

ClassNIK

MAGAZINE

March 2017 - 79th Edition

- ◆ *Myanmar's maritime transformation*
- ◆ *Deploying ocean energy systems*
- ◆ *A natural progression for LNG*



Moving forward

Welcome to the 79th edition of the ClassNK Magazine



The key to growth is innovation, and the maritime industry is one of the finest examples of this. Whether driven by regulatory, economic, or environmental factors, our industry has always banded together to develop solutions for the challenges we face.

The constant pursuit of improving operations is the reason why the maritime industry is a world leader in innovation. However, this is only possible due to the sheer level of

cooperation there is between maritime stakeholders.

At ClassNK, thanks to our independent third party status, we enjoy partnerships with a diverse range of organizations across the industry. By offering our technical expertise, we can help ensure that technologies are developed safely. In this edition, we introduce just some of the projects we have supported.

An article on new tank designs gives insight into the efforts by Kawasaki Heavy Industries' to advance technologies in the LNG sector. The revolutionary technology received General Approval from ClassNK, paving the way for its realization.

Another revolution in technology is the application of LED floodlights in port facilities. ClassNK's recently released Guidelines for Type Certification of Floodlight LED for Port Facilities were used in the certification of the new LED floodlights developed by Stanley Electric Co., Ltd. This article outlines the unique characteristics and benefits of LED floodlights.

We also have an article provided by the United States Coast Guard outlining the importance of ice reporting. The case of the sinking of the Titanic highlights the dangers we face at sea, underscoring the necessity of proper safety procedures.

Our support is not just limited to R&D. An article on our activities in Myanmar shows how we are supporting the local industry. Although providing survey services to Myanmar-flagged vessels since 1986, the establishment of our Yangon Office in 2013 has allowed us to be on the ground with local organizations and work even closer with the industry.

We are also honored to have an interview with Datuk Ir. Nordin Mat Yusoff, Chairman of the Malaysian Shipowners' Association (MASA), on what's in store for the region.

I hope you enjoy this edition of the ClassNK Magazine.

A handwritten signature in black ink, appearing to read 'Dujicase'.

ClassNK

6



9



14



20



- 2 Moving forward**
Welcome to the 79th edition
- 4 ClassNK news**
ClassNK continues to set the industry agenda
- 6 Ripe for investment**
Interview: Datuk Ir. Nordin Mat Yusoff,
Malaysia Shipowners' Association
- 9 Titanic lessons still count**
US Coast Guard reflections on the tragedy
that keeps giving
- 12 Deploying ocean energy systems**
ClassNK rides tropical wave

- 14 Road to a greener future**
A survey of the emission reduction technologies
- 16 A natural progression for LNG**
Kawasaki Heavy Industries makes space for itself
at the forefront of gas carrier technology
- 18 Lighting the way**
LED cuts costs and carbon footprint for ports
- 20 Myanmar's maritime transformation**
ClassNK survey, research and training activities are
pivotal to Asia's fastest growing economy
- 22 A mounting challenge**
Chiba Prefecture
- 23 ClassNK events in 2017**

ClassNK

ClassNK Executive Operations Department,
4-7 Kioi-cho, Chiyoda-ku, Tokyo 102-8567, Japan
Tel: +81-3-5226-2047 Fax: +81-3-5226-2034
E-mail: eod@classnk.or.jp

ClassNK Magazine
79th Edition

Published by JLA media

ClassNKnews

ClassNK wins Environmental Award

24 November 2016 - ClassNK picked up the Environmental Protection Award for its activities at the IJB Awards held on 21 November. This award recognizes organizations that have made significant contributions to reducing marine pollution. Aiming to ensure that ships being recycled at the end of their operational lives pose less risk to human health or the environment, the IMO adopted the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 (HKC). Supporting compliance with new regulations throughout the industry, ClassNK developed "PrimeShip-GREEN/SRM" a cloud-based software solution that creates the required Inventory of Hazardous Materials (IHM) almost automatically from the shipbuilders' input of product locations, which has quickly grown to become the de facto world shipping standard. The software significantly reduces the man hours that it would typically take manually to input the location and quantity of hazardous materials contained on vessels.

ClassNK PSC inspection mobile app

12 December 2016 - ClassNK has released the ARRIVAL CHECKLIST for PSC, the preparatory checklist mobile app for PSC inspections now available for smartphones and tablets. ARRIVAL CHECKLIST for PSC allows users to access the checklist with greater ease and efficiency during preparatory checks of onboard equipment before arrival into port. The app was developed as a ship management solution to help minimize the risk of PSC detentions and deficiencies. The app categorizes items that are frequently pointed out as deficiencies at PSC inspections by location. Inspection results can be input into the system along with notes and photographs for each corresponding checklist item. As a support feature, users have the option of creating a PDF version of the completed results, which can be forwarded shore side. URL: Apple Store: <https://itunes.apple.com/us/app/psc-check/id1181775762?mt=8>
Google Play: <https://play.google.com/store/apps/details?id=jp.or.classnk.checklist&hl=en>

ClassNK amendments to class rules

27 December 2016 - ClassNK has released amendments to its *Rules and Guidance for the Survey and Construction of Steel Ships*. ClassNK is constantly revising its Rules and Guidance in order to reflect the latest results from relevant research and development projects, feedback from damage investigations, requests from industry as well as changes made to relevant international conventions, IACS unified requirements (UR), national regulations, etc. The PDF files of ClassNK Rules and Guidance are available free of charge via ClassNK's website www.classnk.com for those who have registered for the ClassNK "My Page" service. To register for the "My Page" service free of charge, go to ClassNK's website and click on the "My Page Login" button.

New offices in Izmir and Mersin

1 January 2017 - ClassNK has opened new exclusive survey offices in Izmir and Mersin, both in Turkey, with operations beginning 1 January 2017. Both Izmir and Mersin have "Free Zone" areas, and are two of the most well-known port cities in Turkey. In recent years, the number of surveys and audits required in western and southern Turkey including both cities has been increasing. Through the opening of its latest offices, ClassNK will improve the efficiency of its ship surveys and audits along the southwestern part of Turkey. ClassNK will continue to expand its survey offices worldwide in order to meet its clients' requests and provide timely and high quality services.





ClassNK's Dr. M. A. Rahim (center) accepting the Environmental Protection Award at the IBJ Awards

New PrimeShip-Hull (HCSR) software

9 February 2017 - ClassNK has released the latest version of its design support software PrimeShip-HULL (HCSR) Ver.4.0.0., developed in response to the IACS Common Structural Rules for Bulk Carriers and Oil Tankers (CSR BC & OT). The new version incorporates the latest rule amendments to CSR BC & OT and in order to speed up design evaluation, shortens the calculation times in the prescriptive calculation software and offers a new function to preview reports in the direct strength assessment software, improving overall performance and usability. The prescriptive calculation software now has enhanced data linkage functions with 3D-CAD software NAPA Steel. This enhanced function makes it possible for 3D model data of NAPA Steel to be imported into the initial design function and members' data modified in the full ship design function to be imported back to NAPA Steel, a feature which is expected to significantly reduce the man hours required for structural evaluations in NAPA Steel.

LED floodlight certified for Stanley Electric

16 February 2017 - ClassNK issued the first Type Certification for LED floodlights for port facility-use to Stanley Electric Co., Ltd., in line with its recently developed Guidelines for Type Certification of Floodlight LED for Port Facilities on 2 February 2017. Based on its extensive experience in certifying products, materials and equipment for marine use, ClassNK expanded its certification service portfolio with the introduction of LED floodlight certification. Major LED manufacturer Stanley Electric expanded into the maritime market with the development of LED floodlights for port facility use, and chose ClassNK to certify the new technology. Due to harsh weather conditions found at port terminals, high levels of durability are essential for LED floodlights. ClassNK certified that Stanley Electric LED floodlights are safe as well as highly durable. With this landmark certification, terminal operators are assured that this technology meets the high technical, safety, and durability standards outlined in ClassNK's guidelines.

