

SIGTTO

Society for International Gas Tanker
and Terminal Operators Ltd

Continually promoting best practice
in the liquefied gas shipping and
terminal industries for 38 years



SIGTTO Purpose

SIGTTO has been organised to encourage the safe and responsible operation of liquefied gas tankers and marine terminals handling liquefied gas; to develop advice and guidance for best industrial practice among its members; and to promote criteria for best practice to all who have responsibilities for, or interest in, the safety of gas tankers and terminals.



SIGTTO 2020 Vision

(Where the Society wishes to see itself in 2020, according to its Strategic Plan)

SIGTTO will be recognised as the foremost gas shipping and terminal industry body - a modern centre of industry expertise - with all appropriate resources available to address industry technical and operational issues. It will be the industry advocate for the proactive enhancement of safe and sustainable international gas terminal and shipping operations through the provision of consistent guidelines and measures.

SIGTTO

Annual Report 2016

Contents

- | | | |
|---|--|---|
| <p>5 President's report
David Furnival presents an overview of outstanding progress in a notable year</p> <p>7 General Manager's report
Andrew Clifton looks back on notable SIGTTO developments in 2016</p> <p>8 SIGTTO members
Full and Associate Members as of 31 December 2016</p> <p>9 Benefits of SIGTTO membership
Listing of the advantages that Society membership can bring</p> <p>11 SIGTTO in figures
A statistical review of SIGTTO's membership and accomplishments</p> <p>12 SIGTTO history
The evolution of SIGTTO since its formation in 1979</p> <p>14 SIGTTO directors
SIGTTO directors and their companies, as of 31 December 2016</p> | <p>15 SIGTTO Secretariat
The Society's Secretariat office staff</p> <p>16 SIGTTO committees and subcommittees
Internal restructuring to accommodate Strategic Plan 2016</p> <p>18 Industry regulations and standards
SIGTTO participation in the evolving regulatory regime governing gas ships</p> <p>22 The industry year in review
Gas shipping and terminal 2016 timeline</p> <p>26 SIGTTO's widening remit
Work programme extended to compressed natural gas carriers, ISO tank containers and liquefied hydrogen carriers</p> <p>28 Panel Meetings and Regional Forums
Busy SIGTTO meeting schedule facilitates two-way dialogue</p> | <p>30 Hot off the presses
Review of latest industry best practice publications from SIGTTO</p> <p>30 Publications list
Paid publications available from SIGTTO</p> <p>33 Financials
Statement of Comprehensive Income for the year ended 31 December 2016</p> <p>35 Inside Back Cover
Photo credits</p> |
|---|--|---|



Very large gas carrier traffic at the Enterprise terminal in Houston, the world's busiest LPG loading facility

SIGTTO Strategic Plan implementation well underway

I am honoured to present SIGTTO's 2016 annual report, following my appointment as President of the Society in November 2016, a personal 40-year career pinnacle.



Under the effective leadership of General Manager Andrew Clifton, SIGTTO has made strong and steady progress over the past 12 months towards delivering the objectives laid down in the Society's new Strategic Plan. The completed document was approved at the Autumn Board and Annual General Meeting in November 2015.

The goals laid down in the Plan, which covers the five-year period up to 2020, includes a strengthened Secretariat with the competencies and resources necessary to meet the challenges of supporting safety and operational integrity in an ever-growing and diversifying gas terminals and shipping sector.

As part of the drive Ian Harrison has been appointed to join the Secretariat staff as a full-time IMO representative. This new role requires that rare combination of technical and political acumen so necessary to effectively promote the Society's strategies at international governmental level. A look at his CV reveals that Ian is well-qualified to deliver what is needed.

Ian's appointment is enabling SIGTTO's Technical Advisers to focus on new projects and publications. The scope of guidelines on safe operations will be expanded to include new areas such as compressed natural gas (CNG) carriers and LNG transported in ISO tank containers. SIGTTO's widening remit in this respect is described on page 26.

In parallel to the initiative to increase staff resources, SIGTTO is adopting a more systematic approach towards improving process structure and efficiency. As a result good progress has been made to reduce the backlog of projects sanctioned by the General Purposes Committee (GPC). Five paid

publications have been delivered in the last 30 months and there are two more scheduled for publication in the next 12 months, a clear indication of an improving productivity.

Safety and accident prevention are at the forefront of SIGTTO's focus. With this in mind, the adoption of modern risk assessment and mitigation techniques such as the "bow-tie" tool is a welcome development, as is the formation of our new Human Element Committee (HEC). Human error in one form or other remains a causal factor in many accidents and it is imperative that we learn more about the underlying reasons behind accidents and near misses in order to develop more effective preventative measures.

The new, fourth edition of the Society's flagship publication, *Liquefied Gas Handling Principles (LGHP4)*, has proven to be something of a best-seller in the year since its release. This is welcome news on two counts – the royalties provide a revenue stream that underpins the financial security of the organisation and, even more importantly, its popularity across a broad spectrum of readers indicates that there is a significant appetite in our industry to be properly informed on how to handle liquefied gases safely.

The strong focus on engagement with members is paying dividends with a continually growing membership base that now stands at over 220, including 184 full and associate members, located in 55 countries. SIGTTO's Regional Forums are proving to be particularly popular, with the September 2016 South American event in Buenos Aires hosting a record 110 participants.

Additional efforts are being made to attract to the membership a greater proportion of operators from

both the gas terminal community and the LPG and chemical gases sectors. As is the case with LNG, activity in the LPG and chemical gas industries is currently growing strongly. Increased participation from all parties will help ensure that the Society is fully representative of the entire liquefied gas value chain.

As the use of LNG as a marine fuel gains more traction, with 105 LNG-fuelled ships in operation and another 75 on order, the excellent work of our sister organisation, the Society for Gas as Marine Fuel (SGMF), warrants appreciation. In the short time since its inception and with limited resources SGMF's General Manager and Directors have gained genuine credibility and have a broad-based membership of 113. With seven working groups established and six publications already issued, their output has been impressive. SIGTTO remains committed to providing ongoing support to SGMF.

In closing, it is with great sadness that I report the passing of SIGTTO Director Faisal Ismail on 29 June 2017 at the age of 56. Faisal, a former Vice President of LNG at MISC and the Chief Executive of Petronas Maritime Services, was a well-respected member of the Board whose considered contribution to the Society's direction and governance will be greatly missed.

On behalf of my colleagues at SIGTTO, I would like to express our sincere condolences to Faisal's family and friends at this time of loss.

David Furnival
SIGTTO President
July 2017



Many import terminals are being called upon to play additional roles, including handling cargo reloads and transfers to conventional-size and small-scale vessels

SIGTTO enjoyed another busy and eventful year in 2016

During the year 13 new members joined SIGTTO and 11 resigned. As of 31 December 2016 we had a total of 184 full and associate members.



The SIGTTO directors met three times during the year, as per the Society's byelaws. The spring board meeting, kindly hosted by Engie, was held in Boston while the autumn board and annual general meetings took place in Nagoya where Chubu Electric was the host.

The Society is registered in Bermuda as a "not-for-profit" entity. We are allowed to retain any surplus as reserves and each year we set the budget to generate a small surplus which goes to reserves. The reserve level we target is about one year's operating costs and we are comfortably in excess of this target. The Society's finances remain on a sound footing.

SIGTTO's General Purposes Committee (GPC) manages the Society's affairs. The Committee met twice in 2016, at Perth in April and Cyprus in October. The Society maintains a full programme of activities, most of which are addressed by working groups populated by experts selected from the member companies.

SIGTTO's Autumn 2016 Panel Meeting was held in Cyprus on the two days following the October GPC. There was no Spring Panel in 2016 due to the clash with the international LNG 18 conference in Perth. SIGTTO Panels represent the main meeting forum for the members, and the Autumn 2016 Panel, like all the other events in the series, was well attended.

SIGTTO's Regional Forum meetings continue to be held on a regular basis in various locations around the world. The timing of such meetings is largely dictated by the members themselves.

The Society has 'observer status' as a non-governmental organisation (NGO) at the International Maritime Organisation (IMO). SIGTTO's Secretariat attends IMO committee and subcommittee meetings,

as appropriate, and over the years has written/co-sponsored submissions to IMO on various matters related to the LNG/LPG sector of the maritime industry. A principal focus for us in recent years has been the revision of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) and the drafting of the new International Code of Safety for Ships using Gases or other Low-Flashpoint Fuels (IGF Code).

SIGTTO's Secretariat maintains close contacts with other NGOs, principally the Oil Companies International Marine Forum (OCIMF), the International Chamber of Shipping (ICS), the Society for Gas as a Marine Fuel (SGMF), the International Association of Tanker Owners (Intertanko), the International Group of LNG Importers (GIIGNL) and BIMCO. Where appropriate, we co-ordinate our activities to ensure a consistent industry message is conveyed to the wider world.

The revised IGC Code entered into force on 1 January 2016 and was implemented on 1 July. Also in July 2016, SIGTTO issued the fourth edition of *Liquefied Gas Handling Principles*, its premier publication. The IGF Code came into force on 1 January 2017.

The delivery of the IGC and IGF Codes and *Liquefied Gas Handling Principles* means the SIGTTO Secretariat can now focus resources on other areas.

Amongst its roles, the Secretariat maintains a programme of external engagements to promote the Society's profile. These include speaking to various bodies and chairing and presenting papers at international conferences such as Gastech and the LNG series of events. As an example, SIGTTO maintained a high profile at the LNG 18 conference

in Perth in April 2016 and one of the highlights was the shipping session which I had the opportunity to chair.

As LNG shipping embarks on its second half century, it is important that the very proud safety record established by our industry is not forgotten. As the industry leader for disseminating best practice procedures and providing technical support for companies active in liquefied gas shipping and terminals, SIGTTO is at the forefront of maintaining this safety record.

It incumbent on SIGTTO to adapt to meet ever-changing industry requirements and to ensure that the Society remains relevant and fit for purpose to meet the needs and expectations of the membership in the 21st century. To assist in fulfilling its duties SIGTTO completed an updated Strategic Plan in 2016 and this is presently being implemented. The Plan outlines the direction the Society intends to take for the rest of the current decade, and progress in achieving the agreed goals will be reviewed at each board meeting.

The Society continues to be the principal voice for the liquefied gas industry. It is an industry which is currently experiencing both strong expansion and high levels of technological innovation.

