AIDS TO NAVIGATION ENGINEERING WORKSHOP

WORKSHOP REPORT

14 to 17 October 2024

Australian Maritime Safety Authority

Sydney, Australia

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17 October 2024

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International Organization for Marine Aids to Navigation

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Executive Summary

The Aids to /navigation Engineering workshop was held between the 14 and 17 October 2024 at the Australian Maritime Safety Authority in Sydney, Australia.

The workshop was very well attended with 115 participants from 27 countries.

The workshop participants considered the various presentations that were given, and the work conducted in the WGs, and it was concluded that:

- Marine aids-to-navigation remain critical to safe and efficient voyages at sea, and effective protection of the environment.
- Engineering challenges of varying complexity continue to exist in the provision of marine aids-to-navigation around the world, but the level and scope of guidance provided by IALA is reflective of best practice.
- Well-implemented modern information and communication systems have proven to simplify the management and engineering of marine aids-to-navigation.
- Artificial Intelligence has the potential to influence and impact existing marine aids-to-navigation engineering and management practices.
- AtoN providers continue to strive to install and maintain sustainable Marine aids-to-navigation with minimum environmental impact and maximum cost-effectiveness.
- The need for Resilient PNT remains critical to ensure the mariner can rely on their electronic navigation systems and Marine Aids-to-Navigation.
- Visual signals remain a critical part of the marine AtoN service, and IALA's suite of standards, recommendations and guidelines are essential to ensure global practices are harmonised and maintained to a high standard.
- More efficient and robust solar panels are on the horizon but are currently not available on the commercial market.
- The use of lithium batteries is on the increase for power storage within marine aids-to-navigation. It is recognised that their use is currently limited by operating temperature range and transportation regulations.
- Knowledge sharing, collaboration and training continue to be key enablers to harvest the benefits of new technology and deliver high quality and efficient aids to navigation services worldwide.

Contents

Report of the Aids to Navigation Engineering Workshop

1. INTRODUCTION

The Aids to Navigation Engineering Workshop was held between the 14 and 17 October 2024 at the Australian Maritime Safety Authority in Sydney, Australia. 115 participants from 27 countries participated in the Workshop plus five members of the IALA secretariat.
Chair of the Workshop was Alwyn Williams, and the Secretary was Alisa Nechyporuk. The logistics for the event were organized by Julie McGraw, Managing Director and Senior Conference Manager and Angela Karamihas, Asset Management Coordinator at AMSA.

The event was kindly sponsored by the organizations depicted below.

2. SESSION 1 – OPENING OF THE WORKSHOP

This session was chaired by Greg Hansen, Principal Advisor AtoN Engineering at AMSA.

2.1 Welcome to country from Greg Hansen, Principal Advisor AtoN Engineering at AMSA (Introductions and housekeeping)

Greg Hansen, invite Uncle Alan Madden, an elder of the country to make a Welcome to Country.

Uncle Alan extend a warm and sincere welcome to all non-Indigenous brothers and sisters in Gadigal, regardless of their origin, whether it be across the seas, across the state, or across town, acknowledge the First Nations and traditional owners of the lands on which anyone may have come from or work. He also pays respect to all of Aboriginal elders, both past and present.

He also mentioned that Gadigal is one of the nations of Eora's 29 plans. The Hawkesbury River to the north, Lepine to the west, and Georges River to the south are the boundaries of the Eora nation. And this nation of Eora, nestled between those three great rivers. There are 29 clans in that country, and the clan whose property event is on today is Gadigal. He extends warmest greeting to participants on behalf of the Gadigal mob and the members of the Metropolitan Local Aboriginal Property Council once more.

2.2 Welcome from AMSA, Mark Morrow – Executive director of the Response Division, Australian Maritime Safety Authority

Mark Morrow, AMSA Executive director of the Response Division, kindly welcomed everyone to the workshop and Australia, expressing his honour to deliver the opening remarks as the event commenced. He highlighted that Australia has been a long-standing member of IALA by ratifying the treaty and becoming a member of the IGOs Council, and continue to influence key decisions, the development of standards, contribute to the IGOs strategic priorities and stay abreast of technological developments within the field.

He highlighted that Australian Maritime Safety Authority is Australia's national maritime safety regulator and are responsible for promoting the maritime safety of international shipping and domestic commercial vessels in Australian waters, the protection of green environment from ship source pollution, providing infrastructure to support safe navigation in Australian waters and search and rescue for the maritime and aviation sectors nationally in the 52 million square kilometres region. Aids to navigation played a crucial role in maritime search and rescue operations by providing key visual, auditory and electronic signals that help both vessels and search and rescue teams navigate safely and efficiently.
Mark provided information about many lighthouses that are heritage listed and AMSA undertake capital works, refresh paint, replace parts and a range of other things to maintain those lighthouses. Also specific benefits for Australia include incident reduction in Australian waters through better navigational safety and traffic management. Environmental benefits through enhanced protection for Australia's unique marine ecosystems, economic benefits by boosting Australia's capacity to keep up with trends such as towards maritime autonomous surface shifts increase with international legislation and recommendations, including the maritime single window and the navigation hosting this important workshop on delivering the service design in the future is timely for AMSA as continued to optimize network and main maintenance delivery model and provides an opportunity to share knowledge and ideas through this workshop.

2.3 Welcome from IALA, Omar Frits Eriksson – IALA Deputy Secretary-General

Omar Frits Eriksson, IALA Secretary-General, welcomed participants to the workshop and expressed his happiness to see the interest that the event has garnered with more than 70 experts and stakeholders with a keen interest in the development of Aids to Navigation Engineering.

Omar then provided a status update regarding the new IALA IGO this being the first event since the transformation.

The Deputy Secretary-General thanked the AMSA for hosting this event, for putting together an excellent program and collaborating on making this workshop happen. He hoped that all will have a fruitful week and

that the outputs of this workshop will serve everybody well in the months and years to come, working to achieve harmonization in this field.

2.4 Workshop aim and objectives, Alwyn Williams – IALA Chair ENG committee and Workshop Chair

Alwyn Williams, Chair of Workshop and Chair of IALA Engineering and Sustainability Committee (ENG), welcomed participants (a list of participants can be found in Annex A). He highlighted that AtoN Engineering Workshop is a great opportunity to share professional experience and knowledge of different topics, certainly from a sustainability point of view, climate changes, modern courses of worldwide Academy, asset management and working environment.