EU MRV Accreditation from UKAS

2 March 2017 - After undergoing extensive assessments, leading classification society ClassNK has become one of the world's first classification societies to receive accreditation from the UK-based national accreditation body UKAS (United Kingdom Accreditation Service) as an EU MRV verifier, effective as of 1 March 2017. EU MRV is an EU regulation on the monitoring, reporting, and verification of carbon dioxide (CO₂) emissions from vessels, which first entered into force on 1 July 2015. "Following this accreditation from leading accreditation body UKAS, ClassNK will be able to assess Monitoring Plans, verify Emission Reports and issue DOCs in accordance with the EU MRV regulation," said Toshiro Koiwa, Director of ClassNK's Assurance Operations Division. "With extensive experience in the GHG verification, we are committed to providing the same high-quality assurance services for the EU MRV assessment and verification activities."

New ClassNK Executive Vice President

6 March 2017 - Effective 7 March 2016, Dr. Toshiyuki Shigemi was appointed as Executive Vice President as well as Executive Director of ClassNK. Yasushi Nakamura has stepped down as Senior Executive Vice President, and has been appointed as an Advisor to the Society. Dr. Shigemi joined ClassNK in 1981. After a career including roles in plan approval, ClassNK's research institute, and on-site surveys, he took up the position of General Manager of the Development Department in 2008, where he was responsible for overseeing ClassNK's rule development activities for over one decade, at the time when class rules were undergoing major changes, such as development and update of the Common Structure Rules. Dr. Shigemi graduated from the Department of Naval Architecture, Hiroshima University in 1981, and received his Doctorate of Engineering from Osaka University in 2003.

Ripe for investment

Interview: Datuk Ir. Nordin Mat Yusoff, Malaysia Shipowners' Association

ClassNK interviewed Datuk Ir. Nordin Mat Yusoff, Chairman of the Malaysia Shipowners' Association (MASA). Established in 1976 with the main objective of protecting and promoting the interest of Malaysian shipowners, MASA plays a central role in the development of the Malaysian shipping industry.

In your role as chairman of the Malaysia Shipowners' Association, what factors make Malaysia a more attractive hub for the LNG market compared to other South-east Asian locations?

One of the most important factors in being an important hub is location. Malaysia is well positioned in the South China Sea. We have LNG reserves and a steady trade with Japan, Korea and the rest of Asia.

But aside from the very important location we have, our delivery track record is key. We have never failed to make a delivery, and Malaysian shipowners operate to a very high safety standard. Our solid reputation has helped strengthen our trade links with partners like Japan, and without this we would not be in the place we are today.

And what future opportunities do you expect to see Malaysia involved in over the next 10 years?

The opportunities are abundant. As I said, our location is an important factor. I think we mark the point where the East meets the West. We see that more than 200 vessels pass through the Straits of Malacca alone. The Malaysian industry is still growing. We have very rich natu-

ral resources, and our oil and gas reserves can be further exploited. Malaysia is ripe for more investment and I think this will open the way for all kinds of other opportunities.

With a major transition to stricter emissions levels from marine bunker fuel due in 2020, when the global sulfur cap will be reduced to 0.50%, LNG is seen as a viable solution to comply with the new global regulations in the long term. What do you think are the main challenges for LNG to reach its full potential as a marine fuel? And how can these barriers be overcome?

We, as the shipping industry, have an obligation to make our world cleaner. This is why we are supporting this 0.50% sulfur emission initiative by the IMO. The challenge



is that we have to move to a better fuel. There is significant investment in LNG, but the main challenge is the infrastructure. Places like Malaysia and Singapore can offer these facilities, but can this be supplied worldwide? There is a lot of investment to be done, but not only in terms of facilities but also the ship itself. A ship's life is roughly 25 years, it's a capital investment. We have to be practical. For newbuildings, you can design them so that they can be converted to LNG power at a later stage. The bigger problem is with existing ships. They require a bigger investment to make them LNG compatible. Shipowners are already facing tough times, and not just in terms of the market. Other regulations such as the Ballast Water Management Convention will put further financial burdens on ship-

owners. As shipowners, we are now in survival mode. We need to look at this practically, and that may require looking over things again and perhaps certain extensions given in order to meet the requirements of the regulations. Whatever the case, there needs to be affordable solutions to the infrastructure issue and ship conversion issue in place. If we can find a way to supply LNG to ships that is economically viable, then I think we will see a greater uptake in the use of LNG in order to comply with the regulations.

The rapid expansion of the worldwide LNG fleet will soon create a shortage of experienced shipyard staff and crew, raising training and competence issues. How did the Malaysia shipping industry train qualified seafarers and sup-

port new industry's growing requirements?

I think this affects not only LNG, but the entire maritime industry including the offshore sector. In Malaysia we have more than 30 training institutions, and it's important to offer continuous training.. In fact, Malaysia is providing a steady stream of seafarers due to this policy. However, it is important that this continues. After ten or so years at sea, some seafarers may move onshore, so we must have a sufficient workforce to cover this cycle. That is why, major shipping companies, for example, MISC, trains at least 100 candidates a year, both officers and deck hands. There are about 500 vessels trading in the South China Sea at any given time, and Malaysian companies employ roughly 70%

“

Our solid reputation has helped strengthen our trade links with partners like Japan, and without this we would not be in the place we are today

”



*Datuk Ir. Nordin Mat Yusoff
Chairman of the Malaysian
Shipowners' Association*

non-Malaysians on their vessels. So in order to contribute to the pool of seafarers, there is a push to create training and opportunities for Malaysian locals. The “shelf-life” of a seafarer is around 10 to 15 years and taking into consideration the attrition rate, the opportunity for a career as a seafarer is there. We must have the right people with the right exposure, training, attitude and passion for such a career at sea, onboard ships. Although, not everyone can be a seafarer. The most important thing in a seafarer is passion, and finding the right people is the real challenge. We are lucky to have so many talented and passionate seafarers serving on our vessels, and I hope that this trend continues.

Taking into account your extensive experience in the offshore sector, having served at PETRONAS in various capacities, among other roles, can you briefly say how the offshore sector has changed in the last 10 years and what your opinion is on the short to mid-term future of the offshore market?

Innovative technology has certainly changed the offshore sector. For example, 10 years ago Malaysia E&P was mostly limited to shallow water projects – up to 60-100m. Then, five

years ago, with the advent of new technology we moved to deep water projects, which can go as far as 1,200m deep. At that time, investment costs were high, but oil was USD100 per barrel, which fueled interest in these projects. Now in 2017, oil is USD50 per barrel, meaning that a lot of projects are being deferred. Again, I think the only way forward is technology. If we can extract and produce oil at a lower cost, then I think we will see a pick-up in growth in this industry. It’s a question of competitiveness, and the answer is technology.

You have been Chairman of the ClassNK Malaysian Committee since 2015. Can you explain your role on the Committee, and any impact you think the activities have had on the regional industry?

As the Chairman, I think what we want to do is review to see how we can work with ClassNK to protect the investments that we have. We need to have a safe and secure investment that can serve the maritime industry. This is very important. We discuss how ClassNK can assist us as owners and help us reach a certain standard expected in the maritime industry. We discuss the matters that affect our industry at committee level. It’s

a win-win situation with ClassNK. They are our ears and eyes. They are independent and offer certification services to make sure we have the right ship and right people to provide the right service. There are many ships out there that are substandard, but when you have the right classification society to work with, you can ensure you always have the right ship. This goes for the offshore sector too. ClassNK have and continually shared new technologies with the industry. Moving forward, “Green Shipping” is the way for future. So what is green shipping? This means environment-friendly ships and machinery/equipment with human resources of shipboard/shore-based management that with an environment-friendly mind-set. The close engagement of ClassNK with the industry has given a strong and sustainable impact to the industry.

Anything else to add?

The environment is very important to us, and a matter close to our hearts is the cleaning of the Straits of Malacca. We are cooperating with the governments of Malaysia, Indonesia and Singapore to make a proposal to the IMO to make the Straits of Malacca a Special Area.

