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*Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources*
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# Paper #6-9

# ARCTIC OPERATIONS COMMON OPERATIONAL PICTURE

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)

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| **6-9** | **Arctic Operations Common Operational Picture** |
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**SUMMARY**

Common Operational Pictures (COP) are used in offshore Arctic exploration and development operations to facilitate common situational awareness and decision making. Specific Arctic challenges motivating the use of a COP include the complexity and remoteness of the operations that include many geographically distributed parties and stakeholders; dynamic ice environments; and challenging weather conditions with limited visibility. COP technology has been used in historical operations including early Beaufort Sea exploration activities, the Arctic Coring Expedition (ACEX), and Grand Banks exploration and production operations. These historical operations used COP technology to support ice management activities including tracking and forecasting of hazardous ice conditions relative to alert zones around the ongoing operation. Several commercial COP products are identified in a review of the marketplace, and it is noted that proprietary tools have also being used in recent Arctic operations. Moreover, considerable development activity is occurring in related industries. In particular, recent recommendations stemming from the Deepwater Horizon incident have stimulated development efforts for COP technology targeted at oil spill response. The general functionality of a modern Arctic COP is outlined and includes the capability to digest, store, display, and share common GIS formats that can include ice data; weather data; satellite imagery; and vessel and aircraft position data. Taken in context of the required functionality, a review of historical activity and ongoing activity suggest industry efforts are targeted at assembly, customization, or enhancement of existing technology rather than development of new technology. Arctic COP is an area believed to be adequately supported by the commercial marketplace. In line with ongoing oil spill efforts, the industry should consider potential benefits from establishment of uniform practices or standards. Finally, it is noted that Arctic COPs must be supported by a communication system. Potential enhancements to communications in the US Arctic are considered elsewhere.

# I. ARCTIC-SPECIFIC CHALLENGES MOTIVATING USE OF COMMON OPERATIONAL PICTURE

A Common Operational Picture (COP) can generally be described as a shared display of information that facilitates situational awareness and decision making. A COP supports the planning and execution of strategic and tactical operations involving many, potentially geographically distributed, parties. Though COPs have most traditionally been used to support incident management, the Arctic offshore environment has unique challenges that motivate the use of a COP to support regular command and control of day-to-day operations. For example, a COP is a critical component of any ice management system. While ice management technology is discussed in TP3.11, it was deemed important to devote a separate topic paper specifically to the COP technology component. Specific challenges in the offshore Arctic environment that motivate use of a COP include the following:

- Complex and remote operations with many distributed parties and stakeholders
- Dynamic ice environment
- Challenging weather and limited visibility

The COP should be tailored to meet the specific requirements of an operation; however, the general role of the COP, as related to above Arctic challenges, is discussed herein.

## A. Complex and remote operations with many distributed parties

Offshore Arctic operations include exploration and development drilling centered about fixed or floating platforms; production, offloading, and transportation from fixed or floating platforms; and seismic exploration or data collection from moving vessels. These exploration and production operations share the challenges of comparable offshore operations in other environments. However, Arctic operations are typically conducted in highly remote regions. Many personnel from many organizations are involved in the planning and execution of these operations, and the parties involved may be distributed across many geographic locations.

Operations are often supported by a large number of marine vessels serving the needs of the local operation and providing supplies from distant shore bases. Aerial support is often needed from either fixed wing or rotary aircraft, and support may be provided by remotely operated air or water vehicles. Likewise, operations are often supported and observed by shore based centers and personnel including meteorological services; specialized ice data interpretation and forecasting; and management and regulatory oversight and support. Finally, data from satellites, metocean instruments, or other specialized ice instruments are often needed.

The COP serves to collect, store, communicate, and display the information required for the given operation. The COP develops a common situational awareness to facilitate collaborative planning and execution of operations with many remote parties and stakeholders. Though a specific party or component of an Arctic operation may require a specialized display of information, the COP ensures all parties are operating with a common dataset and situational awareness.

## B. Dynamic ice environment

The Arctic ice environment is dynamic and conditions vary with the season. Some operations are only targeted for execution during the finite open water season, or until a limiting ice thickness has been reached during the freeze up period. Likewise, some regions may have distinct iceberg seasons during which a higher frequency of icebergs can be expected on location. The start and end to these seasons are influenced by many regional and global factors. A COP can help analysts and decision makers collect and interpret information around the beginning and end of particular ice season so that appropriate strategic and tactical actions can be taken.

