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MARINE AND OFFSHORE PERSONNEL EVACUATION IN THE ARCTIC

Abstract: Arctic now sees very fast economic and industrial increase. It is accompanied with sharp rise of personnel working in Polar conditions and employed at high risk operations. The most basic problem of human life protection in hazardous conditions is ability of prompt evacuation. Ships plying Artic waters are still using evacuation methods designed for milder climate, open waters operations. Personnel of offshore industry more at risk due to hazardous nature of oil and gas operations. Oil companies are aware of such problem and have developed and introduced new methods of personnel evacuation in Arctic.

Keywords: Arctic, Evacuation, Shipping, Offshore

Introduction

Changes in Earth's climate are gradually reducing ice cover in Arctic. Milder environmental conditions made easier oil and gas exploration in Arctic where very large resources of fossil hydrocarbons were discovered. Today, Canada, Norway and Russian Federation are exploiting Arctic natural resources on large scale. Decrease in permanently ice-cover has intensified commercial shipping at Northern Sea Route (NSR), along coast of Russian Federation. Far East countries, mainly China, are anxious to use shorter and safer in many aspects sea route to Europe. Further reduction in sea-ice permanent cover will eventually lead to opening of Trans-Polar Route (TPR), which is expected to take place in the middle of current century. Characteristic features of Arctic climate are short cold summers and long very cold winters. Temperatures range from +10 °C to -50°C and winter snow blizzards created by Artic low pressure systems are frequent. Earth's axis tilt is responsible for summertime Polar day (period of round the clock daylight wit Sun

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never setting) and winter Polar night when Sun never rises and total darkness reins. Such darkness makes visual detection of navigational dangers virtually impossible and has very negative impact on human performance. Part of Arctic is covered by multiyear permanent very hard and remaining part of area having seasonal, one year ice cover. Southern part of Arctic region is wormer, particular in Barents Sea, due to warming effect of Gulf Stream. Living in such conditions is extremely difficult and most of Arctic shipping lanes and offshore installations sites are situated far from populated centers. Remote location poses serious problem in regard to promptness and efficiency of emergency response and lower the likelihood of survival. Unlike of most navigable waters, which have clearly designated areas of Search and Rescue (SAR) responsibility for costal states, there was no such arrangement in Arctic until 2013. In that year entered into force Arctic Search and Rescue Agreement, signed by states of Arctic Council two years earlier. This international treaty coordinates SAR operations and sets area of SAR responsibility for each party. Agreement was Arctic Council answer to growing economic importance of Arctic forecasted continuous development owing to increased accessibility related to recent climate changes. Arctic states are expanding exploitation of natural resources and international shipping industry more often choses Arctic transit routes as much shorter alternative. Intensification of marine traffic increases risk of large scale environmental disaster and irreversible damage to fragile ecosystem and native population. Large passenger vessels sailing in Arctic waters have heightened risk of emergency on board associated with harsh environment, navigation through the ice and necessity of evacuation of large number of passengers in the area where SAR services are more than problematic. Graphic below presents delimitations of SAR responsibility for Arctic states:

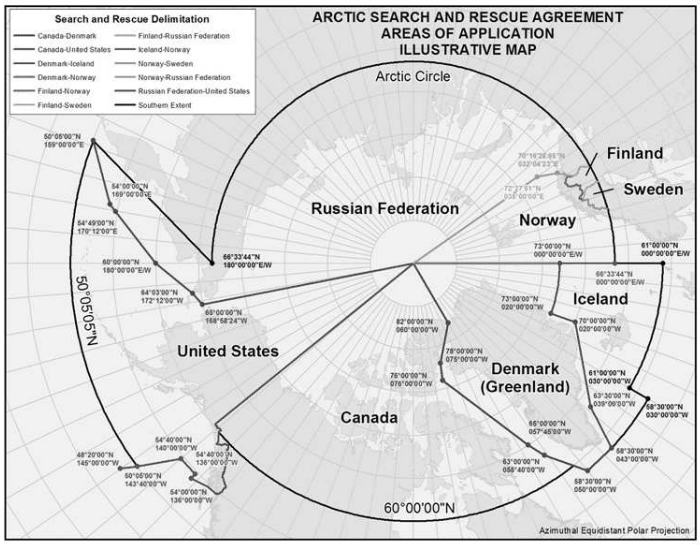

Fig.1. Arctic SAR areas delimitations
Source: https://en.wikipedia.org/wiki/Arctic_Search_and_Rescue_Agreement.

