



INTERNATIONAL OIL & ICE WORKSHOP

Anchorage Alaska • October 10-11, 2007

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Organized by:

Steve Potter, SL Ross Environmental Research Ltd.

David Dickins, DF Dickins Associates Ltd.

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Alaska Clean Seas

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Cook Inlet Spill Prevention and Response Inc.

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Steve Potter, SL
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Background

Over the past ten years, offshore petroleum exploration, development and transport in cold regions has expanded to include Alaska, the Canadian Beaufort Sea, Sakhalin Island, North Caspian Sea, Baltic, Norwegian Barents Sea, and the Russian Arctic. This period has also seen numerous important advances in our understanding of spill behavior and response in cold environments and ice, which is helping to expand the response-operating window for a number of different strategies. The U.S. Minerals Management Service has been a leader in North America for much of this work, funding a wide range of projects, and making full use of the Ohmsett test facility in New Jersey. Organizations in Finland and Norway have led many research and development programs to design new recovery systems and better understand oil behavior and weathering in ice. In April 2000, Alaska Clean Seas together with 16 other government and industry sponsors, organized the highly successful first International Oil and Ice Workshop in Anchorage. That event attracted over 300 participants from around the world and was highly regarded as an opportunity to share the latest information in the field. Given the continued expansion in drilling activity and leasing interest in deep water Arctic areas, as well as rapidly increasing levels of tanker traffic in many ice-covered areas, 2007 is viewed by the sponsors as an opportune time to hold a second specialized workshop on the broad topic of oil spills in ice.

This workshop is designed to bring together an international audience with a common interest in advancing spill response in cold water and ice, and protecting the world's Arctic regions. The workshop goals are to:

- Share international advances in Arctic oil spill research and operations
- Guide future research and development programs towards priority areas of common interest.

The two-day technical program is made up of presentations by recognized experts on a wide range of key topics such as:

- International Arctic oil and gas developments
- Ice environments
- Ice-going vessel technology
- Remote sensing
- Enhancements to mechanical recovery systems
- Chemical herders in ice
- Cold-water dispersants
- Experimental spills
- Case studies
- Ongoing and future research programs



Tuesday October 9, 2007

1800-2000 Early Registration and Opening Reception

Day 1 Wednesday October 10, 2007

Setting the Scene

What is happening around the world and what are the main challenges for Arctic spill response in different geographic regions?

0730-0830 Registration & Light Refreshments

0830-0900 Welcome and Introductory Remarks

Frances Ulmer
Chancellor of the University of Alaska Anchorage

Randall Luthi
Director Minerals Management Service
U.S. Department of the Interior

Rear Admiral Arthur Brooks
Commander, Seventeenth Coast Guard District

0900-0930 Environmental Strategies While Moving into a New and Challenging Oil and Gas Province—The Barents/Pechora/Kara Sea Areas

Bjørn Kristoffersen
Statoil Barents Region, Stavanger Norway

0930-1000 Oil Spill Response Planning for Shell's Offshore Exploration Program in the Alaskan Beaufort Sea

Alan Allen
Spiltec

1000-1030 Break

State of Knowledge in Spill Response

Where have we come since the last conference in 2000 in terms of research and development into oil behavior in ice, knowledge of ice environments, new or enhanced response strategies and marine technology?

1030-1100 Beaufort Sea Ice Zones and Implications for Spill Scenarios
Hajo Eicken, University of Alaska Fairbanks

1100-1130 Maritime Safety Development and Winter-time Demands for Shipping and Oil Spill Response Development in the Baltic Sea Environment

Jorma Rytönen, Finnish MERIKOTKA Research Institute

1130-1200 New Arctic Vessel and Icebreaking Technologies
Mikko Niini, Aker Arctic Technology Inc.

1200-1330 Lunch

1330-1400 Developments with Ground Penetrating Radar to Detect and Map Oil Trapped Under Ice

John Bradford, Boise State University

1400-1430 Operational Multi-Sensor Oil Spill Surveillance Program
Dr. Björn Baschek, Federal Institute of Hydrology,
Koblenz Germany

1430-1500 The Integrated Tracking of Pollution Program (ISTOP) and Ice Forecasting/Mapping Services in the Western Arctic

Laurie Weir, Canadian Ice Service

1500-1530 Break

1530-1600 Behavior and Weathering of Oil Spills Under Arctic Conditions and Implications for Response

Per Johan Brandvik, SINTEF

1600-1630 In Situ Burning in Ice

Ian Buist, SL Ross Environmental Research Limited

1630-1700 Recent Testing of Oil-in-Ice Skimmers

Ivar Singsaas, SINTEF

1830-2100 Workshop Dinner

Presentation: A New Arctic Ocean—

Responding to Marine Access Change at the Top of the World

Lawson Brigham, U.S. Arctic Research Commission
& Alaska Office Director

Day 2 Thursday October 11, 2007 morning

State of Knowledge in Spill Response (continued)

- 0830-0900 Oil Recovery with Novel Oleophilic Skimmer Surfaces under Cold Climate Conditions**
Arturo Keller
University of California Santa Barbara
- 0900-0930 Using Herding Surfactants to Thicken Oil Slicks in Pack Ice for *In Situ* Burning**
Ian Buist
SL Ross Environmental Research Limited
- 0930-1000 Cold Water Dispersant Effectiveness Experiments Conducted at Ohmsett with Alaskan Crude Oils and Corexit 9500 and 9527 Dispersants**
Joseph Mullin
U.S. Minerals Management Service
- 1000-1030 Break**
- 1030-1100 ExxonMobil Research on Remotely Applied Response Options for Spills in Dynamic Ice**
Tim Nedwed
ExxonMobil Upstream Research Company
- 1100-1130 Shoreline Treatment in Arctic Environments**
Ed Owens
Polaris Applied Sciences Inc.
- 1130-1200 Oil Mineral Aggregate Formation in Ice-Affected Waters**
Kenneth Lee
Center for Offshore Oil and Gas Environmental Research
Fisheries and Oceans Canada
- 1200-1330 Lunch**

