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Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources
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Paper #7-12

ICE CLASSIFIED MARINE VESSELS FOR ARCTIC OPERATIONS

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)

7-12	Ice Classified Marine Vessels for Arctic Operations
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SUMMARY

- Maritime vessels are required for both routine and emergency response support. Specific vessel requirements need to link to service conditions.
- Vessel duties for exploration include resupply, anchor handling, subsea construction works with ROVs and divers, ice management, oil spill response and emergency evacuation, while additional duties for development include transport and installation.
- 'Rules for ship design in ice have been in existence for over 100 years and have undergone continuous improvement. This process is driven by a combination of experience, incidents, and improved calculation methods. Further evolution of ship design and Classification Society Rules continue to take place and form the basis of the rules in force today.
- Significant variance exists across Class Society guidance and national regulations. This broad variance in focus and requirement causes needless overlap and added complexity to vessel design, construction and operation.
- The Polar Code is being developed to consolidate and provide common baselines of requirements for polar shipping. Two pronged approach is being followed: The International Association of Classification Societies (IACS) has created detailed Polar Class construction requirements while the Polar Code will provide broad guidelines.
- IACS completed development of the Polar Class Unified Requirements in 2008 which set out 7 classes of construction (lowest class 7, to highest class 1)
- Polar Code Implementation - Mandated by 2016
    - Will not apply to drilling rigs unless in transit
    - Provisions will apply to SOLAS ships on international voyages "operating in polar waters" upon entry
    - Ships constructed prior will need to meet standard at renewal of survey
- There is no direct correlation between the Polar Class notations and current ISO 19906 or API RP 2N standards.

PURPOSE

Provide information on ice classified marine vessels required now and in the future for Arctic operations to include Arctic standards and emerging Polar Code Guidelines and implications.

BACKGROUND

The Arctic Ocean and adjacent seas have been used by mariners since the beginning of time. Historic Arctic marine transport activities reflect continuous indigenous marine use, expeditions and explorations, community supply and re-supply, and expanding use by the global shipping communities.

The first recorded transit of the North West Passage (NWP) was in 1906, and took three seasons to complete. It was not until 1942 that a vessel successfully transited this passage in one season, taking 86 days. In 1969, the tanker 'Manhattan' made a successful transit of the NWP, basically as a model test ship, and in Canada, the MV Arctic was built in 1978 and supported the Canadian Arctic mining industries for over 20 years.

The Classification Societies, who assure that ships are built to defined standards, recognised the need to develop Rules for vessels operating in ice and in 1881, DNV's stipulated that "in all vessels that may have to steam through ice, the frames at the extreme forepart are to be closer than here directed, or some sufficient additional strengthening of the vessel's forepart must be adopted." In 1911 the polar ship Fram, the strongest wooden vessel in the world, enabled Amundsen to reach the South Pole ahead of the competition.

In 1932, DNV introduced the first special requirements for ships intended for operation in ice-covered waters. These rules applied to increased scantlings of frames, plates and stringers given as a percentage increase (15% to 25%) above normal class rules. In 1960, DNV introduced new rules for ice classes in conformity with the established Finnish-Swedish ice regulations. The first requirements for icebreakers were introduced in 1962 with the Norwegian class notations Isbryter (Icebreaker) and Polarisbryter (Polar Icebreaker).

Further evolution of ship design and Classification Society Rules continue to take place and form the basis of the Arctic, ICE and Polar Class rules in force today.

The power of modern computers has greatly enhanced ship building technologies by the use of Computer Aided Design and similar technologies. The ability to conduct Finite Structural Analysis has ensured that the strength and fatigue life of vessels is better understood. There have been similar evolutions in navigational tools. In the 1970's, sextants and compasses were common place; today vessels are fitted with integrated navigational systems utilising Global Positioning Systems. The competence of ships personnel to operate in Arctic waters has been enhanced with the development of Arctic shipping training simulators, similar in concept to those used in the aviation industry.

The opportunity remains to further develop technologies and people to allow us to sustain a safe, reliable, and responsible operation in Arctic waters.

