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International code for ships operating in polar waters: challenges to polar shipping safety rules in China

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Abstract With the sea-ice diminishing steadily in the polar regions, there has been growing interest in new transit routes through polar waters using cost-effective transportation. Among the international regulators over polar shipping, the International Maritime Organization (IMO) is the leading body concerned with drafting marine safety and environmental protection rules. The mandatory Polar Code (International Code for Ships Operating in Polar Waters) adopted by the IMO signals the consensus among maritime states to apply compulsory rules to vessels operating in Arctic and Antarctic waters. As the standing member of the IMO and a major global shipping power, China is preparing to adopt national regulatory standards to develop an adequate vessel infrastructure and crew training system. Proceeding in parallel with the developing polar shipping industry, China will also move ahead in comprehensive collaboration with the Nordic states regarding polar issues.

Keywords **polar shipping, marine safety, IMO, Polar Code, China, the Nordic countries**

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1 Introduction

The polar regions includes the Antarctica and the Arctic. The Arctic, once a frozen land under the exclusive dominion of the Arctic states, is becoming increasingly globalized owing to climate change. According to the Fifth Assessment Report finalized in 2014 by the Intergovernmental Panel on Climate Change of the UNEP, the annual mean Arctic sea-ice extent decreased over the period 1979 to 2012, with a rate that was very likely in the range 3.5 to 4.1% per decade. Arctic sea-ice extent has decreased in every season and in every successive decade since 1979, with the most rapid decrease in decadal mean extent in summer[1]. It is predicted that the Arctic Ocean may experience ice-free summers in the near future given this trend. With the polar ice sheet reaching a record low level, many countries are vying for a say in the polar shipping industry.

Compared with traditional sea routes such as the Suez and Panama Canals, the Arctic passage is significantly more reliable, offering reduced transit distance and requiring less fuel. It is estimated that the Northern Sea Route saved up to 40% of sailing distance from China to Northern Europe, compared with the distance via the Suez Canal, and the Northwest Passage decreases the length of the route between the Pacific and Atlantic Oceans via the Panama Canal by 40%[2]. Additionally, the existing routes through the Suez and Panama Canals have been increasingly threatened by piracy and potential political instability, thus the development of a new route along the Arctic Ocean would greatly enhance the security of international shipping[3].

Recognizing the significance of both maritime safety and preserving the marine environment, the International Maritime Organization (IMO) has been dedicated to researching legal issues in terms of safety and environmental preservation and developing corresponding international conventions and other maritime rules since its establishment in 1959. Besides drafting conventions in terms of global maritime issues, the IMO also attaches great importance to drafting rules especially applicable to polar waters. Acknowledging that the most important initiative for appropriate safety and environmental regulation is a mandatory Polar Code, in November 2014 the IMO adopted

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the *International Code for Ships Operating in Polar Waters* (Polar Code). The Polar Code is the first mandatory rule applicable in both the Arctic and the Antarctic waters, and takes effect on January 1, 2017.

This article will briefly review the key role of the IMO in ensuring maritime safety and marine environmental protection, and then analyze the main points of the Polar Code and its impact on polar shipping. Building on this approach, this article will examine the challenges the Polar Code presents to polar shipping safety rules in China, and explore future possible cooperation between China and the Nordic countries in developing ice-breaking technologies and adopting future IMO conventions and instruments.

2 The key role of the IMO in the governance of polar water shipping

2.1 The international mechanism regulating polar water shipping

The international mechanism of polar water shipping governance mainly includes the 1982 *United Nations Convention on the Law of the Sea* (UNCLOS), the Arctic Council and the IMO. As the most important treaty law concerning ocean governance, UNCLOS established the basic rules of allocation of global marine resources; meanwhile, Article 234 of UNCLOS, "Ice-Covered Areas", gives polar coastal states the right to adopt and enforce non-discriminatory laws and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered areas[4].

