General Lighthouse Authorities

The United Kingdom and Ireland

The General Lighthouse Authorities Strategy has been undertaken by:-

- Irish Lights
- Northern Lighthouse Board
- Trinity House

2030
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NAVIGATING THE FUTURE

The General Lighthouse Authorities (GLA) of the UK and Ireland are:

- the Commissioners of Irish Lights, known as Irish Lights, for all of Ireland
- the Commissioners of Northern Lighthouses, known as the Northern Lighthouse Board (NLB), for Scotland and the Isle of Man; and
- the Corporation of Trinity House, known as Trinity House (TH), for England, Wales, the Channel Islands and Gibraltar; and

The GLA operate a shared *Research and Radio Navigation* Directorate which is recognised as an international centre of excellence on Visual and Radio Navigation and will play a key role in the delivery of this strategy.

The GLA share a mission statement:

"To deliver a reliable, efficient and cost effective Aids to Navigation service for the benefit and safety of all mariners"

Commissioners of IRISH LIGHTS
Navigation and Maritime Services

COMMISSIONERS OF NORTHERN LIGHTHOUSES
IN SALUTEM OMNIUM
1786

Trinity House

EXECUTIVE SUMMARY

2030 - Navigating the Future is the United Kingdom and Ireland's marine Aids to Navigation (AtoN) strategy.

It has been prepared by the General Lighthouse Authorities (GLA) of the United Kingdom (UK) and Ireland for our users, partners and stakeholders.

The GLA shared mission is:

"To deliver a reliable, efficient and cost effective AtoN service for the benefit and safety of all mariners."

Marine AtoN are an important strategic resource for the United Kingdom and Ireland. GLA AtoN will also make a significant contribution to the delivery of the e-Navigation concept. To achieve this, the GLA will drive a multi-agency, coordinated approach to the development and realisation of e-Navigation services. Recognising that e-Navigation will provide varying levels of benefit to different users, the GLA will continue to provide an appropriate mix of visual and radio AtoN for all mariners.

The GLA marine AtoN strategy 2015 and 2030 is:

- to continue to provide an appropriate mix of AtoN for general navigation for all mariners
- to continue to provide a timely and effective response to wrecks, new dangers and AtoN failures
- to continue to undertake superintendence and management of all Aids to Navigation in accordance with international standards, recommendations and guidelines
- to work with users, partners and stakeholders nationally and internationally, to continuously improve the safety of marine navigation through harmonised international standards, recommendations and guidelines
- to improve reliability, efficiency and cost-effectiveness while ensuring the safety of navigation
- to introduce new services and infrastructure in line with user requirements and technological developments, including lights, radio navigation, e-Navigation and the maritime cloud
- to keep abreast of technological developments and undertake research and development on new AtoN technologies
- to protect and exploit our intellectual property where appropriate.

The GLA approach to the introduction of new services will focus on the early delivery of benefits through the integration and delivery of data that is already available, together with new technology, and the development of future solutions.

When delivered, this strategy will ensure safety of navigation and the protection of life, property and the marine environment.

Girdle Ness Lighthouse - ONE OF THE UK DGPS REFERENCE STATIONS

1. INTRODUCTION

1.1 Context

The Governments of the UK and Ireland are signatories to the International Maritime Organization's (IMO) Safety of Life at Sea (SOLAS) Convention [1]. As signatories the Governments have obligations to, inter alia:

> "…provide...such Aids to Navigation as the volume of traffic justifies and the degree of risk requires…"
>
> "…take into account the international recommendations and guidelines…"
>
> "…arrange for information relating to Aids to Navigation to be made available to all concerned…"

Through the Merchant Shipping Acts (MSA) and other legislation, the UK and Irish Governments have empowered the GLA to meet their AtoN obligations under the SOLAS Convention and to carry out other functions in relation to wreck marking. The GLA responsibilities apply equally to all types of mariner from the highly-trained professional navigator through to the amateur leisure user.

The SOLAS Convention requires administrations to adhere to the international Aids to Navigation systems and standards developed and managed by the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA). IALA publishes recommendations and guidelines on AtoN performance, engineering, construction, AtoN management, risk assessment and environmental impact. The GLA participate actively in IALA at Council level and in the committees tasked with the creation and promotion of recommendations and guidelines applied by all AtoN authorities and service providers. These recommendations and guidelines are based on the principle that the mariner receives the same 'signal' from AtoN irrespective of the provider. They detail the AtoN that constitute the IALA Maritime Buoyage System and the provision of all other AtoN, including Lighthouses, Beacons, Vessel Traffic Services (VTS), Radar, Automatic Identification Systems (AIS), Differential GPS and other Radio AtoN.

The IALA definition of an AtoN is:

"…a device, system or service, external to vessels, designed and operated to enhance safe and efficient navigation of individual vessels and/or vessel traffic..."

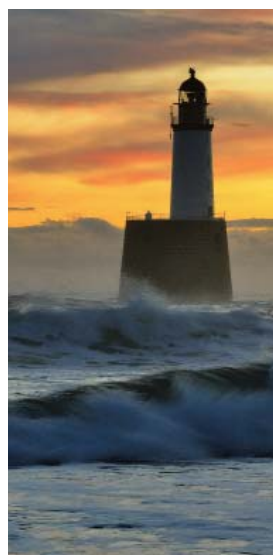
To remain relevant in the ever evolving landscape in which they operate, the GLA must be proactive in anticipating emerging requirements and flexible in adapting to change. The world of navigation has always been subject to constant and at times transformative change. The period covered by this strategy is likely to see very significant change in the science and practice of marine navigation. Improvements in Global Navigation Satellite Systems (GNSS) will see

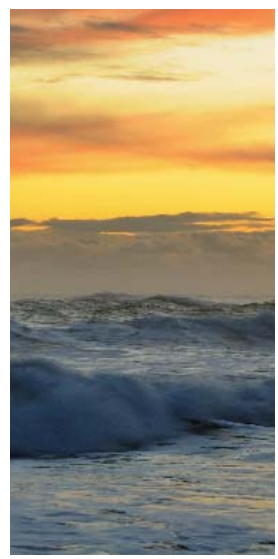
improved accuracy, availability and integrity in what has become the primary means of navigation for most mariners. The need to mitigate the risks inherent in GNSS vulnerability will undoubtedly see new AtoN emerge to support GNSS usage and provide resilience within marine navigation.