Titanic lessons still count

US Coast Guard reflections on the tragedy that keeps giving

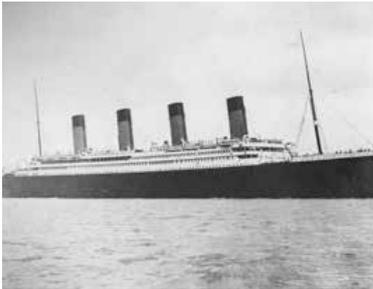


Figure 1: RMS TITANIC

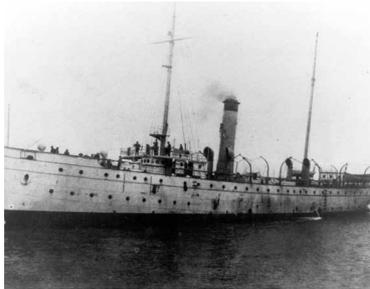


Figure 2: USRC SENECA

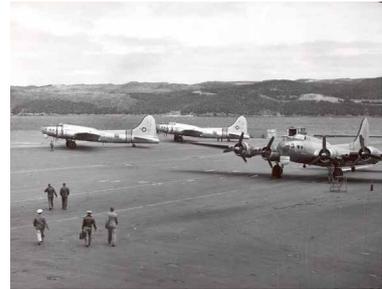


Figure 3: PB1G on Ground



Figure 4: PB1G flying past iceberg (1958)



Figure 5: USCG HC-130J on the airfield in St. John's, Newfoundland



Figure 6: A view of a "blocky" iceberg from the ramp of a USCG HC-130J

From the earliest journeys across the North Atlantic, the risk of iceberg collision posed a danger to vessels. In 1912, on her maiden voyage from Southampton, England bound for New York, the TITANIC (Figure 1) collided with an iceberg just south of the tail of the Grand Banks, at approximately the same latitude as Providence, Rhode Island. The colossal passenger vessel sank within two-and-a-half hours. Although the night was clear and seas were calm, the loss of life was enormous with more than 1,500 of the 2,224 passengers and crew perishing. The vessel had been built with the latest safety design, featuring compartmentation and such innovations as automatically-closing watertight doors. It is ironic that publicity regarding these features had given TITANIC

the reputation of being unsinkable. The loss of TITANIC gripped the world with a chilling awareness of an iceberg's potential for tragedy. The sheer dimensions of the TITANIC disaster created sufficient public reaction on both sides of the Atlantic to prod reluctant governments into action. The result was the very first International Convention for the Safety of Life at Sea (SOLAS) in 1914. The degree of international cooperation required to produce such an unprecedented document was truly remarkable and could not have been achieved without the catalyst provided by this incident. Among the provisions in the first SOLAS convention for passenger ships were new requirements to carry enough lifeboats for those aboard as well as mandated lifeboat drills. Additionally, it initiated the In-

ternational Ice Patrol (IIP). Immediately following the TITANIC disaster, the U.S. Navy assumed the patrol of the Grand Banks for the remainder of 1912. In 1913, the Navy could no longer support this mission, so the Revenue Cutter Service (forerunner of the Coast Guard) assumed responsibility, assigning the Cutters SENECA and MIAMI to conduct the patrol (Figure 2). The mission of the IIP is to monitor the iceberg danger in the North Atlantic Ocean and to provide relevant iceberg warning products to the maritime community. IIP's amazing safety record has stood the test of time: no ship heeding Ice Patrol's warnings has struck an iceberg in the last 104 years.

During the early years of the IIP, the main method of warning shipping traffic was to locate the south-

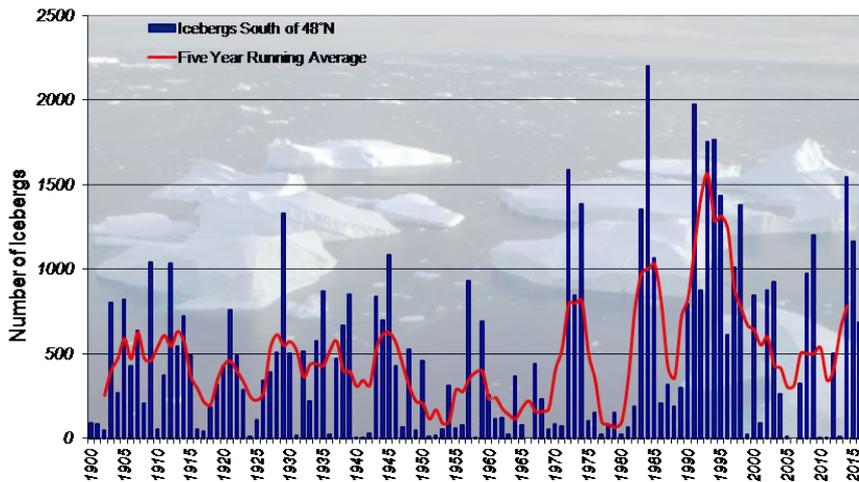


Figure 7: Icebergs crossing South of 48°N and five year running average (1900-2016). The dramatic increase in the numbers after 1983 represents the modern reconnaissance era when aircraft with radar were used to conduct the mission

ern-most iceberg and drift alongside it while making radio callouts of their position. Beginning in 1945, Ice Patrol incorporated the use of shipboard radar into its reconnaissance methods. Although the radar was effective, the weather and sea conditions made it difficult to calibrate the radars effectively. In ad-

dition, there was no way to tell the difference between an iceberg and a ship using radar alone. After World War II, the use of aircraft to conduct the mission began. Compared to ships, an aircraft could cover a much wider search area in a shorter amount of time. Initially, flights were only able to visually locate the

icebergs. Through several airframe trials, it was ultimately the PB-1G (B24) “Flying Fortress” that became the preferred method of reconnaissance (Figures 3 and 4). In 1963, the Ice Patrol began using the HC-130 “Hercules”, “B” model based out of Coast Guard Air Station Elizabeth City, North Carolina. In the 1980s, Ice Patrol progressed to the HC-130 “H” model. In 2009, Ice Patrol began using the HC-130 “J” model with the 360° ELTA-2022 Multi-Mode Radar (MMR) for iceberg reconnaissance. (Figure 5 & 6) Moving into the future IIP intends to incorporate and transition to synthetic aperture radar (SAR) satellite reconnaissance.

Now, IIP tracks the number of icebergs that drift south of 48° North latitude. This latitude is considered the northern boundary of the transatlantic shipping lanes. (Figure 7)

In 2005, the Ice Patrol formed a partnership with the Canadian Ice Service (CIS) and the U.S. National Ice Center (NIC). Together, these three entities comprise the North



American Ice Service (NAIS). Watchstanders produce the NAIS Warning Products daily throughout the year. Iceberg reports from IIP reconnaissance, commercial aerial reconnaissance, vessels at sea, and satellite imagery are incorporated into a computer database. An iceberg drift and deterioration model is then used to predict where the icebergs will move and how they will melt. The database predictions are used by the watchstanders to create a graphical chart and a text bulletin that are disseminated through as many channels as possible to the maritime community. SOLAS regulations require vessels transiting the IIP's operational area to use these warnings. (Figure 8)

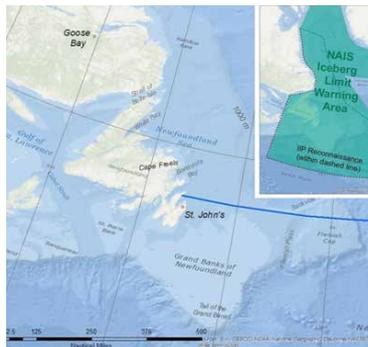


Figure 8: International Ice Patrol's Operational Area. SOLAS Chapter V regulation 6.1 "Ships transiting the region of icebergs guarded by the Ice Patrol during the ice season are required to make use of the services provided by the Ice Patrol"

Please visit the Ice Patrol website at www.navcen.uscg.gov/iip. The daily iceberg chart (Figure 9) and bulletin are available there as well as a treasure trove of history and information. All members of the maritime community are strongly encouraged to fill out the NAIS customer survey. Ice Patrol constantly strives to improve service to customers. They

also ask that mariners check out their Vessel of Opportunity Program document. Within that document, you will find how to report icebergs, how to receive the chart and bulletin, and how to contact their office.

