Working Document of the NPC Study:
Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources
Made Available March 27, 2015

Paper #6-12

OVERVIEW AND BACKGROUND OF ARCTIC PERSONNEL SAFETY AND OFFSHORE SURVIVAL IN EMERGENCIES

Prepared for the

Technology & Operations Subgroup

On March 27, 2015, the National Petroleum Council (NPC) in approving its report, *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Technology & Operations Subgroup. These Topic Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached paper is one of 46 such working documents used in the study analyses. Appendix D of the final NPC report provides a complete list of the 46 Topic Papers. The full papers can be viewed and downloaded from the report section of the NPC website (www.npc.org).

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Topic Paper

(Prepared for the National Petroleum Council Study on Research to Facilitate Prudent Arctic Development)

6-12	Overview and Background of Arctic Personnel Safety and Offshore Survival in Emergencies
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Date: November 15, 2014	**Revision:** Final

SUMMARY

The focus of this topic paper is the health and safety of personnel in arctic oil and gas operations, providing a brief review of the topic, ongoing research, and recommendations for future research and development. Topics discussed include considerations for workforce safety when working in harsh, extreme cold conditions, suits and provisions for survival in the event of emergency situations, standards for personal protection equipment and clothing, and potential areas for advancements in equipment and clothing to facilitate workforce safety and productivity in the Arctic environment.

A. Overview

The focus of this section is the health and safety of personnel in arctic oil and gas operations, providing a brief review of the topic, ongoing research, and recommendations for future research and development.

As noted elsewhere, worker safety is our number one priority, and all E&P companies have developed a very strong focus of health and safety of personnel. In addition, the government regulation SEMS II (Safety and Environmental Management Systems II – aka *Workforce Safety Rule*) also stipulates industry have a strong safety program. As the E&P industry moved into Arctic regions, worker safety practices expanded to also include protection from cold temperatures, and working and transport in icy conditions.

Health and safety in the context of this section refers to factors impacting the physical health and safety of personnel, i.e., the protection of personnel health and safety while exposed to elements of Arctic climate during routine E&P operations. Escape, evacuation, and rescue (EER) in Arctic environments is covered elsewhere, so this section will review health and safety of personnel either while performing their regular duties, or survival while waiting for rescue following precautionary or emergency evacuation from an asset or emergency egress from a transport vehicle/vessel. Two recent cases that illustrate this issue are the sinking of the

excursion cruise vessel *Explorer* in 2007 that struck submerged ice in the Bransfield Strait off the Antarctic coast, and the grounding of the expedition cruise vessel *Clipper Adventurer* in 2010, while transiting Canada's Northwest Passage.

B. Background

In 2008, the Global Oil and Gas Industry Association for Environmental and Social Issues (IPIECA) and the International Association of Oil and Gas producers (OGP) released a report entitled "Health aspects of work in extreme climates - A guide for oil and gas industry managers and supervisors" (http://www.ogp.org.uk/pubs/398.pdf) that outlines guidelines of HSE in harsh environments, including the Arctic. The Arctic section of the report provides a concise overview of the effect of extreme low temperatures on the human body, including Chilblains, trench foot, fingertip fissures, hyperthermia, frost-nip, cold burn, and snow blindness.

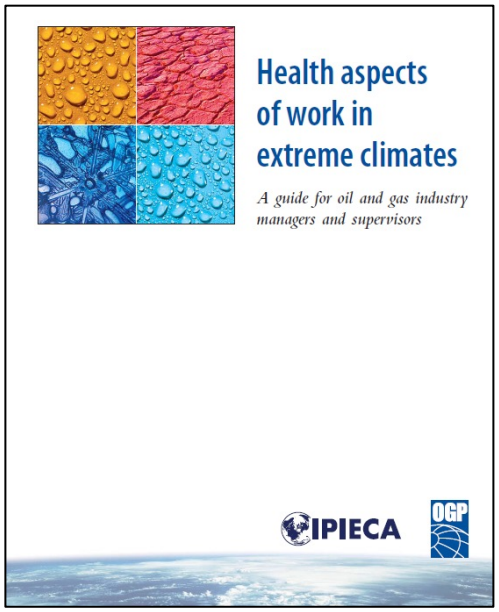


Figure 1: http://www.ogp.org.uk/pubs/398.pdf

The latter section of the report deals with overall prevention, work practices and management of health problems related to working in cold climates, and general recommendations for reducing exposure to the cold, and overall survival. Protective clothing is also discussed, including insulation, layering, *Smart Wear*, reflective fibers, and protection of the head, neck and hands.

Overall, the report provides some useful reference information and guidelines, but does not identify technical gaps requiring further development or research

C. Recent and Ongoing Research

E&P companies have developed their own internal processes and procedures, guidelines and equipment standards for protecting personnel while working in cold environments. Global technological advances in protective clothing for working on the job site, and during transport, including flotation in the event that personnel enter open water (dealt with under the EER section) has been addressed.

When compared to EER R&D, there has been less research focused on general health and safety of personnel during normal routine operations because most of this is already available through work done over many years by those working in all kinds of industries in cold environments. Indeed, most of the industry-led research addresses personnel in emergency situations following helicopter egress and subsequent exposure to open water.