Workshop Chair introduced Workshop programme and mentioned the main topics and activities.

Workshop programme can be found in Annex B.

2.5 Operating environment for delivering AtoN Services, Captain Lawrie Corda – Port Authority of New South Wales

Captain Lawrie Corda, representative from the Port Authority of New South Wales, was focusing on the historical and functional significance of the Sydney port. He introduced the zone of responsibility and structure of the the Port Authority of New South Wales and mentioned that politics in the port of Sydney commenced around 1803, more than 200 years ago.

Captain Lawrie showed a short video showcasing the Hornsby Lighthouse restoration, which was carried out by the Port Authority. This lighthouse was a Sydney icon long before the Harbor Bridge, Opera House at Watson's Bay, a gatekeeper of the Higgs and a guiding light to sea fairies for the past 166 years.

Another case was about Sydney airport inside the port. Due to being in the runway approach, there were restrictions of the height of the structures. Port had cranes that could be used to build the structures, the orientation of these lights, so that they did interfere with the approaching aircraft. The design also had to accommodate vessels of up to 370 meters, the next class of larger container vessels. The solution was to build the leads in the water. The project faced unique challenges, including the stringent requirements for the allowable rotation of the lead lines in winds of 35 knots, construction in depth of 15 meters with a light height of 18 meters above sea level, along with the geotechnical complexity of the sharp side with shallow rock formations, the design to consider the cyclic motion of wave loading, necessitating a fatigue analysis. The final design was violated using the full mission simulator at the Australian Maritime College in Launceston. Now about 36% of the vessels falling and botany are the available depth of water at a high spot in the channel called the Basho, During the design phase of the new leads, the opportunity to realign the shipping challenge the deeper water was identified. This means by adjusting the position of the lead lights, port get extra depth without the need for dredging. And from a safety perspective, it means that the largest vessels are now entering the port using the deepest waters available.

2.6 Technology changes, Jens Ohle – SPX Aids to Navigation

Jens Ohle, representing SPX Aids to Navigation, focused on how technology revolutionises engineering and design. He mentioned that advancements in simulation and AI have enabled us to achieve more in less time. While it is difficult to predict what technology will hold for the future, historic advancements have significantly impacted engineering design, allowing us to extrapolate future trends and adapt how we build products, with a strong shift toward sustainable solutions.

Historically, Operational Technology (OT) operated on separate networks, isolated from other systems, and was used primarily to run power stations, pumps, and similar infrastructure. Now, we are witnessing the convergence of Information Technology (IT) and OT technologies, which brings both opportunities and risks. The integration of IoT devices, built on IT networks, is pushing the boundaries of smart devices and connectivity. However, this convergence also increases security risks.

AI, which simulates human intelligence through technologies like large language models and generative pre-trained transformers, are already used extensively. In engineering, these tools help process large data sets and aid in code generation, playing a key role in many customer-facing applications.

One of the most critical aspects today is product sustainability. Due to growing environmental concerns, regulatory pressures, and increasing consumer demand for eco-friendly products, sustainability has become a top priority in design. Significant developments in renewable energy generation and the use of eco-friendly, reusable and recyclable materials are shaping the future of product design.

3. SESSION 2 – REGIONAL PERSPECTIVE

This session was chaired by Ashton McGill, Advisor on Aids to Navigation & Maritime Communications of the Maritime New Zealand.

3.1 Pacific Safety of Navigation Project – Faranisese Kinivuwai, SPC

Faranisese Kinivuwai, representative from the Pacific Community (SPC), in summary, presented on then Pacific Safety of Navigation (SoN) Project, regional policies relating to safety of navigation, and the project on Safety of Navigation (SoN). She also provided an update on Pacific Regional Energy and Transport Ministers Meeting (PRETMM) that was held in 2023 and some of the resolutions of the ministers or leaders from that meeting.

She emphasised that the Pacific Safety of Navigation Project was funded by the International Foundation for AIDS navigation (IFAN) who have supported 3 phases of the project in the region. She also acknowledged the support by IFAN and the extensive work undertaken in the Pacific region. The SoN project is implemented by the SPC in support of its member countries.

In the project, the SPC also works in partnership with other agencies such as the, International Maritime Organisation (IMO), International Hydrographic Office (IHO) and the South West Pacific Hydrographic Commission (SWPHC) in developing capacities for the region and enhancing the work of safety of navigation. In her presentation, she also discussed the Regional Strategy on Safety of Navigation 2023–2027, a strategy developed with the SON project to promote a consistent and innovative approach to safety of navigation in the Pacific by interlinking the targets, overall objective, results, and indicators as stated in Chapter V of the SOLAS Convention.

In discussing the Strategy, Faranisese mentioned that it was important to assist countries and member states particularly in specific areas as guided by the Regional Strategy such as Safety of navigation governance, legislation and policy development, Navigation warnings and meteorological services, Hydrographic services, Aids to navigation and vessels traffic services (VTS), and Search and rescue services (SAR).

In highlighting the activities in the region, she reiterated that the support from IFAN and SPC has assisted member countries in capacity building specifically for ATONs Managers, Infrastructure Development and simplified IALA Risk Assessment including trainings and consultations.

3.2 G1165 Sustainable structural design of marine AtoN – Sarah Robinson, IALA World-Wide Academy

Sarah Robinson, Advisor of the IALA World-Wide Academy, presented updated IALA Guideline 1165 on Sustainable structural design of marine AtoN and provide background on document structure, acceptance to the regional guidance, and ideas for potential review and expansion. The need for designing AtoN structure, sustainably became very clear to WWA from MSF green Safety Authority of Fiji during visit a couple of years after Cyclone Winston in 2016, when AtoN navigation structures was destroyed in the cyclone. In response, it was decided to develop some IALA guidance on how to design structures in a sustainable manner, and particularly selecting codes that are fit for purpose for the regions and that received enthusiastic support and response from the ENG committee, and support in the region.