Initially, Article 234 of UNCLOS was regarded as the only rule commenced to protect polar waters, and it gradually gained the status of international customary law through coastal countries' application. These countries, including Canada and Russia, gradually adopted national regulations regarding arctic passage issues. On the one hand, the national regulations adopted by coastal countries are strict rules regarding safety and environmental protection. For example, Russia claims jurisdiction over the Northern Sea Route under Article 234 of UNCLOS, and ships navigating through the Northern Sea Route shall obey Russian national law, meaning they must meet Russian standards and use high-cost Russian icebreakers. On the other hand, different coastal polar countries adopt different passage rules, and the fragmented nature of existing national regulations in Arctic countries will inevitably affect the uniformity of polar water passage rules. Therefore, Article 234 of UNCLOS only concerns the coastal countries' rights to make national laws and regulations, and could not contribute to the establishment of an international rule in polar waters.

The Arctic Council is the leading intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States, Arctic indigenous communities and other Arctic inhabitants on common Arctic issues, particularly issues of sustainable development and environmental protection in the Arctic. The Declaration on the Establishment of the Arctic Council lists the following countries as members: Canada, Denmark, Finland, Iceland, Norway, Sweden, the Union of Soviet Socialist Republics (now Russia) and the United States of America. In addition, the Arctic Council determined the Permanent Participant and Observer status of concerned parties. Six organizations representing Arctic indigenous peoples have status as Permanent Participants. This category was created to provide an opportunity for active participation of and full consultation with Arctic indigenous peoples within the Council. Permanent Participants include the Aleut International Association, the Arctic Athabaskan Council, Gwich'in Council International, the Inuit Circumpolar Council, Russian Association of Indigenous Peoples of the North and the Saami Council. Observer status is open to non-Arctic states; global and regional intergovernmental and inter-parliamentary organizations; and non-governmental organizations. In May 2013, China was granted Permanent Observer status by the Council[5]. At the 2004 Ministerial meeting in Reykjavik, the Arctic Council called for the Council's Protection of the Arctic Marine Environment (PAME) to conduct a comprehensive Arctic maritime shipping assessment. As a result of that Ministerial decision, the *Arctic Marine Shipping Assessment* (AMSA) 2009 *Report* was approved at the 2009 Ministerial meeting in Tromso. The Report recognized that climate change, governance challenges, and maritime infrastructure issues would influence current and future maritime uses of the Arctic; therefore maritime safety was the focus of the Report. It specified that to enhance Arctic maritime safety, the Arctic states should cooperatively support efforts at the IMO to strengthen, harmonize and regularly update international standards for vessels operating in the Arctic[6]. In short, it is fair to conclude that the Arctic Council undoubtedly plays a significant role in the Arctic, but there are limits to what a regional organization can do to push forward global governance.

Compared with UNCLOS and the Arctic Council, the IMO is the leading body concerned with drafting maritime safety and environmental protection rules. As a specialized agency in the United Nations, the IMO has adopted globally feasible standards for maritime legal issues, given its authority in the field of maritime shipping. When it comes to operation safety in ice conditions and protection of the fragile polar environment, IMO rules could be fairly divided into two categories. The first comprises international maritime conventions generally applicable in all marine areas, including four principal IMO conventions: *the International Convention on Safety of Life at Sea*, 1974 (SOLAS 1974), *the International Convention for the Prevention of Pollution from Ships*, 1973 Adoption, 1978 Protocol amendment (MARPOL 73/78), *the International Convention on Standards of Training, Certification and Watch keeping for Seafarers*, 1978 Adoption, 1995 amendment (STCW 78/95), and *the International Convention on Maritime Search and Rescue, 1979*. Although those conventions include provisions that can

be applied in polar waters, they were not negotiated or drafted specifically for ships navigating the polar regions. The second group contains the Guidelines and Rules specially drafted for ships operating in polar waters. So far, the most effective regulation is the Polar Code adopted in 2014. This Polar Code, the first mandatory rule with application scope in both Arctic and Antarctic waters, will be regard as a milestone in polar water shipping governance.