Note: Co-authors acknowledged in presentations

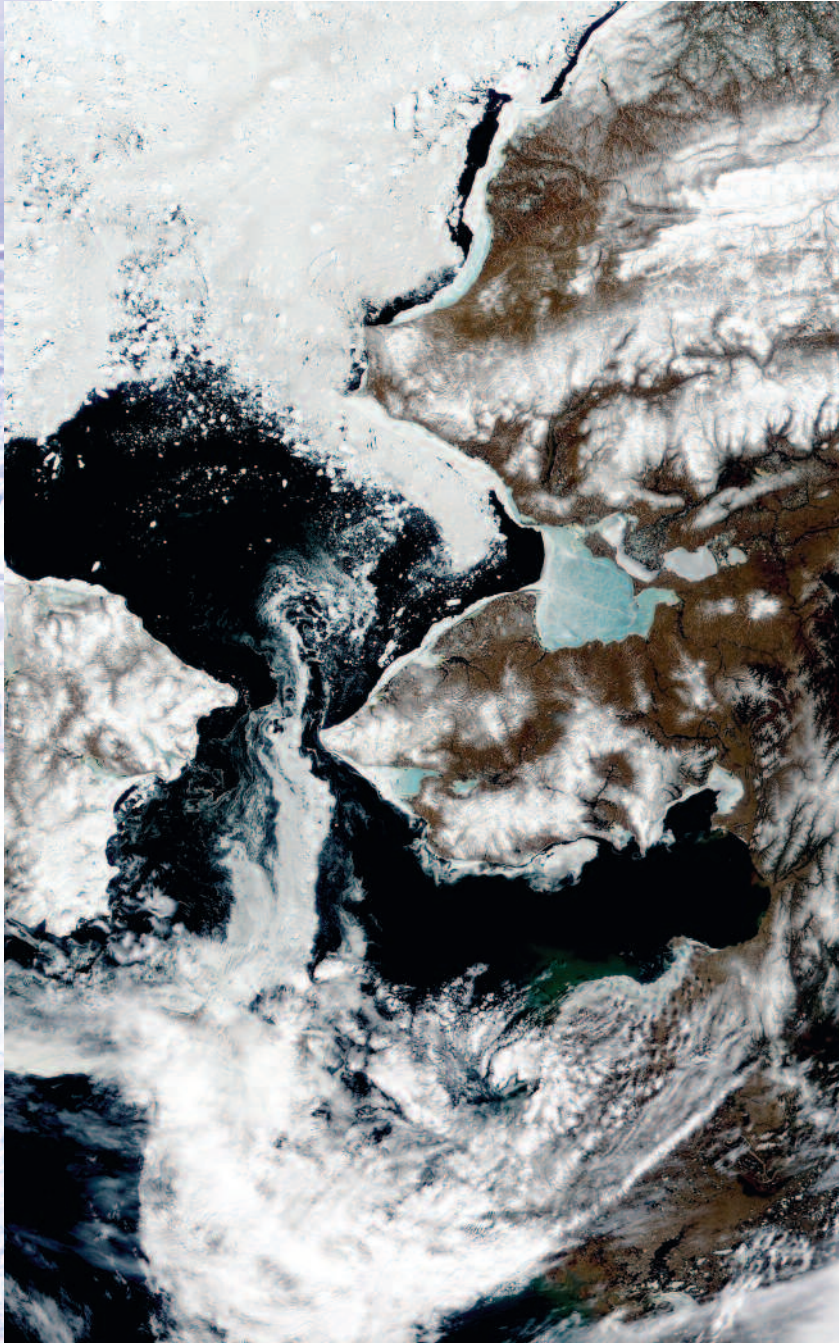
Day 2 Thursday October 11, 2007 afternoon

Case Studies and Ongoing Research

- 1330-1400 Lessons Learned: On-land, Cold-Weather Spill Response Clean-up Operations**
Lee Majors
Alaska Clean Seas
- 1400-1430 Baltic Approach to Oil Spill Recovery in Ice: Case Studies and Recent Development**
Kari Lampela
Finnish Environment Institute (SYKE)
- 1430-1500 Joint Industry Arctic Oil Spill Research Program**
Stein Erik Sørstrøm
SINTEF
- 1500 Closing remarks**



Photo: D. Crossbie



NASA MODIS Satellite Image

Frances Ulmer

*Chancellor of the University
of Alaska Anchorage*



Prior to appointment as Chancellor of the University of Alaska Anchorage, Fran Ulmer served as the Director of University of Alaska Anchorage's Institute of Social and Economic Research. She brings to this position 30 years of experience of public policy in Alaska. Previously, she was a fellow at the Institute of Politics at Harvard University's Kennedy School of Government and a Distinguished Visiting Professor of Public Policy at the Institute of Social and Economic Research. In the early 1980s, Fran was the Mayor of Juneau, then a member of the Alaska House of Representatives (1986-1994) and in 1994, Fran became the first female Lieutenant Governor of Alaska. In that year, she was appointed to the North Pacific Anadromous Fish Commission by President Bill Clinton and served on this international board for 11 years, including as Chair, with representatives from Japan, Russia, Korea, Canada and the United States. Fran has participated in numerous panels, task forces, commissions and forums as a speaker, moderator and panelist to address the intersection of science, economics, politics and policy. Fran currently serves on the Board of Trustees of the National Parks Conservation Association, the Advisory Board of the Union of Concerned Scientists and the Alaska Nature Conservancy Board. Fran has a BA in Political Science and Economics and a Law Degree from the University of Wisconsin.

Randall B. Luthi

*Director of the Minerals Management Service
U.S. Department of the Interior*



Randall B. Luthi was appointed Director of the Minerals Management Service on July 23, 2007.

Luthi, a former speaker of the Wyoming State House of Representatives, is a rancher and attorney in private practice from Freedom, Wyoming. He previously served in the Department of the Interior and at the National Oceanic and Atmospheric Administration (NOAA).

Luthi is a partner in the Luthi and Voyles law firm in Thayne, Wyoming, and manages a cattle ranch in western Wyoming. He was first elected to the Wyoming House of Representatives in 1995, and served as speaker in 2005 and 2006.

He served in Washington in career positions as Senior Counselor for Environmental Regulations in NOAA's Office of General Counsel from 1990 to 1993, and as an attorney in the Department of the Interior Office of the Solicitor from 1986 to 1990.

Based on his work in the Wyoming legislature, Mr. Luthi developed an understanding of the importance of royalties paid to the federal government by companies producing energy on our public lands and waters. As Majority Leader and Speaker of the Wyoming House, Mr. Luthi was instrumental in formulation of state budgets, which relied heavily upon royalties and severance taxes paid by energy companies developing federal leases. In addition, he was a legislative member of the Energy Council, which is an organization comprised of legislative representatives from energy producing states and provinces and private energy-related industries that meets quarterly to learn the latest in developments in energy related technology and to discuss energy policy.