Furthermore, specific ice and iceberg hazards may be present during a given ice season. In summer months, nominally open water areas may include isolated ice features or open water may be interrupted by intrusions of pack ice. In winter months, Potentially Unmanageable Ice Features (PUIFs), features with potential to exceed operational limits, can exist within an area of nominally manageable ice.

Operators working in the arctic develop and use ice management plans that include the detection, tracking, and forecasting of ice hazards relative to the ongoing operation (e.g., Ref 1, 2, 3). The ice management plan defines an alert system that links appropriate procedures (e.g., secure well, deploy icebreaker, or collect additional data) to the temporal or spatial proximity of PUIFs. In this context, the COP is used to determine and communicate ice alerts. The COP is also used by personnel to plan and execute the linked procedures as ice alerts evolve.

### C. Challenging weather conditions and limited visibility

In addition to ice, the weather in the Arctic varies seasonally including differences in air temperatures and the number of and severity of storm systems. Extreme cold or icing can limit the use of particular equipment or operations. Likewise, storms and wind can limit operations or develop sea states that can in turn limit operations. Again, a COP can help analysts and decision makers collect and interpret information around the beginning and end of particular weather seasons, or study and plan for individual weather events.

Additionally, fog and darkness can restrict visibility in Arctic operations. The COP facilitates common situational awareness and coordination of operations that must continue during times of restricted visibility.

## II. HISTORICAL DEVELOPMENT AND APPLICATIONS IN THE ARCTIC AND ARCTIC-LIKE ENVIRONMENTS

Provided herein is a brief review of the historical development and application COPs in Arctic or Arctic-like environments. Though the systems used in the historical operations are not specifically named Common Operational Pictures, these tools serve many of the general functions outlined above.

### A. Beaufort Sea exploration drilling operations

Dixit et al. (Ref. 4) describes environmental and performance monitoring programs used on the Kulluk drillship during early Beaufort Sea exploration programs. The environmental monitoring program was used to identify environmental factors that could impact the operations and to forecast when these hazards were to be present at the site. The operation had two primary bases, a Beaufort shore base and the Kulluk. Data collected, analyzed, and communicated between the two stations including the following:

- visual ice observations collected on helicopters
- SLAR data collected on fixed wing aircraft

- wave, current, and salinity measurements collected from moorings or other instruments
- positional and other data collected from buoys and weather stations
- ice and weather observations collected on icebreakers and Kulluk
- marine radar collected on the Kulluk

In this early application, these data were used to form maps and charts that were communicated between the two bases. The data products and situational understanding formed with the maps and charts were used in conjunction with an alert procedure manual to respond to hazards approaching the drilling operation. Moreover, the alert procedures were improved over time using the information collected from the environmental monitoring program with real-time vessel performance data (e.g., riser angle, anchor tensions) collected from the partner performance monitoring program (Ref. 4).

Danielewicz and Saint (Ref. 5) describe a system used for monitoring ice during drilling operations on the bottom founded single steel drilling caisson (SSDC/MAT). This computer based system automatically updated ice floe positions and issued warnings when potentially hazardous conditions developed. These warnings were again developed using a defined alert procedure. The system allowed personnel to investigate and communicate the positions of hazardous ice floes, expected trajectories, and ice load probabilities.

Melrose (Ref. 6) describes a Shipboard Ice Alert and Monitoring System (SIAM) designed for drillships conducting Beaufort exploration drilling. SIAM was designed to be a system to collect continuous ice, environmental, and operational data; compile and display actual and forecasted data; and distribute information that could be readily assessed by others. The system computed ice movement forecasts and hazard conditions. SIAM included various graphics capabilities including vector plots, time series plots, ice mapping, and hazard condition. Regional and local ice maps were communicated between the relevant nodes.

**B. Arctic coring expedition**

Söderkvist and Jansson (Ref. 7) describe a software tool used to support ice management during the Arctic Coring Expedition (ACEX). During ACEX, icebreakers were used to support geotechnical coring operations being conducted on a drillship. A software tool, IceMS was developed and used to support the planning and communication of icebreaking instructions to the icebreakers.

IceMS contained tools to update ice conditions; tracking data of ships and buoys; and ice drift forecasts. The software enabled combined visualization of map data from satellite, airplane, and ice charts. History lines of ship movement and other land ocean data (e.g., coastlines) were displayed in the software. These map data could also be moved according to observed ice drift recorded by buoys placed on ice floes. Additionally, overlays of polygons and lines could be created to represent and describe areas of ice. These maps and overlays could be exported and shared to facilitate communication and decisions making across the fleet.

