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Via Electronic Filing
November 29, 2010

Anne-Marie Erickson
Secretary of the Board
National Energy Board
444 Seventh Avenue S.W.
Calgary, AB T2P 0X8

Dear Ms. Erickson:

Re:	**Arctic Offshore Drilling Review, NEB File: OF-EP-Gen-AODR 01** **Suggested Studies and Preliminary Response to CFI #1 and #2**

On behalf of WWF-Canada, please find attached submissions for the Board's Arctic Offshore Drilling Review.

In response to the Board's letter of October 27, 2010, the attached submissions provide suggestions as to experts and consultants the Board might retain and the information it might seek from them. A timely announcement from the Board as to the studies it intends to commission would be much appreciated to allow us to plan our subsequent work.

In supporting those suggestions, the attached submissions also provide a preliminary response to some of the questions in the Board's September 30 and November 23 first and second Calls for Information (CFI #1 and #2). Please note that WWF-Canada intends to provide a more complete response to these Calls for Information at a later date after the investigation reports on the Macondo and Montara blowouts are released and we have had time to study them.

Yours sincerely,

Keith Ferguson
Counsel, representing WWF-Canada

Arctic Offshore Drilling Review

Suggested Studies and Preliminary Response to CFI #1 and #2

WWF-Canada Nov 29, 2010

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SUBMISSION COVER PAGE

In response to the Board's request dated Oct 27, 2010 ('Information to be Gathered under Contract by the Board'), this submission is organized to suggest a number of studies the Board might commission from experts and consultants that it retains. In order to explain those suggestions, this submission includes preliminary discussion of a number of the issues in the scope of this Review (Board letter Sept 20, 2010) and preliminary responses to some of the questions in the Board's first call for information (CFI #1, Board letter Sept 30, 2010) and second call for information (CFI #2, Board letter Nov 23, 2010). The following table is provided to help identify which issues and which questions each section of this submission primarily relates to.

Section in this submission	*Primary issues in the scope of the Review that each Section relates to*	*Primary CFI #1 and #2 questions that each Section relates to*
2. Chances of a Blow-Out	#1 (potential hazards & risks) #2 (preventing & mitigating risks) #4 (effectiveness of well control)	1.1.2 (management system re: hazard & risk identification) 1.4.1 (well control) 1.5.1(a),(b) (hazards leading to major blowout) 2.2.1(a),(b) (hazard identification) 2.2.4 (human factors and risk) 2.3.2 (pore pressure prediction)
3. Same-Well Intervention Techniques	#6 (regaining well control) #10 (lessons learned)	1.5.1(a),(b) (hazards leading to major blowout), 1.5.1(m) (length of time to bring under control) 1.6.2 (regaining well control) 1.10.1 (lessons learned)
4. Same Season Relief Well (SSRW) Capability	#6 (regaining well control) #10 (lessons learned)	1.5.1(a),(b) (hazards leading to major blowout) 1.6.1 (relief wells) 1.10.1 (lessons learned)
5. Responding to Spilled Oil	#5 (responding to spills) #7 (spill containment and clean-up)	1.5.1(d)-(g),(k) (response capabilities), 1.5.1(h),(j) (differences to Gulf), 1.5.1(o) (oil recovery), 1.5.1(p) (time to clean-up) 2.7.1 (effectiveness of available spill containment and clean up options)

6. Social-Ecological Impacts of Spilled Oil	#3 (state of knowledge of the Arctic offshore) #9 (state of knowledge of spill impacts)	1.5.1(c) (ecosystem components put at risk), 1.5.1(h) (differences to Gulf), 1.5.1(o) (impact on environment) 1.9.1 (state of knowledge of long term impacts) 2.3.1 (unique Arctic environment)
7. Financial Responsibility and Liability	#8 (financing clean up, restoration, compensation)	1.8.1 (financial liability) 1.8.2 (financial responsibility)

1 INTRODUCTION

As recently noted by the US Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE): "Various events around the world as well as the US over the years demonstrate that catastrophic oil spills can and do occur. The costs associated with such spills can be tremendous."[1]

Public confidence in the safety and environmental responsibility of offshore drilling has been shaken over the past year because of the major blowouts and consequent loss of life and environmental damage at the Macondo well in the Gulf of Mexico, and at the Montara well in the Timor Sea off the North Coast of Australia. And just two weeks ago, Norway's Petroleum Safety Authority (PSA) noted that, "only chance averted a sub-surface blowout and/or explosion, and prevented … a major accident" during drilling of one of Statoil's wells in the North Sea Gullfaks field in May.[2]

Public confidence has been shaken not only by such incidents themselves, but also by over-confident statements expressed by industry and accepted by regulators. For example, in discussing potential impacts on fish habitat, the environmental impact analysis (EIA) in BP's *Initial Exploration Plan* for the Macondo well simply stated:

> "In the event of an unanticipated blowout resulting in an oil spill, it is unlikely to have an impact based on the industry wide standards for using proven equipment and technology for such responses, implementation of BP's Regional Oil Spill Response Plan which address available equipment and personnel, techniques for containment and recovery and removal of the oil spill."[3]

And in discussing potential impacts on beaches, on wetlands, and on birds, BP's Plan uses the same simple wording in each case:

> "An accidental oil spill from the proposed activities could cause impacts to beaches/wetlands/shore birds and coastal nesting birds. However, due to the distance to shore (48 miles) and the response capabilities that would be implemented, no significant adverse impacts are expected."[4]

Of course, as we now know, the outcome was very different. WWF-Canada therefore applauds the Board's decision to retain experts and consultants to help it gather the best information for the Arctic Review, and we hope this helps improve the comprehensiveness and independence of the information gathered. The primary aim of this submission is, as invited by the Board's letter of October 27, 2010, to make suggestions as to the information such experts and consultants might gather.

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[1] BOEMRE Drilling Safety Rule, Oct 2010, page 63364.

[2] PSA Notification to Statoil regarding Gullfaks incident, Nov 2010.

[3] BP Initial Exploration Plan for Macondo, Feb 2009, pages 14-4, 14-5.

[4] BP Initial Exploration Plan for Macondo, Feb 2009, pages 14-5, 14-6.

To support such suggestions, this submission refers to a number of recent reports and also to previous industry submissions, in particular those submitted during the aborted same season relief well (SSRW) hearing,[5] to help identify gaps in knowledge and to highlight disputed issues that could benefit from clarification. The suggested studies are presented at the end of each section of this submission, and are summarized in the appendix. The appendix also provides some suggestions on consultants and experts who might be able to carry out some of the studies.

In making such suggestions, this submission will also provide some preliminary responses to the Board's first and second Calls for Information (CFI #1 and CFI #2). Please note that WWF-Canada intends to provide a more complete response to these calls for information at a later date after the investigation reports on the Macondo and Montara blowouts are released and we have had time to study them.

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[5] See *Hearing Order MH-1-2010 regarding National Energy Board Policy for Same Season Relief Well Capability for Drilling in the Beaufort Sea* ("SSRW hearing"). Documents available at https://www.neb-one.gc.ca/ll-eng/livelink.exe?func=ll&objId=594086&objAction=browse&sort=-name.

2 CHANCES OF A BLOW-OUT

2.1 Calculating the Chances of a Blowout

There are varying reports on the chances of a blowout from offshore drilling. BP, for example, stated in their SSRW submission: "With the level of preparation, rigor and assurance which will be applied, a blow-out with release of hydrocarbons is extremely unlikely when drilling an exploration well."[6] And Imperial, in its SSRW submission, stated:

> "The global incidence of blowouts in offshore exploration wells has declined significantly since the NEB [SSRW] policy was implemented."[7]
>
> "Blowouts are very rare for the entire industry as well as for Imperial … the probability of a blowout is low – one in 285,000."[8]
>
> "The probability of a blowout from a deepwater drilling operation in the Beaufort Sea will be exceptionally low, i.e., about one in 100,000 wells or once in 10,000 years [assuming 10 wells are drilled per year]."[9]

The latter claim is based on a study by Det Norske Veritas (DNV) attached to Imperial's SSRW submission (it is unclear where the one-in-285,000 claim comes from). It is important to note, however, that the one-in-100,000 claim does not refer to 'blowouts' in the usual sense of the word (i.e. an uncontrolled flow of oil, gas or other fluids).[10] Rather, it appears to refer to an estimated probability of a blowout not only occurring but also continuing after a number of techniques have been attempted to bring it under control.

The DNV study starts out with an estimated probability of losing control of an offshore well as one in every 190 wells drilled, which is reduced to one in every 500 wells drilled after removing from consideration blowouts for shallow-water wells, shallow gas blowouts, and underground blowouts.[11] Assuming 10 wells are drilled per year in the Canadian Beaufort Sea, this corresponds to an expected rate of one loss-of-control-event every 19 to 50 years.[12]

The DNV study then estimates how this rate declines as additional safety features are considered. The first such reduction, as reported by Imperial, is for "when a BOP [blowout preventer] is used

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[6] BP SSRW submission, Mar 2010, page 17 paragraph 51.

[7] Imperial SSRW submission, Mar 2010, page 1-10.

[8] Imperial SSRW submission, Mar 2010, page 3-4.

[9] Imperial SSRW submission, Mar 2010, page 4-1.

[10] Imperial SSRW submission, Mar 2010, page GL-1, for example, defines 'blowout' in the normal sense as "An uncontrolled flow of gas, oil, or other well fluids into the atmosphere or into an underground formation", and Imperial would presumably include "or into the ocean" for offshore operations.

[11] Imperial SSRW submission, Mar 2010, page 7-11.

[12] Imperial SSRW submission, Mar 2010, page 7-11.

in a loss of well control event,"[13] and this results in an estimate of once every 1,667 wells drilled, and thus an expected rate of once every 167 years (note this first reduction does not appear to be significantly greater because of the additional BOP ram Imperial proposes to use – as Imperial notes, "the six-ram configuration gave only 0.32% improvement in reliability over the five-ram configuration."[14]) It is after this first reduction in risk is made for the BOP that a 'blowout' in the normal sense of the word appears to occur,[15] although it is not entirely clear to us at what point in DNV's and Imperial's calculations hydrocarbons actually start flowing from the well.

The three subsequent reductions in risk reported by Imperial appear to be post-blowout, in that they seek to estimate the effectiveness of acoustic backup and remotely-operated vehicle (ROV) attempts to activate the BOP, and placement of a second BOP stack on top of the first,[16] in order to bring an uncontrolled flow of hydrocarbons back under control. Imperial reports these activities further reduce the probability to one-in-100,000. Note, however, the DNV study Imperial relies upon acknowledges a number of uncertainties in this calculation, such as "the absence of reliability data for Acoustic Backup Systems,"[17] "limited information available on the likelihood of an ROV successfully regaining control of a blowout,"[18] and "limited experience within the industry of installing a second BOP stack on the first to regain well control."[19]

Given that a blowout is apparently already occurring as these techniques are being attempted, it is important to consider not only their effectiveness, but also what might make them unavailable and how long they might take to work. The latter raises important end-of-season questions, such as whether encroaching ice would allow such efforts to continue (similar but separate to the question of how much time would be required for a same season relief well), and is discussed further below on same-well intervention techniques.

In contrast to the above statistics provided by Imperial, in its regulatory changes following the Macondo blowout, BOEMRE provided the following calculations for deepwater drilling on the US federal outer continental shelf (OCS):

> "There have been 4,123 wells spudded between 1973 and mid-2010 not counting bypasses in water depths of at least 500 feet.
>
> "There have been 20 OCS deepwater blowouts in the history of the program with 3 resulting in a spill during drilling operations. Only one deepwater blowout [Macondo] has resulted in a spill of a catastrophic size. The other two deepwater blowout spills were estimated to be 11 and 200 barrels of crude/condensate spilled.
>
> "The 20 deepwater blowouts average one blowout for about every 200 deepwater wells drilled on the OCS. The average number of wells between blowouts increased until about 1990 but has since levelled off at about one for every 275 deepwater wells.

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[13] Imperial SSRW submission, Mar 2010, page 7-8.

[14] Imperial SSRW submission, Mar 2010, page 7-7.

[15] Imperial SSRW submission, Mar 2010, page 7-6 Figure 7-3.

[16] Imperial SSRW submission, Mar 2010, pages 7-9 to 7-11.

[17] Imperial SSRW submission, Mar 2010, Appendix A, page 25.

[18] Imperial SSRW submission, Mar 2010, Appendix A, page 25.

[19] Imperial SSRW submission, Mar 2010, Appendix A, page 26.

> "Using the estimated 160 new deepwater wells that will be drilled annually, a catastrophic blowout spill under current regulations and practices is estimated to be 1 in 4,123 wells. This implies a baseline major spill once every 26 years under current deepwater drilling rates."[20]

Thus BOEMRE calculates a deepwater blowout to now occur once every 275 wells drilled, six times more often than what appears to be the corresponding estimate provided by Imperial (i.e. one blowout every 1,667 wells drilled). Using the assumption of 10 wells per year for the Canadian Beaufort Sea, the BOEMRE statistics estimate one blowout every 27.5 years, not accounting for any potential increased risk factors due to the difficult conditions in the Arctic (which are discussed below).

