REVIEW OF EXXONMOBIL CANADA'S 2007 OFFSHORE ENVIRONMENTAL EFFECTS MONITORING REPORT

Context

DFO Maritimes Science was asked by the Oceans and Habitat Management Branch to review ExxonMobil Canada Properties Inc.'s 2007 annual report "Offshore Environmental Effects Monitoring Program ExxonMobil Canada Properties – Sable Offshore Energy Project" (Amec and Hurley Environment Ltd. 2008) on 8 April 2008. In addition, ExxonMobil's Environmental Effects Monitoring (EEM) proposal for 2008 was provided for comment in early May. Given the short timeline to prepare a response, DFO Maritimes Science determined that a Special Science Response Process would be used. Environmental Effects Monitoring Reports for the Sable Offshore Energy Project have been reviewed by DFO Maritimes Science in previous years (e.g., DFO 2007).

Background

The Sable Offshore Energy Project's (SOEP) EEM Program was designed to evaluate predictions made during its Environmental Assessment (EA) process. The scale and scope of this environmental effects monitoring program has been reduced over time. In 2007, the proponent monitored contaminants/tainting by examining produced water chemistry and toxicity, seabird and air quality monitoring, mussel hydrocarbon body burden and sediment chemistry and toxicity. This Science Response includes the DFO Science review of monitoring results for produced water chemistry and toxicity, mussel hydrocarbon body burden and sediment chemistry/toxicity. Environment Canada generally reviews monitoring results for seabirds and air quality.

Analysis and Responses

General

More integration and synthesis of information is required. The current report is basically an inventory of 2007 results, and an overall synthesis of conclusions based on monitoring from previous years is lacking. This makes it difficult to determine whether the results of this EEM program have addressed its stated goals and objectives, i.e., whether mitigation has been effective and environmental assessment predictions have been verified. However, subsequent monitoring reports could better describe and/or display the trends in monitoring results and discuss how these trends compare to predictions and/or end points.

DFO provided supporting data to this report from a 2007 research expedition with the *CCGS Hudson*, and these data are useful in supporting the EEM monitoring studies conducted by Industry. However, a more collaborative approach with data collection and processing by industry would reduce duplication of effort and overall costs for sample collection and chemical analysis between our respective programs (both monitoring and research). Further, results obtained from the DFO platform and industry sampling would be directly comparable, and would

allow interpretation of the data at a higher level of resolution (e.g., gas chromatography-mass spectrometry (GC/MS) analysis of hydrocarbons). This would also provide a means to compare the results of emerging toxicity tests, which may be more ecologically relevant (e.g., chronic tests) than the current suite of standard toxicity assays (typically acute toxicity assays).

In addition, details on analytical methods are lacking in many cases. This does not allow the rigor of the testing to be evaluated. Sampling design is also lacking for most studies. As a result, few conclusions can be drawn. Numerous occurrences of "(Error! Reference source not found)" are seen throughout the document.

Benthic Habitat and Fish Density

No progress was made in this area due to problems with the remotely operated vehicle (ROV) support vessel. It is recommended that this activity be included in the 2008 EEM plans.

Produced Water Chemistry and Toxicity

In 2007, produced water samples were collected from Thebaud, South Venture, Alma and Venture platforms. 96 hour toxicity was evaluated using three tests - threespine stickleback, Microtox and sea urchin fertilization.

Hydrocarbon analysis of produced water is restricted to total petroleum hydrocarbons. The concentration of individual polycyclic aromatic hydrocarbons (PAHs) should be determined for interpretation of toxicity data. For example, comparison between produced water collected from the line before discharge with that in the water column may provide insights on evaporative loss of significant toxic fractions.

There appears to be a lack of standardization in sample handling (e.g., storage time and extent of sample aeration) for produced water samples used in the toxicity tests. DFO studies have shown the influence of chemical kinetics on the toxicity of produced water. Hydrolysis metals that precipitate out of solution may sequester both hydrocarbons and potential toxic metals. Descriptions of produced water analysed in the toxicity tests range from a clear liquid to opaque and range in color from yellow, orange and red. This may be due to differences in sample handling that altered the extent of precipitation of iron. Further, in one sample, it was noted that there was a "film" on the surface of the produced water sample. It was unclear how the potential effects of this material were incorporated into the toxicity assays. Also, it would have been useful to know whether it had a petroleum odour or that of phenols.

Lethal concentration 50 (LC50) analyses of produced water indicates that levels as low as <1% can have deleterious effects. However, the importance of this value depends on the quantity of produced water generated over time, which is uncertain. It was noted that the concentrations of the various chemicals in the produced water varied over time, but this factor was not considered in the toxicity analysis. This factor alone may be responsible for changes in LC50 for the various tests. A more comprehensive analysis incorporating the monitored chemicals as covariates is recommended.