2.2 The Polar Code drafting process

Considering the climate conditions in Arctic ice-covered waters, the IMO initiated drafting of guidelines particularly applicable to polar waters. As the Polar Code is based on part of the IMO Guidelines, it is necessary to review the underlying cause of their original drafting to address additional provisions beyond the existing requirements set down by the 1974 SOLAS Convention. The first efforts of the IMO to draft special guidelines for ships operating in the polar regions were promoted by two important IMO committees: the Maritime Safety Committee (MSC) and the Marine Environmental Safety Committee (MEPC). Acknowledging "the need for recommended provisions applicable to ships operating in the Arctic ice-covered waters, additional to the mandatory and recommended provisions contained in existing IMO instruments"[7], the 76th session of the MSC and the 48th session of the MEPC adopted *The Guidelines for Ships Operating in Arctic Ice-Covered Waters*, 2002 (The 2002 Guidelines). The 2002 Guidelines, though not legally binding, provided an important reference for IMO members and the classification societies thereof regarding Arctic shipping.

The AMSA 2009 Report also promoted the drafting process of the Polar Code in terms of providing a basis for protection measures in the Arctic for the IMO to consider. Influenced by the AMSA 2009 Report, and in recognition of the increasing importance of polar shipping in both the Arctic and the Antarctic ice-covered waters, the IMO Assembly adopted *The Guidelines for Ships Operating in Polar Waters*, 2010 (The 2010 Guidelines) which extended the application scope to include Antarctic waters[8]. Part of the official cause for this extension was a decision from the Antarctic Treaty Consultative Meeting. In 2005, the Antarctic Treaty Consultative Meeting adopted *The Decision on Guidelines for Ships Operating in Arctic and Antarctic Ice-covered Waters*, which concluded that the IMO was competent to enact rules applicable to Antarctic shipping. Driven by that decision, the revision of the 2002 Guidelines by the IMO was commenced to "render (the 2002 Guidelines) applicable to ships operating in ice-covered waters in the Antarctic Treaty Area as well"[9]. The 2010 Guidelines were recommendations by the IMO for polar shipping, and thus non-compulsory, but made significant progress regarding the scope of application.

Although environmental and safety issues were addressed in the 2002 and 2010 Guidelines, there had not yet been a comprehensive and mandatory IMO instrument regarding all aspects of polar shipping[10].An array of proposals in 2009 led the MSC to include the work program item of drafting "the Development of a Mandatory Code for Ships Operating in Polar Waters" at its 86th session. In 2010, the 53rd session of the Sub-committee on Ship Design and Equipment (DE) initiated negotiation of the Polar Code and established related proposals and decisions[11]. To meet appropriate standards of maritime safety and pollution prevention, a corresponding group (CG) was established to develop the main principles of the Polar Code.

Based on the comments and decisions made at the 53rd session of the DE, the Polar Code negotiation process then encountered challenges to making the Polar Code compulsory. Disagreements among the IMO members chiefly centered around three proposals[12]. The first proposal was to amend the provisions related to maritime safety in the SOLAS Convention. Thus, the Polar Code could take effect through the SOLAS Convention, but the pollution prevention measures in the Polar Code would be excluded because the SOLAS Convention only relates to maritime safety. The second proposal was to develop a new convention providing special rules for vessels operating in polar waters. The advantage of this approach was that the scope of application would be more explicit, and the new convention would be a mandatory rule without the intrusion of other maritime conventions; however, the contracting members of this new convention might be far fewer in number than those of the SOLAS Convention and the MARPOL Convention, thus putting its applicability in question.

The third approach was making this new Polar Code compulsory using existing legal instruments in the form of amendments to the SOLAS Convention and the MARPOL Convention[13]. This proposal would not affect the framework and structure of international maritime instruments. It therefore turned out to be more practical than the first two, given that the contracting parties of IMO maritime conventions and the Polar Code were similar. Consequently, at its 63rd session the MEPC decided to adopt the third approach[14].

Considering the need for a mandatory framework for ships operating in polar waters that extended beyond existing requirements, the IMO adopted the Polar Code safety measures during the 94th session of the MSC held in November 2014[15]. Likewise, associated MARPOL amendments, the pollution prevention measures of the Polar Code, were adopted at the 68th session of the MEPC in May 2015[16]. The Polar Code takes effect on 1 January 2017, and will apply to new ships constructed on or after 1 January 2017. For ships constructed before that date, relevant requirements must be met by the first intermediate or renewal survey before 1 January 2018.

3 The Polar Code's impact on polar shipping

The Polar Code is the first compulsory blanket rule for polar shipping that addresses potential risks and hazards in Arctic and Antarctic environments, such as ice, remoteness, high

latitude, and rapidly changing and severe weather conditions. It strives to harmonize the design of ice-capable vessels, to set higher levels of ice strengthening for Polar Class ships, and to regulate the training and employment of ice navigators.

