

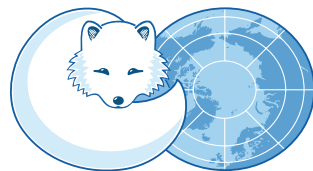
RECOMMENDED PRACTICES FOR ARCTIC OIL SPILL PREVENTION



ARCTIC COUNCIL

EPPR Emergency Prevention,
Preparedness and Response

Recommended Practices for Arctic Oil Spill Prevention



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1 Introduction

This report was prepared by DNV on behalf of the Norwegian Coastal Administration, which represents Norway in the Arctic Council's Emergency Prevention, Preparedness and Response Working Group (EPPR).

This report includes a literature study with reference to projects, experience, conventions, regulations, standards, guidelines, plans, certificates and other documentation collected to form a basis for further discussion within the EPPR R3 project. The reference list is not complete, but includes some key examples. Note that the focus has been on the additional Arctic challenges not directly addressed in rules, regulations and standards but covered by Best Practices. Regular activities, i.e. how the operations are carried out in non-Arctic areas, are not included in this report but are assumed to form the general basis for the different activities. This report identifies some relevant existing standards, regulations, plans and experiences, and areas of potential collaboration and sharing of expertise, thus providing a foundation for future cooperation by Arctic countries within this area.

The report will form the basis and reference for a condensed report to be issued by EPPR and to be presented to Arctic Council Ministers in May, 2013.

1.1 Background

There is a mutual understanding among the Arctic countries of the responsibility to preserve the Arctic environment, including indigenous people. The Arctic countries should learn from each other's regulatory practices and agree on common practices. The man-

date of the Arctic Council's Emergency Prevention, Preparedness and Response (EPPR) Working Group is to deal with the prevention, preparedness and response to environmental emergencies in the Arctic. Members of the Working Group exchange information on best practices and conduct projects to improve capabilities in the Arctic. Activities include development of guidance and risk assessment methodologies, response exercises, and training.

The EPPR Working Group mandate is refined through ministerial declarations and is further shaped by guidance from Senior Arctic Officials (SAOs). The EPPR Working Group reports to the SAOs, who meet twice a year, and through them, to the ministers of the Arctic Council who meet every two years. EPPR includes national representatives from the eight Arctic nations: Canada, Denmark (including Faroe Islands and Greenland), Finland, Iceland, Norway, Russian Federation, Sweden and the United States.

In the 2011 Nuuk declaration, Arctic Council ministers called on EPPR and other relevant working groups to develop "recommendations and/or best practices in the prevention of marine oil pollution".

Thus, the EPPR Working Group initiated a project, *Recommended Practices in the Prevention of Marine Oil Pollution*, the EPPR RP3 project with the goal to identify practices proven or identified to be successful in preventing marine oil pollution and which can be applied in an Arctic setting.

The project was kicked off with a scoping workshop in Oslo, Norway on October 19-20, 2011. Approximately 70 participants



from government agencies, Permanent Participants, observers and other relevant stakeholders from all the Arctic states attended the workshop and identified a number of areas of interest which have formed the basis of this project. The workshop concluded that the largest risk of an oil spill in the Arctic stems from increased activities related to shipping and maritime operations, offshore oil and gas development, and some land-based industry.

The project was co-led by Canada and Norway, in co-operation with the Arctic Council's Protection of the Arctic Marine Environment (PAME) working group, and Det Norske Veritas (DNV). DNV was responsible for undertaking a survey among selected operators with experience from or planning for Arctic operations and for drafting this report. Finally, the results will be presented at the 2013 Arctic Council ministerial meeting.

2 Executive Summary

The mandate of the Emergency Prevention, Preparedness and Response (EPPR) Working Group is to deal with the prevention, preparedness and response to environmental emergencies in the Arctic. In the 2011 Nuuk Declaration, Arctic Council Ministers called on EPPR to develop “recommendations and/or best practices in the prevention of marine oil pollution”.

The EPPR established the RP3 project “Recommended Practices in the Prevention of Marine Oil Pollution” to fulfil the Arctic Council’s tasking. Leadership for the EPPR RP3 project is shared between Norway and Canada.

As a part of the work, DNV was asked to create a report including references to:

- conventions, regulations, standards, guidelines and plans
- relevant prevention programs and development projects
- experience from designed and installed projects
- accident reports
- identification of hazards, risks, existing safeguards barriers and risk mitigating measures
- human resources and competence

The report addresses the prevention of marine oil pollution in the Arctic from offshore oil and gas activities, transport of oil, and land-based activities. Only the additional challenges experienced in the Arctic are included in this work. Best practices developed to address challenges outside the Arctic naturally form a basis for identical challenges found inside the region, but these are not further discussed in this report.

The project kicked off with a scoping workshop in October 2011 in Oslo, at which representatives from all the AC countries identified a list with the most relevant and important topics to be covered. The topics were used as a basis for this report and for a questionnaire used when interviewing experts from oil companies and authorities. Experience from DNV’s own expertise in offshore O&G and especially ship operations is incorporated in the report.

The authors conducted a literature review of available studies, projects, accident reports etc. relevant to EPPR’s mandate. The literature review forms the basis of this report. The mapping of experience from Arctic projects under development or in operation represents valuable information with regard to identifying the main hazards and how they are mitigated. Chronic pollution is only briefly discussed in this report as the cause of chronic pollution is mainly caused by lack of proper inspection and maintenance.

The main goal of this work has been to identify possible “best practices” as defined below:

- *best practice* effective prevention management strategies aimed at completely eliminating the potential for the accidental release of pollutants into the marine environment.

Very often, a *best practice* goes beyond mandatory requirements described in rules and regulations; hence, the sharing of best practices between operators can contribute to a safer operation.

In the industry, the *best practices* are often

the way things are done — but they are not necessarily documented in procedures, making them difficult to find and document. Best practices linked to the attitude in a company are typically among those which are more difficult to point to.

Some of the main findings reported related to best practices or proposed actions to reduce the risk for an oil spill include the following issues:

- Better and more reliable information about the actual local ice/met-ocean conditions
- Identifying the principal hazards and conducting a risk analysis of the actual operation
- Implementing adequate-risk mitigating options
- Implementing a good HSE system, regularly updating it, and ensuring personnel are trained in and kept abreast of updates to the system
- Requirements for training and minimum competence
- A system for continuous improvement through monitoring, updating of procedures, and training
- Building and living up to a strong safety culture at all levels in the organization—*safety first*
- Open and honest communication; reporting and learning from all incidents

Several of the experts interviewed pointed to the need to coordinate research and devel-

opment work in order to get more value for the money invested. Sharing data and results will reduce parallel R&D work, allowing more effort to be put into projects developing real new technology and competence. The lack of full-scale data is also a problem.

Existing, officially-available data should be easier to find and access. As a solution, the Arctic Council could consider the establishment of a R&D and experience database. Not all data and results need to be included, but references to projects, reports, persons, etc. could be included. By including all Arctic Council countries in the database, new R&D projects can be based on results from existing projects; hence, it will be possible to improve both the efficiency and results of future projects. The database could also include references to best practices within different disciplines and thereby prove to be a valuable resource for both the industry and authorities.

The interviewed experts agree that a balance between prescriptive and goal-based rules is best. The development of rules and regulations often lags behind technological development. The use of more goal-based rules is thought to address some of these challenges.

Implementation follow-up of a good HSE and management system has also been highlighted as important. The value of such systems, however, is strongly dependent on regular updates according to the actual operation and that all people involved are trained and updated accordingly.

3 Work Description

If offshore, maritime and land-based activities in the Arctic region are expected to meet a satisfactory safety level, identification of Arctic challenges and hazards that add risks to the existing safety picture need to be addressed and technical solutions and operational best practice need to be identified and discussed.

A number of barriers and risk-reducing measures will serve to decrease the probability of an accident, and a reasonable and practicable risk level can be achieved. A common way to identify the main risks and hence find the best risk mitigating measures is to carry out hazard identification followed by a risk evaluation. The survey among operators has revealed that a great deal of effort has been put into both identifying risks and finding mitigating measures for both planned operations and existing fields.

The aim of this report was to identify a baseline for best practices to prevent oil spills during offshore, maritime shipping and land-based activities in the Arctic. The study was conducted by collecting data through interviews with the industry, through a scoping and expert workshop, by performing a literature study and by reviewing other sources of relevant information.

There is a strong focus on the risk of oil spills from offshore O&G production and the transportation of oil. Following the accident in the Gulf of Mexico, there has been a special focus on how to use barriers to prevent

accidents that may lead to oil spills from exploration platforms and production installations. Risk-based methods have been applied in order to find the most critical links in production and transport chains for installation of effective barrier systems.

The following topics were included in the assessment for the three different areas (offshore oil and gas fields, Arctic shipping, and land-based activities):

- The use of barriers to avoid escalation of minor incidents to large accidents are well known, but now more attention has been given to which barriers and how they are applied in Arctic conditions; and,
- Procedures for inspection, testing and maintenance of the barriers to maintain a design safety level.

Based on input from the offshore industry, safeguarding life, protecting the environment, and maintaining full operation are its top priorities. Also high on the agenda are measures to collect possible minor spills on-board and thereby avoid discharge to the sea.

A modern operational management system includes well-defined procedures for inspection and maintenance of barriers. A regime going from periodic maintenance intervals to a more risk- and monitoring-based maintenance regime also applies for barriers. The attitude and follow-up of procedures and instructions at all levels in the organization are



Figure 3.1

of vital importance for a safe and environmentally-responsible operation.

3.1 Definitions

Definitions of “prevention” and “best practice” are necessary to limit the scope of work and build a common platform for cooperation. The following definitions were established during the workshop in Oslo, 19-20 October 2011.

- *best practice* effective prevention management strategies aimed at completely eliminating the potential for the accidental release of oil, etc. into the marine environment
- *prevention systems* i.e. prescriptive hardware requirements for safe operations, implementation of robust management systems with regulatory accountability criteria, etc.

This report will focus on “primary prevention”, and it will aim at “eliminating” accidental spills.

3.2 Abbreviations

AAmverNet	Arctic Automated Marine Vessel Emergency Rescue Network
AANDC	Aboriginal Affairs and Northern Development Canada
AC	Arctic Council
AC WG(s)	Arctic Council Working Group(s)
AIS	Automatic Identification System
AMAP	Arctic Monitoring and Assessment Programme
AMSA	Arctic Marine Shipping Assessment
AOR	Arctic Ocean Review
ASPPR	Arctic Shipping Pollution Prevention Regulations (Canada)
AWPPA	Arctic Waters Pollution Prevention Act (Canada)

BAP	Best Available Practices
BAST	Best Available and Safest Technology
BAT	Best Available Techniques or Best Available Technology
BMP	Bureau of Minerals and Petroleum (Greenland)
BMPs	Best Management Practices
BOEM	Bureau of Ocean Energy Management (USA)
BOP	Blow Out Preventer
BREA	Beaufort Regional Environmental Assessment
BSEE	Bureau of Safety and Environmental Enforcement (USA)
CCG	Canadian Coast Guard
CISE	Common Information Sharing Environment
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
COCP	Critical Operation and Curtailment Plan
C-Plan	Contingency Plan
CPM	Computational Pipeline Monitoring
DCPI	Division of Communication and Public Information
DELCC	Division of Environmental Law Conventions
DEWA	Division of Early Warning and Assessment
DFO	Department of Fisheries and Oceans (Canada)
DMA	Danish Maritime Authority
DND	Department of National Defence (Canada)
DRC	Division of Regional Cooperation
DTIE	Division of Technology, Industry and Economics
DWOP	Drilling and Well Operations Practices
EC	Environment Canada
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment

EMS	Environmental Management System	MPR	Maritime Pollution Response
EPA	Environmental Protection Agency (U.S.)	MSA	Maritime Situational Awareness
EPPR	Emergency Prevention, Preparedness and Response	NASP	National Aerial Surveillance Program (Canada)
ERMA	Environmental Response Management Application	NEB	National Energy Board (Canada)
ESD	Emergency Shutdown systems	NORSOK	Norwegian Shelf
FC	Fisheries Control	O&G	Oil and Gas
FPSO	Floating Production, Storage and Offloading	OCIMF	The Oil Companies International Marine Forum
GAIRAS	Generally Accepted International Rules and Standards	OGP	International Association of Oil and Gas Producers
GOM	Gulf of Mexico	OMS	Operating Management System
GPA	Global Programme of Action	OSER	Operational Safety and Engineering Research
HAZID	Hazard Identification	OSHA	Occupational Health and Safety Administration
HELCOM	Helsinki Commission	OSR	Oil Spill Research
HSE	Health, Safety and Environment	OSWG	Oil Spill Working Group
I – STOP	Integrated Satellite Tracking of Pollution	PAME	Protection of the Arctic Marine Environment (Arctic Council)
IBM-LE	Integrated Border Management – Law Enforcement	PHA	Process Hazard Analysis
ICS	Incident Command System	PSA / PTIL	Petroleum Safety Authority / <i>Petroleumstilsynet</i> (Norway)
ILO	International Labour Organization	REnR	Renewable Energy Research
IM	Ice Management	RPA	Regional Programme of Action
IMO	International Maritime Organization	RS	Regional Seas
IMP	Ice Management Plan	SAOs	Senior Arctic Officials
INTERTANKO	International Association of Independent Tanker Owners	SAR	Search and Rescue
IOPP	International Oil Pollution Prevention	SCADA	Supervisory Control and Data Acquisition
IPIECA	International Petroleum Industry Environment Conservation Association	SCL	Secondary Containment Liners
KPI	Key Performance Indicators	SIRE	Ship Inspection Report (OCIMF)
LRIT	Long Range Identification and Tracking	SMPEP	Shipboard Marine Pollution Emergency Plan
MART	Marine Aerial Reconnaissance Team	STCW	Standards of Training, Certification and Watchkeeping
MEPC	Maritime Environment Protection Committee	TA&R	Technology Assessment & Research
MLC	Mud line Cellar	TC	Transport Canada
MODU	Mobile Offshore Drilling Unit	TMSA	Tanker Management and Self-Assessment (OCIMF)



TROOP	Transfer of Refined Oil and Oil Products	UNEP	United Nations Environment Program
T-time	Estimated total time to secure the well and leave the location	USCG VTMIS	U.S. Coast Guard Vessel Traffic Monitoring Information System
UNCLOS	United Nations Convention on the Law of the Sea	VTS WHO	Vessel Traffic Service World Health Organization

4 General issues reported from workshops

4.1 Scoping Workshop, Oslo

The following is a summary of the key findings from the Scoping Workshop for the *EPPR Recommended Practices for Arctic Oil Spill Prevention* Project (RP3), held 19-20 October 2011, in Oslo. A set of questions was prepared for the work groups in order to provide support to the decision making process and frame the scope of work and processes.

The first question aimed to set the scope of work for the EPPR RP3:

What should be included in the EPPR RP3 report to ensure that best practices and recommendations to prevention of marine oil pollution in Arctic are described?

It was agreed by the workshop participants that a definition of “prevention” and “best practice” would be necessary to limit the scope of work and to build a common platform for further co-operation. Further, it was agreed that the deliverables should be organized according to the thematic topics addressed in the work groups and that the objective of EPPR RP3 should be to establish and share recommendations on best practices for oil pollution prevention in the Arctic. In that regard, it is of utmost importance to acknowledge what has been done before (e.g. PAME projects) to avoid duplication of work. Topics that could be included in the EPPR RP3 work were identified as:

- HSE management system and elements for effective implementation in Arctic areas

(elements of HSE systems, sources, identify best practice examples and principles, Arctic specific elements, evaluating HSE systems, balance between prescriptive vs. performance-based systems, elements between countries, etc.)

- Human resource management for work in the Arctic (screening/selection, fitness for work, training etc.)
- Details on existing maritime surveillance systems (e.g. Automatic Identification System (AIS), satellite, aircraft, coastal radar, reporting systems, vessel traffic service (VTS)) and co-operation regimes (e.g. Bonn Agreement, Helsinki Commission (HELCOM))
- Gaps in maritime surveillance based on emerging activities (e.g. sensor coverage, communication, applicability of surveillance systems, interoperability challenges)
- New technology for prevention (e.g. BOPs, capping stacks, etc.) and best available technology.
- Places of refuge/stranding for shipping
- Current practices and need for seasonal drilling restrictions
- Key lessons learned and conclusions from major accidents. Accident categories of special interest are:
 - Vessel grounding or collision
 - Oil spill from land-based facilities
 - Spill during transfer (vessels, pipeline, /loading buoys, etc.)
 - Blowout (subsea, surface)
 - Transport along rivers (trucks or railway)
 - Pipeline leaks (onshore, offshore)

- Scouring, subsea equipment
 - Icing of equipment
 - Resources to produce/update charts
 - Terrorism (later changed to security)
- Applicable international and domestic standards
 - Related work done by PAME
 - Catalogue of international standards, international regulations and literature that support best practice recommendations
 - Identify each State's potentially relevant ministries/agencies in the thematic areas addressed in the report; could include a brief general description of agencies' roles/responsibilities

The second question dealt with the final product of the EPPR RP3 work and in what manner this should be presented and shared among relevant stakeholders:

What types of products and deliverables could EPPR RP3 provide that would be useful for you?

The participants agreed that the deliverables should include a report to be distributed among governmental ministries, agencies, project participants, Arctic Council working groups and other relevant stakeholders. In addition to the report, the possibility of creating a web page solution with links to standards, regulation, guidelines, best practices, manuals, on-going project work and the like was discussed. This could be an efficient way of sharing information, both internally among members and externally. EPPR will investigate using its website as a tool for outreach and communication. Also, it was suggested to use the results to inform the IMO Polar Code and other processes.

For question three, the workshop participants discussed the management of the RP3 work and in what way their organisation could contribute to the final product:

Who can or should take part in the preparation of the EPPR RP3 report? (consultants, government authorities, industry or others). How can you or your organization contribute?

The workshop participants agreed on the use of a contractor (external consultant) to conduct project management and prepare a draft text. However, it is very important that the national experts, PPs and other working groups participate in developing and drafting the product and remain involved in the work during the review process. Input to the report should be gathered from:

- Project participants
- AC WGs
- HSE regulators
- Shipping and oil/gas companies
- Technical experts
- Monitoring and surveillance bodies
- Industry bodies (e.g., OGP, OCIMF)
- Classification societies
- Government authorities
- Permanent Participant organizations of the Arctic Council

The last question aimed to identify the processes that would best assist to develop the EPPR report:

What process would best assist the development of the draft EPPR RP3 report?

The work processes to include:

- Workshops with technical experts and thematic groups
- Involvement of Project participants, AC WGs, governments and other stakeholders
- Virtual conference / meetings
- Questionnaire surveys

4.2 Expert Workshop, Iceland

A workshop was arranged on 10-12 June 2012 in Keflavik, Iceland with experts from Arctic countries. The workshop started with opening remarks and an introduction to the RP3 project including background, status and the way forward by the co-chairs Ole Kristian Bjerkemo (Norway) and Michel Chenier (Canada).

A PAME HSE workshop to scope out a new HSE project was arranged in parallel and some of the experts participated in both workshops. Dennis Thurston (U.S.) gave a presentation of



the PAME HSE project, as parts of that project may also be relevant for the RP3.

Finally, Morten Mejlænder-Larsen (DNV), project manager for the RP3 report gave an overview of the RP3 work and report, and introduced the following break-out sessions.

The workshop participants worked in four different break-out groups:

1. Oil and gas
2. Maritime shipping
3. Land-based activities
4. Monitoring
4. HSE and risk based management systems covering Δ-Arctic
 - The Arctic risk reflected in HSE systems
5. Human resources and competence, formal competence and training
6. Available Arctic competence and technology
7. Surveillance and monitoring, possibilities and limitations
8. Maritime safety systems for safer ship operations
9. Key lessons learned and experience from past incidents

The task for the four groups was to discuss the following topics within each area:

1. Reference to existing rules and regulations
2. Existing practice and experience
3. Assessment of existing Arctic prevention programs, with focus on the additional, Δ-Arctic, challenges

Each group gave a presentation in plenum at the end of the workshop. The presentations are included in Appendix IV, Results from Group Work, Keflavik.

The first version of the report was distributed to the workshop participants one week prior to the workshop. Comments and issues discussed in the Keflavik workshop are included in Appendix IV in this report.



5 Existing Conventions, regulations, standards, Guidelines and Plans

The two basic regulatory approaches—a performance-based system and a prescriptive approach—are available for dealing with the safety and environmental aspects of offshore Arctic oil and gas operations. In the performance-based approach, the regulator sets specific quantifiable goals (functional requirements), which allow the operator the flexibility to specify how they intend to comply with the regulatory body’s mandate by implementing technical standards, company guidelines, and “safety case” initiatives. The prescriptive approach is based on a series of specific and detailed regulatory requirements and is typically developed from a series of existing standards, practices, guidelines and procedures.

The regulatory framework applicable for maritime activity in the circumpolar Arctic is built up of conventions, laws, regulations, standards and guidelines prepared and issued at the international and regional level (e.g., United Nations Convention on the Law of the Sea (UNCLOS), International Maritime Or-

ganization (IMO), Arctic Council), at the national level (as flag state, coastal state, or port state), and by other institutions (ISO or other industry standards). Generally, prescriptive jurisdiction by flag states and coastal states is linked by means of rules of reference to the notion of Generally Accepted International Rules and Standards (GAIRAS). For further information regarding international and bilateral/multilateral instruments governing the shipping industry, reference is made to *The Arctic Ocean Review (AOR)*, prepared by PAME, ref./19/.

The classification societies have complete sets of rules and notations for ships with regard to maritime transportation and marine operations. Maritime activity in the Arctic is regulated in the same way as in other oceans, with a few exceptions. The system of using accepted international rules and standards for ships applies in the Arctic. A key difference, however, is that UNCLOS Article 234 authorizes coastal States to enforce non-discrimi-

Figure 5.2

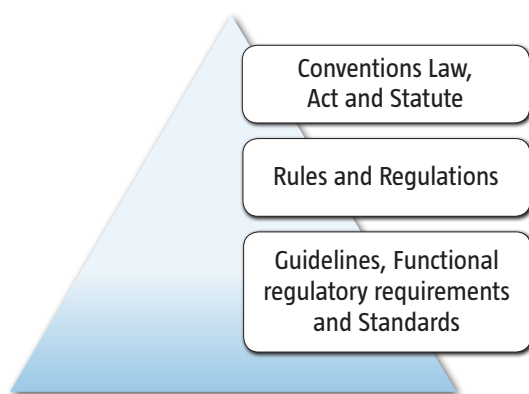


Figure 5.1

Maritime Transport	Offshore Activities
<ul style="list-style-type: none"> • Regulatory regime based on international convention and class • Must comply with safety regulations of the maritime authority in the country whose flag the unit is flying • Classification societies have a leading role 	<ul style="list-style-type: none"> • Regulatory regime based on international convention and unique coastal state regulation • Must comply with the regulations of coastal state in whose waters it is planning to operate • Coastal state regulatory authorities take a lead with respect to offshore activities in waters under their jurisdiction

natory law and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered areas within the limits of the Exclusive Economic Zone (EEZ). Canada and Russia have used this opportunity to set additional requirements for ships sailing in their Arctic waters that go beyond rules and standards laid down in legally-binding IMO instruments that have entered into force. For the most part, neither Denmark, Iceland, Norway nor the USA have enacted specific legislation or regulation for Arctic shipping that applies requirements beyond generally-accepted international rules and standards. The state of Alaska, however, has some rules beyond international and U.S. federal law regarding the discharge and management of waste from cruise ships within Alaskan State waters. While ships sail the world's oceans, offshore installations are typically stationary, located within the continental shelf jurisdiction of a particular state. This difference is one of the reasons why maritime transport activities are regulated in a substantially different manner than offshore activities. The maritime regulatory regime for shipping is based on international conventions and classification society rules, whereas the regime for floating offshore units used in offshore oil and gas activities is based on unique coastal state regulations. Generally, there are different standards applicable to the offshore oil and gas activities than for maritime transport activities. International legal conventions such as MARPOL 73/78 and SOLAS generally apply to maritime transport activities, while offshore activities on the continental shelf are generally not regulated by international conventions. There are, however, a variety of international standards used by coastal states in regulating offshore activities on their respective continental shelves, such as those promulgated by the ISO. Few of the international conventions or standards have been adapted to address the unique operational challenges in an Arctic environment.

Land-based activity is governed by national regulations and followed up by national authorities. Generally, most land-based activity referred to here, such as oil terminals, ports, refineries, mining activities etc., have already been going on for decades in cold climate. The additional risk of oil pollution in this context

is regarded as limited as the industry already has long-standing experience.

Norway, Russia and the USA administer their offshore activities in the Arctic areas the same way as in non-Arctic areas. Russia's offshore regime is relatively new and still under development; however, it is likely to develop Arctic-specific regulations in this process. Canada, on the other hand, has created a special regime for its Arctic areas. In Greenland, offshore activities are administrated by a domestic (i.e. Greenlandic) legislative regime, which can be considered Arctic-specific in its entirety.

The Arctic Council (AC) is a key player at the regional level and has issued the advisory *Arctic Offshore Oil and Gas Guidelines*, ref./4/. The Arctic Council's *Guidelines* state that offshore oil and gas activities should make use of the best available and safest technology, as appropriate, and be conducted in a manner to minimize impact on the environment. Most importantly, the *Guidelines* stress that this capability should be maintained even while operating under extreme Arctic conditions.

The regulatory and legislative systems in the Arctic countries are presented briefly in the following chapter. For more information, see *AMAP Assessment 2007*, ref./8/, and the Pembina report by Dagg et al., ref./75/, which identify similarities and differences between regulatory regimes, focusing particularly on: regulations and regulatory regimes, management system requirements, drilling and well activities, facility and drilling system requirements, requirements for well control, and independent verification of safety and oil spill preparedness requirements. Some key statutes and regulations in Arctic waters are summed up in Table 5-1.

5.1 Arctic countries' regulatory regimes and key statutes

5.1.1 Greenland (Denmark)

Danish law prevails in the maritime sector of Greenland, the principal legislation being the Danish Act on Safety at Sea and the Danish Safety of Ships Act. The Danish Class Agreement, 2003, authorizes recognized class societies to perform statutory survey and certifica-

Table 5-1 Some key statutes and regulations in Arctic waters

Country	Statute / regulation title
Canada	<ul style="list-style-type: none"> – Shipping Act – Arctic Waters Pollution Prevention Act – Canada Oil and Gas Operations Act
Greenland (Denmark)	<ul style="list-style-type: none"> – Danish Act on Safety at Sea – Danish Safety of Ships Act – Greenland Mineral Resources Act – Danish Act on Protection of the Marine Environment
Iceland	<ul style="list-style-type: none"> – The Hydrocarbon Act
Norway	<ul style="list-style-type: none"> – The Svalbard Environment Protection Act – The Petroleum Act – The Pollution Control Act
Russia	<ul style="list-style-type: none"> – Law of Environmental Protection – Regulations for Navigation on the Seaways of the Northern Sea Route (1991) – Requirements for the Design, Equipment and Supplies of Vessels Navigating the Northern Sea Route (1990)
United States	<ul style="list-style-type: none"> – Outer Continental Shelf Lands Act (OCSLA) – Oil Pollution Act – National Environmental Policy Act

tion services on behalf of the Danish Maritime Authority (DMA) for Danish-registered ships and MODUs.

Mineral resources and resource activities in Greenlandic waters are regulated domestically by Greenland; the Greenland Bureau of Minerals and Petroleum (BMP) is the regulatory authority. The principal statutes intended to prevent oil spills are the Greenland Mineral Resources Act (which regulates prospecting, exploration and exploitation of mineral resources on the Greenland continental shelf) and the Danish Act on Protection of the Marine Environment (which aims at preventing and reducing pollution of the marine environment from ships, aircraft, and floating and fixed platforms).

