Comment	Response
Summary comments	
1. The new modelling study was conducted using SIMAP software developed by Applied Science Associates, Inc. (ASA). This model responds to the requirements of the modelling needs much better than the one used in the previous study. Some documentation about the model was provided. Results were presented using color figures and tables.	Noted.
2. Both the stochastic and determinist modelling approaches were used to assess the impact, which is good and appropriate in this project.	Noted.
3. Wind and current data used to conduct the modelling work were similar to the ones used in the previous study. A hydrodynamic model for the Bull Arm site was developed in this new study. However, less analysis of the data was performed than in the previous study, especially for statistical analysis of wind data.	The statistical analysis of wind data from the previous study (Spill Trajectory Modeling for the Hebron Project, AMEC Earth & Environmental, 2009) was used to inform the present study about the wind climatology at the sites. Wind rose plots from the four seasons were prepared but not provided as part of the ASA technical report. These have been provided in a final version of the technical report.
4. The major concern of this new study relates to the duration of the simulations, particularly for offshore spills related to platform and subsea blow-outs. Results from these simulations are not adequate to assess the risk of shoreline oiling, for instance. For most of the scenarios for offshore spills, the simulations were stopped at the end of the spill period. The results of the simulations using the deterministic approach showed that 29 to 79% of the spilled oil remains on the surface at the end of the simulations. The fate of this oil should be tracked further in order to assess shoreline oiling properly. In addition to the oiling of the Newfoundland shorelines, there is a potential risk for oil to reach the	Extended period stochastic model simulations have been completed as follows: • 30 day blowout run for additional 200 days • 100 day blowout run for additional 200 days • 120 day blowout run for additional 200 days The results from these simulations provide a prediction of the fate of all oil remaining on the surface at the end of the blowout discharge. The attached document, “Addendum – Results from Simulations of Oil Spills at the Hebron Well Site” provides additional information regarding these extended run simulations.

Comment	Response
European shores on the Atlantic side. Some recommendations to improve the simulations and the risk assessment study overall are proposed below. The content of the Executive Summary should be revised accordingly.	The results of these extended simulations (up to 10.5 months) demonstrate that: • Surface oil within the model domain decreases to zero within 2 to 4 months after flow stops • There is a low probaility for a small amount of oil (up to 0.7% of total oil spilled) to reach the Newfoundland shoreline as a 0.01 mm sheen between 22 and 275 days following start of flow.
5. Two seasons, summer and winter, were selected to conduct the modelling work without any scientific justification. Wind data at both spill sites should be presented using monthly, or at least seasonal (four), wind rose. Presentation of wind data using annual wind rose is not appropriate for selecting the wind scenarios in this study. To determine the risks of various resources being oiled, modelling scenarios should be based on at least the seasonal wind rose, i.e. need to consider four seasons wind and current conditions.	ASA analyzed the monthly wind roses presented in the previous modeling report (Spill Trajectory Modeling for the Hebron Project, AMEC Earth & Environmental, 2009) and agreed that the summer and winter months were best representative of wind conditions in the offshore. Selection of the summer and winter seasons was based on the plots of monthly wind roses from the previous modeling study. Seasonal wind roses have been included in the revised report. Wind climatology in the summer and winter are substantially different and warrant two sets of spill scenarios. Summer and winter seasons were selected because they exhibit winds with distinct patterns. Summer winds are predominately from the southwest while winter winds are of higher speed and come most frequently from the west. These two wind regimes represent end members of speed and direction while the spring and fall winds represent transitions between them. It is not necessary to simulate spills occurring in the spring and fall because those results would be contained within the summer and winter predictions for oil trajectory and fate. The oil spill modeling for Hebron sampled wind and current from all months of the year, even the spring and fall transitional seasons. This is possible because a spill simulation may start at the end of the summer season, and due to the length of the

