Operations and Safety

1. The number of personnel on board (POB) is given as 230-234. A detailed justification for selecting the POB should be submitted. Experience from certain past projects indicated that the initial selection of POB was not adequate.

Hebron Response #1

Hebron POB was discussed in detail with C-NLOPB during a meeting on October 14, 2010. At that time ExxonMobil reviewed its processes to establish a safe and efficient Platform POB. This process includes ExxonMobil best practice application, use of internal benchmarking tools and lessons learned from both our local and extensive global offshore operations. Since our last meeting with the C-NLOPB we have continued to optimize our design and improve overall safety and efficiency of the platform. The POB design is now 220 and we will continue to study further optimizations during FEED. This POB efficiency improvement is due to optimization and improved work processes during both base and peak activity periods. Base POB is expected to be approximately 151, with accommodation allocation to increase POB to 210 - 220 at peak periods (e.g. additional construction, casing, completions crews). Our base POB has been designed to operate and maintain the specific equipment on board the installation. The specific number of operators and technicians has been determined using our global benchmarking tools and best practices. These processes are designed to ensure the platform integrity and safety requirements are executed in a timely manner. Reliability is also a strong focus of our POB design, since a steady and reliable operation is a safe operation. It is important to highlight that operations and drilling will be at the base POB of approximately 151 for two thirds of a typical well program, therefore allowing significant available living quarters for unplanned maintenance work to be completed. As previously discussed with the C-NLOPB, we will be seeking approval of a regulatory query to increase personnel above the design POB (210-220) during initial start-up and commissioning activities, as well as periodic shutdowns.

It should be noted that it is our understanding that some FPSO operations in the area do not have the 50-60 POB flexibility between base and peak operations being designed into the Hebron installation. At Hebron sufficient reserve is also built into the peak operating number to allow flexibility for unplanned activity during all simultaneous operations, thus ensuring adequacy.

We offer a follow up discussion on this subject to further outline the detail that we have carried out to ensure the Hebron Platform will be operated and maintained in a safe, reliable and efficient manner.

2. The development plan is based on conceptual engineering studies and a number of FEED studies that are ongoing. The list of studies that are ongoing should be submitted along with a schedule of when they will be completed.

In addition, it is indicated that a number of studies will be required to progress detailed design and construction. The list of such potential studies should be submitted along with a tentative schedule for completion.

Hebron Response #2

This comment goes beyond the scope of the Accord Act requirements and is not part of the C-NLOPB guidance documentation. The application is complete without a listing of these studies.

The regulatory process provides for the Certifying Authority to validate the design and compliance with the Installation Regulations.

3. Section 7.1.1 indicates that the open-hole gravel pack completions may exceed current technical limits. The process to ensure that the use of new technology or extending current technology is safe should be submitted.

Hebron Response #3

The open-hole gravel techniques proposed by the Operator do not deviate from the established safety protocols already in existence for current open-hole techniques used by the industry. The Operator has completed trial testing of the proposed open hole techniques which are now considered 'base technology'.

4. a. Section 8.1.3 indicates that the design, fabrication, installation and operation will conform to all applicable Canadian and Newfoundland and Labrador laws, regulations, codes and standards as well as ExxonMobil Engineering Practices (Global Practices) and Global Security Practices. After FEED studies are completed, it is indicated that the list of codes and standards will be updated. A commitment to submit these codes and standards should be made.

Hebron Response #4a

We confirm that a list of codes and standards will be provided at the end of FEED.

b. It is also indicated that the most recent edition of applicable codes will be used. In case of conflict between Global Practices and accepted industry practice, normally the most stringent requirements will take priority**.** A commitment to submit any requirements from Global Practices that are more stringent than the codes and standards referenced in the application should be made.

Hebron Response #4b

This comment goes beyond the scope of the Accord Act requirements and is not part of the C-NLOPB guidance documentation. It is not feasible or advantageous for the project to conduct the requested review of hundreds of ExxonMobil GPs. Any deviations from the GPs are captured through a robust Specification Deviation Process and deviations from the regulations are captured through the Regulatory Query Process.

c. Finally, since codes and standards are revised from time to time, a commitment to submit a description of the process for considering revisions to codes and standards should be made.

Hebron Response #4c

We confirm that the latest revision of codes and standards will be considered as is standard practice of any engineering organization. The EPC Contractors have developed regulatory compliance procedures which effectively describes how periodic changes to codes and standards are identified, considered and implemented. These procedures are also part of the documentation review by the Certifying Authority.

5. Figure 1.7-4 indicates that the OLS includes a vertical riser. In the past, there were challenges with wear on the flexible lines used for an OLS with a vertical riser. A discussion of how the applicant has considered these challenges and how it intends to reduce the risk of wear to the flexible lines should be submitted.

Hebron Response #5

The Operator plans to minimize this historic challenge by taking advantage of both design and operational elements. For design, the project is not using a vertical lower riser that is attached to a subsea buoy at mid column height like other projects, but using a clump weight to keep the downstream end of the lower riser on the sea floor while in the idle condition. This clump weight keeps both the lower and upper riser nearer the seafloor and out of the higher magnitude wave forces. For pick up, the Operator is studying changes that can be made on the service vessel to minimize the time that the upper riser may come in contact with the seafloor, such as a stronger winch, perhaps with heave compensation, and developing procedures to lay down the riser system after loading to avoid having to reposition it later (and thus expose it to scrapping). Consideration is also being given to replacing the riser system with a more flexible and easily handled marine hose.