Sarah explained the use of the word sustainable in the title of the guideline, it was initially intended to be about the consideration that we give to the balance of cost of design and construction versus the durability and design life that hoping to be achieved, and to sustainably design an AtoN for the length of time that require and under anticipated environmental conditions, and got to ensure that the design is undertaken using design standards appropriate for the geographical location, so that includes environmental loading such as wind and wave and the guidelines.

The document covers a brief introduction to the concepts of structural design or assessment. It covers typical structural elements that require design, typical loads, that those elements are subject to the effects of loading on the elements and then generic design standards that are typically used in the structural design and assessment of fixed atop. It looks at non-structural aspects such as durability, sustainability and safety.

3.3 AtoN in Great Barrier Reef – Bill Morley, Maritime Safety Queensland

Bill Morley presented on Maritime Safety Queensland (MSQ), outlining the role as the primary maritime safety regulator in Queensland with key functions including improving safety, minimizing seaborne pollution, emergency incident response and managing regulation. This includes making changes to legislation that improve safety for the boating community.

He explained that MSQ divide Queensland into five regions, with each having their own Harbour Master and a regional operation team. MSQ manage thousands of Aids to Navigation within a sensitive Marine Park environmental context with regional teams managing day to day maintenance, while the Marine Engineering team complete detailed design, procurement and delivery.

3.4 AtoN solutions in the Pacific region – Adam Hay and Adrian Van Boven, M-NAV Solutions Pty Ltd

Adam Hay and Adrian Van Boven, Directors at M-NAV Solutions Pty Ltd, presented on challenges specific to AtoN in the Pacific region, including a case study on the design of a modular AtoN for use in remote locations. He focused on diversity of Pacific region – three different regions, Melanesia, Polynesia, Micronesia, across about 30,000 different islands, and references that some large countries in the Pacific where the landmass, population, the access to the resources allow them to deliver complex systems with very high levels of availability.

Some of the challenges of delivering AtoN, especially for smaller, more remote countries, included limited budgets, access to local resources, limited availability of construction plant and vessels and a reliance on small craft. He referred to one of the most valuable assets being local knowledge and the ability of AtoN technicians understanding what works and what doesn't.

He provided details on a case study that M-NAV Solutions were currently working on, for the design of a modular AtoN that could be installed and removed manually with locally available resources, yet also engineered and certified to withstand environmental loads. He provided the workshop an indicative program that will reach completion by the end of 2026, and ENG committee will be quite interested in progress that will provide regular updates.

4. SESSION 3 – A GLIMPSE INTO THE FUTURE

This session was chaired by Jaime Alvarez, Technical officer of IALA WWA. The session was dedicated to the use of data exchange, data management and portrayal technologies with a view on the applicability of these to a specific case, MASS.

4.1 Machine readability and Artificial Intelligence – Owain Brennan, Seer BI

A representative from Seer BI, Owain Brennan, presented the tools used in the data science lab focused on developments in the Maritime sector based in the United Kingdom. With respect to trade digitalization and AI development, the company has worked with the UK government, international governments, and commercial shipping entities. The presentation focuses on explaining what machine readability is, how it has been applied in other sectors, what AI is including a view of the state of the art and an overview of the work done in the Customs automation sector using machine-readable data and AI in combination.

As he explained, the approach of organization involves taking non-machine-readable data types, such as PDFs, applying artificial intelligence to them, and resulting in machine-readable information. As a result of the use of this tool, maritime engineering sectors and data can be handled in a more secure manner, time can be saved, and all the other benefits can be obtained.

4.2 S201 / S125 and MRN and what it means to AtoN providers – Minsu Jeon, Technical Director of IALA

Minsu Jeon, Technical Director of IALA, who supports and coordinates the work of the technical Committees and serves as a technical liaison for IALA with other international organisations such as IMO, IHO, and etc. The content of his presentation focused on the below aspects:

- Next Generation ECDIS: becoming mandatory from 2029. While this does not imply that IALA's Product Specifications will also be mandatory, it is crucial for IALA to be involved in this development. This presents an opportunity to harmonize AtoN with these advancements.
- Role of IALA in this Development: the role of IALA and contributions in the context of the next generation ECDIS. Named S-200 world.
- Introduction of S-201, S-125, and S-124: Provide a general overview of these Product Specifications, highlighting the opportunities and challenges they present. Training on S-200.
- What is the MRN and its Implication for IALA: The Maritime Resource Name (MRN) serves as the unique identifier for S-100. Guideline G1143 elaborates on its syntax and usage, detailing its significance for IALA.

4.3 Maritime Connectivity Platform implementation – Dr Julius Moeller, AMSA

Dr Julius Moeller, Senior Advisor for Navigation Safety and Digitalisation at the Australian Maritime Safety Authority (AMSA) presented on the Maritime Connectivity Platform (MCP), a secure and reliable framework for information exchange in the maritime sector. The presentation highlighted different use cases of core component of the MCP, with a focus on how it supports and enhances digital Aids to Navigation (AtoN) services, driving efficiency and cyber security in maritime operations.

Dr Julius presented the capabilities of the Maritime Service Registry, which is designed to manage digital maritime services and support future voyage planning by providing seamless access to a global set of S-100 based services, including AtoN information services. He explained how this system will enhance the coordination and availability of high-quality maritime data.

In the second part of his presentation, Dr Julius showcased the application of the Maritime Identity Registry, which handles digital identity management, using it as an example to demonstrate how digital signatures can safeguard ships and shore authorities from common vulnerabilities in the Automatic Identification System (AIS). This approach highlights the importance of cybersecurity in maritime operations.

He concluded by noting the significant potential of the Maritime Connectivity Platform (MCP) to boost both efficiency and security in the maritime domain through the advancement of digitalization. Further, he also emphasized that the MCP is not a centralized cloud for storing participants' data, but a framework that supports the decentralized implementation of independent maritime services, fitting within the broader context of e-Navigation.

4.4 MASS update, current thinking on MASS use of AtoN – Hideki Noguchi, Japan Coast Guard

Hideki Noguchi, the Japan Coast Guard officer and the chair of the IALA DETC Committee. Currently he is appointed as the chair of the IMO NCSR Navigation Working Group. He mainly works for digitalization of marine radiocommunication and navigation in international community. The presentation focuses on mainly IMO's and IALA's work on Marine Autonomous Surface Ships (MASS) and considers the impact to the maritime operations and the need of marine AtoN for MASS in future.