3.1 Safety measures–the Polar Code priority

The Polar Code consists of an Introduction, followed by parts I and II. The Introduction contains mandatory provisions applicable to both parts I and II. Part I is subdivided into Part I-A, which contains mandatory provisions on safety measures, and Part I-B, recommendations on safety measures. Part II is subdivided into Part II-A, which contains mandatory provisions on pollution prevention, and Part II-B, recommendations on pollution prevention.

Although the adoption of the Polar Code is viewed as a major step forward for Arctic shipping, critics argue that the Polar Code will fail to protect the polar environment because it does not fully address ballast water treatment, prevent the use of heavy fuel oil and the discharge of raw sewage into the sea, or adequately equip ships and crews to deal with minor spills[17]. In fact, environmental protection rules in the Polar Code only include the prevention of pollution by oil, control of pollution by noxious liquid substances in bulk, prevention of pollution by noxious liquid substances in bulk, prevention of pollution by harmful substances carried by sea in packaged form, and prevention of pollution by sewage and garbage from ships. Black carbon, heavy oil, a mandatory energy efficiency index, and other sensitive issues consulted in several rounds of MEPC sessions were ultimately excluded from the Polar Code. Because of the more detailed safety measures compared with the environmental measures in the Polar Code, flag states shall attach more importance to the former ones in the near future.

The safety measures of the Polar Code provide goals and functional requirements covering the full range of ship design, construction, equipment, operation, training, and search and rescue. Ships operating in polar waters will be expected to meet functional requirements in terms of ship structure, subdivision and stability, water-tight and weather-tight integrity, machinery installations, fire safety, life-saving appliances and arrangements, safety of navigation, and communications and voyage planning, manning and training.

More specifically, ships constructed for polar shipping must be able to receive and display up-to-date information about the ice conditions as well as visually detect ice when navigating in darkness. As well as improved stability and hull strengthening, the code will require additional equipment for polar ships, such as two separate echo sounders, search lights to spot ice and a means of preventing the accumulation of ice on antennas. Lifeboats must be covered or partially covered and be capable of distress alerting and on-scene communications. Training guidance stresses the importance of officers in charge of a navigational watch having sufficient and appropriate experience in polar waters. To support the decision-making process of the polar ship, the master and crew must be trained with sufficient information regarding the operational capabilities and limitations of the vessel.

3.2 Polar ship classification and certification

Regarding polar ship classification, at its 56th session the DE Sub-Committee divided ships into three categories: Category A, Category B and Category C[18]. In accordance with the Polar Code, ships operating in polar waters will be required to have a Polar Ship Certificate issued by its corresponding national administration. In 2010, Canada submitted a proposal stating that the coastal states of the polar regions were entitled to issue the license for ships operating in polar waters, but this motion was not adopted by the IMO[19]. Nevertheless, owing to the present risks in the Arctic and Antarctic area and the increasing demand for polar shipping, the IMO recognized the necessity of issuing the Polar Class Certificate.

In 2011, the DE subcommittee stated that polar ships should hold the Polar Water Operational Manual (PWOM) besides the Certificate, and the Manual should contain sufficient information regarding the ship's operational capabilities and limitations to support the crew's decision-making process. The Polar Code confirmed the importance of PWOM, and recognized the subcommittee's ruling, thus requiring polar ships to have a PWOM available to aid decision making.

3.3 GBS standards

Recommended by The Bahamas and Greece, the IMO introduced Goal-Based Standards (GBS) at the 89th Council Meeting[20]. The 23rd Assembly established GBS as an important strategic plan for the IMO and arranged their objectives into the five tiers of GBS: the first layer, "safety goals", addresses polar ship design and construction meet the requirements and safe navigation in polar waters; the second layer, "functional standards", requires the structure of polar ships to be consistent with their specific function; the third layer, "compliance verification", aims to set a series of shipbuilding standards for shipping companies by contracting states; the fourth layer "norms of ship design and construction" and the fifth layer "industry practice standards" which are the rules regarding safe navigation and prevention of pollution from vessels formulated by IMO member states. The Polar Code ultimately applied the first three layers of GBS, and left adoption of the fourth and fifth layer at the discretion of national classification societies and shipping associations. Compared with a unified shipbuilding standard, GBS is more conductive to stimulating innovative ship design[21].