All of this effort and energy are designed to prevent another

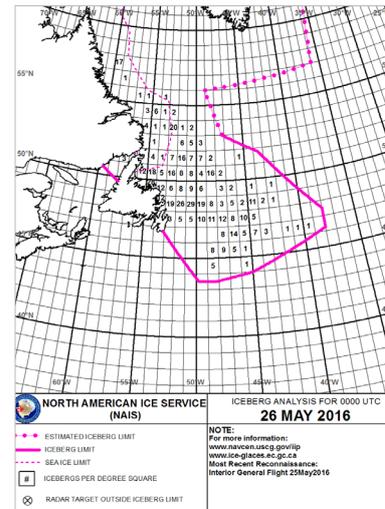
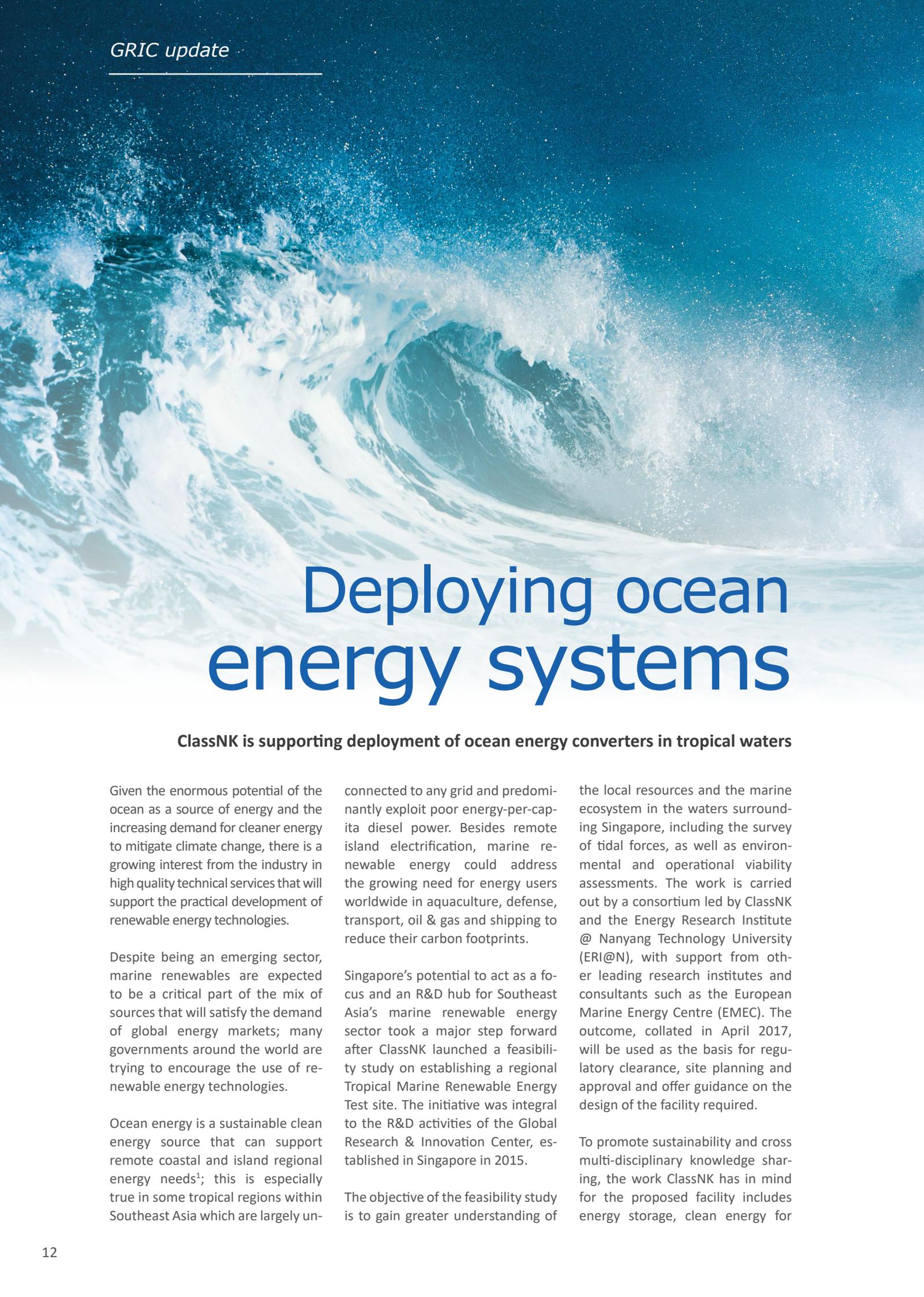


Figure 9: An example NAIS Iceberg Chart from 26 May 2016

tragic event. The loss of life and property that occurred when RMS TITANIC sank must never happen again. This is the duty of the men and women who make up the U.S. Coast Guard International Ice Patrol: to continue their perfect safety record of protecting mariners for another 100 years.





Deploying ocean energy systems

ClassNK is supporting deployment of ocean energy converters in tropical waters

Given the enormous potential of the ocean as a source of energy and the increasing demand for cleaner energy to mitigate climate change, there is a growing interest from the industry in high quality technical services that will support the practical development of renewable energy technologies.

Despite being an emerging sector, marine renewables are expected to be a critical part of the mix of sources that will satisfy the demand of global energy markets; many governments around the world are trying to encourage the use of renewable energy technologies.

Ocean energy is a sustainable clean energy source that can support remote coastal and island regional energy needs¹; this is especially true in some tropical regions within Southeast Asia which are largely un-

connected to any grid and predominantly exploit poor energy-per-capita diesel power. Besides remote island electrification, marine renewable energy could address the growing need for energy users worldwide in aquaculture, defense, transport, oil & gas and shipping to reduce their carbon footprints.

Singapore's potential to act as a focus and an R&D hub for Southeast Asia's marine renewable energy sector took a major step forward after ClassNK launched a feasibility study on establishing a regional Tropical Marine Renewable Energy Test site. The initiative was integral to the R&D activities of the Global Research & Innovation Center, established in Singapore in 2015.

The objective of the feasibility study is to gain greater understanding of

the local resources and the marine ecosystem in the waters surrounding Singapore, including the survey of tidal forces, as well as environmental and operational viability assessments. The work is carried out by a consortium led by ClassNK and the Energy Research Institute @ Nanyang Technology University (ERI@N), with support from other leading research institutes and consultants such as the European Marine Energy Centre (EMEC). The outcome, collated in April 2017, will be used as the basis for regulatory clearance, site planning and approval and offer guidance on the design of the facility required.

To promote sustainability and cross multi-disciplinary knowledge sharing, the work ClassNK has in mind for the proposed facility includes energy storage, clean energy for

“

A feasibility study is critical to the planning and future development of a marine energy harvester

”

ports and offshore terminals, and how to develop charging infrastructure for hybrid/electric boats.

Deploying ocean energy systems could be a regional business growth opportunity and part of the energy mix in some countries, as well as a decisive move in terms of lifestyle choice for marine users; using ocean energy to charge the batteries of ‘e-boats’ could be the ultimate lean and green statement of intent for a city port like Singapore, for example.

However, environmentalists and governments agencies worldwide need to ensure the least interference to existing maritime industries and marine ecosystems when it comes to drawing on ocean energy, which means that the e-boat running on renewables may be some way off for now. Electromagnetic interference, tangled cabling, scouring, ambient noise, also pose potential problems.

“Environmental noise patterns have changed due to an increasing number of marine users, including the shipping industry, but also due to seabed drilling and piling. It is imperative to understand the impact on the marine ecology of all of these factors,” says Pallaniappan Ravindran, Program Manager at ClassNK’s Global Research & Innovation Center.