1. Evacuation means and methods

Survival of human beings in Artic depends on speed and method of evacuation. Evacuation is being defined as planned method of leaving of installation in emergency[2]. Vessels and offshore units operating in Polar waters have to comply with international regulations set by International Maritime Organization (IMO) in Safety of Life at Sea Convention (SOLAS), Life-Saving Appliances Code (LSA) and Polar Code. Rules require use of partially enclosed or totally enclosed lifeboats. All life-saving appliances must be able to be deployed in ice-covered waters or directly onto ice. Every persons on board shall be provided with adequate thermal protection. In order to support survival following abandoning ship, individual and group resources shall be provided to survive on land, water or ice for whole period of maximum expected time of rescue[3]. Cargo ships generally relay upon davit-launched or free-fall lifeboats and inflatable liferafts. Passenger vessels carrying large amount of persons on board often prefer Marine Evacuation Systems (MES) for fast and safe evacuation of physically unfit or partially disabled persons to the platform at the water level. Passengers from platform can be safely transferred to lifeboats or liferafts. Offshore units are operating in more demanding environment often they require evacuation equipment which is not standard for shipping industry. Most problematic is safe evacuation of installation personnel in solid or broken ice. Conceptual development lead to new launch systems for safe depositing evacuation crafts on broken or solid ice. New generation of Totally Enclosed Motor Propelled Safety Crafts (TEMPSC) has been introduced as Ice Reinforced TEMPSC (IRTs). Some installations called for development amphibious crafts and new designs of multipurpose offshore vessels for Arctic service. For offshore industry Arctic conditions are extended to Sea of Okhotsk, Bohai Bay and Northern Caspian Sea. These region are heavily influenced by continental climate with very cold winters and personnel evacuation problems are very like to Arctic.

2. Southern part of Barents Sea

Barents Sea in its southern part is generally free of ice cover during winter due to warming effect of Gulf Stream. Vessels plying these waters are not restricted in use of lifeboats and liferats. Occasionally they may encounter some ice floes and free fall lifeboats may sustain damage when hitting ice chunk. Davit-n lifeboats are much safer in such circumstances. Passenger vessel widely use Marine Evacuation Systems (MES) which have proved their efficiency in ice-free waters. General idea of such system is shown below:

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[2] ISO 15544.

[3] IMO Resolution MSC.385(94). Adopted on 21 November 2014.

Fig. 2. Marine Evacuation System
Source: http://www.rfd.co.nz/products/marine-products/marine-evacuation-systems.aspx.

'Dry' evacuation protects survivors against hypothermia in cold climate and increases their chances for survival. Offshore installations in this are mostly relying upon free-fall lifeboats with strengthened hull. It is necessary as have to be launched from elevated storage points at the oil rigs. Some boat are certified for save launch from height of 50 m. Such launch requires minimum water depth 20 m to avoid boat hitting the bottom[4]. Traditional materials like polyester and fibre glass are sometimes replaced with stronger aluminium alloys like offshore lifeboats pictured below:

Fig. 3. Offshore aluminium alloy, strengthened hull free fall lifeboats
Source: http://www.verhoef.eu/?gclid=COLiiP3godQCFcmsGAod90oAug.

Free fall lifeboats are fast mean of offshore crew evacuation but even small floes of ice can render boat unusable. Solution to this problem is deployment of evacuation chutes allowing 'dry' evacuation to inflatable liferafts. Offshore crew working in Arctic is provided with immersion suits with increased thermal insulation and face protection in excess of IMO standards. Evacuation chutes are used for extremely tall installations, with some of them certified to height of 81m[5].

[4] http://norsafe.com/lifesaving-systems/freefall-lifeboats/ges-52/
[5] https://www.viking-life.com/en/chute-systems/offshore-evacuation-systems/evacuation-systems-/3476-ses-2a-viking-ses-2a-one-size

Equipment designed for offshore applications has fire retardant chute with liferafts stored inside blast proof containers as can be seen below:

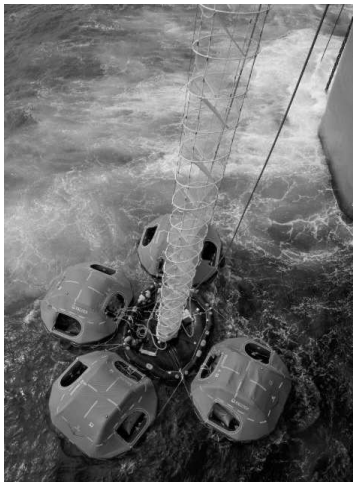

Fig. 4. Offshore chute integrated with liferafts for evacuation of tall structures
Source: https://www.viking-life.com/en/chute-systems/offshore-evacuation-systems/evacuation-systems-/3476-ses-2a-viking-ses-2a-one-size.