This is a very exciting and challenging time to be SIGTTO General Manager. I look forward immensely to working closely with the membership to meet the needs of our dynamic industry in the year ahead.

Andrew Clifton
General Manager July 2017

SIGTTO members (as at 31 December 2016)

Full Members

Aegis Logistics Ltd	Fluxys LNG	Osaka Gas Co Ltd
AES Andres	Freeport LNG Development LP	Pertamina Transportation LNG - JMG
Alpha Gas SA	GasLog LNG Services Ltd	Petrobras Transporte SA - Transpetro
Anglo Eastern Ship Management (Singapore)	Gate Terminal BV	POSCO
Anthony Veder Rederijzaken BV	Gazocean	Prime Gas Management Inc
Atlantic LNG Company of Trinidad & Tobago	Geogas Maritime SAS	Pronav Ship Management
Avance Gas Holding Ltd	Golar LNG Ltd	PT Donggi Senoro LNG
Bahia de Bizkaia Gas SL	Golar Management Norway AS	PTT LNG Company Ltd
Bernhard Schulte Shipmanagement Ltd	Golden Pass LNG	Qatar Petroleum (Industrial Cities Ports)
B-Gas Ltd	H-Line Shipping Co Ltd	Qatar Gas Transport Company Ltd
BP Berau Ltd	Hoegh LNG	Qatar Shipping Company SPC
BP Shipping Ltd	Hyproc Shipping Company	Qatargas Operating Company Ltd
Brunei LNG Sdn Bhd	Hyundai LNG Shipping Co Ltd	QCLNG Operation Company Pty Ltd
Bumi Armada Berhad	Iino Kaiun Kaisha Ltd	Ras Laffan Liquefied Natural Gas Company Ltd
BW Gas AS	Ineos	RWE Supply & Trading GmbH
BW LPG Ltd	Inpex Corporation	Santos GLNG
Calor Gas Ltd	International Gas Transportation Co Ltd	Saudi Arabian Oil Co (Saudi Aramco)
Cameron LNG	Iwatani Corporation	SCF Management Services (Dubai) Ltd
Canaport LNG	Japan Petroleum Exploration Co Ltd	Sempra LNG
Chemgas Shipping BV	JX Nippon Oil & Energy Corporation	Shell International Trading & Shipping Co Ltd
Cheniere LNG Inc	Kansai Electric Power Co Inc	Shipping Corporation of India
Chevron Shipping Company LLC	Kawasaki Kisen Kaisha Ltd	Shizuoka Gas Co Ltd
China LNG Shipping (International) Company Ltd	Kinder Morgan Inc	SK Shipping
Chubu Electric Power Co Inc	Knutsen OAS Shipping	Sonangol Marine Services Inc
Chugoku Electric Power Co Inc	Koch Shipping Pte Ltd	South Hook LNG Terminal Co Ltd
ConocoPhillips Global Marine	Korea Gas Corporation	SPT Ltd
Consolidated Marine Management Inc	Kuwait Oil Tanker Co SAK	Stena LNG Services AB
CPC Corporation, Taiwan	Lake Charles LNG Company LLC	Sunoco Logistics LP
DESFA Hellenic Gas Transmission System Operation	Lauritzen Kosan A/S	Synergy Maritime Pvt Ltd
Dorian LPG Management Corp	LNG Japan Corporation	Teekay Shipping
Dragon LNG Ltd	LNG Shipping SpA	TEPCO Fuel & Power Inc
Dubai Supply Authority	Malaysia LNG Sdn Bhd	The Bahrain Petroleum Company BSC (Closed)
Dynagas Holding Ltd	Maran Gas Maritime Inc	Thenamaris LNG
Egegaz Anonim Sirketi	Marubeni Corporation	TMS Cardiff Gas Ltd
Egyptian Operating Company for Natural Gas Liquefaction Projects	MISC Bhd	Toho Gas Co Ltd
Elengy	Mitsubishi Corporation	Tohoku Electric Power Co Inc
Empresa Naviera Elcano SA	Mitsui & Co Plant Systems Ltd	Tokyo Gas Co Ltd
Enagas Transporte SAU	Mitsui OSK Lines Ltd	Total SA
Energy Transportation Group Inc	Naftomar Shipping & Trading Co	Ultraships ApS
Engie	National Gas Shipping Company Ltd	Uniper Global Commodities SE
Evergas A/S	National Grid Grain LNG	V Ships Ltd
Excelerate Energy LP	Nigeria LNG Ltd	Wilhelmsen Ship Management Sdn Bhd
Exmar NV	Norgas Carriers Private Ltd	Woodside Energy Ltd
ExxonMobil - SeaRiver Maritime	Northern Marine Management Ltd	YPF SA
	NYK Line (Nippon Yusen Kaisha)	
	Oiltanking Antwerp Gas Terminal NV	
	OLT Offshore LNG Toscana SpA	
	Oman LNG LLC	

Associate Members

ABS	Gas Sayago SA	Petronet LNG Ltd
Anadarko Petroleum Corporation	Gazprom Marketing & Trading	Polish Oil and Gas Company
Angola LNG Ltd	Singapore Pte Ltd	Polskie LNG SA
Angola LNG Marketing Ltd	GNL Quintero SA	Port of Rotterdam Authority
Boluda Towage and Salvage	GTT Training Ltd	Port of Sheerness Ltd
Bureau Veritas	Guangdong Dapeng LNG Co Ltd	Saga LNG Shipping Pte Ltd
China Energy Ship	Hazira Port Private Ltd	Singapore LNG
Management Co Ltd	H-Energy Gateway Private Ltd	Corporation Pte Ltd
ClassNK	Jordan Cove LNG LLC	Smit Lamnalco
CNOOC-Fujian LNG Co Ltd	Kotug International	Steelhead LNG Corp
DNV GL	Lloyd's Register	Svitzer A/S
Dunkerque LNG	LNG Canada Development Inc	Total E&P Norge AS
ElectroGas Malta Ltd	Maritime and Port Authority	Venture Global LNG Inc
Etkilman Isletmeleri Dogalgaz	of Singapore	Vitol Services Ltd
Ithalat Ve Ticaret AS	Maritime Safety Queensland	Warsash Maritime Academy
ExxonMobil PNG Ltd	Milford Haven Port Authority	(Southampton Solent University)
FLEX LNG	Moran Towing Corporation	WesPac Midstream
Fratelli Neri SpA	NextDecade LLC	Woodfibre LNG Ltd

BENEFITS OF SIGTTO MEMBERSHIP

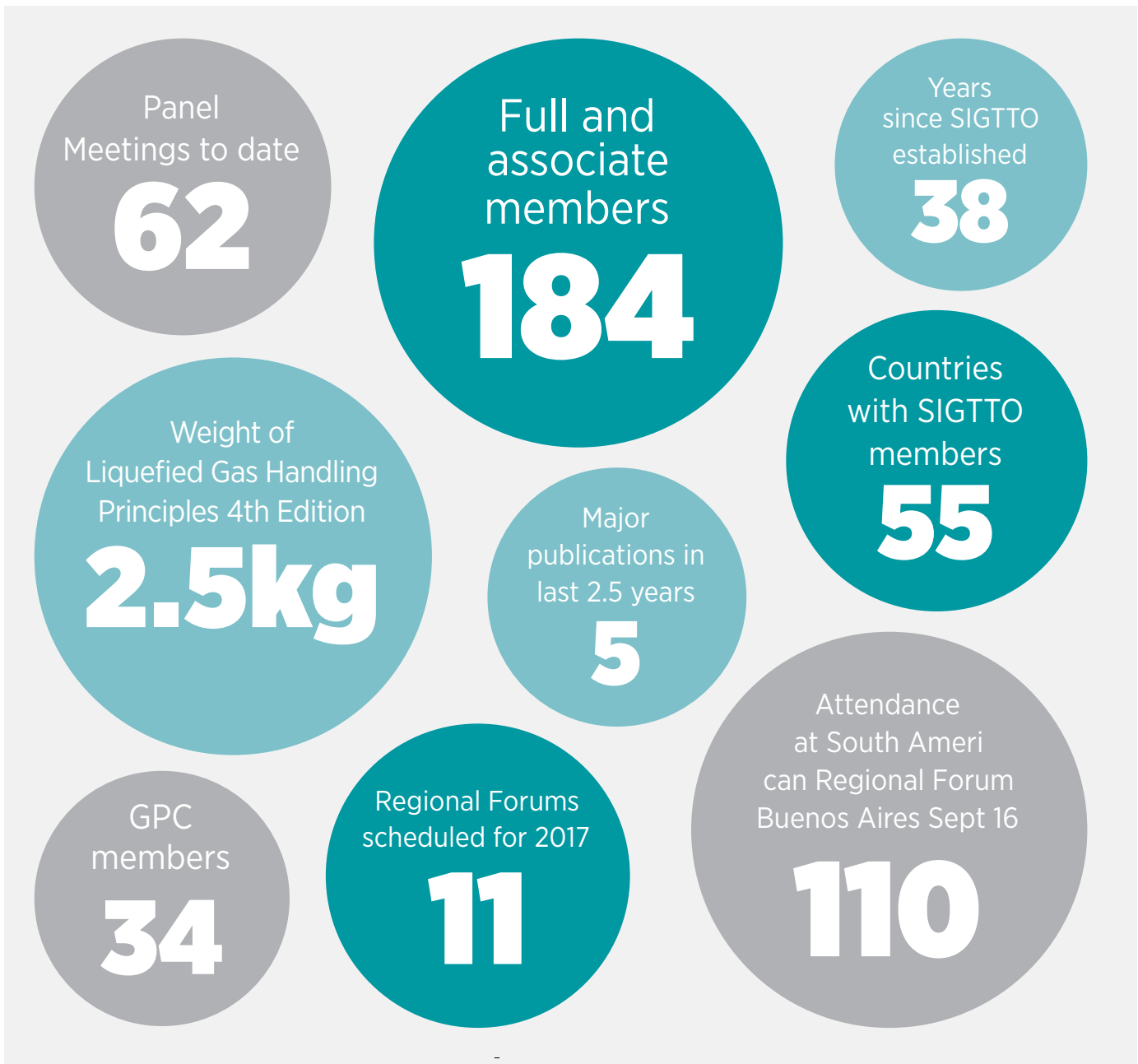
SIGTTO members are actively encouraged to promote membership when dealing with any new players in the industry. Please direct them to our website and to the London Liaison Office for further details of how to join.