“A feasibility study is critical to the planning and future development of a marine energy harvester since it allows all interested parties to understand the key issues leading to a sustainable marine renewable industry,” says Ravindran.

Accordingly, an Environmental Impact Assessment (EIA) focuses on assessing several potential factors, including the hydrodynamic impact, the morphologic impact, the sediment impact and the water quality impact. Deploying an ocean energy system close to the coastline, for example, may hinder the flow of tides and tidal currents near the coast and the lagoon, with effects on the whole region.

“The changes in the tidal hydrodynamics, which can vary according to the size of the tidal lagoon, its location and method of operation, may cause changes in the movement of sediments which may in turn impact the natural ecosystem that is well adapted to the existing conditions”, says Ravindran.

“Therefore, the use of numerical models is recommended to estimate the hydrodynamic impact on the ecosystem.”

Coastal geomorphology is also important in EIA since geomorphological formations and processes are integral components of coastal ecosystems and because it is also directly related to problems such as erosion and flooding.

Waves are a major erosive force, as well as being an important ecological factor, especially in the littoral zone. Most waves are wind generated and can vary in size and force largely depending on wind velocity, duration and fetch. Therefore, wave action will be greatest on coasts exposed to strong onshore winds over extensive areas of sea, while wave effects can be modified by tidal regimes.

The implementation of ocean energy systems, such as tidal turbines and wave energy converters can also lead to areas of reduced tidal currents, due to energy extraction, or to accelerated tidal flows in other areas due to the blockage effects. If the seabed has loose soil, it might lead to changes in sediment transport regime and impact the seabed morphology in a sandy region. For example, vortices and eddies induced from offshore turbine tower and foundation structures are known to result in scouring.

With all this considered, it is important to analyse the seabed of the potential locations for the tidal in-stream device deployment. Not only will information about the seabed be useful for the device deployment and installation, it will also be beneficial for support facilities, such as anchoring of mooring lines, placement of gravity foundations and armouring of subsea cables.

Ocean energy systems should also be chosen with specific consideration given to the marine mammals and other invertebrates living near the chosen site since the different sources of sound of ocean energy systems emitted into the marine environment can potentially affect marine organisms by masking biologically relevant signals.

In some countries, there is also a legal responsibility to assess and mitigate impacts of tidal stream turbines on seabird populations, especially deep-diving seabirds. Auks and cormorants foraging in the water column can collide with the moving parts of ocean energy devices: for ClassNK, this is one more reminder that only by working with all relevant stakeholders can safe and environmentally-friendly marine energy be developed.

1) According to the World Energy Council, the world’s ocean’s energy can suffice human energy needs (*World Energy Council, “Variable renewable energy sources integration in electricity systems”*)

Road to a greener future

A survey of the emission reduction technologies for new environmental rules

At the end of October 2016, the IMO's MEPC agreed to stick with plans to reduce the global permissible sulfur content in ship fuels to 0.50% from 2020, rather than delaying the new limit until 2025. The measure headed off the potential that the European Union might go it alone on ship emissions rules. However, the new global limit is a significant step up for an industry still coming to terms with switching between the fuels of 0.1% sulfur content permitted inside Emissions Control Areas from January 2015 and those of 3.5% content permitted outside.

The agreement nonetheless replaces doubt on the speed towards shipping's low carbon future with the certainty that the industry must get on with adopting alternative eco-friendly fuels such as liquefied natural gas and methanol, or the SOx emission reduction technologies that make HFO sustainable.

At the same time, 2016 proved decisive in terms of NOx emissions, after Tier III regulations came into force on NOx emissions lowered permitted limits by 80% when compared to Tier I regulations and by around 75% against Tier II. In this case, it is difficult to achieve the compliance by taking conventional measures inside the engine itself. Additional technologies are needed, such as exhaust gas after-treatment.

With Tier III already in force and now only three years to go until a new, more stringent cap on fuel sulphur content, it is timely to review recent developments in the different technologies which address regulatory developments, and indeed outstanding issues such as the tendency of



"Sakigake", the first LNG- powered tugboat in Japan

MGO to evaporate in the high temperature of the oil pipe when switching from heavy fuel oil.

LNG-fuelled vessels

With over 70 LNG-fuelled ships currently in service throughout Europe – mainly costal ferries, offshore supply vessels, tugboats and passenger ships – incentives are being provided by European countries through tax incentives as well as the provision of fuel supply facilities in special areas to help owners comply with SOx regulations in the European ECA.

The number of LNG-fuelled ships is on the rise, with more than 160 LNG-fuelled vessels expected to enter into service by 2018. Depending on available bunkering infrastructure, container ships and ferries are also expected to be put into service in North America, and to operate with in Asia and the Middle East.

"In Japan, *Sakigake* was the first tugboat to be powered by LNG and has been operating in Tokyo Bay since entering service in August 2015", says Hayato Suga, General Manager of

ClassNK's Natural Resources and Energy Department. "Delivered from Keihin Dock to owner NYK Line and classed by the Japanese Society, the boat is equipped with the ClassNK type-approved 28AHX-DF dual-fuel engine developed by Niigata Power Systems for offshore support vessels and tugs."

Compared to conventional tugboats that use marine diesel oil, *Sakigake* generates considerably less emissions when using LNG as fuel; about 30% less carbon dioxide, 80% less nitrogen oxide, and almost no sulfur oxide. "ClassNK jointly worked together with the shipyard, owners and engine manufacturer from the first stage of this project," says Suga, adding that "ClassNK carried out the feasibility study, communication for permission and authorization with the Administration, and provided technical advice for the project."

Gas fuel engines are classified into two types. The pre-mix combustion type is characterized by the forced ignition of the gas and air pre-mixture. The second type involves diffusive combustion, and is comparable to

a diesel engine, with high pressure gas injected directly into cylinders. Pre-mix combustion types burn a uniform lean fuel-air mixture to lower the peak combustion temperature and thereby independently comply with the Tier III regulations. Four-stroke pre-mix combustion type gas fuel engines have been commercialized. These engines have so far been installed on LNG carriers, coastal ferries and workboats in northern Europe. The pre-mix combustion type has been seen in a two-stroke engine version on a product tanker.

Diffusive combustion types that directly inject high pressure gas require the use of Selective Catalytic Reduction (SCR) or an Exhaust Gas Recirculation (EGR), or other NOx reduction technology to meet the Tier III regulations. Diffusive combustion-type two-stroke engines have recently been used on a container ship operating in North America and on a car carrier operating in Europe.

In the context of Tier III alone, LNG fuel supply equipment including fuel tanks entail high initial costs, but its relative operational cost will depend on the price of LNG fuel and the bunkering infrastructure.

Methanol

Methanol could be a 100% renewable material, as it can be produced from a variety of renewable feed-stocks or as an electro-fuel. Every year over 70 million tons are produced globally, so it is available worldwide and is very similar to heavy fuel oil (HFO) in character.

Stena Line has been pioneering the use of methanol as a marine fuel in the passenger vessel sector. Oil/chemical tankers equipped with two-stroke dual fuel engines using methanol and heavy oil as fuels were built in Japan and Korea in 2016 and are currently in service. ClassNK welcomed the first methanol-fuelled vessel to its register in 2016.

Handling a liquid like methanol has clear advantages over gas or cryo-

genic fuels in terms of fuel storage and bunkering. However, the drawback is that methanol is a low-flash-point fuel and can be toxic.

Methanol fuel produces no sulfur emissions and relatively low levels of nitrogen oxide emissions, which make it a suitable option to comply with SOx emissions. So far, methanol ships have been powered by diesel concept engines which run on both methanol and marine diesel. However, to reduce NOx from a diesel-fueled engine to Tier III levels, there is a need for additional installations such as a Selective Catalytic Reduction (SCR) or an Exhaust Gas Recirculation (EGR).