The GBS adopted by the Polar Code reflected the trend of international maritime convention development, and polar ships will be expected to meet these functional requirements. As mentioned in the Preamble of the Polar Code, GBS only set the goals for polar shipping using a risk-based approach to determine scope, rather than making compulsory provision of specific shipbuilding standards. Through analysis of the

anticipated range of operating and environmental conditions, such as operation in extra low air temperature, ice and high latitude, GBS set out the functional goals of a polar ship. In addition, it allows the use of alternative methods to fulfill the same goals, which is relatively fairer and more objective than different domestic shipbuilding standards.

In sum, the Polar Code, as the latest mandatory rule regarding polar waters adopted by the IMO, has put in place related standards for polar ship safety, such as ship design, ship construction, and crew training. According to the Polar Code, flag states will make sure that ships in polar waters conform to these safety measures.

4 Challenges to China's polar shipping

In accordance with Article 217 of UNCLOS, flag states must bear the obligation to reduce and control marine environment pollution from vessels, and must adopt corresponding laws and regulations and take measures necessary for their implementation. Additionally, *Implementation Rules of IMO Mandatory Documents*, revised by the IMO Joint Working Group, specifies that flag states are also obliged to implement IMO documents regarding marine safety and environmental protection, and take all necessary measures to ensure that IMO rules and documents are upheld. China accepted treaty compliance review of the IMO in 2009, and its Maritime Bureau of Ministry of Transport formulated *the Maritime Treaty Compliance Framework of China*, and later issued *the Maritime Treaty Compliance Rules of China and Management Standards of Maritime Treaty Compliance*.

China's scientific expeditions in the polar regions, initiated by the Chinese icebreaker R/V *XUE LONG* ("Snow Dragon"), signaled the country's strategy of developing the Arctic and engagement in polar regions[22]; however, the Polar Code provides compulsory standards that present great challenges to the Chinese polar shipping industry. Given that safety measures of the Polar Code take priority over environmental protection measures, China should attach importance to establishing polar shipbuilding industry standards and a crew training system to ensure safe navigation in polar waters.

4.1 Polar shipbuilding industry standards

China has emerged as one of the world's largest shipbuilders and suppliers of seafarers in recent years, and the Chinese government has attached importance to polar shipping safety. As mentioned above, the Polar Code has imposed strict requirements for polar shipbuilding. More specifically, in terms of ship structure and machinery installations, the Polar Code requires that the material and scantlings of the structure retain their structural integrity based on global and local response due to environmental loads and conditions. To encounter extreme cold weather conditions, this Polar Code specifies that polar ships shall be designed with watertight and weather tight integrity[18].

Based on those regulations of the Polar Code, the polar shipbuilding industry of China should consider the ice removal equipment and fire safety appliances necessary to facilitate safe evacuation in emergency circumstances. For example, all lifeboats of the newly-built polar ships must be totally or partially enclosed, and thermal protective aids or proper sized immersion suit must be provided for each person on board[18]. Given that navigation in polar waters imposes additional demands on ships due to the extremely harsh weather conditions, the key principle for developing the Polar Code was a risk-based approach in reducing identified risks.

It is worthwhile mentioning that the China Classification Society (CCS) issued *Guidelines for Polar Ships* in March 2016, which aimed to provide technical guidance for the implementation of the Polar Code in China. These Guidelines include inspection and certification, ship structure and equipment, ship stability, mechanical and electrical equipment, safety equipment, and operation rules in polar waters. The Guidelines make it clear that the hull structure and components of polar ships should be able to resist environmental risks in polar waters stemming from high latitude, bad weather, and polar day/polar night. With respect to Category A and B ships, the Guidelines require that they have a polar service temperature below −40°C and −15°C to −30°C, respectively; additionally, it recommends the use of wear-resistant coatings with high adhesion, resistance to spalling and low friction in those two kinds of polar ships[23]. All these requirements in the Guidelines are in line with the mandatory rules in the Polar Code. It is expected that China will adopt more polar shipping industry standards in the future to guide the production of low-temperature resistant equipment for polar ships.

