WESTERN GRAY WHALE ADVISORY PANEL **WGWAP 1/INF.15**

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MARINE OIL SPILL PREVENTION AND RESPONSE

Sakhalin II: Summary of Oil Spill Response in Ice Conditions

Submitted by SEIC

SAKHALIN II:
SUMMARY OF OIL SPILL RESPONSE IN ICE CONDITIONS

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OVERVIEW

General view of winter ice conditions, offshore Sakhalin. Note the mix of ice ages, rubble and rafting and active leads. (Photo: SEIC)

Oil spill prevention and response are managed within the framework of Shell's Management Systems. Shell Companies are committed to compliance with the relevant legislation, the prevention of accidental spills and being among the leaders in oil spill preparedness and response capability. To this end, Shell recognises the priority of preventing oil spills and promotes the high standards this demands among employees, contractors, and others associated with handling oil products. Shell also seeks to maintain and continuously improve the oil spill response (OSR) capabilities to minimise the impact of oil spills on the environment.

This response approach is in line with the Tiered Response concept of the International Petroleum Industry Environmental Conservation Association (IPIECA), which classifies the need for response capabilities in terms of the size of spill and its proximity to a company's operating facility. Sakhalin Energy Investment Company (SEIC), a Shell operated venture, fully endorses these principles in their exploration, development, production, and associated activities.

Best international practices

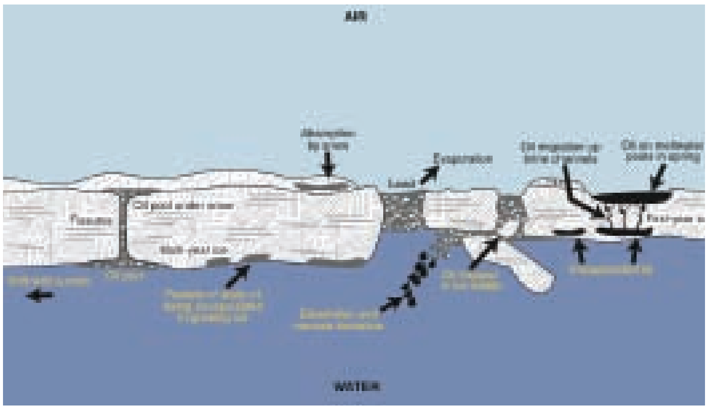
Sakhalin Energy's activities are conducted with the objective of not causing harm to the environment. The Company firmly believes that they can find, develop and produce oil and gas in an environmentally responsible manner and in consultation with all stakeholders. Sakhalin Energy conducts its operations in compliance with national and local legislation/regulation, utilising current industry standards and guidelines, and best international practices. It places primary emphasis on the prevention of spills through the careful design of facilities, detailed operating procedures, maintenance, and training of personnel.

In addition, spill prevention measures such as pipeline leak detection systems by flow measurement, corrosion prevention control, and ongoing maintenance and inspection are part of the programmes in place.

A key environmental component of the Sakhalin offshore winter is ice. Ice presents different challenges to oil spill response than open seas. This challenge is being addressed in all phases of the project by allocating the proper staff and budget resources so that the spill planning and response processes are technically and scientifically sound. In line with industry practice, Sakhalin Energy is assessing the best technologies and procedures available to finalise a response plan before commencing year-around production in 2008.

Sakhalin Energy and Shell have an excellent understanding of the operating environment and believe that the results to date, the ongoing efforts, and the planning that is underway have been outstanding as highlighted below:

- Sakhalin Energy has an excellent record of spill prevention. Since partial year production operations started in 1999, the total volume of oil spilled at Sakhalin Energy operated assets is approximately 350 litres (2.2 barrels), while production has totaled approximately 72 million barrels of oil (or about one litre for every 32.8 million litres produced). The volume spilled includes all sources such as operational movements of diesel fuel that makes the outstanding performance even more significant.
- While ice cover can restrict access to oiled areas, fast ice attached to shore may also act to prevent oiling of shorelines by marine spills. For example, ice covers of between 50% and 70% will greatly inhibit oil spreading and ice coverage of more than 70% will effectively contain the oil. In this instance, oil will collect in leads, enabling direct recovery with skimmers, provided that vessels can locate and access the oil.
- The ice in the northeast of Sakhalin is not a solid sheet of unbroken ice but contains numerous open “leads” in which spilt oil will accumulate. Oil can potentially be recovered from these leads