SOx scrubbers

Exhaust gas cleaning systems (SOx scrubber) can also be installed for reducing SOx emissions to achieve compliance with the regulations if approved by the flag Administration. SOx scrubbers can remove around 98% of sulfur contained in the exhaust gas, being able to desulfurize exhaust gas emitted when using fuel oil with a sulfur content concentration of 3.5% m/m to decrease the concentration to the level equivalent to that of when using low-sulfur fuel oil with a sulfur content concentration of 0.10% m/m.

The use of SOx scrubbers is now mainly aimed to comply with the regulations imposing a maximum limit on sulfur contents of 0.1% in ECAs in force since January 2015.

Scrubbers have been adopted particularly for many ferries and roll-on/roll-off (Ro-Ro) ships operating in the Baltic Sea and the North Sea. According to a report of the Baltic Ports Organization (BPO), because of the survey for nine Baltic Sea and North Sea Ro-Ro ship operators in March 2015, on average, 40% of their ships in operation had already been equipped or were scheduled to be equipped with SOx scrubbers. BPO also confirmed that SOx scrubbers had been installed on 75 ships worldwide as of the end of 2014.

SCR vs EGR

In line with IMO Tier III rules, SCR technology is designed to selectively promote the reduction reaction between NOx and a reductant agent through catalysis to decrease the NOx level in the exhaust gas, using an aqueous solution of urea as the reductant agent. SCR technology can lower NOx emissions by at least 90% without combination with any other technology. It is an after-treatment technology unrelated to the combustion process in the engine, which means that this technology has only a minor impact on the fuel efficiency of the engine itself. However, it entails higher operation costs due to the need for a reductant agent.

A large number of manufacturers have already developed the systems for four-stroke engines. Engines of this kind have been introduced to more than 500 ships, mainly in Norway, which has a system of taxation on NOx emissions, and other European countries.

EGR technology is a method that recirculates part of the exhaust gas after combustion to the combustion chamber. Part of the exhaust gas is separated and passed through an exhaust gas cleaning system called the scrubber. After that, it is mixed with the scavenging air. The mixture of air and exhaust gas lowers the oxygen concentration in the combustion chamber and raises the concentration of CO₂ with a higher specific heat. As a result, combustion is slowed and the gas heat capacity in the combustion chamber rises, which lowers the combustion temperature and reduces NOx emissions.

The EGR system is known to be more expensive to install for a small or medium-sized engine with an output of nearly 15,000 kW or less, but SCR's need for aqueous urea is a clear disadvantage. However, a decision on whether to choose the SCR system or the EGR system needs close attention to the ship type, the hull form design and the ratio of sailing within ECA, among other considerations.

A natural progression for LNG

Kawasaki Heavy Industries makes space for itself at the forefront of gas carrier technology

Demand for natural gas has seen its global production triple over the past four decades, and with world reserves estimated at almost 200tcm this trend is set to continue. The International Energy Agency (IEA) predicts that the natural gas share of the world's energy mix will grow from 21% (as of 2010) to 25% in 2035. There are currently over 440 LNG carriers in operation, and a further 110 on the orderbook. As LNG is one of the only fossil fuels with a growing share of the energy market, the incentive for continued innovation is strong.

Since the advent of the world's first LNG carrier in 1959, technology has evolved to meet the needs of a rapidly growing gas market. The pursuit

of increased cargo capacity while maintaining strict safety standards led to the introduction of membrane type and independent type tanks, each with their own benefits and restrictions. Moss tanks (IMO Type B spherical tanks) introduced in 1973 became a stepping stone for further innovation in the industry. LNG carriers generally employ membrane systems, or Independent Types B or C tanks that conform to specifications according to IMO's IGC Code.

While the introduction of stretched spherical Moss type tanks helped improve cargo capacity compared to conventional spherical IMO type B tanks, it also presented another problem. Vessels employing the

technology are able to carry over 180,000m³ of LNG, however due to the additional space required for the system they are too wide to enter the new Panama Canal.

Kawasaki Heavy Industries (KHI) began looking at ways to further improve LNG carrier designs without sacrificing functionality. KHI proposed a new design featuring a hyper elliptical shape to allow for greater capacity on a New Panamax hull. Due to the numerous safety requirements that need to be taken into account when transporting LNG, KHI carried out investigations into safety evaluation methods that began in 2013 with assistance from a technical consortium which included ClassNK, and Japan Marine Science Inc.



While the rounded sections of the tank largely retain the same properties of conventional spherical tanks, it requires careful assessment to ensure the safety of the design in regards to the effects of sloshing and other factors. Also, the non-spherical curved surfaces of the tank present a challenge to the structural integrity, in particular, buckling evaluation of the tank shell. With technical support provided by ClassNK, JMS and Japan's National Maritime Research Institute and others, using its wealth of technical experience and expertise KHI carried out a range of tests on the prototype model over the course of 2015 and 2016.

Tests were separated into two main categories. Sloshing loads estimation, while the strength evaluation focused mainly on buckling. A series of numerical calculations were also carried out and the results were verified by KHI and ClassNK.

Following the successful research of the new tank model, KHI finalized the design of the tank.

It is predicted that the natural gas share of the world's energy mix will grow from 21% (as of 2010) to 25% in 2035

Source: International Energy Agency (IEA)

ClassNK verified plan drawings together with documentation on cargo tank construction, strength and fatigue analyses, materials, and others. After rigorous evaluation of the structural integrity and confirming that all elements of the project conformed to ClassNK's Rules and Guidance for the Survey and Construction of Steel Ships (Part N) as well as the requirements of IGC Code and the internal guidelines for non-spherical tanks created based upon the

results of the above collaboration research, the design was granted General Approval by the Society on 31 January 2017.

With this General Approval, ClassNK registered LNG carriers will be able to incorporate the new tanks into their design. While the application of this new non-spherical shape Moss type LNG cargo tank is yet to be fully realized, the way has been paved for ever greater innovation in the LNG industry.



Lighting the way

A new approach to lighting will save ports money and reduce their carbon footprint

Energy saving has always been a driving force in the evolution of artificial lighting. After the energy shocks of the 1970s, high-pressure sodium lights gradually took over the night. Following the economic imperative to use the most cost-effective lighting—high-pressure sodium lights consume half as much energy as their predecessor mercury-vapor lamps and can last up to 16,000 hours longer—transportation departments and cities embraced sodium light.

In more recent times, advances in LEDs have brought about another revolution. Evolving dramatically since starting life in the 1960s as indicator lights on electronic equipment, diodes have simultaneously fallen in price and become more powerful, allowing them to displace traditional forms of lighting in more and more spheres of life.

A major breakthrough was made in the early 1990s when a trio of Japanese scientists successfully created the first blue LED. Their invention enabled a new generation of bright, energy-efficient white lamps, as well as color LED screens. It also earned them the Nobel Prize in Physics in 2014.

The incandescent tungsten filament bulbs that light homes worldwide have remained largely the same since their invention by Thomas Edison in the 1879, are being jettisoned

*LED lights are
up to
80%
more efficient than
traditional lighting*

Source: US Department of Energy

in favor of less energy thirsty LED bulbs. Large-scale streetlight-upgrade programs have been completed or are underway in municipalities around the world. Unlike sodium lights, LEDs and other next-generation lights can be tuned to various colors, easily dimmed, arranged into luminous surfaces and shapes, and turned on and off instantly.

LED lights are up to 80% more efficient than traditional lighting such as fluorescent and incandescent lights. Moreover 95% of the energy in LEDs is converted into light; only 5% is lost as heat, a significantly greater ratio than, say, filament light bulbs. Lower energy consumption not only translates into financial saving for the bill payer but reduces demand on power plants, and thus greenhouse gas emissions.

Where a conventional lightbulb may last 12,000 hours, its LED replacement is likely to last five times as long, up to 60,000 hours – equivalent to 2,500 days or more than six years continuous operation. For large installations, this too leads to a substantial cost-saving, as it means expired bulbs have to be replaced less frequently. In cases where lights are fitted in inaccessible locations, maintenance workers are exposed to less risk.