In addition, Luthi worked as a legislative assistant in the office of U.S. Senator Alan K. Simpson of Wyoming. In this capacity, Luthi provided counsel on legal and legislative issues including oil and gas taxation.

Luthi graduated from the University of Wyoming in 1979 with a Bachelor of Science Degree in Administration of Justice, and earned a Law Degree from the University of Wyoming in 1982.

Rear Admiral Arthur E. Brooks

*Commander
Seventeenth Coast Guard District*



Rear Admiral Brooks was commissioned as an Ensign upon graduation from the United States Coast Guard Academy in 1974. His first duty assignment was aboard the Coast Guard Cutter *DEPENDABLE* (WMEC 626), Panama City, FL where he served as Student Engineer and Deck Watch Officer. In addition to his Bachelor of Science degree from the U.S. Coast Guard Academy, he holds a Juris Doctor degree from the Marshall-Wythe School of Law, College of William & Mary, Williamsburg, VA. He was the Coast Guard Fellow in the Department of State's 39th Senior Seminar, National Foreign Affairs Training Center, Arlington, VA and is a graduate of the Harvard University, Kennedy School of Government Senior Executive National and International Security Program.

Rear Admiral Brooks has served in a variety of surface operations, legal, command and staff assignments. Other afloat tours included Commanding Officer, USCGC *POINT HARRIS* (WPB 82376) in both Bodega Bay, CA, and Apra Harbor, Guam, Mariana Islands; Executive Officer, USCGC *CONFIDENCE* (WMEC 619), Cape Canaveral, FL; and Commanding Officer, USCGC *SENECA* (WMEC 906), Boston MA. Ashore tours included the Fifth CG District Operations Center, Portsmouth, VA; Assistant Staff Legal Officer, Eleventh CG District, Long Beach, CA; Head, Department of Professional Development, U.S. Coast Guard Academy, New London, CT; Staff Legal Officer, U.S. Coast Guard Academy; Commandant of Cadets, Coast Guard Academy; Commander, Coast Guard Greater Antilles Section, San Juan, Puerto Rico; and Chief of Staff, Coast Guard Atlantic Area, Portsmouth, VA.

Rear Admiral Brooks's awards include three Legions of Merit, the Meritorious Service Medal with Operational Distinguishing Device, three Coast Guard Commendation Medals, Coast Guard Achievement Medal, and Commandant's Letter of Commendation Ribbon, three National Defense Service Medals, three Humanitarian Service Medals, three Coast Guard Sea Service Ribbons, Expert Rifleman Ribbon, and Pistol Expert Ribbon.

Lawson W. Brigham

*Deputy Director
U.S. Arctic Research Commission &
Alaska Office Director, Anchorage*

Dr. Lawson Brigham is Deputy Director & Alaska Office Director of the U.S. Arctic Research Commission in Anchorage. He is currently Chair of the Arctic Marine Shipping Assessment of the Arctic Council, an intergovernmental forum of the eight Arctic nations. A career U.S. Coast Guard officer he sailed aboard icebreakers on the Great Lakes and on expeditions to the Arctic and Antarctic. He has served as a researcher at Woods Hole Oceanographic Institution and the U.S. Naval War College, and as a faculty member of the Naval Postgraduate School in the Office of Naval Research Chair in Arctic Marine Science. Captain Brigham received his PhD in polar oceanography from Cambridge University in the United Kingdom and has spent more than three decades on research related to the Russian Arctic, ice navigation, and satellite remote sensing of the polar regions.



Dinner Presentation—Wednesday October 10

A New Arctic Ocean—Responding to Marine Access Change at the Top of the World

Arctic sea ice is undergoing an extraordinary transformation that is creating a much more accessible Arctic Ocean. We are also witnessing new marine uses of the Arctic Ocean including expanded natural resource development, tourism, fishing and marine research. All of these uses will have profound implications for the Arctic and its indigenous communities. In addition, the current governance of the Arctic Ocean is complex and a patchwork of regulations and regimes implemented by each of the five nations surrounding the Central Arctic Ocean. In response to these factors, the Arctic Council has called for a comprehensive Arctic Marine Shipping Assessment (AMSA) under the Council's Protection of the Arctic Marine Environment Working Group (PAME). Canada, Finland, and the United States are the Lead Countries for AMSA. Ongoing are a data survey (to determine an estimated total number of ships in the Arctic Ocean for a given calendar year); development of scenarios or plausible futures to 2050; town hall meetings in Arctic communities; a review of the history & governance of Arctic marine transport; and, reviews on the social, environmental & economic impacts of expanded Arctic marine activity throughout the Arctic Ocean.

Technical Presentations



Photo: D. Dickins

Environmental Strategies While Moving into a New and Challenging Oil and Gas Province— The Barents/Pechora/Kara Sea Areas

Bjørn Kristoffersen

Statoil Barents Region, Stavanger Norway

Statoil's environmental policy is founded on the ambition of zero harm to the environment and sustainable operations. This policy has a holistic approach and focus on conserving biodiversity, limiting emissions/discharges, limiting use of land/resources and involving stakeholders.

The presentation will give an overview of the environmental strategies necessary to meet the changing environment in the Barents Region, a large area, with proven reserves and exploration potential, and with favorable location for the markets. With the Snøhvit LNG development, Shtokman and other exploration/projects, this region is an important gateway to the Arctic. The environmental and socio-economic challenges require close co-operation between all stakeholders to ensure co-existence and sustainable technology. Statoil is committed to developing technology for operations anywhere in the Arctic by 2030, and our environmental policy is tailor made to support this. We have established extensive cooperative programs with authorities, research institutions, indigenous peoples, fishery interests and others to meet our goals in the Barents Region. Our approach is risk-based which means that we focus on identifying Best Available Technology to reduce the probability of accidents and we establish the best possible measures to reduce impacts from any potential hazard.

Oil spill contingency in arctic waters is a prerequisite for sustainable operations. This is reflected by the comprehensive program initiated by Statoil in the Barents Region, building knowledge and spill response capability in close co-operation with regional interests in Norway and Russia.