5.1.2 Canada

On July 1, 2007, the *Canada Shipping Act, 2001 (CSA 2001)* replaced the *Canada Shipping Act (CSA)* as the principal legislation governing safety in marine transportation and recreational boating, as well as protection of the marine environment. It applies to Canadian vessels operating in all waters and to all vessels operating in Canadian waters (from canoes and kayaks to cruise ships and tank-

ers). The CSA 2001 promotes the sustainable growth of the marine shipping industry without compromising safety. The Arctic Waters Pollution Prevention Act (AWPPA) defines Canada's internal waters, territorial sea and EEZ. The principal purpose of these acts is to promote safety in marine transportation and protect the marine environment. The Arctic Shipping Pollution Prevention Regulations (ASPPR) serve to implement key aspects of the AWPPA. Among other things, it divides Canadian Arctic waters into sixteen shipping safety control zones and sets technical requirements applicable to all vessels for sailing in these zones. Prior to undertaking any voyage into a control zone, vessels are encouraged to have a valid Arctic Pollution Prevention Certificate issued by the Administration or an approved classification society on its behalf. The certificate is not mandatory; however, ships without a certificate may be inspected by Transport Canada (TC) to verify their compliance with the ASPPR.

Aboriginal Affairs and Northern Development Canada (AANDC) and the National Energy Board (NEB) share regulatory responsibilities for oil and gas exploration and production activities in the Canadian Arctic, including the drilling of offshore wells. The

Canada Petroleum Resources Act and Canada Oil and Gas Operations Act are two of the key statutes governing oil and gas activities. Among other things, operators require a Certificate of Fitness and an environmental assessment prior to any drilling, installation or production activities.

5.1.3 United States

The United States have not enacted specific legislation or regulations for Arctic shipping that applies requirements beyond generally-accepted international rules and standards.

With respect to offshore activity, Arctic offshore resources in the United States fall under either the jurisdiction of the U.S. Federal Government or the State of Alaska. Facilities operating on the U.S. Outer Continental Shelf are regulated principally by the U.S. Coast Guard (USCG), the Bureau of Ocean Energy Management (BOEM), and the Bureau of Safety and Environmental Enforcement (BSEE). BSEE enforces safety and environmental regulations. Other agencies have some regulatory responsibilities offshore as well, including the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA).

Requirements under BSEE for oil and gas drilling activities conducted on the U.S. Outer Continental Shelf (OCS) are specified at Title 30 U.S. Code of Federal Regulations Part 250 – *Oil and Gas and Sulphur Operations in the Outer Continental Shelf* (30 CFR 250). These regulations include both prescriptive and performance-based measures intended to prevent oil spills to the Arctic marine environment. They set U.S. requirements for well design based on site specific shallow geohazards site clearance information, deep seismic data, redundant pollution prevention equipment, testing and verification that equipment is working properly, and training and testing of personnel in well control procedures. These regulations also establish requirements on the technical specifications for the specific drilling rig and the drilling unit. Requirements for conducting drilling operations in the U.S. Arctic OCS prior to the Macondo well blowout include:

- Locating the blowout preventer (BOP) in a well cellar (a hole constructed in the sea bed) so that the top of the BOP is below the maximum potential ice gouge depth. This protects the BOP and assures the well can be safely shut in, in the event the drilling unit had to move off location (250.442l, 451h).
- Using special cements in areas where permafrost is present. These special cements create less heat than normal cements when curing so that permafrost does not thaw (250.415d, 428i).
- Enclosing or protecting equipment to assure it will function under sub-freezing conditions (250.418f).
- Develop critical operations and curtailment procedures which detail the criteria and process through which the drilling program would be stopped, the well shut in and secured and the drilling unit moved off location before environmental conditions (such as ice) exceed the operating limits of the drilling vessel (250.220b, 417e).

5.1.4 Russian Federation

Legislation on Russia's maritime zones is contained in the Federal Law on the EEZ and the Federal Law on the International and Territorial Marine Waters. The Russian Federation has opened the Northern Sea Route for foreign shipping, however they have enacted requirements that go beyond GAIRES and which are applicable to vessels of all flags sailing the route (e.g., pollution standards are stricter than MARPOL). The Northern Sea Route is administered through two principal regulations:

- *Regulations for navigation on the Seaways of the Northern Sea Route (1990), ref./27/*. On the basis of non-discrimination for vessels of all States, it regulates navigation through the Northern Sea Route for the purpose of ensuring safe navigation and preventing, reducing and keeping under control pollution from vessels. Important documents to be approved prior to sailing include a notification and a request for

guiding through the Northern Sea Route, and a certificate of financial security.

- *Requirements for the Design, Equipment and Supplies of Vessels Navigating the Northern Sea Route, ref./28/*. The requirements take into account the special conditions of navigation along the Northern Sea Route. They intend to ensure safety of navigation and to prevent pollution of the marine environment and northern coast of Russia. The requirements are mandatory for all international ships. A fee is required to be paid prior to navigating in the Northern Sea and icebreaker escort will then be available if deemed necessary.

Principal regulatory authority for offshore petroleum activity in Russia resides with the Ministry of Natural Resources and Environment, the Russian Ministry of Emergency Situations, and RosTecknadzor. Other ministries and regulatory agencies also have some responsibilities and authority over offshore activities within their areas of expertise.

5.1.5 Norway

Petroleum activities offshore and onshore, including terminals, are subject to a regulatory regime that may be considered relatively strict. The Ministry of Labour and Social Inclusion has delegated the responsibility for coordinating the total supervision of the activities to the Petroleum Safety Authority (*Petroleumstilsynet*) (PSA/PTIL). PSA is regulatory authority for technical and operational safety, including emergency preparedness and working environment. PSA is divided into six disciplines: drilling and well technology, process integrity, structural integrity, logistics and emergency preparedness, occupational health and safety, and HSE management.

The PSA, the Norwegian Climate and Pollution Agency (former Norwegian Pollution Control Authority) and the Norwegian Board of Health issued five supplementary regulations for offshore oil and gas activities on the Norwegian Shelf. They form the regulatory basis for offshore oil and gas activities on the Norwegian Continental Shelf. The regulations are largely formulated as functional require-

ments and stipulate how standards are to be applied. The PSA, the Norwegian Pollution Control Authority and the Norwegian Board of Health supervise/audit the fulfilment of these regulations in their respective spheres, ref. /2/;

- *Regulations relating to management in the petroleum activities* identify the environmental considerations which the licensees deem to be critical to their preparation of an oil spill contingency plan;
- *Regulations relating to execution of activities in the petroleum activities* and for planning the measures employed in order to reduce the risk of such pollution;
- *Regulations relating to material and information in the petroleum activities* set requirements to material and information to be submitted or made available to the authorities;
- *Regulations relating to the design and outfitting of facilities etc. in the petroleum activities* regulate the design and outfitting of facilities;
- *Regulations relating to health, safety and the environment in the petroleum activities* contain provisions on, responsibility, principles relating to risk reduction, application of maritime legislation as an alternative to technical marine requirements in the regulations, principle relating to health, safety and the environment, working hours, periods of stay and off-duty time.

The majority of the standards referred to by PSA are Norwegian Shelf (NORSOK) standards.

5.2 International Standards

This Section refers to some standards, projects/reports and organisations central for the standards applied in the oil, offshore and maritime industry.

5.2.1 Barents 2020 project – Identification and comments to offshore standards

The Barents 2020 project was initiated in 2007 by the Norwegian Foreign Ministry. The premise of the project was that industry cooperation should look at technical standards that can be used internationally to ensure safe oil, gas and maritime operations in the Barents Sea. The project period was divided into four phases:

- **Phase 1:** Produced five position papers and established the Norwegian-Russian partnership model.
- **Phase 2:** Seven key areas for further work in seven specialist working groups were identified. It was concluded that an acceptable safety level primarily could be reached through reducing the probability of incidents and accidents, and that the existing safety level in the North Sea was to be used as a benchmark for the Barents Sea, ref./1/.

Seven working groups:

- RN01 Common offshore standards
 - RN02 Ice loads
 - RN03 Risk management
 - RN04 Escape, evacuation and rescue
 - RN05 Working environment
 - RN06 Loading/unloading and ship transportation
 - RN07 Operational emissions and discharges to air and water
- **Phase 3:** Identified 130 standards for common use. The aim was to contribute to an acceptable and uniform safety level in the oil and gas activity in the Barents Sea, and improve the basis for cooperation for all involved parties in the future. The aim was further to contribute to a predictable HSE framework for oil and gas companies and contractors independent of nationality, and to create a dialogue, and share knowledge, between relevant Norwegian and Russian parties. The project also aimed to identify areas where there is a need to update existing key industry standards to take into account the additional challenges related to Arctic conditions. The result of the work after completion of phase 3 is contained in

the report, *Barents 2020 – Assessment of International Standards for safe Exploration, Production and Transportation of Oil and Gas in the Barents Sea*, ref./2/, issued in March 2010. Phase 3 focused on potential improvements which would help prevent incidents or accidents from occurring.

- **Phase 4:** Aim to provide concrete guidance and recommendations for operators, contractors and manufacturers for projects related to petroleum exploration, production, installation and transportation in the Barents Sea, as follows:
 - RN01 Co-ordinate deliverables
 - RN02 Prepare guidance document to ISO 19906 for design of offshore installations against ice loads
 - RN03 Conduct workshops on the use of risk assessment, based on ISO and IEC, for Barents Sea installations
 - RN04 Prepare a guidance document to ISO on escape, evacuation and rescue for the Barents Sea
 - RN05 Prepare guidance to ISO for safe working environment for offshore activities in the Barents Sea
 - RN06 Prepare guidance for ice management based on ISO 19906, for Barents Sea operations
 - RN07 Develop a regional standard for the Barents Sea to reflect MARPOL Special Area (SA) requirements for discharge and emissions from oil and gas related ship traffic and offshore units

5.2.2 International Organization of Standardization (ISO)

ISO is a non-governmental organization founded in 1947, and is the world's largest developer of voluntary international standards. It provides practical tools for tackling economic, environmental and societal challenges. It facilitates trade, spreads knowledge, and shares technological advances and good management practice with the public and private sectors internationally. The standards published by ISO distil international exper-

tise and good practice and achieve benefits for business, government and society.

5.2.2.1 ISO 19906 – Arctic Offshore Structures

ISO 19906, ref./3/, specifies functional requirements, recommendations and guidance related to Arctic offshore activities and was first approved in 2010. The standard:

“... specifies functional requirements and provides recommendations and guidance for the design, construction, transportation, installation and removal of offshore structures, related to the activities of the petroleum and natural gas industries in Arctic and cold regions... ISO 19906 is deemed to include both the Arctic and other cold regions that are subject to similar sea ice, iceberg and icing conditions. The objective of ISO 19906 is to ensure that offshore structures in Arctic and cold regions provide an appropriate level of reliability with respect to personnel safety, environmental protection and asset value to the owner, to the industry and to society in general.” ISO 19906, ref./3/

Guidelines for how to calculate/document compliance with ISO 19906’s functional requirements need to be further developed (for example, Barents 2020).

5.2.3 International Maritime Organization (IMO)

IMO is responsible for the ship safety and security and the prevention of marine pollution by ships. The Marine Environment Protection Committee (MEPC) is IMO’s senior technical body on marine pollution related matters.

A paper by Deggim, ref./69/, presents an overview of the IMO’s various requirements for ships operating in polar waters, including relevant portions of SOLAS, MARPOL, STCW, and the Torremolinos Protocol. The paper provides information on topics such as stability, life-saving appliances, navigation, guidelines for ships operating in polar waters, etc. It also provides information on UNCLOS and other international requirements concerning the subject in which IMO is involved.

5.2.3.1 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW)

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, ref./68/ provides minimum requirements which countries are obliged to meet or exceed. It contains both mandatory requirements and recommended guidelines related to the master and deck department, engine department, radio communication and radio personnel; special training requirements for personnel on certain types of ships; emergency, occupational safety, medical care and survival functions; and alternative certification and watchkeeping.

5.2.3.2 IMO Polar Code

In order to meet appropriate standards of safety and to take into account the rapidly changing conditions of the Polar waters, IMO issued its Guidelines for ships operating in Polar waters, Resolution A.1024 (26). First issued for Arctic application in 2002 and later expanded to the Antarctic in 2009, the Guidelines are intended to address additional considerations deemed necessary beyond existing requirements of the SOLAS and MARPOL Conventions when operating in Polar waters. The Guidelines emphasize that safe operation requires specific attention to human factors including training and operational procedures, and that there is a need to ensure that all ship systems are functioning effectively under anticipated operating conditions, ref./21/.

5.2.3.3 IMO International Safety Management Code (ISM Code)

In October 1989, IMO adopted resolution A.647(16), *Guidelines on Management for the Safe Operation of Ships and for Pollution Prevention*. After some experience in the use of the Guidelines, IMO adopted in 1993 the International Management Code for the Safe Operation of Ships and for Pollution Prevention (the ISM Code). In 1998, the ISM Code became mandatory. The purpose of the ISM Code is to provide an international standard for the safe management and operation of ships and

for pollution prevention, and to provide those responsible for the operation of ships with a framework for the proper development and assessment of safety and pollution prevention management in accordance with good practice, ref./77/. According to IMO, ref./77/,

... effective implementation of the ISM Code [should] lead to a move away from a culture of “unthinking” compliance with external rules towards a culture of “thinking” self-regulation of safety – the development of a ‘safety culture’. The safety culture involves moving to a culture of self-regulation, with every individual – from the top to the bottom – feeling responsible for actions taken to improve safety and performance. Application of the ISM Code should support and encourage the development of a safety culture in shipping.

5.2.3.4 MARPOL International certificates and plans

The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) is one of the most important international marine environmental conventions. It was designed to minimize pollution of the seas, including dumping, oil and exhaust pollution. Annex I of the Convention is focused on minimizing accidental discharges of and pollution by oil. Annex I applies to all oil tankers of 150 GT and above, and every other ship of 400 GT and above, and sets requirements related to, among other things:

- Control of discharge of oil originating from machinery spaces
- Control of discharge of oil originating from cargo spaces
- Ballast tank arrangements and locations
- Double hull requirements

5.2.3.5 International Oil Pollution Prevention (IOPP) Certificate

MARPOL Annex I requires ships to carry on board a valid, current International Oil Pollution Prevention (IOPP) Certificate. The IOPP Certificate is to “certify that the ship has been surveyed in accordance with the requirements of Regulation 4 of Annex I of the Convention

and that the survey shows that the structure, equipment, systems, fittings, arrangements and material of the ship and the condition thereof are in all respects satisfactory and that the ship complies with the applicable requirements of Annex I of the Convention” ref./6/. The IOPP Certificate is issued by the ship’s Flag administration. Classification societies have been authorized by many Flag administrations to survey ships for compliance with MARPOL Annex I and issue the IOPP Certificate on the Flag administration’s behalf.

5.2.3.6 MARPOL Shipboard Marine Pollution Emergency Plan (SMPEP)

Regulation 37 of Annex I of MARPOL requires that oil tankers of 150 tons gross tonnage or more and all ships of 400 tons gross tonnage or more carry an approved shipboard oil pollution plan (SOPEP). The International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990, also requires such a plan for certain ships. The plans provide guidance on how to react in the event of a spill of oil or noxious liquid substances, so as to prevent or mitigate negative effects on the environment.

Regulation 17 of Annex II of MARPOL makes similar stipulations for all ships of 150 tons gross tonnage and above carrying noxious liquid substances in bulk: they are required to carry on board an approved marine pollution emergency plan for noxious liquid substances.

The latter should be combined with a SOPEP, since most of their contents are the same and the combined plan is more practical than two separate ones in case of an emergency. To make it clear that the plan is a combined one, it should be referred to as a shipboard marine pollution emergency plan (SMPEP).

The IMO issued *Guidelines for the Development of Shipboard Marine Pollution Emergency Plans* to help Flag administrations and ship-owners meet these requirements. See *Shipboard Marine Pollution Emergency Plans*, 2001 Edition, which includes:

- *Guidelines for the Development of Shipboard Oil Pollution Emergency Plans (SOPEP)* [Resolution MEPC.54(32), as amended by resolution MEPC.86(44)], and

The best available techniques (BAT) and best environmental practices (BEP) identified in the Arctic Offshore Oil and Gas Guidelines issued by PAME, 2009, are as follows, ref./4/:

1. *The use of the best available techniques shall emphasize the use of non-waste technology, if available.*
2. *The term "best available techniques" means the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste. In determining whether a set of processes, facilities and methods of operation constitute the best available techniques in general or individual cases, special consideration shall be given to:*
 - (a) *comparable processes, facilities or methods of operation which have recently been successfully tried out;*
 - (b) *technological advances and changes in scientific knowledge and understanding;*
 - (c) *the economic feasibility of such techniques;*
 - (d) *time limits for installation in both new and existing plants;*
 - (e) *the nature and volume of the discharges and emissions concerned.*
3. *It therefore follows that what is "best available techniques" for a particular process will change with time in the light of technological advances, economic and social factors, as well as changes in scientific knowledge and understanding.*
4. *If the reduction of discharges and emissions resulting from the use of best available techniques does not lead to environmentally acceptable results, additional measures have to be applied.*
5. *"Techniques" include both the technology used and the way in which the installation is designed, built, maintained, operated and dismantled.*
6. *The term "best environmental practice" means the application of the most appropriate combination of environmental control measures and strategies. In making a selection for individual cases, at least the following graduated range of measures should be considered:*
 - (a) *the provision of information and education to the public and to users about the environmental consequences of choice of particular activities and choice of products, their use and ultimate disposal;*
 - (b) *the development and application of codes of good environmental practice which covers all aspect of the activity in the product's life; the mandatory application of labels informing users of environmental risks related to a product, its use and ultimate disposal;*
 - (c) *saving resources, including energy;*
 - (d) *making collection and disposal systems available to the public; avoiding the use of hazardous substances or products and the generation of hazardous waste;*
 - (e) *recycling, recovery and re-use;*
 - (f) *the application of economic instruments to activities, products or groups of products;*
 - (g) *establishing a system of licensing, involving a range of restrictions or a ban.*
7. *In determining what combination of measures constitute best environmental practice, in general or individual cases, particular consideration should be given to:*
 - (a) *the environmental hazard of the product and its production, use and ultimate disposal;*
 - (b) *the substitution by less polluting activities or substances;*
 - (c) *the scale of use;*
 - (d) *the potential environmental benefit or penalty of substitute materials or activities;*
 - (e) *advances and changes in scientific knowledge and understanding;*
 - (f) *time limits for implementation;*
 - (g) *social and economic implications.*
8. *It therefore follows that best environmental practice for a particular source will change with time in the light of technological advances, economic and social factors, as well as changes in scientific knowledge and understanding.*
9. *If the reduction of inputs resulting from the use of best environmental practice does not lead to environmentally acceptable results, additional measures have to be applied and best environmental practice redefined.*

- *Guidelines for the Development of Shipboard Marine Pollution Emergency Plans of Oil and/or Noxious Liquid Substances* [Resolution MEPC.85(44)].

5.2.3.7 IMO “manual on oil pollution, section I – prevention”, 2011 edition

This IMO Manual on Oil Pollution is intended to provide practical guidance related to the prevention of pollution from ships, and describes procedures for the handling of oil cargoes, bunkering, ship-to-ship transfer operations, transfer operations involving offshore units and operations in ice-covered waters. It also provides an overview of the various prevention practices, as a complement to the more detailed industry standards and Codes of Practice, currently available. The information provided is not intended to supersede or replace any information, law, or regulation contained in any other publication with respect to the waters and areas to which it pertains. The manual is a good example of best practices developed to prevent oil spill from ships.

5.3 Guidelines

The purpose of this Section is not to identify all guidelines related to the oil, offshore and maritime industry, but rather identify some guidelines regarded as important.

5.3.1 PAME Arctic Offshore Oil and Gas Guidelines

The *Arctic Offshore Oil and Gas Guidelines* issued by PAME, 2009, ref./4/, are intended to be of use to the Arctic nations in offshore oil and gas activities during planning, exploration, development, production and decommissioning, with the exception of transportation of oil and gas. The goal is to assist regulators in developing standards that can be applied and enforced consistently for all offshore Arctic oil and gas operators. The intention of the Guidelines is to encourage the highest standards currently available by defining a set of recommended practices and outline strategic actions for consideration by those responsible for regulation of offshore oil and gas activities in the Arctic.

The Guidelines state that

“... in permitting offshore oil and gas activities, Arctic governments should be mindful of their commitment to sustainable development, including promotion of the use of best available technology/techniques and best environmental practices”.

Furthermore, the Guidelines may be of help to the industry when planning for oil and gas activities and to the public in understanding Arctic environmental concerns and practices during offshore oil and gas activities.

5.3.2 PAME Guidelines for Transfer of Refined Oil and Oil Products in Arctic Waters (TROOP)

The *Guidelines for Transfer of Refined Oil and Oil Products in Arctic Waters*, ref./15/, were developed by the PAME Working Group and issued in 2004 for vessels operating in the Arctic. The use of these Guidelines is encouraged in all ice-infested waters. The aim is to prevent spillage during cargo/fuel oil transfer. According to the Guidelines, cargo/fuel oil spillage can be prevented by: securing that reasonable precautions have been taken; that adequate resources can be deployed if unforeseen problems develop; and making sure that transfer supervisors and their crew are able to work safely and carefully.

5.4 Canadian Arctic prevention certificates and plans

There are number of regulations which explain the requirements for a company operating in the Arctic. In order to satisfy these regulations, a set of plans and documents need to be provided. The required plans and documentation will vary in extent for the different coastal states. The *Canadian Arctic* prevention plans are summarized in the next chapters as an example.

Prior to operating an offshore drilling project in the Canadian Arctic, companies must provide an application for authorization describing the scope of the proposed activities, an execution plan and schedule for undertak-

A short description of the Contingency Plan and what it shall provide are found in the Canada Oil and Gas Drilling and Production Regulations, ref./30/:

“Contingency plans, including emergency response procedures, to mitigate the effects of any reasonably foreseeable event that might compromise safety or environmental protection, which shall;

- i. provide for coordination measures with any relevant municipal, provincial, territorial or federal emergency response plan, and*
- ii. in an offshore area where oil is reasonably expected to be encountered, identify the scope and frequency of the field practice exercise of oil spill countermeasures;”*

ing those activities. A **“safety plan”** and an **“environmental protection plan”** including information about:

- possible proposed flaring or venting of gas,
- information on any proposed burning of oil,
- a description of the drilling and well control equipment (drilling installation),
- a description of the processing facilities and control system (production installation),
- a field data acquisition program that allows sufficient pool pressure measurements,
- fluid samples, cased hole logs and formation flow tests for a comprehensive assessment of the performance of development wells,
- pool depletion schemes,

A short description of the Environmental Protection Plan and what it shall provide are described in the Canada Oil and Gas Drilling and Production Regulations, ref./30/:

The environmental protection plan shall set out the procedures, practices, resources and monitoring necessary to manage hazards to and protect the environment from the proposed work or activity and shall include;

- a) a summary of and references to the management system that demonstrate how it will be applied to the proposed work or activity and how the duties set out in these Regulations with regard to environmental protection will be fulfilled;*
- b) a summary of the studies undertaken to identify environmental hazards and to evaluate environmental risks relating to the proposed work or activity;*
- c) a description of the hazards that were identified and the results of the risk evaluation;*
- d) a summary of the measures to avoid, prevent, reduce and manage environmental risks;*
- e) a list of all structures, facilities, equipment and systems critical to environmental protection and a summary of the system in place for their inspection, testing and maintenance;*
- f) a description of the organizational structure for the proposed work or activity and the command structure on the installation, which clearly explains
 - i. their relationship to each other, and*
 - ii. the contact information and position of the person accountable for the environmental protection plan and the person responsible for implementing it;**
- g) the procedures for the selection, evaluation and use of chemical substances including process chemicals and drilling fluid ingredients;*
- h) a description of equipment and procedures for the treatment, handling and disposal of waste material;*
- i) a description of all discharge streams and limits for any discharge into the natural environment including any waste material;*
- j) a description of the system for monitoring compliance with the discharge limits identified in paragraph (i), including the sampling and analytical program to determine if those discharges are within the specified limits; and*
- k) a description of the arrangements for monitoring compliance with the plan and for measuring performance in relation to its objectives.*

A short description of the Safety Plan and what it shall provide are described in the Canada Oil and Gas Drilling and Production Regulations, ref./30/:

“The safety plan shall set out the procedures, practices, resources, sequence of key safety-related activities and monitoring measures to ensure the safety of the proposed work or activity and shall include;

- a) A summary of and reference to the management system that demonstrate how it will be applied to the proposed work or activity and how the duties set out in these Regulations with regard to safety will be fulfilled;*
- b) A summary of the studies undertaken to identify hazards and to evaluate safety risks related to the proposed work or activity*
- c) A description of the hazards that were identified and the results of the risk evaluation;*
- d) A summary of the measures to avoid, prevent, reduce and manage safety risks*
- e) A list of structures, facilities, equipment and systems critical for safety and a summary of the systems in place for their inspection, testing and maintenance.*
- f) A description of the organization structure for the proposed work or activity and command structure on the installation, which clearly explain
 - i. Their relationship to each other, and*
 - ii. The contact information and position of the person accountable for the safety plan and of the person responsible for implementing it**
- g) If the possibility of pack sea ice, drifting iceberg or land-fast sea ice exists at the drill or production site, the measures to address the production of the installation, including system for ice detection, surveillance, data collection, reporting, forecasting, and, if appropriate, ice avoidance or deflection; and*
- h) A description of the arrangement for monitoring compliance with the plan and for measuring performance in relation to its objective.*

- field **contingency plans (C-Plan)**,
- description of the decommissioning and abandonment of the site, including methods for restoration of the site after its abandonment.

5.4.1 Certificate of Fitness

All production, accommodation, and diving installations at an offshore production or drilling site are required to have a Certificate of Fitness issued by a certifying authority. The Certificate of Fitness implies that the installation can be operated safely, without polluting the environment, and that it is fit for the purpose for which it is intended, such as drilling in offshore Arctic waters.

5.4.2 Contingency Plan

The C-Plan is an important link between operational risks and response capabilities, and is required under 30 CFR Part 254 for OCS exploration and production operation. The plan must be submitted to the National Energy Board for review and approval.

General experience from past oil spill in-

idents shows that traditional oil spill C-Plans are not sufficient and do not address procedures for how decision-makers should deal with large numbers of oiled animals.

5.4.3 Environmental Protection Plan

The Environmental Protection Plan was released by the NEB in 2011. The NEB, Canada-Nova Scotia Offshore Petroleum Board and Canada-Newfoundland and Labrador Offshore Petroleum Board issued *Environmental Protection Plan Guidelines*, ref./79/, to assist operators in developing Environmental Protection Plans to meet the requirements of the Canada Oil and Gas Drilling and Production Regulations.

5.4.4 Safety Plan

The Safety Plan was released by the NEB in 2011. The NEB, Canada-Nova Scotia Offshore Petroleum Board and Canada-Newfoundland and Labrador Offshore Petroleum Board issued *Safety Plan Guidelines*, ref./80/, to assist operators in developing their own Safety Plan Guidelines required to meet the Canada Oil and Gas Drilling and Production Regulations.

6 Prevention Programs and Projects

This section will identify some of the prevention programs, organizations, commissions, agreements and projects that are thought to be important for pollution prevention. The list is by no means complete however the intention is to highlight some of the Arctic prevention programs—to identify both some of the important work carried out as well as important on-going work which will be of importance for further evaluation of best practices related to oil spill prevention.