Schematic showing a number of possible configurations of oil in sea ice.
Note that there is no multi-year ice off Sakhalin (Bobra and Fingas, 1986)
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- In more open ice, booms will be used in the form of “side sweep” systems that will be stored on board each of Sakhalin Energy’s standby vessels. All booms will be heavy duty to withstand ice abrasion. Sakhalin Energy will also deploy other proven methods for oil clean up in ice conditions, such the use of Brush Bucket Systems, Rope Mop (“Foxtail”) Systems, and Weir Skimmers.
- In the case of oil recovery under ice, Sakhalin Energy ice-breaking standby vessels can break through ice and bring oil to the surface for recovery. Vessels will be equipped with incendiary devices to ignite oil on ice, or oil contained between ice floes. This method is known as in-situ burning.
- Sakhalin Energy OSR continues to assess new technology with a view to acquiring and incorporating them into oil spill response preparedness. This is an ongoing process and an ongoing commitment.
- In terms of ice surveillance and monitoring, Sakhalin Energy is developing procedures specifically tailored to Sakhalin environmental conditions (including ice) and Sakhalin oils. The Company has obtained state of the art surveillance technology and is reviewing the applicability of available remote sensing systems that are currently in use or being developed.
- Finally, Sakhalin Energy is committed to further feasibility and planning, by initiating and funding projects on its own, as well as with industry partners and peers.

OIL SPILL RESPONSE IN ICE

The risk of oil spills and potential consequential environmental damage is a major public and government agency concern. This concern is shared by Sakhalin Energy and Shell alongside the other shareholders and stakeholders to the Sakhalin II Project. The management of potential oil spills is and will be an integral part of the detailed design of all facilities, which incorporate measures to minimise the likelihood and severity of a spill.

While the risk of spills is low, high performance in Oil Spill Response (OSR) is essential for Sakhalin Energy. To this end, Sakhalin Energy is committed to ongoing development and research, aimed at developing and continually improving the overall management of OSR risk issues in Sakhalin Energy's Phase II Project.

Sakhalin Energy Phase 1 operations started in 1999. Phase 1 has its own OSR plan that is fit for purpose for the activities undertaken during those operations. Due to operational limitations presented by the presence of winter ice and the lack of a pipeline for transporting the oil and gas, Phase 1 only operates for approximately six months of the year and does not produce oil in the ice season.

Key OSR work initiatives for Sakhalin commenced in 1999 and it is ongoing. OSR development is described in a wide variety of documents including the Environmental Impact Assessment (EIA), EIA-Addendum chapters, conceptual OSR planning document and other reports. Since the EIA was prepared in 2003, the OSR planning process has been significantly developed. More specifically, the EIA and additional reports provide information relating to the specific issues such as onshore and offshore oil spill response planning. This includes oil spill trajectory modeling, the identification of sensitive areas, the planned level of resources for oil spill response, and future oil spill response related work programs. Sakhalin Energy has extensive experience in operating in ice conditions and has experienced staff and contractors with extensive knowledge of operating in ice. Technology is available for oil spill response (OSR) in ice conditions.

The company has been proactive in ensuring that it acquires the best available technology for oil spill response of all kinds – including ice conditions – and will publicly disclose versions of the final OSR plans once they have been approved by the authorities and prior to commencing year around operations.

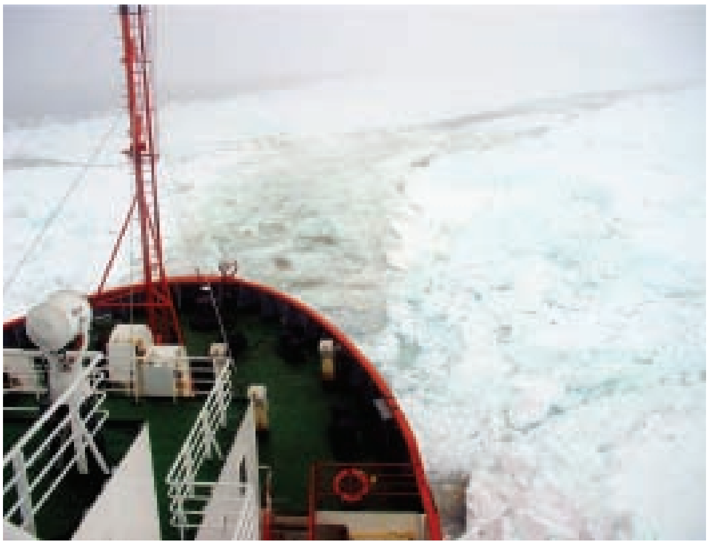
Sakhalin Energy will have icebreaking vessels on standby to ensure that should any emergency occur, vessels will be on scene to deploy equipment rapidly and effectively. The Company is developing OSR capacity in the region in full partnership with both federal and regional government and also industry partners.

The Fate and Behaviour of Oil in Ice

There are numerous options available to recover oil in ice conditions depending on the ice and the nature of the spill. While ice cover can restrict access to oiled areas, fast ice will act to prevent oiling of shorelines by marine spills during the winter. In some cases, a portion of the oil will collect in leads enabling direct recovery with skimmers, provided that vessels can locate and access the oil.

In more open ice, booms will be used in the form of "side sweep" systems that will be stored on board each of the standby vessels. All booms will be heavy duty to withstand ice abrasion. Sakhalin Energy will also deploy other proven methods for oil clear up in ice conditions, such the use of a Brush Bucket Systems, Rope Mop ("Foxtail") Systems, and Weir Skimmers. In the case of oil recovery under ice, Sakhalin Energy ice-breaking standby vessels can break through ice and bring oil to the surface for recovery. Vessels will be equipped with incendiary devices to ignite oil on ice, or oil contained between ice floes. This response method is known as in-situ burning.