Increasing use of technology brings its own challenges and the application of Human Factors science to marine navigational practices will significantly change how we use AtoN.

This strategy will also witness the emergence of autonomous and unmanned vessels that are also likely to impose more stringent performance requirements on AtoN services.

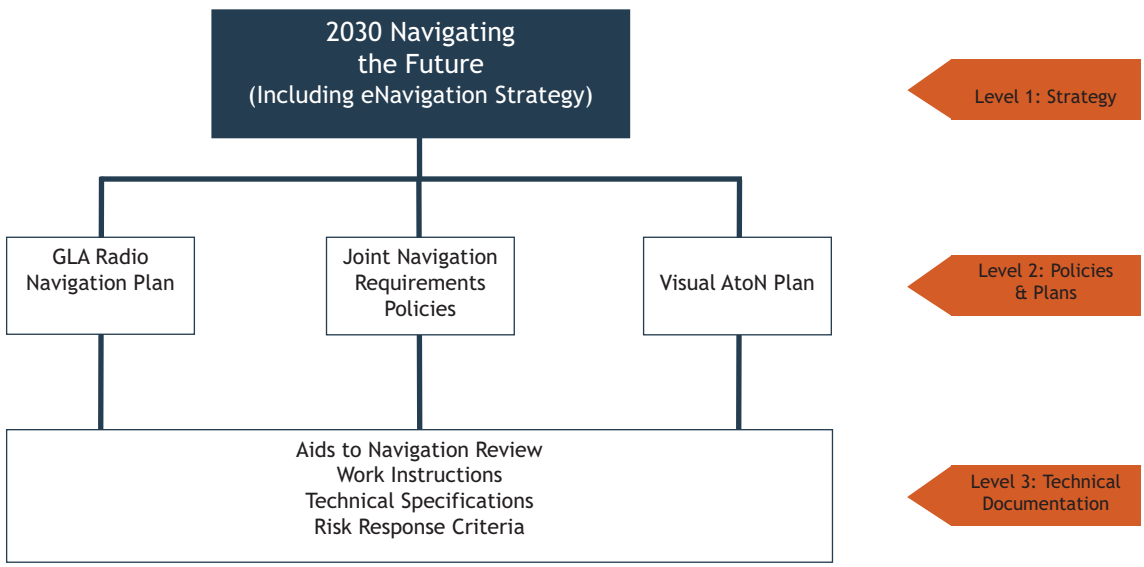
The GLA are also very mindful of the need to continuously improve the efficiency and cost effectiveness of our operations while still meeting the high standards required of a critical maritime safety service. This strategy will deliver real and tangible benefits to users through the development and deployment of new, emerging technologies in a measured and cost-effective way and through appropriate international frameworks.





1.2 Policies and plans

The GLA operate three levels of common documentation with regard to AtoN Requirements.



"2030 - Navigating the Future" sits at the highest level of the document hierarchy and forms the strategic foundation. At the next level policy considerations are contained in the GLA Joint Navigation Requirement Policies; Radio Navigation Plan, Visual Aids to Navigation Plan and e-Navigation Strategy. These documents expand the strategic view and are supported by more detailed technical documentation and work instructions at Level 3.

1.3 User engagement

The GLA provide AtoN services to all mariners, ranging from navigators of the largest and fastest cargo and passenger vessels through the complete spectrum of craft and mariners to the most infrequent leisure and fishing user.

The GLA welcome user input and are committed to consultation with these users when setting policy or determining AtoN requirements. The GLA consult with this diverse range of users through representative bodies of both professional mariners and leisure users. Each GLA has its own regional consultative group which is consulted on an ad hoc basis throughout the year as matters arise and meets formally at least annually. An over-arching Joint Users Consultative Group also meets annually as a combined GLA meeting.

AtoN Reviews form an important part of the User Consultation process. The AtoN infrastructure provided by the GLA requires periodic review to ensure that the AtoN provided are appropriate. The requirement and the rate of change vary geographically. While formal reviews of all AtoN take place every 5 years there is an increasing requirement for ongoing reviews in discrete areas to ensure the most effective provision.

The AtoN Review process includes extensive user consultation as well as close analysis of traffic data from AIS, local sources and coastal intelligence. Risk assessment principles are applied with the overarching objective of ensuring that individual AtoN and the overall AtoN system in any area are:

- Commensurate with the volume of and nature of the traffic
- Appropriate for the degree of risk
- Integrated and cost-effective
- Compliant with internationally accepted standards

The most recent review was published in 2015 and is available on the GLA websites:-

www.irishlights.ie
www.nlb.org.uk
www.trinityhouse.co.uk

2. PLANNING FOR THE FUTURE

2.1 Contributing to marine spatial planning

Whilst the overall responsibility for marine spatial planning lies with other bodies, the GLA are statutory consultees in the planning process. In partnership with other organisations, the GLA will ensure that the principles of safe and efficient navigation are recognised and maintained in national and regional marine plans.