6. Section 9.4.4 indicates that initially the existing tanker fleet operating in the Grand Banks will likely be used to transport the Hebron crude oil to the Newfoundland Transshipment Terminal or direct to market and that the suitability of tanker fleet/standby vessels will be verified during detailed design. Section 10.1.3 of the concept safety analysis (CSA) states that it is assumed that support and standby vessels and shuttle tankers will be suitably ice strengthened to permit their use in most sea ice conditions. This assumption should be reviewed at the design stage to ensure that the possibility of sea ice is considered when selecting evacuation systems. Accordingly, a discussion of ice strengthening of shuttle tankers and standby vessels should be submitted.

Hebron Response #6

While the Hebron vessel strategy has not yet been developed ice strengthening will be considered as part of the development process. Sea ice is in the scope of the EER studies that pertain to lifeboats, life rafts, survival in the sea, and the ability of support vessels to assist in evacuation efforts.

7. Sections 1.7 and 1.8 discuss alternatives to proposed project and the preferred concept. Any supporting documents in connection with this matter should be submitted.

Hebron Response #7

The Operator has no other supporting documents in connection with this matter.

8. Section 8 discusses design criteria but does not mention the need to consider multi-directional wave loading on bottom founded structures. A discussion on how the applicant intends to consider multi-directional waves should be submitted.

Hebron Response #8

For GBS Structural design, long crested extreme waves generate the highest design loads. The Operator is taking account the directionality of these waves and will design facilities accordingly during FEED.

9. The facilities are designed for 30 years. Table 1.9-1 indicates the life of the field as greater than 30 years. A discussion on the rationale for selecting a design life of 30 years when the life of the field is greater than 30 years should be submitted.

Hebron Response #9

The design life is primarily used in the selection of materials and calculating corrosion allowances for piping and vessels. Corrosion estimates are made based on assumptions about the changing chemical composition of fluids in each service over the life of the field. Compositions towards the end of field life are difficult to predict, given uncertainties in well stream compositions over time. A nominal design life of 30 years was selected as a basis for estimating corrosion allowances. Experience has shown that materials often have a longer service life than originally estimated, if the predicted corrosion conditions were not realized. Conversely, piping and vessels may need to be replaced short of their design life if corrosion rates are greater than expected. Inspection, monitoring and maintenance programs throughout the life of the facility will dictate replacement of components or extension of field life.

Decisions to extend the facility life, through refurbishment and replacement of components will be made in the future based on market conditions and economics prevailing at that time.

10. Section 8.1.3 states that iceberg impact loads will be calculated with a probabilistic procedure that accounts for the full range of environmental conditions that could influence iceberg loading at the Hebron location. Additional discussion should be submitted on the following items.

    a. Probabilistic analysis
    Clarification of the probabilistic procedure should be submitted. To our understanding, distributions are assumed for the various parameters used for generating the iceberg impact loads. Often, it is assumed that larger icebergs move at slower velocities than smaller icebergs. However, observations indicate that large icebergs may move at relatively large velocities.

Hebron Response #10a

The probabilistic load calculation for iceberg impact loads is a Monte Carlo simulation procedure in which statistical distributions are used to represent the data that describe the important iceberg input parameters. These distributions are quantified by measured data for these parameters. For iceberg velocities, the data are partitioned by iceberg size, which means that all icebergs are not assumed to drift at the same speed. The iceberg design loads of interest are those at the 10-4/year probability level. At these low probability levels, the loads of interest are associated with the larger icebergs impacting at speeds that are higher than what has been observed. Typical impact speeds for the design level loads are more than twice as high as the mean drift speed that has been observed for icebergs on the Grand Banks; for example, the 10-4/year iceberg design load may result from a 3.1 million tonne iceberg drifting at the speed of 0.72 m/sec.

    b. Return period
    ISO 19906 indicates that the representative value for actions arising from extreme-level ice events shall be determined based on an annual probability of exceedance not greater than 10^{-2}. Unlike wind and waves, iceberg impact loads do not converge to a limit at an annual probability of 10^{-2}. Sometimes a lesser annual probability is used for such actions. A discussion on the selection of annual probability for iceberg loads should be submitted.

Hebron Response #10b

ISO 19906 considers two classes of environmental load events -- frequent environmental events and rare environmental events –- with specified annual probabilities of 10-2 and 10-4, respectively for design loads. Wave loads are an example of a frequent environmental event and iceberg impact loads are rare environmental events. Thus the appropriate annual probability for iceberg impact loads is 10-4/year.

    c. Crushing pressures
    The methodology used to generate iceberg impact load uses a pressure area relationship where the average pressure decreases with increase in area. However, some researchers

suggest that there is potential for increase in pressures with increase in area for small aspect ratio contact areas. A discussion justifying the use of design loads generated by the first approach should be submitted.