Söderkvist and Jansson (Ref. 7) describe application of the software during ACEX. It was used to plan and execute complicated ice management tasks such as forecasting and planning operations into the future. At the time, the authors also noted several potential improvements to both the software and ice drift forecast model:

- Include ability to rotate images according to the observed ice motion.
- Improve tuning procedure for ice drift model.
- Include the ability to represent ice drift forecast with a sector.
- Include the ability to forecast independent floe movement.
- Create automatic updating of ice drift presented in the map view of IceMS.
- Label time along ship and buoy history lines
- Label direction along ice drift history lines.
- Increase update time from the 2 seconds used in ACEX and implement on modern computer to improve performance.
- Create illustrative shapshots of future conditions using SAR image or ice chart and ice drift forecast.

It should also be noted that the IceMS software was tested during transit from the drill site to the ice edge. Though detailed ice information was not available during the transit operation, it was noted that thought was being given to potential improvements that would make the software more suitable to transit and shipping in ice infested waters.

**C. Grand Banks iceberg management operations** Exploration and production has been ongoing along the Grand Banks, offshore the east coast of Canada, since the 1980s. Operational facilities range from the large gravity based structure (GBS) Hibernia, to the floating, production, storage, and offloading (FPSO) units Terra Nova and White Rose, to smaller drilling and tanker operations. Dugal (Ref. 3) summarizes the ice management system supporting Grand Banks operations.

The system is an integrated and coordinated approach to manage the iceberg hazards for all operators working in the region. Information is shared and ice management resources are tasked considering potential effects on all active projects. Iceberg position information is gathered from multiple resources included satellite imagery; rig based radar data; aircraft surveillance including visual identification and radar imagery; and vessels operating in the area that include chase boats specifically deployed to monitor iceberg drift. Each operator develops an ice management plan that defines an exclusion zone around each facility. The potential threat of each iceberg is evaluated against the control zones encircling each facility and larger regional zones that take in consideration the interests of all operators.

Each facility operates a computerized Ice Data Network System (IDNS) that serves as a Common Operational Picture for the Grand Banks operators. Individual operators can input tactical ice data; display site specific and regional ice and oceanographic conditions; and run threat assessment and risk analysis. Each facility's IDNS is linked, via a satellite connection, to a shore-based support center that coordinates the collection, processing, and dissemination to all active operations. IDNS acts as a central database and allows simultaneous access to information from many users from any location in the world. The shore base also provides links to additional sources of ice data that are evaluated and integrated into the IDNS.

Dugal (Ref. 3) notes several benefits of the IDNS. IDNS reduces the chances for confusion and duplication of effort among the operators. Secondly, the effect of individual ice management operations can be evaluated relative to individual facilities and to other operations being conducted in the area. Efficiencies in communication, data availability, and resource sharing were found to reduce the cost of the ice management program while decreasing the down-time related to ice.

## III. ACTIVE INDUSTRY ACTIVITY FOR COMMON OPERATIONAL PICTURE TECHNOLOGY

Provided herein is a state of the art review of industry activity for COP technology for Arctic operations. Consideration is also given to related COP technology being developed in other areas. The review is based upon public information and should not be considered exhaustive.

### A. Commercial products

Tiffin et al. (Ref. 8) reviewed software products either currently available commercially or under development to support ice advisory services in Arctic operations. The products identified by Tiffin et al. (2004) are listed in

Table 1 and supplemented with additional information from product websites. It should be noted that several of the products listed in

Table 1 are under development and/or have only recently become available in the marketplace.

### B. Proprietary products

As noted, the review of products listed in

Table 1 is based upon publically available information and is intended to identify commercial products. Other custom or proprietary tools may be used to support Arctic operations and serve as a COP. As an example, Shell Gulf of Mexico Inc. (Ref. 1, 9), describes a proprietary Common Operating Picture in its regulatory submissions. The tool is used to combine the following for near-real time display:

- Automatic Identification System (AIS) and long range tracking information for all Shell vessels and others operating in the area
- Aircraft tracking system provides location information on aircraft movements
- Shore base camps and facilities, regulatory exclusion areas, and planned track lines
- Overlaid weather and ice information from the Shell Ice and Weather Advisory Center (SIWAC) located in Anchorage, Alaska

Communication between the SIWAC and vessels is achieved via a high-speed data and voice satellite service (Ref. 9). In this application, the SIWAC compiles available data from subscription, specialized, and public services in ArcMAP (Ref. 10). Data, including satellite imagery and field observations, are communicated using automated processes. Additionally, the SIWAC maintains a secure website that allows on demand access to the latest information (Ref. 9).