2.2 Marine risk

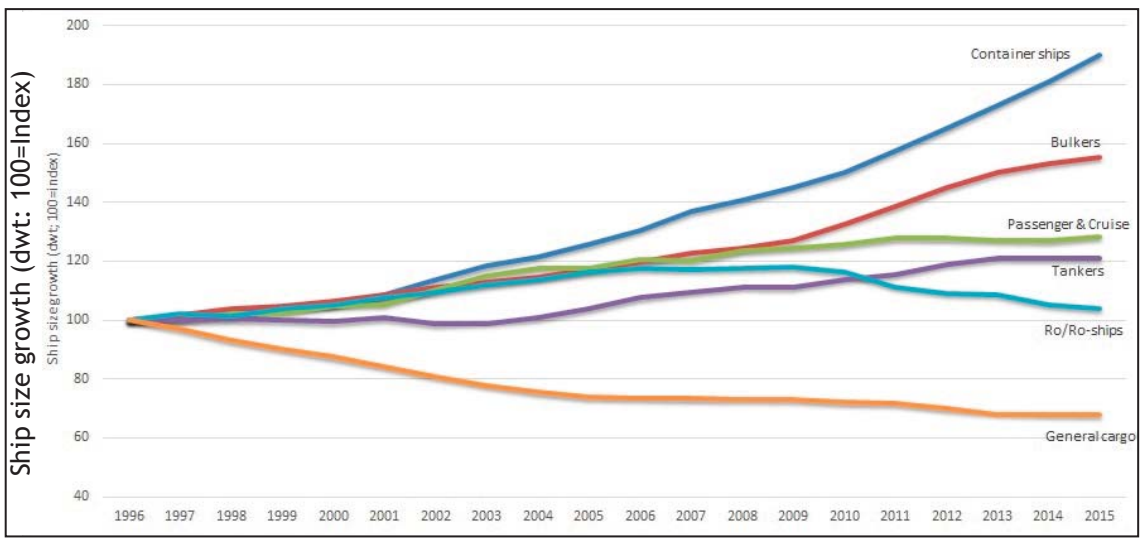
The GLA coastal environment is complex: the Dover Strait is the busiest and potentially one of the most dangerously congested areas in the world; elsewhere there are strong tidal currents and large tidal ranges; and there are around 255 offshore oil and gas platforms, some of which are decommissioned.

There are plans for several thousand offshore wind turbines, in farms of ever increasing size, and increasing numbers of wave and tidal energy installations. There are an increasing number of aquaculture sites and a trend towards establishing such sites in deeper water than was traditionally the case. These developments, as well as the restrictions associated with areas designated for marine conservation, will add further complexity to our already challenging coastal waters. Over the period of this strategy there is likely to be a continuing reduction in available sea room and National Marine Spatial Plans are likely to further influence the free movement of shipping.

These many factors are increasing the pressure on shipping and mariners and constraining the sea area available. Their task becomes more complex and their room for manoeuvre ever more difficult as the number of traffic pinch-points increase, notably on the approach to major ports.

To add to this, there is an international shortage of experienced seafarers, superintendents, surveyors and pilots [2] and the demographic of the mariner is changing with rapid advancement and promotion resulting in higher levels of responsibility with less practical experience than in the past. The IMO estimate a requirement for 600,000 [3] new ships' officers over the period of this strategy. The mariner is also increasingly reliant on technology to support navigation with less opportunity to practice and perfect the traditional navigation skills that would be required during navigation system outages and failures.

The traffic mix comprises vessels of many sizes and performance levels. Recent years have seen significant growth in vessel size in the container sector [4] while ultra slow steaming has become a feature in some parts of the bulk trade. There is an overwhelming reliance on GPS with its inherent vulnerabilities to man-made interference and space weather [5, 6, 7]. The Allianz Safety and Shipping Review 2015 highlights the fact that lessons have not been learned from over reliance on electronic navigation and that Cyber Security is a major concern [8].



CHANGES IN TRAFFIC MIX AND VOLUME (source *International Transport Forum*)

There are numerous examples of accidents and incidents associated with navigational error, including procedures not being followed properly; poor communication, both between officers and between vessels; and lack of situational awareness.

The GLA task is to develop, provide and operate the appropriate AtoN service to mitigate these evolving risks.

2.3 Technology development

The ever increasing pace of technology development is introducing new opportunities and threats into the maritime sector overall and in the provision of AtoN services specifically.

Over the past ten years, e-Navigation has been at the core of marine technology research and development. The IMO, through the Maritime Safety Committee (MSC), has developed and approved (in November 2014) an e-Navigation Strategy Implementation Plan (SIP) which is intended to be implemented during 2015-19. Four work tasks are planned for this period covering:

- Revised performance standards for Integrated Navigation Systems relating to the harmonisation of bridge design and display of information
- Guidelines for the harmonised display of navigation information received via communications equipment

- Guidelines on standardised modes of operation (referred to as S-mode)
- Revised general requirements for electronic navigational aids relating to 'Built-In Integrity Testing' for navigation equipment.

Support for the e-Navigation initiative in IMO will now focus on the above four ship-borne items which will be developed in the early period of this strategy. Further developments within the overall e-Navigation framework can be expected in the later stages of this strategy. Such developments may be led by IMO or emerge from within the industry.

Commercially driven technology developments that can be envisaged over the period of this strategy include:

- Convergence of Networked communications, including VDES, and the increased adoption of the internet of things
- The human machine interface, including coherent presentation of the information to the user, taking human factors into account
- ECDIS and electronic charts – predictive, frequent and real-time updates
- Resilient PNT, including modernised GNSS and independent onboard systems such as inertial navigation systems; quantum devices; etc
- Light technology improvements
- New power systems
- Low maintenance AtoN technologies
- Collection and distribution of environmental data
- Shore-side monitoring and control
- Sea Traffic Management
- Autonomous and remotely-piloted vessels
- Bridge of the future, augmented reality, heads up display
- Developments of the Maritime Cloud [9] concepts.