He mentioned that IMO is currently drafting MASS Code that is non-mandatory instruments as supplemental to SOLAS, applied to a cargo ship engaged in international voyage. The third intersessional working group meeting held in September 2024 finalized the chapter 17 "safety of navigation" of MASS Code that defined functional requirement and expected performance of the Autonomous Navigation System (ANS) and the chapter described some expected performance related to AtoN as follows:

- 17.2 Functional requirements. To achieve the above-mentioned goal, a ship should comply with all relevant requirements for safety of navigation in SOLAS, as modified and/or supplemented by the functional requirements of this chapter, and COLREG.
- 17.3.2 All data necessary for safe navigation should be available, in an appropriate format.
    - EP 1 MASS should meet the requirements of SOLAS regulations V/19.2.1.4 and 19.2.1.5 by electronic means.
    - EP 2 Data used by or for input into an ANS or system for remote navigation should be in a machine-readable format.

Therefore, in short term future, there is no need to change the current AtoN services because MASS should comply with SOLAS Chapter V but, in long term future, there is a possibility that AtoN should provide its information by electronic means in a machine-readable format.

The MASS Code is expected to complete at MSC110 in June 2025 but may be delayed.

4.5 Complimentary use of AtoN and Tsunami monitoring – Mónica Herrero, Mediterraneo Señales Maritimas SL (MSM)

Monica Herrero, COO in Mediterraneo Señales Maritimas talked about the different uses of AtoN apart from the safety use. The use of AtoN for data collection, the user and data receiver of the different types of AtoN (shore or the mariner). Thus, the navigational requirements and technical specification are different.

Monica mentioned that complimentary use of AtoN and Tsunamy monitoring data can be used for the public and authorities to increase the service the barriers with the provision of information, as well as the rating of the organization that may have an interest in those data. In order to use there are some implementations to ensure the successful project. Implementation, the first step is to do regular system definition, considering the limitation to manage important to the terminate, which one can be used depending on the objective of the data. The second definition is that the parameters can be taught for the purpose of the safety of navigation.

5. SESSION 4 – LIGHTS

This session was chaired by Alwyn Williams, Chair of ENG committee and Workshop.

5.1 Review of IALA documentation on lights – Malcolm Nicholson, SPX Aids to Navigation

Malcolm Nicholson, Global Marine Product Manager from SPX Aids to Navigation, focused on IALA standards, especially S1010 Marine AtoN planning and service requirements, recommendation on Port Traffic Signals for visual signalling and S1020 Marine AtoN design and delivery. During reviewed IALA documentation, it was found that a photocopy of a European standard from 1996 was being used. After a global survey of all the national members was found that if it still using so the codes that cause signal lights or traffic lights are still valid.

He mentioned the chromaticity diagram and the chromaticity coordinates, provided in IALA publications. Option is available for plotting in an Excel or machine-readable XML, JSON and guidance to achieve IALA colours.

5.2 LED's with coloured filters – Alwyn Williams, General Lighthouse Authorities of the UK and Ireland

Alwyn Williams, Chair of the Workshop and Chair of ENG committee, presented LED's with coloured filters and focused on the topics as creating sectors with coloured filters, colour and intensity, angle of uncertainty, changing filament lamps to LEDs, etc.

He mentioned main aspects of creating sectors with coloured filters:

- Coloured filters often used to provide sectors.

- Usually from a common light source installed in a traditional source.
- Typically, red or green.
- Different types of each colour available.

Alwyn also introduced issues to consider about changing filament lamps to LED:

- Need different filter material to meet the IALA colour requirements due to different light spectrum.
- Reduction in transmittance, leading to lower intensity in the coloured sector, and a reduced nominal range.
- LED light source might be wider than the filament lamp – leading to a wider angle of uncertainty.

5.3 Replacing obsolete light sources and environmental considerations – Daniel Atkins, AMSA

Daniel Atkins, representative from AMSA, explained environment types for AMSA AtoN, AMSA incandescent rotating lantern replacement program, give considerations for light source, etc. The AMSA network includes approx 362 AtoN sites around Australia, 10 unlit AtoN (3 daymarks, 7 metocean sensors), which are installed in a diverse range of environments.

Daniel represented key aspects of the incandescent rotating lantern replacement program:

- AMSA has now commenced a program to phase out VRB25 lanterns due to increasing reliability issues.
- Learnings from Lady Musgrave Island trial have guided the program.
- AMSAs asset management strategy:
    - Utilise flashing LED lanterns where possible.
    - Utilise MBR300L lanterns where sensitive environmental receptors are present and for heritage structures.

He proposed solutions for environmental considerations:

- AtoN providers should seek advice from the relevant environmental authorities when significant changes are being made to light sources.
- Manufactures should consider the increasing environmental requirements that AtoN providers are facing not only navigational requirements, to ensure that light source solutions are available where environmental sensitivities exist.
- AMSAs view is that there is a need for rotating beacons with Fresnel lens producing concentrated/pencil beams to meet environmental requirements, not just for the long range capabilities.

5.4 Sustainable leading light lanterns and power developments (Peter Schneider, WSV Germany) – Link Powell, General Lighthouse Authorities of the UK and Ireland

Link Powell represented the topic of Peter Schneider from the German Federal Waterways and Shipping Administration (WSV) on the sustainable leading light lanterns and power developments. He reported on a major project in which both the light sources and the remote control and monitoring systems of 900 lights and 1000 shore lights are being renewed. Important sustainability goals are the avoidance of disposable products through the use of durable, replaceable components and the reduction of the energy demand, which in many cases enables a renewable energy supply. This in turn leads to independence from the public power grid and then to the elimination of emergency power systems.

An important part of the project was the procurement of leading light- and shore light lanterns. Both lanterns were not available on the market, but were developed on the basis of the WSV requirements.

The implementation of the energy and sustainability goals was presented in detail. Very high energy savings of several tenfold were achieved with the new leading light lanterns. For the shore lights the factor was still greater than 6. By selecting high-quality electrical and mechanical components and sophisticated coating systems, durable housings have been realised. The choice of glass lenses or high-quality plastic lenses maintains the photometric properties over a long term. Thanks to replaceable LED light sources and high manufacturing accuracy, no readjustment to the fairway is required in the event of a defect, which avoids the use of ships.