And in contrast to the significant declines in the rate of blowouts reported by Imperial, BOEMRE concludes that: "The frequency of deepwater well control events (blowouts) that could lead to a spill does not appear to have changed materially over time."[21] BOEMRE continues:

> "Thus, while a greater number of deepwater wells are being drilled in ever deeper water depths, this history indicates that normal evolution of deepwater practices may not have materially reduced the chance of a blowout event. Moreover, a blowout may pose more problems in deepwater where drilling a relief well is likely to take longer."[22]

Finally, to provide what is admittedly only a preliminary and rough estimate for the rate of blowouts in Canadian offshore drilling operations, we note that recent testimony before the House of Commons Standing Committee on Natural Resources referenced the following statistics:

- There have been four blowouts, two in the north and two in Atlantic Canada.[23]
- 355 wells have been drilled in the Newfoundland and Labrador offshore area.[24]
- 207 wells have been drilled in the Nova Scotia offshore area.[25]
- In addition, Imperial reported there have been 85 wells drilled off the North Coast of Canada.[26]

This information indicates 4 blowouts from a total of 647 wells in Canadian offshore waters, or one in every 162 wells drilled, which is of a similar order to the statistics provided by BOEMRE.

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[20] BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 22. Summarized in BOEMRE Drilling Safety Rule, Oct 2010, pages 63350, 63365.

[21] BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 9.

[22] BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 9.

[23] Standing Committee on Natural Resources, May 13, 2010, page 11, testimony of Mr. David Pryce (Vice-President, Operations, Canadian Association of Petroleum Producers).

[24] Standing Committee on Natural Resources, May 25, 2010, page 1, testimony of Mr. Max Ruelokke (Chairman and Chief Executive Officer, CNLOPB).

[25] Standing Committee on Natural Resources, Nov 2, 2010, page 3, testimony of Mr. Stuart Pinks (Chief Executive Officer, CNSOPB).

[26] Imperial SSRW submission, Mar 2010, page 4-7 (Imperial report 37 wells in the northern shallow shelf and 48 wells on the deep shelf, for a total of 85).

Again, assuming 10 wells will be drilled per year in the Canadian Beaufort Sea, this estimates one blowout expected every 16 years.

Of course, all such statistics should be used with care. For example, BOEMRE is careful to note that their new regulations passed in response to the Macondo blowout "will reduce the likelihood of another blowout and associated spill, but the risk reduction associated with the specific provisions of this rulemaking cannot be quantified because there are many complex factors that affect the risk of a blowout event."[27] BOEMRE adds that "the likelihood of a future blowout leading to a catastrophic oil spill is difficult to quantify because of limited historical data on catastrophic offshore blowouts."[28] And although BOEMRE references the DNV study attached to Imperial's SSRW submission, it notes:

> "We have not discovered sufficient data that would allow adapting that methodology to the change in the probability of blowout associated with the enhanced primary well control measures in this rulemaking. Nor have we found other studies that evaluate the degree of improvement that could be expected from enhanced barriers, pressure tests, and a seafloor ROV function check."[29]

In sum, there appears to be a wide range of differing estimates for the probability of a blowout. And care should be taken in the use of statistics concerning blowouts, with appropriate cautions, statistical ranges and confidence intervals provided. We therefore suggest a study below to help estimate the probability of a blowout occurring, and how to properly report on such estimates.

2.2 Possible Additional Risk Factors in the Arctic offshore

Operating offshore in the Arctic presents additional difficulties compared to other areas, and the Beaufort Sea appears to be especially challenging. According to Chevron's Arctic Basin Assessment, which ranked 11 Arctic basins in degree of challenge (based on open water season, pack ice severity index, and iceberg conditions), the Beaufort Sea was the 3rd most challenging basin despite there being no icebergs present, and was topped only by Northeast and Northwest Greenland.[30] And as proposed operations extend further out into the Beaufort Sea, these difficulties are magnified: water depth increases, well depth increases, pressures transition from normally-pressured to over-pressured, well designs become more complex, the length of the open water season decreases, and incursions of multi-year ice increase.[31]

Such difficulties raise the question of whether the risk of a loss-of-control event or a blowout might be higher in the offshore Arctic than elsewhere, and whether the chances of a blowout

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[27] BOEMRE Drilling Safety Rule, Oct 2010, page 63364. BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 5.

[28] BOEMRE Drilling Safety Rule, Oct 2010, page 63365. BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 6.

[29] BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, pages 19, 20.

[30] Chevron Arctic Offshore Relief Well Equivalency presentation, Jan 2009, slide 6.

[31] Chevron SSRW submission, Mar 2010, slide 36; Imperial SSRW submission, Mar 2010, page 4-7.

resulting in a catastrophic spill might be higher.[32] For example, might factors such as the following increase the risk of a blowout in Arctic offshore drilling?

- *Station-keeping reliant on ice management with icebreakers:* For their proposed Ajurak drilling operations, Imperial states that: "Two to four icebreakers will conduct ice management operations around the drillship to help it maintain its position during ice incursions,"[33] raising questions about potential problems related to the icebreakers and their ice management operations, and consequent drillship station-keeping difficulties. Chevron, for example, notes that while "dynamic positioning in open water [is] well proven," "dynamic positioning in pack-ice is possible but not yet proven."[34]
- *Vessel collisions:* In addition to the icebreakers helping the drillship maintain position, Imperial notes other work and supply boats will be needed.[35] While of course operators will take care to try to plan and coordinate vessels to avoid collisions,"[36] the number of vessels operating in close quarters, and in what may at times be difficult weather, sea and ice conditions, raises the question of the potential for collisions with the drillship and whether such a collision could increase the risk of a blowout or other spill. It appears that vessel collisions have led to blowouts in the past.[37] There are also concerns that Canadian Arctic bathymetric charts do not have the coverage or precision of such charts elsewhere, raising the possibility of increased risks and difficulties in responding to incidents.
- *New equipment:* Although the need for new equipment, including new specialized Arctic drillships,[38] has the potential to incorporate state-of-the-art designs, it also raises questions as to the potential of unexpected problems due to the relatively untested nature of such new equipment, peoples' relative lack of experience with it, and increased complexity leading to increased risk.
- *Arctic conditions:* Arctic temperatures, severe weather, ice conditions (such as whether ice is moving or shearing forming pressure ridges), ice interaction, visibility constraints (e.g. seasonal darkness), cold water and potential gas hydrate formation, and other Arctic conditions, raise questions as to increased risks for all Arctic operations. And to what extent is climate change increasing the frequency of extreme weather events and reducing predictability?[39]
- *No previous deep wells:* Imperial states that 37 wells have been drilled on the shallow shelf (water depth 0-25m) of the Canadian Beaufort Sea, 48 on the deep shelf (25-100m), and 0

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[32] Pew Arctic Oil Spill Prevention and Response Policy Recommendations, Nov 2010, page 8.

[33] Imperial SSRW submission, Mar 2010, page 3-2.

[34] Chevron SSRW submission, Mar 2010, slide 18.

[35] Imperial SSRW submission, Mar 2010, page 3-2.

[36] Imperial SSRW submission, Mar 2010, page 3-9.

[37] As noted by the US Department of the Interior, there was a blowout in US Federal OCS waters in 1969 "that occurred when a supply vessel collided with a drilling rig during a storm and sheared the wellhead." See DOI Safety Measures Report, May 2010, page 6.

[38] Imperial SSRW submission, Mar 2010, page 3-2.

[39] See, for example, the 2010 Arctic Report Card at http://www.arctic.noaa.gov/reportcard.

on the slope (100-1,200m).[40] There therefore appears to be no data from previous nearby wells in deeper waters, raising the question of whether risks are higher when drilling the first wells in an area. BP notes, for example, that "well design and execution … must begin with reliable pore pressure prediction and detection."[41] Imperial explains the three techniques used to predict pore pressure: offset well-based pressure estimation and extrapolation, seismic interval velocity-based pressure analysis, and 3-D basin modeling.[42] Although BP claims the three techniques provide a "thorough understanding of the expected pressures and uncertainty,"[43] given the first technique uses information from previous nearby wells, and the second relies upon "empirical algorithms calibrated to local offset well interval velocities,"[44] two of the three techniques are presumably not available (or at least less accurate) in an area such as the deep Beaufort Sea with no previous wells. And for the third, while Imperial stated that it has an "advantage because it can be used in frontier regions where inadequate offset well control and velocity calibration exists," they note it "less accurately predicts pore pressure compared to the other techniques."[45]

- *Multiple well suspensions and re-entries:* Imperial note that their proposed Ajurak exploration well will take at least two, likely three, and possibly more summer seasons to drill.[46] This will necessitate suspension of the well at the end of each season and re-entry the following year, raising the question of whether multiple suspensions and re-entries increase risk. We note that the Macondo blowout occurred when the crew of the Deepwater Horizon was preparing to temporarily abandon the well.[47] Additionally, suspensions at the end of the year will likely take place in more difficult conditions with approaching winter weather and less daylight, and encroaching ice may create time pressures, again raising questions about increased risk. Indeed, Chevron notes, "A combination of more severe ice conditions and the need to demobilize the rig may require the BOP to be left on the seafloor till the following year – a situation rarely encountered in conventional offshore operations."[48] This raises further questions as to BOP reliability after an extended period on the seafloor over winter, and as to the interaction with ice keels scarring the seabed and potentially destroying equipment in shallower water depths.
- *Potential multiple disconnects:* In addition to suspensions at the end of each season, Imperial notes that: "Ice incursions could result in the Arctic drillship and supporting fleet moving away from the unmanageable ice."[49] This raises questions on the potential of increased risks of blowouts or other problems when having to disconnect during drilling.

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[40] Imperial SSRW submission, Mar 2010, page 4-7.

[41] BP SSRW submission, Mar 2010, page 9 paragraph 27.

[42] Imperial SSRW submission, Mar 2010, pages 5-3, 5-4.

[43] BP SSRW submission, Mar 2010, page 10 paragraph 31.

[44] Imperial SSRW submission, Mar 2010, page 5-4.

[45] Imperial SSRW submission, Mar 2010, page 5-4.

[46] Imperial SSRW submission, Mar 2010, page 3-5.

[47] BOEMRE Drilling Safety Rule, Oct 2010, page 63370.

[48] Chevron SSRW submission, Mar 2010, slide 20.

[49] Imperial SSRW submission, Mar 2010, page 3-9.

The new BOEMRE regulatory requirements in response to the Macondo blowout appear to recognize a certain level of risk when disconnecting – for example, in explaining a new rule that "requires the operator to displace the fluid in the riser with seawater before removing the marine riser," the BOEMRE documentation goes on to explain that "while conducting this operation, the operator must maintain sufficient hydrostatic pressure on the well or take other suitable precautions to compensate for the reduction in pressure to maintain well control."[50] Indeed, replacement of heavy drilling mud by seawater as part of the process for the temporary abandonment of the Macondo well, thus under-balancing the well, has been suggested to be part of the reason for the influx of hydrocarbons and blowout of that well.

- *Disconnects under time pressure:* Increases in risk from disconnects might be particularly notable when weather and/or ice conditions change abruptly requiring a relatively quick disconnect. As BP notes, for example, "drifting floes of ice can be unpredictable, capable of changing direction and quickly changing the hazard time."[51] Indeed, this led BP to note the possible scenario when "the rig goes into an ice alert forcing it to disconnect at the same time a kick is taken."[52] Similarly, Chevron contrasts offshore activities in open water environments where "station-keeping changes are gradual" and "moderate lead times in advance of poor weather conditions provide adequate reaction times," with offshore activities in the Arctic where "station-keeping changes can happen quickly due to ice encroachment" and "pack ice conditions may require frequent and rapid planned disconnects."[53] This raises a further possible scenario with potential risk implications: if, after disconnecting in response to encroaching ice conditions, those (or other) conditions do not allow the drillship to subsequently return to the well that season, the well would then have to over-winter in whatever state it was left at the time of disconnect.
- *Other time pressures:* There may be additional time pressures in Arctic offshore drilling that increase the likelihood of risky decision making or other human errors that increases the risk of a blowout. For example, towards the end of a drilling season, might there be time pressure to finish certain activities to ensure the drillship and other vessels can successfully depart the region before ice conditions block their exit? Chevron notes "the challenge of meeting drilling program objectives within a limited and highly variable open water season."[54] Such time pressures may also coincide with deteriorating weather as winter conditions approach.
- *Other human stressors:* Many incidents are a result of human error, raising important questions as to whether Arctic offshore conditions might increase such errors, and perhaps increase them at particular times, because of, for example, the cold and other adverse weather conditions, increasing darkness late in the season, remoteness and isolation, time pressures (as noted above), etc. In addition, crew changes might be more frequent in such

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[50] BOEMRE Drilling Safety Rule, Oct 2010, page 63360.

[51] BP SSRW submission, Mar 2010, page 16 paragraph 50.

[52] BP SSRW submission, Mar 2010, page 17 paragraph 51.

[53] Chevron SSRW submission, Mar 2010, slide 18.

[54] Chevron SSRW submission, Mar 2010, slide 17.

difficult conditions, raising questions as to whether risks might increase due to such changes and resulting reduction in personnel continuity.

- *Unknown:* In addition to the above, there are perhaps other unknown risks that come with offshore drilling in new areas and harsh conditions such as the deep Beaufort Sea.

The above list of possible increased risk factors is not meant to be exhaustive, but indicative of the types of additional risks that might be present in Arctic offshore drilling. Unfortunately, we could not find any explicit discussion of the above factors in Imperial's calculation of the probability of a blowout in their SSRW submission or their attached DNV study.

2.3 Suggested Study

Given the differing estimations for the chances of a blowout, questions over the correct way to present such probabilities, and the potential for Arctic offshore drilling conditions to increase risks, we suggest the Board commission a study on the chances of a blowout in the Arctic offshore.

Please note that for each suggested study, we suggest a number of issues that study might include. We word these suggested issues as straightforward questions (e.g. 'what are the chances of a blowout') suggesting analysis, but we understand the Board may choose to commission studies that collect and summarize existing information rather than generate new information (and so in the example, the study would collect information on past calculations and the methods to make them, rather than actually generating new calculations). In two of the suggested studies we do, however, suggest analysis be conducted, as will be explained later on in this submission.