As well as the potential for improving maritime safety, efficiency and environmental protection, these technologies bring their own challenges, vulnerabilities and new risks. Cyber security is already becoming a major concern and the importance of having systems that are secure against such threats will be an important challenge throughout the life of this strategy.

Any use of these new technologies within AtoN services will be subject to feasibility, risk, and cost benefit analysis.

Technological development brings with it a new set of risks. There is increasing concern at the misuse of technology and its potential to lead to increased incidents. The IMO is laying increasing emphasis on the importance of non technological skills such as Human Factors science as being a critical part of incident prevention. It is likely over the period of this strategy that human performance and limitation considerations will extend beyond the current STCW HELM requirements. GLA plans will need to include an understanding of the impact of such factors on the use and interpretation of our AtoN.

The IMO e-Nav Strategy Implementation Plan (SIP) identifies the Maritime Service Portfolio (MSP) concept as one of five prioritised solutions for early development. It is likely that MSP will play a significant role in the delivery of Aids to Navigation Services during the period of this strategy. MSP will also offer the opportunity to enhance and develop these services to include the provision of additional data to support safe navigation and voyage planning. The GLA collectively and through IALA will contribute to the process of defining, harmonising, developing and providing MSP.

Research and Radio Navigation - TESTING OF A RED LED LANTERN IN THE OUTDOOR LIGHT RANGE

3. NAVIGATION TO 2030

Marine AtoN are an important strategic resource for the United Kingdom and Ireland and provide for:

- The safety of life at sea
- Safe passage of shipping
- The protection of the marine environment
- The maintenance of trade

The AtoN network is essential for trade as:

- they mark both natural and man-made hazards around our coasts that might otherwise lead to maritime incidents with loss of life and damage to the environment

- they provide situational awareness for mariners, improving the link between the physical world and the digital world of radio navigation, electronic charts and radio communications

- they mark areas and routes so that merchant shipping, fishing, leisure users, offshore energy, aquaculture and nature conservation can co-exist and thrive in our increasingly crowded and complex coastal waters

- they are increasingly used for gathering and distributing data improving safety and enabling additional value-added services.

- GLA response to wreck and new dangers is a critical factor in preventing follow on incidents and multiple casualties.

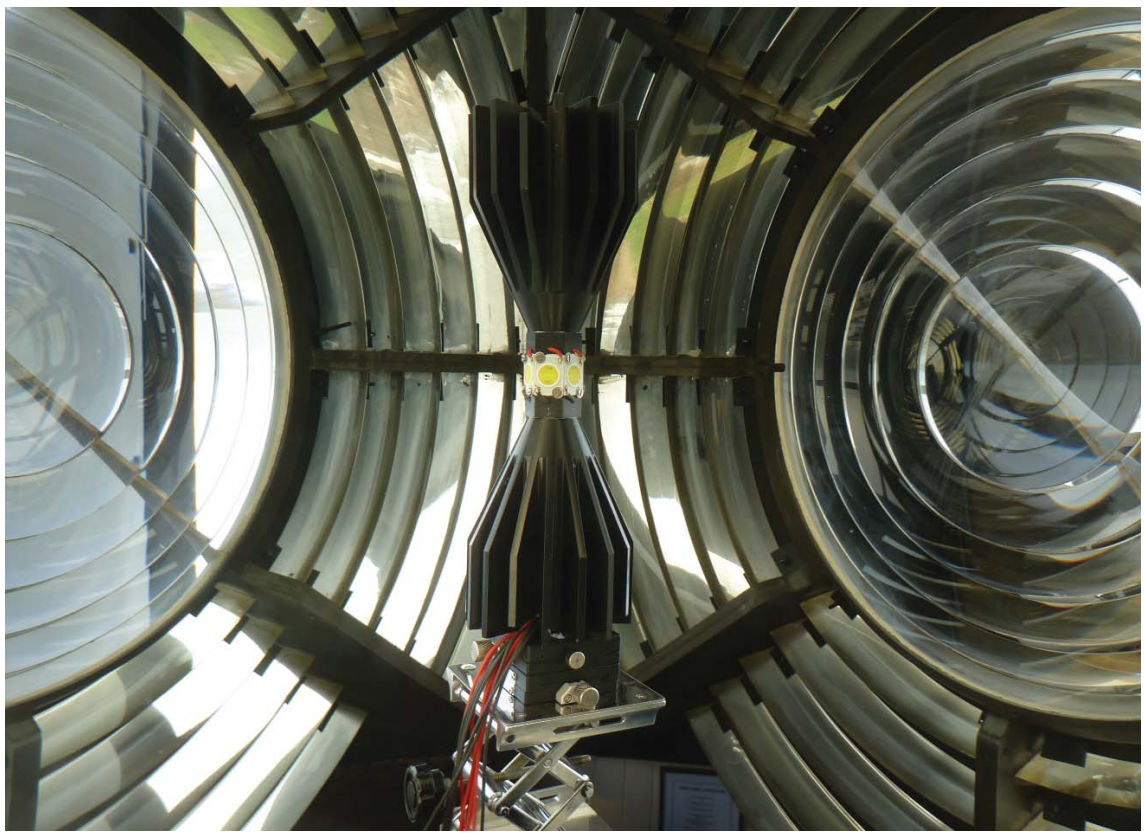
GLA Visual and Radio AtoN will also make a significant contribution to the realisation of e-Navigation, as outlined in the GLA e-Navigation Strategy in Annex B. In line with its e-Navigation strategy, the GLA will drive a multi-agency, co-ordinated approach to the development and realisation of e-Navigation services, enabling the:-

- cost effective integration and validation of the diverse information, available from multiple sources, needed for safe, secure, efficient and environmentally friendly marine navigation

- reliable transmission of that information to appropriate users in a timely manner using the optimum communications channels

- coherent presentation of the information to the user, taking human factors into account.