Comment	Response
	simulation, run into the fall, thereby sampling the wind and current conditions of that season. The revised oil spill trajectory report demonstrates this by comparing plots of the wind data from the entire 30 year wind record with plots of the wind data sampled by the stochastic model for each of the four seasons (Figures 3.1-1, 3.1-2 and 3.1-3). These wind plots clearly show that the 100 stochastic model simulations performed for each spill scenario adequately sampled the relevant environmental data.
6. The trajectory modelling summary is not representative of the new modelling study. Revision is necessary and recommendations are proposed below.	The spill trajectory modeling report will be revised to include, where appropriate, the responses to the comments.
7. The algorithm used to model oil-ice interaction is based on simplified assumptions that were introduced about three decades ago. Significant knowledge about oil-ice interaction has been gained since then. As such, the modelling results obtained with the SIMAP model when ice is present have high degree of uncertainty. This should be stated clearly in the report.	The following text has been added to Section 2.6 of the offshore oil spill trajectory report: The SIMAP model algorithms are based on an early (1980's - 1990's) understanding of oil/ice interactions. Since that time various studies (mostly Norwegian) have improved our understanding of oil/ice interactions, but most of that work focused on developing oil spill response strategies, not oil spill model algorithms. The impediment to more robust simulation of the interactions of oil in ice is not a lack of understanding of those processes as much as it is a lack of data to define the characteristics of the ice over small spatial scales (centimeters to tens of meters) and short time periods (hours to days). A review of oil spill models by Reed, et. al. (1999) identified this as the overriding issue holding back realistic modeling of oil in ice: *"… the prognosis for improved representation of oil behavior in ice-infested waters remains bleak until our capability to model ice alone improves. … the processes governing oil behavior occur at scales of a*

Comment	Response
	few centimeters to a few tens of meters within an ice field. Ice model resolutions are typically at scales of kilometers, to account for effects at active boundaries, such that very crude, ad hoc parameterizations become necessary." Reed, M., et. al., 1999. Oil Spill Modeling Towards the Close of the 20th Century: Overview of the State of the Art. Spill Science and Technology Bulletin, Volume 5, Number 1, pages 3-16.
8. For consistency with Section 14.3, a Summary Table for the modelling work for the Bull Arm site should be presented in Section 14.2 in Document 1. Both summary tables in Document 3 and 4 require revision as discussed below. The captions of the Tables should explain what the data in the Tables represent.	Summary tables will be included in Sections 14.2 and Section 14.3.
9. The entire Section 14.3.4 entitled "Trajectory Modelling Summary" in Document needs substantial revision. This section does not provide a representative summary of the modelling results. The section should be revised considering the additional comments provided in this review. For consistency, similar section should be added for the Bull Arm site, section 14.2.	Sections 14.2 and 14.3 are part of the Hebron Project Comprehensive Study Report. The purpose of these sections is to provide a summary of the modeling results presented in the spill trajectory modeling reports with a focus on the potential environmental effects associated with these low probability spill events. Detailed information regarding the model, its inputs, and results can be found in the specific modeling reports, and the reader is referred to these reports for more information. It is not the intent of Sections 14.2 and 14.3 to include all the information presented in these modeling reports. Where warranted, Section 14.3.4 will be revised to reflect revisions made in the offshore modeling report.
<u>Specific comments</u>: Bull Arm	
1. The selection of the simulation period of 30 days is not justified. The only argument provided in page 2 of Document 4 mentioned "... a length of time sufficient to allow for all of	All diesel spills show zero oil on the surface at the end of thirty days. IFO-180 spills in winter without ice and in the summer show that

Comment	Response
the weathering processes to occur". This is a general statement that applies to any oil spills. It does not provide a justification based on the requirements of the study and the particularities of the spill scenarios. For proper evaluation of the environmental impact, all simulations related to the Bull Arm spill site should be run until the disappearance of the spilled oil from the sea surface.	less than 3% of the 1000 m^3 remains on the surface, and all of this oil is in the open ocean outside Trinity Bay. The IFO 180 spill occurring in the winter with ice present shows about 8% of the 1000 m^3 remaining on the surface after 30 days. The oil remaining is outside of Trinity Bay in the open ocean.
2. The method used to correlate the Oceans Ltd wind data collected in Bull Arm to the data from the MSC50 grid node M13032 is not described. This information is needed to evaluate its validity. Also, why node M13032 was used instead of the nearest M12874 node?	The MSC50 wind time series from location M12874 was correlated with wind observations collected in Bull Arm by Oceans Limited in 1995-1997 to correct for speed and directions differences imposed by the geometry of the Bull Arm fjord. (The ASA report incorrectly identifies the MSC50 location as M12032). The method used is the same method applied in the previous modeling study (Spill Trajectory Modeling for the Hebron Project, AMEC Earth & Environmental) and involves a small correction to the wind speed and direction. The correction method uses the relationship between speed at site M12874 and speed measured at the Bull Arm site to yield a linear regression equation for adjusting the MSC50 wind speeds. The adjustment of wind direction was done using a fixed correction based on the relationship between the directions at site M12874 and the Bull Arm observations (See AMEC, 2010 for details). From this analysis a 30-year wind time series specific to the Bull Arm spill site was produced and used in the oil spill model simulations along with data from the MSC50 sites in Trinity Bay. The revised report provides an expanded explanation of the wind correction method.
3. The hydrodynamic model at Bull Arm was validated using one comparison with observed water elevation only. This is the easy part in the validation process of a hydrodynamic model. It is not sufficient for the validation of the model. The predicted currents should be compared with the existing	A comparison of the Bull Arm hydrodynamic model predictions of speed and direction with the speed and direction data collected by Seaconsult at the site of the Hibernia GBS in January and February 1991 will be carried out and is presented in the revised technical report. No current data from Trinity Bay have been