<u>Suggested Study 1: Chances of an Arctic offshore blowout</u>

a) What are the chances of a blowout occurring from Arctic offshore drilling?

b) The study should take Arctic offshore conditions into account, and discuss the appropriateness of extrapolating experiences from elsewhere to the Arctic. For example, how might the above 'Possible Additional Risk Factors in the Arctic offshore' and other relevant factors affect blowout probabilities?

c) What different risk factors are there in different parts of the Canadian offshore Arctic, such as in the Beaufort Sea versus the eastern Arctic?

d) What are the appropriate statistical/probabilistic techniques that should be used when discussing low probability-high consequence events, and what are the proper methods for explaining uncertainties and confidence factors? What are the significant uncertainties in developing such probabilistic risk assessments?

e) At what times, under what circumstances, and during what activities are the risks of loss-of-control events or blowouts (including due to human errors) heightened, and to what extent?

f) Are there added risk consequences from leaving a BOP on the seabed throughout the winter, or from other unplanned over-winter situations such as may result from disconnects due to ice incursions?

3 SAME-WELL INTERVENTION TECHNIQUES

According to Imperial in their SSRW submission, techniques at the original well are usually the first approach to be used to attempt to bring a blowout back under control.[55] For example, Imperial describes same-well interventions as "by far the best and preferred option", in comparison to drilling a relief well which they describe as "the last and least preferred option."[56]

Interestingly, Imperial states that, "Since 1995 WWCI [Wild Well Control Inc.] has planned a total of 31 relief wells and drilled 15," but that, "in all cases, the preferred method, intervention in the original wellbore, was successful in regaining lost well control."[57] Imperial further states, "Many times relief wells are started, but never finished, because of successful vertical intervention."[58] It is noteworthy, however, that in each of these cases the companies involved have gone to the considerable expense of planning and drilling relief wells even in those cases when they were not ultimately relied upon, presumably reflecting a belief that while not often required, they nevertheless provide an important ultimate solution that needs to be available.

As we have seen with the Montara blowout, same-well intervention techniques are not always possible (with Montara, safety concerns did not permit personnel to approach the original well site). And as we saw with the Macondo blowout, even when same-well intervention techniques can be attempted, relief wells remain a key response technique to be undertaken in parallel with same-well techniques, and relief wells are sometimes completed even after same-well techniques show success.

There thus appears to be a number of important questions regarding same-well intervention techniques, and regarding their relationship to the use of relief wells. This section will consider same-well techniques – their effectiveness, when they might not be available, and how long they might take. The following section then considers relief wells.

3.1 Effectiveness of Same-Well Techniques

As discussed above, in its calculation on the probability of a 'blowout' in its SSRW submission, Imperial appears to incorporate estimates of the risk-reducing effects of a number of same-well intervention techniques to bring a blowout back under control. These included use of acoustic backup and remotely-operated vehicles (ROVs) to activate the BOP, and placement of a second BOP stack on top of the first. Imperial/DNV estimated the probability of success of these methods to be fairly high. Similarly, BP wrote in its SSRW submission, "The policies and best practices related to assurance of fitness and reliability for BOP equipment, used by both BP and the drilling contractors it employs, are extremely rigorous and fully documented, befitting such safety-critical equipment."[59]

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[55] Imperial SSRW submission, Mar 2010, page 1-10.

[56] Imperial SSRW submission, Mar 2010, page 8-2.

[57] Imperial SSRW submission, Mar 2010, page 8-2.

[58] Imperial SSRW submission, Mar 2010, page 8-14.

[59] BP SSRW submission, Mar 2010, page 13 paragraph 40.

Obviously, the Macondo blowout has raised questions about such claims and about the effectiveness of same-well intervention techniques in deep water. In justifying the new US rules for offshore drilling following the Macondo blowout, for example, BOEMRE reasoned:

> "Circumstances suggest that, while a blowout and spill of this magnitude have not occurred before on the OCS, it is unlikely that the problems are unique to the Deepwater Horizon and BP's Macondo well. As noted in the July 12, 2010, decision of the Secretary to suspend certain offshore permitting and drilling activities, most BOPs used in drilling on the OCS are of similar design and are produced by a limited number of manufacturers. Furthermore, the BOPs for the relief wells drilled to intercept the Macondo well encountered unexpected performance problems, initially failing to pass new testing procedures developed in response to the Safety Measures Report, including failure of the deadman and autoshear functions.[60] These multiple failures raise red flags as to the reliability of BOPs to adequately safeguard the lives of workers and protect the environment from oil spills in response to a large blowout. They also suggest the need to review regulations pertaining to well casing and design, the other area of likely failure in the Deepwater Horizon event.
>
> "Even without the full results of the pending investigations, the obvious failures of well intervention and blowout containment systems demonstrate that previous regulatory assumptions concerning their reliability are inaccurate."[61]

BOEMRE has also indicated that there are questions concerning the reliability of acoustic backup systems to activate a BOP:

> "Industry, academics and other stakeholders have raised concerns about how the differences in water temperatures between water layers (deepwater thermocline) will affect the transmission of the acoustic signal to the BOP stack when installed in deepwater. Similar concerns were raised about how different salinities between water layers, noise from a wild well, or other subsea noise may interfere with the successful transmission of the acoustic signals to the BOP stack."[62]

In the offshore Arctic, such concerns might be compounded due to salinity and temperature stratification of water layers because of Mackenzie River outflow and/or ice melt.

In addition to backup methods to activate the BOP, or use of a second BOP, Imperial also briefly mentioned a number of vertical intervention techniques to bring a blowout under control, ranging from pump and kill methods to coiled tubing intervention.[63] A number of such methods were attempted on the Macondo well with varying levels of success, as were a number of oil collection

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[60] BOEMRE Drilling Safety Rule, Oct 2010, page 63359, describes these functions as follows: "Dynamically positioned rigs must have autoshear and deadman systems. Autoshear system is defined as a safety system that is designed to automatically shut in the wellbore in the event of an unplanned disconnect of the LMRP. When the autoshear is armed, a disconnect of the LMRP closes the shear rams. Deadman system is defined as a safety system that is designed to automatically close the wellbore in the event of a simultaneous absence of hydraulic supply and signal transmission capacity in both subsea control pods."

[61] BOEMRE Drilling Safety Rule, Oct 2010, page 63355.

[62] BOEMRE Drilling Safety Rule, Oct 2010, page 63359.

[63] Imperial SSRW submission, Mar 2010, page 8-7.

techniques (such as the unsuccessful 'containment dome' which suffered from gas hydrates, to the more successful 'top hat'),[64] and industry is now actively researching such containment techniques. It is not clear whether meaningful effectiveness rates can be determined for such techniques, given the peculiarities of each blowout that would require them. But it will be important to consider whether Arctic conditions, such as potential increases in hydrate formation from gas outflow from a blowout or from disrupted hydrate formations on the seabed, would create additional difficulties in the use of these techniques.

There are also concerns that same-well intervention techniques might increase pressures and lead to an underground blowout. In its SSRW submission, BP notes the possibility of an underground blowout occurring "when a well is shut in on kick and the pressures exceed the strength of the overlying formations below the last casing shoe."[65] Similarly, as explained in the National Commission staff working paper on stopping the Macondo spill, concerns about an underground blowout were apparently expressed as early as during efforts to activate the BOP.[66] When later capping techniques were being considered, "concerns related to closing the capping stack involved the risk that capping would increase the pressure inside the well and burst either the rupture disks (if they had not already collapsed) or the outermost casings."[67] Once the capping stack was closed, there followed "intense monitoring of the area around the wellhead" to determine if an underground blowout was occurring,[68] and concerns of causing such a blowout resurfaced during consideration of the subsequent static kill.[69]

The staff working paper on stopping the Macondo spill explains some of the potential consequences underlying these concerns:

> "If BP shut the well in and hydrocarbons were flowing up the annulus between the production and 16" casings … the hydrocarbons in this annulus would follow the path of least resistance. They would flow out the rupture disks and into the rock formation in what is called a 'broach' or 'underground blowout.' From there, the hydrocarbons could rise through the layers of rock and into the ocean. Containment of hydrocarbons flowing directly from the sea floor, rather than from a single source like the top of a well, is nearly impossible."[70]
>
> "The stakes were high. Keeping the stack shut could cause an underground blowout and, in the worst case, loss of a significant portion of the 110 million barrel reservoir into the Gulf. That risk had to be balanced against the need to stop the spill, an ongoing environmental disaster. Participants in the conversations were aware of the importance and public impact

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[64] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, pages 11, 23. Other oil collection techniques during the Macondo blowout included the riser insertion tube tool (pages 12, 13), and collection via the choke and kill lines on the BOP (page 23).

[65] BP SSRW submission, Mar 2010, page 17 paragraph 51.

[66] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, pages 3, 4.

[67] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, page 29.

[68] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, pages 34.

[69] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, page 36.

[70] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, page 22.

> of their decision: The public wanted the well shut in and the flow of oil into the Gulf stopped, but the risk of causing greater harm was real."[71]

3.2 Availability of Same-Well Techniques

There may be circumstances under which some or all of the same-well intervention techniques cannot even be attempted.

For example, in deep waters, a number of such techniques presumably depend on the drillship remaining operational after the blowout, given it contains the control systems, ROVs, personnel and so on that would be required to undertake such techniques. In its SSRW submission, in discussing the ability of the drillship to drill a relief well, Imperial confidently asserts that the drillship would not be damaged by a blowout in deep water drilling: "If a blowout occurs, the following factors will ensure that personnel are safe and the drillship and marine support vessels are undamaged and available for drilling a relief well: ensuring that the water depth is adequate – a blowout in 600 m of water will not cause loss of stability for the drillship or support fleet."[72]

Obviously the Macondo blowout, and the fate of the Deepwater Horizon, brings that assertion into question. Indeed, according to a recent Pew report on Arctic spill response, albeit again in the context of relief well drilling: "A review of all available data about well blowouts worldwide does not show a single example of a drill ship drilling its own relief well after blowing out."[73]

The Montara blowout presents another scenario, this time in shallower waters, where same-well intervention techniques may not be possible at all. As noted in a report submitted by WWF-Australia to the Montara Commission of Inquiry,

> "In order to cap and control a well, the well control specialist must be able to access the wellhead to either repair the blowout prevention system (BOP) or remove the defective BOP to control the well pressure. Therefore one of the first challenges, and often the most time consuming, is to remove the rig structure and wellhead debris from around the well, while it is actively blowing out hydrocarbons and drilling muds and at risk of possible explosion. In some cases, the wellhead can be exposed by clearing away the damaged rig or offshore platform components; however, in some cases rig removal may also be required."[74]

Presumably in some cases, damage to the well head and/or BOP might preclude same-well intervention techniques. In the Macondo blowout, for example, there were concerns as to whether the capping stack could be successfully placed on top of the BOP because the BOP "was listing at two degrees from vertical."[75] And in the case of the Montara blowout, although capping the original well was initially considered, "a prohibition issued by NOPSA [National Offshore Petroleum Safety Authority] removed the possibility of surface [i.e. same-] well control

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[71] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, page 33.

[72] Imperial SSRW submission, Mar 2010, page 3-8.

[73] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 96.

[74] WWF-Australia submission to Montara Inquiry on oil spill response, Feb 2010, page 12.

[75] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, pages 28.

activities, due to potential risks to personal safety, leaving drilling a relief well as the only remaining option,"[76] (and the platform did in fact catch fire during the incident).

Might there be other scenarios when some or all same-well intervention techniques could not even be attempted? And to what extent will the remoteness and relative lack of infrastructure in various parts of the Canadian Arctic limit the creation of specific intervention methods to respond to the peculiarities of the incident?

As an aside, 'conditional probabilities' are likely relevant here (and also in subsequent discussions below such as on responding to an oil spill). Generally, to calculate the probability of two independent events occurring, it is possible to simply multiply the probability of one occurring by the probability of the other occurring. But if the fact that one event has occurred changes the probability of the other event occurring, then conditional probabilities should be used. In the present context, for example, a blowout may have occurred because of, amongst other things, difficult environment conditions. Those same conditions may then impede same-well intervention techniques. And as will be discussed below, such conditions may also impede oil spill cleanup techniques. Thus, when considering the likelihood that such techniques would be available and successful, consideration should be given to the conditions under which they are more likely to be required.

3.3 Time for Same-Well Techniques to Succeed

As efforts to bring the Macondo well under control demonstrated, same-well intervention techniques take time. Following the blowout on April 20, 2010, unsuccessful efforts to activate the BOP continued for two weeks (April 21-May 5), the unsuccessful top kill and junk shot was not attempted until over a month following the blowout (May 26-28), while the successful capping stack that ended the flow was not installed and closed until almost three months after the blowout (July 12-15).[77]

Remote Arctic conditions are likely to increase the time to undertake such activities, perhaps significantly, and perhaps especially in the late-season with the onset of winter weather, ice conditions and darkness. As with the end-of-season cut-offs under the SSRW capability requirement, this raises the question of when drilling should stop to allow sufficient time to undertake same-well intervention techniques before winter conditions would make their success unlikely. Such techniques will presumably also take longer as conditions deteriorate.

In contrast, BP suggests that, instead of having an end of season determined by calendar cut-off dates (as under the SSRW capability requirement), that they make the decision on when to end drilling "by comparing the estimated time for the safe and orderly securing of the well to the estimated time before an unmanageable ice floe would arrive at the rig."[78] This would apparently leave neither time for drilling a relief well, nor time for attempting same-well intervention techniques, if a blowout occurred at or near the end of the drilling season.