DISCUSSION

Current Vessel Requirements/Arctic Exploration and Appraisal

The remoteness of some of the lease blocks in the Beaufort and Chukchi Seas presents major logistical challenges to exploration drilling. Alaska has an extensive coastline, more than any other state in the union, with few viable deepwater ports to support the vessels required to conduct offshore exploration. Suitable deepwater ports only exist in the Southern part of the State and the Aleutian Islands, around 2700 nautical miles from the drilling location. A large number of vessels of various types and function is required to safely and efficiently conduct a drilling program in the open water season and allow for season extension, supported by a robust aviation and road transport infrastructure for stores and personnel transport. More people are employed in the logistics and emergency response support functions, on and offshore, than are required to operate a drilling rig.

With a key focus on operations and the protection of the environment and for the people involved, Health Safety and Environmental protection is paramount. However the need for emergency response capability for Medivacs and Oil Spill Response is an integral part of successful operations. A specially modified vessel provides a Spill Containment system, and is supported by dedicated vessels with oil spill response capabilities, with a tanker to receive any contaminated water. Oil skimming vessels, landing craft, and crew boats are located near shore for deployment if required.

Depending on the type of drilling unit employed those that are non self propelled such as a drill rig will require tugs to tow them to location. A large Semi Submersible drilling unit may require up to three ocean going tugs to tow it to location. Once on location, a drilling unit may require anchors to be deployed to keep it in position to drill; and two to three Anchor Handling vessels are required to achieve this. Drilling rigs typically have around 120 to 150 personnel on board and require resupply of perishable provisions whilst on station. With the supply base being 2700 Nautical miles away, offshore supply vessels are required to provide this service. Waste produced from the rigs and field support and ice management vessels needs to be removed and a tug and barge unit are provided for this function. These assets require fuel resupply and infield oil tanker may also be included in the maritime fleet. This tanker could also provide storage for recovered oil in the event of a spill.

Approximately 25 vessels and barge tug combinations are required to support a two rig open water drilling program.

Arctic Development and Production

Vessels to support a full field development will be dependent on the overall footprint of the field including production rate and number of wells. Field development will require support vessels during the platform installation stage, as well as vessels to support any pipe laying activities. Maritime support for development and production needs to consider open water, extended season and full year round capability.

Hydrocarbon production and export to markets will be by pipeline or shipping or a combination of both. There are a number of Arctic hydrocarbon export projects in production in Russia, with Sakhalin exporting LNG all year round using ice strengthened vessels with ice breaker support, and the Varandey project in the Pechora Sea using a Fixed Offshore Ice-Resistant Offloading Terminal (FIORET) to load to specially constructed independently operating ice breaking oil tankers which shuttle between the loading terminal and the transfer terminal offshore Murmansk. There are orders in place for Ice breaking LNG carriers to support the Russian Yamal LNG development, with delivery expected in 2016.

Regulatory Framework – Codes and Standards

A great deal of variance exists between national regulations and vessel design characteristics to meet the regulations and applicable Class Society guidance. Canada's comprehensive Arctic Waters Pollution Prevention Act and Regulations, Russian Register, various Russian Federal Statutes and Northern Sea Route requirements, all of which cover construction and operational requirements for Arctic going vessels, differ in many ways. American, Norwegian and Danish/Greenlandic regulations focus primarily on environmental protection and in some ways remain less specific when related to overall Arctic vessel design and construction, touching only on fit out required for environmental protection. The Finnish-Swedish ice class rules often referred to by many are designed for conditions in the Baltic, where ice conditions are single seasonal in nature only (ice completely melts out each summer) and are not as difficult as those experienced in Arctic waters where multi-year sea ice and glacial ice may be encountered.

This broad variance between national regulations and differences between Class Society rules creates difficulty in assessing equivalency.

Polar Code versus Polar Class Unified Guidelines

The first attempts at an international overarching Polar Code to consolidate and provide common baselines of requirements for polar shipping were made in the early 1990's. Far from bringing it all together, the first result was an Arctic focused document as members of the Antarctic Treaty Organization chose to maintain their distance from IMO codes and regulations. With a lack of clear consensus to make mandatory requirements, IMO opted for two-pronged approach where they would develop broad guidelines and the International Association of Classification Societies (IACS) would create detailed Polar Class construction requirements.