Comment	Response
current and circulation data for Bull Arm and Trinity Bay.	identified for model comparison.
4. Tide currents and wind-driven currents in Bull Arm and Trinity Bay were modeled separately and then linearly added. This is not necessarily correct. Why wind effect was not model simultaneously with tide currents, as it commonly done in hydrodynamic modelling?	In hydrodynamic modeling studies of this kind, when the effects of wind forcing over the water surface are to be included, it is desirable to model the tide and wind effects simultaneously for the entire period being simulated. The present study utilized a wind dataset spanning 30 years, an extremely long time period over which to simulate a wind forced current. It was deemed not practical to do this because of the extraordinarily large file sizes generated during this process for such an extended time period. It is considered sufficient to utilize the scaling approach described above for the purposes of estimating the statistics of oil spill impacts.
5. **A)** In the oil spill model, tide currents are constructed based on the date and time of the simulation. However, average wind speed and direction occurring at that time were used. **B)** Furthermore, the average wind speed was not used explicitly, it was used to scale the current data modeled using a constant wind speed of 8 m/s. This is big and unrealistic simplification of the problem. Average wind and linear scaling do not represent the reality. It may produces a completely different trajectory than the real wind (time dependent), especially if the averaging period is long, as is the case in the selected scenarios for the Bull Arm spill site (30 days). **C)** In addition, working with a constant (average or statistical dominant) wind direction for the entire domain and the simulation period is inacceptable. Results obtained from these simulations cannot be considered as representative when assessing shoreline oiling for instance. **D)** Real wind data (time- and space- dependent), as collected in this study and the previous one, should be used in all simulations. As it is recognised in the first paragraph in page	A. The currents were developed using changes in water level due to tides in Trinity Bay and Bull Arm to capture the tidal currents. In order to also capture the component of the current driven by wind, a constant 8 m/s wind was blown over the area from 8 directions and the resulting currents, which capture both tides and wind driven circulation, were generated. This is done to obtain the combined tide and wind driven currents for the range of possible wind directions. B. The oil spill model is run using the actual wind time series (variable in space and time) and the current data are scaled using the average wind speed from the wind time series to scale the current generated using one of the 8 pre-defined wind directions. C. The currents are forced with a constant wind initially, and then when the oil spill model runs, it scales the currents based on the wind it reads from the wind time series. The oil spill model uses a spatially and temporally varying wind time series to move the oil. D. The data collected in prior studies is not sufficient to run the