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[76] WWF-Australia submission to Montara Inquiry on oil spill response, Feb 2010, page 10.

[77] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, pages 4, 7, 8, 16, 17, 30, 32. These steps were followed by the static kill and cementing on Aug 3-5 (pages 36, 37) and relief well intersection and cementing by Sept 19 (page 37).

[78] BP SSRW submission, Mar 2010, pages 15, 16 paragraphs 47 to 49.

Further, as noted above, it is possible that nearing the end of season is exactly the time when risks of blowouts can be greater, due to time pressures, weather and ice conditions, and so on. In addition, as noted by Chevron: "As the drilling season progresses, well operations typically involve deeper well depths and thus the time requirement to potentially suspend such operations may increase (i.e. the setting of a deep casing string late in the season)."[79] Chevron also notes: "Later season ice conditions will be more severe and rapid changes in conditions at the rig may not provide the window necessary to conduct routine well suspension operations."[80] Thus towards the end of the season, operational demands appear to increase at the same time as conditions become more difficult and time constraints more pressing. This appears to emphasize the importance of allowing sufficient time to bring a well under control before winter conditions make such operations difficult to impossible.

3.4 Suggested Study

In the aborted SSRW hearing, Imperial relied heavily on same-well intervention techniques in their argument for relaxation of the SSRW capability requirement. However, the above discussion raises important questions as to the effectiveness, availability and timeliness of such techniques. We therefore suggest the Board commission the following study.

<u>Suggested Study 2: Effectiveness of same-well intervention techniques in the Arctic offshore</u>

a) What are the uncertainties regarding the success of same-well intervention methods?

b) What problems might be encountered or caused during same-well intervention techniques (e.g. blowout below the BOP, underground blowout, gas hydrate formation, etc), and what are possible solutions?

c) Under what scenarios might attempting some or all same-well intervention techniques be impossible, hampered or delayed? How do those scenarios overlap with the increased risk of blowouts (i.e. recalling discussion above of conditional probabilities, do same-well intervention techniques face additional difficulties under conditions that are more likely to result in a blowout in the first place)?

d) How long might each same-well intervention technique be expected to take, taking past experience into account, both in general and at times corresponding to increased risk of blowouts?

e) What types and quantities of vessels, equipment and personnel would be required to attempt each kind of same-well intervention technique, and what types of redundancy could be provided to allow for damage from the blowout (e.g. a second drilling rig in case the original rig is incapacitated)?

f) How long might the equipment put in place during a same-well intervention technique have to remain functional, and what concerns are there with it remaining in place for that time (e.g. a second BOP stack on top of the first throughout the winter)?

[79] Chevron SSRW submission, Mar 2010, slide 19.

[80] Chevron SSRW submission, Mar 2010, slide 19.

g) The study should take Arctic offshore conditions into account, and discuss the appropriateness of extrapolating experiences from elsewhere to the Arctic.

4 Same Season Relief Well (SSRW) Capability

Imperial describes the SSRW capability requirement as a policy "that an operator not drill into a potentially hydrocarbon-bearing zone (risk threshold) without the ability to drill a relief well in the same season in the event of a blowout."[81] And as Chevron notes, "'Same Season' has been widely interpreted by industry as being the need for a continuous relief well operation that can be completed, and both wells safely killed and suspended, before ice conditions preclude any further operations during that operating season."[82]

4.1 Do Timely Relief Wells Provide an Important Insurance Policy?

Are timely relief wells necessary, or do they simply result in unnecessary costs? In its SSRW submission, Imperial states: "Relief wells do not provide a measurable additional level of environmental protection."[83] Similarly, ConocoPhillips stated, "Relief wells offer little real protection to the environment since a significant spill is possible before a relief well can be drilled."[84] It is difficult to reconcile these statements with the experiences from the Montara and Macondo blowouts. In the case of the Macondo blowout, for example, "as early as April 21 [the day after the blowout], BP started to discuss drilling a relief well to intersect the Macondo well at its source and stop the flow of oil. … Within days of the explosion, BP mobilized two rigs to drill separate relief wells, a primary well and a back-up insisted upon by Secretary Salazar."[85]

While of course prevention of a blowout is preferable, blowouts do occur and same-well intervention techniques are not always available or effective. As noted in the National Commission staff working paper on stopping the Macondo spill, "Several experts from both industry and government described relief wells to Commission staff as the only accepted, high-probability solution to a subsea blowout, even though they take months to drill."[86]

As for the cost of the SSRW capability requirement, in discussing the SSRW policy and past drilling in the Beaufort Sea, Imperial stated that "No relief wells were ever required," and suggested that the SSRW policy simply resulted in "needless expenditures."[87] However, it would seem that characterizing the SSRW policy as resulting in needless expenditures because a relief well was never needed is similar to a car owner, with hindsight at the end of a year, characterizing his or her purchase of car insurance at the beginning of the year as needless because he or she did not crash that year.

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[81] Imperial SSRW submission, Mar 2010, page 2-5.

[82] Chevron SSRW submission, Mar 2010, slide 26.

[83] Imperial SSRW submission, Mar 2010, page 1-10.

[84] ConocoPhillips SSRW submission, Mar 2010, page 1.

[85] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, page 5.

[86] National Commission Staff Working Paper on Stopping the Spill, Nov 2010, page 5.

[87] Imperial SSRW submission, Mar 2010, page 2-8.

In the US following the Macondo blowout, BOEMRE issued two Notices to Lessees (NTLs). One related to exploration plans (EPs), which are required before exploratory wells can be drilled, and added a number of additional information requirements, including:

> "A blowout scenario … that you expect will have the highest volume of liquid hydrocarbons. … Discuss the potential for the well to bridge over, the likelihood for surface intervention to stop the blowout, the availability of a rig to drill a relief well, and rig package constraints. Specify as accurately as possible the time it would take to contract for a rig, move it onsite, and drill a relief well, including the possibility of drilling a relief well from a neighboring platform or an onshore location. …
>
> "Describe the measures you propose that would enhance your ability to prevent a blowout, to reduce the likelihood of a blowout, and conduct effective and early intervention in the event of a blowout, including your arrangements for drilling relief wells, and any other measures you propose."[88]

Not surprisingly, in light of the Macondo blowout, US regulatory authorities have emphasized the importance of timely relief well capability.

Nevertheless, obtaining a better understanding of the use of relief wells, and why they have been drilled even while same-well intervention techniques were being pursued, would be useful.

4.2 Is a Same Season Relief Well Possible?

Industry submissions during the SSRW hearing stated that the ability to drill a deepwater relief well in the same season ranged from unlikely to impossible. For example, BP stated "it is statistically unlikely that [a] relief well could be entirely carried out in the same season."[89] Chevron stated that on the Slope (water depths > 70m),[90] "a combination of deeper water, deeper and complex wells and tougher ice conditions suggests that SSRW Capability may be no longer viable."[91] Imperial was the most emphatic: "For most circumstances in deepwater, completing a relief well operation in a single season is impossible,"[92] and would "take longer to drill than the original exploration well, likely three to four seasons."[93]

As for shallower waters (where the 'same season' might be winter), Imperial stated that drilling a relief well and shutting in both wells in the same season was "unlikely or impossible,"[94] except for "improbable shallow well control problems, coupled with exceptionally benign environmental conditions."[95] On the other hand, Chevron stated that: "Due to the combination of shallow, straightforward wells in a relatively benign ice environment a SSRW is viable on the Shelf [20-

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[88] BOEMRE NTL No. 2010-N06, June 2010, pages 2, 3.

[89] BP SSRW submission, Mar 2010, page 7 paragraph 21.

[90] Chevron SSRW submission, Mar 2010, slide 36.

[91] Chevron SSRW submission, Mar 2010, slide 39.

[92] Imperial SSRW submission, Mar 2010, page 4-7.

[93] Imperial SSRW submission, Mar 2010, page 8-9.

[94] Imperial SSRW submission, Mar 2010, page 4-7.

[95] Imperial SSRW submission, Mar 2010, page 4-3.

50m water depth]," but that at the Shelf Edge (50-70m), "SSRW Capability may be challenged."[96] And as noted in a staff working paper for the US National Commission investigating the Macondo blowout, in relation to its proposed drilling in about 150 feet of water in the Chukchi Sea,[97] "Shell estimates that it could drill a relief well in as few as sixteen days or as many as thirty-four days."[98]

We could not find any discussion of simultaneously drilling a relief well (or perhaps what should be called a 'second' well given there is as yet no blowout) at the same time as drilling the primary well in the industry SSRW submissions. While obviously this would add costs, and understanding that the relief/second well would carry some risks of its own, simultaneous relief/second well drilling does appear a possibility as noted by Kevin Roche of Noble Drilling in his testimony before the Standing Committee on Natural Resources (albeit noting that intersecting the out-of-control well would still take some time):

> "In order to be able to drill a relief well, you have to know the exact trajectory and orientation of the first well. There is an advantage to drilling both of them simultaneously, but you're still going to lose time by having to find the exact trajectory."[99]
>
> "… you can drill two wells together, but in order to make them come together you have to stop, go away, and figure out how you're going to make that happen. That's the only issue. It's not a deal breaker. You can run them both together, but you still have to stop at a certain point in time and figure out how you're going to make them come together that doesn't hold you back."[100]

This no doubt raises a number of questions, such as whether the reduction in the consequences of a blowout at the original well by drilling a simultaneous relief/second well outweigh the added risks of drilling that second well.

But in cases where a same season relief well could not be completed with confidence, what should be done? Interestingly, Mr. David Pryce of the Canadian Association of Petroleum Producers (CAPP) referred to the ALARP principle in the following way in testimony before the House of Commons Standing Committee on Natural Resources: "achieve a risk level that is as low as is reasonably practicable without eliminating the possibility of conducting an activity."[101] Although Mr. Pryce was not discussing relief wells, surely, in cases where a same season relief well is not possible, it has to be asked whether drilling should be allowed at all. In such a case, a deepwater blowout that could not be controlled with same-well intervention techniques in the same season could result in an uncontrolled release of oil for the better part of a year, if not longer. Surely some activities should simply not occur because the risks cannot practicably be

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[96] Chevron SSRW submission, Mar 2010, slide 39.

[97] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 2 footnote 7.

[98] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 8.

[99] Standing Committee on Natural Resources, June 17, 2010, page 5, testimony of Mr. Kevin Roche (General Manager, Noble Drilling (Canada) Ltd., International Association of Drilling Contractors).

[100] Standing Committee on Natural Resources, June 17, 2010, page 10, testimony of Mr. Kevin Roche (General Manager, Noble Drilling (Canada) Ltd., International Association of Drilling Contractors).

[101] Standing Committee on Natural Resources, May 13, 2010, page 11, testimony of Mr. David Pryce (Vice President, Operations, Canadian Association of Petroleum Producers).

reduced to acceptable levels. After all, not every drop of oil underground has to be brought to the surface.

4.3 Is the SSRW Capability Requirement Too Prescriptive?

A number of industry SSRW submissions characterized the SSRW capability policy requirement as too prescriptive. For example, Imperial called for the SSRW capability requirement to be replaced by what they call "a modern, goal-oriented policy."[102] CAPP went so far as to characterize the SSRW capability policy as a "prescriptive approach [that] is inconsistent with a modern, goal oriented regulatory regime."[103]

But goal-oriented regulation is not a call for the removal of any provision with any hint of prescriptive requirement. Rather, it is "a hybrid approach that includes prescriptive and goal- or performance-based elements,"[104] and ensuring the right blend of the two is critical. Further, there is no black-and-white distinction between prescriptive requirements and those that are not prescriptive – rather, there is a spectrum, ranging from highly prescriptive (e.g. dictating the exact equipment that must be installed) to highly goal-oriented (e.g. requiring a high-level goal to be achieved), with many shades in-between. The SSRW capability requirement appears to lie somewhere in that middle zone – it isn't a goal at the highest most abstract level (e.g. 'maintain safety and protect the environment'), but neither is it highly prescriptive (e.g. it doesn't specify how a relief well should be drilled, by whom, with what equipment, etc).

Presumably then, the SSRW capability requirement should not be discarded simply because it is labelled by some to be 'prescriptive.'

4.4 Are Proposed Alternatives 'Equivalent' to SSRW Capability?

Industry submissions during the SSRW hearing argued that better prevention of blowouts and/or better response to blowouts were suitable alternatives to the SSRW capability requirements. For example, BP wrote that it had "proposed an alternative approach"[105] to the SSRW capability policy, after discussing the range of preventive measures such as pore pressure prediction and detection, hydrostatic barrier (mud density), BOPs, well planning, and so on.[106] And Imperial argued that improvements in well control, in regaining lost well control via same-well intervention techniques, and in spill response in ice infested waters (discussed below), obviate the need for SSRW capability.[107]

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[102] Imperial SSRW submission, Mar 2010, page 1-5.

[103] CAPP SSRW submission, Mar 2010, page 1.

[104] RIAS accompanying the *Canada Oil and Gas Drilling and Production Regulations*, quoted in BP SSRW submission, Mar 2010, page 5.

[105] BP SSRW submission, Mar 2010, page 20 paragraph 62.

[106] BP SSRW submission, Mar 2010, page 7 onwards.

[107] Imperial SSRW submission, Mar 2010.