5.5 Measurement process and uncertainty - Link Powell, General Lighthouse Authorities of the UK and Ireland

Link Powell presented on measurement process and uncertainty. Using string length measurement as an example, he identified uncertainty sources that affect the accuracy of the measurement. Using an example result and measurement uncertainty he showed how these are compared against a required specification.

He concluded:

- Even when we try to measure accurately, there are factors that prevent us determining the true value.
- The true value of the measurand will never be known.
- We can assess our measurement system and methods and calculate the uncertainty of our results.
- We can use this result to determine if we are sufficiently confident that something meets our requirements.

Link also referred to these documents for further reading:

- IALA Recommendation E-200-3 on Marine Signal Lights – Measurement. 2008.
- UKAS M3003 – The expression of uncertainty and confidence In measurement.
- JCGM 100:2008 Evaluation of measurement data – Guide to the expression of uncertainty in measurement.
- CIE 198 Determination of Measurement Uncertainties in Photometry.

6. SESSION 5 – POWER

This session was chaired by Malcolm Nicholson, Global Marine Product Manager from SPX Aids to Navigation and Working group Chair of ENG committee.

6.1 Photovoltaic technologies and sustainability of materials – Dr Moonyong Kim, School of Photovoltaic & Renewable Energy Engineering, UNSW

Dr Moonyong Kim represented the School of Photovoltaic & Renewable Energy Engineering, UNSW, and focused on the cell and the module for photovoltaic technologies. He emphasized a roadmap to achieving near-carbon-free PV production:

1. Decarbonise electricity (DC) – The main reduction comes from silicon and aluminium.
2. Green steel and decarbonized concrete.
3. Improve performance/yield (emission reduction by 50 %, achievable through decarbonization of electricity alone).

Dr Moonyong Kim summarised that the crystalline silicon modules currently dominated the PV technology market and their large scale (+500 GW/year) could be achieved by using the low cost, large scalability, and prolonged lifetime (over 30 years) where the TOPCon and Heterojunction (SHJ) are likely to dominant cell technologies which with exceed current dominant cell technology of PERC's efficiency. However, he mentioned that there would potentially be a problem in silver usage where higher efficiency cells (TOPCon

and SHJ) require more silver, leading to a potential sustainability problem. The emissions from making PV modules will also be noticeable as the market reaches over the TW scale, but there is still nothing compared to the other fossil fuel-based power plants. Recycling of PV modules could be challenging to overcome but not a significant problem as other types of waste like plastic, coal ash, or oil sludges.

6.2 Impact on power systems due to lantern selection – Peter Dobson, Trinity House

Peter Dobson, representative from Trinity House, who currently run a group that develops standards for installation, develops new products and manage obsolescence, indeed. He mentioned a particular example of Mumbles lighthouse, that was originally built in 1794 as part of a Victorian Defense and remains in Swansea Bay, on the south coast of Wales. It was solarized 1988 and the access to it is not by boat, but walking on and off, and you can only do this during spring tides in order to allow you enough time on site.

Peter explained that organization wanted to keep some level of control – remote telemetry control and local control to turn up and check the operation, and additionally, the ability to confirm the operational power of the lantern . The solution was to develop a little control system that essentially power cycle the lantern. The organisation uses the control systems as two independent main and standby arrangement. When this was first fitted to Mumbles with new 15NM lanterns, a problem was encountered. This was seen as both lanterns not working. An initial fix was to leave a multimeter in circuit. When time allowed the problem as identified as being the high initial current resulting in the voltage collapsing due to cable inductance. Improvements were made with local capacitors preventing the voltage collapse. The main and standby system was seen as nicely stable, and the scope capture now showeds minimal impact as a result of the initial power. The cause was as a result of power cycling the lantern. A number of alternative solutions were identified for similar situation but the best solution is to get the batteries near the location of the loads.

6.3 Battery developments and options – Lithium experience – Jonas Lindberg, SPX Aids to Navigation Oy

Jonas Lindberg, representative from SPX Aids to Navigation Oy, focused on lithium-ion batteries in Marine AtoNs in comparison to traditional lead acid batteries in safety aspects and battery management system. He mentioned that against a lead acid battery, it has much higher energy density, so it can store more energy in a smaller and lighter package. This is very suitable for application in limited space and for longer lifespan, dramatically longer lifespan.

He concluded that the main reasons for choosing lithium-ion battery over lead acid is longer cycle life, higher energy density, lighter and superior charge efficiency, and you need to make sure that you are using high quality products.

6.4 Enhancing AtoN System Safety: Remote Diagnosis & Monitoring of Lithium Batteries – Tae Uk Chang, Quantum Solution

Tae Uk Chang introduced the AtoN project led by the Korean Ministry of Oceans and Fisheries, and explained that Smart AtoN enables real-time data monitoring and remote control based on IoT technology, efficient maintenance, marine environment protection, and next-generation AtoN that interconnects with navigating vessels.
He mentioned that the project aims to propose safe and efficient operation and verification of AtoN energy systems (including lithium batteries) as a global standard.

7. SESSION 6 – POSITION, NAVIGATION AND TIMING

This session was chaired by Jeffrey van Gils, representative from the Ministry of Infrastructure and Water Management of Netherland and Working group Chair of ENG committee.

7.1 Need for Resilient PNT – Dr. Kiyeol Seo, KRISO – Korea Research Institute of Ships & Ocean Engineering

The session focused on eLoran and R-Mode developments in ROK. The coming development plan to establish effectively an efficient RPNT solution for the maritime operations with a special attention to the use of new technologies on long time available sources of positioning. The progress on fitting with AI to the transmitter station for error detection of the eLoran signal, is a prove of such developments. The system also will provide a resilient timing service to the user.