Hebron Response #10c

The $10^{-4/}$year local pressures used in the design of the ice wall range from 9 to 16 MPa for a contact area 0.6m or less. However, the contact area associated with a 10^{-4}/year iceberg global load is 100's of square meters. For example, the contact area associated with a 3.1 million tonne iceberg at 0.72 m/s drift speed is 338.2 m^2. In summary, high ice pressures associated with small contact areas are used for the local design of ice walls while extreme iceberg loads associated with large contact areas determine the global design iceberg load for the structure.

11. The CSA indicates that the quantified risk assessment is based on a risk model that can be refined and updated throughout the life of the project. A discussion on the criteria (trigger) for updating the CSA should be submitted.

Hebron Response #11

The Newfoundland Offshore Petroleum Installations Regulations require the Operator to maintain and update the CSA when changes in operating procedures and practices would necessitate an update. The Hebron Project will assess risk at various stages of the project design and execution as listed in the Part II document "Early Project Risk Assessment Plan", and as updated during project design and execution. The ExxonMobil Operating Integrity Management System calls for re-assessment of risk when any of the following occur:

- Change in the platform design (according to EM Management of Change (MOC) process)
- Change in operating procedures (according to EM MOC process)
- Recognition of a new hazard

The CSA will be updated should any of the above risk assessment results identify a change in assumed risk in the initial CSA.

12. Reference is made to the Drilling Regulations and the Production and Conservation Regulations in sections 7.1.10, 7.2.10 and 14.6. Reference should be to the *Newfoundland Offshore Petroleum Drilling and Production Regulations*.

Hebron Response #12

Noted. Future references will be shown as proposed.

Environmental Protection

13. The documentation associated with the Comprehensive Study Report (CSR) pursuant to the Canadian Environmental Assessment Act is intended to fulfill the requirements for an Environmental Impact Statement under the Accord review and as outlined in Chapter 5 of the *Development Plan Guidelines*. Comments on the draft CSR have been provided to the proponent and are in the process of being addressed. A number of the comments made on the CSR are also relevant to the Hebron development application. When CSR issues are resolved, the applicant should, as required, incorporate those changes into the relevant sections of the application so the CSR and the application contain the same information. Examples of common issues are the disposal of water based mud and cuttings, produced water reinjection, flaring and oil spills.

Hebron Response #13

The Proponent is satisfied that its Development Plan is aligned with the updated CSR.

14. The applicant has not mentioned, "… the quantities and composition of atmospheric emissions, including those arising from production fluid combustion and gas flaring" as outlined on page 37 of the development plan guidelines. Atmospheric emissions are dealt with in the CSR but no connection between the CSR and the development application are made.

Hebron Response #14

The CSR is intended to address the requirements of Chapter 5 – EIS of the Development Plan Guidelines. In this respect, the CSR is a part of the Development Application.

15. The applicant has not discussed control of biological growth within the facilities seawater systems in the development plan, but has considered the use of sodium hypochlorite for biological control in the CSR. The applicant should make the connection between the CSR and the development plan.

Hebron Response #15

As previously noted, this issue is covered in the CSR. The CSR is one of the components of the Hebron Project Development Application.

16. Biofouling of the facility or control of biofouling has also not been presented in the application but biofouling has been discussed in the CSR. The applicant should make the connection between the CSR and the development plan.

Hebron Response #16

Please see Response #15.

17. Section 7.1.6.3: The applicant is reminded that use and disposal of completion fluids should be in accordance with the *Offshore Waste Treatment Guidelines*, 15 December 2010.

Hebron Response #17

The applicant acknowledges the reminder and notes that the use and disposal of completion fluids will be in accordance with the referenced OWTG guidance and procedures will be described in the offshore environmental protection plan.

18. Section 9.1.1: Disposal of interface is subject to review and to the proponent's CSR.

Hebron Response #18

The comment is noted by the applicant. The crude oil storage system is designed to keep the crude oil–water interface within the storage cell and the storage displacement water will be treated according to the OWTG. All waste handling procedures will be captured in the offshore environmental protection plan that will be reviewed and approved by the C-NLOPB.

19. Section 9.1.1: The level of detail provided on the storage displacement water system is not sufficient to understand how crude will not be accidentally discharged to sea through the open system, i.e. cell over filled. It is also unclear as to what is meant by "residence time may be reduced to fit void volume in the GBS". Additional detail is required on the system and residence time.

Hebron Response #19

The crude oil storage cells will be provided with a crude oil interface level measurement system with alarms which will be interlocked with a shut off valve on the filling line at Topsides to prevent overfilling of the cells and overflow to the displacement water system. The displacement water lines from the storage cells will be routed through a manifold and connected to the tricells in the GBS, which constitute a buffer volume towards sea. Each tricell has an area of 11.6 m^2. Total area in the system is 81.2 m^2. The internal height of the tricells is 69.2 m giving a total volume of the tricells of approximately 5600 m^3. In addition, the total buffer may include the buffer in the storage cells below the high-high level corresponding to the Lower Interface level (currently at EL. 13.9 m). This buffer of 1.5 m in one cell of approximately 500 m^2 corresponds to an additional buffer volume of approximately 750 m^3. The total effective buffer volume is therefore approximately 6350 m^3. With a crude production rate of maximum 1022 m^3/h as defined in the GBS Design Basis the residence time will be approximately 5-6 hrs.