Enhanced light dispersion is a further benefit. LEDs produce a more focused light, which can be directed to a specific location without the use of an external reflector, achieving a higher application efficiency than conventional lighting.

Ports are a relatively late adopter of LED technology. Until recently, the bulbs simply did not offer sufficient power or reliability. However, times have changed, as manufacturers have addressed all kinds of weather, salt corrosion and other consequences of the harsh port environment.

Tackling these challenges was the aim of a partnership of UNI-X Corporation (a logistics and harbor transportation subsidiary of NYK) and Stanley Electric Corp, a manufacturer of LEDs for the automotive industry since the 1970s, supplying well-known automakers such as Honda, Mazda and Toyota. Building on their

experience, these two organizations joined forces with NYK Line to work on the “KIRARI_LED” project, pooling expertise in an alliance of global carrier vessels, port operations, and lighting manufacturing technology. The “KIRARI_LED” project comes from the Japanese *kira-kira*, or shining brightly, and is focused on developing durable LED technology that can withstand harsh port environments.

In addition to undergoing a host of endurance tests, many based on rigorous automotive standards, the new lamp was the first to be certified by ClassNK according to its recently developed Guidelines for Type Certification of Floodlight LED for Port Facilities. The impetus behind the development of these guidelines was two-fold; aiding the further development of innovative technologies in order to provide the maritime industry with eco-efficient solutions, while ensuring the safety of any new projects. Based on its extensive experi-

“
The introduction of increasingly stringent environmental regulations has seen the maritime industry urgently looking at ways to reduce GHG emissions while improving efficiency
”

ence in certifying products, materials and equipment for marine use, these guidelines set out the high levels of durability and safety essential for LED floodlights.

“The introduction of increasingly stringent environmental regulations has seen the maritime industry urgently looking at ways to reduce GHG emissions while improving efficiency,” says Hirofumi Takano, Director of ClassNK’s Innovation Development

Division. “Ports are no exception, and significant investment in eco-efficient technologies has been made to lower their carbon footprint in recent years. These LED floodlights, which consume less electricity than conventional sodium lights or mercury lamps and are resilient enough for use in port facilities, provide terminal operators with a green alternative.”

With this landmark certification, terminal operators are assured that this technology meets the high technical, safety, and durability standards outlined in ClassNK’s guidelines.

An often overlooked difference between LED lights and their sodium cousins is that the former can be frequently switched off and on without affecting their lifetime or light emission. Industrial grade sodium lamps, on the other hand, can take 30 minutes to warm up to full illumination. This paves the way for even greater energy savings as terminals become more automated. As LEDs can be dimmed, or turned on and off quickly, they can be set to deliver just the right amount of light, only where it’s needed. With the application of LED clearly on the uptake, the future certainly looks bright for the industry.



Koichi Fujiwara, Chairman and President, ClassNK; Masahiro Sagae Executive Officer, Executive General Manager Lighting Application Division, Stanley Electric

Myanmar's maritime transformation

ClassNK survey, research and training activities are pivotal to Asia's fastest growing economy¹

After decades of self-imposed isolation, Myanmar has only started to re-engage with the region and the rest of the world in the last three years, following its transition to civilian government in 2011. After 50 years when its only engagement was with China, significant developments have followed the gradual repeal of sanctions, ushered in after the inauguration of President Thein Sein. A rapid phase of industrialisation and deep economic transformation across different sectors and institutions is underway.

Despite flooding that devastated one fifth of the country's agricultural land in 2015, Myanmar's economy is expected to grow 8.4% in 2017, the highest rate in Asia and the Pacific according to the Asian Development Bank's Asian Development Outlook 2016. Garment exports increased by 28%, to \$2 billion. Tourism was also a major driver of the economy with 4.7 million arrivals in 2015 with about 70% of visitors entering overland from neighbouring countries. In addition, natural gas exports showed signs of growth.

Nevertheless, Myanmar faces challenges to its growth path. Like others in Asia, the slackening pace of growth in the Chinese economy is a key indicator, only partly mitigated by closer economic relations with India, and Thailand.

Longer term, the nation has generous reserves of hydrocarbons and other precious minerals which support a positive outlook, as well as millions of hectares of arable land and an abundant water supply to cultivate them. Myanmar's hydrocar-

bon reserves are estimated at 2.5trcm of natural gas and 3.2 billion barrels of crude oil, and the country is the largest natural gas exporter by pipeline in the Asia Pacific region, where gas is mainly imported by Thailand and China.

In this context, liberalisation positions Myanmar on the cusp of an industrialisation process, supported by a youthful population keen to benefit from foreign direct investment.

Shipping is and will be critical to the transition, and the growth of the Myanmar Industrial Port offers a clear indication that the industry is an early beneficiary of and engine for growth.

Located in central Yangon, for example, the port is Myanmar's largest existing port complex and can serve vessels up to 15,000-20,000 dwt, with works underway to increase to a 35,000-dwt vessel capacity. The International Finance Corporation (IFC), the private arm of the World Bank, is looking to inject \$200 million in the form of debt financing to modernise the port and help unlock

its potential in global maritime trade. Japanese businesses are also heavily involved in the transformation of the Myanmar economy, as demonstrated by the joint venture to build the industrial complex in the Thilawa Special Economic zone, only 16 km from Yangon and one of the country's key logistics hubs. The Thilawa SEZ - the first-ever special economic zone in Myanmar - has attracted clothing, automotive and other manufacturing interests.

Last year, Japan's Toyo Construction Co. and JFE Engineering Corp. signed a Yen13.8 billion (\$118 million) contract with the Myanmar Port Authority to build a new container terminal at Thilawa which will handle larger ships and meet growing demand.

ClassNK has been carrying out surveys for Myanmar-flagged vessels for various international conventions since receiving the Recognized Organization status from the Government of Myanmar in 1986. In response to the growing importance of Myanmar in the global maritime industry, ClassNK established its first exclusive in-country survey office, in





Yangon on 1 April 2013, also signing an agreement with the Government of Myanmar granting authorization to carry out surveys on its behalf.

“With the establishment of this new office, ClassNK can now directly dispatch surveyors throughout the Myanmar region”, says Kenji Takami, General Manager of our Yangon Office.

ClassNK has since carried out both surveys and audits including periodical surveys of ships, occasional surveys, shipboard audits for ISM & ISPS code, shipboard MLC inspections, and certification service (ISO 9001 Quality Management System) work. The ships concerned have included general cargo vessels, bulk carriers, vehicles carriers, container carriers, oil/chemical tankers, and pusher/tug and barges.

Cooperation with and support from industry and affiliated maritime institutions will also play a vital role in developing the marine engineering, ship operational and port handling skills that will sustain its growth as a maritime nation. Here, too, ClassNK

has been very active, working in close collaboration on technical and statutory issues with the Department of Marine Administration (DMA), for example. It has also developed voluntary certification for Myanmar’s Seafarer Recruitment and Placement Service (SRPS) companies.

The Myanmar seafarers market is currently a niche, but it has the potential to be developed into a global source for maritime labor. Maritime training and education is included in the Myanmar Government development strategy, with financial support given for training equipment and to promote cooperation among industry and training institutions.

“Myanmar can be one of the main nations for seafarers, for example, and ClassNK has also offered certification service of ISO 9001 for crew manning companies, maritime training centers and the medical centers which examine seafarers”, says Mr. Takami.

“Working with a total of 70 organizations (52 crew manning companies, 15 medical organizations and three

maritime training centers) for certification services, we have provided the voluntary certification for Seafarer Recruitment and Placement Service (SRPS) and issued Statement of Compliance to 52 crew manning companies in Myanmar so far.”

The maritime industry will be pivotal in the transformation of the Myanmar economy and the public sector, as well as private interests, will be critical to the transition process. ClassNK’s supporting role has also taken in the approval of the ‘Myanmar Excellent Stars’ Maritime Training Centre (MES.MTC), which was established in January 2013 under the supervision of the Department of Marine Administration of the Ministry of Transport of Myanmar.

The institution aims to be a centre of Excellence for maritime education in general, also providing the highest quality licensed officers for the world’s merchant marine fleet.