Ice-breaking vessels stationed at each platform and facility undertake winter oil spill response. These vessels are on 24-hour standby and break up the ice at each platform. Trained crews will deploy OSR equipment from these vessels. Strategies and methods in the OSR Plans are based on existing proven techniques. Strategies and equipment selected by Sakhalin Energy represent world's best practice and are based on a review of available technologies (see Table 1 below for a summary of what is intended for the vessels).



Overall view of offshore response/standby icebreakers

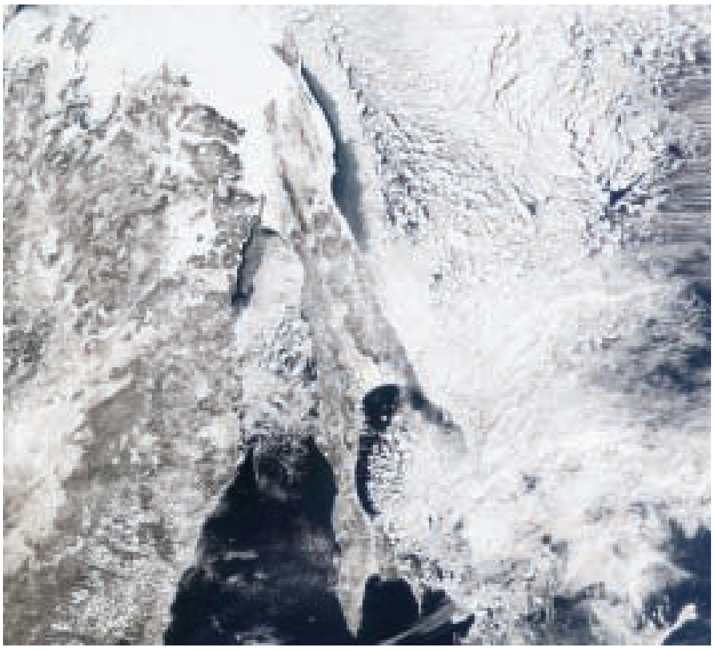
Table 1 Planned Vessel OSR Equipment

ITEM	QUANTITY
Ocean boom neoprene 1500 (in 50m sections) - 200m on reel, draft 1.5m, freeboard 0.8m, reel, hydraulic power pack for reel and skimmer with hoses, hydraulic air fan for boom inflation, tow bridles	2 (400m)
Side sweep system (including jib arm and approx 50m boom)	1
Side sweep system (including jib arm and approx 25m boom)	1
Ocean skimmer (disk/brush) + spares, hoses, power pack, hydraulic submersible transfer pump and hoses	1
Brush Bucket Skimmer/Rope Mop (Foxtail) system	1
Ocean Skimmer (Weir) + spares, hoses, power pack	1
Transfer pump + hoses	1
On-deck vessel-work skiff and Fast Response Craft	1 each
Drift Tracking Buoys	2
In-Deck Storage for recovered oil in vessels	>750 m3
On-deck storage tanks or pillow tanks of 100m3 capacity	100 m3
Steam cleaners	2
Incendiary device (winter only)	8
Oil in ice skimmer system (winter only)	1

Ice Conditions in North East Sakhalin and Aniva Bay

The ice in the northeast of Sakhalin is not a solid sheet of unbroken ice but contains numerous open “leads” in which spilt oil will accumulate. Oil can be recovered from these. In addition, the ice-breaking vessels that will be on standby can break the ice, support other recovery vessels and expose any underlying oil. Prevailing ice conditions at these locations are described in Table 2.

Ice conditions in Aniva Bay are much less severe than off the NE Sakhalin shelf. In Aniva Bay, near the TLU and LNG marine terminal facility sites, freeze-up typically begins in mid-January, one to two months later than freeze-up further to the north. Once formed, the ice cover in the Aniva Bay area normally persists until late March to early April. The duration of significant ice cover is highly variable and can be less than two months. Fast ice is not an annual feature, and average drifting pack ice concentrations are in the range 60%-90%. Around the terminal locations, thin ice conditions similar to those in the polynya further north, are very common in winter. In unusual situations thicker floes can move down from further north and enter Aniva Bay. Floe sizes are generally small.



