Review of Cairn *Oil Spill Prevention and Contingency Plan* (OSCP), Exploration Drilling Programme – 2011 Greenland

Professor Richard Steiner, University of Alaska (ret.), Oil Spill Consultant
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There are several associated documents with relevance to the environmental risk of Cairn Energy / Capricorn's 2011 exploration drilling programme off Greenland (e.g., the EIAs, the NERI Oil Spill Sensitivity Atlas for Greenland, Ocean Rig Operations Manual, etc.), and I have had access to, and have reviewed, *only* the Oil Spill Prevention and Contingency Plan (OSCP). One important procedural comment: If this OSCP was indeed just made public last week (mid-August), which is well into the drilling season, then it is obvious that the public has not had an opportunity to review and comment on the plan prior to drilling. This should be considered unacceptable for any corporate or governmental policy on public transparency and engagement. In the future, it is my sincere recommendation that any and all plans be made available publicly, and open for comment, well before any drilling takes place. Based upon my brief review of this OSCP, below are some brief comments.

Overall, I find the OSCP lacking in its three primary focal areas: spill prevention, well control, and spill response. With respect, I find it surprising that the government of Greenland would approve the Cairn/Capricorn Greenland 2011 drilling programme based on this document. The OSCP is not complete, and does not provide sufficient detail with which to judge the safety of the projects, or the potential effectiveness of an emergency response. The Plan asserts that the Bureau of Minerals and Petroleum (BMP), the UK Well Inspector, Det Norse Veritas (DNV) and independent External Peer Reviewers have reviewed and approved the design and equipment for each proposed well. As well, the plan asserts that all aspects of the programme meet or exceed all new U.S. offshore drilling rules. However, as the OSCP provides no details to substantiate these assertions or the independent reports, it is simply not possible to judge the safety of the designs and equipment based on this document alone. As well, the OSCP makes many questionable assumptions in its discussion of spill risk and response. The OSCP dramatically understates the potential size and impacts of a blowout from one of these four wells, and it dramatically overstates the potential effectiveness of any spill response. Unfortunately, this is typical of oil industry assertions made in order to gain approval of offshore development proposals. Yet it is imprudent to base risk mitigation and response planning upon such overly optimistic assumptions.

Given the extreme ecological sensitivity of the coastal environment of west Greenland, the high risk of exploratory drilling in deepwater reservoirs, and the difficulties in drilling in Arctic waters, I feel Greenland deserves a much more deliberate, comprehensive, and carefully developed spill prevention and response plan.

Spill Prevention / Well Control

The Gamma B, LF7-C (Lady Franklin), and AT7-A (Atammik) wells are all in very deep water, and thus carry significant additional risk over shallow water drilling. Indeed, at 1,520 meters of water depth (4,987 feet), Gamma B is as deep as the Macondo wellhead in the Gulf of Mexico. And not knowing for certain the depth and pressures of the reservoirs beneath the seabed (they anticipate target zones between 8,000 m - 13,124 m, and worst-case reservoir pressure at 10987 psia, but will not know until the well is drilled), it is impossible to judge risk from this document alone.

The risk reduction standard used in the OSCP - "As Low As Reasonably Practicable" or "ALARP" - is not sufficient for such risky operations in such biologically sensitive environments. The risk reduction standard should be elevated to "As Low As Possible", or

ALAP. ALARP implies that more costly risks will be left to chance, and this is unacceptable for a region as sensitive as west Greenland / eastern Canada.

It would be useful for the OSCP to contain a complete casualty history for both Ocean Rig Driller and Capricorn Greenland. This could help judge the credibility of their assertions regarding safety. And responsibilities between Capricorn Greenland (the subsea wells) and Ocean Rig Driller (the wellhead, risers, and rig) may cause problems, and this needs much more elaboration.

The OSCP asserts that there is rigorous process in place, but it does not detail the exact design of each well planned. To judge the safety of the well designs, it should present results for each well design and piece of equipment by the External Peer Review, the BMP review, the Major Hazard Assessment (MHA) by Det Norsk Veritas (DNV), and the UK Well Examiner report. However, the OSCP does not present any information on these systems-critical independent reviews.