Bjørn Kristoffersen is (as of September 2007) Vice President Environment of the Barents Region business area in Statoil International E&P. Statoil is an international oil company with interests in more than 30 countries. The company is partly owned by the Norwegian State and has developed world-class offshore operating competence throughout the development of the Norwegian Continental Shelf, a harsh environment stretching from the North Sea to the Barents Sea. Mr. Kristoffersen has been with Statoil for 23 years and has been involved in most project developments in Norway up to 1995 when he was posted to Azerbaijan as environmental manager for Azerbaijan International Operating Company. After four years in the Caspian region he moved to Statoil International E&P, working in Brazil, Venezuela, Africa, Russia and other parts of the world. The latest three years he has been engaged with environmental challenges in the arctic region.

Note: Statoil is merging with the Norwegian oil company Norsk Hydro on October 1st.

Oil Spill Response Planning for Shell's Offshore Exploration Program in the Alaskan Beaufort Sea

Alan A. Allen

Spiltec

Woodinville, WA

Shell, together with its primary response contractors, ASRC Energy Services (AES) and Alaska Clean Seas (ACS), has developed one of the most comprehensive oil spill response programs ever assembled for an Arctic exploration program. For the remote possibility of a major spill, Shell has provided, on location, a highly trained response team and the best available cold-climate resources for an immediate response to contain, recover and/or eliminate as much oil as possible thereby minimizing environmental impacts. Because of the possibility of ice incursions during the open water period and the natural variability of the timing and duration of freeze-up, Shell's oil spill response strategies and tactics have been designed to cover a wide range of open water and ice conditions. In heavy ice concentrations (e.g., ice incursions in summer, new ice at freeze-up, or with drifting floes at break-up), Shell's high-volume, viscous-oil recovery systems would be supplemented with tactics involving the rapid and efficient elimination of oil with controlled burning. Established burn guidelines are in place to allow *in situ* burning to take place with scientifically monitored safeguards to protect responders, the environment and local populations.

Mr. Al Allen has over 38 years experience as a technical advisor and field supervisor involving hundreds of oil spills around the world. His assignments have spanned more than 65 countries, providing training and operational guidance for government and industry organizations in the use of mechanical cleanup, the application of chemical dispersants, and the use of controlled burning. Al has spent over 30 years working in Alaska and other cold climates managing oil spill cleanup operations, serving as an advisor to oil industry and regulatory organizations, and conducting offshore and onshore spill prevention, control and research programs.

Beaufort Sea Ice Zones and Implications for Spill Scenarios

Hajo Eicken

University of Alaska Fairbanks

The Beaufort Sea ice cover exhibits a distinct zonation. Landfast ice lines the entire coastline during the ice season. Grounded ridges along the outer edge stabilize the landfast ice and separate it from recurring leads in the flaw zone. In recent years, Beaufort Sea ice has substantially thinned, with a northward retreat of the summer minimum ice edge. The ice regime of the coast and inner shelf has changed in a more complex fashion, with later freeze-up and higher winter temperatures. Maximum landfast ice extent has not changed significantly, but winter break-out events are increasingly common.

The presentation will conclude with a discussion of implications for oil-spill scenarios. Remote-sensing data reveals substantial local variations in key variables, such as onset of stable ice or break-up, with Prudhoe Bay exhibiting a particularly long, stable landfast ice season. There is some evidence that the deformation regime of the flaw zone and ice-seafloor interaction have changed over the past few decades. At the same time, multiyear ice occurrence in inshore waters has decreased significantly, although incursions of multiyear ice from the Northeast during the winter are still quite common.

Hajo Eicken is Professor of Geophysics at the University of Alaska Fairbanks (UAF). Before joining UAF, he was a senior scientist at the Alfred Wegener Institute where he led the research group for sea ice physics and remote sensing. Dr. Eicken's research interests include studies of the growth, evolution, and properties of sea ice in the Arctic and Antarctic. He is particularly interested in determining how microscopic and macroscopic properties affect larger-scale sea-ice processes and its role in the climate system. Dr. Eicken is serving on a number of scientific and technical committees. Currently he is heading an effort at UAF to enhance use of scientific data by a range of different stakeholders at the local and international level during the course of the International Polar Year.

Maritime Safety Development and Winter-time Demands for Shipping and Oil Spill Preparedness in the Baltic Sea Environment

Jorma Rytkönen

Research Director

Kyminlaakso University of Applied Sciences, Finland

Merikotka Research Institute, Finland

Shipping has steadily increased around the Baltic Sea over the past decade. Around 2,000 sizeable ships are normally at sea at any time in the Baltic, including large oil tankers, ships carrying dangerous and potentially polluting cargoes, and many large passenger ferries. The Baltic Sea has some of the busiest shipping routes in the world.

The trend to increasing marine oil transport in the region started with the disintegration of the former Soviet Union. Russia lost parts of its Baltic ports to the surrounding States. These developments quickly led to new harbour and terminal developments such as: the Muuga oil terminal in Estonia, St. Petersburg oil terminal rehabilitation, and new terminals at Primorsk and Vysotsk in Russia. Oil transportation along the North-Eastern part of the Baltic Sea exceeded 100 million tons for the first time in 2004. New prognoses have estimated that at current crude oil price levels the total oil volume transported in only the Gulf of Finland may exceed 250 million tons before 2015.

High levels of tanker traffic in a sensitive and shallow sea require special procedures and safeguards to maintain safety. Winter vessel traffic creates special challenges to maintain schedules and reliability in all weather and ice conditions. This paper gives an overview of shipping statistics in the Baltic, the current level of accidents and the main actions taken to improve maritime safety, focusing on winter navigation. The safety-related actions of HELCOM, and latest joint activities in the area are briefly highlighted along with an introduction to the challenges of winter spill response.

Mr. Jorma Rytkönen is currently working as a research director of the Kyminlaakso Polytechnic University in Kotka, Finland. He has more than 20 years background in maritime R&D in the areas of maritime safety, environmental impacts, oil combating, mechanical recovery and oil bioremediation. Recently he has worked closely with the Baltic scientific community preparing a joint report on the risks of oil transportation in the Baltic and a manual for open sea monitoring of illegal oil discharges. He is also the research director of the MERIKOTKA Research Institute, a joint venture of four main Universities in Finland. The focus is on maritime safety, winter navigation and environmental protection.

New Arctic Vessel and Icebreaking Technologies

Mikko Niini

Aker Arctic Technology Inc.
Helsinki, Finland

The paper describes the recent revolutionary improvements made in ship technology for operations in ice and describes the new possibilities available through the use of azimuthing thrusters in ice going vessels. In addition to describing the recent applications of such new technologies and especially the improvements in ship operations safety Mr. Niini will be discussing the possibilities of using such new technologies in new oil combating vessel designs and in combating operations.