Comment	Response
7 of Document 4, the wind effects dominate the hydrodynamic circulation in Bull Arm and Trinity Bay.	simulations defined for this study because they do not have adequate spatial or temporal coverage. The MSC50 wind data are the best available for the purpose of determining the probabilities of oil trajectories from spills for this kind of risk assessment.
6. Two seasons, summer and winter, were selected to conduct the modelling work without any scientific justification. Wind data at Bull Arm spill site should be presented using monthly, or at least seasonal (four), wind rose. Presentation such as the one shown on Figure 2.4-2 for annual wind rose cannot be used to select the wind scenarios in this study. To determine risks of various resources being oiled, modelling scenarios should be based on at least the seasonal wind rose.	Selection of the summer and winter seasons was based on the analysis of the wind data completed in the previous modeling study (Spill Trajectory Modeling for the Hebron Project, AMEC Earth & Environmental). Summer and winter seasons were selected for modeling oil spills because they exhibit winds with distinct patterns. Summer winds are predominately from the southwest while winter winds are of higher speed and come most frequently from the west. These two wind regimes represent end members of speed and direction while the spring and fall winds represent transitions between them. It is not necessary to simulate spills occurring spring and fall because those results would be contained within the summer and winter predictions for oil trajectory and fate. (see additional information provided in response to Summary Comment 5, above) • Wind rose plots from the four seasons and a discussion of the reason for using summer and winter seasons for oil spill simulations have been included in the final report. • The modeling sampled wind and current from all months of the year, as discussed in response to Summary Comment 5 above.
7. Evaporated oil volume shown in Table 14.1 in Document 1 (Table 4.2-1 in Document 4) for IFO 180 is overestimated (15.5 to 18%), according the actual state-of-knowledge. The fact that the results showed that oil evaporation under ice conditions is equal or higher that the one obtained without ice in winter is not realistic. This is further evidence that the	Not sure what “actual state-of-knowledge” refers to. The IFO 180 specifications were taken from the Environment Canada database of oil properties. This database reports percent aromatics for this fuel oil ranges from 39-51 percent. It is not understood how modeled predicted evaporation rates of 15.5 to 18 percent would be considered an overestimation. See

Comment	Response
algorithm used to model oil-ice interaction is not appropriate. Revisions of the evaporation model used for the IFO 180 and the algorithm used for oil-ice interaction are necessary.	response to Comment 13 (below) for additional information.
8. Results obtained under ice conditions are missing in Table 4.1-1 in Document 4.	We did not model ice conditions with the stochastic model, only the deterministic model.
9. Were the ice condition kept constant for the entire modelling period (30 days)? If yes, this not realistic. The simulations should be re-run time-dependant ice conditions as show in the data. If not, this should be mentioned in the report.	Yes. The ice data available for this area are not sufficient to define ice coverage over space and time in periods shorter than 30 days. The decision was made to use 65% ice coverage because it is the maximum under which operations can occur.
10. Table 4.1-1 in Document 4 should be added to Document 1, just before Table 141.	Noted. The table will be included in Section 14.2 of the CSR.
11. A column showing the length of oiled shorelines should be added in Table 14-1 in Document 1 and Table 4.2-1 in Document 4.	This data will be included in the appropriate reports..
12. Results on time for shoreline oiling (Figure s B5-B8 in Document 4) should be included in Document 1.	Summary statements regarding shoreline oiling probability will be included in Section 14.2.
13. How possible entrainment of IFO 180 into the water column under ice condition is higher than without ice during the winter (10 to 25 m3 compared to zero in Table 4.2-1/Document 4 and Table 14-1/Document 1)? This is one more evidence that the algorithm used to model oil-ice interaction in the SIMAP software is adequate.	The numbers reported for water column oil in the summary tables were in error for these spill scenarios. This will be corrected in the revised report.
14. Estimation of the volume of oil that contaminates the shorelines is strongly controlled by the type of shorelines. Where proper data on the types of shorelines in Bull Arm and Trinity Bay gathered and used in the model? If yes, the information should be discussed and presented in the report. If not, the results shown in Tables 14.1 and 4.2-1 about	Shoreline types were defined using data provided by ExxonMobil Canada for Bull Arm (refer to Section 12 of the CSR) and the southwestern corner of Trinity Bay. Shorelines were defined as gravel beach or rocky. Shoreline types for the remainder of Trinity Bay were defined as rocky (see Figure 2.7-1 in the

<table>
<tr><th>Comment</th><th>Response</th></tr>
<tr><td>shoreline oiling are questionable and require revision. New simulations using proper information on shoreline types are required.</td><td>Nearshore Modeling Report.</td></tr>
<tr><td>15. Information on how the "Decayed Oil" is calculated is missing in the report and the Annexes describing the SIMAP software. This information is needed and should be presented in details in the report. Explanations should be presented also to clarify how ice effect is modelled in the calculations of the decayed oil. Modelling results presented in Tables 14-1 and 14-3 showed that the volume of decayed oil is significant.</td><td>

Oil Degradation

Degradation may occur as the result of photolysis, which is a chemical process energized by ultraviolet light from the sun, and by biological breakdown, termed biodegradation. Many types of marine organisms ingest, metabolize and utilize oil as a carbon source, producing carbon dioxide and water as by-products. The biodegradable fraction of various crude oils ranges from 11 to 90% (NRC, 1985, 1989).