6.1 Arctic Council

The Arctic Council is an intergovernmental forum that promotes coordination, cooperation and interaction among the Arctic states. It is a valuable platform for discussions of relevance to the Arctic and the people who live there. Arctic Council member states are Canada, Denmark (including Greenland and the Faroe Islands), Finland, Iceland, Norway, Russian Federation, Sweden, and the United States of America, ref./11/. The scientific work of the Arctic Council is carried out in

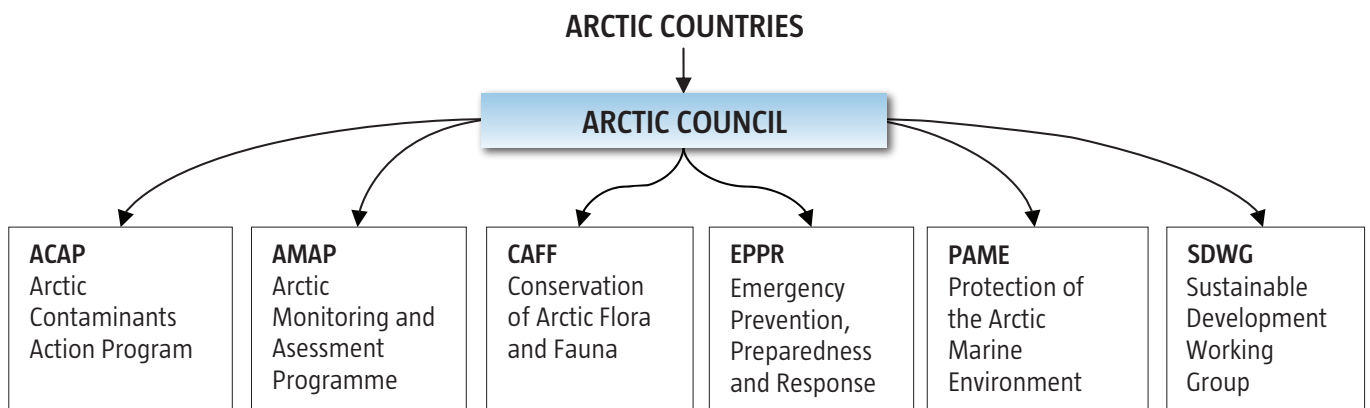
six working groups, see Figure 6-1. They report to the Arctic Council Ministers through their Senior Arctic Officials (SAO). Focus areas are monitoring, assessing and preventing pollution, climate change, biodiversity conservation and sustainable use, and emergency preparedness and prevention. Moreover, the Arctic Council maintains an overarching focus on the indigenous peoples of the region.

The Arctic Council has a number of on-going projects and activities relevant to the management of the Arctic marine environment. The following sections will summarize some of the main projects; e.g. the PAME ecosystem approach project, guidelines on fuel transfer, and the EPPR field guide for oil spill response in Arctic waters.

6.1.1 Arctic Monitoring and Assessment Programme (AMAP)

The primary function of AMAP is to provide information on the status of, and threats to, the Arctic environment, and advise on matters relating to the Arctic region. AMAP has produced a series of high quality, scientific-

Figure 6.1 Organization map



AMAP states that the highest priority should be to prevent oil spills in ice-infested marine waters. In this respect AMAP recommends that considerations should be given to, ref. /8/:

- The conduct of risk assessments in association with all means of transport of oil and gas
- The use of best practices and technology in transport and storage
- Seasonal restrictions on oil and gas activities
- The need for protected areas closed to oil and gas activities
- Strengthened capabilities and improved coordination of oil spill prevention, preparedness, and response
- Rapid availability of adequate oil spill response equipment and well-trained personnel

ly-based assessments of the pollution status of the Arctic. They are available as electronic documents on the AMAP website, ref./7/.

AMAP has produced two types of assessment reports:

- The State of the Arctic Environment Reports
- The AMAP Assessment Reports

The State of the Arctic Environment report series is designed to provide easy-to-read summaries of the most important findings and conclusions from each assessment report. All of the background data, methodology and references to the scientific literature may be found in the related assessment report.

Section 6.1.1.1 and Section 6.1.1.2 contain a short summary of the main oil spill pollution prevention findings from the *AMAP Assessment 2007* report and the *Arctic Oil and Gas 2007 report*.

6.1.1.1 AMAP Assessment 2007 – Oil and Gas Activities in the Arctic – Effects and Potential Effects, Volume 1

The AMAP Assessment Report issued in 2009, ref./8/, presents the results of the 2007 Assessment of Oil and Gas Activities in the Arctic, which was conducted under the auspices of the Arctic Council and coordinated by AMAP. It is a fully referenced, comprehensive, technical and scientifically-presented assessment of all validated data on the status of the Arctic environment relative to the AMAP mandate. It includes conclusions and recommendations, and covers issues of a more scientific nature, such as proposals for filling gaps in knowledge. The report makes recommendations relevant to future monitoring and research work.

This assessment is published in three volumes. Volume I provides much of the background that sets the scene for the assessments in other chapters. It presents past practices, best available technologies, and new technology. Volume II includes the assessment of contamination resulting from oil and gas activities in the Arctic, and the effects of exposure on the environment, biota and humans to this contamination. Volume III presents the assessment of the status and

AMAP further states that significant impacts from oil and gas activities can be prevented, to a large extent, by use of best and most appropriate technologies. According to AMAP, best available practice for oil spill prevention should include, ref./8/:

- Appropriate consultations and collaboration with communities that may be affected, to develop strategies for avoiding negative impacts
- Closed-looped drilling systems where drilling wastes are re-injected or cleaned and safely deposited
- Transportation and other infrastructure, including pipelines, to be built, modernized, and maintained according to the highest industry and international standards.

The AMAP Arctic Oil and Gas 2007 Report identifies further measures and recommendations to prevent oil spills, ref./76/:

- Laws and regulations should be enacted, periodically reviewed, evaluated, strengthened and rigorously enforced
- Use of best industry and international standards should be addressed in laws and regulations
- Management systems and regulations should be clear and flexible, and reviewed regularly
- Guidelines should be improved where necessary
- Industry should adopt the BAT and BAP currently available
- Use real-time monitoring when appropriate
- Use scientifically-based best practices
- Tanker operations in Arctic waters should employ the stricter measures for spill prevention and response, including improved communication, training, and cargo handling techniques, and the use of ice-strengthened and double-hulled vessels
- International coordination of oil transport information should be improved
- International standards and national legislation for ships engaged in oil transportation in seas with potential for ice problems should be reviewed for adequacy and strengthened as appropriate
- All pipelines projects should use the best available Arctic engineering and environmental standards, including right-of-way selection, inspection using state-of-the art leak and corrosion detection systems, monitoring and environmental studies
- Considerations should be given to whether Arctic areas should be opened for oil and gas activities or transportation where the methods of dealing with a spill or other major accident are lacking
- Action should be evaluated and applied to reduce risk

vulnerability of Arctic ecosystems to oil and gas development.

Findings with regards to oil spills and best available technology/practice were the positive effect of the development of drilling techniques for exploratory drilling (down-hole steering tools, extended-reach operation, navigation, borehole telemetry, coiled tubing etc.). The report also refers to recent work in the Canada on sump stability, which shows that careful positioning and adequate insulation can greatly reduce the risk of failure. According to AMAP, remotely controlled sub-sea production systems and facilities can help reduce the negative impact risk.

6.1.1.2 AMAP Arctic Oil and Gas 2007 Report

The AMAP Working Group developed the *Arctic Oil and Gas 2007 Report*, ref./76/, to document what is known about the effects of past and current oil and gas activities, to project the likely course and potential impact in the near future, and to make recommendations. This report is based on the findings of the *AMAP Assessment 2007*. It presents a holistic assessment of the impacts of current oil and gas activities in the Arctic.

“Oil and gas industries are responsible for some spills, but other sources such as shipping, fishing fleet operations, and spills at local storage depots also account for much of the oil spilled”, ref./76/.

In order to fill the information gaps, AMAP suggests that governments and industry develop better information on infrastructure related to oil and gas, as well as better reporting procedures and monitoring programmes. Environmental monitoring can track effects and help evaluate new approaches; compliance monitoring and enforcement can ensure that best practices are indeed used. In order to fill the information gaps related to oil and gas, AMAP also suggests that governments and industry develop better infrastructure for sharing of available information. Better reporting procedures and monitoring programs can track effects of new approaches and ensure that best practices are used. More experience from Arctic operations: stricter regulations, enforcement of existing regulations and adherence by industry to accept international standards and best operating practices will reduce future possible negative impact on the environment.

6.1.2 Protection of the Arctic Marine Environment (PAME)

The main activities of the PAME working group are related to the protection and sustainable use of the Arctic marine environment. The working group makes recommendations to support the Arctic Council's Arctic Marine Strategic Plan (2004), and it carries out activities as set out in bi-annual work plans approved by the Arctic Council, ref./12/.

Appendix I lists past and present work by PAME in relation to marine pollution. This section presents a summary and findings from some selected PAME reports.

6.1.2.1 PAME Arctic Marine Strategic plan, 2004

The Council agreed in 2002 to develop a strategic plan for protection of the Arctic marine environment under the leadership of PAME. The *Arctic Marine Strategic Plan* (2004) ref./14/, covers all Arctic marine areas and key activities affecting Arctic marine ecosystem. One of four goals stated in the Strategic Plan is to reduce and prevent pollution in the Arctic marine environment. The Strategic Plan sets out a range of actions: improve knowledge and understanding of the marine environment; respond to emerging knowledge; implement and comply with applicable international / regional commitments; apply an *ecosystem approach to management*; facilitate partnerships and technical co-operation; build the capacity and engagement of Arctic inhabitants; and support communication, reporting and outreach, ref./14/.

6.1.2.2 PAME Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities

In 1998, Arctic Council ministers adopted the Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities (RPA). The RPA is the regional extension of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA).

Appendix I of the RPA report, ref./16/, provides a summary of possible recommended activities, along with a wide range of strategies, measures and management approaches that are generally applicable to the RPA. It recommends treatment, waste minimization, clean technology, sound disposal, recycling and spill response as important measures to reduce and/or eliminate anthropogenic sources of pollution.

6.1.2.3 PAME Ecosystem-Based Oceans Management

The Arctic Council initiated a project on ecosystem-based oceans management. The project report, *Best Practices in Ecosystem – Based Ocean Management in the Arctic*, ref./17/, was published in April 2009. It sought to present the concepts and practices Arctic states have developed for the application of an ecosystem-based approach to oceans management. The 2004 Arctic Marine Strategic Plan defines ecosystem-based management as an approach that “requires that development activities be coordinated in a way that minimizes their impact on the environment and integrates thinking across environmental, socio-economic, po-

The Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities has as its objectives the following:

- Take action, which will lead to the prevention, reduction, control and elimination of pollution in the Arctic marine environment and the protection of its marine habitat;
- Respond to the impacts of climate change as they relate to land-based sources of marine pollution in the Arctic;
- Identify and assess regional problems from land-based activities
- Establish regional priorities for action as it relates to sources of land-based marine pollution
- Strengthen regional and national capacity building; and
- Harmonize, as appropriate, and adjust measures to fit the particular environmental and socio-economic circumstances.

According to AMSA, marine incident prevention is based upon addressing four conditions that may result in pollution incident, ref./10/. They are as follows:

- Human error or failure caused by fatigue, malfeasance, unfamiliarity or other conditions, either exclusively or in conjunction with each other
- Lack of operational readiness and preparedness caused by marginal/unprepared ship or crew
- Older vessel or vessel operating outside of operation parameters
- Arctic climatic conditions, situational unknowns caused by less predictable or rapidly changing weather and ice conditions, lack of iceberg awareness, and failure of mechanical systems unprepared for the rigors of Arctic operations

litical and sectoral realms”, ref./14/. The Arctic states identified the following as important best practices: flexible application, integrated and science-based decision-making, commitment to ecosystem-based oceans management, area-based approaches and trans-boundary perspectives, stakeholder participation, and adaptive management. For more information, see the project report, ref./17/.

6.1.2.4 PAME Arctic Marine Shipping Assessment (AMSA) 2009 Report

The *Arctic Marine Shipping Assessment*, ref./10/, is the product of an Arctic Council ministerial decision in Reykjavik 2004. The report focuses on marine shipping in the Arctic, its potential impacts on humans and the Arctic marine environment, and its marine infrastructure requirements. The report addresses both current and future marine activities.

The AMSA recommendations are presented as three broad themes:

1. Enhancing Arctic marine safety
2. Protecting Arctic people and the environment, including oil spill prevention
3. Building marine infrastructure

The topics presented in the report are, ref./10/:

- Arctic marine geography, climate and sea ice
- History of Arctic marine transport
- Governance of Arctic transport
- Current marine use and AMSA 2004 database
- Scenarios, futures and regional futures to 2020
- Human dimensions
- Environmental considerations and impacts
- Arctic marine infrastructure

AMSA findings related to oil spills include the following, ref./10/:

- From an environmental point of view, Arctic shipping poses a threat to the region’s unique ecosystems. This threat can be effectively mitigated through careful planning and effective regulation in areas of high risk
- Release of oil into the Arctic marine environment, either through accidental release or illegal discharge, is the most significant threat from shipping activity
- Safe navigation is often dependent on the skills of a limited number of seasoned northern mariners. There is an increasing demand for skilled mariners, and a need for universal or mandatory formal education, training and certification requirements.
- There is a need for better hydrographic data to support safe navigation. In addition, expansion of the current routes is required to allow alternative courses when deemed necessary
- Electronic Chart Display and Information Systems (ECDIS), coupled with Digital Global Positioning Systems (DGPS), improve navigational safety.
- There are few systems to monitor and control the movement of ships in ice-covered Arctic waters
- There are limitations to radio and satellite communications for voice and data transmission
- There is a need for a comprehensive suite of data, products and services covering meteorological, oceanographic and ice conditions (both sea ice and icebergs)

Preventive measures according to AMSA include, ref./10/:

- Vessels operating in the Arctic meet appropriate design, construction and equipment standards
- Vessel personnel have the specialized skills needed for operating in Arctic conditions, including operations in ice-infested waters where applicable
- Information needed for safe navigation is available, from accurate charts to timely information on meteorological and ice conditions and on other vessel traffic/activities in the area

AMSA held a workshop in 2008 entitled “Opening the Arctic Seas: Envisioning Disasters and Framing Solutions”. The workshop focused on the qualitative risk factors for five plausible Arctic marine incidents; the scenarios were selected to explore a range of spill response, search and rescue, fire fighting, salvage, communications, governance, jurisdiction and legal issues.

For detailed information regarding the roadmap, actions and key issues for oil spill prevention reference is made to the *Arctic Marine Shipping Assessment Workshop Report*, ref./13/.

6.1.2.5 PAME Status on Implementation of the AMSA 2009 Report Recommendations

In 2011, PAME issued a status report on the implementation of the AMSA report’s 17 recommendations. The status report was intended to draw attention to areas and recommendations where progress is limited and more work may be needed. It identifies areas for further cooperation and increased efforts to protect the Arctic marine environment, and summarizes the lead state and party’s status to fulfilling each recommendation.

6.1.2.6 PAME The Arctic Ocean Review (2009-2011)

The Arctic Ocean Review (AOR), a project under PAME, is an international and multi-lateral instrument governing the shipping industry. The AOR Report provides an overview of the status and trends of the Arctic marine environment and activities of global instruments relevant to the Arctic environment. It addresses integrated oceans management, international practices that have been developed and identifies the next steps for the AOR project, ref./19/.

6.1.3 Emergency Prevention, Preparedness and Response (EPPR)

The EPPR working group addresses policy, pollution prevention and control measures related to the protection of the Arctic marine environment. The goal of the working group is to help protect the Arctic from an accidental release of hazardous substances. Members of the working group exchange information on best practices; they also conduct projects to develop guidance, risk assessment methodologies, response exercises, and training.

One of the themes addressed was strategies to improve prevention and preparedness; the main best practices mentioned were as follows, ref./10/:

- Conduct a comprehensive environmental risk assessment and impact assessment to assist in decision-making, route planning, emergency response, etc.
- Increase emergency response assets, equipment and supplies in the Arctic, placing emphasis on regions of active development; self-sustaining, forward-operating response bases should be established
- Improve knowledge in Arctic incident response through training and engagement of the local community, responders and the maritime industry. Arctic indigenous people should be trained in response, and local communities must participate in response operations.

Roadmap and actions in regards to oil spill and prevention listed in the *Arctic Marine Shipping Assessment Workshop Report*, ref./13/:

- The most significant strategy remains keeping oil contained ashore and within ships: i.e., the prevention of Arctic oil spills.
- Initiate a comparative evaluation of schemes across Arctic states, including: strength of prevention regimes, liability standards, damage compensation, preparedness laws, fuel transfer standards, compliance, and enforcement of regulations.
- Enhanced cooperation and dialogue on unified standards of prevention and levels of tolerance/enforcement.
- Initiate an effectiveness evaluation of training, systems, technology and environmental knowledge
- Conduct response gap analysis with a view to required research and capacity-building.
- Explore the possibility of marine areas or zones where there is restricted traffic for tankers and Liquefied Natural Gas ships.
- Development of a potential liability incentive fund for prevention.

6.1.3.1 EPPR Working Group meeting 2011

The EPPR Working Group produced an extensive report based on its 2011 meeting held in Whitehorse, Canada, ref./20/. Some of the topics will be further elaborated and highlighted in this chapter, including the on-going Environmental Response Management Application (ERMA) project and the Arctic Automated Marine Vessel Emergency Rescue Network (AAmverNet) project.

ERMA is useful as a planning and preparedness tool. It has two interfaces—one public and one private. It is a web-based platform for building a comprehensive, Arctic-wide electronic database. The database can contain, among other things: the location of response equipment caches in the Arctic region; equipment type and their specifications; logistic information concerning ports, air and land facilities; links to authorized national and local responder organizations; location of hospitals, places to stay, and resources needed by responders in nearby communities, etc.

AAmverNet is a voluntary global ship reporting system used by search and rescue authorities to arrange assistance to persons in distress at sea. It can further work as a force multiplier. AAmverNet can immediately impact Arctic Search and Rescue because it is a viable platform for linking the vessel reporting systems of all eight Arctic member countries.

During an important discussion considering prevention related to shipping and O&G activities, the EPPR took up the following topics, ref./20/:

- EPPR should not establish new rules, but capture best practices

- Each nation should consult their experts and come together to share best practices
- Risk assessment with focus on lessons learned from the Gulf of Mexico disaster should be done
- Develop a risk matrix to consider what coastal nations have done, are doing, and can do to prevent incidents
- EPPR should lead and collaborate where appropriate
- EPPR may want to consider the different bodies involved to see if there are lessons learned
- A report on prevention Best Practices in place around the Arctic is a starting point to identifying gaps, overlaps, and opportunities for improvement.

The Working Group discussed complacency, pressure to reduce costs, and human error as issues for consideration in the work on prevention. Furthermore, the Working Group stated that greater attention should be given to training and equipping Arctic communities, ref./20/.

An overview over the Beaufort Regional Environmental Assessment (BREA) and the work of the BREA Oil Spill Preparedness and Response Working Group were presented during the meeting. BREA's main purpose is to assist the partnering of Inuvialuit communities, industry, governments, and regulators to prepare for oil and gas activity in the Beaufort Sea by, ref./20/:

- Filling regional information and data gaps related to offshore oil and gas activities; and

- Supporting efficient and effective regulatory decision making through the provision of scientific and socio-economic information to all stakeholders.

6.2 International Association of Oil & Gas Producers (OGP)

The International Association of Oil & Gas Producers is a unique global forum in which members identify and share best practices. It is also an effective communication platform for the upstream industry and an increasingly complex network of international regulators. OGP has access to technical knowledge and experience, and this knowledge is collated and distilled into a range of reports and guidelines. Some of the OGP's publications relevant for oil spill prevention are listed below. For a complete list please visit OGP's website, ref./47/.

- *Process safety: recommended practice on key performance indicator*, ref./43/
- *Offshore environmental monitoring for the oil & gas industry*, ref./45/
- *Catalogue of international standards used in the oil & gas industry*, ref./46/
- *International recommendations on well incident prevention, intervention and response*, ref./44/
- *Asset integrity – the key to managing major incident risks*, ref./48/
- *Health aspects of work in extreme climates. A guide for oil and gas industry managers and supervisors, 2008 issued by IPIECA and OGP*

Process Safety, ref./43/, focuses on key performance indicators (KPIs) to prevent unplanned releases that can result in a major incident. *Asset integrity*, ref./48/, is intended as a companion document. It provides advice on how to implement an asset integrity management system for new and existing upstream assets. It includes preliminary guidance on monitoring and review, including how to establish lagging and leading KPIs to strengthen risk control (barriers) to prevent major incidents.

6.3 International Association of Independent Tanker Owners (INTERTANKO)

The International Association of Independent Tanker Owners has been the voice of independent tanker owners since 1970. INTERTANKO is allowed to speak authoritatively and proactively on behalf of tanker operators at the international, regional, national and local levels. INTERTANKO produces publications across a range of technical, operational, environmental, documentary and market issues. The Association seeks to contribute to a safe, responsible and competitive oil shipping industry by, among other things, developing and promoting best practices in all sectors of the tanker industry, positive and proactive influence with key stakeholders, profiling and promoting the tanker industry, and providing key services to its members.

The INTERTANKO Environmental Committee provides guidance and best practices to its members to further enhance the tanker industry's environmental performance. The Committee is also active in its engagement with regulators in the development of environmental legislation.

There are several papers available on the INTERTANKO webpage, ref./64/; two particularly relevant papers are:

- *Oil Pollution Legislation in Littoral States of the USA*, ref./65/. This paper provides an overview of relevant oil pollution legislation enacted by the individual states of the USA (that is, at the non-federal level). It is intended as a guide for any tanker owner trading at US ports.
- *INTERTANKO's Guide for a Tanker Energy Efficiency Management Plan*, ref./66

6.4 Oil Companies International Marine Forum (OCIMF)

The Oil Companies International Marine Forum is an association of oil companies with interest in crude oil shipment and terminals, oil products, petrochemicals and gas. OCIMF provides the oil industry with expertise in the

safe and environmentally-responsible transport and handling of hydrocarbons in ships and terminals and setting standards. OCIMF was granted consultative status at the IMO in 1971. OCIMF has developed a range of tools to support oil companies in assessing and vetting tankers and offshore vessels. These include:

- Ship Inspection Report (SIRE) programme
- Tanker Management and Self-Assessment (TMSA), ref./74/
- Offshore Vessel Management and Self-Assessment (OVMSA), ref./70/

SIRE is a set of guidelines in a checklist format used by vetting agents to vet ships for charter by oil companies. The TMSA and OVMSA are tools to help operators of tankers and offshore vessels to assess, measure and improve their safety management system, and is based on industry best practices and KPIs for operators. SIRE and TMSA have gained worldwide recognition and acceptance. The more recently launched OVMSA seeks to expand this experience to the offshore vessel sector. All three include guidance for vessels operating in ice-infested waters.

6.5 OSPAR Commission

OSPAR is an international organization through which governments of the western coasts and catchments of Europe, together with the European Community, cooperate to protect the marine environment of the North-East Atlantic. The OSPAR Commission works under UNCLOS, and it is guided by the ecosystem approach. In their efforts to prevent and eliminate marine pollution, the contracting parties pledge to apply the precautionary principle, the polluter pays principle, best available techniques (BAT) and best environmental practices (BEP), including clean technology.

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention), ref./22/, entered into force on 25 March 1998. A series of Annexes are contained within the OSPAR Convention; they address the following specific areas, ref./23/:

- Annex I: Prevention and elimination of pollution from land-based sources
- Annex II: Prevention and elimination of pollution by dumping or incineration
- Annex III: Prevention and elimination of pollution from offshore sources; and
- Annex IV: Assessment of the quality of the marine environment
- Annex V: Protection and conservation of the ecosystems and biological diversity

6.6 United Nations Environment Program (UNEP)

UNEP was established in 1972 and is the voice for the environment within the United Nations system. UNEP is divided into several divisions, as follows, ref./24/:

- Division of Early Warning and Assessment (DEWA)
“The Division of Early Warning and Assessment (DEWA) provides timely, scientifically credible, policy-relevant environmental analysis, data and information for decision-making and action planning for sustainable development. It monitors, analyzes and reports on the state of the global environment, assesses global and regional environmental trends and provides early warnings of emerging environmental threats”.
- Division of Environmental Policy Implementation
- Division of Technology, Industry and Economics
“The Division of Technology, Industry and Economics (DTIE) provides solutions to decision-makers and helps change the business environment by offering platforms for dialogue and cooperation, innovative policy options, pilot projects and creative market mechanisms.”
- Division of Regional Cooperation
“The Division of Regional Cooperation (DRC) leads the delivery of UNEP’s Programme of Work in the regions by initiat-

ing, coordinating and catalysing regional and sub-regional cooperation and action in response to environmental problems and emergencies”

- Division of Environmental Law and Conventions
“The Division of Environmental Law & Conventions (DELIC) is the lead division charged with carrying out the functions of UNEP that involve the development and facilitation of international environmental law, governance and policy”
- Division of Communication and Public Information
“The Division of Communications and Public Information (DCPI) communicates UNEP’s core messages to all stakeholders and partners, raising environmental awareness and enhancing the profile of UNEP worldwide”

The Regional Seas (RS) Programme is one of UNEP’s most significant achievements. It engages neighbouring countries in comprehensive and specific actions to protect their shared marine environment. The Antarctic, Arctic, Baltic Sea, Caspian Sea and North-East Atlantic Regions are members of the RS family, ref./25/.

6.7 International Petroleum Industry Environment Conservation Association (IPIECA)

International Petroleum Industry Environment Conservation Association is the global oil and gas industry association for environmental and social issues. IPIECA followed the launch of UNEP. IPIECA helps the oil and gas industry improve its environmental and social performance by, ref./34/:

- Developing, sharing and promoting good practices and solutions
- Enhancing and communicating knowledge and understanding
- Engaging members and others in the industry
- Working in partnership with key stakeholders

IPIECA has working groups that addresses several areas, such as oil spill preparedness. The Oil Spill Working Group (OSWG) serves as a key international industry forum to help improve oil spill contingency planning and response.

The OSWG aims to improve oil spill preparedness and response around the world by, ref./34/:

- Enabling members to exchange information and best practices
- Supporting industry and government co-operation at all levels
- Encouraging ratification and implementation of relevant international conventions
- Promoting the principle of “Net Environmental Benefit Analysis” and the “Tiered Response” approach to designing response strategies
- Developing and communicating the industry’s views and activities to external audiences

Some of the IPIECA’s publications relevant to oil spill prevention are listed below. For a complete list please visit IPIECA’s website, ref./58/.

- *Oil Spill preparedness and response report series summary*, ref./60/. This series provides a practical and accessible overview of the issues relevant to preparing for and responding to oil spills at sea; it represents consensus on best practice, ref./62/.
- *Managing oil and gas activities in coastal areas: an awareness briefing*, ref./61/
- *Guide to tiered preparedness and response*, ref./59/. This publication describes the principle of tiered preparedness and response, and it provides guidance on designing and building oil spill response capabilities. Tiered preparedness and response is a structured approach that allows potential oil spill incidents to be categorized in terms of their potential likelihood and severity. It focuses on the volume of the oil spilled (large, medium, small) and location of the spill (local, regional, remote). The purpose of this guide is to have an internationally recognized, consistent, efficient and highly effective framework for

building preparedness and response capabilities for oil spills worldwide.

- *Improving social and environmental performance: Good practice guidance for the oil and gas industry*, ref./62/

6.8 Transport Canada (TC)

Transport Canada is the lead federal department responsible for preventing pollution from ships.

TC conducts aerial monitoring of areas under Canadian jurisdiction in support of marine safety and security objectives, the Canadian Coast Guard (CCG), the Department of National Defence (DND) and the Department of Fisheries and Oceans (DFO). The main objectives of TC are to:

- Prevent pollution from ships by acting as a deterrent to potential polluters through surveillance of commercial shipping routes;
- Conduct sovereignty patrols of waters under Canadian jurisdiction and monitor vessels of interest;
- Survey the fishing zones which border the EEZ in support of DFO's mandate;
- Conduct ice reconnaissance missions to map the sea ice and icebergs in order to ensure safe navigation of ships transiting the Arctic, in support of Environment Canada's mandate.

Monitoring of vessels coming into Canada is carried out by use of long range identification and tracking (LRIT) and NORDREG. Transport Canada surveillance flights also captures Automatic Identification System (AIS) data in real time for vessels outside the EEZ. All AIS information is sent to the Marine Security Operations Centre every 15 minutes from the aircraft to help create a comprehensive maritime picture in the Arctic. This is true for every flight in the Arctic, no matter the mission profile or area covered.

The goal is to provide support as a contingency/response tool to the CCG or other government departments during pollution incidents by monitoring the incident and providing information on situational awareness.

Transport Canada is able to assist neighbouring countries during incidents of similar nature outside Canadian jurisdiction. For example, TC provided services upon request to the USA during the Gulf of Mexico incident.

6.8.1 TC National Aerial Surveillance Program (NASP)

The National Aerial Surveillance Program is a means by which Transport Canada can keep a watchful eye over ships transiting waters under Canadian jurisdiction and thereby prevent pollution. According to the TC, regular aerial surveillance flights have contributed to the decrease in oil discharges, as ships are increasingly aware that their pollution activities can be detected. A Marine Aerial Reconnaissance Team (MART) provides timely, accurate and useful information from aerial surveillance operations, while the Integrated Satellite Tracking of Pollution program (I-STOP) provides an early warning to help personnel direct the aircraft to locations of potential pollution incidents in near real time.