1) Asian Development Bank’s Asian Development Outlook, 2016 (<https://www.adb.org/publications/asian-development-outlook-2016-asia-potential-growth>)

A mounting challenge

While Japan is famed for its high-speed trains and technological advancements, its natural beauty is no less admired. Chiba Prefecture, located on the coast just east of Tokyo, is home to many of Japan's scenic spots. Together with Tokyo and Kanagawa (home of Yokohama Port), the prefecture spans the coast of Tokyo Bay.

Far away from city life, Chiba's countryside offers a tranquil alternative to Tokyo's bustling metropolis. Covered in vast forests of Japanese sumac and Itajii trees, Chiba certainly lives up to its namesake of thousand leaves.

Hidden away in the south of the prefecture is Mount Nokogiri. Running east to west, this low mountain has a distinct saw-toothed profile, lending itself to the name nokogiri, or saw. Used as a quarry in Japan's Edo period (1603-1868), it is now a popular hiking trail for active mountaineers and sightseers alike.

While comparatively low at 329.4m at its summit, the sheer number of stone steps leading up

and down the many peaks and troughs presents a challenge even to the fittest of walkers. However, it is certainly worth the effort. After trekking through long stretches of wooded trails, climbers are rewarded with stunning views across Myogane Cape, and scenes of all types of vessels entering and exiting Tokyo Bay.

The real reward however, is granted only to those who make it to the top. Visitors are greeted by an image of Buddha carved into the mountainside. Standing at 10.3m tall, this carving marks the entrance into the Nihon-ji temple. Through the passage way lies a wide, open field overlooked by an even larger statue of Buddha. This peaceful plateau provides the perfect spot for a well-deserved rest.

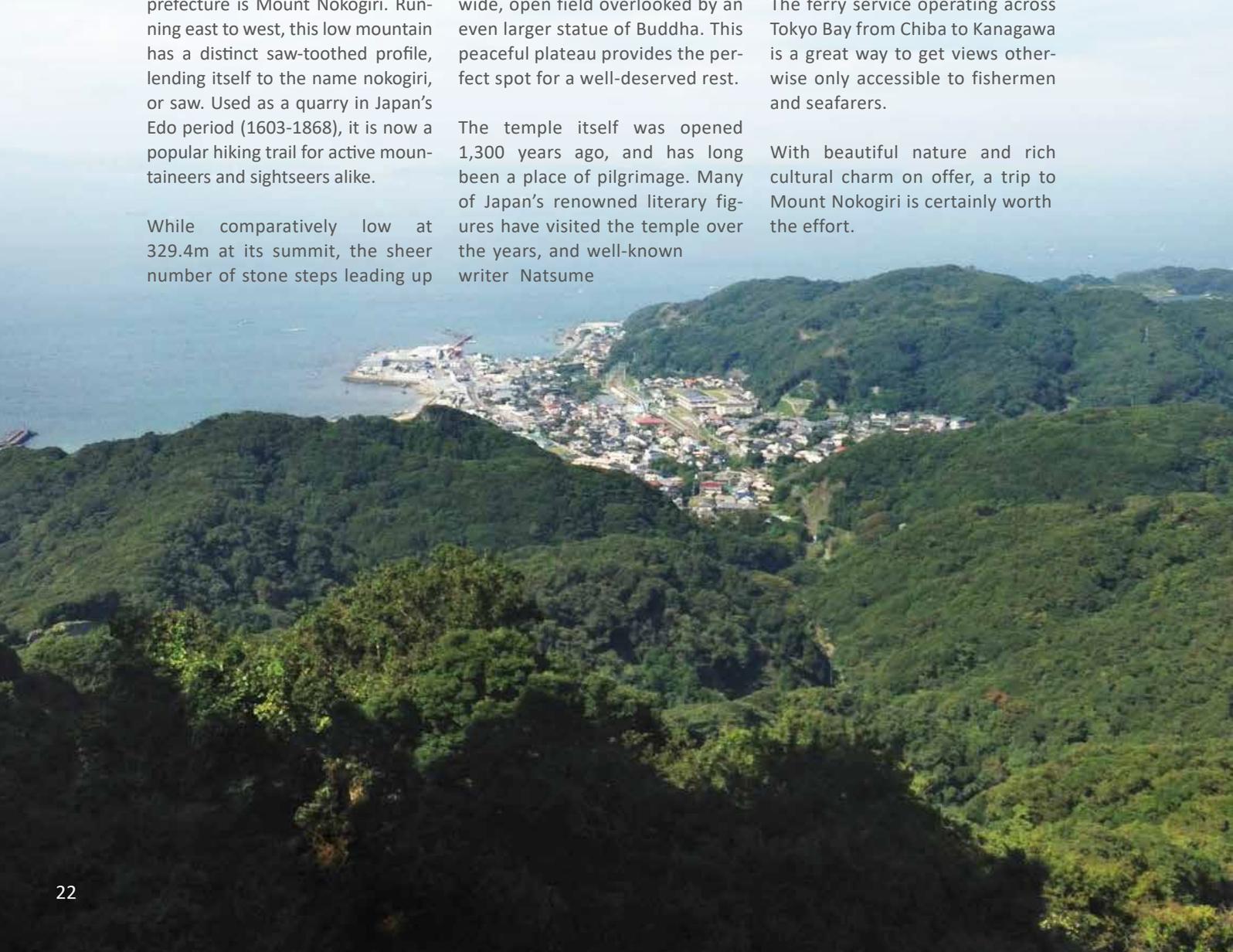
The temple itself was opened 1,300 years ago, and has long been a place of pilgrimage. Many of Japan's renowned literary figures have visited the temple over the years, and well-known writer Natsume

Soseki even wrote about his time there.

Located nearby the site are the Gohyaku Rakan, or the Five-Hundred Arhats - small stone figures depicting those who have attained Nirvana. While called the Five-Hundred Arhats, there are in fact over 1,500 figures to be seen. After seeing all the area has to offer, the only thing left is the way down.

Although the climb down is just as demanding as the way up, once back on the ground, travelers have the option to either take a train to Tokyo or take a more scenic route. The ferry service operating across Tokyo Bay from Chiba to Kanagawa is a great way to get views otherwise only accessible to fishermen and seafarers.

With beautiful nature and rich cultural charm on offer, a trip to Mount Nokogiri is certainly worth the effort.



ClassNK events:

- ◆ **GASTECH, MAKUHARI, JAPAN, 4TH - 7TH APRIL**
Please visit ClassNK at booth #14-160
- ◆ **SEA ASIA, SINGAPORE, 25TH - 27TH APRIL**
Please visit ClassNK at booth at the Japan Pavilion (#B2-T09)
- ◆ **OFFSHORE TECHNOLOGY CONFERENCE, HOUSTON, USA, 1ST - 4TH MAY**
Please visit ClassNK at booth at the Japan Pavilion (#9707)
- ◆ **BARI-SHIP, IMABARI, JAPAN, 25TH - 27TH MAY**
Please visit ClassNK at booth #A-06
- ◆ **NOR-SHIPPING, OSLO, NORWAY, 30TH MAY - 2ND JUNE**
Please visit ClassNK at booth #B03-19

CONTACT DETAILS FOR THIS ISSUE:

ClassNK Executive Operations Department

4-7 Kioi-cho
Chiyoda-ku
Tokyo 102-8567
Japan
Tel: +81-3-5226-2047
Fax: +81-3-5226-2034
E-mail: eod@classnk.or.jp

www.classnk.com



Working toward a safer, greener future.

At a time when the preservation of our precious environment is crucial, switching to newer, safer, greener technology and techniques in the maritime and offshore industries is crucial, too. Harnessing knowledge and experience gained from over 110 years as an international classification society, **ClassNK** offers support through the pursuit of technical innovation and dedicates its efforts to safer seas and preserving the environment. Learn more about **ClassNK's** activities for the future at www.classnk.com

Global Authority in Maritime Standards

ClassNK
www.classnk.com