A satellite image of Sakhalin Island

Table 2: Ice Conditions Offshore NE Sakhalin

ICE CHARACTERISTIC	EXPLANATION	NE SAKHALIN CONDITIONS
Ice season		125 to 195 days
Ice thickness	Rafting of ice may significantly increase ice depth. Rubble formation and ridging increase both draft and height (surface elevation).	Between 5-200 cm thick. Ice drifting from other areas may have greater thickness. Usually highly variable.
Ice concentration	Describes the amount (measured in tenths, or coverage in percentage) of the water surface covered by ice as a fraction of the observed area, that 10/10 will mean that 100 % of observed area is covered by ice.	At the end of freeze up period (generally 15-30 days), maximum ice concentrations range from 9/10 to 10/10. The concentration of any ice in the area may vary from 0 to 10/10. When all ice types (thin to thick) are included, typical concentrations are generally in 9/10 or more. However, the level of coverage doesn't describe ice conditions and level of operability completely.
Flaw lead	Flaw leads (or polynya) are very thin ice (up to 30 cm thick approx.) with open water leads, between the narrow land-fast ice zone and the heavier pack ice areas towards the east. These can persist for periods of days to several weeks during winter.	Thin flaw leads are quite common at Piltun and Lunskoye, and over the pipeline routes, particularly during the early January to mid March. When the flaw lead occurs, it can result in thin drifting ice conditions (less then 30 cm thick) at the platform sites and over the sub-sea pipeline to the coast (or the landfast ice edge if it exists).
Ice floe size		Floes may be of different size, particularly in mid-ice season. There are reports of ice floe size more than 30-35 km across. Typically, floe sizes are smaller during the freeze-up, early winter and break-up periods, with most floe having dimensions of tens of meters to several hundred meters. In mid-winter, ice floes are characteristically larger, in the range of hundreds of meters to a kilometre or more.
Ice drift speed		Ice drift speed for NE Sakhalin is quite variable and depends on winds and tidal currents. It may achieve 170 cm/sec (more than 2 knots). However, in the average this speed is about 20-30 cm/sec.
Fast ice parameters		A narrow strip of fast ice is typically found along the shallow waters adjacent the coast. This strip of ice attached to shore is very unstable and can appear and disappear a few times per season. Maximum estimated level ice thicknesses are in range of 1.6 to 1.7 m. Based on field measurements, rafted (or layered) ice areas in the fast ice have been reported to have an average thickness of 1.9 to 2.2 m, with maximum values of 3.5 m in occasional drill holes.

KEY OIL SPILL RESPONSE STRATEGIES

Spill response strategies for working in offshore ice conditions rely on some of the same methods used at other times of the year but with the addition of strategies and equipment to both utilize and compensate for the presence of ice. The issues posed by oil spilled in ice are well known and understood by Sakhalin Energy. Extensive research and practical field experience by consultants, equipment manufacturers, academia, government agencies, spill response organizations, and industry over the past thirty years have led to a broad knowledge base on the fate of behaviour of oil in different types of ice and on the necessary strategies to deal with different spill situations in ice.

A wide range of ice conditions needs to be considered in developing the most effective response strategies. The main differences between OSR in ice and open water centre around the different operational limitations that ice imposes on marine equipment and the implementation of different strategies. For example, ice can restrict access to areas impacted by the oil, and in some situations make it difficult to locate oil that has collected under the ice. Specialized ice capable response vessels are required.

Offshore oil spill response may involve the application of a number of strategies independently or in some cases concurrently: detection and monitoring, physical containment and recovery, controlled in-situ burning, and the application of chemical dispersants if allowed by the authorities. Other response activities may include shoreline protection and cleanup, as well as the disposal of recovered oil/debris and burn residue. As with any spill that may occur anywhere in the world, there are times and conditions when it is simply not practical or safe to deploy personnel and equipment for any of the above activities. Should the presence of moving broken ice, poor visibility, high wind/sea conditions, etc. preclude a safe and effective response, it is best to track and forecast the spill movement and be ready to activate offshore, nearshore or shoreline response as soon as it is safe to do so.

Cold water spills

Oil spilled in cold water spreads more slowly than it does in temperate open water, and stays at a greater thickness. In concentrations of 60% and above, the ice floes themselves provide a high degree of natural containment and provide an effective physical barrier to the spread of oil. Under solid ice, even large spills will be contained within a few hundred metres of the spill source, depending on ice currents and roughness. Natural variations in first year ice thickness provide huge natural reservoirs to effectively contain oil spilled under ice in a small area. Winter under-ice currents in most arctic nearshore areas are not sufficient to spread spilled oil much beyond the initial point of contact with the ice under surface. As the natural containment increases with ice thickness, the area needed to contain a given spill volume decreases steadily throughout the winter (Dickins and Buist, 1999). Natural variations in ice thickness comprise the most important physical characteristic limiting the spreading of oil from a subsurface release.

Under ice

Spills on and under ice will generally not move independently of the ice, but remain in the vicinity of the spill site; if the ice is drifting, the oil will drift with it. The exception is oil under ice with currents exceeding the threshold velocity needed to initiate movement (~ 0.25 knots with smooth ice). An assessment of the necessary threshold velocity as a function of ice roughness and oil type is presently being conducted (SL Ross and DF Dickins – ongoing).