Mikko Niini, born 1946, graduated from Helsinki Technical University as a Naval Architect in 1970. While completing his studies Mikko joined Wärtsilä Helsinki Shipyard in 1970 for the “Manhattan” project and developed his thesis on the basis of the very first ice model tests in Finland. Since then Mr. Niini has held different positions within design, marketing, publicity and sales. After the merger of Wärtsilä and Valmet shipbuilding activities in 1986 he continued as Vice President, Marketing and Sales of Kvaerner Masa-Yards Inc. In recent years Mikko Niini has led Aker Yards (ex Kvaerner Masa-Yards) to be involved in oil and gas transport developments in North of Russia, Sakhalin and the Caspian Sea. The yard has been awarded contracts for the first icebreaker new building for the Sakhalin projects and for the world's first Arctic container vessel for OJSC Norilsk Nickel. In the beginning of 2005 Mikko Niini was appointed President of Aker Arctic, a newly established company for widening Aker's business scopes in the icy waters. Aker Arctic has already won two important design contracts, for the world's first Arctic shuttle tankers, two for ZAO Sevmorneftegaz/JSC Sovcomflot being built in St. Petersburg and another three for ZAO Naryanmarnftegaz/JSC Sovkomflot being built at Samsung in Korea. Currently Aker Arctic develops new solutions for oil combating in the Baltic Sea.

Developments with Ground Penetrating Radar to Detect and Map Oil Trapped Under Ice

John H. Bradford

Center for Geophysical Investigation of the Shallow Subsurface
Boise State University – Boise, ID USA

Since 2004, we have undertaken a series of laboratory and field experiments to test hardware and develop analysis tools for the purpose of detecting crude oil spills on, within, and beneath sea ice using ground-penetrating radar (GPR). Notably, the experiments include: 1) a set of small spills (49 – 188 l) within and beneath laboratory grown urea ice (~35 cm thick) conducted at the U.S. Army's Cold Regions Research and Engineering Laboratory; and 2) a contained spill (3,400 l) under natural sea ice (~65 cm thick) conducted on Svalbard. In all cases, we successfully identified the location and spatial distribution of the majority of spilled oil. Oil film thicknesses under natural sea ice may vary from a few mm to 20 cm or more. GPR wavelengths at 500 MHz are on the order of 30 cm, therefore the target layers are typically less than the signal wavelength, placing the detection of oil films in the realm of thin bed analysis. When the thickness of a reflecting layer is less than the signal wavelength, the recorded waveform is actually the result of interference of waves reflected from the top and bottom of the layer. This interference causes amplitude, phase and frequency anomalies whose form depends on the thickness of the layers and the contrast in electric properties at the boundaries. Detecting oil films depends on differentiating the waveform anomalies from the background response. Our experimental results suggest that GPR coupled with thin bed analysis can be a valuable component of spill characterization and clean up. Ongoing work includes an extensive modeling effort to understand GPR response varying conditions such as ice and oil thicknesses, ice salinity and temperature.

John Bradford received B.S. (1994) degrees in both Physics and Engineering Physics from the University of Kansas and a Ph.D. (1999) in Geophysics at Rice University. From 1999 to 2001 he worked as a research scientist at the University of Wyoming. He is currently Director and Assistant Professor of Geophysics at the Center for Geophysical Investigation of the Shallow Subsurface at Boise State University. His research interests include numerical modeling, imaging, and attribute analysis of wave-propagation based geophysical data.

Operational Multi-Sensor Oil Spill Surveillance Program

Dr. Björn Baschek

Federal Institute of Hydrology (BfG)
Koblenz Germany

Germany is using a combined system of aerial remote sensing and satellites for maritime surveillance and the detection of oil pollution. On behalf of the Federal Ministry of Transport, Building and Urban Affairs, the Central Command for Maritime Emergencies (CCME) coordinates the operational surveillance, the Federal Institute of Hydrology is the scientific consultant, and the Naval Air Wing 3 “Graf Zeppelin” operates the aircraft.

The talk will present in detail the multi-sensor system of the two “DO228” oil spill surveillance aircraft. As a long-range sensor for the localization of a possible oil spill serves a side looking airborne radar (SLAR). The data of the extended near-range sensor system consisting of IR/UV scanner, microwave radiometer, laserfluorosensor and a camera system (e.g. FLIR) is processed by the on-board analysis to determine e.g. oil spill area, thickness, volume and type. Thus, also under adverse weather and light conditions detailed information can be provided for the support of oil spill combating.

Björn Baschek is a physicist who made his Ph.D. in the field of radar remote sensing applied to meteorology. Since 2005 he is working at the German Federal Institute of Hydrology (BfG) within the Department Geoinformation and Remote Sensing. He is scientific advisor of the German oil spill surveillance project. This is including responsibility for the sensor system of the German surveillance aircraft as well as participation in the European satellite project MarCoast. He is member of the European Group of Experts on Satellite Monitoring and Assessment of Sea-based Oil Pollution (EGEMP).

The Integrated Tracking of Pollution Program (ISTOP) and Ice Forecasting/Mapping Services in the Western Arctic

Laurie Weir

Canadian Ice Service
Ottawa, Ontario Canada

The Canadian Ice Service's (CIS) operational program ISTOP (Integrated Satellite Tracking of Pollution) is designed to effectively use SAR satellite imagery from Canada's Radarsat-1 as an aid in marine oil spill detection. The CIS has established research priorities that will help ensure that the ISTOP program will continue to play an effective role in the mitigation of marine oil pollution today and in the years to come. The program is a partnership between the Canadian Space Agency, Transport Canada, the Department of Fisheries and Oceans and Environment Canada.

The Canadian Ice Service (CIS) as part of the North American Ice Service (NAIS) provides ice charts, ice forecasting/ice drift models and imagery for the western arctic. This year CIS will be supporting a number of research initiatives in the Arctic as part of its contribution to the International Polar year. This information could provide a valuable resource in the event of a trans boundary spill in this region.