In addition to the credibility in the industry that membership brings, SIGTTO members benefit by:

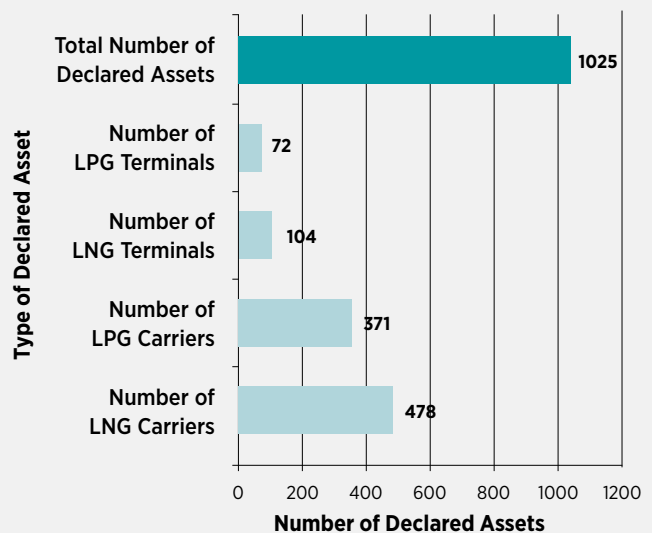
- Access to information that is exclusive to members, such as casualty information and industry statistics
- Regular updates on matters affecting the industry such as legislation, either new or pending, technical or operational developments
- Access to the very comprehensive technical library maintained in the London Office
- Submitting proposals for projects and studies to the General Purposes Committee
- Access to the Technical Advisers in the London Liaison Office who can give advice and obtain advice, on behalf of a member, from within the Society
- Participating in discussion forums with other members each year on topics of particular and mutual interest
- New members receive a copy of all publications, free of charge, produced by SIGTTO
- Free access to the LNGwebinfo portal for updated LNG information as required to conduct compatibility studies. This information is restricted to members of SIGTTO and GIIGNL only



Ship-to-ship transfers for onward distribution are an integral part of LPG carrier operations



SIGTTO Members' Declared Assets



SIGTTO grows with the gas carrier trades



From the outset, in the exploratory talks on the merits of a liquefied gas industry association, participants realised that the membership should encompass both ship and terminal operators

When the Society of International Gas Tankers and Terminal Operators was established as a new industry association, with 10 founder members, in October 1979, the LNG carrier fleet stood at 52 vessels. All the ships were engaged in shuttling between export and import terminals on dedicated routes and under long-term charters.

Although global seaborne movements of LNG had by then been underway for 15 years, the market was still in the early stages of development and struggling to gain a foothold at a time when oil dominated tanker shipping.

There were only six LNG exporting nations in 1979 and five importers. The US was unique in having a foot in both camps, exporting LNG from a small terminal in Alaska and receiving overseas cargoes at three East Coast facilities.

Gas dynamics

The industry, and SIGTTO, have come a long way since then. As of 31 December 2016 the Society had 184 full and associate members and there were 19 LNG exporting nations and 39 importers. Furthermore, in

June 2017 the existing LNG carrier fleet welcomed its 500th ship.

In addition to conventional size vessels, the current LNG carrier fleet includes coastal distribution tankers, floating storage and regasification units (FSRUs) and multigas carriers able to carry LPG and a range of chemical gases as well as LNG. Also, the first dedicated LNG bunker tankers and the first floating LNG production (FLNG) vessel have entered into service over the past year.

The LNG and LPG sectors are currently amongst the most dynamic in shipping. Global seaborne movements of LNG in 2016 totalled 263.6 million tonnes (mt), a 7.5 per cent jump on a year earlier while LPG movements climbed 6 per cent, to 90.7 mt. Some 28 per cent of the LNG cargoes were fixed on a spot or short-term basis.

A good proportion of the new LNG and LPG volumes becoming available stem from the processing of shale gas in the US. The emergence of ethane as a new international gas trade over the past year is another result of the US shale gas phenomenon. Chemical manufacturers

worldwide are keen to make use of competitively priced ethane as a feedstock and US export volumes are scheduled to reach the 15 million tonnes per annum (mta) mark by 2020. Such a volume would make ethane the fourth largest gas carrier cargo in volume terms, after LNG, LPG and ammonia.

SIGTTO origins

The origins of SIGTTO can be traced back to 1977 when a number of LNG carrier operators began to exchange correspondence on the merits of a possible industry association focused on ship safety and operational best practice matters of common concern.

The initiative found favour and gathered strength, to the extent that a series of meetings was convened between December 1978 and March 1979 in order to discuss the need for and possible formation of such an association. El Paso LNG and Compagnie Nationale Algerienne de Navigation (CNAN) were amongst the shipowners driving the feasibility investigation forward.

The meetings showed that there was a strong measure of support for an

industry body amongst the participants and that it should be established without delay. Although the initial interest was centred on LNG carrier operations, the meetings included representatives from across the liquefied gas transport spectrum. It was quickly recognised that the working brief of the new association should encompass all types of gas carrier.

Furthermore, the ship/shore interface was identified as a critical area in safe and reliable ship and terminal operations. It was agreed that by also welcoming terminal companies as an integral part of the membership the new industry body would be providing a channel of direct liaison between ship and terminal operators on matters impacting ship/shore interface safety.

The founder members understood that an industry body with an all-encompassing gas carrier and terminal operator membership would stand the best chance of developing and maintaining safety standards of the appropriate rigour and comprehensiveness. Wide-ranging participation would also facilitate the process of gaining public acceptance of these standards.

At the first board meeting, which was held in Bermuda on 5 October 1979, it was agreed that The Society of International Gas Tanker and Terminal Operators Ltd was the most appropriate name for the new industry body. SIGTTO was established as a Bermuda exempted company with limited liability and with membership and shareholding in the company open to those owning or operating a liquefied gas carrier or a liquefied gas marine terminal.

The first technical issues the Society dealt with were as follows:

- Contingency planning
- Ship/shore linked emergency shutdown
- Safe havens
- Cargo strainers
- Training

These are generic and timeless subjects that continue to evolve in tandem with technological advances and the development of liquefied gas transport infrastructure and logistics. For this



Amongst SIGTTO's many accomplishments is the development of competency standards for the various grades of deck and engineer officers on different types of gas carriers

The 10 founder members were as follows:

- El Paso LNG Company
- Energy Transportation Corporation
- Malaysian International Shipping Corp
- BP Tanker Company Ltd
- Moore, McCormack Bulk Transport Ltd
- P&O Bulk Shipping Ltd
- Gotaas Larsen Inc
- Marine Transport Lines
- Shell Tankers Ltd
- Exxon

Within a year the SIGTTO membership had grown to 30 members, including several terminal operators.

reason it is not surprising that many of these same topics continue to be the focus of SIGTTO attention today, as standards and industry best practice procedures are revised and updated.

Steady progress

During the early 1980s the General Purposes Committee (GPC) was established as SIGTTO's technical committee while the constitution written and approved by the board at the time is still in place today. The membership passed the 50 mark in 1982, the same year that SIGTTO was granted

consultative status at the International Maritime Organisation (IMO).

By the end of the decade SIGTTO's Panel Meetings programme had been established; a number of publications were released to the industry; and the Society had gained a reputation for impartiality and integrity in addressing gas shipping and terminal operational and safety issues. The latest in the two-day Panel Meeting series - the 62nd such event - was held in Cyprus in October 2016.

The 100th member joined the Society in 1994 and in 1997 the number of LNG ships in service passed the 100 mark. In 2008 SIGTTO facilitated the revision of The International Code for the Construction and Equipment of Ships Carrying Liquefied gases in Bulk (IGC Code) on behalf of the IMO.

Interest in the use of LNG to power ships that are not gas carriers has been growing over the past decade and in 2013 SIGTTO formed the Society for Gas as a Marine Fuel (SGMF) to focus on the development of safety standards and industry best practices governing the use of LNG as a marine fuel.

Growing interest in gas-fuelled ships and a healthy take-up in membership enabled SGMF to be established quite quickly as a separate and autonomous industry association. The split has enabled SIGTTO to revert back to and focus on its core subject - the handling of liquefied gases carried by sea as cargo.

SIGTTO Board of Directors (as of 31 December 2016)



Following the Spring 2016 Board Meeting in Boston in May SIGTTO's Directors visited the USS Constitution in drydock

Mr David Furnival	Bernard Schulte SM [President]	Mr Abdullah Al-Sulaiti	Nakilat
Mr K Ban	Chubu Electric [Vice President]	Mr E Inamura	Osaka Gas
Mr Chris Bailey	BP Shipping [Vice President]	Mr T Hashimoto	MOL
Mr Luc Gillet	Total SA	Mr Riju Cherian	BW Gas
Mr S Tschudi-Madsen	Höegh LNG	Mr David Glendinning	Teekay Shipping
Mr Peter Justesen	Engie	Mr Keith Trotter	SeaRiver Maritime (ExxonMobil)
Mr A Kono	NYK	Mr Adri Postema	Shell
Mr Lloyd Bland	Chevron Shipping	Mr Steffen Jacobsen	Evergas
Mr Paul Oliver	China LNG Shipping	Mr P Pearman	Conyers Dill & Pearman
Mr Faisal Ismail	MISC	Mr E Mortimer	Company Secretary



SIGTTO Directors had the opportunity to enjoy a reflective moment at the Autumn 2016 Board meeting in Nagoya

SIGTTO Secretariat Staff



Andrew Clifton
General Manager



Cherian Oommen
Technical Advisor



Robert Steele Technical
Advisor (ExxonMobil)