There is a great deal left out of the well control section, that would be necessary in order to judge the well design effectively: for instance, the exact BOP design and history or repair and maintenance, how many centralizers will be used to keep the well string centered for a good cement job, what casing liner and tie back will be used, the precise cement slurry formulation, the negative pressure test protocol, and so on.

The well control section of the OSCP is essentially a general textbook well drilling discussion, but all of this is meaningless unless it is all strictly implemented and enforced. The plan does not contain a detailed discussion of blowout control, e.g., whether or not they would use the Marine Well Containment System (MWCS) developed in the U.S. to cap a blowout at the wellhead. It simply states that: "well capping equipment shall be airlifted to Kangerlussuaq…." And it states that this well capping equipment "has been designed and built to incorporate the BOEMRE recommendations." Yet it does not discuss exactly what this capping equipment is. As was seen in the attempts by BP to cap the Macondo blowout, the equipment must be pre-designed, tested, and ready for deployment.

The subsea dispersant protocol is so general as to be of questionable utility. This needs far more elaboration.

That they will have two rigs near each drill site – the Corcovado and Leiv Eiriksson – is an effective safety protocol to speed the drilling of a relief well in the event of a blowout, but the public should see the specifications for these rigs, and these are oddly blacked out. I see no reason for this.

The drilling operation window at Lady Franklin and Atammik until Dec 1 seems too long to provide an adequate a margin of safety before the winter season. If they had a blowout in mid-November, it would take until January, or longer, for the other rig to intercept the failed well with a relief well, and in my judgment, that is too far into the winter season. I recommend the drilling window be shortened by one month – to November 1 - for the southern well sites.

The OSCP ice management discussion is good, but they should conduct a practice drill attempting to tow one of the larger icebergs possible, upwards of 10 million tons. The plan does not detail the towing characteristics of the tugs on standby, e.g. engine horsepower, bollard pull, etc., thus it is impossible to know their towing / pushing capability for large icebergs.

Time anticipated to complete a relief well is taken from "another very large operator," and estimated to be 16 days for an 8,000 feet deep well, and 34 days for 14,000 feet deep well. But there is no substantiation of this relief well drilling time in the OSCP. This seems conjectural, rather than a rigorous estimate specific to Cairn's projects. Given recent experiences in deepwater relief wells in more hospitable conditions, 34 days to intercept a failed well with a relief

well seems overly optimistic. The relief well for the Deepwater Horizon blowout took 4 months to intercept and conduct a final kill of the failed Macondo well. The relief wells drilled for Macondo were ordered to disconnect for weather, and to suspend operations several times, thereby lengthening the total drill time. As well, there apparently are relief well plans, but they are not included in the OSCP. Thus, their adequacy cannot be judged based upon this document.

It is very good that an Independent Well Control Expert (WCE) is assigned to each rig. This individual should make daily reports available to the public.

Regarding the standards for well integrity and well control, the OSCP states the following:

Following the tragic incident in the Gulf of Mexico, industry wide recommendations were developed. Cairn Energy reviewed and confirmed the existing procedures and equipment fully complied with, or exceeded, the Bureau of Ocean Management (BOEMRE) recommendations.

This is an extremely important, yet unsubstantiated, assertion. This assertion needs to be itemized in a detailed checklist, but receives no further mention (Note: some of this may be itemized in the Ocean Rig Operations Manual Section 17: Well Control). The new US (BOEMRE) offshore drilling rules include the following: ensure Blow Out Preventer (BOP) function and Remotely Operated Vehicle (ROV) hot stabs; ensure Emergency Disconnect Sequence (EDS); independent certification of BOP function; independent verification of Blind Shear Ram (BSR) function; ensure lockdown sleeve for casing at wellhead; dual mechanical barriers in addition to cement plugs for final casing string; need to provide schematics for all control systems and control pods; verify that BOP is specific to rig; independent verification that cement formulation and casings are appropriate to the well design; conduct negative pressure test for well integrity; all BOP inspections and maintenance reported; detailed drill fluid displacement procedures; and so on. Further, the provisions in US rules that address well control equipment include:

1. Submission of documentation and schematics for all control systems;
2. A requirement for independent third party verification that the blind shear rams are capable of cutting any drill pipe in the hole under maximum anticipated surface pressure (MASP);
3. A requirement for a subsea BOP stack equipped with ROV intervention capability. At a minimum, the ROV must be capable of closing one set of pipe rams, closing one set of blind-shear rams, and unlatching the Lower Marine Riser Package (LMRP);
4. A requirement for maintaining an ROV and having a trained ROV crew on each floating drilling rig on a continuous basis;
5. A requirement for autoshear and deadman systems for dynamically positioned rigs;
6. Establishment of minimum requirements for personnel authorized to operate critical BOP equipment;
7. A requirement for documentation of subsea BOP inspections and maintenance according to API RP 53, Recommended Practices for Blowout Prevention Equipment Systems for Drilling Wells;
8. Required testing of all ROV intervention functions on the subsea BOP stack during the stump test and testing at least one set of rams during the initial test on the seafloor;
9. Required function testing of autoshear and deadman systems on the subsea BOP stack during the stump test and testing the deadman system during the initial test on the seafloor; and
10. Required pressure testing if any shear rams are used in an emergency.

From the OSCP, it is not clear that Cairn / Capricorn has met all of these requirements, and this must be verified.

Spill Response

The OSCP correctly admits that sea ice will cause failure of booms and mechanical oil spill recovery at ice coverage as low as 10%, and this is an honest admission. As well, the plan admits that low temperatures (below the pour point of the oil) will cause oil to solidify, and make it very

difficult if not impossible to pump. These two admissions underscore the fact that oil spill recovery in ice-covered seas is virtually impossible.

The OSCP states that: "even in the most ideal conditions, recovery rates will never be 100% and are actually more likely to be around 10-20%," but in most spill scenarios in the Arctic offshore recovery will almost certainly not be anywhere near that high. Regardless, this is an honest admission that 80-90% of the oil cannot and will not be mechanically removed from the environment during a spill from these wells.

Dispersants are not effective in many circumstances, for instance if there is much sea ice limiting turbulent mixing. If they work as designed, they transfer oil spill damage from the sea surface down into the pelagic water column, and can accelerate degradation of the oil. But dispersants combined with crude oil can be more toxic than either component alone. It is good that the government of Greenland does not establish pre-approved zones for dispersant use, and will consider their use *only* on a case-by-case basis. But, the OSCP recommends using dispersant in nearshore waters in certain circumstances, while most countries do not permit such. I recommend that dispersants never be permitted for use within 10 km of shore (as with in-situ burning), or anywhere the dispersant/oil mixture may drift nearshore. And offshore, dispersant should only be used in a wind/wave/weather window where sufficient mixing will occur, but natural turbulence alone is not enough to disperse the surface oil (e.g., 10 - 20 knots of wind). And it should only be used on fresh, not emulsified, oil. As *Dasic Slickgone NS* is the only approved dispersant in Greenland, the plan should detail its known contents, characteristics, its toxicity on local organisms, and its effectiveness on the crude oil expected to be encountered. Parts of the Material Safety Data Sheet (MSDS) for this product contained in the OSCP are virtually illegible (particularly the list of its hazardous ingredients), but it clearly does not include information on toxicity to local aquatic organisms, or its expected effectiveness on crude oil. These are two critical issues that must be resolved before application of this product should be considered. In the Gulf of Mexico spill, there were more effective, less toxic dispersants available, but they were not used. Also, many scientists, including myself, do not feel that dispersant application on the Gulf spill was effective.

In most spill scenarios, in-situ burning will almost certainly not be as effective as envisioned in the OSCP. As stated in the OSCP, in-situ burning will be ineffective at more than 30% sea ice coverage, and at emulsification rates (water in oil) of 30% or more. And, the difficulties of ignition, maintaining a burn, dealing with residues, and keeping wildlife away from a burn are not adequately addressed in the OSCP. And the OSCP accurately states that: "residues which sink are difficult to recover." Residue collection is an important issue for offshore in-situ burns, and the OSCP does not adequately address this issue. If in-situ burns are conducted, it is imperative that personnel have PPE protective equipment, respirators, etc.

Regarding shoreline cleanup, the OSCP states: "The coastal environment in Greenland does not facilitate containment, recovery, or protection due to the uneven rocky substrate that prevails in the region." This essentially means that effective oil spill shoreline cleanup should not be expected in a major spill.