7.2 Resilient PNT Requirements – Florin Mistrăpău, GMV

Florin Mistrăpău provided a view on the components to set up RPNT focusing both in the AtoN part and the on-board equipment. Measurements of radio signal interference shows different threats; jamming, spoofing and meaconing that impact not only war areas in the Mediterranean (close to Ukraine and Israel, Gaza and Lebanon) but also strategic shipping areas as the Spanish strait separating Europe with Africa. Detailing the methodology used to compute the PNT requirements, GMV based their approach, endorsed by ESA on the ECSS standard, establishing the protection levels for maritime. When it comes to RPNT, the systems should ensure the continuity, availability and integrity of the service. The general resilience requirements presented are in line with the US homeland security agency. The parameter to set such requirements in aviation are characterised by the calculation of Horizontal Protection Level and Horizontal Alert Limit. A look into the aviation characterisation of the safety case, was also done. Therefore, GMV bases the RPNT into three aspects: security, safety and PNT.

Finally, the AVIS project was shortly presented where the EO and EGNSS will play a key role in providing a reliable source of PNT.

7.3 Resilient PNT Guideline – Kaisu Heikonen, Finnish Transport Infrastructure Agency

The presentation was done by Emma Rieu-Stephan from Cerema. The speaker provided the overview of the Guideline G1180 Ed1.0 on Resilient PNT approved in December 2023.

7.4 Timing and synchronization – Stefan Gewies, German Aerospace Center (DLR)

Stefan Gewies, representative from German Aerospace Center (DLR), gave a technical introduction to the timing and synchronization in the context of maritime navigation. Stefan presented the history of measuring time and introduced the current definition of the second as SI unit. Furthermore, he explained the concept of the Coordinated Universal Time (UTC) and stressed the point that only realizations of UTC in the labs of metrological institutions are in real-time available but not UTC itself. He explained that the traceability to UTC is important for applications with high demands related to time accuracy.

He introduced several basic technologies that providing time for application with lower accuracy requirement:

- Computer networks (NTP, PTP)
- Radio clock
- GNSS (GPS)
- eLoran and R-Mode when systems and receivers are available.

For application with high accuracy requirements (e.g. terrestrial navigation systems) possible options for the synchronization are:

- GPS common view.
- TWSTFT.
- Optical fiber transfer.

Several oscillators are available on the market that enable hold-over capabilities and reduce synchronization noise.

7.5 SouthPAN – Southern Positioning Augmentation Network Update – Australia and New Zealand's SBAS – Vincent Rooke, Geoscience Australia

Vincent Rooke, presented Geoscience Australia, and focused on the innovations in Southern Positioning Augmentation Network.

He mentioned the benefits of using the Satellite Based Augmentation System (SBAS) SouthPAN:

- Improved accuracy, reliability and availability of GNSS.
- Designed for Safety-of-Life for the aviation sector.
- Provides Open Services to users in service coverage area.
- AUS and NZ Government Partnership.

Vincent highlighted the available services offered by SouthPAN:

- Open Service L1 SBAS.
- Open Service DFMC SBAS (Dual Frequency Multi Constellation).
- Open Service PVS (Precise Point Positioning via SouthPAN).
- Safety-of-Life L1 SBAS (Highly reliable and with integrity SBAS that can be used for aviation operations).

Maritime benefits for using SBAS technology includes operating cost savings, improvement to on-port efficiencies, easier cargo movements

8. SESSION 7 – PNT CANDIDATE TECHNOLOGIES

This session was chaired by Jeffrey van Gils, representative from the Ministry of Infrastructure and Water Management of Netherland and Working group Chair of ENG committee.

8.1 ERPS Enhanced Radar position system – Paul Mueller, Half-PI Electronic Product Development

Paul Mueller, Half-PI Electronic Product Development, represented ERPS Enhanced Radar position system and explained the process of using measurements, distance to the target, the azimuth, relation to the heading of the vessel, antenna, rotation rate and vessel velocity, which is course overground or heading and speed over ground.

He mentioned that the IMO required accuracy resolution, better internet resolution and the IMO in their radar scanners currently explain the angular accuracy as a resolution that they feel is still digital to figure.

8.2 Development Status of Resilient PNT – Younghoon Han, KRISO – Korea Research Institute of Ships & Ocean Engineering

Younghoon Han, Senior Research Engineer of the Korea Research Institute of Ships & Ocean Engineering, presented development status of Resilient PNT for based region navigation system. He mentioned achievements in eLoran test bed development and R-Mode test bed development, that was developed for the northern part of West Sea where ,mostly effected by GNSS interference.

Korean eLoran test bed system, that includes:

- 1 eLoran transmitting station.
- Synchronize 2 existing Loran-C station to UTC(KRIS).
- 2 differential eLoran (dLoran) station.
- ASF survey and ASF map generation.

R-Mode test bed system, that includes:

- 4 MF R-Mode transmitting stations.

- 3 VDES R-Mode transmitting stations.
- 1 Differential R-Mode and monitoring station.
- Integrated navigation receiver development.
- Using the existing eLoran Loran-C signal.

He concluded that the currents status of the terrestrial navigation system being developed in Korea continued to develop and as second research project for development of advanced eLoran technology was kick-off in R.O.K.

8.3 New technology racon (NT Racon) – Chunhai Liu, Shanghai Navar

Chunhai Liu, from Shanghai Navar, focused on new technology racon.The presenter mentioned that shipping industry should consider from the shore side, the application of a new generation of racon that can respond to both traditional magnetron radars and solid-state radar. The solution, digital full-bandwidth direct-forwarding racon system, that has broken through the response distance of 10 nautical miles, can simultaneously respond to multiple radars and can respond to any waveform and frequency modulated marine navigation radar.

8.4 R-Mode (Michael Schütteler – WSV Germany) – Stefan Gewies, German Aerospace Center (DLR)

Stefan Gewies from the German Aerospace Center represented the presentation of Michael Schütteler from WSV Germany and focused on the necessity for alternative position, navigation and timing (PNT) and opportunities to achieve it. He mentioned that the dependency on GNSS represents a significant challenge for shipping and R-Mode offers a cost-efficient solution for providing alternative navigational signals for coastal navigation. This addresses especially the current situation of a rising number of recognised GNSS jamming and spoofing events.

Stefan explained that R-Mode measurements show that it can provide position accuracy (95%) of 10-100 m depending on the availability of R-Mode signals, time of day and distance to the transmitter. He explained that further investigation and completion of international standardisation is required and asked participants for support.