Most studies of microbe-hydrocarbon interactions have been carried out under controlled laboratory conditions and results are not always applicable to the marine environment. Several parameters can limit biodegradation including the microbial population, temperature, oil composition, toxicity and state of weathering; and availability of nutrients and dissolved oxygen.

In the SIMAP model, degradation occurs on the surface slick, oil on the shore and the entrained oil and aromatics in the water column. A first order decay algorithm is used.

The degradation rate, $\overset{\circ}{M}_b$ (g/sec), can be defined as:

$$\overset{\circ}{M}_b = \frac{dM_{b,i}}{dt} = -K_i M_i$$

<table>
<tr><td>i</td><td>Environmental compartment (water, or shoreline surface, water column, and sediments)</td></tr>
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$M_{b,I}$	Mass of oil lost by degradation from i(g)
M_i	Mass of oil subjected to degradation from i(g)
K_i	Degradation constant from compartment i (1/day)

A typical degradation rate results in the loss of 1% of the available oil mass per day. A degrdation constant (K_i) of 0.01 was used in the spill model simulations.

National Research Council (NRC), 1985. Oil in the Sea: Inputs, Fates and Effects, National Academy Press, Washington, D.C., 601 p.

National Research Council (NRC) 1989. Review of the State-of-Knowledge Regarding Dispersant Usage in Open-Ocean Spill Responses. NRC Marine Board, Washington, DC., 306p.
</td></tr>
<tr><td>16. A)The Summary Table in the Executive Summary in Document 4 should be revised. The data presented should be consistent with those presented in similar Table in Document 3. The percentage should be used and proper caption should be added to explain what the data in the Table represent.

B) All process affecting the mass balance calculation should be listed. Information about the percentage of the spilled oil that remains on the surface should be mentioned.

C) As discussed above, this percentage should be ZERO when the simulations in this study are re-run until the oil disappears from the surface.</td><td>A) The executive summaries will be revised to ensure that data presentation is consistent.

B) The executive summary provides a concise overview of the results of the modeling and should not include the detailed information, as presented in the main report.

C) All diesel spills show zero oil on the surface at the end of thirty days. IFO 180 shows ranges from 0-2.8% surface oiling at the end of 30 days.</td></tr>
<tr><td colspan="2">Specific comments: Hebron</td></tr>
</table>

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<tr><th>Comment</th><th>Response</th></tr>
<tr><td>17. A) The Summary Table in the Executive Summary in Document 3 should be revised. A proper caption should be added to explain what the data in the Table represent.

B) All process affecting the mass balance calculation should be listed. Information about oil on shorelines and the length of oiled shorelines is missing. The percentage of the spilled oil that remains on the surface should be mentioned.

C) As discussed above, this percentage should be ZERO when the simulations in this study are re-run until the oil disappears from the surface.</td><td>A) The executive summaries will be revised to ensure that data presentation is consistent.

B) The executive summary provides a concise overview of the results of the modeling and should not include the detailed information, as presented in the main report.

C) See response to Summary Comment 4 (above)</td></tr>
<tr><td>18. Selection of the spill scenarios is crucial in this study. It is not clear how the 35K bpd for the platform blowout and the 20K bpd for the subsea blowout were estimated. Considering recent event of well blowout, these rates are underestimated by two to three orders of magnitude. Details about scientific estimation of the release rate should be provided. The estimate should provide a range of values. The spill scenarios include extreme and average values in this range.</td><td>The following text will be added to the Offshore Spill Trajectory Modeling report to provide additional rationale for the chosen scenarios.

Two blow-out scenarios were included in the spill trajectory modelling: a platform case and a subsea case.

The scenarios presented consider the rate at which oil could flow under a blow-out scenario for the Hebron Field. This rate was derived based on existing knowledge of Hebron crude properties, known reservoir properties for the Hebron field and assumptions made for specific well conditions at the time of the blowout. Reservoirs differ greatly from one to another and thier properties (pressure, volume, oil/gas ratio, etc.) are unique to each reservoir. Therefore, the flow rates described below reflect the properties of the Hebron Field. Historical flow rates from other spill events are not predictive of what would happen in other reservoirs, however they can be used to put specific events into perspective.

