is not determinable with certainty as such factors are dependent upon other factors, and the Company's course of action would depend upon management's assessment of the future considering all information available to it at the relevant time. Any forward-looking statement speaks only as of the date on which such statement is made and, except as required by applicable securities laws, the Company undertakes no obligation to update any forward-looking statement to reflect events or circumstances after the date on which such statement is made or to reflect the occurrence of unanticipated events.