Because e-Navigation will provide varying levels of benefit to different users, the GLA will continue to provide an appropriate mix of visual and radio Aids to Navigation for all mariners.



Research and Radio Navigation - LED LIGHT SOURCE BEING TESTED IN A LIGHTHOUSE OPTIC

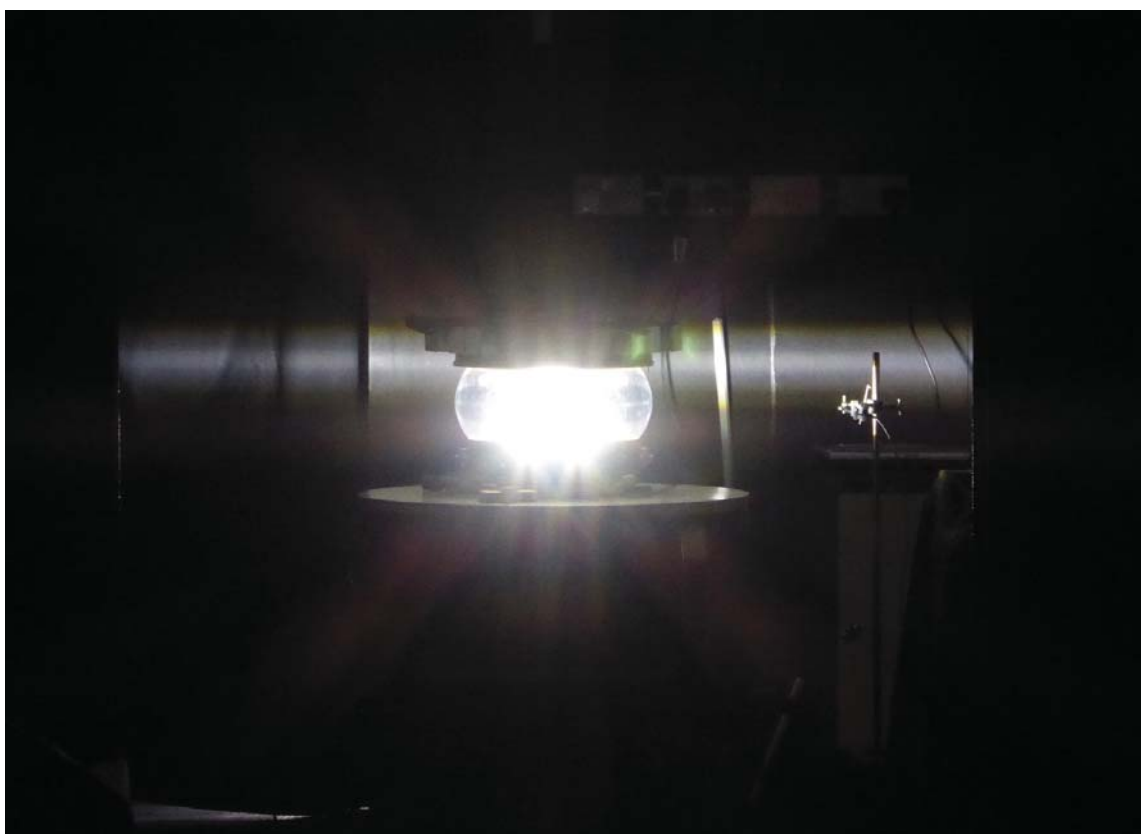
4. THE STRATEGY

The GLA marine Aids to Navigation strategy for UK and Ireland between 2015 and 2030 is to:

- continue to provide an appropriate mix of AtoN for general navigation for all mariners
- continue to provide a timely and effective response to wrecks, new dangers and AtoN failures
- continue to undertake superintendence and management of all Aids to Navigation in accordance with international standards, recommendations and guidelines
- work with users, partners and stakeholders nationally and internationally, to continuously improve the safety of marine navigation through harmonised international standards, recommendations and guidelines
- improve reliability, efficiency and cost-effectiveness while ensuring the safety of navigation
- introduce new services and infrastructure in line with user requirements and technological developments, including lights, radio navigation, e-Navigation and the maritime cloud
- keep abreast of technological developments and undertake research and development on new AtoN technologies
- protect and exploit our intellectual property where appropriate.

The GLA approach to the introduction of new services will focus on the early delivery of benefits through new technology, and the integration and delivery of data that is already available, together with the development of future solutions.

The GLA will work within established international and national frameworks, proactively partnering with other organisations where required, to ensure effective delivery of the AtoN service. As part of that service the GLA will work to ensure that e-Navigation progresses and is delivered coherently and cost effectively, and to the benefit of all mariners. Our detailed strategy for e-Navigation is described in Annex B.