6.9 Norway: preventing acute pollution

The most important part of contingency planning is to implement measures that can prevent the occurrence of acute pollution incidents. Several departments within the Norwegian Coastal Administration are responsible for the prevention of acute pollution, e.g. through marine safety measures.

Objectives

- Enhance international cooperation on preparedness against acute pollution, especially in the High North, by initiating and participating in assessments and development work, and by developing and strengthening bilateral relations with Russia and the other stakeholders in the region through participation in the Arctic Council and other relevant forums.
- Survey and assure the quality of ports of refuge along the entire coast of Norway, including Svalbard, and integrate these in the Coastal Administration's contingency plan.

Provide public access to information about the location and suitability of these ports via the online map service “Kystinfo kartløsning”.

- Improve the Environmental Sensitivity Index (ESI) maps for Svalbard.
- Secure access to relevant resources for efficient surveillance of acute pollution incidents, make new aerial surveillance contracts, ensuring that the aircraft is equipped with the best technology available, and facilitate the co-utilization of the aircraft by other public agencies and the petroleum industry.
- Establish sufficient, nation-wide emergency towing preparedness based on hired vessels, make agreements with the towboat industry, the petroleum industry and neighboring countries, and ensure the further improvement of emergency towing services.
- Make recommendations for how to deal with shipwrecks containing oil or other harmful substances that pose an unacceptable environmental risk, to avoid any future threat to the environment by the wreck

6.10 BSEE Technology Assessment & Research (TA&R) Program

The Technology Assessment & Research Program is a research element and program under the U.S. Bureau of Safety and Environmental Enforcement (BSEE), ref./5/. The TA&R Program supports research associated with operational safety and pollution prevention as well as oil spill response and clean-up capabilities. It was established in 1970's to promote the use of the Best Available and Safest Technologies (BAST). The program's functional research activities are as follows:

- Operational Safety and Engineering Research (OSER)
- Oil Spill Response Research (OSRR)
- Renewable Energy Research (REnR)

This program has four main objectives:

- provide technical support;

- investigate and assess industry application of technological innovations and promote the use of the best available and safest technologies in the Bureau regulations, rules and guidelines;
- promote leadership in research on operational safety, pollution prevention in offshore energy extraction activities, and oil spill response and clean-up; and,
- provide international cooperation for research and development initiatives.

TA&R often sponsors workshops with various industry organizations to exchange information, identify concerns and problems, transfer technology, review recent accomplishments and set future research needs.

6.11 Helsinki Commission (HELCOM)

The Helsinki Commission works to protect the marine environment of the Baltic Sea from all sources of pollution and to restore and safeguard its ecological balance. HELCOM is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention). The main objective of this agreement is to encourage cooperation on response arrangements and sharing of experience and resources between countries.

Surveillance

By international law, any release of oily wastes or oily water from ships is prohibited in the Baltic Sea, where oil pollution can affect sensitive ecosystems for long periods. But ships persist in making illegal discharges, despite improvements in port reception facilities, and a harbour fee system which means there is no financial gain to discharge. Every year national surveillance aircraft detect several hundred illegal oil discharges in the Baltic Sea. The actual number of illegal discharges is probably much higher than this. In fact, during most years, more oil is released on purpose around the Baltic Sea than is spilled accidentally. The HELCOM States endeavour to fly – as a minimum – twice per week over

regular traffic zones including approaches to major sea ports as well as in regions with regular offshore activities and once per week over the regions with sporadic traffic and fishing activities.

Twice a year, several Baltic Sea states jointly organize surveillance flights (24 to 36-hours) – one covering the southern part of the Baltic Sea, and another flight over waters further north. HELCOM facilitates these Co-ordinated Extended Pollution Control Operation (CEPCO) flights in order to:

- assess the amounts of oil being discharged into the Baltic Sea;
- give aircrafts and crews of different nationalities experience working together, which could be valuable in the event of a major accident; and,
- find illegal spills of oil or other substances and possibly identify the polluting ships.

In 2009, a Super CEPCO operation, which lasted for six days, was organized for the first time in the Baltic Sea involving aircrafts from a number of HELCOM countries and countries outside the Baltic Sea.

6.12 Bonn Agreement

The Bonn Agreement fosters cooperation in addressing pollution of the North Sea by

oil and other harmful substances. It applies, ref./26/:

- a. *Whenever the presence or the prospective presence of oil or other harmful substances polluting or threatening to pollute the sea within the North Sea area, as defined in Article 2 of this Agreement, presents a grave and imminent danger to the coast or related interests of one or more Contracting Parties; and*
- b. *“to surveillance conducted in the North Sea area as an aid to detecting and combating such pollution and to preventing violations of anti-pollution regulations”*

The Bonn Agreement Oil Spill Identification Network (OSINET) of Experts is a working group of the Bonn Agreement. Their task is to give mutual assistance in case of an oil spill, to improve the quality of methods and to unify the methods applied.

6.13 EU Maritime Surveillance in the Northern Sea Basins (MARSUNO)

Maritime Surveillance in the Northern Sea Basins was a pilot project initiated by the European Commission. Twenty-four authorities from ten countries were partners to the project, which aimed to achieve a higher degree of interoper-

The Maritime Surveillance in the Northern Sea Basins pilot project objectives were to:

- Test the capacity of project partners to exchange surveillance and monitoring information
- Test joint maritime surveillance operational procedures among law enforcement
- Determine the extent to which project partners are potentially able to set up an exchange of information mechanism at cross sectoral and cross border level that is viable and durable in time
- Identify legal, administrative, technical obstacles
- Identify best practices and legal adjustments needed to overcome the obstacles identified
- Determine the extent of added value both in qualitative and quantitative terms

The Maritime Surveillance in the Northern Sea Basins pilot project best practices identified:

- Cooperation with relevant authorities at national and international level
- Joint or shared IT-systems and registers determine the extent of added value both in qualitative and quantitative terms



ability among existing monitoring and tracking systems in order to improve maritime surveillance in the Baltic Sea and the North Sea area. MARSUNO is also part of the Baltic Sea Region Action Plan, labelled a flagship project within the Action plan.

The main purpose of the pilot project was to create a common information sharing environment for the EU maritime domain. The work was divided into six work groups:

- Integrated Border Management – Law Enforcement (IBM-LE)
- Vessel Traffic Monitoring Information System (VTMIS)
- Maritime Pollution Response (MPR)
- Search and Rescue (SAR)
- Fisheries Control (FC)
- Maritime Situational Awareness (MSA)

The aim was to optimize the efficiency and the cost of maritime surveillance throughout the EU. The pilot project supports the policy process of the European Commission to create a Common Information Sharing Environment (CISE). The purpose of this program is to integrate existing surveillance systems and networks and give all concerned authorities access to the information they need for their missions at sea.

The goal of CISE is to make different systems interoperable so that data and other information can be exchanged easily through the use of modern technology. For more information, visit the European Commission and Maritime Affairs internet pages, ref./73/.

7 Existing Experience

Offshore oil and gas activities, maritime activity and land-based activity create a potential for accidental oil spill. The risk of an oil spill is the product of the probability and consequence of the incident. A comprehensive risk assessment that provides or predicts the likelihood or probability of an event occurring and the potential adverse consequences has proven to be an effective tool to identify the main risk elements and find the best mitigating measures. In order to predict the likelihood and potential adverse consequences, previous records, data, information and experience are necessary. In order to put efficient and effective measures/barriers in place to reduce the potential adverse consequences, existing practices and experience are of high value.

To prevent pollution and achieve a high level of environmental protection by strengthening the barriers, key findings and prevention recommendation from previous events, projects, offshore operation and maritime transportation are important.

An introduction to a risk analysis is often a HAZID workshop, where experts with experience with similar equipment, operation, area etc. are invited to participate and share their experiences. Often, statistics and data are not available because of limited operations that are similar in nature. A qualitative evaluation based on experience from similar operations is therefore of vital importance. The next chapters describe some cases from which lessons can be learned.

7.1 Documented Experience and Reports

In this chapter, existing practices and experiences are looked into by reviewing reports and documents. The list of reports referred to here is by no means exhaustive, however its purpose is to gain knowledge from previous experience and to discover how the industry has documented best practices.

7.1.1 US Arctic

Shell has several decades of experience operating in a number of Arctic and sub-Arctic regions, e.g. Shell drilled multiple wells in the Chukchi and Beaufort Seas in the 1980s and 1990s. They have spent several years preparing for exploration in the shallow waters off the coast of northern Alaska, and they are now eager to continue their plans and activities for offshore exploration in the Chukchi Sea, Alaska. Two relevant papers prepared for offshore exploration activities in the Chukchi Sea are;

- *Chukchi Sea Regional Exploration Oil Discharge Prevention and Contingency Plan*, ref./31/
- *Comprehensive Contingency Planning for Arctic Offshore Operation*, ref./32/

The *Chukchi Sea Regional Exploration Oil Discharge Prevention and Contingency Plan* (C-Plan), ref./31/ prepared for offshore exploration activities in the Chukchi Sea, Alaska, was designed to aid Shell in its effort to prevent spills, share some of the best available technology and best practices implemented as

well as experience in preparation for offshore activity and shipping activities in the Arctic.

The C-Plan contains both prevention practices and mitigation procedures however the mitigation procedures will not be further evaluated. The main findings related to oil spill prevention in the C-Plan is a comprehensive program which includes prevention training programs and spill prevention practices, fuel transfer procedures, best management practices (BMPs), maintenance programs, checklists and operating requirements for exploration. The C-Plan also addresses topics such as visual and manual inspections and leak detection, blow out prevention and emergency shutdown, well control, overfill prevention of oil storage tanks (tank liquid level determination), debris removal, drill floor drainage, automatic or manual emergency shutdown systems (ESD), functional testing and pressure testing, recording of incidents and ice management systems (two ice-class vessels), ref./31/.

An analysis of potential discharges and their impacts are presented in the C-Plan. Severe weather, ice conditions, structure icing and reduced hours of daylight increase the risk of operation in the Polar waters. The C-Plan refers to Shell's critical operation and curtailment plan (COCP) which provides a series of procedures for monitoring and responding to various ice conditions and weather/wave conditions at the drill sites. Shell's monitoring and forecasting systems include metrological observations, on-site weather forecasts, oceanographic observations, sea state forecasts, ice monitoring, ice forecasting, real time measurements and an ice alert system (T-time¹), ref./31/.

An Ice Management Plan (IMP) was implemented to ensure safe operations at all times, and exploration drilling was set to not be conducted after October 31, however other project activities were allowed to continue until the onset of freeze up. The C-Plan presents the command systems and emergency management organization structure is based on the National Incident Management System, and during an emergency response situation,

1 Estimated total time to secure the well and leave the location

incident command system (ICS) would be used, ref./31/.

The Nuka Research and Planning Group, LLC Pearson Consulting, prepared in November 2010 an oil spill prevention and response report for inclusion in the U.S. Arctic Ocean Oil report, the *Comprehensive Contingency Planning for Arctic Offshore Operation*, ref./32/ where the purpose was to examine the risks, challenges and potential consequences of oil spills associated with oil and gas exploration and production in the outer continental shelf (OCS) of the U.S. Arctic Ocean. This report was one of the papers published during the international oil spill conference in 2011 by Shell Project and Technology and Shell Exploration & Production Company, and it shares some of the best practices implemented by Shell during the preparation for exploratory drilling in the Alaskan Beaufort Sea and Chukchi Sea.

According to the *Comprehensive Contingency Planning for Arctic Offshore Operations* report, ref./32/, to prevent pollution and achieve a high level of environmental protection, Shell will undertake spill prevention measures, including 24-hour/7 day-a-week monitoring of drilling activities through Real Time Operation Centres, advanced weather monitoring and forecasting, mechanical barriers, etc. Shell will also undertake a dedicated science program which includes collection of environmental baseline data (met-ocean, ice, biological and shoreline) as well as continued ecosystem-based monitoring and assessment, research and development of spill response techniques.

The Oil Spill Prevention and Response in the U.S Arctic Ocean-Unexamined Risks, Unacceptable Consequences report, ref./33/, was prepared for U.S. Arctic Program, Pew Environmental Group, and it examines the risks, challenges and potential consequences of oil spills associated with oil and gas exploration in the outer continental shelf of the United States Arctic Ocean.

Important findings from this report conclude that a comprehensive risk assessment is vital in order to identify the types of oil spills that may occur and what those impacts might be. Specific measures could then be identified and put in place to reduce these risks.

To ensure well control, Shell applies several layers of prevention. The *Comprehensive Contingency Planning for Arctic Offshore Operations* report identifies the layers, ref./32/:

- “Global standards governing well designs and operating procedures, rigorous training of Shell and contractor personnel, as well as early risk identification and mitigation using drill string conveyed detection and logging tools.
- Multiple robust barriers, including both hydraulic and mechanical barriers, between pressure regimes and the surface. These barriers may include but are not limited to the mud column hydrostatic pressure, blowout preventers, casing, wellhead housings, seal assemblies and cement. Regular testing and inspections are performed to ensure competency and integrity.
- 24-hour/7 day-a-week remote monitoring. During drilling, wells are monitored in real time from a global network of onshore operating centers manned by drilling experts. This constant surveillance provides oversight of critical issues including early detection of “kicks,” or abrupt changes in pressure that instigate flow and timely implementation of kick response procedures, such as shutting down the pumps, performing a flow check, and killing the flow before loss of control.
- Real time weather monitoring and forecasting for safe operations in ice conditions.
- Shell requires Original Equipment Manufacturer (OEM) certification for critical well control equipment such as BOPs and that procedures be in place to ensure safe equipment operation and regular testing of shear rams.”

The report underlines the fact that in order to reduce the risk by implementing barriers, it will require a mature understanding of how and where spills might occur. It will further require knowledge of how the timing, size and location of spills could impact the Arctic ecosystems in the short and long term, ref./33/.

It was further concluded in the PEW report that oil spill risk increased with the age of the equipment, hence routine maintenance, inspection, repair and replacement programs help to reduce the risk of oil spills from production operations. Monitoring vessel traffic, developing a comprehensive, collaborative program of research, monitoring, data collection, mapping and documentation of local and traditional knowledge were other preventive measures discussed and highlighted in the report. Spill prevention measures for tankers and other vessels may include; structural features such as double hulls or double bottoms, engineering systems that detect leaks or ice monitoring systems and navigational restrictions during periods of adverse weather. The report further states that human or organizational errors are estimated to cause as much as 85 percent of marine vessel accidents. Personnel training, drug and alcohol testing, medical monitoring and watch-standing procedures are also preventive measures mentioned in the report. ESDs (manual automatic) should be installed to limit the probability of any single (human) failure, ref./33/.

The PEW report highlights challenges such

as a short open-water season and ice conditions that may cause drill ships, floating processors and associated vessels to overwinter in an emergency due to high ice coverage and limited access to leads causing the vessels to be iced in. ref./33/.

The report also highlights the logistical challenges of the U.S Arctic Ocean, hence self-sufficiency may be a necessity. Backup drilling rigs on site and requirements to operators to have a drilling rig on standby to initiate relief well drilling and to have purpose-built well capping structures is an additional requirement for reducing blowout risk and improving blowout control.

7.1.1.1 Relevant Alaska projects and reports

This chapter includes reference to reports which have relevance for the development of best practices. Although they may not be cast as Arctic initiatives, they do have direct applicability to development of best prevention practices that would apply in the Arctic. The Emergency Towing System project, for example, has direct applicability to Arctic shipping since it has been found that international vessels do not have an adequate tow line on board by which to render assistance and prevent groundings. Each of the projects can potentially contribute information about the development of best prevention practices for the Arctic.

ALEUTIAN ISLANDS RISK ASSESSMENT <http://www.aleutiansriskassessment.com/>
This is a risk assessment of vessels using the circumpolar route through the Aleutian Islands in Alaska. There are many supplemental and useful back up reports about shipping at this website.

COOK INLET RISK ASSESSMENT <http://www.cookinletriskassessment.com/>
This is a risk assessment of vessels using Cook Inlet in Alaska. Cook Inlet is ice-infested and serves Anchorage which is the highest volume port in Alaska. This project has useful information relevant to shipping at this website. Winter ice navigation rules have been developed for Cook Inlet which may be relevant.

BERING STRAITS PORT ACCESS STUDY
Being conducted by the United States Coast Guard. This is a vessel traffic risk assessment that will generate recommendations for navigation in the Bering Strait to accommodate Arctic shipping. The Bering Strait is the Gateway to the Arctic.

ALASKA HAZMAT COMMODITY FLOW STUDY <http://dec.alaska.gov/spar/perp/hazmat/study.html>
This document outlines the extent, degree and type of hazardous materials that are used and transported in Alaska. It may have useful information for the “land-based” theme.

ALASKA EMERGENCY TOWING SYSTEM <http://dec.alaska.gov/spar/perp/ets/index.htm>
This website presents information about the emergency towing system developed in Alaska and now being expanded throughout the state. This information is relevant to the “shipping” theme.

POTENTIAL PLACES OF REFUGE <http://dec.alaska.gov/spar/perp/ppor/home.htm>
This website presents information about how Alaska identifies potential places of refuge for vessels in distress around Alaska’s coasts. This information is relevant to the “shipping” theme.

ALASKA SPILL DATA SUMMARY <http://dec.alaska.gov/spar/perp/data.htm>
This website contains information from Alaska’s spill database which includes information from all spills that have occurred from all sources in Alaska since 1995, when the database went digital. This information may be useful to all themes and can be used to search for specific information needs.

ALASKA RISK ASSESSMENT <http://dec.alaska.gov/spar/ipp/ara>
This is a risk assessment previously completed for Alaska’s North Slope oil fields. This website has information relevant to the “land-based” theme.

BEST AVAILABLE TECHNOLOGY – PIPELINE LEAK DETECTION
<http://dec.alaska.gov/spar/ipp/batpage.htm>
This website has information from a recent state-of-the-art-review (2011 conference report) of leak detection systems for oil field pipelines.

WEST COAST VESSEL TRAFFIC REPORT http://www.oilspilltaskforce.org/notesreports/wcovtrm_report.htm
This website describes the background work to establish offshore vessel routing as a significant prevention measure to prevent groundings for disabled ships. The offshore routing was established for the Pacific west coast and has been very successful.

ICE RADAR DETECTION <http://www.pwsr-cac.org/projects/MaritimeOps/icedetect.html>
This website describes the ice radar detection system developed and used in Prince William Sound in Alaska.

These projects provide useful lessons learned and background information that could be considered in the development of best prevention practices.

External and internal methods identified in the Alaska Department of Environment Conservation-Best Available Technology 2004 Conference Report are, ref./52/:

- Hydrocarbon gas or liquid-sensing devices as well as aerial surveillance along pipeline corridors.
- Optical fibers, acoustic sensors, chemical sensors, and electrical sensors.
- Computer-based systems are used to monitor measurements from external hydrocarbon sensing devices.
- A Supervisory Control and Data Acquisition (SCADA) system is a commonly used computer-based communications system that collects data from these external field sensors to remotely monitor and control pipeline facilities.
- Instruments to measure pressure, flow, temperature, sound, etc., of the gas, oil and/or water inside the pipeline.
- A SCADA system is used to collect data from the internal instruments.
- Computational pipeline monitoring (CPM) systems have been developed to analyze inflow and outflow product flow rates, mass, pressure, and sound for individual segments of a pipeline to detect and locate a pipeline leak. Outputs from the software analysis are displayed on computer monitors.
- Pipeline controllers are trained in leak pattern and false alarm recognition.

7.1.1.2 Alaska Department of Environment Conservation – Best available Technology 2004 Conference Report

Alaska Department of Environment Conservation-Best Available Technology 2004 Conference Report, ref./52/, summarizes a review and an appraisal of proven technologies that could be used by Alaskan plan holders in their oil discharge prevention and contingency plans. Leak detection for crude oil transmission pipelines, secondary containment liners for oil storage tanks, fast water booming, viscous oil pumping systems, well capping and source control technologies were selected for review during the conference, and are described in

the document. Two documents, explaining both external and internal methods used to detect leaks from crude oil transmission in pipelines, were identified in the report. They are as follows:

- *Technical Review of Leak Detection Technologies, Volume 1, Crude Oil Transmission Pipelines, ref./53/*
- *Worldwide Assessment of Industry Leak Detection Capabilities for Single and Multi-phase Pipelines, ref./54/*

Secondary containment liners (SCL) for oil storage tanks are identified as a prevention device. The secondary containment area

SYSTEM	BEST AVAILABLE TECHNOLOGY
Crude Oil Transmission Pipelines	<ul style="list-style-type: none"> • ATMOS Pipe • duoThane • LeakNet Wave • Alert • Sonicate/Ultrasonic Flowmeter
Secondary Containment Liners for Oil Storage Tanks	<ul style="list-style-type: none"> • Petrogard VI and X • GSE High Density Polyethylene Liners
Viscous Oil Pumping Systems	<ul style="list-style-type: none"> • Foilex Pumps • GT-A Pumps • Annular Water Injection
Source Control Technologies	<ul style="list-style-type: none"> • Pipeline Clamp • Well Blowout Control
Well Capping	<ul style="list-style-type: none"> • Abrasive Jet Cutter • Voluntary Well Ignition • Capping While Burning

Table 7-1 Best Available Technology from the best available technology 2004 Conference report

must, according to the report, ref./52/, have the capacity to hold the volume of the tank plus enough additional capacity to allow for local precipitation. The purpose the SCL is to prevent the release of spilled oil to the environment.

Well capping, circular drilling muds of increased density, and a relief well are identified as prevention devices.

The document presented 18 technologies at the best available technology Conference and they are summed up in the Table 7-1, ref./52/.

7.1.2 Risk Level in Norwegian petroleum activities

A study carried out by SINTEF on behalf of the Norwegian Petroleum Safety Authority, addresses causes and measures related to well control incidents in Norwegian petroleum waters, ref./63/. The study is part of the main report *Risk Level in Norwegian Petroleum Activities*. The study is based on a review of investigation reports and incident reports, other reports and documents submitted by the industry. It is also based on interviews with selected personnel in the industry. One of the issues discussed in the report was how the petroleum industry can continue working to reduce the number of incidents. Some of the key findings are summed up in this sub-section.

Challenges in connection with drilling and well operations are complex, and critical decisions regarding safety are, according to the study, often made during demanding conditions with great uncertainty. Additional challenges such as work pressure and conflicts where the efficiency and cost reduction requirement could impact safety are concerns highlighted in the study. The suggested solution to these challenges was integrated operations with experts in distributed teams with information flow and good decision support. In addition, it was stated that the key to maintain safe drilling and well operations was the interaction between humans, technology and organisation. Based on data collected, the study presents four challenges identified to reduce the number of well control incidents, ref./63/:

1. Create framework conditions for good interaction in the operator-supplier hierarchy
2. Stronger efforts in technical measures to improve safety
3. Increased efforts in planning, barrier management and better adapted risk analysis
4. More focus on major accident risk – more investigation of incidents.

Based on the results of the study, four key challenges facing the industry in relation to further reducing the number of well control incidents were identified, ref./63/;

1. Stronger effort on technical measures to improve safety
2. Increased focus on planning, barrier management and more adapted risk analyses
3. More focus on major accident risk – more incident investigations
4. Create framework conditions for good collaboration in the operator-supplier hierarchy

7.1.3 API and Joint Industry Task Force reports on offshore safety changes

In response to the Gulf of Mexico (GOM) incidents, the oil and gas industry assembled two Joint Industry Task Forces to focus on critical areas of GOM offshore activities. They brought together industry experts to identify best practices in offshore drilling operations and equipment. The goal was to further enhance safety and environmental protection. One of the objectives was to immediately prepare recommendations regarding GOM deep-water drilling operations. These recommendations were to both identify and close gaps in current blowout preventer operating practices and align international standards for well drilling and completion practices with recognized best practices, ref/71/.

Relevant papers published on the American Petroleum Institute webpages, ref./72/:

- *Joint Industry Offshore Task Force – Executive Summary*
- *Final Report on Industry Recommendations to Improve Offshore Operating Procedures and Equipment*

- *Final Report on Industry Recommendations to Improve Subsea Well Control and Containment*
- *Joint Industry Preparedness and Response Task Force, Progress Report on Industry Recommendations*
- *Joint Industry Task Force Recommendations for Improving Offshore Safety*
- *Joint Industry Oil Spill Preparedness and Response Task Force Recommendations*
- *Joint Industry Subsea Well Control and Containment Task Force Recommendations*



Washington Sea Grant Program). The report presents three elements which must exist simultaneously for oil spill to occur, Figure 7-1.

The oil spill triangle can, according to this report, be used to identify the causes of spills and serve as a reference for preventing future incidents.

Training of personnel may also encourage teamwork, provide a review of job standards and individual performance, and recognize each employee as a critical component in reducing discharges, ref./36/.

Figure 7.1 *The oil spill triangle*

7.1.4 The oil spill triangle: A preventive tool

The oil spill triangle: A preventive tool report, ref./35/, was one of the papers published during the international oil spill conference in 2011 by Erik H. Olsson (University of

The first leg of the spill triangle is the oil product, and several risk control measures are suggested, ref./36/:

- Use durable, high-quality lubricants and adhere to oil change intervals based on equipment design and workloads
- Keep equipment tuned to reduce fuel consumption
- Wear and repair oil leaks
- Increase knowledge of the physical and chemical properties of the oil-based fluids used
- Increase knowledge of the exposure risks, and compatibility of these products

The second leg of the oil spill triangle is operation failure (human failure). Preventive measures to avoid operation failure suggested in the report are as follows, ref./36/:

- Careful planning, and ensure that crew members are fully aware of their duties
- Anticipate that something may go wrong, and be prepared
- Provide effective communication and adequate lighting and adhere to checklists for fueling or repairs
- Training (hands-on training and practice sessions)
- Maintenance (repairs should be tested under load).

The third leg of the oil spill triangle is the overboard route. It is the path available for oil to enter the water. Preventive measures suggested are as follows, ref./36/:

- Only containers that are designed for the intended oil product and that are resistant to the rigors of the marine environment should be used
- Oil tanks should never be filled beyond effective capacity, accounting for product volatility, temperature fluctuations, venting and other constraints
- Open containers should never be used to carry oil or left to become a spill or fire hazard
- Provide adequate fixed or portable containment around tank vents and under manifolds and plugging scuppers during fueling

7.2 Experience from operations and planned projects

There is an extensive amount of information from operations and planned projects. The Goliat, Shtokman, and Capricorn fields will be discussed in this section.

7.2.1 Planned Goliat Field in South West Barents Sea (Operator ENI)

The Goliat operation will, according to ENI Norge, satisfy all the requirements with regard to minimising environmental risk. The floating production, storage and offloading unit (FPSO) is being built with a double hull and bottom to prevent any accidental oil spills caused by collision, grounding, stranding or explosions. Goliat has its own oil storage, a higher freeboard than normal and the risers from the seabed are located inside the ballast water tanks. In addition, all the internal areas are well protected from the environmental elements. The standby vessel will be stationed by the production facility with oil spill protection equipment stored below deck. The ship will be equipped with oil-detecting radar, an infrared camera capable of detecting oil spills, equipment for chemical dispersal of oil, a Man Overboard boat (MOB boat), and have large storage capacity for recovered oil. Radar and monitoring systems will contribute to more efficient oil spill protection during long winter nights and poor visibility. The operation and equipment installed on the seabed will be monitored using advanced sensors and periodically monitored using a remotely controlled mini-submarine. Together, these make up a set of barriers or impediments in-

stalled and implemented with the intention to prevent discharges and accidents. Duplicate sets of equipment at critical points, a set of quality-controlled procedures and new technology are examples of such preventive measures ref./37/.

Special-equipped helicopters that can search for oil using infrared cameras and special radar on the sea surface (under any weather and light conditions) are available to assist if deemed necessary. Antifreeze systems, solutions and measures are implemented to prevent freezing of equipment, which could cause hazardous problems to the vessel, ref./37/.