4.2 Crew training system

Besides the harsh environment of polar waters that poses a possible threat to ships and crewmembers, the Preamble of the Polar Code also acknowledges that polar ecosystems could be vulnerable to human activities, such as improper operation of the crew. The Polar Code thus made a compulsory provision in the 12th chapter "Manning and Training" of section I-A "Security Measures" that requires that masters, chief mates and officers in charge of a navigational watch must meet the qualifications according to Chapter V of the STCW Convention and the STCW Polar Code.

The Polar Code separates ice conditions into three kinds: ice free waters, open waters, and other waters. The polar ship types were also divided into tankers, passenger ships and other ships. In terms of specific training requirements, the STCW Convention would be not applicable to all ships navigating in ice free waters and other ships navigating in open waters. Masters, chief mates and officers in charge of a navigational watch must have completed appropriate training, and the extent of crew training depends on the type of polar ship and the ice conditions.

For tankers and passenger ships navigating in open waters, the master, chief mate and officers in charge of a

navigational watch must receive basic training in accordance with the Polar Code. For all ships navigating in other waters, master and chief mate bear strong responsibility of safe navigation, and shall receive advanced training accordingly, whereas officers in charge of a navigational watch receive basic training. In addition, the master of the polar ships shall also be trained to be alert to current information on various conditions of the intended route, including identification of icebergs and marine mammals.

Considering the obligations set out in the Polar Code, China must establish a training program for polar ship operators. *The Maritime Safety Law*, adopted in 1983, required that the master and other crewmembers should have a job certificate but did not make arrangements regarding crew training. *The Decision of Revising the Management Rules of Crew Training*, created by the Ministry of Transport of the People's Republic of China and effective 1 April 2014, proposed compulsory training programs such as shipboard training, tankers and other special ship device training, as well as security awareness training in accordance with the STCW convention. According to this Decision, each crewmember of a polar ship must be familiar with his/her assigned duties provided in the PWOM, and the crew size must be sufficient to allow for a three-shift watch[24]. From a long-term perspective, the relevant laws and regulations in China regarding polar shipping shall consist of specific training programs and courses to adapt to international standards.

5 Polar shipping cooperation between China and the nordic countries

The polar region is undergoing a geopolitical state-change that will determine how this region and its resources will be used, making it possible for navigating in polar waters with advanced shipping technologies[25]. It is well-known that the leading countries of ice-breaking shipbuilding technology at present mainly include Russia, the United States, Canada, Finland, Denmark, Norway, and Iceland, inside which Norway, Finland, and Sweden have already boasted of thriving development in research institutions of ice-breaking ship design and construction[26]. From the long term perspective, China shall conduct comprehensive cooperation with the Nordic countries regarding ice-capable polar vessel design and ice strengthening for Polar Class Ships, as well as reach more international standards under the IMO.

5.1 Strengthening ice-breaking technology cooperation

China is the top trade partner of the Nordic countries in Asia, and in some cases, the top trade partner in the entire world. Sweden and Denmark were the first Nordic countries to forge comprehensive partnership with China. With the economic potentiality of the NSR, Denmark, a global leader in the field of icebreaker, has become one of China's important partners in Arctic issues. In March 2016, the Danish Maritime Bureau authorized that Magne Viking of Viking Supply Ships was the first ship meeting the requirements of Polar Code all over the world[27], and it greatly reduced the construction cost of icebreaker by setting the function of ice-breaking, expedition, commercial transportation together.

Finland and Norway have been China's important trade partners for many years, and their trade cooperation spans across shipbuilding industry, infrastructure development, information and communication technology, oil energy and metal resources, and environmental products. The first Chinese ice-breaking ship, Jidi, was imported from Finland in 1985. Being a supporter of China's observer status in the Arctic Council, China-Finland cooperation has been deemed to be of great importance by the Chinese government. Finnish Aker Arctic Technology Incorporation was selected to perform the conceptual and basic design of Chinese icebreaker commissioned in 2014[28]. China and Norway have embarked on a formal bilateral dialogue on Arctic affairs, and China has become one of Norway's prioritized partners for polar research collaboration. The Norwegian government recognized that China is becoming a key player in the Arctic issues.