The initial IMO Guidelines for Ships Operating in Arctic Ice-covered Waters (2002) were issued as MSC/Circ.1056 and MEPC/Circ.399 and set out recommended requirements for vessel construction, equipment, operation and basic environmental protection. They were very basic and as they were non-mandatory in nature they were often ignored. After a particularly media worthy sinking of a cruise ship in Antarctic waters, the IMO was approached and the IMO Assemby Resolution A.1024(26) entitled 'Guidelines for Ships Operating in Polar Waters (2010) was promulgated. The Polar Guidelines remained recommendatory only.

IACS successfully completed development of the Polar Class Unified Requirements in 2008. The Polar Classes adopted by IACS and in turn accepted by IMO clearly set out 7 classes of construction (lowest class 7, to highest class 1) based on the whether the vessel is intended to operate seasonally or year round, and in what ice conditions it is expected to operate in (defined by WMO Sea Ice Nomenclature). The lowest Polar Classes are identified as equivalent to sub-arctic classes 1A Super and 1A as identified in Swedish-Finnish ice class rules and other classification societies

Development

Given the continued diversity of national and regional regulations governing polar shipping, the IMO began to consider the need to revisit the recommendatory aspect of the Polar Guidelines after promulgating the 2010 Polar Guidelines. The IMO Secretary General directed the , IMO Committees, Sub-Committees and Working Groups to develop mandatory guidelines, with the intention to provide a clear international standard that signatory flag and coastal states would adopt into their national legislation. The Polar Code is not a stand alone document, but is supplemented by existing IMO instruments, such as SOLAS chapter XIV, MARPOL and STCW. It uses a risk based methodology as its basis to determine scope and is meant to provide guidance to member states in developing detailed regulation to ensure safe and environmentally responsible shipping in the Polar Regions.

Because of its often high level approach to measures, numerous flag states (country with a maritime interest, predominantly where ships are registered.), classification societies and NGO's interested in marine Polar matters have indicated that they will develop additional measures and guidance to the Polar Code.

Current status

The IMO document MSC 94/3/1 of 30 July 2014 outlines the present draft of the Polar Code for consideration for adoption at MSC 94. This document still contains numerous [square brackets] indicating that outstanding issues remain. Ongoing work continues to further define details in the proposed International Code for Ships Operating in Polar Waters with MEPC and NCSR through the fall of 2014.

As of writing, the draft Polar Code consists of two parts: Part I Safety Measures, of which Part I-A covers mandatory measures in 12 chapters, and Part I-B recommendatory Additional Guidance to Part I-A; and Part II Pollution Prevention Measures (Environmental Protection Measures), of which Part II-A covers mandatory measures in 5 chapters and Part II-B recommendatory Additional Guidance.

Part I-A
Chapter 1 General
Chapter 2 Polar Water Operation Manual
Chapter 3 Ship Structure
Chapter 4 Stability and Subdivision
Chapter 5 Watertight and Weathertight Integrity
Chapter 6 Machinery Installations
Chapter 7 Fire Safety/Protection
Chapter 8 Life Saving Appliances and Arrangements
Chapter 9 Safety of Navigation
Chapter 10 Communication
Chapter 11 Voyage Planning
Chapter 12 Manning and Training Familiarity

Part II-A
Chapter 1 Prevention of Oil Pollution
Chapter 2 Prevention of Pollution from Noxious Liquid Substances
Chapter 3 Prevention of Pollution by Harmful Substances in Packaged Form
Chapter 4 Prevention of Pollution by Sewage from Ships
Chapter 5 Prevention of Pollution by Garbage

Implementation

The Polar Code has been subject to numerous delays in implementation even during the latest attempt spurred on by the Secretary General to have in place a mandatory Code by the end of 2016. Even when adopted, there will undoubtedly be immediate moves for amendment as the present rush to meet deadlines imposed by the Secretary General have left many areas unresolved and wording for the final drafts watered down to minimal requirements in order to gain some form of consensus.

Implications

Under the new SOLAS chapter XIV, Polar Code provisions will apply to SOLAS "ships operating in polar waters" upon entry into force. "Ships constructed before [date of entry into force] shall meet requirements...by the first intermediate or renewal survey, whichever occurs first after [one year after date of entry into force]. Discussions continue in MEPC on application under MARPOL.

The Polar Code will not mandatorily apply to non-SOLAS ships operating on 'coastal voyages' although member states are encouraged to apply it to all ships.

The Polar Code provisions will not apply to drill rigs, given IMO's focus on ship-focused instruments; however drill ships in transit would be expected to comply.