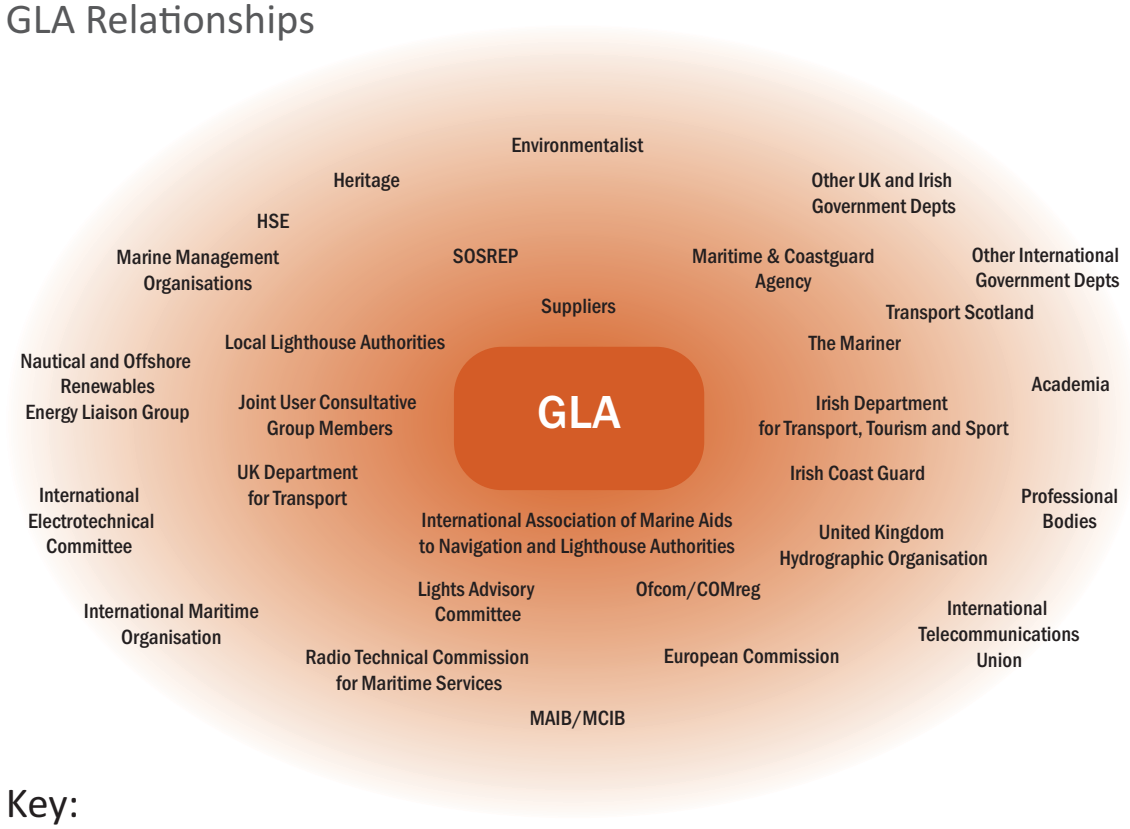
Research and Radio Navigation - TESTING OF AN LED LIGHT SOURCE IN THE OUTDOOR LIGHT RANGE

5. IMPLEMENTATION

5.1 Context

The GLA operate in a complex multi-stakeholder environment comprising of user groups, government departments and other government agencies, international organisations, standards bodies, regulators and commercial customers. Relationships with stakeholders range from strategic, long-term relationships to short-term and transactional and can be direct or indirect.

GLA Relationships



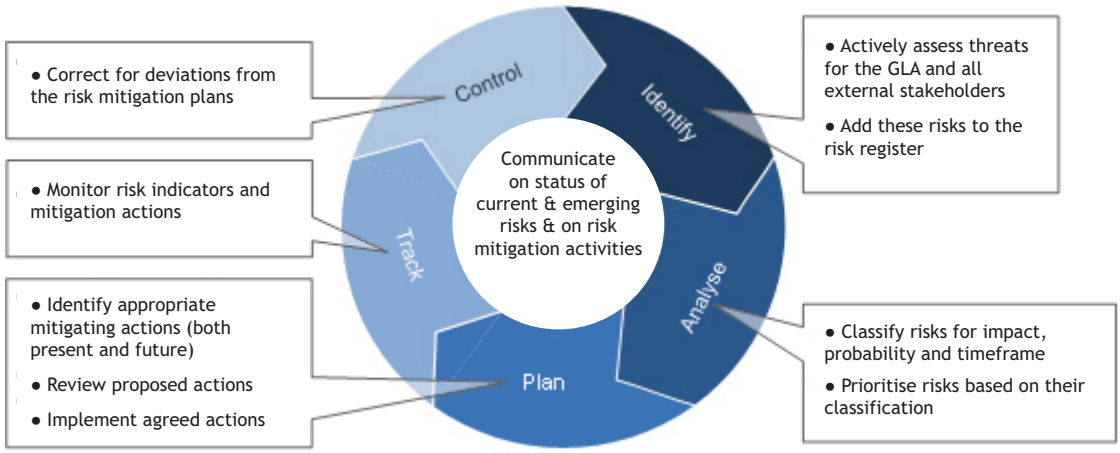
Key:

5.2 Risk Management

The GLA use IALA risk management techniques when identifying the AtoN requirement (type location etc). Risk management is a term applied to a structured (logical and systematic) process for:

- identifying, analysing, assessing, treating, monitoring and communicating risks for any activity
- achieving an acceptable balance between the costs of an incident, and the costs of implementing measures to reduce the risk of the incident happening.

The Risk Management process comprises six steps that follow a standardised management or systems analysis approach.



5.3 Our Commitment

The GLA will:

- collaborate to maximise the benefit to mariners and other stakeholders
- regularly review our AtoN requirements in consultation with our users
- offer a safety critical, efficient and cost effective service
- consult regularly with users through the Joint User Consultative Group, individual consultative committees and local user groups, to understand their needs, inform them about developments, and consider their views to improve the service we provide for all mariners
- engage with other maritime service providers in the UK and Ireland to ensure a coordinated approach to safety of navigation in our areas of responsibility
- work with local lighthouse authorities and our neighbouring littoral states to ensure that users receive an effective and seamless service
- provide a reliable AtoN service, for general navigation, that meets international standards, recommendations and guidelines
- respond to wrecks, new dangers and AtoN failures in a timely fashion to minimise risk to safe navigation
- engage with international organisations, governments and other bodies to promote the standardisation of Aids to Navigation services
- ensure that, through continuous review, the AtoN mix is appropriate for the volume of traffic and degree of risk
- conduct activities in a way that minimises impact on the environment.

When delivered, this strategy will mitigate risk and provide for the safety of navigation, the protection of life, property and the marine environment.