20. Section 9.1.1.6: The applicant mentions intakes but does not mention the location or design of discharges. Both the location and design of discharges are important for dispersion and to minimize other potential effects of the discharge. The applicant also does not mention the need or how biological growth in the facilities various water systems will be accomplished. More detail is required.

Hebron Response #20

The seawater intake location(s) (orientation, elevation) has been established considering produced water, drill cutting dispersion modeling and marine growth. The seawater intake location is platform south away from shale chute 2, which is located on platform west. Seawater supply shall be taken from approximately 70 m below sea level.

The design of the seawater discharge system is not finalized at present. However, the design will consider siphon flow, partially vented flow, and fully vented flow operating conditions, as well as impacts on nearby systems and facilities.

Control of biological growth will be affected by use of biocides, primarily chlorine. Use of biocides, and all other chemicals, will be subject to implementation of the Chemical Screening Process developed in accordance with the Offshore Chemical Selection Guidelines (2009), which will be submitted as part of the Environment Protection Plan.

21. Section 9.2.3.2: The applicant states gas will; be scrubbed to remove liquids, hydrocarbons and water; and, dehydrated. The applicant should describe what the scrubbing medium is and what happens to the medium after scrubbing. The applicant should also describe how gas will be dehydrated.

Hebron Response #21; Andrew Jacob provided comments.

a) Scrubbing in this context refers to dropping out of liquids from a gas stream via physical means (a vessel with internal baffles). There are no chemical mediums involved in this process.

b) The purpose of the Gas Dehydration System is to dehydrate gas to an adequate level to avoid condensation and possible corrosion or hydrates in the production casing and injection tubing. It should be noted that, as part of the ongoing FEED optimization work, dehydration is currently not part of the Hebron design. However, some studies are still pending such that dehydration may ultimately be reincorporated back into the Hebron design. Conceptually, the dehydration system would operate as follows. Gas from the HP compressor will be routed to the Dehydration Inlet Scrubber where liquid will be knocked out. The wet gas enters the Glycol Contactor at the bottom and flows upwards through the structured packing sections, where water vapor will be absorbed by the lean TEG flowing in the opposite direction. The dry gas leaves the contactor through the top and goes downstream to the Gas Lift Compressor. Rich TEG collected in the bottom section of the contactor will be sent to the Glycol Regeneration Skid for regeneration, where fuel gas will be used as a stripping gas. Water and flashed gas from the regeneration process will be sent to flare.

22. Section 9.2.3.5: Accompanying the development plan are two reports on reservoir souring: one produced for Chevron and the other for ExxonMobil Canada Properties (EMCP). The latter report was produced because the depletion strategy for the reservoir was changed. This

change appears to have altered the souring predication in that the reservoir will sour sooner and that there is little difference between the souring potential of seawater and produced water when used for water flood. One of the reasons the applicant gives for not re-injecting produced water is that, as compared to seawater injection, the souring potential was greater. Since this predication according to the souring study done for EMCP may not be valid, the applicant should review the rational for not re-injecting produced water based on souring potential.

Hebron Response #22

The applicant believes that the 2010 reservoir souring study indicates more than a "little difference" between the souring potential of SW injection and PWRI. The key data that shows the impact of reservoir souring in this study is the total H_2S production (kg/day). The magnitude and evolution of the total H_2S production as a function of water cut shown in Figures 4.1 to 4.12 is as much as 50% greater with mixed PW/SW injection than with SW injection only. The applicant has reviewed the rational for not re-injecting PW based on souring potential and believes that the greater souring potential of PW is but one of several potential risks in adopting PWRI at project start-up. As stated in the Part II document "Produced Water Management Strategy," additional data is needed to confirm that the identified risks of PWRI are manageable. The additional data required can only be obtained and analyzed after there has been sufficient water production (several years post start-up). Hebron will initially operate with marine discharge of PW at start-up. Hebron will switch to PWRI for routine operations if testing and studies (post water production) demonstrate that the risks and impacts of PWRI are understood and acceptable.

23. Section 11.3: Spill or pollution is not mentioned in the section.

Hebron Response #23

Credible emergency scenarios provided in Section 11.3 are noted as "not necessarily be limited to". Spill or pollution may be considered credible emergency scenarios and will be incorporated into emergency response plans.

24. Section 14.1.2: The proponent's environmental assessment assesses the probability of an environmental event based on historical data from the local jurisdiction and internationally. Based on these probabilities, the risk to the environment in combination with the associated event is assessed. The assessment is not specific to a facility or its design; it is based on historical performance of all drilling or production facilities. Unlike the environmental assessment, the CSA is for a specific facility and not a generic analysis of the probability of an event occurring. The applicant should reflect the probabilities and mitigations identified in the project's environmental assessment in the design of the facility. Where it is practical to reduce the probability of an event occurring further, the necessary measures to reduce the probability are to be incorporated into the design of the facility.

Hebron Response #24

A fundamental part of the Hebron Project risk assessment process is the generation, tracking, completion, and closure of actions to mitigate risk. These mitigating actions are identified during the risk assessments listed in the Part II Document Hebron Project Risk Assessment Plan by a formal, qualitative risk assessment process with management approval of risk assessment scope, purpose, action items, and completion of action items. Mitigations identified in any risk assessment are tracked and stewarded by this same process such that these mitigations are incorporated in the facility design.