7.2.2 Planned Shtokman Field in the Russian Barents Sea (Operator Shtokman Development (SDAG))

A conference paper prepared by Liferov and Metge, *Challenges with ice-related design and operating philosophy of the Shtokman Floating Production Unit*, ref./36/, for the Port and Ocean Engineering under Arctic Conditions describes sea ice and iceberg-related challenges connected to design and operating philosophy of the Shtokman FPU. The report also presents actions performed by SDAG to address the challenges and to ensure sound design and safe operation with acceptable downtime.

The offshore facilities consist mainly of subsea production system, umbilicals, flow lines and risers, ice-resistant moored disconnectable FPU and trunk line to shore.

Ice Management (IM) is implemented as a barrier to increase the operability of the FPU, however the design limits of the Shtokman FPU with respect to sea ice have not been de-

The main ice-related design philosophy for hull and mooring according to Liferov and Metge, ref./36/, are as follows:

- *“The hull structure will have to resist all possible local sea ice and iceberg actions. While some denting may be tolerated, no damage should result in a need for dry docking*
- *The mooring system will have to resist all expected iceberg actions and most sea ice actions. No direct contact between mooring lines and icebergs will be accepted. Mooring forces and FPU response will be monitored by a fully redundant system*
- *The hull is considered a “life buoy”. Turret, mooring and disconnection systems will be designed such that required hull stability is maintained in all conditions.”*

creased due to use of IM. The objectives of IM for the Shtokman FPU operation are to detect and evaluate all potential ice threats, physically manage the hazardous ice inside the ice management zone to prevent disconnection and improve working conditions on the FPU, to assist the FPU during ice drift reversals, to facilitate re-connection in ice and to assist evacuation in ice if needed.

One of the challenges according to Liferov and Metge, ref./36/, is to ensure the required reliability in all conditions, and to maintain required training levels during long periods without actual ice invasions on site.

7.2.3 Capricorn Greenland Exploration

The Capricorn Greenland Exploration – 1 report, ref./38/, is the Non-Technical Summary of an Environmental Impact Assessment (EIA) for an offshore multiple well exploration drilling programs. It was conducted with a two-month contingency window during November and December in case relief well drilling was required. The EIA has been produced by Environmental Resources Management on behalf of Capricorn Greenland Exploration. The report contains and addresses several important aspects concerning oil pollution prevention and risk control measures. The measures that will be established to prevent unplanned events and to respond to any such events that do occur are summarized in the Environmental Management and Mitigation chapter.

According to the report, the potential for major environmental harm will be dependent on the context and location of the oil spill, and closely related to the size. It was further concluded that the main risk of a large spill during exploration drilling was either a vessel collision or a loss of well control in a critical phase, and that spills of crude oil from the reservoir, diesel and heavy fuel were considered the most significant due to the potential effect of a major oil spill. Spills occurring on vessels in areas where fuel is handled is considered minor/small spills and considered of lesser potential significance, due to the implemented preventive measures (bounded areas). The report therefore focused on medium and larger spills, however it suggested that equipment standards, operational control, procedures

and training, planning of critical activities, navigational risk control and meteorological control are key factors in reducing the likelihood and severity of small spills during fuel handling and storage, ref./38/.

7.3 Experience from accidents

Following incidents, investigations and studies have been carried out in order to determine what happened and to identify possible measures to avoid similar accidents in the future. The Macondo field accidents will be discussed in detail in Section 7.3.1, while lessons learned from the Ocean Ranger, Piper Alpha and Montara H1 well blowout will be discussed in Section 7.3.2.

7.3.1 Macondo field accident

On 20 April 2010, a massive explosion tore through the Deepwater Horizon drilling rig in the Gulf of Mexico during the drilling of the exploratory Macondo well, claiming the lives of 11 men and unleashing the largest oil spill in the history in the United States.

Many investigations followed the Macondo field accident in order to determine the cause of the disaster, and to identify possible measures to prevent similar accidents in the future (e.g. BOEMRE/USCG, National Commissions, SINTEF, BP, PSA).

The Macondo well blowout and its aftermath provided new information about drilling on the outer continental shelf (OCS). Two major U.S. rulemakings pertaining to energy development on the OCS: (1) *Increased Safety Measures*²; and (2) *Safety and Environmental Management Systems (SEMS)*³ resulted from

- 2 See attached Increased Safety Measures [Federal Register reference: DEPARTMENT OF THE INTERIOR – Bureau of Safety and Environmental Enforcement, 30 CFR Part 250 – [Docket ID: BSEE-2012-0002], RIN 1014-AA02; Oil and Gas and Sulphur Operations on the Outer Continental Shelf-Increased Safety Measures for Energy Development on the Outer Continental Shelf].
- 3 See attached Safety and Environmental Management Systems [63610 Federal Register / Vol. 75, No. 199 / Friday, October 15, 2010 / Rules and Regulations.

investigations. These laws imposed new (and further codified existing) safety measures that directly address the suspected root causes of the *Deepwater Horizon* accident. These regulations provide a mix of (1) *prescriptive* requirements, designed to ensure redundancy in blowout preventers (BOPs), promote well bore integrity, and enhance well-control capabilities; and (2) *performance-based* requirements intended to facilitate a culture of safety and environmental protection through operational and personnel management. Excerpts from these rules provide the following summaries of U.S. actions taken to further prevent oil spills (Arctic or otherwise) from OCS oil and gas operations:

Increased Safety Measures: Amends existing regulations related to well control, including: subsea and surface blowout preventers, well casing and cementing, secondary intervention, unplanned disconnects, recordkeeping, and well plugging. These regulations:

- Establish new casing installation requirements;
- Establish new cementing requirements;
- Require independent third party verification of blind-shear ram capability;
- Require independent third party verification of subsea BOP stack compatibility;
- Require new casing and cementing integrity tests;
- Establish new requirements for subsea secondary BOP intervention;
- Require function testing for subsea secondary BOP intervention;
- Require documentation for BOP inspections and maintenance;
- Require a Registered Professional Engineer to certify casing and cementing requirements;
- Establish new requirements for specific well control training to include deepwater operations.
- Update the incorporation by reference to the second edition of API Standard 65-part 2. This standard outlines the process for isolating potential flow zones during well construction. The new Standard enhances the description and classification of well-control barriers, and defines testing

requirements for cement to be considered a barrier.

- Revise requirements on the installation of dual mechanical barriers in addition to cement for the final casing string (or liner if it is the final string), to prevent flow in the event of a failure in the cement. The final rule provides that, for the final casing string (or liner if it is the final string), an operator must install one mechanical barrier in addition to cement, to prevent flow in the event of a failure in the cement. The final rule also clarifies that float valves are not mechanical barriers.
- Revise requirements of the operator to perform a negative pressure test only on wells that use a subsea BOP stack or wells with a mudline suspension system instead of on all wells.
- Add new requirement stating that an operator must have two barriers in place before removing the BOP, and that the BSEE District Manager may require additional barriers.
- Extend the requirements for BOPs and well-control fluids to well completion, well-workover, and decommissioning operations.

Well control equipment is a general term for the technologies used to control a well by mechanical means in the event that other well control mechanisms fail. Well control equipment includes control systems that activate the BOPs, either through a control panel on the drilling rig or through remotely operated vehicles (ROVs) that directly interface with the subsea BOP to activate the appropriate rams. Regulatory provisions that address well control equipment include:

1. Submission of documentation and schematics for all control systems;
2. A requirement for independent third party verification that the blindshear rams are capable of cutting any drill pipe in the hole under maximum anticipated surface pressure (MASP);
3. A requirement for a subsea BOP stack equipped with ROV intervention capability. At a minimum, the ROV must be capable of closing one set of pipe rams,

closing one set of blind-shear rams, and unlatching the lower marine riser package (LMRP);

4. A requirement for maintaining an ROV and having a trained ROV crew on each floating drilling rig on a continuous basis;
5. A requirement for auto shear and deadman systems for dynamically positioned rigs;
6. Establishment of minimum requirements for personnel authorized to operate critical BOP equipment;
7. A requirement for documentation of subsea BOP inspections and maintenance according to American Petroleum Institute (API) Recommended Practice (RP) 53 – Recommended Practices for Blowout Prevention Equipment Systems for Drilling Wells;
8. Required testing of all ROV intervention functions on the subsea BOP stack during the stump test and testing at least one set of rams during the initial test on the seafloor;
9. Required function testing of auto shear and deadman systems on the subsea BOP stack during the stump test and testing the deadman system during the initial test on the seafloor; and
10. Required pressure testing if any shear rams are used in an emergency.

Safety and Environmental Management Systems (SEMS): Establishes a new subpart to 30 CFR 250: *Subpart S – Safety and Environmental Management Systems (SEMS)*. The SEMS Rule requires operators to develop and implement a comprehensive management program for identifying, addressing and managing operational safety hazards and impacts, with the goal of promoting both human safety and environmental protection. The SEMS Rule applies to all offshore oil and gas operations within the BSEE jurisdiction and applies to the design, construction, start-up, operation, inspection, maintenance and decommissioning of offshore rigs and platforms.

The SEMS Rule incorporates by reference, and makes mandatory, the API Recommended Practice for Development of a Safety and Environmental Management Program for

Offshore Operations and Facilities (API RP 75), Third Edition, May 2004, reaffirmed May 2008. The SEMS Rule contains the following 13 elements, believed to constitute a complete Safety and Environmental Management System:

1. General provisions regarding the implementation, planning, and management review and approval of the SEMS program;
2. Safety and environmental information requirements establishing the minimum safety and information needed for any facility relating to design data; facilities process and flow diagrams; and mechanical components, such as piping and in instrument diagrams;
3. Hazards analysis that includes a facility level risk assessment;
4. Management of change program for addressing any facility or operational changes, including management changes, shift changes, and contractor changes;
5. Operating procedures, including requirements for the evaluation of operations and development of written procedures;
6. Safe work practices, including the development of appropriate manuals, standards, and rules of conduct;
7. Training relating to safe work practices and technical issues, including the training of contractors;
8. Mechanical integrity, including requirements relating to preventive maintenance programs and quality control;
9. Pre-startup review of all systems;
10. Emergency response and control systems that must be implemented and validated by drills, including emergency evacuation plans, and oil spill contingency plans;
11. Procedures for investigating incidents and making appropriate corrective actions;
12. Regular audits that must be conducted initially within two years and then at three-year intervals; and
13. Maintenance of records and documentation that describe all elements of the SEMS program.

The BSEE SEMS requirements and comparisons to other Arctic HSE program requirements have been identified through joint

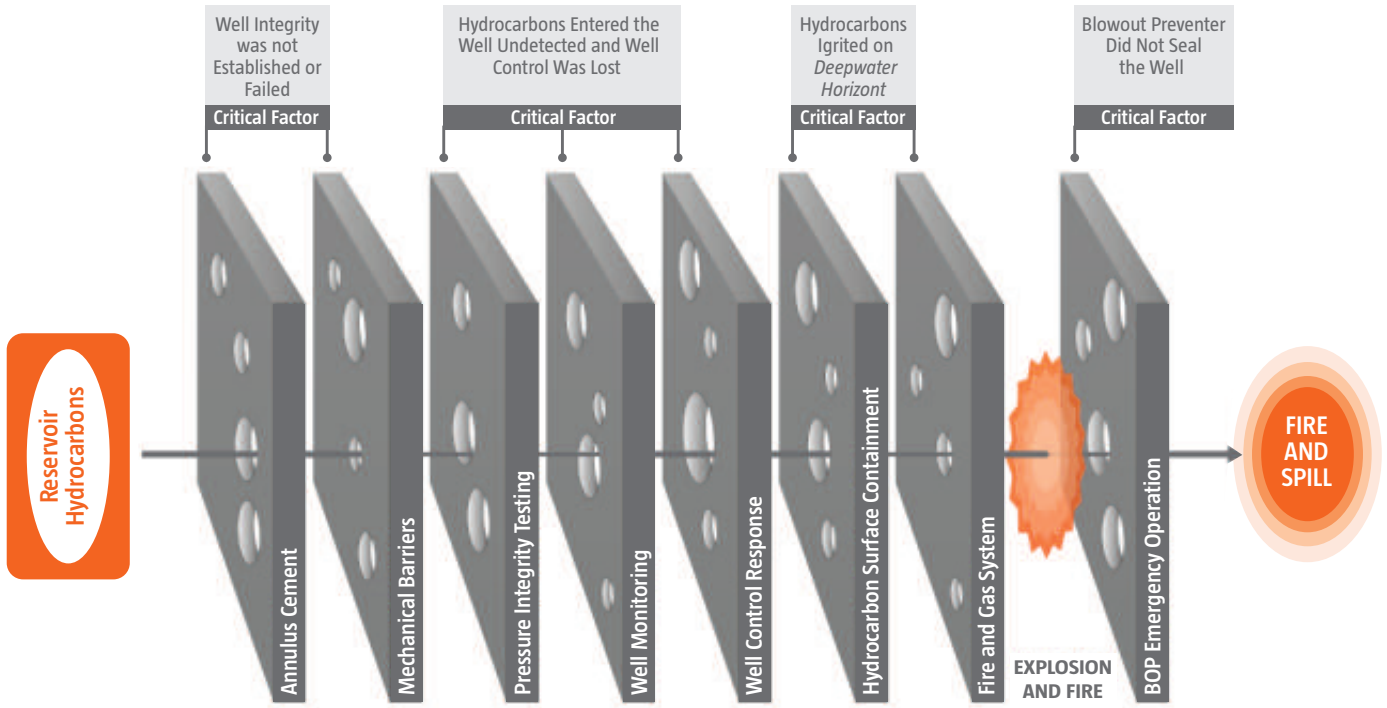


Figure 7.2 Illustrates barriers needed to avoid the critical factors that cause a fire and an oil spill according to Deepwater Horizon Accident Investigation Report, ref./39/

EPPR/PAME HSE Workshops (October 2011, and June 2012). The results of this combined work are detailed in the PAME HSE project report.

7.3.1.1 BP

An internal BP incident investigation team prepared in September 2010 a *Deepwater Horizon Accident Investigation report*, ref./39/, where the purpose was to present an analysis of the events leading up to the Deepwater Horizon accidents, key findings related to the events and prevention recommendations. The recommendations were intended to enable prevention of similar accidents occurring in the future by strengthening the barriers needed to reduce the probability of an incident to develop into an accident. They address contractor oversight and assurance, risk assessment, well monitoring and well control practices, integrity testing practices and BOP system maintenance, among others.

The investigation report recommendations cover Drilling and Well Operations Practices (DWOP) and Operating Management System (OMS) implementation. In addition it present recommendations related to contractor and service provider oversight and assurance.

The report suggests eight barriers needed to avoid critical factors that cause a fire and an oil spill: annulus cement, mechanical barriers, pressure testing, well monitoring, well control response, hydrocarbon surface containment, fire and gas system and BOP emergency operation, Figure-7-3.

Audits, verification, process safety performance management, capability and competence, procedures and engineering technical practices, cementing services assurance, well control practices, rig process safety, and BOP design and assurance are important pollution prevent practices and technology according to the investigation report ref./39/.

7.3.1.2 National Academy of Engineering

A National Academy of Engineering report examines the causes of the blowout and presents recommendations both for the oil and gas industry and government regulations, intended to reduce the probability and consequence of any future losses of well control during drilling operations.

The list of recommendations is not complete; however more detailed information is found in the National Academy of Engineering report, ref./40/.

The committee developed a set of recommendations, ref./40/:

- Guidelines should be established to ensure that the design approach incorporates protection against the various credible risks associated with the drilling and completion processes
- *"All primary cemented barriers to flow should be tested to verify quality, quantity, and location of cement. The integrity of primary mechanical barriers should be verified by using the best available testing procedures. All tests should have established procedures and predefined criteria for acceptable performance and should be subjected to independent, near-real-time review by a competent authority."*
- *"BOP systems should be redesigned to provide robust and reliable cutting, sealing, and separation capabilities for the drilling environment to which they are being applied and under all foreseeable operating conditions of the rig on which they are installed. Test and maintenance procedures should be established to ensure operability and reliability to their environment of application. Furthermore, advances in BOP technology should be evaluated from the perspective of overall system safety. Operator training for emergency BOP operation should be improved to the point that the full capabilities of more reliable BOP can be competently and correctly employed when needed in the future."*
- *"Instrumentation and expert system decision aid important for timely warning of loss of well control to drillers on the rig. If the warning is inhibited or not addressed in an appropriate time interval, autonomous operation of the blind shear rams, emergency disconnect system, general alarm, and other safety systems on the rig should occur."*
- *"Industry should ensure timely access to demonstrated well-capping and containment capabilities."*
- Implement a hybrid regulatory system that incorporates a limited number of prescriptive elements into a proactive, goal active risk management system
- Critical safety points during well construction and abandonment need to be explicit, regulatory reviewed and approved
- *"U.S government agency should be designed with responsibility for ensuring an integrated approach for system safety for all offshore drilling activities"*
- *"Operating companies should have ultimate responsibility and accountability for well integrity. Operating companies should be held responsible and accountable for well design, well construction, and the suitability of the rig and associated safety equipment. The drilling contractor should be held responsible and accountable for the operation and safety of the offshore equipment"*
- Expand formal education and training of personnel engaged in offshore drilling to support proper implementation of system safety
- Systems for reporting of incidents
- Foster an effective safety culture

7.3.1.3 National Energy Board

Based on a review of the Macondo accident, the NEB issued in December 2011 a *Review of offshore drilling in the Canadian Arctic*, ref./41/. The review addresses drilling safety while protecting the environment, responding efficiently when things go wrong, lessons learned, and filing requirements for future offshore drilling applications. The key findings from reviewing the root causes of the incidents considered in the report were a neglect of, or even an absence of, processes and procedures to identify, mitigate, or eliminate potential risks and that the cause of most offshore accidents is the lack of broadly shared safety culture.

The Filing Requirements, ref./42/, a separate part of the NEB review of offshore drilling

in the Canadian Arctic, are based on input received by the Board during its Arctic Offshore Drilling Review. It lists the information required by applicants seeking authorization to drill an Arctic offshore well. The applicant must submit an Environmental Protection Plan, Safety Plan and a Contingency Plan (see Section 5.4.2). No approval of a development plan or any authorization of work or activity shall be issued until a benefits plan in respect of the work or activity has been approved.

The filing requirements describe the information the NEB will want to see included in a project description. One of the main purposes of the project description is, according to NEB, that it provides sufficient detail to demonstrate, ref./42/:

An article in the annual report from PSA, *Safety-Status and Signals* highlights three topics the industry need to carefully consider, ref./56/;

- **Organization and management**

Decision-making and prioritization processes, management of expertise and operational changes, were identified as management failures. It was further stated that failure to communicate and share information within companies and between operator, contractor and management priorities driven by short-term financial gain, all contributed to the total sum of failures.

- **Risk management**

PSA stresses that the industry should be able to analyze, assess and understand change-related risk in a better way than is the case today.

- **Barrier management**

According to PSA, the industry needs to develop a more integrated and uniform approach to barrier management. PSA further highlights the need for better and more specific performance requirements for a number of barrier elements, and that the industry must continue to give improved barrier management a high priority.

“an understanding of how the unique Arctic environment will interact with the project; and that this knowledge has been incorporated in the project design to address safety and protection of the environment”.

The board also requires the applicant to consult with persons or groups who may be affected by the proposed project and a consideration of the environmental effects⁴ of the project.

7.3.1.4 Petroleum Safety Authority (PSA)

Taking the lessons to heart, an article in the annual report from PSA, *Safety-Status and Signals*, ref./56/, identifies three key areas where action is needed to help reduce major accident risk on the NCS.

The article in the annual report from PSA, *Safety-Status and Signals*, ref./56/, states that;

“At the PSA, we feel it’s important to contribute to global safety work. Exchange information, sharing knowledge and professional updating are crucial in preventing major accidents.”

4 These include environmental effects of malfunctions or accidents. They also include any cumulative environmental effects that are likely to result from the project in combination with other projects or activities

7.3.2 Lessons learned from accidents

Lessons learned from accidents, incidents and emergency response exercises were presented as a part of the *Review of offshore drilling in the Canadian Arctic* report, ref./41/. This report discusses some of the lessons learned from other regulators, and how a strong safety culture and a commitment to management systems contribute to offshore drilling projects that are safe and do not damage the environment. Ocean Ranger, Piper Alpha, Cougar helicopter Flight 491, Montara blowout and the Deepwater Horizon was investigated. We will only address the Ocean Ranger, Piper Alpha and Montara blowout in this section.

Lessons learned from the Ocean Ranger were the importance of management systems. The crew failed to close the valves used to control the stability of the rig. Det Norske Veritas noted that the rig owner’s career management policy focuses on growth through experience without formal training. The filing requirements state that, ref./41/., *“the management system shall e.g. demonstrate that the management system has systematic, explicit, comprehensive, proactive, and documented processes for; the development of annual objectives and target and a means to measure theme, and the establishment of competency requirements and effective training programs so that a proper level of training and competence are met.”*

The Piper Alpha accident also showed the importance of proper management systems.

The Det Norske Veritas report concluded that, ref./41/, *“the crew did not follow procedures when they completed the fitting of the blind flange. The flange was not properly adjusted. In addition, the work situation and the status of the job were poorly communicated at the shift handover.”* The lessons learned from the accident are addressed in the filing requirements. According to the filing requirements the management systems shall *“demonstrate that the management system has systematic, explicit, comprehensive, proactive, and documented processes for the evaluation and management of risks associated with all hazards, and communication of preventative, protective and mitigative measures for identified hazards risk, and internal and external communication that support safety, security, environment protection etc.”*

The direct cause of the blowout at the Montara H1 Well was the failure of the primary well barrier, the cemented casing shoe. The Montara Commissions Inquiry later, ref./41/, *“found that at the time the H1 Well was suspended in March 2009, not one well barrier complied with the operator’s own Well Construction Standards... Relevantly, the cemented casing shoe had not been pressure-tested in accordance with the company’s Well Construction Standards, despite major problems having been experienced with the cementing job”*. The Commissions of Inquiry identified two broad categories of direct causes for the incident. The direct cause was the failure of the primary well barrier (cement casing), and the systemic

failure in how the operator implemented the regulatory regime, rather than inadequacy of the regulations themselves. The well barrier filing requirements are relevant for the Montara accident.

The filing requirements state that the well shall have at least two independent and tested physical well barriers in place during all well operations. Well barriers shall describe the well integrity and well barriers with enough detail to demonstrate that: reliable well control equipment is installed to control kicks, prevent blowout, and safely carry out all well activities, including drilling completion, and work over operations. If well control is lost and environmental protection or resource conservation are threatened, the operator will take any action necessary to rectify the situation without delay, despite any condition to the contrary in the Well Approval, ref./41/.

The common thread in all these accidents was the neglect of processes and procedures to identify, mitigate, or eliminate potential risks. It was further stated in the report, ref./41/, that *“beneath that deficiency lays an even deeper and more disturbing pattern of organizational cultures that did not put safety first.”*

Additional measures identified include: establishing an oversight team, monitoring, calling an operations timeout, observing key operations from on-board the rig, ensuring that spill response equipment was ready for rapid deployment and reviewing the well termination program.

The common thread in the Piper Alpha,

Summary of main findings from previous accidents:

- Organization culture did not put safety first. Strong safety culture and commitment to management systems contribute to offshore drilling projects that are safe and do not damage the environment.
- The management system shall e.g. demonstrate that the management system has systematic, explicit, comprehensive, proactive, and documented processes for the development of annual objectives and targets and a means to measure theme, and the establishment of competency requirements and effective training programs so that a proper level of training and competence are met.
- The Commissions identified failure of the primary well barriers and a system failure in how the operator implemented the regulatory regime rather than the inadequacy of the regulations themselves. Well barriers shall describe the well integrity and well barriers with enough detail to demonstrate that: reliable well control equipment is installed to control kicks, prevent blowouts, and safely carry out all well activities, including drilling completion, and work over operations. If well control is lost, and environmental protection or resource conservation are threatened, the operator will take any action necessary to rectify the situation without delay, despite any condition to the contrary in the Well Approval.
- Neglect of process and procedures to identify, mitigate, or eliminate potential risks.



Montara blowout, Ocean Ranger and Macondo well blowout incidents is that the organization cultures did not put safety first. An organization's safety culture is made up of beliefs, values, attitudes, and behaviours about safety. A positive safety culture is, according

to the review of offshore drilling in the Canadian Arctic, ref./41/, characterized by “... *communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventative measures.*”

8 General Identification of Hazards, Risks, Existing safeguards, barriers and risk-reducing measures

Offshore and marine activity in the Arctic region is challenging. The climate, the sea ice, icebergs and hydrology make offshore activities and the consequences of an accident – in terms of loss of lives, environmental damage and/or economical loss – more severe due to the remoteness and lack of infrastructure. Darkness, fog, strong winds (polar lows), sea ice and closing fairleads make emergency response challenging and time-consuming. Icing on decks and superstructures due to sea spray can significantly modify the buoyancy and stability of the floating structure and affect the dynamic and static response. Ice and snow

blocking vents and drains, and icing of equipment on deck may cause operational problems. Extreme temperatures may be hazardous for personnel and operation as well, since low temperatures influence the construction materials and may cause vital systems to freeze. The impact and consequence of an oil spill will also depend on its location and the type of oil spill. In addition, due to large distances to shore and restricted resources in Arctic areas, the oil pollution risk is expected to increase unless countermeasures are implemented.

In order to maintain an acceptable safety level it will be necessary to reduce the prob-

There are, according to the International Association of Oil and Gas Producers (OGP), ref./43/, three types of inputs which can be used together to help identify weak or critical barriers:

- **Pro-active**
A pro-active approach relies upon identification of hazards and risks which could lead to a major incident. Information can, according to OGP, ref./43/, be drawn from recent Process Hazard Analysis (PHA), HAZID, HAZOP analysis and other risk assessment which will include the barriers identified. Pro-active input is important for determining which barriers will need to be in place in order to control the most important process safety risks and the management system elements to maintain and improve those barriers.
- **Reactive**
A reactive approach is based upon root cause investigation of major incidents that could have resulted in an actual incident. The review of causes should be thoroughly mapped and analyzed to identify the need for new barriers where gaps exist, ref./43/.
- **External**
An external approach takes external inputs of experience and best practice risk control systems shared in the oil and gas or other industries. Learning from others can highlight critical barriers and suggest key performance indicators which may provide useful starting points, ref./43/.

ability of a spill by introducing barriers and risk-reducing measures to prevent harmful operation and especially accidental oil spills. A variety of operational procedures, both active and passive techniques, can be used to modify the frequency and the magnitude of ice actions. The success of implementing barriers may be difficult to predict, and therefore previous experience is vital in determining which barriers are effective and should be further evaluated and implemented. However, as incidents do not occur very frequently, especially in the Arctic, it can take very long time to gather statistically relevant data on major incidents alone.

8.1 Definitions of general terms, principles and guidelines

8.1.1 Definitions and terms

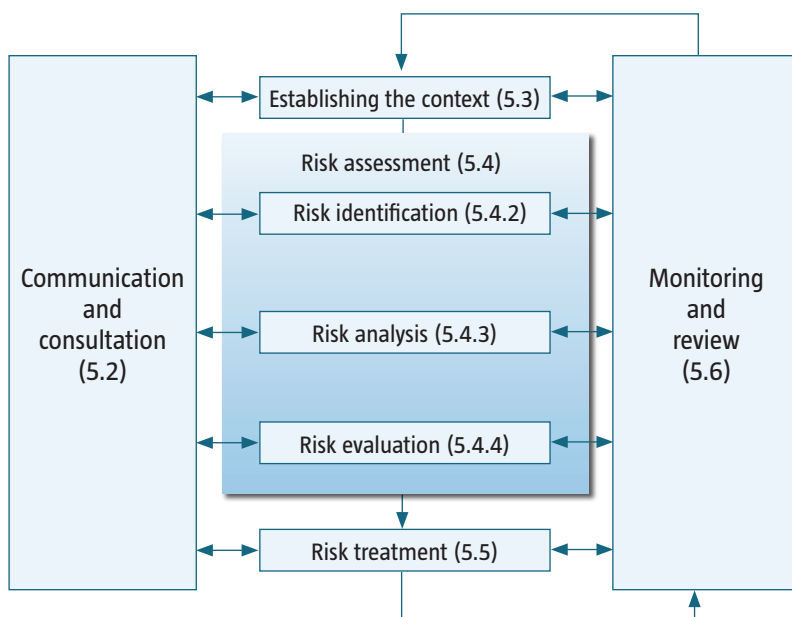
The following terms and expressions are highly relevant for this chapter:

- **Hazards.** Physical situations which have the potential to cause harm. The word “hazard” does not express a view on how likely it is that the harm will actually occur. A major hazard is a hazard with potential to cause significant damage or multiple fatalities.
- **Accidents.** Actual realization of a hazard. They are sudden, unintended departures from normal conditions, in which usually

some degree of harm is caused. They range from minor accidents, such as a small gas leak, to major catastrophes such as Piper Alpha, Chernobyl, Exxon Valdez. Sometimes, the more neutral phrase “event” is used in place of the more colloquial term “accident”.