Broken ice

Oil spilled among broken ice will tend to move with the ice, unless there is a low percentage of ice cover. In broken ice with concentrations of 3/10 or 4/10, oil will tend to move independently of the ice over time. Oil spreading in these open pack ice conditions will approximate open water rates. Oil trapped in converging broken ice can thicken as the ice concentration increases. Some of the oil that was floating on the water or in slush ice between floes prior to compression will be incorporated into the raised crushed ice edges as the floes contact and grind against one another under the wind generated pressure.

Oil in slush among pancake ice during an experimental spill in pack ice off the coast of Nova Scotia, Canada in March 1986 (Ref. SL Ross and DF Dickins, 1987)

The major weathering process that occurs for spills on ice or among broken ice is evaporation. Dispersion rates are very low in the presence of ice due the effective wave damping of the ice floes. Oil spilled under ice with sustained air temperatures below freezing is quickly encapsulated by the growing ice sheet and does not evaporate or weather to any significant extent during the winter period (Dickins and Buist 1980; Norcor 1975). During the spring melt, the encapsulated oil will rise through the ice to be exposed on the surface in a close to fresh state.

Oil spilled on the ice surface is rapidly contained by snow. Ice deformation features such as rafting, rubble and pressure ridges can lead to localised increases in roughness. Any oil spilled on the surface of rough ice may be completely contained in a thick pool bounded by ridge sails and ice blocks.

Sampling oil on the surface of pancake ice during an experimental spill in pack ice off Nova Scotia, Canada in 1986 (Ref. SL Ross and DF Dickins, 1987)

The main methods utilised to respond to a winter spill would be:

i. Containment and recovery using mechanical equipment

Methods are essentially the same as with open sea (non-ice season) response except that the use of booms is restricted (dependent on the amount of ice coverage). Booms will be used in open ice leads, although this can be restricted to short side sweep systems. With assistance of the ice-breaking vessels these leads can be maintained for extended periods of time. Two of these recovery systems will be on board each of the Sakhalin Energy standby vessels and both can be deployed from a single vessel. All booms will be heavy duty to withstand ice abrasion and steamer will be used to prevent of icing-up. At higher ice covers, ice will contain the oil allowing skimmers to recover the oil. In such conditions booms may not be needed. As with any operation, the spill response team will need to assess the ice conditions, the movement of the oil, the weather, and other factors to deploy the most suitable strategy for response and recovery. Sakhalin Energy standby vessels will be equipped with the following:

- Brush Bucket Skimmer/Rope Mop (Foxtail) System - These systems can be deployed in relatively small openings in the ice and in most ice conditions. They pick up very little water but will pick up some ice. This may cause some wear and tear on the mop and so additional mop sections will be carried on the vessels and held in stock.

Brush bucket combination skimmer being used over the side of an oil spill response vessel to recover oil on ice during an accidental spill in the Baltic. Photo: Finnish Environment Institute

- Weir Skimmers - A weir skimmer will be maintained on each standby vessel. Weir skimmers will be deployed in open areas amongst the ice. These systems can also tend to pick up slush or brash ice mixed with the oil. This mixture can be separated later on board the vessel. The system selected will have a large recovery capacity and will be used where oil is contained in thick layers between the ice.

Brush bucket combination skimmer (close up). Photo: Finnish Environment Institute

- Disc/ Brush Skimmer System - These are versatile systems, which pick up minimal water or ice with the oil.
- Oil Recovery Under Ice - Sakhalin Energy's ice-breaking standby vessels can break through ice and bring oil trapped under the ice to the surface for recovery. In addition, one Sakhalin Energy vessel will carry a Remote Operated Vehicle (ROV) for locating oil under ice. Available systems for guided vacuum recovery of this oil are being reviewed. It should be noted that the underside of ice is not smooth and entrapment of oil will occur.

Rope-mop skimmer being demonstrated in broken ice in Alaska (Photo: Alaska Clean Seas)

ii. In-situ burning (ISB)

Vessels will be equipped with incendiary devices to ignite oil on ice, or contained between ice, should this be assessed as safe and effective. Sakhalin Energy crude ("Vityaz") is light, volatile with low asphaltenes. It will burn and is unlikely to result in a significant residue. Tests on heavier oils have shown effective burns of up to 98%. Analysis is currently underway to determine the safe window for burning and the nature and fates of any residues.

Over the past 25 years, a great many studies and trials have investigated and documented the burning of large crude oil slicks, fresh and emulsified, in open water and wetland areas (e.g. Williams et al. 2003; Buist et al., 1994, Fingas 1998). In addition, large scale field trials and tank tests have demonstrated that oil can be burned effectively among broken ice (e.g., SL Ross and DF Dickins 1987, Allen 1983 and 2000, Guénette and Wighus, 1996), on melt pools on top of solid ice (Norcor 1975, Dickins and Buist 1981), in leads or mixed with snow (Brown and Goodman, 1986) and most recently with brash and slush (Buist et al. 2003). Recent laboratory and tank tests have shown that the introduction of very small dose rates of a non-toxic herding agent can thicken oil slicks on open water to the extent that it may be possible to conduct in-situ burns without containment booms in intermediate ice concentrations (3 to 6/10), conditions previously viewed as not amenable to burning (Buist and Morrison 2005; Buist et al. 2006 – ongoing).