Ian Harrison
IMO Representative



Nikolaos Panagiotakopoulos
Technical Support Officer

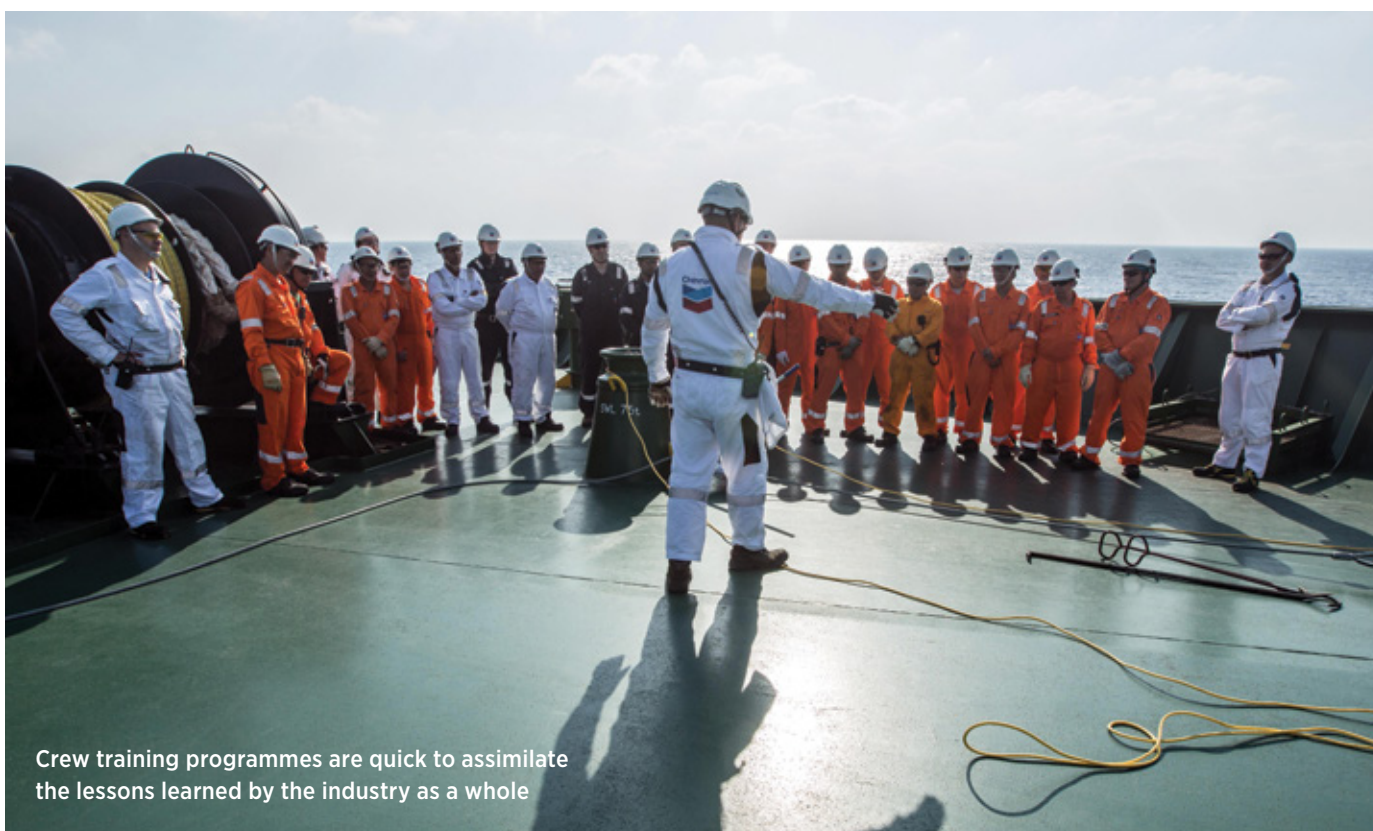


Andrea Baseley
Office Manager



Susan Humphrey
Membership Manager

Strategic Plan 2016 drives SIGTTO committees



Crew training programmes are quick to assimilate the lessons learned by the industry as a whole

In autumn 2015 SIGTTO's Board of Directors approved the Strategic Plan 2016, a key document that outlines the direction the Society intends to take for the rest of the decade. Progress towards achieving the "2020 Vision" goals laid down in the Plan are reviewed at the biannual Board meetings.

It is necessary for SIGTTO to reappraise its goals and adapt accordingly from time to time. This is especially true today which is a time of rapid technological advances and strong industry growth across the gas shipping and terminal sector.

The goals laid down in the Strategic Plan 2016 will ensure that SIGTTO not only meets the industry's changing requirements but also remains relevant and fit for purpose in the drive to meet the needs and expectations of the membership in the 21st century. Having been a major driving force over the past four decades in achieving the exemplary safety record built up by gas shipping and terminal operators, SIGTTO is committed to playing a central role in maintaining this record going forward.

Help for General Purposes Committee

The General Purposes Committee (GPC) is SIGTTO's technical body and meets twice a year. Chris Clucas of Bernhard Schulte Shipmanagement stepped down as GPC chairman towards the end of 2016 after a four-year tenure. His replacement is Mark Hodgson of Shell.

GPC has traditionally originated and coordinated all the internal projects generated at SIGTTO. Completion of the project work itself is carried out by working groups comprising relevant experts from amongst the membership. The technical publications which are the end-result of these projects are effectively the best practice procedures, recommendations and standards that guide the industry's day-to-day operations.

To deal with a growing and increasingly diverse industry, the Strategic Plan 2016 calls for, amongst other things, increased resources to be deployed within the SIGTTO Secretariat. It also

specifies that the results of a review of GPC's role, function and methods be utilised to enhance the Society's committee structure. Amongst the measures agreed to accommodate the growing workload and ease the burden on GPC is the establishment of, first, a Human Element Committee (HEC) and, second, a range of subcommittees to support and augment GPC and HEC.

The decision to form HEC recognises the critical importance of the human factor and training in the ongoing effort to sustain a safety performance which to date is unmatched by any other maritime sector.

Smooth interfacing arrangements between the various committees and subcommittees are an integral part of the restructuring exercise. For example, the HEC chair is also a GPC member and vice versa with the GPC chair.

The work of GPC itself will be guided by an updated set of key performance indicators (KPIs) which reflect the evolving needs of today's gas carrier and terminal operators.

Human Element Committee (HEC)

The first HEC meeting (HEC 01) was held in London on 13 September 2016. As initially configured, the group has 13 members and two observers while John Adams of Teekay is the inaugural chairman. Like GPC, the new HEC meets twice a year and reports to the Board. As part of the liaison arrangements between the two committees, it is intended that HEC meetings be held six weeks before those of GPC whenever possible.

The primary focus at HEC 01 was on agreeing the scope and activities of the new Committee. Discussions were wide-ranging and touched on a number of themes and subject areas, including the definition of the human element, management of incidents and a review of the design and ergonomics of cargo control rooms.

SIGTTO's Board has recognised that, with the formation of HEC, the responsibility for some of the publications in the Society's portfolio might more appropriately fall to the new Committee. It has been suggested that the following SIGTTO titles, and any necessary revision work that needs to be carried out in future, should be transferred to the aegis of HEC:

- 1 Crew Safety Standards and Training for Large LNG Carriers. Essential Best Practices for the Industry (2003)
- 2 LNG Shipping Suggested Competency Standards - 2nd Edition (2008)
- 3 LPG Shipping - Suggested Competency Standards (2008)
- 4 LNG Steamship - Suggested Competency Standards for Engineers - Guidance and Suggested Best Practice for the LNG Industry in the 21st Century (2010)
- 5 Simulation Information Paper (2010)
- 6 Suggested Quality Standards for LNG Training Providers (2014)

Sharing experience

One of SIGTTO's established, long-term aims is the fostering of a learning environment for the benefit of the membership and the industry in general.



The first meeting of SIGTTO's Human Element Committee was held in London in September 2016

This is accomplished not least by sharing lessons learned amongst the Society's members and promoting transparency in reporting accidents and near misses.

The Strategic Plan 2016 builds on this endeavour by setting additional goals, including revising the Society's incident reporting form; investigating how incident trends and statistics can be utilised more effectively; proactively encouraging the sharing of incident data amongst the membership; and establishing a safety reporting questionnaire for members.

SIGTTO is confident that the measures laid down in its Strategic Plan 2016, including the new committee and subcommittee structure and the focus on efficiency and production in the allocation of resources, will yield optimum outcomes when it comes to meeting the needs of its members for the remainder of this decade and beyond. Their implementation will also yield benefits for the industry in general, not least through helping to preserve the unparalleled safety record of gas tanker and terminal operators.



The Strategic Plan's updated set of key performance indicators recognise the technological advances that have been made in gas carrier and terminal operations

SIGTTO participation in the rulemaking process



The Liquefied Gas Senior Executive Forum technical visits are helping familiarise US Coast Guard personnel with gas ship and terminal operations

At any one time a number of rulemaking initiatives are underway at the International Maritime Organization (IMO), the European Union (EU) and the US Coast Guard (USCG) which impact gas carrier operators engaged in international trade. Because close alignment of systems and procedures at the ship/shore interface is critical to safe and reliable gas ship operations, many maritime legislative decisions also affect terminal operators.

SIGTTO plays a key role in the rulemaking processes of the various agencies, contributing information necessary for the drafting of sound and effective regulations; representing member interests on issues of gas ship safety and reliability; and disseminating the results of the progress being made at the various regulatory meetings amongst the membership.

IMO is the leading international body for maritime safety and environmental protection affairs and

has a busy schedule of committee and subcommittee meetings each year. In the past IMO liaison work was handled by one of the Society's technical advisers. However, SIGTTO has recently appointed as Ian Harrison as its first IMO representative.

The new position highlights the increasing complexity of the issues discussed at this UN agency and the importance of these issues to liquefied gas shipping operations. Ian Harrison's presence has enabled the Society's technical advisers to focus their attention on other projects of topical concern to the membership.

IGC Code revision

Amongst notable SIGTTO participation at IMO in recent years was its preparatory work on the revised International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). The updated Code entered into force

on 1 January 2016 and became fully applicable on 1 July 2016 for all gas ships whose keel was laid on or after that date.

A comprehensive revision of the IGC Code was necessitated by the major advances in gas carrier technology that have taken place over the past two decades. Following an agreement with IMO in 2007, SIGTTO coordinated the revision work, managing the input of 140 experts from within the membership and amongst the wider gas shipping and storage industry. Drawn from 20 countries, the experts represented over 40 entities and participated in nine working groups.

The drafting work was completed in 26 months, thanks to the efforts of 39 working group meetings in 14 countries and six sessions of the project's steering group. The IGC Code update marked the first time that IMO had delegated coordination of a major instrument update to a non-governmental organisation (NGO).

Following submission of the draft document to IMO in 2010, SIGTTO thereafter participated in the IMO consultation process which led to the adoption of the revised IGC Code for new ships in 2014 and its full implementation in July 2016. Subsequent to its adoption, IMO has also developed *Interim guidelines for the carriage of liquefied hydrogen*; these were adopted in November 2016.

SIGTTO has also cooperated with the Membrane Owners' Group in the compilation of *Awareness of Isolated Vapour Pockets in Membrane Type LNG Cargo Tanks*. Published in November 2016, the document gives information to operators regarding the action to be taken in the highly unlikely scenario of a large angle of heel forming vapour pockets within a membrane tank.