- **Risk.** Combination of likelihood and consequence of accidents. More scientifically, it is defined as the probability of a specific adverse event occurring in a specific period or in specified circumstances. The distinction between “hazard” and “risk” is important, although in colloquial use, and also in popular dictionaries, risk and hazard are treated virtually as synonyms.
- **Likelihood.** May be expressed either in terms of a frequency (the rate of events occurring per unit time) or in terms of a probability (the chance of the event occurring in specified circumstances).
- **Consequence.** Refers to the expected effects of an event occurring. In risk analysis it usually refers to the size of the zone within which fatalities are expected.
- **Safety.** The inverse of risk. The higher the risk of any level of harm from an activity, the lower is its safety. Complete safety, as implied by the colloquial definition of safety as “the absence of risk”, is a worthwhile goal for engineers, but is practically impossible in an intrinsically hazardous activity. A realistic target is to reduce the risk of accidents until the safety of the activity is acceptable, bearing in mind the benefits which it brings.

Figure 8-1 Risk Management process, ref./50/



8.1.2 International Standards

ISO 31000 Risk management – Principles and guidelines was prepared by the ISO Technical Management Board Working Group on risk management and published in 2009. The approach described in this International Standard provides the principles and guidelines for managing any form of risk in a systematic, transparent and credible manner and within any scope and context.

ISO 31010 Risk management–Risk assessment techniques is a supporting standard for ISO 31000 and it provides guidance on selection and application of systematic techniques

Quotes from ISO 31000 relating to risk management and risk treatment, ref./50/:

- “Organizations manage risk by identifying it, analyzing it and then evaluating whether the risk should be modified by risk treatment in order to satisfy their criteria”
- “The organization should identify sources of risk, areas of impacts, events and their causes and their potential consequences. The aim of this step is to generate a comprehensive list of risks based on those events that might create, enhance, prevent, degrade, accelerate or delay the achievement of objectives. Comprehensive identification is critical, because a risk that is not identified at this stage will not be included in further analysis”
- “Risk treatment involves selecting one or more options for modifying risks, and implementing those options. Selecting the most appropriate risk treatment option involves balancing the costs and efforts of implementations against the benefits derived, with regard to legal, regulatory, and other requirements such as social responsibility and the protection of the natural environment.”

for risk assessment. The application of some techniques is introduced, however it does not provide specific criteria for identifying the need for risk analysis, nor does it specify the type of risk analysis method that is required.

According to ISO 31000 the risk management process shall be an integral part of management, embedded in the culture and practice, and tailored to the business processes of the organization. The risk process should comprise the activities shown in Figure 8-1.

8.2 HAZID methodology and analysis

A HAZID is a structured approach where documentation/drawings and a set of guide words form the basis for a structured brainstorming for identifying hazards involved with an operation or the use of equipment and/or systems. HAZIDs are commonly used throughout the industry for all types of safety and risk assessments. HAZID methodology and analysis are a common way to analyze Arctic operations and systems.

The purpose of the HAZID is to identify hazards that may represent risks to the environment. Hazards are contained by multiple protective “barriers” or “risk control systems”, and they may be managed by system procedures, physical engineered containment or other layers of protection designed to prevent incidents.

Section 8.2.1 presents an example of a classification form for triggering and underlying

causes for well control, while Section 8.2.2 presents an example of a HAZID table for an ice management system.

Example tables identifying some relevant hazards, causes, possible consequences and risk reducing measures related to offshore, maritime and land-based activities are presented in Appendix II.

8.2.1 Classification form for triggering and underlying causes for well control

A form used to categorize triggering and underlying causes and the type of measures is shown in Table 8-1. The Table is taken from a report issued by PSA, *The causes and measures related to well control incidents in Norwegian petroleum activities*, and is an example of a classification form for triggering and underlying causes for well control, ref./63/.

For more information regarding triggering and underlying causes and classification form, please see *The causes and measures related to well control incidents in Norwegian petroleum activities* report, ref./64/.

8.2.2 Ice Management Systems

Some of the main hazards when operating in Arctic waters are seasonal ice, drifting sea ice and icebergs. Ice accumulation in front of the structure and pressure ice will cause operational problems, and may cause damage to the structure. A variety of operational procedures can be used to reduce the probability of an iceberg collision, enhance ice clearance around

Table 8-1 Classification form for triggering and underlying causes and the type of measure for well control incidents, ref./63/

General	Specified type of cause or measure
Human	Error type slip/carelessness/mistakes
	Cognitive error (due to deficient expertise and/or risk understanding)
	Error directly connected to poor/deficient design
	Error connected to breach of applicable practice /procedures
Organization	Company management, facility management
	Work management
	Risk assessment/analyses (SJA, etc.)
	Planning/preparation
	Procedure/documentation
	Work practice/operational follow-up of the barriers
	Work load
	Inspection /check / verification
	Communication /cooperation/interfaces
	Competence / training
	Goal conflicts – safety/efficiency
	Change management
Technology	Technical well design (cement, plugs, casings, etc.)
	Technical fault in. or inadequate detection of well kick
	Technical fault /weakness in primary barriers/mud column
	Technical fault/weaknesses in secondary barrier/BOP
	Other technical equipment fault or weaknesses in safety-critical equipment
	Ergonomics/human-machine interface/design of workplace
	External causes – geology and reservoir

the unit, and to mitigate the frequency or the severity of global and local design ice actions on an offshore installation. Ice management can be used to alter the ice regime, through decreasing the floe size or deflect the incoming ice. It can serve as a safety function and increase the redundancy in the system, and thereby increase the operability. The main ice management objectives are to detect, evaluate and deflect all potential ice threats, to facilitate reconnection and assist under evacuation and disconnection by clearing the potential escape routes for Emergency Evacuation and Rescue (EER) craft. An ice management system may therefore include *ice detection, tracking, phys-*

ical ice management such as ice breaking, ice clearing and iceberg towing.

8.3 Main concerns related to maritime, offshore and land based activities in the Arctic

According to PSA, the key safety challenges facing Norway’s petroleum sector are:

- “The industry must work purposefully to prevent accidents which can cause acute discharges”

HAZARD	CAUSE	POSSIBLE CONSEQUENCE	BARRIERS AND RISK REDUCING MEASURES
General Concerns			
– Late decision	– Human error, conflicting goals	– Wrong decision	– Procedures, responsibilities, decision criteria
– Wrong decision	– Human errors, conflicting goal	– Ice management failure	– Procedures, responsibilities, decision criteria
– Monotonous operation	– Crew fatigue	– Reduced effect of IM and increase in risk	– Vessel tracking, increased manning, off course alarm, use of auto pilot
– Scouting vessel not performing task	– Inexperienced crew	– Misidentify dangerous ice	– Experienced crew, training schemes, quality of ice identified by scouting vessel only, ice bergs may be detected by helicopter, radar etc. Use UAV, sonar permanently installed at bottom in future
– Insufficient data	– Difficult to detect and evaluate incoming ice	– Wrong decision, maybe decide shut down, additional cost	Us several different sources
– Threat not understood	– Physical and geometrical properties of ice features not investigated	– Dangerous ice approaching zone 2 where IB may not be able to handle it	– Ice monitoring, experienced crew, measuring sail high, immediate reporting and communication and use same terminology
Insufficient data	– Scouting not efficient	– Incorrect decision taken	– Better planning of operation, better SAT imagery.
Methods fail	– Communication failure	– Wrong tracking trajectory	– Common terms and criteria. Standardized maps
Loads wrongly monitored	– Error on monitoring system	– Overload on risers, Wrong feedback to IM operation	– Data from multiple systems
Lack of limited ice information	– Difficult to detect and evaluate incoming ice	– Late or wrong detection of ice	Use several different sources
No satellite data	Weather condition, fog	– Late detection of approaching ice features, late mobilization	Ice radar, scouting vessels, possible to optimize image, correct resolution

- *“Management at all levels of the industry must work to reduce major accidental risk, and ensure that this work is pursued in an integrated manner”*
- *“Safety barriers must be maintained in an integrated and consistent manner in order to minimize the risk of a major accident.”*

Human error, malfunction of equipment due to lack of proper maintenance or production error, or other underlying causes such as lack of international regulations and best industry practices and the missing standardization which may contribute to a sudden accidental uncontrolled blowout are other identified issues.

A large blowout may result in injuries and even fatalities. However, it may also result in a large oil spill. The size of the oil spill depends

on factors such as the relief well capabilities, the management system efficiency, the size of the reservoir, the remoteness of the exploration/production site.

Although the scenario is very unlikely due to several barriers such as blowout preventers, cement casings, etc. the consequences could be high in terms of injuries and environmental pollution.

Thus, prevention measures and barriers should be implemented in order to reduce the risk level to as low as reasonably practicable. The importance of safety culture is well documented in literature, as is that the underlying cause of an accident is very often related to human errors. It is therefore important to make sure that management at all levels of the industry work to reduce major accidental risk. Good communication and decision making

Table 8-2 *Ice Management State of the Art Report Barents, ref./51/*

are essential in order to ensure that this work is pursued in an integrated manner. Human resources and competence will be further discussed in Chapter 9.

Risk-based methods are also important for the industry in order to find the most critical links, so that effective prevention barriers can be identified. Proactive approach and reactive approach based upon root cause investigation of major incidents are important to identify the need for new barriers where gaps exist. A common sharing platform, where incidents, best practices and recommendations can be reported and easily available for all the Arctic countries may be of great importance during an external risk assessment.

Offshore industry blowout, well-head or pipeline rupture may be considered as two of the main concerns. The reasoning behind this statement is that the consequences are catastrophic. This is well documented in several reports published after the Deepwater Horizon drill rig accident in the Gulf of Mexico. E.g. internal corrosion, permafrost, old pipelines, lack of maintenance and late detection of pipeline rupture may result in oil spills with catastrophic consequences. Pipeline rupture or pipeline leakage may result in huge oil spills if not detected in a timely manner. Prevention barriers, such as internal and external detection devices, are important to reduce the consequences if a rupture of a pipe or a leakage in the well-head system, small boards, valves, or flanges may occur. Late detection, inefficient decision-making and late response may cause a moderate oil spill to escalate to a catastrophic oil spill.

Offshore operation in areas with drifting sea ice and icebergs will need a design capable of performing disconnection if deemed necessary. If ice possessing a risk to the structure capacity or station-keeping abilities is entering the critical zone, and there is no time to deflect the incoming ice, the offshore structure needs to initiate a planned disconnection. However if the incoming ice is detected too late, there is a high probability that the disconnection will result in damage to the systems and equipment which may result in an unwanted, uncontrolled oil spill.

Grounding, hose rupture or damage to the manifold system during cargo loading or

fuel transfer, may be considered as the main general concerns for maritime activity in the Arctic areas.

High energy groundings have the potential to penetrate the vessel's bottom structure and further breach into the cargo tanks(s). The consequences may be a large release of oil into the water. However, the vessel will most probably hit the bow or fore part of the bottom structure first if the grounding/stranding is a result of navigational failure. Poor navigational information and many shallow spots cause the risk of grounding to be relatively high in comparison with other areas in the world. The risk of grounding is high, even though there is often high positioning accuracy. This is because the charting is poor and it is difficult to determine the depth. Collision with other vessels is slightly less likely in the Arctic due to the remoteness and minimal traffic.

A high energy collision has the potential to penetrate the vessel's side and further into the cargo tank(s). We may differentiate between damage to the hull caused by ice, and damage caused by vessel-vessel interaction or vessel-structure interaction. The consequence may be considered as equal for both scenarios however damage to the hull caused by ice may be more likely than damage caused by collision with another offshore structure or vessel.

The mechanisms of a high energy collision will most likely result in immediate oil leakage. The size of the oil leakage will depend on several factors, but is limited to the amount of oil carried by the vessel, and how many cargo tanks are damaged. Worst case scenario includes severe damage to several cargo tanks. The consequence of an oil spill will be dependent on several factors: the location, the response time, the type of oil disposed to the sea and the cargo volume. The consequence will be less catastrophic for an oil spill from a ship than from a blowout, since the oil spill is limited by the amount of cargo or fuel stored in the vessel.

Due to human error, station-keeping problems, malfunction of equipment, production error and lack of maintenance, a large leak in the flange connection or a hose rupture may contribute to a serious oil spill. Other underlying causes such as lack in interna-



tional regulations and best industry practices on bunkering may contribute to leaks at the connection point (manifold).

The size of the oil spill will depend on the size of the damage (hole), filling rate and the detection and isolation time of the system.

Pipeline rupture may be considered as one of the main concerns for land-based activities in the Arctic areas. Rupture may be caused by internal corrosion, material defects, permafrost, ground erosion and tectonic movements on the sea bottom, poor maintenance due to lack of infrastructure and pipe damage caused by ice, contact with ship anchors and bottom

trawls. The likelihood of pipeline rupture is considered likely however new technology and several barriers may allow oil leakage to be detected before the oil is visible on the sea surface. Due to new technology and detection devices, the consequences of pipeline leakage are moderate, however a pipeline rupture caused by ice damage may be considered more serious. The reasoning behind this statement is the fact that rupture may cause a larger damage to the pipeline, hence a larger hole and the possibility for a larger oil spill than what a leakage may provide.



9 Human Resources and Competence

The human factor is one of the main causes for accidents, hence a careful evaluation of the human factors and best practices are vital when considering oil spill prevention. Inexperienced crew, lack of routine and quick decision-making are factors that may be crucial when short response time is required to prevent an incident from escalating to a major environmental accident. Lack of competence is a major hazard and focus on education and development of highly skilled crew with special competence and knowledge of operation in extreme conditions are important. Lack of competence may contribute to hazardous navigation, and damage to equipment which needs special attention prior to entering cold waters. Due to the extreme conditions, new technology may be used and the crew would need to be familiar with the systems to efficiently use them. In order to achieve a high level of competence, education, continuous training and courses are important. It is further important that guidelines and practical procedures be readily available.

9.1 Safety Culture

A good safety culture on all levels in an organization is vital to prevent oil spills. What is most important, according to the *Macondo Well Deepwater Horizon Blowout, Lessons for improving offshore drilling safety report*, ref./40/, is that:

“every company involved – including operators and partner companies, drilling contractors, and equipment and service providers-develop, promote, and operate in a system safety cul-

ture embraced by top management and implemented in every phase of drilling operations.”

A positive safety culture, according to the *Review of offshore drilling in the Canadian Arctic*, ref./41/, is characterized by “... *communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventative measures*”. It could also be characterized by the organisation’s willingness and ability to understand and manage activities so that safety is taken into account.

An organisation’s safety culture is made up of beliefs, values, attitudes and perceptions, competence and patterns of behaviours for safety. Due to the fact that the safety culture is important for the overall risk picture of an organisation, best practices to increase the safety culture may increase the awareness of its importance. However, changing people’s beliefs, values, attitudes and behaviours may be a time-consuming process; however constant reminding and focus on safety at ALL levels in the organization, from the board room to the rig, may contribute to an increased safety level.

The *Review of offshore drilling in the Canadian Arctic*, ref./41/, suggests that one of the causes of Piper Alpha, Montara blowout, Ocean Ranger and Macondo well blowout accidents was the lack of safety culture in the organisation. An overall international, national and local culture may therefore focus on increasing the safety culture in all levels in the organisation. It may further be concluded that a strong safety culture emphasizes the importance of understanding and learning from past incidents and accidents.

An effective safety culture embodies the following generic traits according to the *Macondo Well Deepwater Horizon Blowout, Lessons for improving offshore drilling safety report, ref./40/*:

- *“Leadership, safety values and actions:* Safety is treated as a complex and systemic phenomenon. It is also a genuine value that is reflected in the decision-making and daily activities of an organisation in managing risks and preventing accidents.
- *Personal accountability:* All individuals take personal responsibility for safety and contribute to overall safety.
- *Problem identification and resolution:* Issues potentially affecting safety are readily identified, fully evaluated, and promptly addressed and corrected.
- *Work processes:* The process of planning and controlling work activities is implemented so that system safety is maintained. The most serious safety issues get the greatest attention.
- *Continuous learning:* Opportunities to learn about ways to ensure safety are sought out and implemented by organisations and personnel. Hazards, procedures, and job responsibilities are thoroughly understood. Safety culture strives to be flexible and adjustable so that personnel are able to identify and react appropriately to various indications of hazard.
- *Environment for raising concerns:* A safety-conscious work environment is maintained, where personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment, or discrimination. They perceive their reporting as being meaningful to their organisations and thus avoid underreporting.
- *Effective safety communication:* Communications maintain a focus on safety. Knowledge and experience are shared across organisational boundaries, especially when different companies are involved in various phases of the same project. Knowledge and experience are also shared vertically within an organisation.
- *Respectful work environment:* Trust and respect permeate the organisation.
- *Questioning attitude:* Individuals avoid complacency and continuously challenge existing conditions and activities to identify discrepancies that might result in unsafe conditions. A subordinate does not hesitate to question a supervisor, and a contractor employee does not hesitate to question an employee of an operating company.”

The key to achieving a safety culture is, according to IMO, ref./77/, in:

- *“Recognizing that accidents are preventable through following correct procedures and established best practices*
- *Constantly thinking safety; and*
- *Seeking continuous improvement “*

A paper issued by the International Shipping Federation on Safety Culture, ref./78/, states that the key to achieving a safety culture is:

- *“Recognizing that all “accidents” are preventable and normally only occur following unsafe actions or a failure to follow correct procedures*
- *Constantly thinking safety, and*
- *Always setting targets for continuous improvement“*

The paper further suggests three components that are highly relevant for implementing a safety culture:

- Commitment from the top
- Measuring the scale of the problem
- Changing behavior

According to the *Macondo Well Deepwater Horizon Blowout, Lessons for improving offshore drilling safety report, ref./40/*:

“Industry, BSEE, and other regulators should foster an effective safety culture through consistent training, adherence to principles of human factors, system safety, and continued measurement through leading indicators.”

The *Macondo Well Deepwater Horizon Blow-out, Lessons for improving offshore drilling safety report*, ref./40/, provides several generic traits. They are provided in the box below.

Safety culture is closely linked to the philosophy underlying the IMO, ISO Code. According to the paper issued by the shipping Federation on Safety Culture, ref./78/, the proper implementation of the ISM Code should result in a safety culture.

9.2 Training

Basic training is required before personnel is allowed to work offshore. The minimum required course includes a basic safety and emergency course and various different company standard courses. For Arctic operations, these courses have to include necessary skill and competence about and how to deal with the additional Arctic challenges.

DNV has developed a standard for certification of courses developed for ship officers. The standard is called *Competence of officers for Navigating in ice*, issued 2008, ref./55/.

The standard focuses on the performance-areas of the ship's officer who is responsible for operations, course and speed of a vessel in cold weather conditions (below 0°C) and/or in ice-infested waters, from the moment the order is received to proceed to such an area, or when the voyage plan is made, to when the vessel leaves the area. The standard focuses on navigational and normal operational issues, with the crew remaining on board the vessel. Emergency evacuation and personal survival techniques in cold weather are not part of the scope. The standard comprises a set of competence requirements for navigating different ice-infested areas and ice conditions throughout the world.

Training of personnel should address fatigue and stress management, acclimatization, the potential for other illness to impact on tolerance to extreme cold, nutrition, clothing requirements, preventive practices, actions to be taken in the event of hypothermia, etc., and basics of body temperature and heat exchange.

In emergency situations, quick decision-making may be crucial in order to prevent an incident to escalate into a major

accident. Training and awareness of possible outcomes may be one of the keys to efficient decision-making. The need for HAZID analysis is important so that mitigation measures can be implemented, however; it is equally important that the information gained is easily available for all persons that it may involve. Distribution of information and preparation of the crew prior to any hazardous operations is important. HAZID information sharing may therefore be something that may increase the awareness and prepare the crew when emergency situations occur.

9.3 Routines and Checklists

Good routines and checklists may act as barriers, however; it is vital to know the functional requirements behind the procedures so that correct measures can be taken if the system fails. Activities in the Polar waters have contributed to an increased level of competence and experience. However there is still a lack of experience and it is therefore suggested that there may be a need to shift from prescriptive to performance-based regulations when moving into Arctic areas. Hence the need for clear routines and checklists to satisfy the functional requirements may be difficult to develop. The harsh climate makes good routines increasingly important. It may also be difficult to maintain routines as a lot of the activities are seasonal.

Because of the lack of operational experience in Arctic waters, it is important to have readily available checklists and/or a manual identifying main concerns and hazards that the crew needs to be aware of. This important tool may help to prevent hazardous situations.

Routines come with experience and as resource development activities increase in Polar waters, the level of experience and routines will also increase.



10 HSE and Risk-Based Management System

Risk-based methods have been applied in order to find the most critical links in production and transport chains for installation of effective barrier systems. A regime going from periodic maintenance intervals to a more risk and monitoring based maintenance regime also applies for barriers.

The objective of an HSE system is to ensure optimal health, safety, performance and decision-making of people working on marine and offshore structures and installations in Arctic environmental conditions. Additional requirements are needed to ensure safe working conditions in the Arctic regions due to the challenging climate. One of the Barents 2020 working groups focused on how to mitigate risk to health, of accidents and human work capacity due to Arctic environmental conditions. Physical environment and safety of workers in cold climate, risk of accidents from accumulation of ice and snow, impairment of physical tasks and work efficiency, fatigue and impairment of complex mental tasks, cognition and decision-making, first aid and medical provision were all topics addressed and discussed.

Further, the *Barents 2020 report*, ref./1/ suggests functional standards for safety of outdoor work in cold climate and according to the report, operators should develop and implement a work regime/system for outdoor work according to the wind chill index, and should define the type of work, the length of time that workers may be exposed to the cold climate, types of clothing and protective gear, and personnel monitoring and surveillance. For work under extreme cold conditions, a

work permit and a risk assessment are two risk control measures which may be implemented by the operator.

10.1 HSE Definition

Since 1950, the International Labour Organization (ILO) and the World Health Organization (WHO) have shared a common definition of occupational health. It was adopted by the Joint ILO/WHO Committee on Occupational Health at its first session in 1950 and revised at its twelfth session in 1995. The definition reads, ref./74/:

“Occupational health should aim at: the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities; and, to summarize, the adaptation of work to man and of each man to his job.

The main focus in occupational health is on three different objectives:

- 1. the maintenance and promotion of workers' health and working capacity;*
- 2. the improvement of working environment*

HAZARD	POSSIBLE CONSEQUENCE	EXISTING SAFEGUARDS AND BARRIERS	RISK REDUCING MEASURES/COMMENTS
Recommended key HSE risk reducing measures			
Low temperatures	Hypothermia, cold-related injuries and diseases (cold allergy, peripheral neuropathy, peripheral vascular disease, white fingers, unwanted effect of medications)	Protective clothing and survival suits (emergency evacuation suits), medical checks and examination (OGP Report no. 398), routine checks throughout the working period, wind chill index	Safety culture, easy access to protective clothing, increased information about hazards related to low temperatures, routine controls, introduce allowable limit of time crew can be exposed to cold temperatures, adequate medical care (nurses, supply, communication, staffing), try to avoid maintenance in cold weather
Slippery surfaces	Injuries	Antifreeze systems (heating cassettes, manual removal of ice, hot water systems etc.), railings, signs, passive winterization system (built-in areas, cover)	Safety culture, routine checks of areas exposed to icing, no running allowed
Falling ice	Injuries, death	Routine checks of areas exposed to ice accretion, passive winterization system (built-in areas, cover)	Get approval to remove hazardous ice
Fatigue and imperilments of mental tasks cognition and decision-making	System failure, collision, grounding, etc.	Appropriate medical surveillance routines. personnel selection guidelines, training addressing their own health and safety as well as that of their co-workers	Work/rest regimes, short breaks in warm environment. Due to physical and mental challenging environment an Arctic health fitness assessment shall be undertaken prior to work in Arctic climate, at routine intervals throughout the working period, and whenever deemed necessary.
Physical tasks	System failure, collision, grounding, etc.	Limit the amount of working hours in harsh environment	Regular, short breaks in warm environment

Table 10-1 HSE hazards and risk-reducing measures and barriers

- and work to become conducive to safety and health, and;*
- the development of work organizations and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance productivity of the undertakings. The concept of working culture is intended in this context to mean a reflection of the essential value systems adopted by the undertaking concerned. Such a culture is reflected in practice in the managerial systems, personnel policy, principles for participation, training policies and quality management of the undertaking.”*

10.2 Management System standards

The HSE management system should be risk-based, including monitoring, experience feedback and updated when necessary.

The ISO 14000 family addresses various aspects of environmental management and

it provides practical tools for companies and organizations looking to identify and control their environmental impact and improve their environmental performance. The very first two standards, ISO 14001:2004 and ISO 14004:2004 deal with environmental management systems (EMS). ISO 14001:2004 provides the requirements for an EMS and ISO 14004:2004 gives general EMS guidelines.

The other standards and guidelines in the family address specific environmental aspects, including: labelling, performance evaluation, life cycle analysis, communication and auditing.

10.3 HSE hazards

Table 10-1 presents an example of HSE hazards and risk-reducing measures and barriers.

10.4 Barrier management

A basic requirement is that facilities be operated and maintained within the current design

envelope to ensure the sound performance of Safety Critical systems, functions and Equipment (SCE) that form barriers. This means that functionality, integrity (reliability / availability) and vulnerability requirements should be maintained in a fit-for-purpose condition throughout the life of the facility by appropriate testing and maintenance programmes.

Each physical barrier should have a Performance Standard. A Performance Standard is a statement of **what the barrier is designed and expected to do**. A performance standard includes the overall measures of suitability and efficiency of the safety systems/functions to carry out their designated role.

- Functional criteria will include appropriate definition of and requirements to the relevant functional parameters of the particular barrier; i.e. the essential duties that the system/function is expected to perform.
- Integrity criteria will include appropriate definition of and requirements to the relevant reliability and availability parameters of the particular barrier; i.e. probability of failure on demand, failure rates, demand rates, test frequencies, deterioration of system components, environmental impairment, etc.
- Survivability criteria determining how a barrier will remain functional after a major incident, i.e. under the emergency conditions that may be present when it is required to operate.

The Norwegian PSA expectations to a Barrier Management system, Management Regulation §5 defines that:

“Barriers shall be established that:

- a. reduce the probability of failures and hazard and accident situations developing,*
- b. limit possible harm and disadvantages.*

Where more than one barrier is necessary, there shall be sufficient independence between barriers.

The operator or the party responsible for operation of an offshore or onshore facility shall stipulate the strategies and principles that form the basis for design, use and maintenance of barriers, so that the barriers’ function is safeguarded throughout the offshore or onshore facility’s life.

Personnel shall be aware of what barriers have been established and which function they are intended to fulfil, as well as what performance requirements have been defined in respect of the technical, operational or organisational elements necessary for the individual barrier to be effective.

Personnel shall be aware of which barriers are not functioning or have been impaired.

The responsible party shall implement the necessary measures to remedy or compensate for missing or impaired barriers.”



ROYAL ARCTIC LINE

IRENA ARCTICA
AALBØRD

11 Monitoring

Arctic challenges add risks to the existing safety risk picture. Drifting icebergs and ice floes, seasonal ice cover, polar lows and reduced visibility require trustworthy, efficient and safe surveillance, monitoring, and management systems. According to *Barents 2020*, ref./1/, there is a lack of sufficient data on ice and icebergs, and less knowledge about the physical environment. It introduces larger uncertainties in the estimates of values with annual recurrences of 10^{-2} and 10^{-4} .

“It will take several years until the data uncertainties for the Barents Sea have reduced to the same level as in the North Sea. Until more extensive databases have been established,

design and operational planning must take the uncertainties into consideration”, ref./1/.