The above Shell (Ref. 1, 9) application is an example of a proprietary system developed to serve as a Common Operational Picture. It is used here as an example since some description is available in public literature. It is envisioned that other custom or proprietary tools are being developed or used by other operators.

### C. Oil spill response COP

The United States Department of the Interior, Bureau of Safety and Environmental Enforcement (BSEE) studied lessons learned from the Deepwater Horizon Incident in the Gulf of Mexico and issued updated guidance to owners and operators on oil spill response plans (Ref. 11). In the notice, BSEE encourages the use of a Common Operating Picture by all spill management and response personnel, including Federal and State governmental officials. This recommendation from BSEE has stimulated much activity around COPs specifically targeted at oil spill response.

For instance, the Open Geospatial Consortium (OGC) along with the International Association of Oil & Gas Producers (OGP) through Geomatics Committee of the IPIECA are operating a joint industry project to produce recommended practice for the use of Geographic Information Systems (GIS) technology and geospatial information in forming a COP for management of oil spill response (Ref. 12). Two workshops have been held in which results from a Request for Information (RIF) were presented and reviewed. Responses from the RIF ranged from operators representing individual development activities to commercial entities offering COP technology solutions.

The requirements and functionality of oil spill and Arctic COP are similar in many respects (e.g., geographically distributed parties, large numbers of marine vessels and resources). Developments in oil spill COP technology and recommended practices should be considered when pursuing Arctic COP efforts.

### D. Other industries and activity

It is also prudent to consider COP activity in other related technology areas. For example, Ou (Ref. 13) and Ou et al. (Ref. 14) describe an Integrated Spatial System (ISIS) and a real-time decision support tool, ICE-VU, being used to support Canadian Coast Guard operations. ICE-VU allows Coast Guard and Ice Service Specialist to receive real-time radar data; download imagery and other GIS products; incorporate real-time Global Positioning System (GPS) information, and plan navigation routes and deviations.

Likewise, marine software packages (e.g., dKart Navigator and Fugawi Marine 5; Ref. 15, 16) can fulfill many of the requirements of an Arctic COP. These packages allow users to import and visualize GIS data including ice information. ICEMAR (Ref. 17) has elected not to involve development of tools to visualize ice products since most ships already have charting or GIS software capable of performing this role.

Finally, the COP development efforts in traditional GIS software products should be considered (e.g., ArcGIS and Google Earth; Refs. 10, 18). Many industries (e.g., ports, emergency planning and response) are using commercial and/or freely available GIS products to develop custom COPs.

## IV. General Functional Requirements and Potential Technology Enhancements

Though a COP should be tailored to the specific requirements of the target application, the above can be used to outline the general functional requirements of an Arctic COP:

- The COP should provide functionality to digest and display common GIS formats that can include ice data, weather data, satellite imagery, vessel and aircraft position data.
- The COP should facilitate communication and sharing of common displays, maps, commands, plans, or other data to create a common situational awareness and support planning and decision making across multiple and geographically distributed parties.
- A common dataset should be established such that all parties are operating with the same information. The COP should facilitate the collection and storage of this dataset.
- When applicable, the COP should allow customized views to support specific local requirements using the common dataset. This can be achieved through layering or other visualization methods within the GIS software environment.
- The COP should be efficient and facilitate continuous and near real time operations in a dynamic ice and weather environment.
- The COP should be integrated with the ice management plan and, as applicable, provide functionality to monitor hazards and provide alerts.
- When applicable, consideration should be given to coordination and/or integration with other COPs (e.g., oil spill response).
- The COP should be paired with a robust and reliable communication system capable of supporting communication of the data volumes required and at Arctic latitudes, in extreme weather environments, and with restricted visibility.

As noted above, there is considerable ongoing activity in the areas of COP technology development and application. This activity includes efforts targeted specifically at Arctic applications and in other related areas making use of COP technology and related software. This is an area believed to be adequately supported by a healthy commercial marketplace as current industry effort appears targeted at assembly, customization, or enhancement of existing technology, rather than targeted at development of new technology. In line with ongoing oil spill COP efforts, the industry could benefit from development of uniform practices or standards for Arctic COP. Finally, the COP should be supported by a robust and reliable communication system capable of handling the data volumes necessary for Arctic operations. Potential enhancements to communications in the US Arctic offshore are considered elsewhere.