"To deliver a reliable, efficient and cost-effective Aids to Navigation Service for the benefit and safety of all mariners"

IRISH LIGHTS	NORTHERN LIGHTHOUSE BOARD	TRINITY HOUSE

Commissioners of IRISH LIGHTS
Navigation and Maritime Services

COMMISSIONERS OF NORTHERN LIGHTHOUSES
IN SALUTEM OMNIUM
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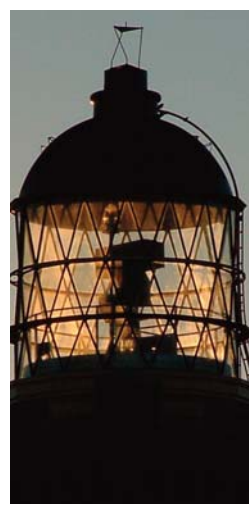


ANNEX A – STATUTORY FRAMEWORK

Responsibility and authority are given to the GLA through the various Merchant Shipping Acts (MSAs). These Merchant Shipping Acts direct the GLA to undertake the superintendence and management of all lighthouses, buoys and beacons within their respective areas. This superintendence includes the inspection of all AtoN under Local Lighthouse Authority management and making general reports as necessary to relevant Ministers. Additionally, the GLA consider and grant consent, where appropriate, to the establishment, alteration or removal of AtoN within their area of jurisdiction. In the superintendence of LLAs the GLA apply the principles of provision and reporting within the Port Marine Safety Code.

The MSA also lay requirements upon the GLA to mark, destroy, remove or raise any vessels which are sunk, stranded or abandoned (wrecks) that in their opinion are an obstruction or pose a danger to navigation and which lie outside areas controlled by harbour or conservancy authorities. In addition to the MSAs, the Harbours Docks and Piers Clauses Act 1847 [10] vests in the GLA the same powers to grant sanction to harbour authority aids but also extends this power to apply to third party aids within the jurisdiction of the harbour authority and to the establishment of temporary or unlit AtoN.

In addition, the Wreck Removal Convention Act 2011 gives the UK Secretary of State (SoS) powers (when the convention is ratified) to instruct a GLA to mark or remove a sunken or stranded ship; or any part of a sunken or stranded ship, including any object that is or has been on board such a ship; or any object that is lost at sea from a ship and that is stranded, sunken or adrift at sea; or a ship that is about, or may reasonably be expected, to sink or to strand, where effective measures to assist the ship or any property in danger are not already being taken. The implementation of these powers is subject to a MoU between the GLA and SoS.

The GLA are consultees in a number of statutory licensing processes for marine based developments.

The costs of the GLA services are met from the General Lighthouse Fund (GLF), which derives its income mainly from light dues that are charged on commercial shipping calling at United Kingdom and Republic of Ireland ports, and UK fishing vessels over 10m in length. Charges are set by Government to ensure the user meets the costs of the services provided. The Irish Government makes a direct contribution to the GLF under the terms of an agreed formula. The GLF is administered by the UK Secretary of State for Transport who has a duty to ensure the effective management of the GLF. An advisory body, known as the Lights Advisory Committee, drawn from shipping and ports' representatives, is consulted by the Department for Transport on certain financial matters relating to the GLF.

ANNEX A – STATUTORY FRAMEWORK

ANNEX B – E-NAVIGATION STRATEGY

Vision

To meet the UK and Ireland's responsibilities as Contracting Governments to the IMO's SOLAS Convention, the GLAs will continue to provide an appropriate mix of visual and radio aids to navigation (AtoN) as a significant component of e-Navigation and drive a co-ordinated approach to the development and realisation of e-Navigation services.

The GLA vision for e-Navigation is that it will enable innovative solutions for the:

- cost effective integration and validation of the diverse information, available from multiple sources, needed for safe, secure, efficient and environmentally friendly marine navigation;

- reliable transmission of that information to appropriate users in a timely manner using the optimum communications channels; and

- coherent presentation of the information to the user, while avoiding information overload.

e-Navigation will build on existing services to facilitate the controlled, phased and prioritised introduction of new technology, systems and services for the benefit of all mariners.

The Strategy

e-Navigation is an international, multi-agency initiative. The GLA will work within established international and national frameworks, proactively partnering with other organisations where required, to ensure that e-Navigation progresses and is delivered coherently and cost effectively, and to the benefit of all mariners. The GLA will influence and drive developments in their areas of technical expertise and legal competence. The GLA will also support partner organisations through provision of infrastructure, technical services, guidance and other advice.

The GLA approach to e-Navigation will focus on the early delivery of benefits through the integration and delivery of data that is already available, together with the development of future solutions. To achieve this, the GLA will work with other UK and Irish organisations involved in e-Navigation to encourage a coherent, holistic and efficient approach to innovation, data and infrastructure integration and delivery of information to users.

The GLAs' e-Navigation strategy comprises the following elements:

ANNEX B – e-NAVIGATION STRATEGY

Strategy

- Recognising e-Navigation as an international, multi-agency initiative the GLA will work within established international and national frameworks, proactively partnering, where required, with other organisations
- to drive the development of e-Navigation ensuring integration of an appropriate mix of AtoN for all mariners
- to engage the maritime community ensuring e-Navigation remains user-driven, users are consulted on developments and raise awareness of human factors and training requirements
- recognising the importance of resilience in positioning and timing, participate in specification and development of appropriate solutions
- to take advantage of the concept of maritime service portfolios (MSPs) to improve the delivery and cost effectiveness of our services.