In the toxicity tests, it was noted that "observed mortality levels were possibly caused by polyaromatic hydrocarbons even though measured TPH (Total Petroleum Hydrocarbons) levels were below regulatory limits and phenol concentrations were below concentrations known to be lethal to fish. There is also speculation regarding the influence of salinity. Potential toxic metals

and physical effects of particulates may also be a consideration. Time-series trends in produced water toxicity should be followed up in future EEM programs.

The description of analytical techniques used to determine the chemical composition of the produced water is incomplete (e.g., for organics – "Methods and method summaries of analysis are available upon request"). It would be useful to know what the resolved individual components and their detection limits are.

While SOEP's 2007 EEM program on produced water chemistry and toxicity was an improvement over that seen in 2006, questions still remain regarding potential impacts and effectiveness of mitigation.

Mussel Body Burden

Studies on the mussels are non-conclusive due to the selection and quality of chemical analysis utilized. If standard 4-cm solid phase extraction cartridges were used, reliable detection of polycyclic aromatic hydrocarbons is probably not possible. More evidence than gross observations of the profile is required to verify the association of resolved aliphatic hydrocarbons with biogenic species (e.g., ratio of even/odd numbers). In regards to Figure 6.2, sharp well defined peaks of aliphatic hydrocarbons can be observed with petroleum hydrocarbon species.

Underwater Noise and Marine Mammals

The 2007 report states the 'Underwater Noise' component of the EEM is not applicable. The EA prediction stated that "Underwater noise from construction activities or from platform operations will not be above ambient noise levels in the Gully". However, the rationale given for a lack of applicability was "Noise associated with drilling and production activities was shown to have minor contribution to the overall noise field and estimated to be well below the prolonged noise threshold level known to induce behavioral responses in marine mammals and sea turtles". Note that the original EA assertion and the reason cited for current non-applicability are quite different.

It is unclear from the current report as to what industrial activities might have occurred in 2007. If noise production was limited to routine drilling and normal production activities, the original EA assertion would stand. However, if activities such as 'pile driving' occurred in 2007 (as was the case in 2006), a monitoring program should have been implemented.

Fish Health

The 2007 report lacked a credible fish health component. While some monitoring occurred in 2007, a more systematic approach to monitoring indicator responses is required, similar to that conducted on the Grand Banks and Europe. It was not clear how the DFO summer groundfish survey could be used to evaluate fish health as no protocol was provided.

The biological component of the EEM program on the Grand Banks includes (a) sediment bioassays (b) benthic community structure, and (c) fish health, as assessed by early warning health effect indicators (namely mixed-function oxidases or MFO) and histopathology. This is in addition to fish morphometrics (e.g., age, fish and organ condition). This approach, which is supported by water and sediment chemistry, is in line with recommendations made by the Oslo-Paris Commission over a decade ago as a "core" for biological monitoring programs in general –

with the understanding that new components might come on line in accordance with new research and validation. This is also the approach found in many formal and informal programs since then (with selected “add-ons” depending on purpose). Fish contamination and tainting, which is of major socio-economic importance, is also a core component of EEM on the Grand Banks.

Health effect indicators are recognized to be an important component of fish health studies since fish morphometrics alone, such as change in fish and organ weights, can be insensitive indicators of fish health problems due to their timescale for occurrence. They can also be highly variable in relation to feeding providing considerable potential for type 1 or type 2 errors. Furthermore, animals injured at a site in the short term may suffer unrecognizable mortality, suffer mortality after moving away from the site, or be rapidly removed by predation with the niche being rapidly filled by fish in good condition. Thus, fish in “good condition” might be commonly obtained at any specific sampling site near an effluent, resulting in a situation with considerable potential for type 2 errors.

Overall, the use of fish morphometrics alone (as recognized by various agencies) can present major problems in EEM programs, even in small bodies of water such as brooks, rivers and lakes. This problem would be greatly magnified on the open sea where major/catastrophic impacts would likely have to occur before they could reasonably be linked to a contaminant cause. It is important to note in this regard that cod condition varies naturally over quite small geographic areas in the offshore.

The use of health effect indicators can be a critical supplement to use of fish morphometrics, especially in the offshore. Biomarkers are also especially valuable for diagnosing unanticipated health effects, and providing information on their geographical reach. ICES and other agencies have been a major driving force for use of indicators in biological monitoring, and such indicators are being used extensively in various countries. It is also important to note that biomarkers are a powerful tool for providing assistance in “disproving” as well as “proving” whether contaminants may be having effects on fish health. For instance, perceptions or concerns about population-level effects around oil development sites would have little scientific credibility in the absence of no or limited evidence for early warning health effects.

It should be noted that the fish health and tainting studies on the Grand Banks were implemented along with other components after considerable consultation and input by advisory groups and workshops. Fish health and tainting components were specifically included so that regulators and industry would be in a position to address any questions arising in these two important areas.