Regarding oil spill waste, the OSCP states that: "vast amounts of waste may be generated. In extreme cases, 30 times more waste could be generated than the volume of oil spilled." The OSCP spill waste management plan does not adequately detail this issue.

The OSCP fails to adequately address the enormity of logistic requirements in a large-scale oil spill response. Experience has shown that all large-scale spill responses (e.g. Exxon Valdez, BP Deepwater Horizon, etc.) quickly overwhelm pre-planned logistic capabilities. This should be more thoroughly addressed.

The OSCP fails to adequately address response difficulties in dark, cold, inclement weather of the Arctic offshore and onshore environments in late autumn and winter. This must be more thoroughly addressed.

The discussion of sensitive species in the OSCP is overly simplistic, and dramatically understates potential impacts. For instance, while the OSCP states that: "marine mammals are generally less sensitive to oiling than many other organisms," oil spills have been known to cause extensive injury to marine mammals (e.g. Exxon Valdez in Alaska where several thousand marine mammals were killed). The OSCP does suggest that impacts to narwhal populations "could be significant." On fish impacts, the OSCP states that: "in open seas toxic concentration will seldom be high enough to cause mortality," and this may not be so, particularly to fish eggs and planktonic larvae. The plan asserts that intertidal spawning of Lumpsuckers and Capelin occurs outside of the drilling season, and thus they would not be at risk. But this ignores the likelihood that oil which comes ashore from a spill in the summer / autumn drilling season would almost certainly remain in nearshore areas through the next spawning season, thereby impacting reproduction of these important fish populations. And the OSCP entirely ignores other fish spawning behavior and potential impacts of a spill. The plan does not include a good analysis of impacts on plankton communities. The OSCP correctly states that: "rates of recovery in the Arctic may be slower due to slow growth rates and short reproductive seasons." As well, it states that: "A high proportion of the breeding adult Atlantic puffins and razorbills from important breeding colonies in the outer Disko Bay are likely to be exposed to oil during a spill that reached the area, as are other acids (black guillemot, little auk)." These impacts could be quite severe.

Further, there is no discussion of potential long-term impacts of a large spill, but hopefully such discussion is contained in the Environmental Impact Assessments for the Cairn 2011 drilling projects.

The OSCP does not contain a Wildlife Response Plan -- that is, a detailed plan as to how and where the company intends to handle, clean, rehabilitate oiled wildlife in a spill, such as birds and marine mammals. It is critical to develop this plan before a spill occurs.

The OSCP does not contain a plan to conduct a scientific Natural Resource Damage Assessment (NRDA) in the event of a spill, in conjunction with the government resource agencies.

The OSCP recognizes that oil spilled into sea ice covered waters will become entrained in ice, spread with ice movement over the winter, and remobilize into the water upon thaw. Again, this is an honest admission of the risk of oil spills in Arctic marine environments, and dramatically expands the area of potential impact from a late-season spill. Yet, the OSCP oil spill modeling does not account at all for this transport mechanism.

The OSCP recognizes that " extreme sensitivities exist for most of the coastline," and this must be taken into account for offshore response and shoreline protection. It is questionable whether such risky deepwater, offshore drilling should be conducted off such ecologically sensitive shorelines.

For spill modeling, the OSCP presents a scenario of a 37-day blowout, releasing 5,000 barrels/day, tracked for 60 days. Yet this is far from a worst-case discharge. The OSCP envisions a maximum blowout discharge rate of 5,000 bbls/day, but the assumptions upon which this is based are highly questionable. The plan lists the worst-case maximum pressure expected is 10,987 psia, which is close to what the Macondo well in the Gulf of Mexico produced (12,000 psi). Thus a blowout in one of Cairn/Capricorn's wells could release comparable amounts of oil/day. Further, actual reservoir and wellhead pressures encountered could be higher than anticipated. The Macondo blowout was estimated to have released 62,000 bbls/day at first, declining to about 53,000 bbls/day before being killed, and the oil release continued for about 3 months (85 days). Clearly, the

maximum discharge for the 2011 Cairn/Capricorn wells is 10 – 20 times larger than 5,000 bbls/day over 37 days. I recommend that a spill of 50,000 bbls/day over 60 days, or a total of 3 million barrels, be modeled and used for response planning purposes. This size of spill, while hopefully improbable, is certainly possible.