Flow rates for Hebron platform wells were estimated at 5,600 m^3/d (approximately 35,000 bbl/d) based on the reservoir properties, assuming a blowout to atmosphere (e.g. ~70 m above</td></tr>
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Comment	Response
	mean sea level) and accounting for the viscous (thick - difficult to flow) nature of the oil from this reservoir. Flow rates for MODU wells were estimated at 3,200 m^3/d (approximately 20,000 bbl/d) based upon the properties of its reservoir, a subsea blowout (~90m below sea level) and a lighter, less viscous oil. ExxonMobil's well control philosophy is focused on prevention using safety / risk management systems, management of change procedures, and global standards. ExxonMobil has a mature Operations Integrity Management System (OIMS) that emphasizes relentless attention to Safety, Well Control, and Environmental Protection. This includes proper preparation for wells (well control equipment inspections / tests), detecting the influx early, closing-in the well efficiently (personnel training / drills), and circulating out the kick with kill weight mud in a controlled manner. In the event of a blow-out, ExxonMobil's primary objective would be to stop the flow as quickly as possible. For both surface and subsea wells, this would involve shutting in at the wellhead and killing the well through the wellhead. Relief well drilling, and the subsequent dynamic kill, is considered a back-up strategy in the event shut-in and/or killing through the wellhead is not possible or is unsuccessful.
19. Statistical presentation of wind is not adequate for this study (Figures 2.4-2 to 2.44 in Document 3). As for the Bull Arm study, wind rose should be presented for each month of the year, or at least for the four seasons. Definition of the wind conditions to consider in the study should be based on such analysis, instead of considering two seasons only (summer and winter).	ASA analyzed the monthly wind roses presented in the previous modeling report (Spill Trajectory Modeling for the Hebron Project, AMEC Earth & Environmental, 2009) and agreed that the summer and winter months were best representative of wind conditions in the offshore. Selection of the summer and winter seasons were based on the plots of monthly wind roses from the previous modeling study. Seasonal wind roses have been included in the revised report.

Comment	Response
	Wind climatology in the summer and winter are substantially different and warrant two sets of spill scenarios. The spring and fall seasons in this region are transitional months, where wind speed is generally less and direction is widely variable. Spill simulations using the wind data from these transitional periods result in spills that travel less distance and remain clustered near the spill source. Spills modeled during the winter and summer months, when winds are stronger and persist in direction, result in spills that travel greater distances from the release point and therefore present a more plausible scenario. The oil spill modeling for Hebron sampled wind and current from all months of the year, even the spring and fall transitional seasons. In order to demonstrate this, plots of the wind data from the entire 30 year wind record are compared with plots of the wind data sampled by the stochastic model for each of the four seasons. These wind plots clearly show that the 100 stochastic model simulations performed for each spill scenario adequately sampled the relevant environmental data. The comparison plots and a discussion of the results have been included in the revised report.
20. Why wind data observed from the nearby platforms were not considered in this study? A complete comparison of the MSC50 wind data and the observed data for several years should be performed to show the accuracy of the wind data used in the simulations.	EMCP's contractor, ASA, approach is to use the best data available and the MSC50 wind data are generally considered the best. The oil spill modeling requires wind data covering a large area of the ocean over multiple decades and the MSC50 data are the best available for use in a risk assessment modeling study of this kind. Although a comparison of the data was not done, the results of such a comparison will not necessarily "show the accuracy" of the wind data used in the modeling. The observed data from nearby platforms have gaps and are temporally and spatially limited. They are only useful to characterize the wind at the point of collection and for the limited time period over which they were