In situ burning was used to effectively remove over 95% of oil that surfaced through the ice after an experimental spill in Svalbard, Norway during March 2006 (DF Dickins and SINTEF 2006 – in preparation). The elimination of spilled oil through controlled burning, especially in remote areas where containment and physical removal may not be practical, is now recognized as a safe and efficient means of removing large quantities of oil quickly and with minimal impact to the environment. The short-term reduction in air quality at the burn site is usually a preferred impact when compared to the potential long-term impacts of the oil reaching shorelines and other sensitive resources. Most oils, once ignited, will burn efficiently leaving only a few millimetres (or less) of burn residue. The difficulty, especially with weathered and emulsified oils, is with the initial ignition of the spilled oil. Generally, ignition can be initiated easily with a broad range of hand-held ignition systems when it is safe to do so on the ground or solid ice. Ignition of oil at sea is best conducted from the air with the Heli-Torch® ignition system.

In situ burning is a highly effective and environmentally acceptable means of protecting wildlife and habitat threatened by an oil spill where mechanical methods become inadequate to contain and remove spilled oil. The Alaska, USA Regional Response Team's Science and Technology Committee determined that the benefits of in-situ burning outweigh any of the potential harm posed by in situ burning smoke and residue. The Committee also concluded that in offshore, nearshore, and estuarine environments, burning a crude oil spill poses less risk to wildlife than not burning. Burning greatly reduces the volume of oil and therefore the probability that oil comes in contact with wildlife. Burning also eliminates the volatile/soluble fraction of the spill (Cambell et al., 1994; Buist et al. 1994).

In-situ burning in late May 2006 of approximate 3000 litres of Statfjord crude spilled experimentally two months earlier under sea ice in Svalbard Norway. Burning time 11 minutes. Photo: SINTEF

KEY OIL SPILL RESPONSE STRATEGIES (CONTINUED)

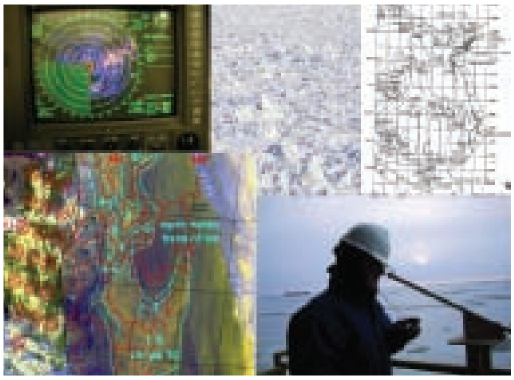
Helitorch being used to ignite oil contained in a fireproof boom during an Experimental spill offshore Newfoundland in 1993. Photo: Environment Canada

iii. Use of dispersants

Although dispersants are known to be effective on Sakhalin Energy crude oil, their use in ice conditions is currently not included into the OSR Plans. Tests conducted during 2006 at the MMS facility in Ohmsett have proven that dispersants can be effective in ice regions; the report of the study and tests will be issued later in 2006.

iv. Surveillance and tracking

Sakhalin Energy is developing an OSR Aerial Surveillance Handbook and procedures tailored to Sakhalin environmental conditions (including ice) and oils. The Company already has an ice trajectory model and will secure state-of-the-art surveillance technology. Sakhalin Energy is reviewing the applicability of available remote sensing systems that are currently in use or being developed. The trajectory model is being used to predict ice movement for autumn and spring seasons and is being expanded for use during the winter season. Sakhalin Energy is also evaluating a number of oil spill trajectory models in order to significantly upgrade its capability to predict the location and movement of oil in both ice and ice-free seasons. In addition, techniques such as ice coring, diver observations, ground penetrating radar, and other sensing technologies can be utilised.



Ice Drift forecasting examples - seven seasons of development and practical application for seasonal operations at Piltun-A. SEIC scientists and observers engaged in ice tracking and forecasting as part of routine operations. (SEIC)

Issues Affecting OSR in Ice

Sakhalin Energy acknowledges the fact that oil spill response in ice conditions can be more difficult than in open water but it can be managed and proper planning can mitigate the circumstances. Sometimes the ice can act as a barrier to help trap the oil or to contain it from spreading. Issues that can influence oil spill response in the winter include:

- Safety - Working in ice conditions, whether onshore or offshore, can be dangerous and special safety procedures must be developed. These include provision of adequate protective clothing, development of safe field deployment and work practices, acquisition of suitable equipment and, most importantly, the training of personnel in all of these.
- Access to the oil - Ice cover can restrict access to oiled areas. At sea, access to oil between ice floes or beneath ice can be gained using the ice class vessels that will be on standby at the offshore facilities. This restriction of access may also apply to the oil; fast ice will act to prevent oiling of shorelines by marine spills. Ice covers of between 50% and 70% will greatly inhibit oil spreading and coverage of more than 70% will generally effectively contain the oil.
- Use of booms - This becomes difficult as ice cover increases and is likely to become only partially effective to ineffective if ice cover exceeds 30%. On the other hand oil spreading rates are greatly reduced and oil will collect in leads enabling direct recovery with skimmers, provided that vessels can locate and access the oil.
- Surveillance - Oil below ice and in small leads may be difficult to locate. This is particularly difficult if oil is below thick ice. Use of remote sensing and tracking buoys will enable responders to locate and track oil in ice.