E&P companies have, however, completed their own internal research, and participated in some JIPs on the effect of arctic conditions on personnel health and safety, clothing /personal protective equipment (PPE), work practices and regulations.

For example, in 2013, Statoil contracted the SINTEF Department of Health Research, Work and Physiology to complete a study entitled "Arctic weather protection, health effects, monitoring systems and risk assessment" (H. Faerevik *et al*, SINTEF, 2013). The main objectives of the study were:

- To better understand the need for better protection against the weather, negative effects on health, surveillance systems, and risk assessments for workers in the Arctic; and
- To develop guidelines for recommended use of the wind chill factor to help decide when to use weather protection, recommended work/reheat period and special PPE.

The report included the following deliverables:

1. Summary and an extensive bibliography of relevant research articles and documentation regarding critical factors for work in cold climate, updated information on wind chill indices/frostbite, contact cooling and hypothermia; and
2. Suggestions for new requirements, standards and guidelines for working in Arctic conditions related to weather protection, health effects of cold exposure (including indication of critical requirements for vulnerable people), surveillance systems and risk assessment (re. wind chill index).

Specific to the design of PPE for arctic environments, in 2013 Statoil also contracted the Institutet för Kemisk Analys Norden AB (IFKAN, Sweden) to research the following main questions regarding the effect of temperature on respirator mask performance (M. Dalene, *et al*, 2013):

1. Is the protection factor of different respirator masks influenced by the ambient temperature during use?
2. Is the user experience of different respirator masks influenced by the ambient temperature during use?
3. Does beard stubble impair the performance of the respirator mask when used at different temperatures?
4. Which respirator performs best at low temperature (if any difference occurs)?
5. Is ice formation or water condensation in- or outside the mask an issue?

Conclusions from the IFKAN study were that below -5^{O}C, none of the tested respirators performed in an acceptable manner mainly due to visual disturbances and uncomfortable cooling of the face skin. A fan assisted respirator was the most robust device as compared to negative pressure respirator. However, there is a need to develop a fan-assisted device with preheating of the air that is sweeping against the face skin.

Also, a number of companies recently entered into a JIP managed by SINTEF named *ColdWear* (www.sintef.no/Projectweb/ColdWear/), the objective of which is to create the knowledge and scientific background for developing new clothing solutions that enable a significant increase in performance and safety of operations in the High North.

The *ColdWear* website describes some of the work being completed, including integration of electronic systems into clothing, and includes a list of relevant publications and abtracts on cold weather PPE.

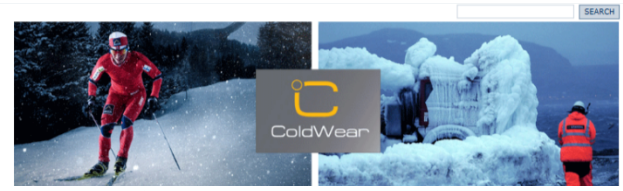
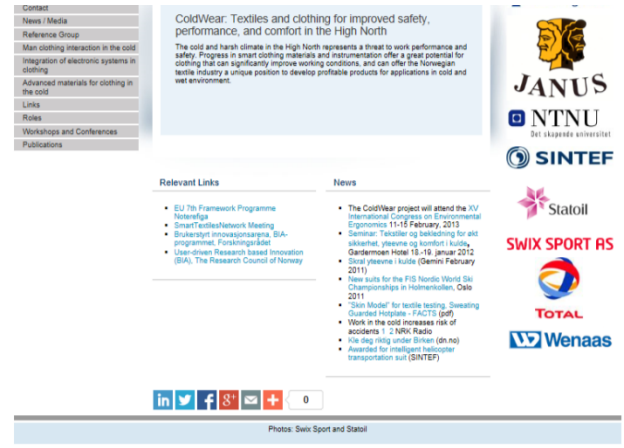


Figure 2(http://www.sintef.no/Projectweb/ColdWear/



The project manager, Hilde Færevik, is a also a member of the board of European Society of Protective Clothing (http://www.es-pc.org/).

D. Recommendations for Future Research

The study team has identified the following research areas for HSE of workers in Arctic environments:

1. EER: Development of dual-purpose aircraft/abandonment suit would be of value. Flight suits are designed for aircraft egress and floating survival but are not designed for long-term survival in near-freezing water or sub-freezing air temperature.
2. Cold regions clothing – specifically during abandonment – existing exposure suits are not well suited for survival on the ice for extended periods, or for transit over ice rubble to a rescue/icebreaker vessel. ExxonMobil developed a strategy for carrying small sack of survival clothing in a watertight bag, but recently marketed smart clothing may provide benefits in this area.
3. Breathing (respirator) masks in low temperature conditions – challenge linked to condensed water on masks in cold climate.

4. Heavy cold-weather gloves – human factors need to be considered when designing switches and buttons because dexterity is restricted when donning cold weather gloves. The United States military is developing gloves that address this issue, and efforts should be made to collaborate.