Offshore production facilities are built to industry accepted standards and methodologies for safe and reliable design. These designs incorporate site specific data for wind, wave, temperature, ice hazards, water depth, and geologic conditions. Offshore structures are designed and constructed to ISO 19906, API RP 2N or API 2GEN standards under the supervision of a certified professional engineer and reviewed and approved by an independent Certified Verification Agency. API RP 2N 3rd edition is currently in publication and will mirror ISO 19906, Arctic Offshore Structures. This latter standard codifies nearly 50 years of established practice with structures in ice.

Facility design issues are thoroughly addressed in the US Coastguards 30 CFR Part 250, Subpart I, the incorporated standard API RP 2A-WSD (which includes Arctic specific guidance), and other applicable design standards (e.g. ASME, ANSI) and regulations. All Arctic structures are also subject to the third party verification program pursuant to 30 CFR 250.909 -.918.

It should be noted that there is no direct correlation between the Polar Class notations and ISO 19906 or API RP 2N.

Specific Challenges

Success in the Arctic will depend on having a rigs and support vessels that comply with the regulatory framework in place. For Alaska, the Jones Act has a major influence on support vessel availability. The granting of Jones Act exemptions is under continued scrutiny within the US Federal Government.

New vessels will be required to meet the Polar Code requirements to support future exploration and appraisal opportunities.

For future production , the oil will have to be shipped from Alaska to markets in the US, or overseas if legislation permits. If the oil is to be transhipped in the US rather than going direct from the production site to market in a foreign country , the Jones Act requires domestic vessels to be built, manned and owned by a US company and current shipyard capacity is limited to meet the demands in a timely manner. The oil tankers required will be around 185,000 dwt in size and only two shipyards in the US have the facilities large enough to build these vessels at the current time. The advent of the Light Tight Oil (Shale) boom with the US has seen domestic shipyard order books to fill to capacity through to 2017/2018.

Ships compliant with Jones Act and Coastal Trade Legislation need not necessarily comply with SOLAS, which is only applicable to ships conducting International voyages. Vessels that are required to comply with the Polar Code requirements may not readily be grandfathered in, unless some system upgrades are completed. Fully compliant Jones Act and Polar Code vessels may need to be built to support the production opportunities.

A recent MARAD report indicated that vessels operating under the Jones Act requirements have an OPEX of 2.7 times that of foreign vessels which adds to the overall project economics when the viability of field development could be marginal. Similarly, the capital cost of building a Jones Act compliant vessel within the US has a comparable cost inflator when measured against matching international built vessels.

Shell in the US have tried to recruit US nationals to man some of its oil and gas tankers and has struggled to find suitably competent and qualified officers to do so. Future growth of oil and possibly Liquefied Natural Gas Carriers (LNGC) will place greater demands on a limited skillpool and will require early action to address this long lead time issue.

Conclusions

The Polar Code, once formally ratified, will drive changes to vessel design and operations. However it will be some years before it becomes mandated, and there will be a lag before all vessels are fully compliant. There is currently a shortage of suitable qualified vessels to adequately support multiple exploration and appraisal projects, without a significant refresh to fully comply with the Jones Act and Polar Code requirements.

Ice design requirements for semisubmersible and jack up drilling rigs fall outside the Polar Code, Classification Society Polar Class Notations and structural codes and standards.

For vessels engaged in coastal trades the use of equivalent standards should be utilised to ensure that assets which do not readily meet the Polar Code requirements can continue to operate until such times as fully compliant assets can be sourced.

RECOMMENDATIONS

The potential growth in vessel numbers to support multiple oil and gas related exploration, appraisal and developments provides a great opportunity to re-energise the US Shipbuilding (and Ship repair) capability, with an investment in infrastructure and people to be able to deliver the wide range of vessels required for a full field development.

The subsequent demands that this places on the currently constrained skill pool, both in vessel fabrication and operations will require an update of studies previously conducted in 2004 on the maritime skill pool capabilities. Moreover, significant investment in shipbuilding yards and simulation/training need to be considered now to meet the future demand.

References

Arctic Marine Shipping Assessment – Status on Implementation of the AMSA 2009 Report Recommendations (May 2013)

Arctic Marine Shipping Assessment – History of Arctic Marine Transportation (April 2009)

DNVGL website