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<tr><td></td><td>collected (months to a few years).</td></tr>
<tr><td>21. Values of the variables used in the calculation of the oil droplet size distribution shown in Table 3.2-1 in Document 3 should be listed in the document. Selection of these values should be justified.</td><td>Oil droplet sizes are calculated using a method described in Rye, et al., 1998. Inputs to the droplet size calculation include the following:
<table><tr><td>GOR</td><td>110.6</td></tr><tr><td>Discharge Temperature</td><td>58° C</td></tr><tr><td>Well Diameter</td><td>15.9 cm</td></tr><tr><td>Temperature/Salinity Profile</td><td>From NODC, winter and summer</td></tr><tr><td>Oil Density (15° C)</td><td>0.9334</td></tr></table>
Rye, H., Johansen, O., and Kolderup, H. 1998. Drop size formation from deep water blowouts. SINTEF Report.</td></tr>
<tr><td>22. The oil droplet size distribution shown in Table 3.2-1 in Document 3 is valid for the dynamic zone of the jet close to the exit. It is not correct to use the droplet size distribution in the SIMAP to track the fate of the spilled oil in the far-field. The end results obtained using such assumption, as it is done in this study, may lead wrong estimation of the fate, especially estimation of oil entrainment into the water column. Above the dynamic zone of the jet, the intensity of turbulence weakens and coalescence of oil droplets takes. This leads to formation of bigger droplets. In the far-field, oil droplet size distribution is controlled by local turbulence and the state of oil weathering. So, was the oil droplet size distribution shown in Table 3.2-1 used in the SIMPA model kept constant in the entire simulation period? If yes, results from such simulations are not correct and related simulation should be re-run. If not, details about the procedure used should be discussed in</td><td>The model calculates the initial oil droplet size distribution using the methods referenced above. This distribution applies to the initial stage of the blowout. As time passes, the spill model can recalculate droplet sizes as the oil coalesces into larger droplets. (There is no evidence that the initial droplet size distribution changes while the droplets are in suspension and rising to the surface during a blowout.) Once the oil reaches the surface and is transported by currents and winds, it can be entrained by waves and the size distribution is recalculated based on the oil viscosity and surface wind/wave conditions. These dispersed droplets can then coalesce into larger droplets so it is a dynamic process throughout the spill simulation.</td></tr>
</table>

Comment	Response
Document 3.	
23. Estimation of the volume of oil that contaminates the shorelines is strongly controlled by the type of shorelines. Where proper data on the types of shorelines in the affected areas gathered and used in the model? If yes, the information should be discussed and presented in the report. If not, the results shown in Tables 14.3 and 4.2-1 about shoreline oiling are questionable and require revision. New simulations using proper information on shoreline types are required.	The shoreline type specified for the offshore spill simulation is exposed rocky shore which is the predominant shore type of the east coast of Newfoundland. In the SIMAP model, this shore type has a width of 3 meters and an oil thickness of 2mm. This results in a maximum oil mass holding capacity of 5.6 kg/meter. Once the oil on the shoreline reaches this amount, oil is no longer able to accumulate on the shore and it either stays in the water or moves along shore if forced by wind and current where it may come ashore in areas where the threshold capacity has not been reached.
24. For simulations with 100 and 120 days of release, it is doubtful that the 100 simulations used in the stochastic model are sufficient to assess the probability of oiling. Selection of this number should be justified with a quantitative analysis, i.e. consider different number to show convergence of the results.	The oil spill modeling sampled wind and current from all months of the year, even the spring and fall transitional seasons. In order to demonstrate this, plots of the wind data from the entire 30 year wind record are compared with plots of the wind data sampled by the stochastic model for each of the four seasons. These wind plots clearly show that the 100 stochastic model simulations performed for each spill scenario adequately sampled the relevant environmental data and that the probabilities calculated by the model accurately reflect the climate at the site.
25. Second paragraph in page 14.3 in Document 1. The justification proposed to focus on a 30-day platform blowout at a rate of 5,600 m^3/d, and a 100-day subsea blowout at 3,200 m^3/d is not acceptable. As discussed in this review, all simulations should be considered with longer simulations period (until the disappearance of oil from the sea surface).	See response to Summary Comment 4 above.
26. First paragraph in page 14-10 in Document 1. The statement "... represent a worse possible outcome" is not correct. The phrase should be removed from the report or revised according to the comments provided in this review. oiling of	The text “worst possible outcome” will be deleted.