Other operators proposed more specific improvements to the BOP stack.[108] Transocean pointed to, for example, the additional redundancy provided by an additional annular type BOP and two additional ram type BOPs on modern BOP stacks.[109] Chevron proposes a new kind of ram, named an Alternative Well Kill System (AWKS), which is being designed to shear and seal pipe simultaneously instead of relying on two rams to perform those functions (although two AWKS units in the BOP stack are proposed given that, "as with conventional shear rams, the AWKS cannot guarantee a shear and seal on a tubular connection.")[110] ConocoPhillips suggest that a two-barrier system (e.g. drilling mud density plus BOP) with an auxiliary safety isolation device (described as "an extra set of blind-shear rams which are independent of the primary rig well control system") would provide an "improved alternative to the relief well approach."[111]

Imperial suggests that instead of the SSRW capability requirement, the Board's 'desired end result' for a relief well policy should be "an appropriate overall level of environmental protection," and that "same well interventions should be attempted before initiating the drilling of a relief well."[112] CAPP, in advocating a change to the SSRW capability requirement, suggested "several important elements that should be captured in the goals of the revised policy. These are: (1) Protection of the environment. (2) Timely and effective response. (3) Limit any negative impacts on the environment."[113]

Presumably no one would disagree with such goals, but put in such vague terms they would seem to provide little to no explicit direction, assurance or accountability. This leads us to ask: how are the goals of the SSRW capability policy requirement best expressed in order to judge what might be an equivalent alternative?

One goal is certainly to avoid a blowout continuing through the off-season.

A second goal could be expressed as follows: ensure there is a timely response technique that is fundamentally different in nature from other techniques so as to allow for a broad range of potential and unexpected problems. Mud densities and BOPs to prevent blowouts, and same-well intervention techniques to bring a blowout under control, all operate at the original well and require access to the top of that well. Relief wells are fundamentally different. They approach the original well from some distance away and from underground. They appear to be the one response backstop that does not depend on access to the original well bore from the top and that does not have to contend with the hydrocarbons flowing from the top of the well. Improving prevention and same-well intervention techniques are of course important, but they appear to be of a different nature to relief wells. This second goal suggests that the tool bag of timely response methods should maintain sufficient diversity to deal with a broad range of potential and unexpected problems, and in light of this goal, something is 'equivalent' to SSRW capability

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[108] As an aside, it is interesting to recall that Imperial notes in its SSRW submission that "the six-ram configuration gave only 0.32% improvement in reliability over the five-ram configuration" (Imperial SSRW submission, Mar 2010, page 7-7). It is not clear to us how this relates to the various BOP improvements suggested by other operators.

[109] Transocean SSRW submission, Mar 2010, page 7.

[110] Chevron SSRW submission, Mar 2010, slides 48 to 50.

[111] ConocoPhillips SSRW submission, Mar 2010.

[112] Imperial SSRW submission, Mar 2010, pages 2-13, 2-14.

[113] CAPP SSRW submission, Mar 2010, page 3.

only if it maintains that diversity. Replacing SSRW capability with more rams on the BOP stack does not.

To provide a perhaps overly-simplistic analogy, it is of course important to continually improve the brakes in cars and other features designed to reduce the probability of road accidents. But such improvements do not replace the need for safety belts, a fundamentally different approach to harm reduction. Quite simply, improved brakes are not 'equivalent' to safety belts.

In sum, a careful examination of all the goals, functions and benefits that the SSRW capability requirement provides is warranted to help judge what, if anything, are equivalent alternatives. For example, additional goals implicit in the SSRW capability requirement are suggested by consideration of the following:

- As mentioned above, during the capping procedure for the Macondo well there were significant concerns that it might cause an underground blowout. Presumably a relief well provides a response to such a blowout that further same-well intervention techniques might not. Such scenarios suggest an overall goal should be to maintain a range of timely blowout control techniques that can respond to all types of blowouts and to potential problems that might be created by attempts with other techniques.
- Are there scenarios where same-well intervention techniques would not be successful on their own, but might be successful in conjunction with a relief well? For example, might a partially-successful relief well reduce the hydrocarbon flow from a blowout sufficiently to allow same-well intervention techniques to then be successfully used? Such scenarios suggest that an overall goal should be to maintain a sufficiently diverse and complementary set of blowout control techniques to be able to work around the broad range of problems that could be created by a blowout.

4.5 Suggested Study

Whether to maintain the SSRW capability requirement presumably remains a key question in the present Review. Given the above discussion, we suggest the Board commission the following study:

<u>Suggested Study 3: Potential benefits of relief wells in the Arctic offshore</u>

a) What are the requirements for relief wells in other jurisdictions?

b) Why have same-well intervention techniques and drilling relief wells been undertaken at the same time, and what types and quantities of vessels, equipment and personnel are necessary to do both in parallel?

c) Under what scenarios are same-well intervention techniques likely not possible (or hampered or delayed), but relief wells are possible?

d) How long might a relief well take, taking into account the time to mobilize the necessary equipment and drill rig?

e) What types and quantities of vessels, equipment and personnel would be required to attempt a relief well, and what types of redundancy could be provided to allow for damage from the blowout (e.g. a second drilling rig on-site in case the original drilling rig is incapacitated by the blowout)?

f) Would simultaneous relief/second well drilling provide SSRW capability where it otherwise might not be possible? What issues might favour, and what might disfavour, such simultaneous drilling? Are there other methods to allow for a more timely relief well completion?

g) What are the various benefits or functions provided by the SSRW capability requirement that would not be provided by same-well intervention techniques alone? For example, under what scenarios would the availability and success of same-well intervention techniques be unlikely, but a relief well would likely succeed?

h) Are there differences in the degree of permanence and control of a blowout between same-well intervention techniques and relief wells? Do same-well intervention techniques sometimes only provide a temporary solution that still requires a relief well?

i) The study should take Arctic offshore conditions into account, and discuss the appropriateness of extrapolating experiences from elsewhere to the Arctic.

5 RESPONDING TO SPILLED OIL

Given the focus of the previous SSRW hearing on relief wells, and recent concerns resulting from the Macondo and Montara incidents, the above has focused on oil spills from blowouts. But oil spills are also possible from vessels, storage and transfer systems associated with exploration drilling, and it will be important to estimate the potential frequency and quantity of such spills and how Arctic conditions might affect such estimates. This section, however, turns to the question of responding to spilled oil, whether from a major blowout or from a smaller spill.

Imperial appears confident in its SSRW submission with regards to responding to an oil spill in Arctic waters. Their submission states, for example:

> "30 years of improvements in spill response capabilities … demonstrates that there are response techniques that: are environmentally effective; are environmentally sound; are effective in all Arctic conditions; [and] can be mobilized quickly in response to an incident."[114]
>
> "Credible response options are available to respond to all types of spills in the Arctic offshore in both open-water and ice conditions."[115]
>
> "The knowledge and capability gained in the past 20 to 30 years in enhancing oil spill response effectiveness is one of the many reasons to remove the *same season* aspect from a modern relief well policy."[116]

Others do not share this level of confidence.

The US National Oceanic and Atmospheric Administration (NOAA), for example, in commenting on proposed lease sales in the US Beaufort Sea, "conveyed its concern about the lack of oil spill response preparedness in the Arctic and encouraged leasing to be delayed pending additional research."[117] Likewise, NOAA "expressed the view that no leasing should occur in the Chukchi Sea without additional research on oil spill response."[118]

A staff working paper for the US National Commission investigating the Macondo blowout notes with respect to Shell's proposed exploratory drilling in the Chukchi Sea: "Although Shell has pre-positioned assets dedicated to potential spill response in the Chukchi Sea, bringing any assets, both the pre-staged equipment and any additional resources brought from elsewhere, to bear on a spill in the Arctic would be more difficult than in the Gulf of Mexico. And once the winter freeze occurs, any spill would be impossible to access for purposes of response."[119]

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[114] Imperial SSRW submission, Mar 2010, page 6-1.

[115] Imperial SSRW submission, Mar 2010, page 6-2.

[116] Imperial SSRW submission, Mar 2010, page 6-9.

[117] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 5.

[118] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 6.

[119] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 2.

And the US Arctic Research Commission recently wrote: "Although improvements are needed in both the ability to clean up oil spilled under ice and the detection of thin oil slicks trapped under ice in the Arctic and sub-Arctic regions, little progress has been made over the last two decades. Recovery statistics for mechanical response techniques are similarly disappointing."[120]

There appears to be good reason for being sceptical of confident claims with regards to responding to an Arctic oil spill, as the following discussion on logistics, response gap, tracking, and the individual response techniques demonstrates.

5.1 Logistics

As of May 13, 2010, BP reported there were approximately 13,000 people, over 1.5 million feet of boom, over 500 response vessels, 37 aircraft, 1,000 local vessels, more than 4,000 volunteers, and the "most massive shoreline protection effort ever mounted", all involved in the response to the Macondo blowout.[121] At the height of the response, more than 6,500 response vessels, 3 million feet of boom, and nearly 900 skimmers were employed.[122] However, given the remoteness, lack of infrastructure, transportation challenges including ice breaker requirements, weather, and relatively small population in the North, it seems extremely unlikely that such a scale of efforts could be replicated to any significant degree in the Arctic.

For example, a 2008 workshop that included US and Canadian government representatives discussed some of the logistical challenges that might be faced in responding to a diesel spill resulting from a hypothetical scenario in which an ice management support vessel loses control and rams a drillship, 20 miles offshore on the Canada-US Arctic border:

> "This incident occurs far from critical assets, including heavy lift helicopters, emergency salvage and towing capacity, and fixed wing oil spill detection and surveillance capability, which would likely hamper the response. The drill ship cannot support an extended response and an icebreaker will take several days to arrive on scene. Kaktovik, the closest U.S. town, has a population of approximately 300 and few resources to support responders. The closest Canadian town, Tuktoyaktuk, also has few resources. Transporting responders and equipment and setting up a command post in small towns local to the incident will be difficult and likely disrupt the communities. While Prudhoe Bay has adequate resources, it is 200 miles away, making it an unacceptable location for accommodating responders involved in daily operations. There will likely be language barriers that have the potential to complicate or delay the response. Communication deficiencies are also likely to exist due to a lack of infrastructure (e.g., satellites, on shore towers)."[123]

Such logistical challenges would not only limit the scale of response effort, but also its timeliness. But, as noted in the recent Pew report, "with all three oil spill response options [mechanical recovery, in situ burning, and dispersants], time is critical. As soon as oil is spilled

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[120] Arctic Research Commission White Paper on research needs, May 2010, page 4.

[121] Standing Committee on Natural Resources, May 13, 2010, page 10, testimony of Mrs. Anne Drinkwater (President, BP Canada Inc.).

[122] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 64.

[123] Coastal Response Research Center Opening the Arctic Seas report, Jan 2009, page 18.

in water, it begins to spread, evaporate and emulsify, and as time passes, it generally becomes more difficult to track, contain, recover and treat."

Even with the massive and prompt response efforts in the Gulf, only 8% of the oil released from the Macondo well is estimated to have been burned or skimmed.[124] It seems reasonable to assume that significantly less would be burned or skimmed from a comparable Arctic spill.

5.2 Response Gap

Even without logistical difficulties, there will be times when response efforts will not be possible. As explained in the recent Pew report, "A response gap exists whenever environmental conditions exceed the operating limits of oil spill cleanup equipment, meaning that if a spill occurred during this time, it could not be contained or cleaned up."[125] Such a response gap may exist, for example, because of adverse ice conditions, fog, darkness, wind, sea state, temperate, or wind chill.

A response gap study was undertaken for two locations in Prince William Sound on the south coast of Alaska.[126] The study aimed to estimate how much of the time each of the three main techniques to respond to a large oil spill (i.e. mechanical recovery, aerial application of dispersants, and in situ burning) would not be possible because of weather, sea state, visibility, or a combination of those factors.[127] Six years of local data for wind, temperature, and sea state (wave height and wave period) were used. The following table shows the results for the entrance to Prince William Sound.[128] As an example, it was estimated that mechanical recovery techniques (e.g. booms and skimmers) could <u>not</u> be used 15.6% of the time during the summer season, 65.4% of the time during the winter, and 37.7% of the time across the whole year. The percentage of time that the other two techniques could not be used was even higher.

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[124] National Commission Staff Working Paper on the Amount and Fate of the Oil, Oct 2010 page 19 (17% is estimated to have been directly recovered from the wellhead, 5% burned, and 3% skimmed).

[125] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 90.

[126] Prince William Sound Mechanical Response Gap study, Feb 2007; Prince William Sound Non-Mechanical Response Gap study, Apr 2008. For a summary, see Prince William Sound Response Gap Summary Flier.

[127] Prince William Sound Mechanical Response Gap study, Feb 2007, page 8; Prince William Sound Non-Mechanical Response Gap study, Apr 2008, page 8.

[128] Prince William Sound Mechanical Response Gap study, Feb 2007, page 52; Prince William Sound Non-Mechanical Response Gap study, Apr 2008, pages 24, 26. Strictly speaking, the results reported were calculated as the percentage of time each technique is estimated to be possible or not possible when the Sound was open to laden tanker traffic – it was closed due to extreme weather conditions about 1.7% of the time.