Laurie Weir graduated from Queen's University with an H BSc. Degree in Earth and Atmospheric Science. Her career includes:

- Meteorological technician—Atmospheric Environment Service, Cape Parry & Hay River NWT.
- Meteorological radar technician—Atmospheric Environment Service, Sudbury, ON
- Aviation Weather Analyst and Briefer—with the Meteorological Service of Canada, Toronto
- Ice Observer and Ice Analyst—Canadian Ice Service, Ottawa

Behavior and Weathering of Oil Spills Under Arctic Conditions and Implications for Response

Per Johan Brandvik

SINTEF Marine Environmental Technology, Trondheim, Norway

The knowledge regarding weathering processes in Arctic oil spills with presence of ice is limited. Experimental studies have been performed in laboratories, but only to a limited degree in the field. This paper summarizes and compares results from field and laboratory experiments performed in North America and Norway from the mid seventies until today, with focus on the experience from newer experiments. Status and results from several ongoing projects will also be presented.

Several weathering properties for the oil spill in broken ice are strongly influenced by the low temperature, reduced oil spreading and reduced wave action caused by the high ice coverage. Reduced water uptake, viscosity, evaporation and pour point could extend the operational time window for several contingency methods compared to oil spills in open waters. This could open up for dispersant treatment and in-situ burning even after an extended period of weathering for an oil spill in broken ice.

The main author Dr. Brandvik has worked at SINTEF in Norway as a Research Scientist focusing on weathering processes in marine oil spills and their influence on operational oil spill contingency for over 20 years. In recent years he has especially focused on oil weathering and field experiments in Arctic areas. He has also worked as a associate professor at the Norwegian University of Science and Technology (NTNU) in Trondheim and presently holds an adjunct position at the University Center at Svalbard (UNIS).

In Situ Burning in Ice

Ian Buist

SL Ross Environmental Research Ltd.

Ottawa, Ontario Canada

In situ burning is one of the few practical options for removing oil spilled in ice-covered waters. In many instances *in situ* burning, combined with surveillance and monitoring, may be the only response possible. As with all countermeasures in any environment, the suitability of burning a particular spill depends on the characteristics of the spilled oil and how the oil behaves in the particular ice conditions. There is an extensive body of knowledge concerning *in situ* burning of oil in ice situations, beginning with laboratory, tank and field studies in the mid-1970s in support of drilling in the Canadian Beaufort Sea. *In situ* burning research has been conducted primarily in Canada, Norway and the United States. This paper serves as a review of the subject, focusing on recent research results, summarizing the following topics:

- The basic requirements and processes involved with *in situ* burning;
- Trade-offs associated with burning in ice-covered waters;
- How oil spill behavior in various ice conditions controls *in situ* burning;
- The application of burning in various ice situations;
- *In situ* burning of oil spills in snow.

Ian Buist is one of Canada's leading experts on oil spill behavior and countermeasures and an acknowledged authority on *in situ* burning. For four years he was chief research engineer for Dome Petroleum Ltd. on oil spill prevention and control for their Beaufort Sea program. In this capacity Mr. Buist was involved in the development of several novel oil spill countermeasures techniques including air-deployable igniters, incinerators and fire resistant booms. He was also manager for several field experiments of oil spill behavior and countermeasures in the Beaufort Sea. Since joining SL Ross in 1983, Mr. Buist has developed oil recovery concepts for use in ice conditions, researched the use of chemicals to enhance spill control, analyzed the response needs of drilling and production operations in the Atlantic, Pacific and Arctic oceans, conducted numerous experiments to predict the behavior of various crude oils and study alternative countermeasures, and performed field and tank trials to evaluate oil spill behavior and response in open water and ice conditions.

Over the past twenty years Mr. Buist has been heavily involved in various projects related to *in situ* burning, and continues to be regarded as one of the world's leading authorities on the subject. Another of Mr. Buist's special areas of expertise is the mathematical modeling of oil spill processes. He has developed algorithms to describe oil spill behavior (spreading, dissolution, dispersion and emulsification), and *in situ* burning (of both slicks and surface blowout plumes).

Recent Testing of Oil-in-Ice Skimmers

Ivar Singasaas

SINTEF Materials and Chemistry
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As part of the Joint Industry Program “Oil Spill Contingency for Arctic and Ice-covered Waters” testing of a selection of oil recovery skimmers has been performed. The testing was performed in SINTEF’s ice basin at low temperatures and in the presence of two different ice conditions. The selection of skimmers was made in cooperation with manufacturers. In total, six skimmers were tested, four brush drum skimmers, one brush belt skimmer and one drum skimmer equipped with lamellas.

As has been demonstrated in previous basin testing, brush and brush/drum skimmers have shown a high potential for recovery of oil in ice. However, equally important as the oil recovery principle is the ice processing capabilities of the skimmer. Two of the skimmers tested showed better ice processing capabilities than the others and gave promising results in the basin testing.

Ivar Singasaas is a Senior Research Scientist at SINTEF Materials and Chemistry, Marine Environmental Technology Department in Trondheim, Norway. He obtained his MSc from the University of Trondheim and has worked with oil spill contingency at SINTEF since 1991. Main scientific areas are: weathering studies of oils, oil spill contingency analysis and planning, and oil spill response technology development.

Oil Recovery with Novel Oleophilic Skimmer Surfaces under Cold Climate Conditions

Arturo A. Keller

Bren School of Environmental Science & Management
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Increasing oil exploration, production and transport in Arctic waters will increase the risk of an oil spill occurring in cold and ice-infested waters. The presence of ice crystals in oil emulsions affects the adhesion processes between an oil slick and the surface of an oleophilic skimmer and prevents oil from being efficiently recovered. The objective of this project was to perform a comprehensive analysis of the adhesion between oil or ice-in-oil mixtures and various surface patterns and materials, under cold climate conditions. This knowledge was then applied to improve existing mechanical response equipment. The novel recovery surfaces that proved to increase the recovery efficiency of a drum skimmer up to two times in warm waters were also successful in cold climate conditions. Based on the results of the laboratory tests at subfreezing conditions, we selected materials and surface patterns with the highest oil recovery potential under cold climate conditions, and performed field scale oil spill recovery tests with three different oils. This provided valuable information about the correlation between the laboratory tests and full-scale experiments. It also demonstrated the potential of the skimmer modifications under conditions similar to response operations. The field tests were very successful, with high rates of oil recovery under cold climates, with and without ice present. However, the presence of ice did decrease the overall rate of oil recovery to some extent.

Arturo Keller received M.S. and Ph.D. degrees in Civil and Environmental Engineering from Stanford University. He holds a B.S. in Chemical Engineering and a B.A. in Chemistry from Cornell University. Dr. Keller has more than 20 years of industrial experience in projects involving wastewater treatment, hazardous waste handling and management, pollution prevention and minimization, recycling and process modifications to reduce emissions. He is a Professor at the University of California in Santa Barbara.