The new IGF Code

SIGTTO also played a central role in the development at IMO of the new International Code for Ships using Gas or other Low Flash-Point Fuels (IGF Code), an instrument which entered into force on 1 January 2017. The IGF Code, as currently implemented, covers the use of LNG as a propulsion system fuel.

Work on Phase 2 of the IGF Code, which will include the use of fuel cells and methyl/ethyl alcohol as means of propulsion, is continuing under the purview of IMO's Carriage of Cargoes and Containers (CCC) Sub-committee.

In November 2014 IMO adopted interim guidelines covering the training of crews on gas-fuelled ships and approved amendments to the Standards of Training Certification and Watchkeeping (STCW) Convention regarding training for crew members on gas-fuelled ships.

EEDI regime and gas ships

In 2014 IMO also adopted amendments to its Energy Efficiency Design Index (EEDI) regime, as laid down in Annex VI to the Marine Pollution (MARPOL) Convention. Amongst the new provisions are requirements that LNG carriers with a non-conventional, dual-fuel type of propulsion system comply with the EEDI regime. The changes establish one reference line

for LNG carriers, with steam turbine, slow-speed diesel and diesel-electric propulsion systems, and one reference line for all other gas carriers.

The entry-into-force schedule covers vessels whose shipbuilding contracts were placed on/after 1 September 2015; whose keels were laid on/after 1 March 2016; or whose delivery is on/after 1 September 2019. In May 2015 IMO adopted guidelines on the survey and certification of the amended EEDI regime and approved the International Association of Classification Societies (IACS) Procedure PR38 for the calculation and verification of EEDI.

As part of the EEDI regime implementation, the phased reduction of the required EEDI is being reviewed as experience is gained and EEDI data is collected by IMO.

European Union CO₂ emissions initiative

Regional and national bodies charged with responsibility for implementing maritime laws generally adopt the provisions of IMO, in support of global harmonisation and recognition of the international nature of maritime trade. However, on occasion, such rulemakers will introduce measures which seek to either fast-track the scheduled IMO implementation timetable or introduce additional requirements specific to their territorial waters.

The European Union has always been rigorous in its enforcement of maritime safety and environmental measures. One example of where the paths of the EU and IMO have diverged is in their respective regimes that have been put forward for monitoring carbon dioxide (CO₂) emissions from ships. The IMO requirements are laid down in Regulation 22A to MARPOL Annex VI whereas European Commission is seeking to implement its Monitoring, Reporting and Verification (MRV) regulation.

Introduced by IMO in October 2016, Regulation 22A to MARPOL Annex VI enters into force on 1 March 2018 and will require ships to collect and report data on their fuel consumption, starting from 1 January 2019. The MRV

regulation requires shipowners and operators to annually monitor, report and verify CO₂ emissions for vessels of 5,000 gross tons or larger calling at any EU port. MRV data collection, which will take place on a per voyage basis, is set to start on 1 January 2018.

The EU is, however, still working on the details of the monitoring and verification final rules. Under the current proposals LNG carriers will use volume, as per the custody transfer measurement system (CTMS) readings, to determine the amounts of cargo carried and boil-off gas (BOG) burned as propulsion fuel. Other gas carriers will use mass, as per bills of lading, to determine cargo carried.

Sulphur oxides (SO_x) emissions

In October 2016 IMO confirmed 1 January 2020 as the implementation date for the reduction of the global sulphur limit in ship emissions from 3.50 to 0.50 per cent m/m (mass/mass). IMO also agreed a new programme item focused on facilitating implementation of the new, stricter regime. Amongst the initiative's elements are consideration of the new limit's impact on fuel and machinery systems; verification issues and control mechanisms/actions necessary to ensure compliance; and the development of a standardized system for reporting fuel oil non-availability.

Regulations 4 and 14 of MARPOL Annex VI, dealing with equivalency and sulphur oxides (SO_x) emissions in emission control areas (ECAs), have been the subject of attention by the European Union (EU) and the US Coast Guard in recent years.

In 2015 the EU agreed to allow the use of heavy fuel oil (HFO) pilot fuel as an alternative compliance option for steam turbine-powered LNG carriers under Directive 2012/33/EU, provided that the dual-fuel mixture has a sulphur content in mass of less than or equal to 0.50 per cent.

The requirement covers vessel operations in the North Sea ECA. Recognition of this degree of equivalency obviates the need for extensive modifications to >



The European Union equivalency ruling enables steam turbine-powered LNG carriers to burn heavy fuel oil as pilot fuel, provided that the dual-fuel mixture has a sulphur content of 0.5 per cent or less

> steam-powered LNGCs, such as separate distillate fuel systems and burner management changes.

In the US the Code of Federal Regulations (CFR) provisions have been amended to align with MARPOL Annex VI, exempting steam turbine-powered LNGCs (without distillate fuel systems) built before August 2011 from the SO_x requirements until 2020. This decision impacts vessel operations in those parts of the North American and Caribbean ECAs over which the US has jurisdiction.

Nitrogen oxides compliance

In 2015 IMO approved a circular providing guidance for the uniform application of Tier III requirements governing ship nitrogen oxides (NO_x) emissions to dual-fuel and gas-fuelled engines. Tier III requirements entered into force in the North American ECA in January 2017.

The guidance highlights potential problems for gas carriers with Tier III-compliant dual-fuel engines when cargo boil-off gas (BOG) may not be available onboard, e.g. while on maiden ballast voyages or heading to/returning from a drydock. It also provides guidance on disclosing auxiliary control device limitations, i.e. low load, manoeuvring and start/stop operations.

In July 2017 IMO adopted the North Sea and Baltic Tier III NO_x emissions control area, with an entry into force date

of 1 January 2021 and applicability to ships constructed on or after that date operating in the area. There are some limited exemptions in the new Tier III NO_x ECA, including for dual-fuel, Tier II-compliant vessels entering or leaving the area in a gas-free condition, i.e. as a new ship or for repair or maintenance.

Reduction of ship GHG emissions

In October 2016 maritime nations agreed a “roadmap for developing a comprehensive IMO strategy on the reduction of greenhouse gas (GHG) emissions from ships” extending to 2023.

The roadmap aims to build on measures already in place such as EEDI, the Ship Energy Efficiency Management Plan (SEEMP) and fuel consumption data collection requirements. It will utilise the data collection results in decision-making as IMO discusses further potential measures for GHG reduction. A fourth IMO GHG Study using data from 2012-2018 will be initiated as part of the plan in 2019.

US Coast Guard

The sudden and rapid rise in gas carrier traffic in US waters as a result of the shale gas phenomenon in that country and surging LNG, LPG and ethane exports has had a major impact on the US Coast Guard (USCG). The agency has port and flag state jurisdiction to

regulate US-flag and foreign vessels operating in US waters. In these various capacities the USCG conducts some level of design plan review in advance of vessel arrival or operation; onboard inspection and verification; and security checks to protect the vessel and the port.

The Coast Guard established its Liquefied Gas Carrier National Center of Expertise (LGC NCOE) in 2009 to concentrate and coordinate its gas shipping expertise. Since then the responsibilities of the Center have increased exponentially, in tandem with the workload and manpower levels of USCG field inspectors directly involved with visiting gas carriers. In meeting its obligations LGC NCOE has encouraged and benefitted from close liaison with industry, including safety-focused industry associations such as SIGTTO.

USCG staff training is central to achieving the necessary level of expertise amongst a growing workforce committed to the gas shipping sector. In 2013 the USCG and SIGTTO signed a Mutual Training Agreement to formalise their shared values and mission. More recently, SIGTTO provided technical advice during the preparation of *Foreign Gas Carrier Examination Tactics, Techniques and Procedures*, a new 225-page USCG recipe book on how to conduct a foreign gas ship inspection.

SIGTTO has also worked closely with the USCG over the past two years as a co-sponsor of the agency's three-day Liquefied Gas Senior Executive Forum. This annual event, held in Houston in December and with attendances in excess of 250, looks set to become a permanent fixture on the calendar of all those concerned with safe gas ship and terminal operations.

Both the USCG and SIGTTO are alert to the industry-wide challenges which lie ahead, not least the growth in spot market trading, the emergence of many new players in an expanding market, low freight rates and the need for increasing numbers of mariners. The two organisations recognise that the optimum way to maintain gas shipping's exemplary safety record is through close cooperation between industry and regulatory agencies.



“Liquefied Gas Handling Principles” was last revised in 2000; the fourth edition issued in July 2016 represents a major update of SIGTTO’s premier publication

Gas shipping and terminal timeline 2016

A roundup of key gas shipping and terminal developments in 2016 highlights many aspects of a dynamic industry. These include the spread of an increasingly diverse global infrastructure; the application of new technologies; the emergence of new players and cargoes; and the introduction of new vessel types.

January

- The 9 million tonnes per annum (mta) Australia Pacific LNG (APLNG) project, the third Curtis Island coal seam gas-to-LNG scheme in the port of Gladstone, loaded its first LNG shipment. The 163,000m³ *Methane Spirit* transported the inaugural cargo.
- The revised International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) entered into force on 1 January 2016 and was fully implemented on 1 July 2016.

February

- Cheniere Energy despatched the first cargo to be liquefied at its Sabine Pass terminal. It was the first export consignment from the lower 48 US states and the first from a worldscale US liquefaction complex. Chevron's 160,000m³ *Asia Vision* lifted the shipment and transported it to Brazil.
- Teekay took delivery, from Daewoo, of the 173,400m³ *Creole Spirit*, the first newbuilding LNGC to be propelled with a two-stroke, dual-fuel propulsion system with fuel gas supplied at high pressure.

March

- A new global gas carrier trade was inaugurated when the 27,500m³ *JS Ineos Intrepid* lifted the first shipment of ethane from Sunoco's Marcus Hook terminal near Philadelphia. US shale gas production is making large quantities of ethane available to world markets, and 17 new high-capacity gas carriers have been built specifically to transport this product.
- Chevron's Gorgon project in Western Australia despatched its first LNG cargo, onboard the 160,000m³ *Asia Excellence* to Chubu Electric.



JS Ineos Intrepid and the seven other vessels in the Evergas series of Dragon-class multigas carriers have opened up the international trade in ethane



Asia Excellence lifted the inaugural cargo at Australia's new Gorgon LNG export terminal on Barrow Island 60km off the coast

April

- Sinopec's 3 mta Beihai LNG receiving terminal in China's Guangxi region began commercial operations with an APLNG cargo transported by the 163,000m³ *Methane Spirit*. Beihai is China's 14th LNG import terminal.