		Mechanical	Dispersants	In-situ burning
Summer (April through September)	Possible	84.4	43.5	64.7
	(Not possible)	*(15.6)*	*(54.7)*	*(35.3)*
Winter (October through March)	Possible	35.4	29.7	14.1
	(Not possible)	*(65.4)*	*(70.3)*	*(85.9)*
Entire year	Possible	62.6	38.4	42.1
	(Not possible)	*(37.7)*	*(61.6)*	*(57.9)*

Note that a number of potential constraints on the use of each response technique were not included in the study. For example, the study did not consider the presence of ice (because ice is not common in Prince William Sound), and daylight versus darkness was the only visibility limitation considered (fog and precipitation were not considered due to data difficulties).[129] Taking such additional factors into account would increase the response gap (i.e. increase the percentage of time that each response technique is not available for use), as too would worsening weather conditions (as some predict will result from climate change).[130]

Overall, the response gap study for Prince William Sound estimated there are significant periods of time when the three main response techniques would not be available. Given the presumably more difficult conditions further north, including the presence of significant sea ice, the response gap in Arctic waters would presumably be even larger. However, as noted by a staff working paper for the US National Commission:

> "It does not appear that a similar comprehensive response gap analysis has been conducted for the Arctic. However, the Shell C-Plan[131] notes that temperature alone would be a significant limitation. All non-emergency work stops when temperatures reach below -45 degrees Fahrenheit. This limitation would prevent response 50% of the time in the month of January and 64% of the time in the month of March."[132]

5.3 Tracking

Assuming the logistical challenges can be sufficiently overcome, and that weather, ice conditions and sea state do not preclude response efforts, the next challenge in dealing with an oil spill in the Arctic is finding the oil. "If oil cannot be detected, it cannot be recovered," notes a WWF-US report.[133] As explained in a staff working paper for the US National Commission: "One of the

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[129] Prince William Sound Mechanical Response Gap study, Feb 2007, pages 16, 29; Prince William Sound Non-Mechanical Response Gap study, Apr 2008, pages 11, 14, 17.

[130] Prince William Sound Mechanical Response Gap study, Feb 2007, page 53; Prince William Sound Non-Mechanical Response Gap study, Apr 2008, page 30.

[131] 'C-Plan' refers to an Oil Discharge Prevention and Contingency Plan (ODPCP) required under US regulations for OCS operations. For a critique of Shell's C-Plan for its proposed Chukchi operations see, for example, Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, pages 90 to 103.

[132] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 11.

[133] WWF-US Not So Fast report, Dec 2009, page 6.

main challenges for oil spill responders in Arctic waters is the problem of locating oil. Oil spilled into broken ice will tend to move with the ice. Oil is also more difficult to locate if it moves under ice floes or becomes encapsulated into surrounding ice. Visual observations are not an adequate means of detection, as the oil is generally hidden from view beneath the ice."[134]

In their SSRW submission, Imperial state they will consider a number of technologies to monitor oil movement, and that such monitoring "will greatly increase Arctic spill response capabilities" in comparison to the 1970s.[135] And in discussing modelling the trajectory of spilled oil, Imperial states, "algorithms have now been developed and field-tested that can predict with a high degree of accuracy the movement of an oil spill under varying environmental conditions, including in ice"[136]

Once again, however, others do not paint such a confident picture. For example, the staff working paper for the US National Commission notes:

> "The existing method for locating oil in or under ice involves drilling holes in a grid through the ice to detect oil underneath. This method is expensive, dangerous, and not always possible based on ice conditions. MMS has conducted several research studies aimed at evaluating potential solutions to this problem. Ground penetrating radar (GPR) is the only technology viewed as having potential. GPR units can be used by personnel walking on the ice or can be mounted on helicopters flying over the ice at a very low altitude. …
>
> "Though GPR represents an advance over the drilling method, many factors limit its usefulness. MMS's field test report acknowledges that '[d]etection of oil under ice through multi-year ice or rafted/ridged first-year ice might be difficult or impossible.' Other types of rough or pocketed ice will pose similar difficulties. Additionally, though oil slicks may tend to be thicker in the Arctic environment than in other places as a result of the cold temperatures, the oil is still likely to spread out, making the ability to detect only slicks that are more than two centimeters thick a serious limitation."[137]

Similarly, a WWF-US report states, "Detection of thick, oil slicks (>1") under ice 1-7' thick has improved using GPR. However, spills spread rapidly and are usually thin (<0.008"). Slicks less than 1" thick still require responders to resort to the labor intensive, manual approach of drilling holes though ice to detect oil," and "GPR cannot detect thin oil slicks or oil trapped under new ice, young ice, first year ice, rafted ice, rubbles or ridges, or ice thicker than 7'."[138]

The recent Pew report similarly notes the complexities and uncertainties concerning the spread of spilled oil, and difficulties in tracking and modelling its movement. For example:

> "Sea ice is dynamic and constantly moving, … and oil trapped under or within ice could be extremely hard to even locate in the springtime. Oil trapped under multiyear ice could remain in the marine environment for many years. A scenario developed in the mid-1980s

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[134] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 11.

[135] Imperial SSRW submission, Mar 2010, page 6-9.

[136] Imperial SSRW submission, Mar 2010, page 6-7.

[137] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 12.

[138] WWF-US Not So Fast report, Dec 2009, page 6.

> for the Chukchi Sea estimated that spilled oil trapped in ice could move as much as 300 to 500 miles."[139]
>
> "Oil will drift separately from the ice at less than 30 percent ice coverage, and with the ice at 60 to 70 percent (or greater) coverage," but its movement is "unpredictable in broken-ice conditions."[140]
>
> "A 2010 study found that detecting isolated patches of oil amid sea ice is a major challenge to all existing technologies and that darkness, low clouds and fog limit tracking and surveillance methods regardless of ice conditions."[141]
>
> "Predicting the fate of oil in the specific circumstances surrounding any incident, especially in an ice environment, is beyond the capacity of existing models. In fact, in current oil trajectory studies that have been completed for the offshore Alaska Arctic, ice conditions have been excluded entirely because of the inability of NOAA models to account for oil-ice interactions."[142]

Dr. William Adams, in his testimony before the Standing Committee on Natural Resources, also noted some of the complications that could occur in a real world incident, such as how gas accompanying oil in a blowout might alter the spread or characteristics of the oil.[143] This raises further questions relevant to tracking oil, such as how the presence of gas might affect the movement of oil under ice, and whether such gas might break through the ice permitting the oil to reach the surface.

5.4 Mechanical Containment and Recovery

At those times when the logistical, response gap and tracking challenges can be sufficiently overcome, the next question related to response effectiveness concerns the actual techniques to deal with the spilled oil. There are three main ones: mechanical containment and recovery (e.g. boom and skimmers); in situ burning; and chemical dispersants.

With regard to the first, in their SSRW submission, Imperial acknowledges that "the performance window for mechanical recovery would be limited to open water or up to 3/10 ice cover for most equipment."[144] But when it is available, Imperial claims that "a 25% recovery rate, including encounter rate, recovery, storage and disposal, should be possible and 50% could be achieved under favourable conditions."[145]

In marked contrast, only 3% of the total oil spill from the Macondo blowout was estimated to have been skimmed in the Gulf, where conditions and response efforts were no doubt vastly

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[139] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 97.

[140] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 44.

[141] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 72.

[142] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 48.

[143] Standing Committee on Natural Resources, May 25, 2010, page 12, testimony of Dr. William Adams (Research Scientist).

[144] Imperial SSRW submission, Mar 2010, page 6-16.

[145] Imperial SSRW submission, Mar 2010, page 6-16.

better than what could be expected in the Arctic.[146] The staff working paper for the US National Commission explains some of the additional limitations in the Arctic:

> "Skimmers can become clogged with ice and slush, and they need to be positioned between ice floes, which may not always be possible. Additionally, a skimming vessel will break up ice floes, moving the natural ice barrier and letting the oil spread out, thus making it harder to skim. The oil that is skimmed will still likely contain pieces of ice. Although some advances in the material used to make skimmers, such as the development of grooved skimming drums, have improved skimmer efficiency in ice conditions, overall skimming potential is limited by the presence of ice."[147]

The recent Pew report notes that "broken ice trials in the Alaska Beaufort Sea [in the year 2000] … demonstrated that the actual operating limits for mechanical recovery systems – which are typically defined in the literature as being operable in up to 30 percent ice coverage – were closer to 10 percent. During fall freeze-up, ice conditions as low as 1 percent constituted the operating limit for a barge-based mechanical recovery system using conventional booms and skimmers."[148] Given such difficulties, and as summarized by Pew, a 2004 study on oil spill response in ice-covered waters "indicates a 'low' confidence in the ability to improve mechanical response in ice, noting 'improvements likely to be incremental, resulting in modest increases in recovery effectiveness.'"[149]

With regard to specific technologies, in their SSRW submission Imperial claims, for example: "In recent studies sponsored by MMS, research and testing was performed to optimize the use of oleophilic skimmers in the presence of ice. These new designs greatly increase the overall operating efficiency of oil recovery efforts."[150] In contrast, a report by WWF-US references specific MMS studies on such skimmers and concludes:

> "Some improvements were made in oleophilic brush and drum skimmer technology, improving oil recovery in ice conditions by a few percent. MMS research shows that grooved drum skimmers may increase oil recovery by 20% over current skimming systems, <u>improving total overall recovery by only a few percent</u>, if the skimmer can even access the oil.
>
> "This slight increase in skimmer performance over an extremely low recovery rate still leaves more than 80% of the spilled oil in the sea even under the most optimal recovery conditions. In reality, the inability to track the oil, access it, and collect it while it is thick enough to be recovered by mechanical systems is more likely to leave 95%+ of the oil in the sea."[151]

Similarly, in his testimony to the Standing Committee on Natural Resources, Mr. Ron Bowden of Aqua-Guard Spill Response Inc. testified to the difficulty of recovering oil in ice infested waters,

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[146] National Commission Staff Working Paper on the Amount and Fate of the Oil, Oct 2010, page 19.

[147] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 13.

[148] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 88.

[149] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 83.

[150] Imperial SSRW submission, Mar 2010, page 6-10.

[151] WWF-US Not So Fast report, Dec 2009, page 9.

and to the difference between cleaning up oil from a ship versus cleaning up oil from a blowout on the seabed: "There does not exist today technology that can recover oil from ice or under ice, in snow. … In fact, the Exxon Valdez, for example, was a ship that released oil in a bay. The oil in the gulf is being released from one mile below the surface, so by the time it reaches the surface, it's already dispersed. So imagine this, for example, in the Arctic. You can't lay boom around ice; you can't recover oil from the surface because it's hampered by the ice or under the ice. So it's quite a different scenario. There is really no solution or method today that we're aware of that can actually recover oil from the Arctic."[152]

5.5 In-Situ Burning

Imperial states that "in situ burning of oil in both open water and under ice conditions is now acknowledged as one of the most effective spill response options available."[153] Imperial acknowledges that "the performance window for in situ burning is limited in open water, but has potentially high success in ice leads and melt pools. A rate of 10% in open water up to 3/10 ice cover should be expected, and a 90% disposal rate should be expected in ice opened by icebreakers and melt pools in spring."[154] Imperial summarizes the performance of burning using modern advances as "90-100%" for both open water and ice conditions.[155] Shell seems equally confident in materials submitted for proposed drilling off the north coast of Alaska. As noted in a staff working paper for the National Commission, "The Shell C-Plan takes a positive view of in situ burning, asserting that 'the consensus of research' is that it is an 'effective technique with removal rates of 85 to 95 percent in most situations.'"[156]

Once again, however, in marked contrast, only 5% of the total oil spill from the Macondo blowout was estimated to have been burned in the Gulf.[157] The National Commission staff working paper explains some of the additional difficulties likely to be encountered in the Arctic. While it acknowledges that in situ burning "is an important strategy in the Arctic, where there is less risk of having a fire spread out of control" and that "there is potentially less concern about the negative air quality impacts,"[158] it goes on to say:

> "Burning in the Arctic, however, is not without difficulty. In order to stage the fire-proof boom, vessels must be able to … access the area and boom must be pre-staged for quick deployment. Oil is more difficult to ignite at lower temperatures. Chemical 'herders' may be required to gather and thicken the oil, but no commercially-produced herders are currently approved for use in Arctic waters. Oil that enters the water column before hitting

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[152] Standing Committee on Natural Resources, June 15, 2010, page 13, testimony of Mr. Ron Bowden (Manager, International Sales, Aqua-Guard Spill Response Inc.).

[153] Imperial SSRW submission, Mar 2010, page 6-11.

[154] Imperial SSRW submission, Mar 2010, page 6-16.

[155] Imperial SSRW submission, Mar 2010, page 6-17 Table 6-2.

[156] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 15.

[157] National Commission Staff Working Paper on the Amount and Fate of the Oil, Oct 2010, page 19.

[158] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 14.

> the surface, such as from a subsea pipe leak or blowout, will be more likely to become emulsified and spread out once it reaches the surface and will therefore be harder to burn…
>
> As with all response techniques, the efficiency of in situ burning will vary widely. Efficiency rates of 90% were achieved in an experiment in Norway that simulated a tanker spill, but a 1998 well blowout study estimated only 3.4-6.4% efficiency in fall freeze-up conditions on open water."[159]

Similarly, a WWF-US report explains:

> "Most oils spread rapidly on the sea, making the slick too thin for burning to be feasible within a very short time from point of release. … While MMS reports burn efficiencies between 55-98% in cold water and broken ice conditions, these burns were done in lab and field conditions where the oil was contained in a tank or by boom, thickened and available for burning. … These conditions will not be common in an actual spill. Catastrophic oil spills (e.g. well blowouts or subsea pipeline releases) will not provide optimal thick, non-emulsified oil for burning across the spill area.
>
> "In such scenarios, fire-resistant booms are needed to concentrate oil so it can be burned, but fire booms are subject to the same wind, wave and ice limitations as conventional mechanical response booms."[160]

Dr. William Adams, who as a research scientist for Environment Canada was involved in the Beaufort Sea studies in the 1970s in which oil was spilled in a contained area during the winter under landfast ice, explained some of what they found with regard to in situ burning: "Partial disposal of oil by burning is possible, and in June we did begin to try burning. Oil can be burned when it first arises in the spring, but soon after being exposed to the air and the sun, the lighter fractions disperse and you can't burn it. Large areas of the surface can also be contaminated by black soot from the burning."[161]

5.6 Dispersants

Dispersants "are usually used in oil spill response when it is desirable to reduce the amount of floating oil to minimize damage to shorelines, wildlife, and other sensitive resources."[162]

Imperial states: "Cold temperatures do not inhibit dispersant effectiveness. However, colder temperatures do increase the viscosity of the spilled oil, but as long as the pour point of the oil is lower than the ambient water temperature, as is the case for most crude oils and petroleum products, dispersants have been shown to be effective."[163] While Imperial acknowledge that ice can affect dispersant use, such as "through its influence on the mixing energy available to generate and then diffuse small oil droplets," Imperial goes on to suggest that "Energy generated

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[159] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, pages 14, 15.