To avoid installation of multiple evacuation systems and risk of hitting ice floating in the water, some offshore companies prefer davit-launched lifeboats with specific design known as Boat-In-A-Box, developed for Norwegian installations at Barents Sea. Protective shack prevents boat from icing and shields launching gear, which improves its reliability. Crew embarkation can be carried out in much safer way while personnel inside is protected against any external factors including blast wave. Typical design is being shown below:

Fig. 5. Boat-In-A-Box system
Source: http://www.offshoreenergytoday.com/xervo-lifeboats-for-worlds-largest-jack-up-rig/.

All those systems work satisfactory in ice-free waters or with minimal ice presence. Heavier ice cover prevents any movement of lifeboats and liferafts, making further evacuation impossible. Ice rubble accumulating around base of installation may crush evacuation craft and escalate emergency situation.

3. Ice-covered Arctic waters, accessible by sea-going vessels

Commercial and passenger shipping are limited to Arctic area with seasonal ice cover. Operations in ice-free waters are allowed for so called 'blue water' vessels, not designed for Polar conditions. Areas covered with first-year ice require vessels with proper Polar class for passage without icebreaker assistance. Passage through permanent ice is available only for purpose built icebreakers. For time being, offshore Arctic activity is also limited to first-year ice area for economic and technical reasons and waters with depth suitable for structures with base resting on sea bottom or built on artificial islands. Vessels plying these waters are complying with Polar Code requirements regarding carriage of partially enclosed or fully enclosed lifeboats designed for open waters. Offshore industry initially accepted open waters evacuation systems for use in ice-covered waters but later has developed several new evacuation system which are better suited for installations where drifting ice (ice pack) frequent phenomenon. Offshore installation in ice pack is pictured below:

Fig. 6. Gravity base offshore oil rig in ice pack
Source: https://www.bastamag.net/L-Arctique-soumise-au-rechauffement-climatique-resistera-t-elle-a-la-convoitise

Evacuation in moving ice field may result in crushing of evacuation craft under ice pressure. Safest place to launch evacuation craft is wake behind offshore structure as shown on graphic below:

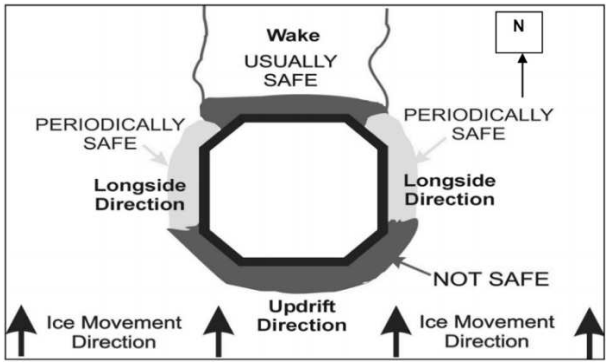

Fig. 7. Potential evacuation directions
Source: Poplin J., Wright B., Dickins D., *Overview and Background of Escape, Evacuation,and Rescue of Offshore Personnel in the Arctic*, National Petroleum Council, Washington D.C., 2014, p. 6, 10.

Craft should be lowered in safe distance from installation to avoid accumulated ice rubble and survivors can be safely picked up by stand-by vessel. To overcome short range of typical davit for lifeboat launching, several concepts have been proposed. One of the proposals, called Seascape has been tested and found prospective for further development[6]. System uses long, articulated arm to lower in controlled manner aluminium TEMPSC in distance 20-30 m from offshore structure. Basic idea of this concept is given below:

Fig. 8. Articulated Seascape System
Source: Poplin J., Wright B., Dickins D., *Overview and Background of Escape, Evacuation,and Rescue of Offshore Personnel in the Arctic*, National Petroleum Council, Washington D.C., 2014, p. 6, 10.