25. The applicant has not established a target level of safety for risk of damage to the environment in the application or the CSA. Nor has the applicant defined “significant” or “not significant”. The application does not adequately demonstrate how section 43 of the *Newfoundland Offshore Petroleum Installations Regulations* and section 4.1 of the *Development Plan Guidelines* will be achieved, for environmental risks.

Hebron Response #25

The target level of safety for risk of damage to the environment is established in the Hebron Project Comprehensive Study Report (CSR). The definition of “Significant” is discussed in Section 4.3.3 of the CSR for each VEC. The CSR has the following conclusion:

> The Project will benefit from the experience of the existing production projects offshore Newfoundland and Labrador, with respect to many key items, including reducing resource conflicts with commercial fishers, development of effective monitoring programs and effective emergency response planning.
>
> Ecological processes will not be disturbed outside natural variability, and ecosystem structure and function will not be critically affected by the Hebron Project. Most environmental effects are reversible, and of limited duration, magnitude and geographic extent. While significant adverse environmental effects have been predicted for Marine Birds, bird Species at Risk (SAR) and Sensitive or Special Areas (those located in the nearshore only) in the case of an accidental event, the likelihood of this occurring is considered very low. EMCP will have pollution prevention measures and emergency response procedures in place.
>
> The various routine components and activities associated with the proposed Project are predicted to result in not significant residual adverse environmental effects on Air Quality, Fish and Fish Habitat, Commercial Fisheries, Marine Birds, Marine Mammals and Sea Turtles, Marine SAR and Sensitive or Special Areas.

Resource Management

26. References are provided in the Geology section and the Petrophysics section. References should also be provided in the Reservoir Engineering section, Reserve Estimates section, Reservoir Exploitation section as well as the Drilling and Completions section.

Hebron Response #26

References provided in the Geology and Petrophysics sections are to published papers, journal articles, etc used in the discussions in those sections. Sections 4 – 6 (Reservoir Engineering, Reserves Estimates and Reservoir Exploitation) do not have a list of references because these sections do not refer to any published information. Additional reference materials (project proprietary) utilized in developing these sections have been provided as Part II documentation.

Geology and Geophysics

27. The application discusses trapping configuration for Hebron (3 way fault dependent trap) but not West Ben Nevis and Ben Nevis fields. Is the configuration the same in these fault blocks?

Hebron Response #27

Added the following text to Section 2.2.1 (Structural Geology):

"The West Ben Nevis and Ben Nevis Fields lie on adjacent fault blocks to the northeast **and are also three-way fault-dependent traps**."

28. Figure 2.21 shows all of the trapped hydrocarbons at Hebron. Additional maps to show the individual pools and prospects from the Figure 2.21 map should be provided to better illustrate size and distribution.

Hebron Response #28

Figure 2.2-1 split into 5 new Figures. (2.2-1 through 2.2-5)

29. On page 2-24 it is hard to distinguish between use of the Avalon Formation in the formal stratigraphic sense and the "lumped" reservoir unit which includes the Eastern Shoals Formation and the A Marker as defined on page 2-21. For example, if the base of the Avalon is a sequence boundary, is this the base of the Avalon Formation only, or the base of the whole lumped unit? Terminology needs to be strict (always referring to the "Avalon reservoir unit" where appropriate) to avoid confusion. This should be updated to ensure common terminology.

Hebron Response #29

Revised text to read:

"The Early Cretaceous Avalon Formation and "A" Marker are collectively called the Avalon Formation / Reservoir for the geologic technical evaluation and for modeling purposes."

Deleted the following sentence:

"Overall, the Avalon Formation is a coarsening upward marine shoreface sandstone that represents progradation into the Jeanne d'Arc basin."

Added following text to Section 2.2.2.1.1:

"In this document, the Avalon Formation is defined as the interval from the Base Ben Nevis sequence boundary to the base of the "A" marker, which tested oil in the B-75 ands I-45 wells."

30. Page 2-31: Shoreline trending "northeast to southwest" is the opposite of what is depicted in Fig.2.2-8. Please clarify.

Hebron Response #30

Revised text to read:

"Seismic attribute and seismic facies analyses were used to determine that the Ben Nevis shoreline trend is west-northwest to east-southeast."

31. The petrophysical criteria and log-cut offs used to define the Ben Nevis and Avalon reservoir facies, should be provided in a format similar to Table 2.2-1 page 2 -42.

Hebron Response #31

There is no accompanying Table because logs were not used to define petrofacies in either Pool 1 or Pool 3.

Added the following text to Section 2.2.2.1.3:

"Reservoir facies were defined in the Ben Nevis Pool 1 reservoir model by tying Environments of Deposition (EOD's) deterministically at the wells. The representative fraction of each rock type (petrofacies) in each EOD was then assigned and the distribution of rock types was modeled geostatistically using Gaussian random function simulation.
In the Pool 3 reservoir model, petrofacies were predicted by integrating core-based lithologic descriptions and log-derived total porosity and shale volume using Geolog's Facimage software. Target percentages of each petrofacies were then assigned to EOD's and populated geostatistically in the model. Cemented intervals were identified from a combination of density and microresistivity logs at the wells and populated geostatistically in the model. Reservoir facies were not defined in the Avalon in these models."