[160] WWF-US Not So Fast report, Dec 2009, page 11.

[161] Standing Committee on Natural Resources, May 25, 2010, page 12, testimony of Dr. William Adams (Research Scientist).

[162] WWF-Australia submission to Montara Inquiry on oil spill response, Feb 2010, page 16.

[163] Imperial SSRW submission, Mar 2010, page 6-12.

at these ice edges and in broken ice and slush fields is sufficient to disperse chemically treated oil," and that: "In a complete ice cover situation, the mechanical energy provided by a ship's propeller can be used to both expose trapped oil for dispersant application and to shear dispersant-treated oil into a fine oil cloud that will diffuse into the water column."[164]

Imperial concludes, "The performance window for dispersant use has no particular limits. A dispersal rate of 100% for visible encountered oil slicks on the water surface should be possible."[165] Imperial summarizes the performance of dispersants using modern advances as "100%" in open water, and "25-50%" under ice conditions.[166]

But in marked contrast, only 8% of the total oil spill from the Macondo blowout was estimated to have been chemically dispersed in the Gulf.[167] Once again, the staff working paper for the National Commission notes some of the additional difficulties for the Arctic:

> "Dispersants were used extensively in the Deepwater Horizon response and are often a critical component of oil spill response. However, their potential Arctic use is limited by uncertainty over their effectiveness and toxicity in that environment.
>
> "… Application by boat can increase mixing as the vessel churns up the water, but requires a boat capable of traveling in the ice and appropriate weather. Once the oil is encapsulated into or emulsified with the water, dispersants are unlikely to be effective. A 2001 study commissioned by the Prince William Sound Regional Citizens' Advisory Council found that dispersants were less than 10% effective when applied to Alaska North Slope crude oil spilled on water at the temperature and salinity common in the estuaries and marine waters of Alaska."[168]

The staff working paper also notes that "to be effective, dispersants must be applied to fresh crude before it has an opportunity to emulsify or weather," and notes concerns related to "applying dispersant on or near sea birds or marine mammals."[169] The recent Pew report concludes that "Many questions remain about the efficacy of dispersants in Arctic waters, the potential toxicities, and the operational feasibility of applying dispersants in ice-infested waters," and that "substantial scientific and technical work still must be done before dispersants can be considered a practical response tool for the Arctic."[170]

Dispersants can impact the use of other response methods that attempt to remove the oil: "the decision to apply dispersants can have implications on the potential success of other response options, like on-water mechanical recovery. Once a slick is chemically dispersed, it will be much more difficult to corral, concentrate, and recover the remaining un-treated oil."[171] A WWF-

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[164] Imperial SSRW submission, Mar 2010, page 6-13.

[165] Imperial SSRW submission, Mar 2010, page 6-17.

[166] Imperial SSRW submission, Mar 2010, page 6-17 Table 6-2.

[167] National Commission Staff Working Paper on the Amount and Fate of the Oil, Oct 2010, page 19.

[168] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 15.

[169] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, pages 16, 17.

[170] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 80.

[171] WWF-Australia submission to Montara Inquiry on oil spill response, Feb 2010, page 17.

Australia report suggests this is likely what happened in response efforts to the Montara blowout: "Because dispersants were used so persistently during the response, very little of the oil released during the blowout was actually recovered."[172]

Dispersants, of course, only disperse oil – they do not remove it from the environment. As noted in one of the National Commission staff working papers, "As Administrator Lubchenco has stated, 'dispersed or diluted doesn't necessarily mean benign.'"[173] For example, as noted in a WWF-Australia report on response to the Montara blowout, "dispersed oil has been demonstrated to be more toxic to some marine organisms than untreated oil," and "chemical dispersion of oil has been shown to enhance oil uptake and bioaccumulation."[174]

And as noted in the recent Pew report, whether dispersed or not, "The persistence of oil is particularly problematic in cold environments, where biological degradation is greatly slowed."[175] Degradation is slower because "the oil tends to be more viscous and does not evaporate as quickly, making it less accessible to bacteria,"[176] and because the "metabolic rates of bacteria are slowed in cold waters."[177]

5.7 Why Estimates of Effectiveness Differ So

For each of the above three main response techniques, there was a marked difference between the effectiveness rate reported by Imperial versus the rate reported by others and in the Macondo response experience. The recent Pew report provides a highly informative discussion that helps explain these differences.[178] The Pew report explains that many of the higher reported effectiveness rates come from small scale laboratory tests or from controlled field tests, such as those conducted during the Joint Industry Program (JIP) on Oil Spill Response for Arctic and Ice-covered Waters. The Pew report notes there are serious limitations on extrapolating the results from such experiments to real world incidents, for at least four reasons:

- First, the field tests were small scale, conducted under controlled conditions, at pre-selected times and locations where researchers had ready access to the area and were able to pre-position the necessary resources to conduct the experiments as planned. Furthermore, the response methods were applied almost immediately after oil was released into the water, and so it was fresh and remained pooled.
- Second, lab tests usually only involve one or two components of a spill response system, and so do not give a sense of the difficulties of ensuring all the components work together, in which the overall effectiveness can be limited by the weakest link. For example, "a tank test demonstrating that a skimmer will not clog until ice concentrations exceed 40 percent

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[172] WWF-Australia submission to Montara Inquiry on oil spill response, Feb 2010, page 19.

[173] National Commission Staff Working Paper on the Amount and Fate of the Oil, Oct 2010, page 22.

[174] WWF-Australia submission to Montara Inquiry on oil spill response, Feb 2010, page 28.

[175] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 52.

[176] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 47.

[177] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 52.

[178] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, pages 84 to 89.

coverage does not mean that the full oil spill recovery system – vessels, boom, skimmer and storage barge – could operate safely or effectively up to that limit."[179]

- Third, field tests only report on success of response to one patch of oil, and so caution is required before extrapolating such reports to the total volume of oil spilled.
- And fourth, as discussed above, there are times in the real world when some or all response methods are simply not possible, due to logistical, response gap or tracking difficulties. For example, sufficient vessels might not be available, if available they might nevertheless not be able to access a spill due to weather conditions, and if available and able to get out on the water they might nevertheless not be able to find significant quantities of the oil (or they may have been so delayed that the oil is weathered and/or emulsified making response less effective).

With regard to in situ burning, for example, the Pew report explains:

> "In-situ burning tests conducted as part of the JIP showed that 98 percent of pooled oil can be burned in three-tenths ice coverage. However, the oil was introduced into a pre-contained area at the desired thickness, then immediately ignited, and all vessels were on site and standing by. In the real world, the oil would have to be contained using fire booms or other barriers, and vessels would have to be able to navigate in and around the burn area, all before the oil became significantly weathered or emulsified. And even if the burn were extremely efficient and removed 98 percent of the oil within the containment area, the oil contained within that single burn might represent only a fraction of a percent of the total amount spilled."[180]

5.8 Suggested Studies

In light of the above discussion, it appears that the fraction of spilled oil that might be recovered in an Arctic release would be the product of several limiting factors:

- First, logistics: difficulties in mobilizing the necessary materials, equipment and trained personnel in sufficient quantities and in a timely manner, including transporting them to the accident site and maintaining them there (e.g. housing personnel).
- Second, response gap: the inability to use available materials, equipment and personnel at certain times because of adverse environmental factors such as weather, sea state and visibility conditions.
- Third, tracking and response technique effectiveness: when equipment and personnel are available and can be used, the limited effectiveness in finding significant amounts of the spilled oil and the limited effectiveness in then recovering, burning or dispersing it.

As noted in the above discussion, there are a number of interactions here – for example, delayed mobilization of personnel and equipment or delays due to a response gap will allow time for the oil to drift, to be weathered, or to be encapsulated in ice, all likely reducing the effectiveness of tracking (i.e. finding the oil), and then recovering or burning it. It is therefore necessary to

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[179] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 113.

[180] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 88.

understand not only the limitations imposed by each of the above limiting factors individually, but also how these limiting factors combine, in order to determine the ultimate percentage of oil that might be recovered from an Arctic spill.

We therefore suggest the Board commission the following studies:

<u>Suggested Study 4: Logistical challenges in responding to an Arctic offshore oil spill</u>

a) What challenges would be encountered in mobilizing, transporting and maintaining materials, equipment and personnel to respond to an Arctic offshore spill, for different regions of the Canadian Arctic?

b) What time delays in doing so might be expected?

<u>Suggested Study 5: Response gap in the Arctic offshore</u>

a) To be most useful, this study would not just collect existing information on response gaps in Arctic waters, but would actually conduct a response gap analysis akin to the analysis undertaken for Prince William Sound discussed above, taking Canadian Arctic conditions (including ice) into account. Thus this study might include the following:

b) Identify the data needs to conduct a response gap analysis for the Canadian Arctic offshore (e.g. data on wind, visibility, temperature, sea state, ice conditions, etc), and determine if such data is available.

c) Estimate the operating limits for each of the oil spill response techniques expected to be used in a response to an oil spill.

d) Apply the available data to the operating limits to determine the percentage of time that each response technique could be attempted.

e) This study might analyze the response gap for one location in the western Canadian Arctic (e.g. at Imperial's proposed Ajurak site) and another in the eastern Canadian Arctic. Ideally a response gap analysis would be conducted for each ice zone (i.e. moving pack ice, landfast ice, and the intermediate ice zones).

<u>Suggested Study 6: Effectiveness of tracking and response techniques in Arctic waters</u>

a) What are the effectiveness rates for tracking and for the different oil spill response techniques in Arctic waters?

b) This study would be careful to explain when effectiveness rates come from controlled tests, and discuss the extent to which such results might extrapolate to a real world Arctic offshore incident. This would consider, for example, how oil mixed with gas emerging from a seabed blowout would differ from oil spilled onto the sea surface in a controlled experiment.

c) This study would also be careful to distinguish between a surface spill, such as in controlled experiments, and a spill from a seabed blowout, given that oil spilled from the latter would emulsify and spread to a different degree than from the former.

d) In the case of a blowout that was not brought under control in the same season and thus continued through the off-season, how effectively could the oil, which may be spread over several hundred kilometres and either under or encapsulated in ice, be tracked?

e) What improvements in effectiveness rates might be possible for the three main response techniques, versus what are likely inherent limitations?

Suggested Study 7: Overall effectiveness of responding to an Arctic offshore oil spill

a) From the above three studies, estimate the overall effectiveness of response to an offshore Arctic oil spill, taking into account interactions, such as logistical or response gap delays decreasing tracking and response technique effectiveness.

b) Identify factors that might change the overall effectiveness from one region of the Canadian Arctic to another.

6 SOCIAL-ECOLOGICAL IMPACTS OF SPILLED OIL

Compared to other regions, there appears to be limited ecological baseline information on arctic marine ecosystems, and limited information on the impact that an oil spill would have on such ecosystems. Credible environmental assessments of proposed drilling activities, and credible monitoring afterwards, will thus likely be a challenge. This section therefore just gives a taste of some of what is known and what is not, before suggesting some studies.

6.1 Impacts on Species and Ecosystems

Some of the more comprehensive studies to date for the western Canadian Arctic were conducted in the 1970s as part of the Beaufort Sea Project, which resulted in a number of technical and overview reports. The overview reports included, for example, a report on Birds and Marine Mammals, and another on Fishes, Invertebrates and Marine Plants.[181]

More recently, the Pew report notes that: "Characteristics of many Arctic species put them at a heightened risk for impacts from oil spills. Many Arctic animals have long life spans and slow reproductive rates, potentially prolonging population level impacts."[182]

The Pew report explains that types of phytoplankton and amphipods have been found to be particularly sensitive to oil, and that recovery can take considerable time and have "reverberating impacts across the food web."[183] Higher up the food chain: "One lesson from the Exxon Valdez spill was that fish embryos and larvae are far more sensitive to oil than are adult fish, making previous toxicity calculations a drastic underestimate."[184] Arctic seabirds appear to be especially vulnerable to oil spills, and "a large spill can cause a massive acute die-off of oiled birds."[185]

As for mammals, "In case of a spill, whales may pass through the oil, exposing their bodies to harmful hydrocarbons. No research has studied the toxic effects of inhaled or ingested oil on bowhead whales, but scientists believe the consequences would be similar to those for polar bears and seals, which are both seriously affected by oiling."[186] Toxic contaminants from oil can accumulate moving up the short Arctic food chains, as predators eat and thus absorb the contaminants from their prey at each level (known as 'bio-magnification'). For example, "Beluga whales … feed higher in the food web and may be exposed to toxic compounds that are accumulated in lower trophic species."[187] So too might seals and polar bears.

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[181] These overview reports are briefly summarized at http://www.aina.ucalgary.ca/scripts/minisa.dll/144/hiproe/hiproeya/sisn+1172+or+sisn+3222+or+sisn+21027+or+sisn+29580+or+sisn+47661?COMMANDSEARCH.

[182] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 53.

[183] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 56.

[184] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 52.

[185] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 59.

[186] National Commission Staff Working Paper on Oil Spill Response in the Arctic, Oct 2010, page 21.

[187] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 58.