Comment	Response
Newfoundland shore becomes much worst if the For the 120 day simulation, results in Table 14.3 in Document 1 showed that 51% of the spilled oil remains on the surface at the end of the simulations!	
27. Figures 14.10 to 14.16 in Document 1 and the corresponding figures in Document 3 should be replaced to show details of the oiled shorelines, i.e. zoom on the oiled areas, as shown in Figures 14.5 to 14.10 in Document 1.	Figures representing oiled shorelines are included in the final technical report.
28. One of the important outcomes from the simulations presented in this report is the need to extend the simulation domain to include the European shorelines on the Atlantic side, including Greenland and Iceland. Figures such as 14.8 and 14.9 in Document 1 (Figures 29 and 33 in Document 3) are clear illustration of the need to extend the modelling domain for proper assessment of the shoreline oiling. It should be noted that the oiled area shown in these figures is expected to extended significantly when the simulations are continued until the disappearance of the oil from the seas surface.	As discussed at the May 6, 2011 meeting with the regulatory agencies, EMCP has defined a model domain for oil spill trajectory simulations for the purposes of environmental assessment. This domain is defined as the area between 40 and 55 degrees north latitude, and 30 and 60 degrees west longitude. This area is sufficient to determine potential environmental impacts in the Newfoundland offshore area, including potential shoreline impacts in Newfoundland. Potential transboundary environmental effects are also discussed in the CSR. Within this domain, extended period spill simulations (see response to Summary Comment 4 above) clearly show surface oil approaching zero.
29. Results presented in Table and Figures in Document 3 should be reviewed once all simulations are re-run until oil disappears from the water surface, as recommended in this review.	The offshore modeling report has been revised to include responses addressed herein, as appropriate. As described above, within in this offshore modeling domain, extended period spill simulations (see response to comment 25 above) clearly show surface oil within the domain approaching zero.
Recommendations	
1. All simulations (using stochastic and deterministic approaches) should be re-run until the disappearance of oil from the sea surface. This may require extension of the simulation periods for few months. The result should be	This comment has been addressed in response to Summary Comment 4 (above)

Comment	Response
shown in the mass balance calculations. Stopping the simulations at the end of the spill duration, as it is done in most of the simulations conducted in this study, is not adequate for assessing the environmental impact, especially shoreline oiling. This has been validated by the observation from the Deepwater Horizon oil Spill in the Gulf of Mexico and from several other oil spills. It is also obvious from some of the results of this study when the simulation duration was extended from 30 to 60 days for a 30-days spill.	
2. The domain of the simulations should be extended to include the European shorelines on the Atlantic side, including Greenland and Iceland.	See Response to Specific Comment 28, above.
3. Additional scenarios should be studied for the platform and subsea blowouts considering a release period longer than 120 days. Based on past well blowout events, this is not an impossible event. In addition, the remote location of the Hebron site and the harsh weather in the area are additional justifications to increase the release during beyond the three months period.	Neither the CEAA nor the RAs have prescribed a blowout scenario in support of environmental assessment. For the purposes of the Hebron Project CSR, the Operator selected a a plausible low-probability spill scenario for the spill trajectory modeling. The Proponent concedes that different scenarios could be theoretically contemplated. However, we are confident that the scenario described represents a reasonable basis for undertaking an environmental assessment. The selected scenario should not be interpreted as a commitment by the Operator to a specific response plan. The Operator intends to develop, in accordance with regulatory requirements, contingency plans to address offshore spill events.
4. Results from both the stochastic and deterministic simulations for the spill scenarios representing 50% shoreline oiling, surface oiling and oil entrained in the water column should be presented for the Bull Arm spill site, in addition to the 95% event for which the information was presented in the report.	50^{th} percentile results would show less impact than the 95^{th} percentile cases. Therefore, the report includes the 95^{th} percentile cases.

Comment	Response
5. The hydrodynamic model developed for the Bull Arm site should be validated using existing current and circulation data for Bull Arm and Trinity Bay water systems.	A comparison of the Bull Arm hydrodynamic model predictions with the current data collected by Seaconsult at the site of the Hibernia GBS in January and February 1991 has been carried out and is presented in the revised report. No current data from Trinity Bay have been identified for model comparison.
6. Wind data in both spill sites should be presented using monthly, or at least seasonal, wind roses. Seasonal wind (four) should be used in the simulations.	Winds in Bull Arm and at the well site show a typical pattern for locations at this latitude. The summer and winter seasons see a predominant wind direction with less variation than the spring and fall seasons when the wind is in transition. The transitional spring and fall months see winds fairly well distributed from all directions. Spills in the winter and summer will consequently travel a greater distance from the spill site and spills during the transitional months will tend to remain closer to the source. For the well site spills the predominant wind direction is likely to result in the most impact because the oil is moved over longer distances, increasing the chances for contact with the shoreline. For the Bull Arm spills the transitional wind may result in the most impact because it potentially oils more shoreline. Since all of the Bull Arm shoreline is oiled this only applies to Trinity Bay. For additional detail regarding wind data see response to Summary Comment 5. Seasonal wind rose plots have been included in the revised report.