32. A paleogeography map for the Jeanne d'Arc formation is to be provided.

Hebron Response #32

Added new Figure to Section 2.2.2.3.10:
Figure 2.2-30: Jeanne d'Arc Formation "B" Sand Paleogeographic Map

33. The petrophysical criteria and log-cut offs used to define the Jeanne d'Arc reservoir facies should be provided in a format similar to Table 2.2-1 page 2-42.

Hebron Response #33

The following text and tables were added to Section 2.2.2.3.11:

Reservoir facies were defined for the Jeanne d'Arc H reservoir by binning the FZI porosity versus permeability relationship described in the following table.
Table 2.2-2: Jeanne D'Arc H Sand Facies

Reservoir facies were defined for the other Jeanne d'Arc reservoirs using the following petrophysical cutoffs:
Table 2.2-3: Jeanne D'Arc Other Sands Facies

34. A depth migrated or converted seismic volume or Petrel velocity model is required.

Hebron Response #34

Information requested provided as Part II document.
Latest average velocity model (VM10) - separate Petrel project. This velocity model is NOT available to the general public and is labeled privileged / confidential.
-- Avg_velocity_model.pet (submit as Part II)
-- Avg_velocity_model.ptd (submit as Part II)
NOTE: Our Geophysical Applications Group has prepared a short list of comments regarding the use of this Vavg model to accompany the model itself.

35. The resolution and scale of seismic sections is insufficient to determine character of interpreted horizons and surface well ties. For example, in Figure 2.4-2, log character, or the well picks, cannot be distinguished.

Hebron Response #35

Figure 2.4-2 has been deleted and text modified to read that a representative well tie is displayed in Figure 2.4-1.

36. The top and base Avalon seismic horizon interpretation in time and depth (ASCII format) should be provided.

Hebron Response #36

Given our definition of the Avalon Fm (top=base BenNevis, Base=base Amarker), these seismic horizons have already been provided in our previous submission to C-NLOPB in July, 2010.

37. The fault interpretation at the Jeanne d'Arc level in time and depth (ASCII and Petrel Format) should be provided.

Hebron Response #37

JdA fault polygon file provided as a Part II document.

38. On page 2-76, Fig. 2.4-3 the green and red lines on the map should be defined in the caption.

Hebron Response #38

(now Figure 2.4-2) The following text was added as a note in the caption:
Bold green and red lines represent fluid contacts (red=gas-oil, green=oil-water).

39. Section 2.4.3.7.3 – there appears to be an inconsistent use of the acronym "low water large tide" (LLWLT). Later in the text, reference is made to LLWT. Is this the same reference?

Hebron Response #39

The following correction has been made to the text:
Water depth at the proposed GBS location is 92.5 m LLWLT.

40. It appears that the caption for Figure 2.4-23 does not accurately depict what is in the figure. Please clarify.

Hebron Response #40

Figure 2.4-23 is now Figure 2.4-22
Revised caption:
Seismic SW-NE traverse through the Hebron I-13, West Ben Nevis B-75, Ben Nevis L-55 and Ben Nevis I-45 wells. *Caption Note: Figure illustrates shallow amplitude anomaly at approximately 850 ms at H3 horizon. Line of section is shown in Figure 2.4-23.*

Figure 2.4-24 is now Figure 2.4-23
Figure replaced with updated text, symbols and line of section to figure. Revised caption:
Relative Amplitude on H3 Horizon. *Caption Note: This figure illustrates line of section shown in Figure 2.4-22*

41. Page 2-84, Fig. 2.4-14: Provide a gas-down-to contact for the Ben Nevis Block on this map.

Hebron Response #41

Figure 2.4-14 is a depth structure map of the top of the upper Hibernia. This zone tested water as deep as - 4169 ssTVD.

42. Net pay isopach maps for Pools 1, 4H, 4B and 3 should be provided.

Hebron Response #42

Added in Section 2.5:
Figure 2.5-3: Pool 1 & 2 Isopach of Net Pay Map
Figure 2.5-7: Pool 5 Isopach of Net Pay Map
Figure 2.5-11: Pool 4 H-Sand Isopach of Net Pay Map
Figure 2.5-15: Pool 4 B Sand Isopach of Net Pay Map
Figure 2.5-19: Pool 3 Isopach of Net Pay Map

43. A net pay isoporosity map for Pool 4H is required.

Hebron Response #43

Added Isoporosity map (Figure 2.5-10).

44. Page 2-104, Fig. 2.5-6 and page 2-108, Fig. 2.5-11: Both maps have a legend labeled "Thickness", when it should be "% porosity".

Hebron Response #44a

Figures updated. Figure 2.5-11 now Figure 2.5-14

A hydrocarbon pore volume map of Pool 5 should be provided.

Hebron Response #44b

Added in Section 2.5.
Figure 2.5-8: Pool 5 Hydrocarbon Pore Volume Map

45. Copies of all maps are to be submitted to the Board in digital form (ASCII format or high resolution format) so that they can be reviewed in detail. Color scale for some isochore and HCPV maps is insufficient - for example Figure 2.5-14 has no color variation.

Hebron Response #45

Information requested provided as Part II document.

46. Tables in the Hebron Development Plan are required in a digital format other than jpeg to facilitate analysis by Board staff. MS Excel format would be acceptable.

Hebron Response #46

Information requested provided as Part II document.