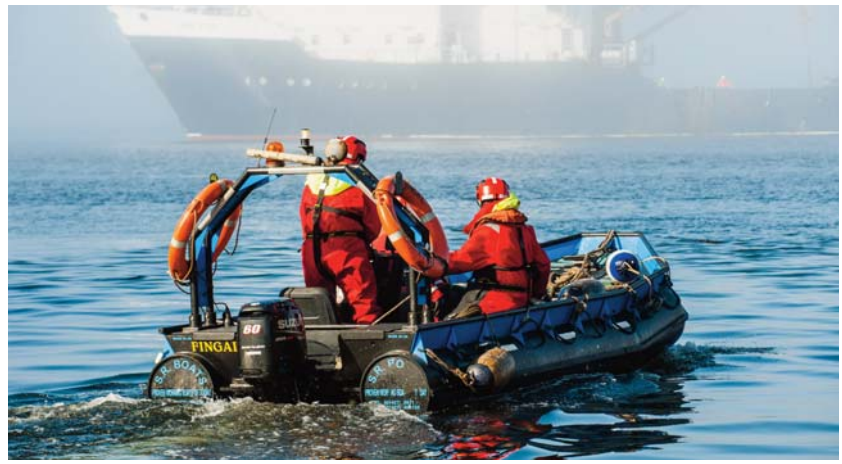
Implementation

- to produce maritime service portfolio (MSP) requirements, working in partnership with other organisations, taking into account ship design, traffic and incident analysis, risk assessment, location-specific conditions and links to marine spatial planning
- to develop and deploy along with partner organisations e-Navigation components to deliver the maritime services comprising the MSPs to enhance safety, security, efficiency and environmental protection
- to understand and mitigate any potential technical, legal, institutional and jurisdictional barriers to the introduction of e-Navigation services
- to participate in the development of standards for data integration and validation as an enabler for the delivery of e-Navigation services
- to continue involvement in the development of the common maritime data structure
- to continue involvement in specifying and developing the appropriate mix of communications systems and services (e.g. the Maritime Cloud) to deliver information to users
- to continue to encompass e-Navigation and associated infrastructure in the AtoN review process.

ANNEX C – GLOSSARY

AtoN	Aid(s) to Navigation
AIS	Automatic Identification System
eLoran	enhanced Long Range Navigation System
GLA	General Lighthouse Authorities
GLF	General Lighthouse Fund
GNSS	Global Navigation Satellite Systems of which GPS, GLONASS, Galileo & BeiDou are types
GPS	Global Positioning System
GRNP	GLA Radio Navigation Plan
GVNP	GLA Visual Aids to Navigation Plan
HELM	Human Element, Leadership & Management
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IMO	International Maritime Organization
IoT	Internet of Things
JNRP	Joint Navigation Requirements Policy
JUCG	Joint Users Consultative Group
LLA	Local Lighthouse Authority
MSA	Merchant Shipping Act
MSP	Maritime Service Portfolio
NLB	Northern Lighthouse Board
PNT	Positioning, Navigation and Timing
SIP	Strategy Implementation Plan
SOLAS	Safety of Life at Sea Convention
SoS	Secretary of State
TH	The Corporation of Trinity House
UK	United Kingdom
VTS	Vessel Traffic Service

ANNEX C - GLOSSARY



ANNEX D – REFERENCES

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[4] Review of Maritime Transport 2015, United Nations Conference on Trade And Development

[5] GLA GPS jamming trials

[6] Volpe Report on GPS Vulnerability

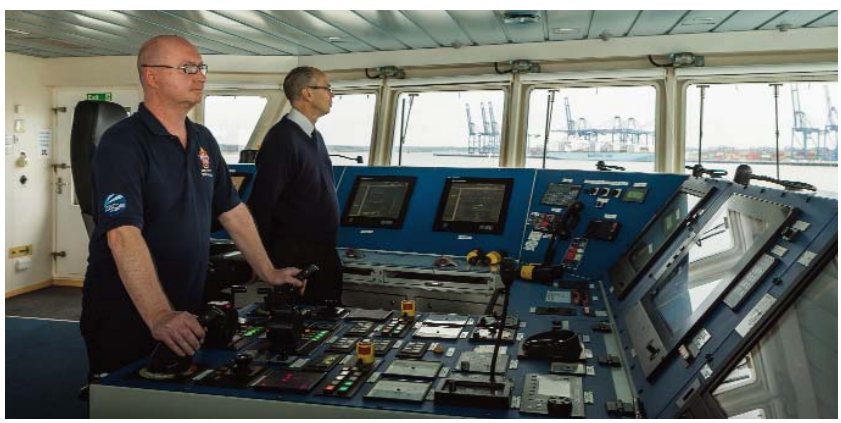
[7] Space weather preparedness strategy, Cabinet Office, July 2015

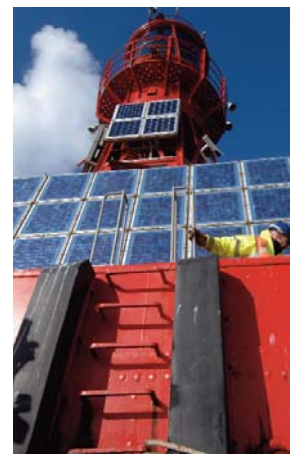
[8] Safety and Shipping Review 2015, Allianz Global Corporate & Specialty

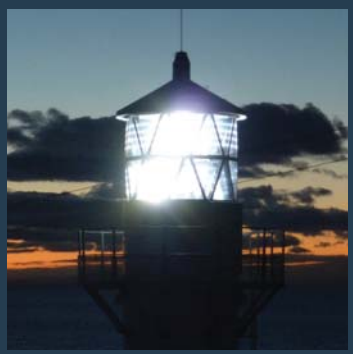
[9] A communication infrastructure providing authorized seamless information transfer on board ships, between ships, between ship and shore and between shore authorities and other parties with many related benefits.

[10] Harbours Docks Piers Clauses Act 1847

ANNEX D - REFERENCES







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