Using Herding Surfactants to Thicken Oil Slicks in Pack Ice for *In Situ* Burning

Ian Buist

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In situ burning is an oil spill response option particularly suited to remote ice-covered waters. The key to effective *in situ* burning is thick oil slicks. Concentrated pack ice can enable *in situ* burning by keeping slicks thick. In loose pack ice conditions oil spills can rapidly spread to become too thin to ignite. Fire booms can collect and keep slicks thick in open water; however, even light ice conditions make using booms challenging. A joint industry group recently completed a multi-year study to evaluate oil-herding surfactants as an alternative to booms for thickening slicks in light ice conditions to facilitate *in situ* burning.

Small-scale laboratory experiments were completed in 2004 and 2005 to examine the concept of using herding agents to thicken oil slicks among loose pack ice for the purpose of *in situ* burning. The encouraging results of the preliminary experiments prompted further meso-scale testing at the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), the Ohmsett facility, and the Fire Training Grounds in Prudhoe Bay, AK.

The non-proprietary cold-water herder formulation used in these experiments proved effective in significantly contracting oil slicks in brash and slush ice concentrations of up to 70% ice coverage. Slicks in excess of 3 mm thick, the minimum required for ignition of weathered crude oil on water, were routinely achieved.

Slicks that were too thin to be ignited after spreading to equilibrium were thickened by applying herder, ignited, and burned equally well in both brash and slush ice conditions at air temperatures as low as -17°C . The burn efficiencies measured for the herded slicks were only slightly less than the theoretical maximums achievable for equivalent-sized, mechanically contained slicks on open water.

Cold Water Dispersant Effectiveness Experiments Conducted at Ohmsett with Alaskan Crude Oils and Corexit 9500 and 9527 Dispersants

Joseph Mullin

Minerals Management Service
Engineering and Research Branch
Herndon, VA USA

One myth in oil spill response is that “chemical dispersants do not work effectively in cold water.” This is due to the general misconception that cold water inhibits dispersant effectiveness (DE) and the lack of experimental data to indicate otherwise. To address this issue, the U.S. Minerals Management Service (MMS) funded and conducted two series of dispersant experiments in very cold water at Ohmsett—The National Oil Spill Response Test facility, located in Leonardo, New Jersey from February-March 2006 and January-March 2007. Four Alaskan crude oils Alaska North Slope (ANS), Endicott, Northstar and Pt. McIntyre and two dispersants Corexit 9500 and Corexit 9527 were used in the test series. The crude oils were tested fresh, weathered by removal of light ends using air sparging and weathered by placing the oils in the tank in both breaking wave conditions and non-breaking wave conditions. Results from the 2006 and 2007 Ohmsett test series demonstrated that both Corexit 9500 and Corexit 9527 dispersants were more than 90% effective in dispersing the fresh and weathered crude oils tested. This verified the results from laboratory and small-scale experiments. MMS expects that results from these test series will assist government regulators and responders in making science based decisions on the use of dispersants as a response tool for oil spills in the Arctic. The results from the 2006 and 2007 Ohmsett dispersant effectiveness test series bust the myth that chemical dispersants are not effective in cold water.

Mr. Mullin is a Research Oceanographer with 34 years of scientific research and program management experience in the areas of marine science and oil spill response. He is responsible for developing, implementing and managing the U.S. Minerals Management Service's Nationwide Oil Spill Response Research Program. Mr. Mullin has been closely involved in the development, testing and evaluation of various oil spill equipment and techniques including fire resistant booms, skimmers for broken ice conditions, *in situ* burning in various environments and cold water dispersant effectiveness. He has authored or co-authored 120 scientific papers, technical articles and peer-reviewed publications.

ExxonMobil Research on Remotely Applied Response Options for Spills in Dynamic Ice

Tim Nedwed

ExxonMobil Upstream Research Company
Houston, TX USA

ExxonMobil Upstream Research Company (URC) has an internal oil-spill response research program designed to enhance capabilities in dynamic marine ice conditions. The research has focused on developing capabilities for large-scale spills using the remotely applied techniques of chemical dispersants and *in-situ* burning. These techniques may provide the necessary oil spill encounter rates in a challenging ice environment while keeping personnel safely away from potentially hazardous conditions.

Research findings indicate that dispersants are an option for spills in ice given adequate mixing conditions and the appropriate oil. To enhance capabilities, URC is developing a new dispersant gel that has a number of advantages. For conditions with inadequate ambient mixing, URC has developed a concept to utilize the prop wash of response vessels to supply the necessary energy to disperse chemically-treated oil. URC is developing a better understanding of the fate of oil after a marine spill particularly after dispersant treatment in low-energy conditions.

Regarding *in-situ* burning, URC led the recently completed joint-industry research project evaluating the concept to extend *in situ* burning to lower ice conditions using chemical herders.

URC is beginning evaluation of a novel concept that utilizes a well known physical phenomenon to remotely map and detect oil spilled under ice.

This presentation summarizes key components of URC's oil-spill response research program.

Dr. Nedwed has a B.S. degree in Chemical Engineering and a Ph.D. in Environmental Engineering. He has worked for Exxon and ExxonMobil in the Upstream Research Company for 10 years and leads the oil spill response research program for the upstream portion of the corporation.

Shoreline Treatment in Arctic Environments

Edward Owens

Polaris Applied Sciences Inc.
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Shoreline operations in Arctic and subarctic environments involve an understanding of the fate and behavior of oil in snow and ice in order that decision makers can develop appropriate objectives and strategies for treatment or cleanup activities. The first part of the paper summarizes the results of a review of the "state-of-the-art" regarding the behavior of oil on ice and snow covered shorelines and the response options for cleanup or treatment. This review was undertaken, in part, as the basis for considering R&D options to redress gaps in our knowledge or technological deficiencies for response operations on shorelines with snow and ice.

Two key components of the decision process for Arctic regions are remote area logistics/operations and waste generation. The second part of this paper describes a current project to develop a *Decision Guide and Job Aids* for waste management in the Arctic. The volume of waste generated by the response activities is not controlled by the size of the spill, nor the location, but rather is a direct function of the response objectives and the response methods decisions made by the management team. It is important therefore to understand the decision process and to provide the decision makers with relevant information regarding waste generation, waste types, and waste volumes upon which they can set the response objectives.