47. a. The workflow for Pools 1, 2 and 3 geological models need to be described in more detail similar to the GOCAD Earth Model reports for Pools 4 and 5 that are in the Part II document. The workflow reports for Pools 1, 2 and 3 should address the following points:

- Discussion on base, low and high cases, including a detailed explanation of the methodology, parameters, and statistical populations.
- Discussion on the five rock types, including how they relate to the six lithofacies, 4 petrofacies and 6 EODs defined in Section 2.2.2.1.2
- EOD maps should be included for each zone.
- Discussion on the porosity trends for each rock type and how they were estimated.
- What is the perm/porosity transform? How was permeability modeled? (e.g. what is the algorithim? Is it the same for both fault blocks? Was the permeability co-kriged with the porosity or was it calculated using a porosity model?)
- How are the contacts captured in the model—are they transitional or distinct?

Hebron Response #47a

The applicant is preparing a summary document describing Common Scale model construction. Summary will be available August 2011.

<u>Reservoir Engineering</u>

47. b. Fluid Analysis for Pool 2 in the West Ben Nevis should be provided and discussed.

Hebron Response #47b

Fluids Analysis, saturation functions and SCAL work were provided and discussed as inputs into reservoir simulation studies for the Pools targeted in the initial development phase of the project (Pools 1, 3, 4 & 5 - please refer to Sections 5.1 and 6.2). Pool 2 is not included in the initial development phase and the potential development of this resource is discussed in Section 6.8.2.3 under Contingent Developments. As such, the required simulation studies inputs (fluids analysis, saturation functions and SCAL work) for Pool 2 have not been generated. This will be done as part of a reservoir study prior to making a final development decision for Pool 2. Per the concluding paragraph of Section 6.8.1, "..a revised depletion scheme (including details of any associated studies conducted) will be communicated to and discussed with the C-NLOPB."

48. Reference to the injectivity studies that are presented in the Part II document: Hebron Water Injection Study should be provided. Also, a copy should be provided of the study mentioned in the Part II document Meng et al. "Feasibility Evaluation of Sea Water Injection on Hebron" Nov 2002.

Hebron Response #48

Information requested provided as Part II documents.

49. Saturation functions and SCAL work for Pool 2 in the West Ben Nevis should be provided and discussed.

Hebron Response #49

See comments provided for 47b above.

Reserve Estimates

50. Economic justification for the 30 year field life presented in the production forecasts should be provided.

Hebron Response #50

The 30-year field life is based on the nominal 30-year design life of the Topsides facilities (See response to Comment #9 – see below).

30-year field life was selected for the production forecasts to portray a reasonable expected field life to represent expected production and operations. The actual end of field life will be determined in the future when either the facility life is reached or the economic limit is reached. The facility design basis is 30 years for the topsides and 50 years for the GBS but the final facility life will be dependent on actual conditions of service over the field life. The economic limit will occur when the revenue from the produced fluids falls below the cost of operations of the field and will be impacted by oil price, production rates, operating costs, taxes and royalty rates. The end of field life will trigger abandonment and decommissioning of the field, which will be done in accordance with applicable regulatory requirements.

51. In-place estimates have only been provided for oil. In-place gas estimates distinguishing between solution gas, gas-cap gas and non-associated gas for each of the pools is also to be provided.

Hebron Response #51

In-place gas volumes have been added to the associated tables in Section 5.

52. Oil reserve estimates have been presented. Gas and NGL resource estimates are also to be provided for each pool.

Hebron Response #52

Gas resource estimates will be provided as part of the response to Comment #51. Gas reserves are not applicable, as the initial phase of the development does not currently include gas sales.

53. The information that was used in Excel and @risk software should be provided for each pool. Sensitivity value ranges for each of the parameters that impact the reserve estimates should also be provided.

Hebron Response #53

Information requested provided as a Part II document. However, we do not have values for the Chevron prepared models (Pool 3, 4 and 5).

54. The reserves estimates for each alternative production scenario should be provided.

Hebron Response #54

This information is not readily available as the GBS development option was selected nearly ten years ago. However in selecting a final development concept there were many factors that were considered including reserves, field life, economics, execution certainty and local content. The GBS option was determined to be the best development concept when all of these factors were taken into consideration.

<u>Reservoir Exploitation</u>

55. The base case list of drilling well sequence together with the rationale should be provided. This information should be supplemented with a map showing the well location in each block or pool to illustrate the proposed drilling sequence.

Hebron Response #55

Information requested provided as Part II document.

56. The Prosper inputs/results for different tubing sizes to understand the sensitivities of sizes and well inflow is required.

Hebron Response #56

Information requested provided as Part II document.

57. A description of future well workovers in terms of type of completions and a base case estimate of their frequency should be provided.

Hebron Response #57

It is anticipated that both rig based and non-rig based workovers will be employed for the Hebron Project.

Rig workover frequency is based on the anticipated reliability of the proposed completion techniques, and/or the need to alter the producing configuration to improve resource recovery. While full details of these workovers have yet to be developed, they may include workovers to alter the tubing design, or install isolation assemblies to modify the producing profile. Workovers to sidetrack existing wellbores are anticipated to utilize slots for increased recovery opportunities when possible.