Maritime monitoring can be useful to detect oil spills or a break of navigation rules, maritime incidents and accidents, ice conditions, extreme weather conditions and can be employed as a deterrent.

Examples of topics and projects related to maritime monitoring systems in operation identified in the scoping workshop in Oslo in October 2011, ref./9/, were:

- AIS satellite
- Sjöbasis

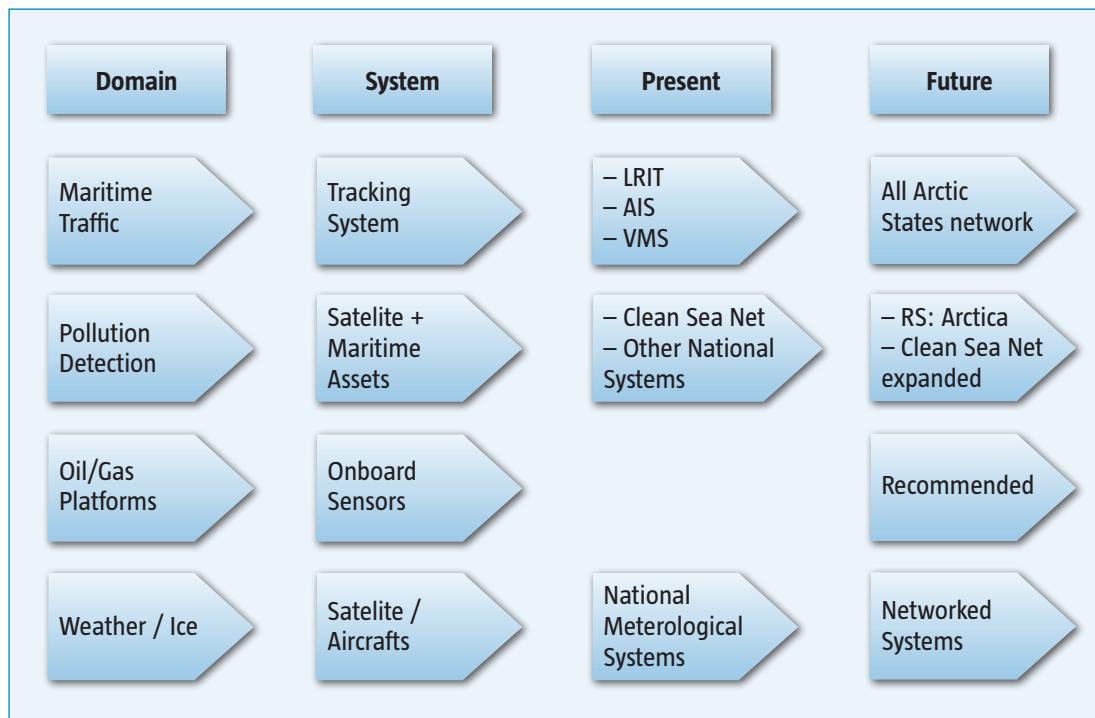
The *Barents 2020* report suggests the following recommendations to improve operational issues, ref./1/:

- *“Improve weather, ice and iceberg forecasts by improving observational networks for weather forecasting and metrological databases for the Barents Sea*
- *Implement management of sea ice and icebergs around installations (surveillance, tracking, forecasting and mitigation)*
- *Implement procedures for allowable operations in areas with sea ice or icebergs*
- *Establish methods for inspections of subsea equipment in areas with sea ice”*

According to the *Barents 2020*, ideally one would like to, ref./1/:

- *“Harmonize data collection with actual needs for design and operations. Measurements programs may be quite different in their objectives and scope*
- *Have common guidelines on how to classify ice types and glacial ice*
- *Have common guidelines on how to measure various ice parameters, set-up of the measurement program, requirements to accuracy and repeatability*
- *Have guidance to how to interpret the data, a checklist with possible pitfalls, requirements for representativeness and for documentation*
- *Have common classification of ice types and glacial ice.”*

Figure 11-1 Workshop
Iceland Maritime Surveillance Work Group



- Marsuno
- Nordreg (Canada, mandatory reporting system)
- Russian reporting system
- BAREP, Norway and Russia will take a joint reporting system to IMO
- AAmverNet
- Clean sea net

A set of recommended surveillance/monitoring best practices and systems was described during the workshop at Iceland, 2012;

- Network existing (and future) surveillance systems
- Encourage use of platform-based sensors
- Perform risk analysis to assign surveillance resources
- Advertise existence of monitoring systems to better deter pollution

It was further concluded during the workshop that to enhance ship safety there is a need for better determination of ice thickness, perhaps with shipboard equipment. The Prince William Sound reporting system is mentioned. A combined satellite based oil spill/dischARGE/monitoring system similar to the COSPAS/SARSAT system-coast sharing was suggested as a surveillance and monitoring possibility.

Maritime ship reporting systems identified during the workshop at Iceland were the following:

- International Association of Antarctic Tour Operations ship reporting system
- Gulf of Finland Reporting System
- Automatic Mutual Assistance Vessel Rescue System (AMVER/USCG)
- Greenland Ship Reporting System

12 Questionnaire

The questionnaire is based on the topics identified in the scoping workshop arranged in Oslo in 2011 and covers in general the topics described in chapter 3. The questionnaire covers Arctic offshore O&G operations, maritime shipping, land-based industry. The focus is the additional risk involved when developing new and large Arctic O&G fields and the related activities, shipping and land-based activity. Existing mandatory rules and requirements are not included in the analysis and the main objective is to learn more about the experience and most important issues identified by the industry. Possible best practices developed by the industry itself in order to reduce identified risks will also be included.

Finally, the aim is to share these best practices and if found expedient forward to regulatory bodies for future implementation in rules and regulations.

Operational experience from the more extreme Arctic is limited thus far, but a lot of work has been done in planning and collecting experience from operations in the “easier” parts of the Arctic. Generally, the ways of operating in warmer areas are brought into the Arctic but adapted to the additional Arctic challenges, the Δ -Arctic. Here, as in the whole report, focus is on the additional Arctic challenges and not those generally applicable and used in non-Arctic areas.

Persons with relevant experience/competence from Arctic development projects have been interviewed and the general findings are;

- Additional Arctic risks “All Arctic challenges” include, but are not limited to: low temperatures, darkness, ice, limited knowledge regarding the geology, communica-

tion, permafrost, scouring, sparse or poor bathymetric information, rapidly changing conditions, remoteness, isolation, lack of infrastructure and support facilities, human factors and lack of access to experts and less experience.

- It was identified that there is a lack of competence and a need for Arctic-specific training requirements and procedures. There is a lack of proper understanding of the risks related to the operation. Hence there is a need for documentation of basic competence, skills and their ability to work in remote areas. It was mentioned that there is a need for a robust training and qualification document which identifies each position, its responsibilities, minimum qualifications, skills and training required as well as minimum number of people for each position. It was also highlighted that the operators should be responsible for training and that all subcontractors participate in training activities.
- There is a need for further technology development due to all the Arctic additional challenges. It was also stated that there is lack of data (met-ocean data) and easy excess to information (previous experience, best available technology, practices, incidents etc.). In this regard the need for sharing of information, results, new best available technology and previous experience were identified as important.
- It was further concluded that there is a lack of consistency between standards and national requirements and that there is a need for more international common standards. It is also stated that that the enforcement



of rules and regulations is not consistent among regulators and nations. Rules and regulations need to be more robust and a combination of prescriptive and functional (goal-based) requirements was deemed the best solution.

- The HSE systems have to be adapted to the Arctic conditions with main focus on winterization of people and equipment. A good integrated management system is needed (ref. the Arctic Offshore Drilling Review) with proper understanding of the risk related to the operation (ice loads, cold climate etc.). Good attitudes towards reducing risk and preventing discharge of oil at all levels in the organization are identified as important.
- Winterization needs to be designed and documented case by case depending on the actual operation. Performing a risk analysis/HAZID will help to adapt the best method for winterization.
- HAZID and risk assessment for identification of possible non-compliance and continuous improvement of the management system are regarded as important.
- Offshore loading of oil in ice infested waters is regarded as one of main hazard related to maritime transport of oil in the Arctic. Ice management is identified as a

risk reducing measure; however that more research are needed in this area.

- There is a need for combining data from different monitoring sources to improve the quality and efficiency. Further development and improvement of e.g. satellites and satellite images is needed; however the costs are identified as a limiting factor.
- UAV and subsurface vehicles are assumed/expected to increase in the future.
- There should be a functional requirement opening up for alternative solutions to same relief well capability.
- Robustness, reliability, and redundancy in people, practice, and policies as well in tools and technology.
- It was stated that there is a need for a centralized communication and onshore process monitoring and that there is a need for a database with links to R&D projects, results, people and institutions including data and results to improve the efficiency and outcome of future projects.
- It was also stated that we should work towards a more circumpolar cooperation regulatory forum.

More details about the answers are presented in Appendix III.

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Appendix I

Past and present work by PAME in relation to marine pollution

Past Work by PAME in Prevention of Marine pollution that may contribute to the EPPR RP3 work:

- AMSP. Arctic Marine Strategic Plan, 2004 (Promotes basic principles and ecosystem based management-EBM is a basic tool for prevention of marine pollution and its negative consequences) <http://www.pame.is/arctic-marine-strategic-plan>,
- TROOPS. Guidelines for Transfer of Refined Oil and Oil Products in Arctic Waters, 2004 (covers fuel transfer in local communities--one of the largest sources of petroleum and associated compounds in the Arctic; in English, French, Russian and Inuktitut) http://www.pame.is/images/stories/PDF_Files/Doc_lib/OilandGasReports/TROOP%20-%20English%202.pdf,
- RPA. Regional Program of Action on Land Based Sources of Pollutants, 2009 (covers non-marine sources of pollution of the marine environment-English and Russian) <http://www.pame.is/regional-programme-of-action>,
- BPOMAR. Best Practices in Ecosystem-Based Oceans Management in the Arctic, 2009 (case studies of Arctic EBM. EBM is a basic tool for prevention of marine pollution and its negative consequences) http://www.pame.is/images/stories/Ecosystem_Approach/SDWG-PAME_Best_Practices_in_Ecosystem_based_Oceans_Management_20091.pdf, \ref.5\
- AOOGG. Arctic Offshore Oil and Gas Guidelines, 2009 (guidelines and best practices--operational and managerial) <http://www.pame.is/images/stories/FrontPage/Arctic-Guidelines-2009-13th-Mar2009.pdf>
- AMSA. Arctic Marine Shipping Assessment, 2009 (many recommendations for prevention of pollution in the marine environment and spawned a series of follow-up projects also addressing prevention) <http://www.pame.is/amsa/amsa-2009-report>,
- AMSA Status Report 2011. Arctic Council Status on Implementation of the AMSA 2009 Report Recommendations (contains a detailed look at what has been accomplished and what needs to be done in implementing the recommendations) http://www.pame.is/images/stories/AMSA_Status_on_Implementation_of_the_AMSA_2009_Report_Recomendations-May_2011.pdf
- HFO Phase I. AMSA I(B) Enhancing Arctic Marine Safety: Heavy Fuel Oil in the Arctic Phase I, 2010 (an assessment of the use and carriage of HFO and baseline for risk assessment and gap analysis leading to Recommendation in Phase II see below) http://www.pame.is/images/stories/Phase_I_HFO_project_AMSA_rec_IBFinal_report.pdf
- AOR Phase I. Arctic Ocean Review Phase I 2011 (a review of global and regional measures that are in place for the conservation and sustainable use of the Arctic marine environment and an analysis of their ef-

fectiveness) http://www.aor.is/images/stories/AOR_Phase_I_Report_to_Ministers_2011.pdf,

On-going Work in PAME for the Prevention of Marine pollution:

- HFO Phase II. AMSA I(B) Enhancing Arctic Marine Safety: IMO Measures for Arctic Shipping Heavy Fuel Oil in the Arctic Phase II (Develop recommendation(s) to the Arctic Council in the Spring of 2013 for action by member governments regarding possible additional or supplemental international actions or regulations for the purpose of mitigating or minimizing the risks associated with the use or carriage of HFO in the Arctic Ocean.) <http://www.pame.is/pame-work-plan-2011-2013>
- Polar Code. AMSA I(B) Enhancing Arctic Marine Safety: IMO Measures for Arctic Shipping: Polar Code in IMO (working with IMO representatives from Arctic countries in developing a binding Polar Code) http://www.pame.is/images/stories/AMSA_Status_on_Implementation_of_the_AMSA_2_009_Report_Recomendations-May_2011.pdf
- Cruise Ship Safety. AMSA I(D) Enhancing Arctic Marine Safety: Strengthening Passenger Ship Safety in Arctic Waters (Monitor and support IMO initiatives to strengthen passenger vessel safety. Take actions to encourage the Arctic cruise tourism industry to adopt new, or update existing, best practices for operations in the Arctic. Strengthening Passenger Ship Safety in Arctic Waters: Monitor and support IMO initiatives to strengthen passenger vessel safety. Take actions to encourage the Arctic cruise tourism industry to adopt new, or update existing, best practices for operations in the Arctic.) http://www.pame.is/images/stories/AMSA_Status_on_Implementation_of_the_AMSA_2_009_Report_Recomendations-May_2011.pdf
- Significant Areas. AMSA II(C) Protecting Arctic People and the Environment: Identification of Areas of Heightened Ecological and Cultural Significance (a report and GIS database by AMAP, CAFF and SDWG will be presented to PAME with areas identified and evaluated against the IMO PSSA criteria). Due end of 2011 final Report by April 2012 http://www.pame.is/images/stories/AMSA_Status_on_Implementation_of_the_AMSA_2_009_Report_Recomendations-May_2011.pdf
- Specially Designated Areas. AMSA II(D) Protecting Arctic People and the Environment: Specially Designated Arctic Marine Areas (will use AMSA II(C) Report findings and will explore the need for internationally designated areas for the purpose of environmental protection of the Arctic Ocean from shipping in areas beyond national jurisdiction) TOR by PAME I 2012 <http://www.pame.is/pame-workplan-2011-2013>.
- MREWIR Project. Management, Regulation and Enforcement Web-based Information Resource (MREWIR Project (a web site for national and regional regulatory authorities for Arctic offshore oil and gas activities that will facilitate communication and knowledge of international offshore oil and gas activities and the regulatory regimes, an important step in preventing accidents and pollution) April 2-12 <http://www.pame.is/pame-workplan-2011-2013>
- EA/LME. Ecosystem Approach Sub working Group (is developing boundaries and content of Large Marine Ecosystems in the Arctic for use in management of human activities--EBM is a basic tool for prevention of marine pollution and its negative consequences) A concept paper that summarizes previous discussions and agreements on concepts and terminology related to ecosystem approach to management for discussion within the Ecosystem Approach Expert Group for submission to the PAME I-2012 meeting. <http://www.pame.is/ecosystem-approach>
- AOR Phase II. Arctic Ocean Review Phase II (will analyse information gathered in Phase I with an emphasis on areas where the Arctic Council can effectively add value to the existing global and regional instruments and measures in place for the Arctic marine environment, and will serve as validation for future direction of the Arctic Council in relation to the Arctic



marine environment. It will result in a final report with recommendations (2013) for endorsement by the Arctic Council Ministers.) <http://www.pame.is/pame-work-plan-2011-2013>, \ref.18\

Future Work in PAME for the Prevention of Marine pollution:

- HSEMS Project. Health, Safety and Environmental Management Systems and the Use of Best Operating Practices for Offshore Arctic Oil and Gas Drilling Activities—A Report and Possible Guidelines (HSEMS Project is to look at all of the national and industry HSE systems employed in the Arctic offshore and compile and compare them with an analysis of their

coverage and application, enforcement etc. and have a workshop to gain the input of the investigations into the Deepwater Horizon and other national and international processes (i.e. Canada's National Energy Board Hearings on Arctic oil and gas activities or the G20 Global Marine Environmental Program looking at ways to improve the management and safety culture in offshore activities prevention of marine pollution) A report will be made of the HSEMS workshop and the HSEMS comparison and analysis study, and possible Arctic Specific Guidelines may be developed accordingly). TOR at PAME I 2012. <http://www.pame.is/pame-work-plan-2011-2013>, \ref.19\



Appendix II

Risk tables

An identification of hazards related to offshore, maritime and land-based activities are summed up in the following table. Some of the most relevant, best available procedures and technology are also listed. The following table presents examples of some of the general barriers, causes, possible consequences, risk-reducing measures and safeguards for offshore, shipping and land-based activities.

The following chapters will therefore identify sources of risks (hazards) and risk treatments (barriers, risk reducing measures, etc.).

The lists of hazards are by no means complete, and several hazards and barriers are not mentioned.

Important sources of oil pollution, hazards and concerns identified during the workshop in Oslo, October 2011, are documented in the scoping workshop report, ref./9/.

The list is by no means exhaustive, however it highlight some of the main general barriers and safeguards.

Table 0-1 *Examples of general barriers and risk-reducing measures*

SAFEGUARDS, BARRIERS and RISK-REDUCING MEASURES
Personnel
– Mandatory practices, recommended practices and operation guidance and procedures
– Identification of critical safety positions and provide a job description
– Clearly defined monitoring practices and checklists
– Identification of human factors and propose controls
– Controlled training programs
– Central expert team and an information sharing platform
– Adequate technical authorities available on site
– Ensure all workers are aware of potential threats, hazards, and remedies
– Certification of personnel
– Safety culture
– Internal and external communication
– Risk assessment
– HAZOP, HAZID (Identification and analysis of potential hazards)
– Internal reporting of hazards, near misses, and incidents
– Incident investigation and reporting
– Redundant system (several barriers)
– Establish minimum requirements and conduct a gap assessment
– Certificate of Fitness
– Data system to monitor and analyse trends
– Repair and replacement programs
– Audits, reviews, verification, visual and manual inspections, maintenance and testing
– Update technical practices regularly
– Original Equipment Manufacture certificate
– Environmental Response Management Application (ERMA) ⁵
– Remote Operated Vehicles (ROV)
– Ice Management
– Schedule for drilling intervals
– Filing Requirements
– Operating Licence & Exploration Licence
– Develop, retain and maintain records, documents, procedures etc.
– Quality assurance program
– AIS

5 ERMA is an online mapping tool that integrates both static and real-time data for environmental responders and decision-makers so that they can make informed decisions for emergencies. ERMA Southwest and ERMA for the Arctic are in current development, ref./49/

HAZARD	CAUSE	POSSIBLE CONSEQUENCE	BARRIERS AND RISK REDUCING MEASURES
Weather			
Icing	<ul style="list-style-type: none"> – Cold weather – Wind – Sea spray 	<ul style="list-style-type: none"> – Icing on deck and superstructure – Vents and drain blockage – Raise the level of wave and current forces – Modify the buoyancy and stability 	<ul style="list-style-type: none"> – Anti-icing systems (Heating, Hot-water) – De-icing equipment – Covers – Lower speed – Change course
Restricted visibility	<ul style="list-style-type: none"> – Rain – Snow – Fog – Darkness – Iceberg 	<ul style="list-style-type: none"> – Collision 	<ul style="list-style-type: none"> – Radars – Lights on deck – Airborne surveillance and satellites – Common ice charts – Visual observation from ice breakers and in-situ observation – Good routines, procedures and guidelines – Infrared Cameras (FLIR Technology)
Pressure ice	<ul style="list-style-type: none"> – Wind and heavy ice cover 	<ul style="list-style-type: none"> – Stuck in ice, cause damage to the hull and stability problems 	<ul style="list-style-type: none"> – Synthetic Aperture Radar (SAR) – Icebreaker assistance
Vent and hose blockage	<ul style="list-style-type: none"> – Low temperatures 	<ul style="list-style-type: none"> – System failure 	<ul style="list-style-type: none"> – Low viscosity oil – Heating covers – Design systems for cold climate
Material failure	<ul style="list-style-type: none"> – Low temperatures 	<ul style="list-style-type: none"> – Equipment failure, structure failure 	<ul style="list-style-type: none"> – Design equipment/materials for cold climate, operational procedures
(High energy) collision/stranding/grounding			
Collision with installation	<ul style="list-style-type: none"> – Pressure ice – Sudden wind – Restricted visibility 	<ul style="list-style-type: none"> – Hull damage and damage to the installation – Oil spill – Explosions, fire 	<ul style="list-style-type: none"> – Procedures, – Safety culture, – Weather monitoring and alarms – Management Systems – HAZOP – Ensure all workers are aware of potential threats, – Central expert team – Communication between installation and vessel. Information sharing platform
Collision with another ship	<ul style="list-style-type: none"> – Towing operation – Convoy – IM – Sailing in leads – Increased risk to traffic management 	<ul style="list-style-type: none"> – Hull damage – Oil spill – Explosions, fire 	<ul style="list-style-type: none"> – Competent and educated crew – HAZOP, HAZID – Double hull – Ensure all workers are aware of potential threats, hazards, and remedies – Central expert team of competency – Information sharing platform /Increased level of communication
Grounding/Stranding	<ul style="list-style-type: none"> – Drifting sea ice – Pressure ice – Grounded iceberg 	<ul style="list-style-type: none"> – Damage to hull – Loss of stability – Oil spill 	<ul style="list-style-type: none"> – Safety Policy – Pilot in critical waters – Icebreaker assistance
Ice Collision	<ul style="list-style-type: none"> – Ice not detected – Ice condition not correctly predicted 	<ul style="list-style-type: none"> – Damage to hull – Oil Spill 	<ul style="list-style-type: none"> – Detection devices and system – Ice feature prediction systems (strength of incoming ice, thickness etc.) – Systems – Courses, training and field experience
Other			
Equipment failure	<ul style="list-style-type: none"> – Low temperatures – Fatigue – Overload – Poor maintenance 	<ul style="list-style-type: none"> – Explosion – Fire 	<ul style="list-style-type: none"> – Audits – Inspections
Shift work	<ul style="list-style-type: none"> – Fatigue 	<ul style="list-style-type: none"> – Poor communication and lack of shared information 	<ul style="list-style-type: none"> – Shorter shift periods – Procedures/meetings with sharing of information

Table 0-2 Hazard, barriers and risk-reducing measures for maritime activities

HAZARD	CAUSE	POSSIBLE CONSEQUENCE	BARRIERS AND RISK REDUCING MEASURES
Minor/Oil Spills			
– Fuel transfer to or from the drillship including transfer from the drill ship to other supporting vessels (e.g. anchor handler)	– Lack of maintenance – Lack of communication – Safety culture	– Minor oil spill on deck or on harbour	* – Checklists, visual inspections, testing, training, practice and direct and open communication. – No fuel transfer during HIGH RISK SITUATIONS without direct approval of OIM. – Alarms and emergency shutdown systems (ESD) – Emergency stop button – Identify critical stages, emergency procedures, etc. prior to fuel transfer – Procedures – Computerized maintenance programs may be a BAT for reporting and logging information after an inspection
-Fuel transfer to or from the OSRV, including transfers from these vessels to other supporting vessels such as work boats	– Lack of maintenance – Lack of communication – Safety culture	– Minor oil spill on deck or in harbour	– See * – Pre-deployed boom
-Internal fuel transfers (emergency generator day tank and the incinerator day tank)	– Lack of maintenance – Lack of communication – Safety culture	– Minor oil spill on deck or in harbour	– Ref. *
-Helicopter transfer	– Helicopter bounded poorly	– Minor oil spill on deck or on harbour	– Ref. * – Proper alignment of fuelling facilities – Electrical bounding of the helicopter to the vessel – Proper alignment of ESD – Disconnect hot work on areas deemed necessary – Electrical bounding or grounding of the helicopter to the vessel
– Spills from drilling deck or spill from single rooms	– Lack of maintenance – Lack of communication – Safety culture – Blockage of drains	– Minor oil spill	– Floor drains around drilling deck, heating of drains to avoid ice blockage, and sufficiently large bilge tank
– Topping off	– Alarm failure – Broken sensors	– Minor oil spill	– Alarms, and “regularly” inspections and testing of equipment – Visual inspection and manual gauging of tank level – Valve control system – Float level gauge control system – Procedures stating that oil tanks never should be filled beyond effective capacity
– Un-tuned equipment	– Increased fuel consumption	– Small regular oil spill	Keep equipment tuned to reduce fuel consumption
– Minor damage to pipes	– Poor maintenance – Damage not detected	– Small regular oil spill – Oil spill	Wear and repair oil leaks
– Fuelling	– Damage to pipes	– Oil spill	Provide adequate fixed or portable containment around tank vents and under manifolds and plugging scuppers during fuelling
– Oil handling and repairs	– Lack of good procedures – Lack of safety culture and awareness	– Oil spill	Have absorbent pads available

Table 0-3 Hazard, barriers and risk-reducing measures of offshore operation

HAZARD	CAUSE	POSSIBLE CONSEQUENCE	BARRIERS AND RISK REDUCING MEASURES
Major Oil Spills			
Carrying of oil	–	– Oil Spill	Open containers should never be used to carry oil
Collision with ice	– Ice not detected – Ice condition not correctly predicted	– Damage to hull – Oil Spill	– Software to integrate ice speed and ice drift – FLIR technology – Alarm systems – Ice Management ⁶ – Monitoring and forecasting (metrological observations, on-site weather forecast, oceanographic observations, sea state forecast) – AIS
Offloading/ disconnection	– Emergency disconnection – Kick	– Damage to system – Oil Spill – Blowout	– Alarm systems – Procedures – Risk analysis (risk identification) – Inform the crew about the hazard – Estimate T-time so to prevent emergency disconnection – Automatic monitoring systems – Check systems which may have been influence by the cold climate prior to offloading (pre-planning) – Sufficient icebreaker support
Oil Blowout	– Kick – Available data from seismic operation and field measurements not interpreted and applied. – Poor maintenance	– Major oil spill	– Blow out preventer (controlling at least 150 percent of the max. anticipated pressure) – Mud column hydrostatic pressure – Wellhead housing – Casing – Cement and seal assemblies – Verify that the fluid density and volume in the wellbore are sufficient (BAP) – Proper design casing/cementing programs, drilling fluid systems and flexible well design (BAT) – Training, drills, risk identification, hazardous operation analysis and contingency planning (DWOP) – Software and well control simulators, and site-specific well– and dynamic control modelling – Pit drills and trip drills – Available data from seismic operations interpreted and applicable – Monitoring of drilling fluids (manual and automatic) – Flow check – Kick identification and detection – Measurements While Drilling Pressure While Drilling – Real time operation centre – Functional testing and pressure testing – Relief well drilling – Well capping – Drill string conveyed detection – Logging unit – Maintenance, inspections, repair and replacement programs

6 e.g. satellite-based (SAR), airborne, reconnaissance, icebreaker reconnaissance, ice forecasting, weather forecasting, detection, deflection, physical ice management (break the ice), estimation of T-time

Table 0-4 Hazard, barriers and risk reducing measures for land based activities

HAZARD	CAUSE	POSSIBLE CONSEQUENCE	BARRIERS AND RISK REDUCING MEASURES
Regular oil spills (minor)			
<ul style="list-style-type: none"> – Iceberg drifting – Poor maintenance – Failure in systems (high pressure) 	<ul style="list-style-type: none"> – Pipe damage 	<ul style="list-style-type: none"> – Oil spill 	<ul style="list-style-type: none"> – Internal methods use instruments to measure pressure, flow, temperature, sound, etc., of the gas, oil and/or water inside the pipeline. A SCADA system is used to collect data from the internal instruments. Computational pipeline monitoring (CPM) systems have been developed to analyse inflow and outflow product flow rates, mass, pressure, and sound for individual segments of a pipeline to detect and locate a pipeline leak.
Offloading	<ul style="list-style-type: none"> – Poorly maintained equipment 	<ul style="list-style-type: none"> – Oil spill 	<ul style="list-style-type: none"> – Checklist prior to offloading – Use of durable, high-quality lubricants
Accidental oil spills (major)			
Drifting icebergs in shallow waters cause harm to pips	<ul style="list-style-type: none"> – Pipes not buried – Permafrost etc. – Old pipelines 	<ul style="list-style-type: none"> – Damage to pipes 	<ul style="list-style-type: none"> – Double walls or thick cement casing – Located below the sea bed
Internal Corrosion	<ul style="list-style-type: none"> – Old, not maintained 	<ul style="list-style-type: none"> – Failure 	<ul style="list-style-type: none"> – Inspections if possible

Appendix III

Interviews

Telephone interviews with four operators were carried out and responses are included in the tables below:

Peter Velez	SHELL
Bharat Dixit	NEB
James A. Lusher	BSEE
Nina Skjegstad	STATOIL
Laurence Pinturier	TOTAL
Ian Dennes	Conoco Phillips

The answers are based on personal experience, opinion and knowledge of the interviewee and hence the responses do not represent official statements from the companies nor represent a complete answer.