May

- Mitsui OSK Line's 23,000m³ *Triputra* (ex-*Surya Satsuma*) launched the 300,000 tonnes per annum (tpa) Benoa LNG receiving project on the Indonesian island of Bali. The cargo was discharged to a dedicated floating storage unit (FSU) and then fed to a floating regasification unit (FRU).
- Shizuoka Gas commissioned a cargo reloading capability, the first such in Japan, at its Sodeshi import terminal.

June

- The 79,000m³ LPG carrier *Lycaste Peace* became the first gas ship to pass through the Panama Canal's new expanded locks.



July

- The laden 163,700m³ *Maran Gas Apollonia* became the first LNGC to transit the Panama Canal expanded locks.
- LNG imports were received for the first time at the Dunkirk terminal in France and the Pori terminal in Finland. Dunkirk is France's fourth LNG receiving facility while Pori is Finland's first.
- BP announced it will build Train 3 at its Tangguh export terminal in eastern Indonesia.

August

- Rotterdam's Gate LNG opened its breakbulk terminal, complete with a third jetty, for handling small-scale LNGCs.
- Abu Dhabi commenced LNG imports utilising the 138,000m³ FSRU *Excelerate* moored at Ruwais. Abu Dhabi is the Middle East's sixth LNG importer, joining Dubai, Kuwait, Egypt, Jordan and Israel.

October

- Jamaica commenced LNG imports when the 138,000m³ *Golar Arctic*, serving as a floating storage unit (FSU), transhipped cargo to the 6,500m³ *Coral Antheia* at its Jamaica coast mooring point, for delivery to the nearby Bogue power plant in Montego Bay.

Gas shipping and terminal timeline 2016

November

- Daewoo delivered the 172,000m³ *Christophe de Margerie*, the world's first icebreaking LNG carrier, to Sovcomflot. She is the inaugural vessel in a series of 15 such ships that the yard is building for use in lifting Yamal LNG cargoes at the project's Sabetta LNG plant high in the Russian Arctic.
- Colombia commenced LNG imports using the 170,000m³ FSRU *Hoegh Grace* moored at Cartagena. Sociedad Portuaria El Cayao (SPEC) has chartered the vessel for 20 years.
- *PFLNG Satu*, the world's first floating LNG production (FLNG) vessel, started processing gas on the Kanowit field off Sarawak in Malaysia. The vessel, which has 180,000m³ of storage capacity for LNG and 20,000m³ for condensate, was built by Daewoo for Petronas and is able to produce up to 1.2 million tonnes per annum (mta) of LNG.



Christophe de Margerie is built to the Arc7 ice class and is the world's first icebreaking LNG carrier

December

- The fully refrigerated, 87,000m³ *Ethane Crystal*, the world's first very large ethane carrier (VLEC), entered service. The ship was built by Samsung for Reliance Industries and the transport of ethane from the US Gulf to India.
- The 7,920 dwt ro-ro cargo ship *Searoad Mersey II* commenced operations on the Bass Strait crossing, becoming the first LNG-powered vessel in the Australian coastal trades and the first dry cargo ship to use a roll-on/roll-off ISO tank-based LNG fuel supply system.
- The Bontang export terminal in Indonesia's East Kalimantan shipped its 9,000th cargo. The facility started operations in July 1977 and is currently running half of its original eight LNG trains.



The delivery of *Hoegh Grace* earlier in the year enabled Colombia to commence LNG imports



Global movements of LPG expanded by 6% in 2016

Summary

The seaborne trade in LNG increased by 7.5 per cent in 2016 compared to the previous year, to 263.6 million tonnes (mt). Five new liquefaction trains were commissioned in Australia, two in the US and two in Malaysia - one onshore and one offshore. Four new countries - Colombia, Finland, Poland and Jamaica - joined the LNG importers league table, boosting the total to 39, while 11 new regasification

terminals were commissioned. Of the latter, five were based on the use of floating storage and regasification units (FSRUs).

The seaborne trade in LPG rose by 6 per cent in 2016, to reach 90.7 mt. A 25 per cent jump in US exports, to 25.4 mt, underpinned the growth in global trade. A record annual total of 44 very large gas carriers (VLGCs) joined the LPGC fleet during the year.

Membrane tanks are currently the most popular choice of containment system for LNG carriers



SIGTTO broadens its work programme



Jayanti Baruna, the first compressed natural gas carrier, fitting out at the shipbuilding yard in China

SIGTTO's membership continues to expand in tandem with the robust growth and diversification of global gas transport. As an example, several newly appointed members in recent years are operators of ethane carriers and terminals. Thanks to its widespread availability, especially in the US, and its suitability as a petrochemical feedstock, ethane has emerged as a strong gas shipping market within the space of a few years.

The ethane ship and terminal operator influx was pleasing to note and the Society continues to encourage new members to join, including by reviewing the membership eligibility of new industry sectors. SIGTTO's byelaws were recently amended to enable operators of compressed natural gas (CNG) carriers and container ships carrying LNG in cryogenic ISO tank containers to join the Society as associate members.

SIGTTO's Board of Directors and General Purposes Committee (GPC) monitor industry developments on an ongoing basis, with a view to further broadening the membership base as the need arises. One such topic now coming onto the Society's radar is the transport of liquefied hydrogen by sea in dedicated gas carriers.

Compressed natural gas ships

A new era in gas transport was inaugurated in January 2017 when *Jayanti Baruna*, the world's first compressed natural gas (CNG) carrier, was launched by the Hantong Ship Heavy Industry yard in China. The vessel will be utilised by Pelayaran Bahtera Adhiguna, a subsidiary of Indonesia's state-owned power company Perusahaan Listrik Negara (PLN), to transport natural gas from Indonesian fields in East Java to remote communities on the island of Lombok.

The 2,200m³ *Jayanti Baruna* is classed by ABS according to its *Guide for Vessels Intended to Carry Compressed Natural Gases in Bulk*. The containment system features 832 linked vertical cylinders able to hold gas at a pressure of 250 bar. The Chinese firm CIMC ENRIC constructed the cylinders which stand 12m high and have a diameter of 615mm and a plate thickness of 19mm. The configuration gives the gas carrier a lightship weight of 6,000 tonnes and provides a cargo hold time of eight days. The 110m long vessel's Wärtsilä 9L34DF dual-fuel engine will enable a 13.9 knot service speed.

The International Gas Carrier (IGC) Code covers the carriage of gases that are liquefied but not compressed natural gas. However, although CNGCs are not addressed directly in IMO regulations, the philosophy and intent of the IGC Code can be applied to such ships, with appropriate modifications. The same hazards covered in the IGC

Code for an LNG carrier, for example, should be considered for a CNGC.

Although the *ABS Guide for Vessels Intended to Carry Compressed Natural Gases in Bulk* uses the same format as the IGC Code, the Code's provisions were modified to take into account the use of the risk assessment method in ship design, active and passive fire safety scenarios and the characteristics of CNG containment systems. The latter provisions encompass containment system material requirements in terms of fatigue and fracture; in-service inspections; specific safeguards; pressure protection in cargo holds; and probabilistic limit state design.

Tank containers by sea

Tank containers are helping to spread small-scale LNG globally in a range of ways, including distribution by sea to remote locations and island communities keen to replace diesel fuel with competitively priced, clean-burning gas.

An LNG tank container is essentially an insulated, cryogenic IMO Type C pressure vessel fitted within an ISO standard-size frame of either 20, 30 or 40 foot in length. The intermodal attributes of ISO tanks obviate the need for cargo transfers at intermediate stages along the supply chain. Laden units can be switched between road trailer chassis, flatbed rail cars and container ships with standard container-handling equipment.

The 40-foot unit is the tank of choice in the majority of projects requiring a multimodal solution. Such tanks hold up to 43.5m³, or 17.25 tonnes, of LNG. The unit's insulation system ensures holding times of considerable duration before the buildup of vapour pressure inside the vessel opens the pressure relief valve and allows the venting of boil-off gas.

Relatively low fill levels, of 80 per cent say, will usually provide holding times in excess of 75 days for a tank with a good insulation system. National authorities will usually allow fill levels of up to 95 per cent if the likely required transit time is well below the unit's stated maximum holding time.

Amongst the notable operators beginning to make use of 40-foot tank containers for the seaborne distribution of LNG is Crowley Maritime's Carib



Kawasaki and Shell plan to build a pilot vessel as the first step towards the commercial transport of liquefied hydrogen by sea

Energy affiliate and Grupo Sousa of Portugal. Carib Energy employs a fleet of tanks to ship LNG from Jacksonville, Florida to Puerto Rico on behalf of several customers while Sousa's tanks load LNG at the Sines import terminal in Portugal from where they move by road and container ship to the island of Madeira.

Elsewhere, Barbados has commenced LNG imports using 40-foot ISO tanks, again sourced from Florida, while such units are being utilised in Indonesia for domestic coastal distribution. In Spain Enagás has commenced tank container shipments to Tenerife, with the LNG having been loaded at its Huelva import terminal on the mainland.

The tank container movements to the Canary Islands signal the start of the trade and will eventually be replaced by shipments of larger volumes in bulk in LNG carriers. Notwithstanding the temporary nature of tank use in the Spanish case, the future for LNG ISO tanks is bright. Forecasters predict a compound annual growth rate of 8-9 per cent through 2022 for LNG movements in tank containers.

Liquefied hydrogen carriers

There have been occasional preliminary investigations into the transport of liquefied hydrogen by sea in the past but it has only been in recent years that the study of this gas carrier cargo has gained momentum. Hydrogen is regarded as the ultimate clean-burning gas energy source, with no carbon dioxide (CO₂) given off during its combustion.

Early in 2017 a group of 13 major industry players, including Engie, Linde,

Air Liquide and Total, established the Hydrogen Council to promote use of the gas as an energy source.

Although hydrogen transport technologies are still in their infancy, two Council members - Shell and the Japanese shipbuilder Kawasaki Heavy Industries (KHI) - are jointly developing designs for LH2 carriers. Iwatani and Electric Power Development (J-Power) are also participating in the initiative. Japan is looking to import hydrogen from Australia, following its gasification from brown coal.