Transplanted mussels can provide general information on water quality, but they are of limited value or ecological relevance for addressing questions on whether fish health in and around the production platform is being affected or not. Sediment and water chemistry can often provide more useful information in this regard. Furthermore monitoring of toxic effects on mussels can be greatly confounded by the effects of suspended particles. If mussels, scallops, lobsters, etc. are found naturally in the area, there could be valid scientific and/or socio-economic reason to assess potential zones of impact on these species.

Plume validation in itself is always a useful exercise but may be of limited value unless an extremely large sampling program is carried out over a fairly broad geographic area at varying distances in the water column and under different wind conditions. Information on chemical concentrations alone would have limited biological value since there are no dose-response studies available to translate into potential effects on the health of fish or other organisms.

Thus, one will still have the “so what” question in relation to potential biological effects and field work for effects will still be required.

Overall, continuation of 2005 fish health studies is recommended, particularly since MFO activity was noted to be higher in fish around the site at this time. This induction was small, but cod do not typically display large levels of induction on exposure to production water and petroleum, so this initial observation might be providing an important signal in relation to potential chronic effects. Bile can be collected for hydrocarbon metabolites as a "cross reference" for MFO. It is important to note that MFO and the various types of liver and gill histopathologies cover a spectrum of exposure time frames.

If age and fish condition are to be measured, a decent sea-balance and stable platform would be required for “small fish”, but large fish can be reliably assessed for any significant difference in fish condition. Liver volume rather than weight could be assessed before sample fixation for histology. Gonad volume could also be assessed if they are not running. However, logistics at sea can be difficult, and fish condition and age will give a pretty good idea of important morphometrics, with the biomarker and histopathology studies presenting a greater overall scientific reliability on whether platform related effects are occurring in fish at the site.

Sediment Chemistry

As recommended in the 2006 review of the SOEP EEM, DFO and the proponent co-operated on the collection and analysis of sediment samples at the Thebaud Platform and the Gully. The Thebaud samples were collected with a specially designed corer from the *CCGS Hudson* at stations that have previously been sampled with the same technology. In both the 2006 and 2007 programs, samples have been normalized to aluminum (Al) to remove the effect of grain size. This new method has improved our ability to evaluate if levels of metals in the sediment exceed baseline. The values reported are consistent with those collected previously by DFO and show that only barium (Ba) is elevated at stations within 500m of the platform. Gully samples were collected in the same manner and metals analysis was interpreted with respect to baseline levels determined using Al normalization.

Co-operation with DFO and the application of new sampling methods has improved our interpretation of sediment metals concentration and confirm earlier results from sediment monitoring. Efforts should be made to include sampling with the Slo-corer in future monitoring.

Thermal Discharge Monitoring

Monitoring of the compression platform cooling water discharge above ambient could not be completed due to the unexpected loss of nearly all temperature recording devices.

Proposed 2008 EEM Monitoring Plan

Operational difficulties prevented collection of data in 2007. For 2008, it is proposed to revisit the activities which could not be completed. ROV survey video will be used to estimate densities of commercial fish and snow crab in the vicinity of the platforms and subsea pipeline. As well, another attempt to characterize the thermal plume from the compression platform is proposed.

Monitoring activities proposed to be continued in 2008 are toxicity studies on produced water, as well as mussel hydrocarbon body burden. For both of these activities, it is recommended that deficiencies identified in this review be addressed in the 2008 EEM monitoring program.

Monitoring of sediment chemistry and toxicity is to be discontinued. Based on the findings of the 2007 studies and that of previous years on sediment chemistry, it appears that analysis does not have to be conducted on an annual basis as rapid changes are not occurring, toxicity values and chemical concentrations are generally within the range of baseline values.

Summarization of fish health indices is mentioned in the plan for 2008, but it is not clear what information would be summarized.

Conclusions

SOEP's 2007 EEM report is an improvement over that seen in 2006, particularly regarding the investigation of chemistry and toxicity of produced water and sediments. It is encouraging to see that many of the recommendations from the review of the 2006 report have been incorporated.

However, a serious shortcoming in the SOEP's monitoring is the failure to address fish health and fish quality issues. In similar monitoring programs from other areas (Grand Banks, Europe) biomarkers are seen as an important tool in proving or disproving whether oil development is having an effect on fish. The monitoring approach to date does not allow this. It is hoped that this improvements can be made in this area for 2008 and beyond.

A number of analytical issues have been raised regarding the chemical composition and toxicity testing of produced water. These issues must be addressed if the results are to be interpreted in a meaningful manner.

Finally, it is recommended that SOEP develop a reporting format for the EEM results that would allow routine comparisons across years for monitoring components which are collected annually.

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Sources of Information

AMEC, and Hurley Environment Ltd. 2008. 2007 Annual Report Offshore Environmental Effects Monitoring Program. Submitted to ExxonMobil Canada Properties – Sable Offshore Energy Project by AMEC and Hurley Environment Ltd. on behalf of ACCENT Engineering Consultants Inc.

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