WESTERN GRAY WHALES

Sakhalin Island is also a part-time home to Western Gray Whales (WGW), which feed offshore during the summer and autumn during an annual migration that takes them from the South China Sea to the Sea of Okhotsk and back. These whales are critically endangered, with only ~100 or so individuals still living. In the early 20th century, whaling activities dramatically reduced WGW populations worldwide; the Atlantic population was extirpated. In the Pacific Ocean, Eastern Gray Whales have recovered to a population thought to be as large as before whaling, while the WGW have not. Indeed, only recently was the population of WGW "re-discovered" and shown to still exist. (Sleptsov 1952).

Sakhalin Energy appreciates and shares the concern of environmental organisations for the status of the WGW. The Company is committed to minimising risk to the whales while pursuing its objective of bringing Sakhalin's oil and gas to market. For example, the offshore section of the pipeline was relocated in 2005 to avoid the feeding area of the WGW. Sakhalin Energy has established a scientific program to monitor and mitigate construction noise effects on the WGW, which uses a team of acoustic scientists in conjunction with a team of marine mammal observers. Observers on the coast watch for whales in the nearshore feeding area and note their location and behaviours while acoustic scientists continually monitor the noise created by the project. Information from both teams is continually synthesized to watch for behavioural reactions by the whales.

Three level analysis

In addition, Sakhalin Energy has developed a three-level analysis to determine potential oil spills risks to the whales. The first level is a probability analysis of the likelihood of a spill occurring as a result of development and operation that takes into account the magnitude and frequency of historical spills. This analysis predicted that the probability of a spill of greater than five tonnes was less than 4% over the lifetime of the field. The second level calculated the probability that a spill would move towards areas where the WGW congregate, such as their feeding grounds, based upon local meteorological and oceanographic conditions.

Clearly, the potential for impacts to the WGW is extremely low. Sakhalin Energy was also concerned for the potential to impact the feeding grounds of the WGW with spilled oil, which might affect the population's ability to find sufficient food, and undertook an additional study as the third level. (Shell Global Solutions 2005).

Examples of onshore and offshore monitoring

This study found that the seafloor would not be prone to incorporating spilled oil. Even using unusually high estimates for winds, wave height, and amount of suspended sediment in the water column, modeling suggested that only 0.1-0.3% of the feeding area could be affected by a spill.
These levels of potential disturbance are negligible given the high degree of seasonal disturbance these benthic areas receive from a combination of ice scour, storm events, and whale feeding. The sum of these calculations indicates that even a "worst-case" spill would have minimal effect on WGW feeding resources.

Granted that even the potential for a spill to affect WGW is extremely low, concern has recently been expressed that any oil spills in ice could have a catastrophic impact on the WGW. The non-governmental organisation, WWF, recently stated that Sakhalin Energy is ignoring a 'response gap', present only because of the complications caused by ice. Sakhalin Energy does not agree that such a response gap exists. The Company is confident that a prompt and effective oil spill response in ice can be undertaken in Sakhalin's offshore environment.

RESPONDING TO THE WWF REPORT

In response to the WWF report entitled: "Offshore Oil Spill Response in Dynamic Ice Conditions" A report to WWF on Considerations for the Sakhalin II Project", Sakhalin Energy immediately commissioned a recognized expert to review the organisation's findings. [Summary of Preliminary Review Comments: "Offshore Oil Spill Response in Dynamic Ice Conditions" A report to WWF on Considerations for the Sakhalin II Project"]

In summary, the review stated that that the authors of WWF report quote from or paraphrase numerous sources, and in some cases use these references to provide a convenient interpretation that is different in context and intent from the original report being referenced. There is an ongoing misconception that responding to oil spills in icy conditions is inherently more difficult than dealing with spills on land or in open water. This is not necessarily the case. There are many situations even in broken, moving ice where spill response could be easier and more effective than in rough open water. For example, in many winter spill scenarios, the ice can help to contain spilled oil, allowing in-situ burning (a key response strategy) and other response methods to be more effective. Furthermore, the use of authors is selective, choosing those who represent a particular viewpoint as the basis for sweeping generalisations, disregarding other recognised scientists who may draw very different conclusions. The WWF report authors quote from the Arctic Marine Assessment Programme in reference to Sakhalin, yet there are fundamental differences between the two areas in terms of ice conditions. The unique ecology and ecosystems of the Sakhalin marine environment cannot simply be put in an 'Arctic' framework.