The first KHI/Shell project is the design of a pilot small-scale LH2 carrier of 2,500m³ in capacity. The ship's two Type C cargo tanks would have vacuum insulation to ensure that the cargo's carriage temperature of -253°C - liquefied hydrogen's boiling point - is maintained. The principals hope to construct the ship, for completion by 2020, and in the meantime are also studying the feasibility of large LH2 carriers of up to 160,000m³.

Although there are currently no specific requirements in the IGC Code governing the design and construction of LH2 carriers, IMO adopted *Interim Recommendations for the Carriage of Liquefied Hydrogen in Bulk* in November 2016 in response to the growing interest in hydrogen transport.

In March 2017 the Tokyo-based classification society ClassNK released its *Guidelines for the Safe Construction and Operation of Liquefied Hydrogen (LH2) Carriers*, based on the IMO guidelines. ClassNK participated in the risk assessment of the pilot LH2 carrier's design.

SIGTTO meetings smooth two-way communications



The 110 delegates at the South American gathering in Buenos Aires in September 2016 was a record turnout for SIGTTO Regional Forum

SIGTTO's busy schedule of Panel Meetings and Regional Forums enables the Society to maintain a regular and ongoing dialogue with its full membership. The events provide opportunities for not only the Secretariat and members participating in current project working groups to highlight the key issues concerning the greater industry but also the greater membership to contribute to the discussions and raise new matters to consider.

Panel Meetings are the main SIGTTO events, attracting global audiences of member companies and guest speakers for a busy two days of presentations and discussions. Usually of a single day's duration, Regional Forums extend the outreach, being aimed at the Society's members within particular geographical areas.

SIGTTO normally organises two Panel Meetings per annum, one in the spring and one in the autumn, while the Regional Forum programme has gradually been built up to the extent that there now around 11/12 such events each year.

Cyprus Panel

There was no spring Panel in 2016, as the event would have clashed with the international LNG 18 conference in Perth where Andrew Clifton, SIGTTO's General Manager, chaired the shipping session. The autumn Panel - the 62nd in the series to date - was held in Cyprus on 5-6 October 2016 and hosted by SCF Management Services.

SCF was proud to update the Panel delegates on the parent Sovcomflot group's newest LNG carrier. The 172,600m³ ship is the world's first

icebreaking LNG carrier and the lead vessel in a series of 15 that will load cargoes at the Yamal LNG terminal on Ob Bay high in the Russian Arctic.

Dimitry Rusanov, head of Sovcomflot's gas carrier division, profiled the SCF gas fleet and its LNGC ice training programme in his keynote speech. The milestone LNGC, named *Christophe de Margerie*, marks the culmination of a rapid gas ship evolution at the company that began in 2006 with the purchase of the 1969-built, 71,500m³ *SCF Arctic* (ex-*Arctic Tokyo*) and *SCF Polar* (ex-*Polar Alaska*) and proceeded with the construction of the 145,000m³ ice class IC, Moss spherical tank LNGC newbuildings *Grand Elena* and *Grand Aniva*.

There followed two further pairs of LNGC newbuildings for Sovcomflot -

Velikiy Novgorod and *Pskov* in 2014 and *SCF Melampus* and *SCF Mitre* in 2015. All four offer 170,000m³ of cargo-carrying capacity in membrane tanks, are propelled by dual-fuel, four-stroke engines and are built to the ice class IC standard.

As Sergey Popravko, managing director of SCF Management Services, reported to the Panel audience, amongst the Sovcomflot fleet with a high ice class are five 70,000 dwt Arc6 oil shuttle tankers with Azipod propulsion units serving the Varandey and Prirazmnomoe projects in the Arctic waters of the eastern Barents Sea.

The training programme for the *Christophe de Margerie* crew members has been able to incorporate sea time onboard both these Arctic shuttle tankers and the company's LNGCs. The use of simulators, including at the specialist SCF college in St Petersburg, and attendance at targeted STCW/SIGTTO courses are amongst the other key elements of the training regime.

Regional Forums abound

Of the busy Regional Forum timetable of meetings in 2016, several merit a mention. First, the South American Regional Forum held in Buenos Aires on 27 September and hosted by YPF had an attendance of 110, an astonishing, and in fact a record, number for a Regional Forum.

The event was the second South American Forum, the first having been staged in Montevideo in 2014, and the first in the Argentine capital. The Buenos Aires Forum included a technical visit to the Escobar LNG import terminal on the River Plate where cargoes are received by means of a floating storage and regasification unit (FSRU).

The year finished off with a flurry of Regional Forums. Six meetings - in Singapore, Tokyo, Perth, Doha, Houston and Mumbai - took place in the seven weeks between 21 October and 7 December 2016.

The SIGTTO Asian Regional Forum in Tokyo in November and the Indian Regional Forum in Mumbai in December were the first such events to be held in their respective countries. At the Tokyo Forum SIGTTO was introduced

to Vice-Admiral Satoshi Nakajima, commandant of the Japan Coast Guard. The meeting has set the stage for the development of closer relations between the two organisations.

The last time SIGTTO was in India was for a Panel Meeting, also in Mumbai, in April 2006. India is a country with rapidly expanding imports of a range of liquefied gases and the Society is keen to follow up the Mumbai 2016 gathering and make the Indian Regional Forum an annual event going forward.

US Coast Guard liaison

SIGTTO's December 2016 Pan American Regional Forum in Houston aligned, for the second year running, with the new series of Liquefied Gas Senior Executive Forums that was organised by the US Coast Guard (USCG) in tandem with SIGTTO and the Society for Gas as Marine Fuel (SGMF). The combined, three-day event attracted a turnout of over 250.

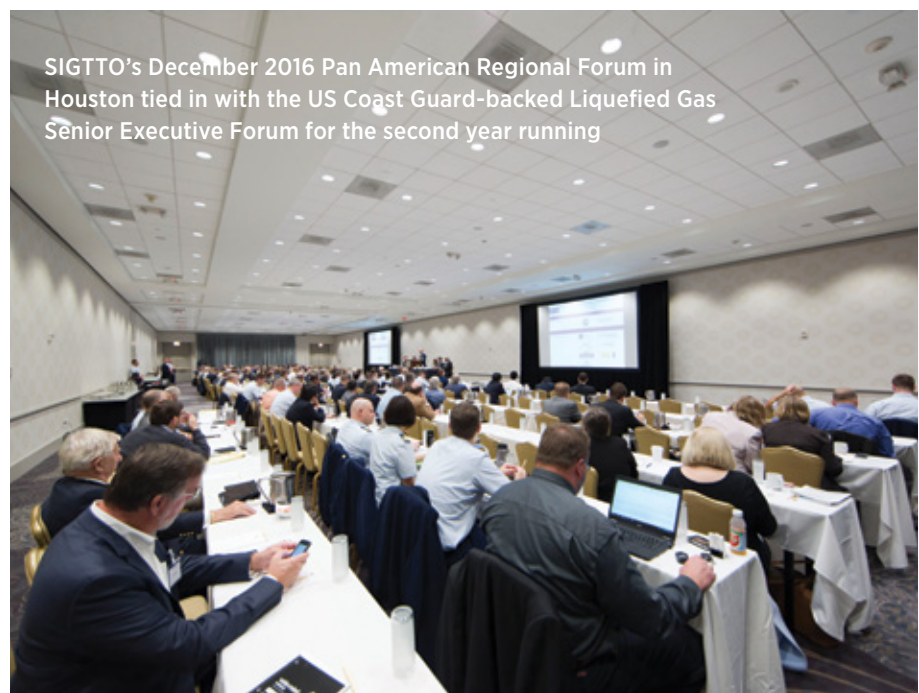
The popularity of this new event in the liquefied gas calendar reflects the current high level of interest in gas carrier and terminal activities in the US, due not least to record LPG exports, the start of worldscale LNG and ethane exports and the introduction of LNG-powered ships and LNG bunkering. In one of the Executive Forum presentations Commander Jason Smith

of the USCG's Liquefied Gas Carrier National Center of Expertise (LGC NCOE) outlined some of the challenges facing the personnel in his agency as the US liquefied gas surge takes hold.

USCG inspectors are currently handling approximately 1,000 gas carrier arrivals at US ports per annum and this number is expected to climb to 3,700 visits by 2020. The dramatic increase in traffic raises the issue of having a sufficient number of adequately trained inspectors in place, backed by the necessary field support in a nationally consistent manner.

Another challenge is the need to ensure that US domestic regulations are updated and fully compatible with the international requirements. A project is currently underway to harmonise US rules with IMO's revised International Gas Carrier (IGC) Code.

Because many of the technologies now being developed, not least in the LNG bunkering sector, are innovative, it is important that Coast Guard personnel develop their technical capacity in tandem with the industry. The strengthening of industry partnerships, including with SIGTTO, is integral to the establishment of this in-house capability and will enable the USCG, in turn, to provide consultation and advice as the industry grows.



Crucible of industry best practice guidance

As was acknowledged at the SIGTTO Board of Directors meeting at Nagoya in Japan in November 2016, the Society had issued four paid publications over the previous two years while three more were due in next 12 months.

The entry into force of the revised International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) in July 2016 and the new International Code of Safety for Ships using Gases or other Low-Flashpoint Fuels (IGF Code) in January 2017, along with the publication of the 4th Edition of *Liquefied Gas Handling Principles: On Ships and in Terminals (LGHP4)*, had represented a major clearing of the decks. The completion of these major undertakings is enabling the Society to catch up on a range of other projects.



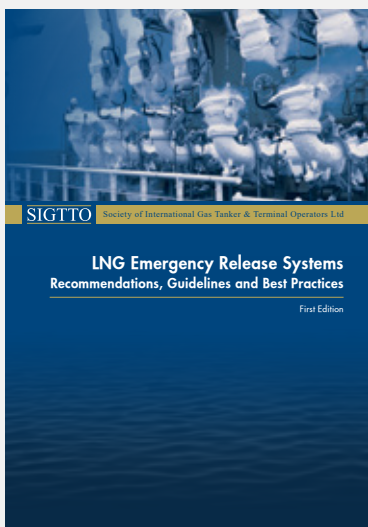
Liquefied Gas Handling Principles

LGHP4, the latest version of SIGTTO's flagship publication, was issued in July 2016, following

approval of the 530-page document at the spring 2016 Board meeting in Boston. The new edition incorporates extensive updates and a wide range of new material to reflect the many changes and technological advances that have taken place in the gas shipping and terminal industry since the third edition was published in 2000. Topics impacted by the changes include, but are not limited to, vessel

design, propulsion systems, size of fleet, floating regasification and reliquefaction, Arctic LNG, containment systems, improved vessel energy and environmental efficiencies, vessel capacities, equipment technology, industry best practices and legislation.