Iceland, though not a traditional trade partner of China, has opened formal dialogues in Arctic issues with China in the Arctic Council. The President of Iceland, Grimsson A., has stated several times that Iceland and China are keen to cooperate on the developments in the Arctic and were interested in the implications of the NSR opening up over the next few years[29]. The trade relationship, especially icebreaking technology cooperation between the two countries has been intensified by Framework Agreement on Arctic Cooperation in 2012. It is suggested that China can build giant strengthened container ships navigating in the NSR as the ice melts, and that the Icelandic fjords would be an obvious site for a transshipment port.

Recent years has witnessed continuous innovation of icebreaker design among the Nordic countries. Advanced technologies were developed to graft icebreaking capabilities in LNG ships and oil tankers, building ice-breaking LNG (Liquefied Natural Gas) ships and ice-breaking oil tankers. Considering the cost-effective routes along the NSR, it's a necessity for China to lead the way in comprehensive technical exchanges and cooperation of icebreaker building with the Nordic countries.

5.2 Promoting future development of IMO rules

As the standing members of IMO, China and some of the Nordic countries, such as Norway, Sweden and Denmark should make joint efforts to play the dominant role in future IMO legislation by promoting GBS to be the general standard of the future polar rules.

It is worth mentioning that the Nordic countries have technical advantages in a range of cutting-edge fields with regard to ship navigation in polar waters. The ship manufacturers in Finland have been committed to the research and promotion of icebreakers for decades, and this will play a vital role in future NSR shipping. Collaborative design of

innovative icebreakers and polar ships based on GBS standard of Polar Code between China and the Nordic countries would create a huge potential market of polar shipping for both parts.

With respect to the environmental protection measures in polar waters, China and the Nordic countries shall promote the research and development of energy-saving vessels which meets the mutual benefits of the Nordic countries and China. The Nordic countries are increasingly affected by climate change in the Arctic region. China, as a near-Arctic country, is also affected by the melting of Arctic sea ice due to atmospheric circulation. Scientific research has shown that the eastern coastal areas of China are suffering the direct threat from the Arctic sea level rise, and the reduction of Arctic sea ice is leading to extreme weather conditions in China[30]. The Nordic countries are the word's leading countries in polar marine safety and environmental protection technologies, thus the Chinese government shall attach great importance to technology cooperation with the Nordic countries with respect to polar issues.

6 Conclusion

Climate change has catalyzed the globalization of polar affairs, transforming the polar region from a frozen and inaccessible wasteland to a globally hot frontier with high potential. Because a larger portion of the polar region is expected to be ice-free in the near future, the expected economic benefits of polar shipping would be sharply growing. Accordingly, international shipping in polar waters has increased dramatically within a relatively short period, posing challenges for international regulators regarding maintaining navigation safety and preventing pollution.

Among the international mechanisms regulating polar affairs, the IMO is the leading body most concerned with providing guidelines and applying mandatory shipping rules to polar waters, compared with UNCLOS and the Arctic Council. The IMO increasingly plays a significant role in developing a better understanding of the need for maritime safety and marine environmental protection in this area. The Polar Code adopted by the IMO signals the consensus among all maritime states to apply compulsory rules to vessels operating in the polar waters.

As a major global trading power, China is preparing its strategies and capabilities in anticipation of year-round commercial transit through polar waters at a reduced distance and cost. It is expected that China will adopt more polar shipping industry standards in the future to develop adequate infrastructure including icebreakers, ice-class polar ships and rescue facilities. Crew training will also be given great importance, to guide emergency response mechanisms as well as technical services.

China is a Category A member of the IMO and a permanent observer of the Arctic Council. The rise of China in Arctic issues is clearly positive for international shipping as it leads to further international cooperation on global issues such as safe navigation in polar waters. Recent years have witnessed continuous innovation of icebreaker design among the Nordic countries. Advanced technologies were developed to graft icebreaking capabilities to LNG ships and oil tankers. Proceeding in parallel with developing polar shipping standards in accordance with the Polar Code, China has been moving ahead in comprehensive collaboration with the Nordic countries. In the long term, China and the Nordic countries are expected to cooperate on polar shipping issues to create further international rules and standards.

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