NA means that the question is not considered relevant or the interviewee did not have

sufficient knowledge about the actual area to answer.

The unique Arctic environment introduces additional risks beyond what may exist for oil and gas exploration, production and transportation in Polar waters. Additional Arctic risks “All Arctic challenges” was identified; these include, but are not limited to:

Low temperatures, darkness, ice, limited knowledge regarding the geology, communication, permafrost, scouring, sparse or poor bathymetric information, remoteness, isolation, lack of infrastructure and support facilities, human factors and lack of access to experts.

The authors express thanks to the interviewees for their contribution to the questionnaire and for fruitful discussions.

	QUESTION	SUMMARY OF ANSWERS FROM INTERVIEWS
1.	Questions related to general concerns when developing Arctic oil fields, and during transport and storage of oil in the Arctic	
1.1	What do you think are the main hazards involved during the development of Arctic oil fields, transport and storage?	<ul style="list-style-type: none"> • Ice features; Multiyear ice • “All Arctic challenges” represents an additional risk and that they have to be considered • Lack of ice/met-ocean data in transition zones (open water/ice) • Rapidly changing conditions (weather, ice conditions etc.) • Limited knowledge regarding the geology
1.2	What are the main gaps and lack of measures that may reduce these risks? – technology, – competence, – procedures, – rules – regulations – etc.	<ul style="list-style-type: none"> • Lack of competence, need to have Arctic specific training requirements • Technology needs to be further developed and adapted to the Arctic conditions (Winterization) • Met-ocean data • Site-specific physical, biological and geo-science information • HSE system have to be updated to the Arctic conditions • Lack of consistency between standards and national requirements and follow up • Procedures need to be adopted to Arctic conditions • Good integrated management systems
1.3	What are the main hindrances for reducing the risks?	<ul style="list-style-type: none"> • Lack of proper understanding of the risk related to the operation • Attitude • Improper training • Economy • Lack of data (Missing or limited access to data). There is a need for sharing of information, results, new best available technology and previous experience • Lack of competence • More international common standards
1.4	Are the rules and regulations at the right level?	<ul style="list-style-type: none"> • Yes, however they are lacking behind the development in technology in some areas • Since companies add own requirements it can be assumed that the level is not adequate. • Rules and regulations need to be robust • Yes, but enforcement of rules and regulations is not consistent among regulators and nations
1.5	Should the mandatory rules and regulations be more functional or prescriptive?	<ul style="list-style-type: none"> • There is a consensus that a combination of prescriptive and functional is best
1.6	Does the seasonal time pressure on the operation represent a significant increase in the risk?	<ul style="list-style-type: none"> • The seasonal time pressure will to some degree represent an increased risk • The risk is expected to decrease with more experience from seasonal drilling
1.7	Is there a need for special focus on security in the Arctic?	<ul style="list-style-type: none"> • No, it is not expected to be a significant difference between worldwide operations and Arctic operations • Normal safety and security measures and provisions are applicable in the Arctic

	QUESTION	SUMMARY OF ANSWERS FROM INTERVIEWS
2.	Questions related to maritime transport of oil in the Arctic	
2.1	What do you consider as the main hazards related to maritime transport of oil in the Arctic? (On/off loading, navigation, convoy, broken channels, ice management and emergency situation)	<ul style="list-style-type: none"> • Sea ice is considered as the main hazard • “All Arctic challenges” represents an additional risk and that they have to be considered • Loading offshore in ice will require ice management, an operation with limited experience today
2.2	What are the main navigational challenges in the Arctic?	<ul style="list-style-type: none"> • Identification of actual ice conditions • Rapid change of weather/ice conditions • Lack of experienced and competent crew

	QUESTION	SUMMARY OF ANSWERS FROM INTERVIEWS
3.	Monitoring: The need and use of monitoring to prevent oil spills in the Arctic	
3.1	<p>Increased use of monitoring is expected in the Arctic. Which are the most commonly used monitoring systems/methods and what is your experience using monitoring systems related to;</p> <ul style="list-style-type: none"> – identify ice conditions – detect oil spills – detect violation of navigation rules – detect maritime incident and accidents – detect extreme weather conditions – deterrent, prevent illegal actions 	<ul style="list-style-type: none"> • Satellites are mainly used for ice information, but further development of the technology is needed to have more reliable information (e.g. ice thickness, ice properties, etc.) • An improvement of the quality of satellite images is needed for detection of oil spills in ice covered waters • There is a need for combining data from different monitoring sources to improve the quality and efficiency • Use of UAV and subsurface vehicles is expected to increase in the future • Costs may limit use and development of satellite information

	QUESTION	SUMMARY OF ANSWERS FROM INTERVIEWS
4.	General HSE	
4.1	What are the main Arctic-specific elements of an HSE system?	<ul style="list-style-type: none"> • Focus on safer working environment in cold conditions • Winterization of people and equipment • Handling of ice loads on structures • Focus on how to prevent discharge of oil in the Arctic
4.2	<p>The ISO14001 is a standard for environmental management systems. Can you comment upon how regulating entities implement and audit (internal / external) HSE systems, and identify examples of practice for Arctic application?</p> <ul style="list-style-type: none"> • Measurement of compliance • KPI 	<ul style="list-style-type: none"> • Reference is made to the Canadian National Energy Board's Arctic Offshore Drilling review and the questions posed in the Call for Information that are aimed at identifying Arctic offshore specific elements of a HSE system • Tracking of all incidents • US Chemical Board has developed KPI's for some areas and used third party audits • It is also referred to OGP and military experience from Arctic operations
4.3	Are individual decisions made outside the HSE management system (non-compliance) representing a hazard? Are there any experience or procedures to detect or measure non-compliance related to procedures, checklist etc.?	<ul style="list-style-type: none"> • Not necessarily, but will depend on the individual experience • Not possible to identify all situations in an HSE Management system, but when new situations occur this should be documented and included as a part of the continuous improvement of the management system • Use HAZID and risk assessment for identification of possible non-compliance • All the elements of the management system should be considered including training, documentation, and awareness
4.4	What are sources for HSE systems?	<ul style="list-style-type: none"> • International standards and companies specific/adapted standards
4.5	What are best examples of HSE practices/systems and their common elements?	<ul style="list-style-type: none"> • Elements related to training • Element for avoiding incidents and accidents
4.6	Can you identify/comment upon Human Resource Management for work in the Arctic? Is there a need for specific requirements to personnel working in the Arctic?	<ul style="list-style-type: none"> • Document basic competence and skills • Demonstrate the ability to work in remote areas • A robust training and qualification document which identifies each position, its responsibilities, the minimum qualification, skills and training required as well as minimum number of people for each position
4.7	Is it possible to maintain a sufficient level of experience on board ships and platforms used for seasonal operation in the Arctic?	<ul style="list-style-type: none"> • Yes, but special training has to be provided
4.8	Are Best Available Techniques and Best Available Practice sufficient to assure safety of personnel and a sufficient level of experience?	<ul style="list-style-type: none"> • The Best Available Techniques and Best Available Practice may not be appropriate, adequate, or aligned with the risks and consequences that may be experienced or exposed to in the Arctic offshore • Applied technology needs to be qualified for Arctic operations

	QUESTION	SUMMARY OF ANSWERS FROM INTERVIEWS
5.	Offshore Oil and Gas	
5.1	Is there a higher risk for blowout in the Arctic? What are the main measures to reduce this risk?	<ul style="list-style-type: none"> • Same probability at least for all equipment which is not exposed to the Arctic conditions • Due to limited drilling activity in the Arctic, there is less experience with regard to geological challenges (high pressure reservoirs and high temperatures) • Robust design and surveys
5.2	Pipeline leaks(onsshore/offshore) What are the main parameters having an impact, and possible risk reducing measures?	<ul style="list-style-type: none"> • Ice scouring in case of icebergs and large ridges • Monitoring (external and internal) and action taken to anticipate, prevent, mitigate and manage consequences of a failure • Possible risk-reducing measures are shorter distance between valves, automatic shut down and pressure drop detection
5.3	Is it possible to winterize all equipment to ensure same operability in the Arctic as worldwide?	<ul style="list-style-type: none"> • Yes, but expensive • Based on risk analysis adapt the best method for winterization to the different parts of the equipment • Winterization needs to be designed and documented case by case depending on the actual operation
5.4	Same Season Relief Well Capability requirement? Are there any other alternatives? (Double BOP systems and other well control capabilities, Possible seasonal drilling restrictions – length of season – large seasonal variations of ice. etc.)	<ul style="list-style-type: none"> • There should be a functional requirement opening up for alternative solutions to same relief well capability • Should aim at same international requirements • Documented similar good solutions should be accepted
5.5	Experience and lessons learned from the most important incidents applicable for the Arctic: – Deepwater Horizon (2010) – Piper Alpha (1988) – Exxon Valdez (1989) – Montara (2009) – Ixtoc (1979)	<ul style="list-style-type: none"> • A robust and rigorous hazard identification and risk evaluation • Include system processes in the HSE system • Robustness, reliability, and redundancy in people, practice, and policies as well in tools and technology • Centralized communication and onshore process monitoring • Operators are responsible for training and include all subcontractors in training activities • Have a complete and updated HSE system for the actual operation and proper implemented and followed up

	QUESTION	SUMMARY OF ANSWERS FROM INTERVIEWS
6.	Land Based	
6.1	Challenges related to Oil spill from oil terminals. What are possible additional Arctic risks related to; <ul style="list-style-type: none"> – terminals – oil spill in general in ports – oil transfer ship/shore – oil transfer truck/railway – power generation facilities – buried tanks and pipes 	<ul style="list-style-type: none"> • Same Arctic challenges as for oil and gas • Canada and Russia have long experience from cold climate operations
6.2	What are the main risks and possible risk mitigating practices related to transport of oil in Arctic; <ul style="list-style-type: none"> – pipes – trucks – railway – river 	<ul style="list-style-type: none"> • Carry out HAZID • For pipes: risk related to seismic areas and permafrost
6.3	Any special issues related to best practices with regard to chronic oil spills versus accidental catastrophic spills?	<ul style="list-style-type: none"> • More accurate monitoring to avoid chronic oil spills • Record deviation in consumption/transported volumes • Improved surveys to avoid smaller leaks escalating to large oil spills
6.4	Do you consider increased activities same as increased risks? Why/why not?	<ul style="list-style-type: none"> • No • Increased activity basically results in increased probability. However more activity will also include better preparedness and technology which can result in a lower risk

	QUESTION	SUMMARY OF ANSWERS FROM INTERVIEWS
7.	General	
7.1	Are there any specific topics the AC could contribute to and facilitate implementation to reduce risk during offshore, maritime and land based industry?	<ul style="list-style-type: none"> • Work towards a more circumpolar cooperation regulatory forum • Share information about awareness and education • Share experience • Standardize rules and regulations • Coordinate Arctic R&D • Establish a database with links to R&D projects, results, people and institutions including data and results to improve the efficiency and outcome of future R&D projects
7.2	Are there any best practices you are aware of and that can be shared and implemented among the Arctic countries?	<ul style="list-style-type: none"> • No explicit practices but reference to projects such as Barents 2020, SEMS, HSE standards etc.



Appendix IV

Workshop Power Point Presentations

The workshop participants worked in four different break-out groups;

- Oil and Gas
- Maritime shipping
- Land based activities
- Monitoring

The following topics were to be discussed within the break-out groups and presented in plenum;

- Reference to Existing Rules and Regulations
- Existing Practice and Experience
- Assessment of existing Arctic prevention programs, Δ-Arctic

- HSE and Risk based Management systems covering Δ-Arctic
 - The Arctic risk reflected in HSE systems
- Human Resources and Competence, formal competence and training
- Available Arctic Competence and Technology
- Surveillance and Monitoring, possibilities and limitations
- Maritime Safety Systems for safer Ship operations
- Key Lessons Learned and experience from past incidents

The power point presentations from the Reykjavik workshop are presented in this Appendix.

EPPR RP3

Shipping/Maritime



1. Reference to existing rules and regulations

2. Existing practice and experience

- Consider combining numbers 1 & 2 to capture/balance all applicable regulations at the International, national, and sub-national level
- Consider industry guidelines & practices
 - International Association of Classification Societies
 - INTERTANKO
 - For the purposes of best practices, the Baltic nations should be included

3. Assessment of existing Arctic prevention programs, Delta Arctic

- No mention of IMO Resolution A.1024(26) Guidelines for ships operating in Polar waters
- Consider reviewing International Requirements for ships operating in Polar Waters, Heik Dedggin (presented 2009)

HSE & risk based management
Human resources/competence
Available Arctic
competence/technology

- DNV should consider/review STCW and include in the RP3 document
 - Ice pilot training
- The physical & mental health of seafarers operating in Arctic areas must be taken into account

7. Surveillance & monitoring
possibilities & limitations

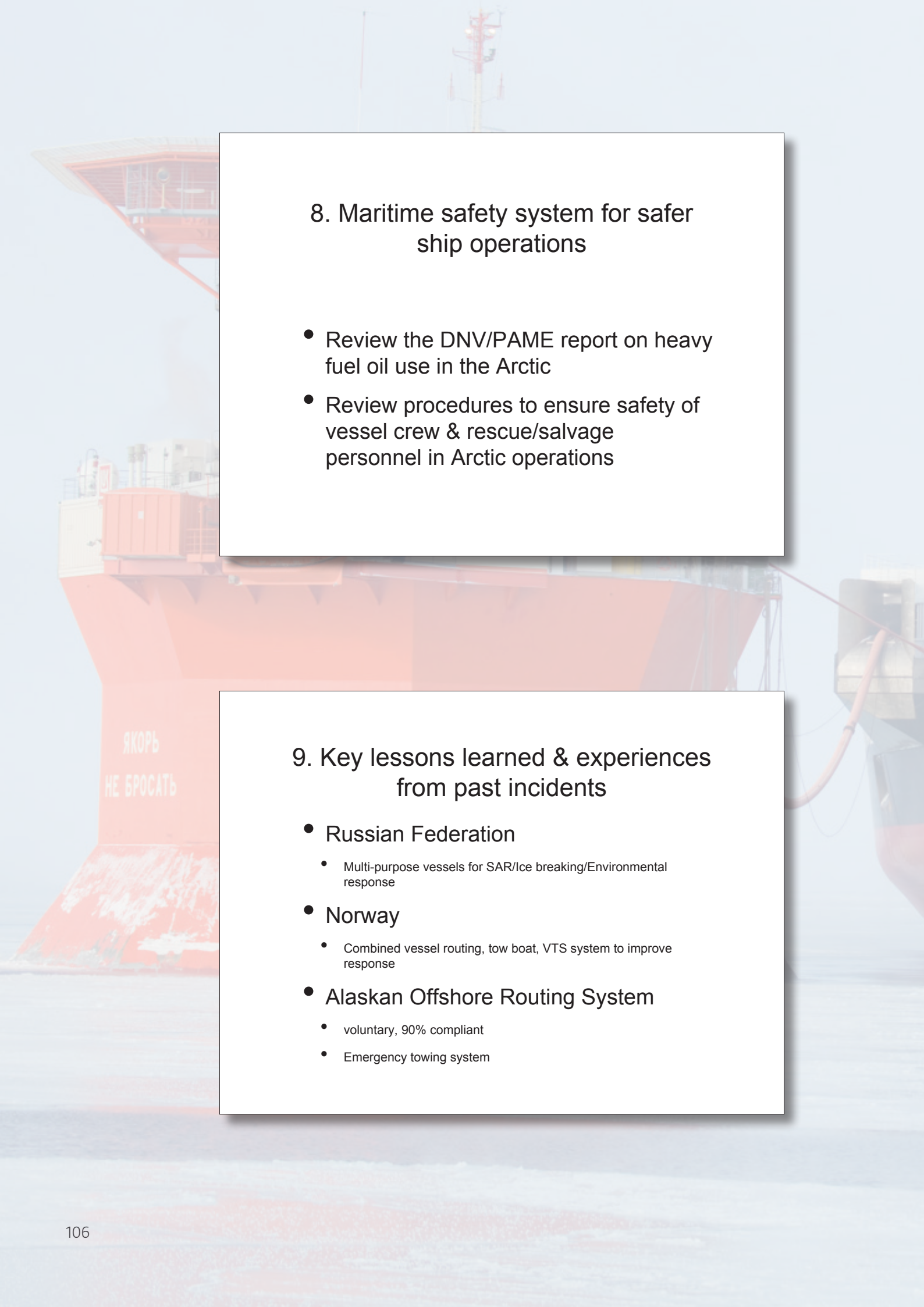
- To enhance ship safety there is a need for better determination of ice thickness, perhaps with shipboard equipment
 - Prince William Sound ice reporting system
- Reliable Ice Forecasting
- Reliable Arctic communications

7. Surveillance & monitoring possibilities & limitations

- A combined satellite based oil spill/discharge/monitoring system
 - Similar to the COSPAS/SARSAT system-cost sharing

8. Maritime safety system for safer ship operations

- Review Baltic Sea experiences/consult Sweden
- Ship reporting systems
 - International Association of Antarctic Tour Operators ship reporting system
 - Gulf of Finland Reporting System (Russian/Finland/Estonia)
 - Automated Mutual Assistance Vessel Rescue System (Amver/USCG)
 - Greenland Ship Reporting System



8. Maritime safety system for safer ship operations

- Review the DNV/PAME report on heavy fuel oil use in the Arctic
- Review procedures to ensure safety of vessel crew & rescue/salvage personnel in Arctic operations

9. Key lessons learned & experiences from past incidents

- **Russian Federation**
 - Multi-purpose vessels for SAR/Ice breaking/Environmental response
- **Norway**
 - Combined vessel routing, tow boat, VTS system to improve response
- **Alaskan Offshore Routing System**
 - voluntary, 90% compliant
 - Emergency towing system

9. Key lessons learned & experiences from past incidents

- Despite experience in ice, conditions change quickly
- Emergency unloading situations
- Coordination/reference
 - International Tanker Owners Pollution Federation
 - Oil Spill Intelligence Report

9. Key lessons learned & experiences from past incidents

- Places of refuge
- Best practice- keep a minimum distance of 10 times the height of a glacier
- Reinforce the need to include Baltic best practices
- Consider including Saint Lawrence Seaway best practices

9. Key lessons learned & experiences from past incidents

- Review of military ice navigation manuals
- Bering Strait port access study

Thank You



Land Based Activities

EPPR RP3 workshop
11-12 June 2012

Sources of pollution

- Small spills in communities all the time, might go into the sea (e.g. from above ground storage tanks) and cause chronic pollution
- Risk for big accident: pipe lines, shipment of fuel on rivers, oil terminals
- Spills during ship to barge transfer
- Under ground storage tanks, in the Arctic these are above ground – leakage, maintenance – regulations, inspections?

Causes of Emergencies and other Risk Factors

- Infrastructure changes (permafrost melt)
- Natural disasters
- Capacity to respond in Arctic communities can be quickly overwhelmed, pressure on prevention to lower the risk
- Infrastructure sometimes in poor condition (home heating storage tank farms)

1. Rules and Regulations

- Final support should identify gaps and a minimum basis for prevention activities
- Does any country have specific regulations for the high Arctic? – if -> recommendations/baseline for others
- Do regulations need update (changing Arctic)?
- Does the existing regulation cover arctic issues properly?

2. Practice and Experience

- Only double hull for barges on the rivers. This technology has lowered the number of spills
- Canada "Oil spill hot line" – response actions directed to right authority. Serves also as a planning group
- Results oriented regulations promote innovation
- Compliance and enforcement of prevention regs not adequate
- Inspections of plans – weakness in most places: expensive, time and resource intensive, issue of legal liability risk for approving contingency plans
- Russia may have most experience in pipelines

3. Assessment of Existing Arctic Prevention Programmes

- 72 hour spill recovery capacity (Prince William Sound)
- Training, info on preventing small spills with local community (fishing boats refueling, private owners, AANDC)
- Territorial laws that are Arctic specific: a compliance and enforcement programs for these regs need to be present.
- Industry/Community risk identification and contingency planning: CMMI model

4.HSE

- Same issues as spill prevention (training, contingency planning, safety culture, practice)

5.Human Resources and Competence

- The local communities are most possibly the first responders – lack of skills & equipment (need for training & equipment, eg. Containment)
- Training local people responsible for oil transport/transfer to think about prevention during fillup – safety culture

6. Available Arctic Competence and Technology

- Pipelines – problems: ageing, melting permafrost: Many kms of pipeline need upgrading
- Inspections: need capacity to inspect
- Pressure measures – detects leakage if big
- Regs should not discourage the use of new technologies

7. Surveillance and Monitoring, Possibilities and Limitations

- Trends analysis key for risk analysis and knowing what you need to do for prevention
- Monitoring pipeline spills in the Arctic (esp wintertime) is difficult: visual inspections are expensive and people intensive.

9. Key lessons learned and experience from past incidents

- Need a place/forum where to share lessons learned after accidents in an open minded manner (near-misses and public information about the causes, and solutions to major emergencies)
- Information sharing (industry – municipality), good idea to do e.g. do risk assessment together
- The local communities are most possibly the first responders – lack of skills & equipment (need for training & equipment, eg. Containment)
- Higher safety standards for infrastructure (tanks, pipelines, etc)

Conclusions

- Land based activities are varied and tend to cause small, frequent spills and chronic pollution.
- Pipelines are the most likely cause of a major emergency
- Standards and technology should be adapted and upgraded for Arctic conditions
- A solid risk assessment based on trends analysis, environmental scan, open dialogue with the public will give you the right information for prevention planning

Conclusions

- The consequence of having low response capacity at a local level is there needs to be a greater emphasis and higher standards for prevention in place
- Do prevention training at the residential level where most chronic pollution occurs

Oil and Gas Break-out

RP3 - Priorities

Δ Arctic = \uparrow Risk

Risk of system integrity issues leading to accidental release (pipelines and drilling installations) as a result of:

- \uparrow Probability
- \uparrow Risk

↑ Probability

- environmental effects on personnel
- communication challenges
- Timing/seasonal pressures
- Ice and icing + temperatures result in unique design considerations
 - Equipment and instrumentation
 - Scouring
 - Permafrost trapping gas
 - Leak detection
 - Burying of pipelines
 - Cementing

↑ Consequence

- efficacy of response
- environmental consequences/sensitivities
- lack of infrastructure
- economics effects of limiting future activities
- Social acceptability of impacts on previously undeveloped areas

Δ Arctic = \uparrow Risk

Necessitates:

- **Increased oversight**
- **Increased redundancies**
- **Special focus on:**
 - **Implementation, ongoing review and corrective action processes included in safety management systems**
 - **Safety Culture**
 - **Certain HSE elements**

Increased rigour in oversight and redundancies required – due to increased risks, untested equipment, challenges with operation of remote operated vehicles,

Note: Balance between prescriptive/performance based regulation will shift as we move into Arctic. Greater reliance on safety case as we move north. Greater reliance on goals-setting and performance simply because of lack of experience. Focus on Prescribing processes and Establishing objectives as opposed to prescribing technological and design considerations

Driving safety culture –
Indicators

Incentivize: is performance tied to safety -- balance of safety vs. financial goals, especially at top management levels. Consistency of message.

Ability to think the unthinkable

HSE Elements

Special focus on *certain* HSE elements

- Hazard Assessment
- Training and competence
- Accountability

Hazard Assessment

near-miss data becomes particularly important given lack of experience for all operators, in Arctic important to have all instances reported, important for on-going risk analysis.

Accountability

– critical decision making processes – who is responsible at all times?
– std. communication processes don't necessarily transfer to the Arctic

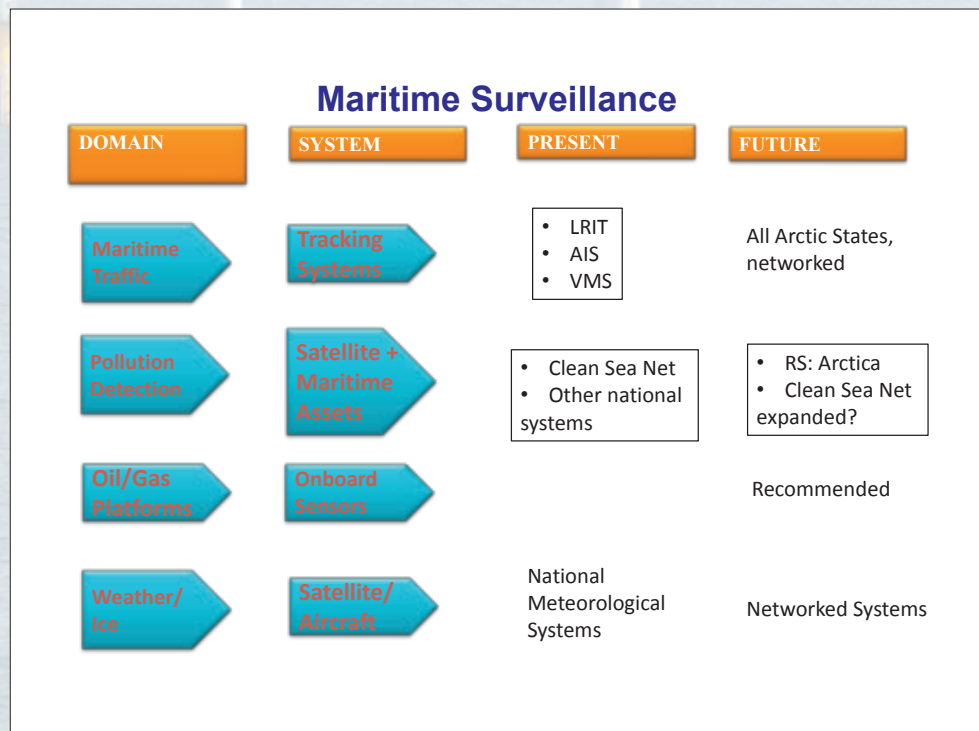
Training and Competence for Arctic

- mechanical
- psychological
- communication is different
- conditions affect decision making
- Great turnover of experienced people

Maritime Surveillance Work Group

RP3 Workshop

Keflavik, Iceland June 11-12 2012

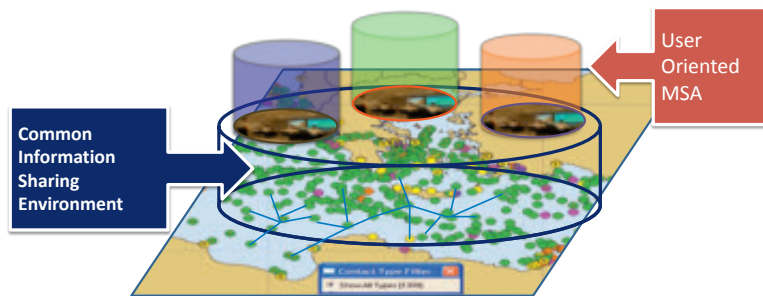


The second strand is related to the integration of Maritime Surveillance Systems.

In the slide we can see some of the MSA systems currently working in the EU. All of

them look to their narrow and very specific environment without taking into account what is really happening nearby or in other domains.

Future Arctic Maritime Situational Awareness



"By implementing these recommendations, a risk-based analysis will allow networked national systems to detect and respond quickly and cost-effectively to pollution events, resulting in a decreased consequence of oil pollution in the Arctic environment."

Additional Points

- Prioritization based on risk
- Risk = Probability x Consequence
 - Probability
 - Shipping Lanes
 - Pipelines
 - Platforms
 - Others?
 - Consequence = Sensitive Areas
 - Sensitivities
 - Ecological
 - Cultural

The way towards the integration should be based in a common information shared environment allowing each agency to work on it depending upon each respective legal competences.

We think problem to share information is based in a lack of confidence about com-

petences; therefore to be able to progress we think it will be necessary to explain the benefits for any of our works to have a better information available and to establish an initial compromise that current competences will be respected.

Recommendations

- Network existing (and future) surveillance systems
- Encourage use of platform-based sensors
- Perform risk analysis to assign surveillance resources
- Advertise existence of monitoring systems to deter deliberate pollution

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