Although the new publication serves as a valuable reference work for all those involved in the design, construction and operation of gas carriers and terminals, it has been compiled primarily for serving ships' officers and terminal staff who are responsible for cargo handling operations. Particular emphasis is placed on the importance of understanding the physical properties of liquefied gas cargoes in relation to the operation of gas-handling equipment and systems on the ship and at loading and discharge jetties.



Emergency release systems

Following approval of the document by the Nagoya Board the Society published *LNG Emergency Release Systems - Recommendations, Guidelines and Best Practices* in January 2017. The new publication signals SIGTTO membership recognition of the fact that that the

effective performance of LNG terminal emergency release systems (ERS) is essential for both safeguarding life and equipment and maintaining the industry's exemplary safety record

Compilation of the document was prompted by a number of incidents involving ERS malfunctions at LNG terminals in recent years. A SIGTTO working group was established in 2014 to address the issues, make recommendations and provide guidance to industry.

A modern ERS is comprised of two ball valves with an integrated powered emergency-release coupler (PERC) between them. These systems, which are independent of the vessel, are activated by position-monitoring sensors. On occasion problems have arisen due to the secondary uses to which some terminals have put the ERS double ball valves.

"The new publication has been prepared to provide project development teams, terminal operators and maintenance personnel

with a good understanding of the role and functioning of LNG ERS," states David Ervin, senior LNG marine operations adviser at Chevron Shipping and chairman of the SIGTTO working group. "Vessel operators and crew will also find the document a valuable reference tool."

The ERS working group used the bow-tie method to analyse the risk of inadvertent ERS actuation and the failure to actuate when required. The ERS publication also includes suggested competencies and training levels for personnel whose job functions bring them into contact with such systems.

In describing a principal conclusion of the document, David Ervin stated, "The SIGTTO working group agreed that the use of the double ball valve for secondary purposes and the added complexity such use introduces increase the risk of an incident. The document recommends that the ERS should not be used for anything other than its primary purpose."

SIGTTO has compiled industry best practice guidelines for actions to be taken by gas terminal support vessels to prevent and mitigate accidents



Support craft at offshore gas facilities



SIGTTO also published *Support Craft at Liquefied Gas*

Facilities: Principles of Emergency Response and Protection - Offshore in 2016. At its 66th meeting, in October 2012, SIGTTO's General Purposes Committee (GPC) had established a working group tasked with defining the expected response, by emergency response craft, during incidents involving liquefied gas carriers at onshore terminals and offshore facilities.

Each gas terminal, as part of its emergency response plan, has traditionally specified the performance standards that the specialist assist vessels it utilises must comply with. GPC formed the working group because the variable nature of these requirements had increased over the years as the global network of gas terminals has spread.

The working group made good progress and SIGTTO issued, in 2015, *Support Craft at Liquefied Gas Facilities: Principles of Emergency Response and Protection - Onshore* as the first of what was to be a pair of documents. Together, the

onshore and the new offshore documents lay down what is believed to be industrywide best practice guidelines for actions to be taken by gas terminal support vessels to prevent and mitigate accidents.

SIGTTO's working group employed a risk assessment methodology to define the example scenarios and to put the appropriate response measures into context. Although the guidance covers a range of vessels that provide support services at gas terminals, it is aimed primarily at the tugs which assist with gas carrier handling and berthing and which, in some cases, remain in attendance while the ship is moored.

Other recent documents

The Nagoya Board also approved two other completed documents - *Awareness of Isolated Vapour Pockets in Membrane Type LNG Cargo Tanks* and *SIGTTO LNG and LPG Experience Matrix Guidelines for Use* - both of which have now been released.

The latter publication points out that when evaluating risk, in the event of non-compliance with a particular element of the *SIGTTO LNG/LPG Officer Experience Matrix*, issued in 2011, consideration should be given to other mitigating factors. These include bespoke training, the manning scale in place, duration of employment with

the LNG/ LPG shipowner/operator and the ship operator's wider competence management systems used in officer recruitment and development.

Further SIGTTO working groups have been established to tackle new projects. The GPC, at its 70th meeting in October 2014, formed a group of experts from the membership tasked with identifying the possible root causes of LPG ship/shore interface-related incidents and updating or rewriting SIGTTO's 1997 publication *Ship/Shore Interface Safe Working Practice for LPG and Liquefied Chemical Gas Cargoes*.

The end result of the work will be a publication issued in 2017 and

entitled *LPG Ship/Shore Interface - Best Practice for LPG/Chemical Gas Vessels and Terminals*.

Another project underway is a revision of the 2011 SIGTTO publication *Manifold Recommendations for Liquefied Gas Carriers*. The working group involved is cooperating with the Oil Companies International Marine Forum (OCIMF) on the initiative and set to complete its draft document in 2017.

Next on the agenda are a new publication on gas detection and a revision of one of SIGTTO's oldest publications, *Guidelines for the Alleviation of Excessive Surge Pressures on ESD*.

SIGTTO Paid Publications



LNG Emergency Release Systems - Recommendations, Guidelines and Best Practices
(2017; £125.00)

Liquefied Gas Handling Principles on Ships and in Terminals, 4th Ed (LGHP4)
(2016; £275.00)

Support Craft at Liquefied Gas Facilities: Principles of Emergency Response and Protection - Offshore
(2016; £125.00)

Support Craft at Liquefied Gas Facilities: Principles of Emergency Response and Protection - Onshore
(2015; £125.00)

SIGTTO Information Papers, Consolidated Ed 2014
(2014; £175.00)

Guidance for LNG Carriers Transiting the Panama Canal
(2014; £125.00)

Ship-to-Ship Transfer Guide for Petroleum, Chemicals and Liquefied Gases
(2013; £225.00)

Liquefied Gas Carriers: Your Personal Safety Guide
(2012; £25.00)

Manifold Recommendations for Liquefied Gas Carriers
(2011; £125.00)

Liquefied Gas Fire Hazard Management Video, 2nd Ed
(2011; £550.00)

Application of Amendments to Gas Carrier Codes Concerning Type C Tank Loading Limits
(2011; £25.00)

Liquefied Petroleum Gas Sampling Procedures
(2010; £25.00)

LNG Steamship Suggested Competency Standards for Engineers
(2010; £125.00)

LPG Shipping Suggested Competency Standards
(2008; £125.00)

LNG Shipping Suggested Competency Standards, 2nd Ed
(2008; £125.00)

Jetty Maintenance and Inspection Guide
(2008; £175.00)

Hydrates in LPG Cargoes
(2008; £75.00)

Ship Vetting and its Application to LNG
(2004; £50.00)

Liquefied Gas Fire Hazard Management
(2004; £175.00)

Crew Safety Standards and Training for Large LNG Carriers: Essential Best Practices for the Industry
(2003; £75.00)

LNG Operations in Port Areas
(2003; £75.00)

Guide to Contingency Planning for Marine Terminals Handling Liquefied Gases in Bulk, 2nd Ed
(2001; £40.00)

LNG Log 24 (2000; £50.00)

Guidelines on the Shipboard Odourisation of LPG
(2000; £40.00)

Guide to Contingency Planning for the Gas Carrier Alongside and Within Port Limits, 2nd Ed
(1999; £40.00)

Contingency Planning and Crew Response Guide for Gas Carrier Damage at Sea and in Port Approaches, 3rd Ed
(1999; £40.00)

A Risk Based Approach for the Evaluation of Firefighting Equipment on Liquefied Gas Jetties
(1999; £40.00)

Introduction to the Design and Maintenance of Cargo System Pressure Relief Valves Onboard Gas Carriers
(1998; £40.00)

Ship/Shore Interface (IP No 16) Safe Working Practice for LPG and Liquefied Chemical Gas Cargoes
(1997; £40.00)

Site Selection & Design (IP No 14) for LNG Ports & Jetties
(1997; £40.00)

Quantity Calculations LPG and Chemical Gases, 2nd Ed
(1997; £40.00)

Accident Prevention (IP No 4) The Use of Hoses and Hard-Arms at Marine Terminals Handling Liquefied Gas, 2nd Ed
(1996; £40.00)

Guidelines for the Alleviation of Excessive Surge Pressures on ESD
(1987; £30.00)

Details of more than 60 free SIGTTO publications, newsletters, annual reports and articles are given on the Society's website: www.sigtto.org

SIGTTO

Society of International Gas Tanker and Terminal Operators Limited

Statement of Comprehensive Income For the year ended 31 December 2016

	<u>Note</u>	<u>2016</u>	<u>2015</u>
Revenue			
Members' annual dues		1,316,593	1,138,661
Royalties		321,404	133,204
Interest receivable		2,000	2,689
	2(b)	<u>1,639,997</u>	<u>1,274,554</u>
Expenditure			
Employee benefit expense	5	413,401	394,590
Office supplies, web and library costs		61,934	53,151
Members' meetings		184,360	177,520
Rents, rates and services		127,518	132,279
Bad debts		5,600	-
Professional fees		395,899	304,485
Project costs		978	6,477
Communications		3,989	4,145
Depreciation	4	1,461	1,350
Miscellaneous expenses		6,375	10,091
		<u>1,201,515</u>	<u>1,084,088</u>
Surplus for the year		<u>£ 438,482</u>	<u>£ 190,466</u>

SIGTTO

Statement of Financial Position at 31 December 2016

	<u>Note</u>	<u>2016</u>	<u>2015</u>
Non-current Assets			
Property, Plant and Equipment	4	4,239	456
Non-current element loan receivable	6	116,667	233,334
		<u>120,906</u>	<u>233,790</u>
Current Assets			
Trade and other receivables	6	965,933	483,201
Cash and cash equivalents		2,241,132	1,729,638
		<u>3,207,065</u>	<u>2,212,839</u>
Total Assets		£ <u>3,327,971</u>	£ <u>2,446,629</u>
Current Liabilities			
Trade and other payables	7	816,658	375,474
Total Liabilities		<u>816,658</u>	<u>375,474</u>
Capital and Reserves			
Called up share capital	8	31,789	30,113
Retained earnings		2,479,524	2,041,042
Total Equity		<u>2,511,313</u>	<u>2,071,155</u>
Total Liabilities and Equity		£ <u>3,327,971</u>	£ <u>2,446,629</u>



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SIGTTO

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