The OSCP does not discuss in sufficient detail the underwater plumes arising from a deepwater blowout, or their likely ecological effects. These were well documented in Deepwater Horizon, and are confirmed by other studies of deepwater blowouts. The subsea plumes can stabilize at depth, and spread with deep currents in different directions than the surface slicks. The OSCP 3D modeling discusses some aspects of these subsurface plume dynamics, but not in sufficient detail. This should be methodically addressed in the Cairn OSCP.

The OSCP spill modeling shows extensive oiling of east coast of Baffin Island, yet no sensitivity assessment or a collaborative response with Canada is discussed. A spill from any of the four wells would almost certainly cross international borders into Canadian waters, becoming a transboundary spill. The OSCP spill modeling reports "a large section of Baffin Island's eastern coastline experiences shoreline oiling probabilities in excess of 10%," and this would be even more pronounced at the southern drill sites at Lady Franklin and Atammik. Further, using the much larger spill size projection (50,000 bbls/day over 60 days), a spill would travel much further than the current OSCP model predicts. Such a worst-case spill would travel down along Baffin Island to the Labrador coast, Newfoundland, and beyond. The plan should detail relationships with the Canadian government as to how this threat will be mitigated.

The OSCP estimates for cleanup effectiveness are overly optimistic. Yet that the plan estimates that oil to water ratio at the surface would be approximately 75% initially, and 50% later, tends to confirm that much of the oil coming from a deepwater blowout would not be accessible to any recovery effort. And the plan's emulsification assumptions are questionable as well. The OSCP assumes that, while a maximum water content of spilled oil may be 70%, an average water content of only 20% is used, thus deriving an "oil volume requiring cleanup" of only 4,375 bbls/day from a total release of 5,000 bbls/day. Given the long response times actually encountered in major spills, it is far more realistic if a higher emulsification rate is used, say 40% and 60%. These emulsification rates give a spill "volume requiring cleanup" of 8,600 bbls/day and 13,000 bbls/day, respectively. And again, the total release volume should be modeled as much as 10 times the OSCP modeled 5,000 bbls/day. Using these much higher total spill volume estimates, and higher emulsification rates, the 94 m3 / day (about 650 bbls/day) recovery rate appears less significant, and more realistic.

The dispersant effectiveness assumptions (648 m3 / day, or 4,076 bbl/day) are not plausible, particularly in sea ice and with inefficient turbulent mixing. As well, the production capacity of Dasik is reported to be only 50m3/day. The in-situ burn effectiveness assumptions are also not plausible, and the estimated burn rate (541 m3/day, or 3233 bbl/day), are likewise overly optimistic.

Thus, the total amount of oil that estimated to be collected, dispersed, or burned in the OSCP-1398 m3 / day, or 8793 bbls/day – seems unrealistic. But even if this amount were achievable, if one assumes the higher spill rates and volumes discussed above, this amount of oil would still represent only a small fraction (a few percent) of what may be spilled. Thus, it is clear that response to a major spill from one of the Cairn 2011 Greenland offshore wells will almost certainly be ineffective.

It is clear from the OSCP that the drilling permits for Cairn / Capricorn exclude the Greenland government from leading or coordinating a spill response from a Cairn/Capricorn drilling project. The government should clearly retain the ability to nationalize a spill, if a responsible party or their contractors are not performing adequately. But apparently, Greenland Command (the coast guard) is excluded from such. This should be remedied.

It is not clear what financial liability protocol exists in Greenland law to cover spills from the Cairn/Capricorn drilling projects. The CLC and 1992 Fund to which Greenland is a signatory only cover tanker spills, and not offshore drilling installations. This issue should be clearly elucidated, and liability should be commensurate to cover a worst-case discharge. Given that the BP spill in the Gulf of Mexico is likely to cost some $40 billion USD, I would encourage the government of Greenland to establish *unlimited liability* for these offshore drilling projects. As well, ensuring that Cairn/Capricorn has sufficient insurance coverage for a worst-case discharge is important.