9. SESSION 8 – ASSET MANAGEMENT AND WORKING ENVIRONMENT

This session was chaired by Greg Hansen, Principal Advisor AtoN Engineering at AMSA.

9.1 Optimising asset management and information systems – Kylie Tully, AMSA

Kylie Tully works within the Asset Management and Preparedness team, which is a part of the Australian Maritime Safety Authority's (AMSA) Response Division. Asset Management and Preparedness is responsible for managing all the assets used by the Response Division, which includes search and rescue aircraft, emergency towage vessels and a network of marine Aids to Navigation.

Kylie's presentation focused on AMSA's journey of optimising asset management and information systems, including the why, what and how of AMSA's asset management uplift and initiatives that were identified to address deficiencies and gaps. The presentation provided examples of an existing key data source that was improved, and how Microsoft 365 software has been implemented to improve the usability of data.

9.2 Contracting out AtoN upgrade work in New Zealand – Ashton McGill, Maritime New Zealand

The presentation by Ashton McGill from Maritime New Zealand outlines the transition to outsourcing the maintenance of Aids to Navigation (AtoN) in New Zealand, detailing the history, tools, and processes used to manage contractors. Several specialist areas are also outsourced, with larger contracts and property agreements often using specialized contractors. This includes the transfer of historic land under the New Zealand treaty settlement process, and a small number of museum loan agreements were also drafted by outsourced legal services. The presentation highlights a case study of the Maria Island AtoN upgrade,

emphasizing the challenges and solutions in planning, design, and execution, including environmental and cultural considerations. Key factors for successful contractor management include clear communication, effective project and relationship management, and respect for indigenous values. These elements are crucial for ensuring smooth and successful AtoN upgrades using contractors.

9.3 AtoN performance in the field, managing risk and defining nautical requirements – Terry Skinsley, AMSA

Terry Skinsley, representing the AMSA navigation safety team, focused on the process of determining requirements for AtoNs within the AMSA network. He described the process used by the navigation team to assess and recommend AtoN requirements, including that:

- The process is used for new and existing AtoNs.
- AMSA uses a navigation safety risk assessment based on SIRA.
- It is a consultative process.
- It is expensive, accounting for traffic density, survey quality and much more.
- It is internally reviewed within AMSA.
- Is cognisant of IALA guidance.
- Considers cost-benefit analysis.

Terry highlighted that AMSA uses SIRA (Simplified IALA Risk Assessment) as the basis for navigation safety risk assessment that follows IMO Formal Safety Assessment methodology and identifies and rates individual hazards, guides the formulation of controls and allows development of comprehensive reporting.

9.4 Assessment of the PNG – NMSA AtoN Navigation Network – Harvey Lahani, National Maritime Safety Authority of PNG

Harvey Lahani provided a brief of Papua New Guinea, the National Maritime Safety Authority and the background of their AtoN network. Presenter provided information about Papua New Guinea, that has 17,000 kilometers of coastline, hundreds of islands, the country is divided into 22 provinces, 15 of which are Maritime Provinces. The National Maritime Safety Authority was established in 2006 and has the role of regulating maritime safety, coordinating search and rescue and regulating marine environment protection. The Authority's annual AtoN maintenance program is divided into three schedules, ~~a~~ Southern Region covering the southern part of the country, Momase Region covering the northeast coastline and the New Guinea Islands Region covering the New Guinea Islands. The main challenges was to implement monitoring of critical lights and to install secondary light option at Jomard Island.

10. SESSION 9 – IALA AND PANEL DISCUSSION

This session was chaired by Omar Frits Eriksson, IALA Deputy Secretary-General.

10.1 Overview of IALA guidance – Minsu Jeon, IALA

Minsu Jeon facilitated a session centred on IALA guidance documents, beginning with an introduction to IALA's mission, followed by a brainstorming session with three key questions:

1. What challenges have you or your organization faced when implementing IALA guidance?
2. Are there specific topics where additional guidance is needed for practical implementation?
3. How can the guidance better support the transition to digital or smart maritime services?

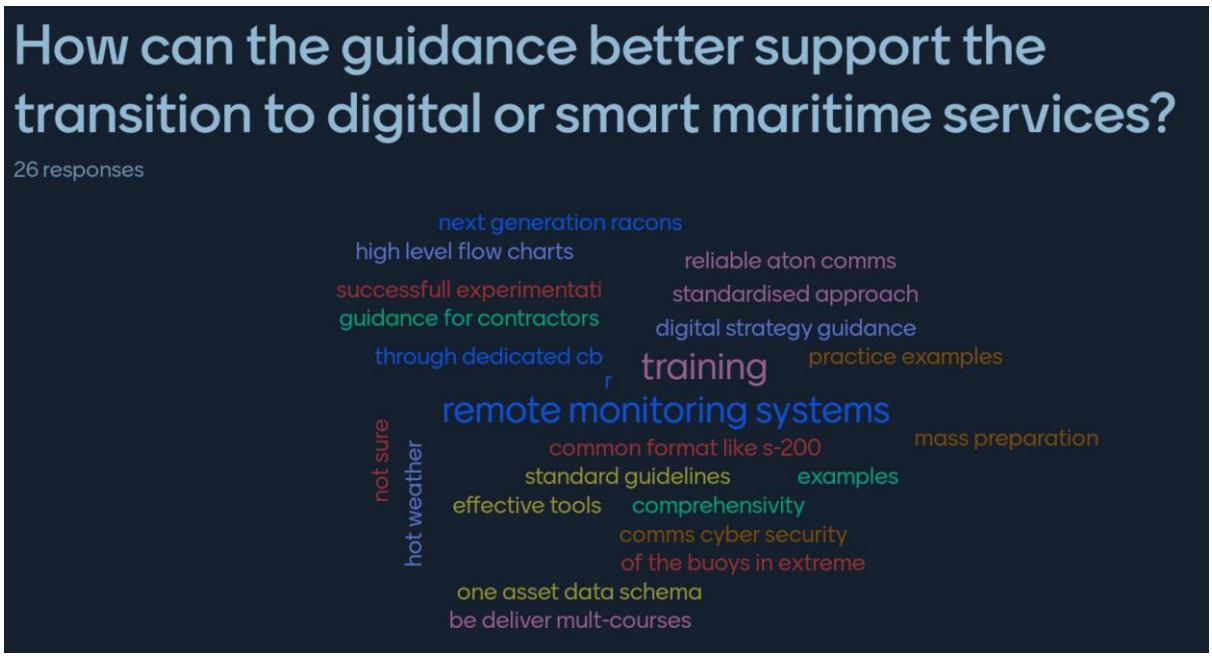
The brainstorming session revealed important insights on transitioning to digital and smart maritime services. Participants highlighted the importance of enhancing remote monitoring systems and the need for comprehensive training programs, stressing the delivery of multiple courses to adequately prepare stakeholders. They also emphasized the need for standardized guidance, including high-level flow charts,