[6] B.D. Wright, G.W. Timco, P. Dunderdale, M. Smith, *Evaluation of Emergency Evacuation Systems in Ice-Covered Waters,* PERD/CHC Report 11-39, Ottawa 2002, p. 28.

4. Shallow Arctic and Arctic-like ice-covered waters

Some Arctic offshore installations are built upon artificial islands in shallow waters of Beaufort Sea. Shallow water installations can be also found in the Northern part of Caspian Sea and Bohai Bay, where winter conditions are similar to those in Arctic. Installations are accessible from water side only by shallow draft vessels, mostly purpose build for particular location. Personnel evacuation in such circumstances requires only standard open water rescue means. Ice cover during winter time make evacuation process much more complicated. Icebreakers have difficulties to operate in shallow waters and special crafts are needed for crew evacuation. For Caspian Sea and light ice conditions it has been designed and built shallow water Ice Breaking Emergency Evacuation Vessel (IBEEV)[7]. Several such vessels were built by Stocznia Remontowa in Gdańsk for oil companies operating in Northern Caspian Sea. Picture of IEEBV is shown below:

Fig. 9. Caspian Sea IEEBV
Source:https://en.wikipedia.org/wiki/Ice_Breaking_Emergency_Evacuation_Vessels#/media/File:Ice_Breaking_Emergency_Evacuation_Vessel_2,_an_special_purpserescue_vessel_on_the_icy_Caspian_Sea.jpg.

Vessel can accommodate ten casualties on strechers and 328 evacuees. She is capable to evacuate large oil production complex in one trip. Propulsion consists of 2 x 800 kW main engines and 2 x 550 kW azimuth thrusters. Compressed air storage allows for 50 minutes operation in burnibg oil pools or oxygen deficient areas.

Local conditions at Beaufort Sea nad Bohai Bay preclude use of any vessels for evacuation purposes. For these locations the only aswer is amphibious vehicle. With technical input and funding from oil companies unique vehicle has been built. Named Arktos, vehicle is built as two independed pods linked with articulated, hydraulically operatet arm. Each pod has 250 HP Diesel engine driving tracks and water-jet propulsor. Depeniding on version it can accommodate 50-52 evacuees. Vehicle has unsurpassed abilities to climb steep slopes, drive through multi-year ice, brash ice, open water, quick sands and mud. Internal air storage and

[7] https://en.wikipedia.org/wiki/Ice_Breaking_Emergency_Evacuation_Vessels.

fire resistant hull made of kevlar and e-glass witj thermal insulation allow for passing through burning oil pools, Arktos is mainly used at Beaufort Sea, Bohai Bay and some crafts are serving in Caspian Sea. Vehicle can be seen below:

Fig. 10. Arktos moving through broken ice.
Source: http://alternathistory.com/kanadskiy-vezdekhod-korabl-arktos-potushit-pozhar-v-pustyne-i-na-plyazhakh-antarktiki.

Conclusion

Development of Arctic has brought to light problem of human life protection in case of major emergency which may occur either in shipping or offshore industry. The best way of personnel protection is prompt evacuation into the safety. Shipping in Artic is still using evacuation means designed for open waters which may fail in harsh environment. Offshore industry is even more exposed to dangers associated not only with Polar conditions but also with high risk gas and oil production activities. Heightened level of risk has stimulated oil companies to develop and introduce more efficient evacuation methods.

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Abstrakt

Ewakuacja personelu ze statków i instalacji ofshorowych w Arktyce

Arktyka przeżywa obecnie okres szybkiego ekonomicznego i przemysłowego rozwoju. Związany jest z tym szybki wzrost liczebności personelu pracującego w polarnych warunkach i zatrudnionego przy niebezpiecznych operacjach. Podstawowym problemem ochrony życia ludzkiego w niebezpiecznych warunkach pracy jest możliwość szybkiej ewakuacji. Statki pływające na wodach arktycznych do tej pory używają metod ewakuacji opracowanych dla łagodniejszego klimatu i otwartych wód. Pracownicy przemysłu offshorowego są bardziej narażeni na niebezpieczeństwa z powodu zagrożeń związanych z wydobyciem ropy i gazu. Firmy naftowe są świadome tych zagrożeń i dlatego opracowały i wprowadziły nowe metody ewakuacji pracowników w warunkach arktycznych.

Słowa kluczowe: Arktyka, ewakuacja, żegluga, offshore