"The most obvious toxic impact of spilled oil is direct contact with wildlife and habitat. Images of oiled animals and shorelines dominate typical media coverage of major oil spills. Yet toxic impacts from spilled oil persist beyond direct oiling, and the long-term toxicities and complex interactions between spilled oil and ecological processes are still the subject of considerable research and debate. Although oiled wildlife provides the most vivid images of a spill's impact, the level of ecosystem harm is much greater than the acute mortality would suggest. Long-term ecosystem impacts come from chronic exposure to oil in sediments and beaches, reduced fitness of animals exposed to sublethal doses of oil, and impacts through the food web."[188]

6.2 Polynyas and Leads

Open water areas between ice cover hold special significance, in that they concentrate life, oil and response activities, thus increasing the chances that a spill will affect a large number of animals.[189] As noted by the recent Pew report, for example, "Many of the oil spill response plans developed by the industry for Arctic OCS drilling propose to concentrate oil spill response activities within open water areas that occur when sea ice is present. However, these open water areas – referred to as ice leads or polynyas – are a major source of nutrients in the Arctic and are considered to be of vital importance to the entire marine food web, including marine mammals… Concentrating oil in these open water areas so that it could be burned or removed with skimmers would have unforeseen food web impacts and could increase the likelihood that marine mammals will contact the oil as they come up to breathe."[190]

Similarly, in discussing the spring Bowhead whale migration through the US Chukchi and Beaufort Seas, the recent Pew report notes that, "Bowhead whales are vulnerable to oil spill impacts because of their concentration at ice edges and leads where spilled oil may concentrate," and that "calves would be even more vulnerable than adults, because they need to surface more often to breathe and have less ability to travel under ice or to break ice to breathe."[191] The Pew report notes that Beluga whales might be similarly exposed. And as for Arctic seabirds, "Many seabirds congregate to feed at ice edges, polynyas and open leads, where their prey species congregate and where oil may concentrate."[192]

6.3 Knowledge Gaps

As explained in the recent Pew report, there is a "relatively small data set" and hence "limited understanding" on the impacts of oil spills in Arctic waters.[193] "A 2007 assessment of worldwide oil exploration and production activities in Arctic regions emphasizes that the current state of knowledge regarding Arctic oil spill impacts and oil toxicity to Arctic species is extremely limited. Significant research is needed on the behavior of oil spilled in ice-filled seas, the

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188 Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 51.

189 Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 54.

190 Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, pages 7, 8.

191 Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 58.

192 Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 59.

193 Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 53.

vulnerabilities of Arctic ecosystems to oil toxicity, and the short- and long-term impacts of oil spills on Arctic food webs, plants, animals and people."[194]

The US Arctic Research Commission similarly recently noted: "Fundamental baseline scientific information is lacking for living resources in much of the region, and basic biological aspects, such the ecology of the area, and the spatial habitat of flora and fauna that might be at risk from spills are poorly known. Information is also required on the effects of oil on wildlife and on effective response intervention."[195]

And Dr. William Adams, who was a research scientist with Environment Canada and was involved in the 1970s 'Beaufort Sea Project' which studied "the physical and biological impacts of the largest – to date – controlled experimental crude oil spill on sea ice,"[196] recently testified before the Standing Committee on Natural Resources:

> "My recommendation is that, first, more research is needed to assess the degree of risk. Secondly, I recommend a moratorium on drilling that is not either on landfast ice or in shallow water areas until the required technological capability and scientific knowledge is in place. Our present knowledge base is not adequate for the open-water situation in deep drilling, and is certainly not adequate to risk drilling in deeper ice-covered Arctic waters."[197]
>
> "Basically, if there were a blowout in the Beaufort Sea or in the Arctic, particularly in the moving pack ice area, we do not have a base of knowledge to be able to predict what would happen."[198]

6.4 Suggested Studies

As discussed above, knowledge gaps, both in terms of baseline ecological information and in terms of the impact of an oil spill on species and ecosystems, appear to be of special concern in the Arctic. In order to understand the potential consequences of oil released into the Arctic environment, it will also be necessary to understand how oil changes over time in the Arctic marine environment. In the Beaufort Sea we would need to understand, for example, where and how much of the heavy fraction oil might sink, contaminating the benthos, and how the low-salinity plume of the Mackenzie River would affect the precipitation of heavy fractions if a spill were to occur there or migrate there. And we would need to understand where lighter fractions might be carried within the water column and on the surface by tides and currents.

We therefore suggest the Board commission the following studies:

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[194] Pew Arctic Oil Spill Prevention and Response Report, Nov 2010, page 107. See also Pew Arctic Oil Spill Prevention and Response Policy Recommendations, Nov 2010, pages 5, 6.

[195] Arctic Research Commission White Paper on research needs, May 2010, page 2.

[196] Standing Committee on Natural Resources, May 25, 2010, page 11, testimony of Dr. William Adams (Research Scientist).

[197] Standing Committee on Natural Resources, May 25, 2010, page 12, testimony of Dr. William Adams (Research Scientist).

[198] Standing Committee on Natural Resources, May 25, 2010, page 16, testimony of Dr. William Adams (Research Scientist).

Suggested Study 8: Fate of oil in the Arctic marine environment

a) How would oil be expected to change over time in the Arctic marine environment, such as via weathering, emulsification, evaporation, and sedimentation, and what is the expected lifetime of its toxicity?

b) How would salinity and temperature stratification of water layers (due to, for example, Mackenzie River outflow and/or ice melt) affect oil behaviour and spread?

c) To what extent is it possible to predict the trajectory of an oil spill in the Arctic? For example:

  i) What are the general approaches used for spill trajectory modelling, how can such modelling take Canadian Arctic conditions into account, and what are the major gaps in modelling techniques to confidently take those conditions into account?

  ii) What are the types of data necessary to model spill trajectories (e.g. bathymetry, local wind, tides, sea currents, and ice conditions), and is adequate data being collected and made available in key regions of the Canadian Arctic?

Suggested Study 9: Spill trajectory modelling in Arctic waters

a) To be most useful, this study would not just collect existing information on spill trajectory modelling, but would actually develop a model and apply it – thus this study might include:

b) Using the most appropriate modelling techniques and data available, develop a model that can be used to predict the trajectory of different release quantities and durations over time in the Arctic, for different environmental conditions such as weather, sea ice, and sea currents.

c) Model the trajectory of a hypothetical blowout in the Canadian Arctic for a number of different durations (e.g. from a few weeks or months assuming the blowout was controlled within the same season, to a few years assuming it was not), and identify the level of confidence for the modelling results.

d) This study might focus on a hypothetical blowout lasting for different durations at a deepwater site in one of the exploration licence areas granted in the past few years (e.g. might use Imperial's proposed Ajurak well site), and if possible also for a site in the eastern Arctic.

Suggested Study 10: Ecological baseline gaps and knowledge gaps for oil impacts on Arctic life

a) What are the major knowledge gaps related to each of the following questions that are relevant to understanding and monitoring the short- and long-term impact of an oil spill and other potential impacts from offshore drilling, what research is underway to fill those gaps, and what additional research and funds are necessary to do so:

  i) What species live in the path of a hypothetic oil spill and thus what species would potentially be impacted by it?

  ii) How would an oil spill impact those species?

iii) How would an oil spill impact the food chain, such as through population impacts and bio-magnification, or otherwise impact the Arctic marine ecosystem?

iv) What environmental features are particularly sensitive to oil impacts?

v) How would the three main response techniques impact Arctic marine species and ecosystems, such as from in situ burning residue and soot (including the potential impact of soot on albedo and ice melt), or dispersant toxicity?

7 Financial Responsibility and Liability

7.1 Estimating the Cost of a Major Blowout

Following the Macondo blowout, BOEMRE calculated the cost of a catastrophic spill resulting from a deepwater blowout in the Gulf of Mexico to be about $16.3 billion, resulting primarily from: "(1) Natural resource damage to habitat and creatures, (2) infrastructure salvage and cleanup operations of areas soiled by oil, and (3) containment and well-plugging actions plus lost hydrocarbons."[199] BOEMRE estimated the major costs as follows:[200]

Cost	*$ million*
Damage / loss of drilling rig	338
Well containment (e.g. same-well and relief well interventions)	1,467
Lost oil and gas	362
Natural resource damage and assessment	2,880
Oil spill response and damage assessment	10,970
Other (e.g. recreational losses, commercial fishing losses, human mortalities and injuries)	270
Total	*16,287*

BOEMRE acknowledge there is of course a "considerable degree of uncertainty" in estimating the costs of a future spill, given the unknown timing, magnitude, duration and trajectory of such a spill,[201] and that spill costs "could be much higher if all costs … could be monetized."[202] But given that costs potentially specific to the Gulf of Mexico (such as commercial fishing and recreation) do not figure highly in their calculation, and that "possible losses from human health effects or reduced property values have not been quantified in this analysis,"[203] BOEMRE's calculation might provide a suitable starting point for estimating the costs of a major Arctic spill.

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[199] BOEMRE Drilling Safety Rule, Oct 2010, page 63364. BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 7.

[200] BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 32 Table 4, page 63 Table 23, and page 64 Table 24.

[201] BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 33.

[202] BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 63.

[203] BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 7.

Recent media reports suggest the actual cost of the Macondo spill could be considerably higher than the above estimates, with the latest reports putting the cost at about $40 billion.[204]

Some factors suggest that the cost of a spill in the Arctic could be considerably higher. For example, the above estimate for natural resource damage was based on an estimate of $604 of damage per barrel of oil,[205] but BOEMRE notes that "a future catastrophic spill could result in a significantly higher natural resource damage value per barrel spilled, depending on the circumstances. In the Exxon Valdez oil spill, which resulted in a release of 261,905 barrels of oil, natural resource damages plus assessment costs averaged $5,005 per barrel."[206] Using this higher figure would add over $20 billion to the above figure of $16.3 billion.[207] Costs for an Arctic spill could also be considerably higher given the additional challenges in the Arctic, such as the potentially increased time to contain a blowout and respond to spilled oil given weather and ice conditions, the reduced amount of local infrastructure, the increased distances to transport equipment and personnel, etc.

7.2 Recent Required Levels of Financial Responsibility

Eric Landry testified before the Standing Committee on Nature Resources that, "The amount of financial responsibility or liability is set at approximately $350 million, in the case of the offshore boards. That would apply to both Newfoundland and Labrador and Nova Scotia."[208] And according to Mimi Fortier, "Recently, in the Beaufort Sea, the last well had to show its financial capability to meet a liability up to $1 billion."[209] A recent media story announced that "Greenland is demanding that oil companies bidding to drill in huge areas of its Arctic waters each pay an estimated $2bn (£1.25bn) upfront 'bond' to meet the clean-up costs from any large spill."[210]

Compared to the above BOEMRE estimates, and the actual cost of the Macondo blowout, these appear to be at least an order of magnitude too small.

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[204] Guardian story on BP oil spill costs, Nov 2010.

[205] BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 37

[206] BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, page 39.

[207] BOEMRE calculated $2.88 billion for natural resource damage and assessment by multiplying $604 per barrel by 4.77 million barrels, a blowout scenario based on an estimate of the amount of spilled oil from Macondo (BOEMRE Drilling Safety Rule – Benefit-Cost Analysis, Sep 2010, pages 12, 34 to 39). Replacing $604 by $5005 gives $23.87 billion, which is $20.99 billion more than $2.88 billion.

[208] Standing Committee on Natural Resources, June 15, 2010, page 10, testimony of Mr. Eric Landry (Director, Frontier Lands Management Division, Petroleum Resources Branch, Department of Natural Resources).

[209] Standing Committee on Natural Resources, June 15, 2010, page 10, testimony of Ms. Mimi Fortier (Director General, Northern Oil and Gas, Department of Indian Affairs and Northern Development).

[210] Guardian story on Greenland bond requirement, Nov 2010.

7.3 Suggested Study

Given the above apparent discrepancy between the level of financial responsibility required and the actual costs of a major deepwater blowout, and the potential that a blowout in the Arctic offshore could be even more costly, we suggest the Board commission the following study.

<u>Suggested Study 11: Potential cost of an Arctic offshore blowout</u>

a) Estimate the potential total cost of a major blowout in the Arctic offshore, including loss of natural capital and ecological services.

b) This study might estimate such costs for a few blowout durations, such as a few weeks or months assuming the blowout is brought under control in the same-season, to a few years assuming it is not.

c) This study would be careful to discuss the appropriateness of extrapolating cost estimates from elsewhere to the Arctic, and to consider potential additional costs in the Arctic.

References

All references, other than those already on the NEB's website, are attached.

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WWF-US Not So Fast report, Dec 2009	*Not so Fast: Some Progress in Technology, but US Still Ill-Prepared for Offshore Development – A Review of U.S. Department of the Interior, Minerals Management Service (MMS)'s "Arctic Oil Spill Response Research and Development Program – A Decade of Achievement."* December 2009. Commissioned by WWF-US, prepared with the assistance of technical expertise from Harvey Consulting, LLC. Available at http://www.worldwildlife.org/what/wherewework/arctic/WWFBinaryitem14712.pdf.

APPENDIX: SUMMARY OF STUDIES

This submission has suggested the following studies (please see indicated page for suggested study details and the section preceding that page for discussion):

The following individuals and consultants might be appropriate to undertake one or more of these studies:

- For oil spill simulations etc: Triton Consultants Ltd, Vancouver, BC. Website: http://www.triton.ca.
- For response gap analysis etc: Nuka Research and Planning Group, Seldovia, Alaska. Website: http://www.nukaresearch.com.
- For effectiveness of oil spill recovery techniques etc: Harvey Consulting, LLC. Contact Susan Harvey, Eagle River, Alaska.
- For human errors in challenging conditions etc: Dr. Mark Fleming, Saint Mary's University.