Non-rig workovers are anticipated to be more frequent in nature than rig based workovers, but with reduced scope. Gas lift valve modifications, setting of isolation systems, retrieval of isolation systems, and re-perforating are all examples of techniques that may be utilized. Frequency of operations will be dependant upon many factors. Reservoir response, wellbore reliability, and inflow performance relationships will all influence the timing and quantity of operations required. However, operations will be conducted in a timely manner to maintain wellbore integrity and maximize recovery of the Hebron asset.

58. The reservoir simulation results of the impact of production rate(s) on ultimate oil recovery are required for each pool.

Hebron Response #58

Information requested provided as Part II document.

59. Section 6.5.2: Pool 3 Base Case Depletion Plan discusses the three approaches being considered for development. The applicant has mentioned it is currently being studied. The timing of completion of this study should be discussed.

Hebron Response #59

The preliminary study of Pool 3 development options is based upon the geologic and reservoir studies included in the Development Plan. Additional studies to further define the Pool 3 design basis including cost and schedule estimates are anticipated to be complete in 2012.

60. The timing and approximate location for an appraisal well to initiate the development approach for Pool 3 should be provided.

Hebron Response #60

Per Section 6.5.2 of the Development Plan, the appraisal well option is one of three options being considered for the development of the Pool 3 resource. The Hebron Project has not yet made a decision to pursue the appraisal well option for Pool 3. If this becomes the preferred development approach, the timing and location of the appraisal well will be communicated to the C-NLOPB.

61. Production forecasts for oil, gas and water for each of the pools should be provided in MS Excel format.

Hebron Response #61

Information requested provided as Part II document.

62. The oil, gas and water production forecast for each well for each of the pools should also be provided in MS Excel format.

Hebron Response #62

Information requested provided as Part II document.

63. "Gcf" is referenced in section 6.8.2.6. Please define.

Hebron Response #63

Gcf – billion cubic feet (of gas) – updated document with definition.

64. Figures of reservoir simulation models (such as Figure 6.2-1) need to include reference points such as north direction, well locations and layer depth.

Hebron Response #64

Figures 6.2-1, 6.3-1, 6.4-1, 6.4-2 & 6.5-1 of Part I updated.

65. Additional figures of reservoir simulation model base case results for each of the Pools should be provided, such as cross sections north-to-south or east-to-west, top of reservoir unit and bottom of reservoir unit. As well, time sequence snapshots of base case should be presented at time t=0, t= 5 years, t= 10 years and t =30 years to understand sweep efficiency.

Hebron Response #65

This request is related to the technical assessment of the depletion plans proposed and is better handled during technical review phase of the submission. It is not a requirement for document completeness.

66. Maps showing the most likely areas for each of the discovered resources and potential prospects listed in the report are required.

Hebron Response #66

An assessment on the discovered resources described in Section 6.8 (Contingent Developments) has not been performed. The Operator is preparing maps similar to those shown on pages 2-17 to 2-21 (Figures 2.2-1 through 2.2-5) which depict prospective areas based on available data. Maps will be available in August 2011.

<u>Drilling and Completion</u>

67. The applicant states that 41 wells are necessary to fully exploit the resource for the main reservoir. A three dimensional map of the well locations shown in Figure 7.1-1a and Figure 7.2-1 should be provided.

Hebron Response #67

A three dimensional map of all wellbores is in development as part of the work plan but not currently available. Once such work has been completed, it can be forwarded as requested.

68. Section 7.1.6.2 discusses multi-function well bores; please provide more information on the types and use of these well bores in the context of the Hebron project.

Hebron Response #68

There are currently three types of multi-functional wellbores envisioned for Hebron, as referenced in sections 7.1.6.1 and section 7.1.6.2.

The first involves water injectors that are capable of supporting gas injection. This provides a redundant injection mechanism in the event primary gas injectors are unavailable. These wellbores will be designed to ensure both operating envelopes (gas injection and water injection) are supported by the final design.

The second type of multi-functional wellbore involves gas injectors that are capable of gas production. This provides the facility the ability to produce gas back from the injection zone when facility gas requirements exceed gas available from production.

The third type of multi-functional wellbore involves water injection wellbores that are capable of supporting annular cuttings re-injection. These wellbores would have non-aqueous drilling material (fluids and cuttings) injected into an approved disposal zone via the annulus of the wellbore. Water would be injected into the producing reservoir via the tubing.

69. The Development Plan references non-aqueous based drilling fluids. The type of drilling fluids being considered should be provided.

Hebron Response #69

There are currently two types of drilling fluids anticipated for Hebron; water based fluids and non-aqueous fluids. While formulations are still under development, water based fluids utilize fresh water or seawater as a base fluid, depending on hole section and interval exposed. Non-aqueous fluids would utilize industry standard fluids such as Petro Canada PureDrill IA35LV, a synthetic isoalkane commonly used in drilling mud and in current use in Eastern Canada.

Development and Operating Cost Data

70. Any quantitative economic assessments performed in respect of the alternatives described in Table 1.8-1 should be provided.

Hebron Response #70

The information is not readily available as the GBS development option was selected nearly ten years ago. However in selecting a final development concept there were many factors that were considered including reserves, field life, economics, execution certainty and local content. The GBS option was determined to be the best development concept when all of these factors were taken into consideration.