Dr. Owens has 40 years experience in arctic and sub-arctic environments in the Canadian Arctic and on the Alaska North Slope. He has been involved with Sakhalin Island oil development and production projects since 1995 and with arctic oil spill response operations or oil spill experiments in Spitzbergen, Russia, and Canada. Dr. Owens focus is on shoreline operations and he has flown and mapped the arctic coasts of the Northwest Passage from Baffin Bay to Point Hope.

Oil Mineral Aggregate Formation in Ice-Affected Waters

Kenneth Lee

Center for Offshore Oil and Gas Environmental Research
Bedford Institute of Oceanography, Fisheries and Oceans Canada
Dartmouth, Nova Scotia Canada

The promotion of Oil Mineral Aggregate (OMA) formation has been proposed as an oil spill countermeasure for oil spills in ice-infested waters. In a manner similar to that of chemical oil dispersants, this technique is based on the dispersion of oil from the surface into the water column; the premise being that resultant concentrations will be below the threshold limits that cause detrimental biological effects. Laboratory studies and field trials have shown that dispersed oil in association with mineral fines has an expanded oil-to-water surface area that will promote enhanced microbial degradation rates. Thus, spilled oil is not merely transported into the water column but effectively removed from the environment by natural processes. In terms of use in the Arctic, *in situ* methodologies may offer a major operational advantage, as there is no need for the physical removal and treatment of contaminated waste materials for treatment.

A collaborative field program between the Canadian Coast Guard and Fisheries and Oceans Canada has been initiated to provide fundamental scientific knowledge, field validation of response technologies, and training to oil spill responders. This presentation will describe our 2007-2008 project to be conducted in ice-infested waters of the St. Lawrence estuary prior to submission of a full-scale Arctic program.

Kenneth Lee received his B.Sc. degree in marine biology from Dalhousie University, followed by Masters and Doctoral degrees in limnology and microbiology from the University of Toronto. During his post-doctoral research studies in chemical oceanography with the Department of Fisheries and Oceans at the Institute of Ocean Sciences, Victoria, British Columbia Dr. Lee became interested in the development and validation of marine oil spill countermeasures. He has conducted research programs on chemical oil dispersants, natural attenuation, bioremediation, phytoremediation, and oil mineral aggregate formation. He is a lead researcher on the assessment of environmental impacts associated with offshore oil and gas exploration and production.

Dr. Lee is currently the Executive Director of the Department of Fisheries and Ocean's Centre for Offshore Oil and Gas Environmental Research (COOGER) based at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. This centre is responsible for the coordination of a national strategic program in environmental and oceanographic research of oil and gas activities as they relate to the Department of Fisheries and Oceans Canada mandate.

Lessons Learned: On-land, Cold-Weather Spill Response Clean-up Operations

Lee Majors

Alaska Clean Seas
Planning and Development Manager
Prudhoe Bay, Alaska USA

Alaska Clean Seas (ACS) is the Oil Spill Recovery Organization for the North Slope of Alaska. Annually, ACS responds to over 300 reportable spills and many other spill events.

Presented will be an overview of a few of the larger spill events over the last couple years. Emphasis will be placed on spill events in snow and ice, tactics utilized, and lessons learned. Included will be overview of the 2H pad and Drill Site 14 responses in 2005 plus the Gathering Center 2 pipeline spill response in 2006. The Gathering Center 2 pipeline response was the largest spill response ever on the North Slope of Alaska. These responses outline the tactics on land in snow and ice and extreme weather.

In 2005 and 2006, ACS conducted training and demonstrations on spill response tactics on overflood ice conditions. Tactics and lessons learned from these sessions will also be presented.

Lee Majors has over 20 years of spill response experience with ten years in the marine environmental field with the U.S. Coast Guard. The last seven years he has been the Planning and Development Manager for Alaska Clean Seas overseeing Oil Spill Response Research and Development, Spill Response Training, and Safety.

Baltic Approach to Oil Spill Recovery in Ice: Case Studies and Recent Development in Baltic Sea States

Kari Lampela

Finnish Environment Institute (SYKE)
Helsinki, Finland

The Baltic Sea is one of the most heavily operated sea areas and maritime transport is expected to increase still. The increasing transport of oil and oil products is the most significant reason for this development. On account of the fact that Baltic Sea is already heavily polluted, avoidance of any extra pollution load to the sea is one of the main principles when choosing response methods. Northern and Eastern parts of the Baltic have ice every winter and about once in 30-40 years the whole sea area is covered by ice. Because about 80% of Finnish transport is by sea, continuous and safe sea traffic during the ice season is vital to Finland and to other Baltic Sea states.

This paper gives an overview of the oil spill response policy adopted by Baltic Sea states mainly due to the work of the Baltic Sea Environment Protection Commission, HELCOM, concentrating on oil spill response in ice and cold conditions. There have been some minor accidental oil releases in ice during recent years, which are described in the paper. Due to the greatly increased oil traffic especially in the Gulf of Finland, there is a great demand to develop new methods and equipments to collect oil in ice. Some of the latest developments, studies, new mechanical response units and response vessels are explained as well.

Mr. Lampela has over 40 years of experience in different governmental bodies in Finland. In addition to the overall management of the field of oil spill response Mr. Lampela is in charge of the related research and development work of the Finnish Environment Institute. He has provided leadership to a diverse team of scientists, both domestic and international and his responsibilities include also extensive liaison with key governmental agencies and environmental groups around the Baltic Sea.

Joint Industry Arctic Oil Spill Research Program

Stein Erik Sørstrøm

SINTEF Technology and Society
Trondheim, Norway

Stein Erik Sørstrøm has a Masters of Science degree from the University of Trondheim. He has spent 30 years in various roles related to environmental management including freshwater and wildlife management, oceanography, and environmental technology. Much of this time has been with SINTEF, the largest research and development organization in Norway and the fourth largest in Europe.

From 1997 to 2005 he worked in a private company in innovation and business development with a focus on environmental technology, energy and environment (mainly in China), environmental monitoring, environmental consulting and project management. Since 2005 he has been Senior Adviser for SINTEF Division Technology and Society.

Stein Erik has been involved in oil spill R&D since 1978 and has broad experience in this field as project manager for a number of projects. Stein Erik is presently working for SINTEF Materials and Chemistry as Program Coordinator for the Joint Industry Program on Oil spill contingency for Arctic and ice-covered waters, the subject of this presentation.



Photo: Shell E & P



Photo: D. Dickins



Photo: Finnish Environment Institute



Photo: A. Allen



Photo: D. Dickins