The WWF report also claims a lack of knowledge regarding the behaviour of oil spilled in ice, disregarding more than 35 years of studies that have been conducted into this that provide a solid base of knowledge. Moreover, the report itself fails to understand some of the issues, and presents incorrect descriptions of both ice conditions and the behaviour of oil in ice, suggesting that the ice conditions that render OSR most problematic persist for half the year. In some years, these conditions are only present for 15% of the year.

The report also fails to appreciate the fact that the unanimous opinion of experts is that In Situ Burning is the preferred, most effective response strategy for Arctic areas, by claiming that technical debate persists on this issue. The WWF authors claim that oil will not ignite (although this is not borne out by extensive research), and then go on to claim that the residue left after burning spilled oil will sink and damage the WGW feeding ground. This is pure conjecture. There is extensive evidence that such residues are non-toxic and pose less risk than not burning at all.

In sum, the report contradicts a broad knowledge base of experience in suggesting that winter conditions prevent effective OSR.

ONGOING RESEARCH AND PROJECTS

Much work is being done to advance spill management in ice. Some of this is done through international collaboration efforts such as JIPs (Joint Industry Projects). Other work involves the active participation by government agencies as a collaborative effort. Sakhalin Energy and Shell are willing participants in these efforts and also are doing some of their own research programs. Sakhalin Energy is also an active participant in the development of regional OSR capabilities and has indeed taken the lead in a number of initiatives. Some of this work includes:

- Sakhalin Energy brokered a Memorandum of Understanding (MoU) between oil companies on Sakhalin (both Foreign and Russian) to cooperate in OSR planning and mutual assistance during emergencies. This was the first agreement of its type in the Russian Federation.
- Sakhalin Energy was the first company to sign the Sakhalin Oblast Governor's MoU to assist in the development of a Tier 2 Oil Spill Response organisation on Sakhalin Island.
- Sakhalin Energy participates in the Sakhalin Oblast Governor's Working Group responsible for the development of the Tier 2 OSR Centers and has authored and provided key documents to the Group.
- Review of Oil Spill Response in Ice - A three-part review of existing knowledge with particular emphasis on Russian experience and Sakhalin Island conditions was completed.
- Laboratory study of the behavior, weathering and fate of Sakhalin Energy crude oils under varying energies and sea temperatures.
- Laboratory study of effectiveness of burning of Sakhalin Energy crude oils and chemical constituency of residues from various burn efficiencies.
- Laboratory investigation of dispersant efficiencies in ice conditions and open sea at various temperatures.
- Development of Safety Procedures for Working in Ice - the safety of workers working in ice conditions is a priority and safety guidelines are being developed as part of a Health & Safety Operational Handbook, which will include ice issues.
- Ongoing review and assessment of equipment and surveillance technology.
- Ongoing surveys of shorelines, pipeline routes and rivers to obtain environmental and OSR data and Island wide aerial surveillance.
- Further study that is underway of the effectiveness of dispersants in waters with broken ice which includes tank testing at the MMS' Ohmsett Facility in New Jersey, USA (Sakhalin Energy /Shell participation with other operators, agencies, and scientists).
- A study into the use of herding agents that includes small-scale test tank research on using oil herding surfactants to thicken oil slicks in broken ice for in situ burning (PERF 2003- 05 undertaken by SL Ross, Canada). This project is progressing from successful small-scale Phase II testing to larger-scale Phase III testing.
- Laboratory study of the effectiveness of time and low temperatures on the effectiveness of dispersants (PERF 2004-05 undertaken by SINTEF, Norway and CEDRE, France).
- SINTEF Phase I – A review of literature on behavior of oil in ice environments and the effectiveness of treatment and recovery methods. Objective to provide a state-of –the-art overview and technology gaps for prioritizing tasks for Phase II. This review formed the basis for the SINTEF Phase II study in line with the priorities that were determined by the wide group of participants (both Sakhalin Energy and Shell participated).
- SINTEF Phase II Joint Industry Project (JIP) – This JIP project will be a comprehensive program that studies the treatment and recovery methods that are prioritized from Phase I for different types of oil and ice conditions. The scope has been detailed into 8 projects each with several tasks and prioritized by the JIP participants. The work started in late June 2006 at a total cost of $6.3 million US (both Sakhalin Energy and Shell participating).

Boise State University scientists towing a portable ground penetrating radar system over oil trapped under under ice during an experimental spill in Norway, March 2006 (Photo: D. Dickins)

ONGOING RESEARCH AND PROJECTS (CONTINUED)

16. Helicopter flying a suspended ground penetrating radar over an experimental spill under sea ice in Norway, March 2006 (Photo: D. Dickins)

- Controlled field spill in Svalvard, Norway conducted in March 2006 to verify successful laboratory testing of Ground Penetrating Radar for detection and monitoring of a spill under solid ice. The experiment tested a number of promising remote sensing technologies, including airborne radar and ground-based acoustic systems. Preliminary findings confirmed that existing portable radar systems can reliably detect and map oil under ice from the surface. A future phase is in the proposal stage to develop higher-powered radars to operate from a helicopter.

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