strategic digital guidance, and tailored communication channels for AtoNs. The significance of technological advancement and successful experimentation was noted, with an emphasis on next-generation RACONs and unified data schemes to address cybersecurity concerns.

While many participants felt that current guidance is largely sufficient, gaps were identified in areas like digital technologies, shore-based communication, and sustainability. Suggestions included expanding guidance on structural considerations, metocean conditions, and light ranges classification.

Challenges in implementing IALA guidance included resistance to change, alignment with local requirements, and a lack of training and awareness among end-users. Participants pointed to the complexity and volume of guidelines as significant obstacles, compounded by limited awareness of standards and unclear legislative frameworks.

In conclusion, the feedback highlighted a need for clearer, more practical guidance, along with strengthened training initiatives to ensure effective implementation of IALA standards and a smoother transition to digital maritime services.



10.2 Panel discussion on IALA and application for AtoN services

This session was chaired by Omar Frits Eriksson, IALA Deputy Secretary-General.

Panel discussion members were Minsu Jeon, Alwyn Williams, Malcolm Nicholson, Jeffrey van Gils and Latifa Oumouzoune.

The group revealed important insights on main topics:

- IALA sustainability Workshop within the content of UN sustainability development goals.
- Ocean literacy and discussing ocean decade principles from the Academy perspective.
- Assessing the amount of carbon that producing because of carrying out operations.
- The effects of climate change and application for AtoN services.
- Innovations' durability: the optics have remained constant, but the light sources have evolved over time.
- Decommissioning racons, transition to the satellite navigation.

11. SESSION 10 – TECHNICAL DISCUSSION FORUM

11.1 Technical discussion group – Lights and vision – Malcolm Nicholson, SPX Aids to Navigation

Malcolm Nicholson moderated the discussion on lights and vision, providing a clear understanding of the following concepts:

The calculation of intensity through explaining step by step the formulae gathered into the R0202 Marine Signal Lights - Calculation, Definition and Notation of Luminous Range which states that all luminous range calculations are based on Allard's law:

$$I = E_r * D^2 * 0.05^{-D/V}$$

Where:

I is the luminous intensity of the light [cd]
E_r is the required illuminance at the eye of the observer [lx]
D is the luminous range in metres [m]
V is the meteorological visibility in metres [m]

It was recalled that the Competent Authority should publish the level of service of their AtoN in the Lists of Lights and that the Nominal Range of a maritime signal light is calculated for a meteorological visibility of 10 nautical miles (18,520 m) and an illumination at the eye of the observer:

of 2×10^{-7} lx for night time range

of 1×10^{-3} lx for day time range

The use of the nominal range tables in R0202 (nighttime – Table 1 and daytime – Table 2) to determine the parameters of the above formulae.

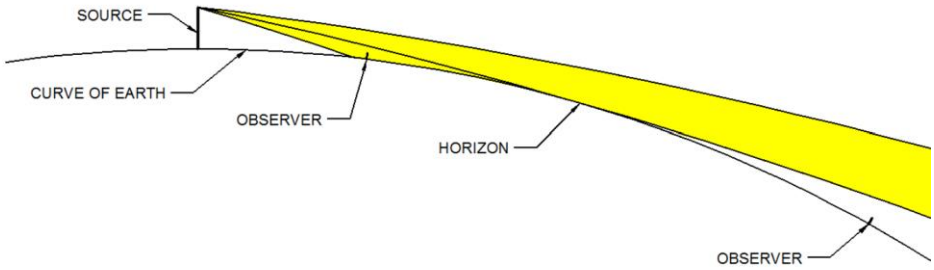
It was also recalled that the calculation takes into account the service condition factor – transmissivity of the atmosphere set to 0.74 in the formulae. Also, it should be considered the implications of the different colours.

It was noted that if it comes to a flashing character, then the intensity used for range calculation will apply the flash character and profile as per R0204 Marine Signal Lights – Determination and Calculation of Effective Intensity.

Vertical divergence

Malcolm explained the necessity to consider the geographical range based on the height of the AtoN (elevation above sea level) and the height of the observer (mariner).

G1065 AtoN Signal Light Beam Vertical Divergence explains the geographical range is "the greatest distance at which an object or a light source could be seen under conditions of perfect visibility, as limited only by the curvature of the earth, by the refraction of the atmosphere, and by the elevation of the observer and the object or light". As the observer moves further away from the source, there will come a point where the light is obscured by the Earth. This is illustrated in the Figure below:



This maximum distance is determined by the equation:

$$R_g = 2.03 \times \left(\sqrt{h_0} + \sqrt{H_m}\right)$$

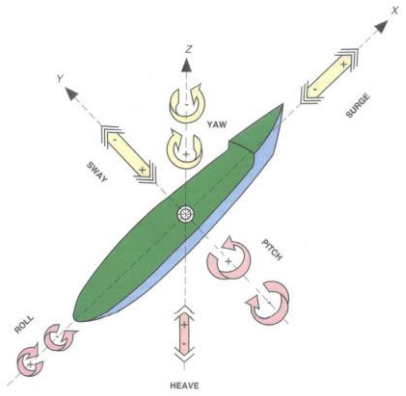
Where:

R_g is the geographical range (nautical miles) (M)

h_0 is the elevation of observer's eye (metres) (m)

H_m is the elevation of the mark (m)

It was also explained that when it comes to a floating AtoN the service condition factors apply to the motion of a floating AtoN. Heel, Roll, and Heave have a direct effect on the performance of the signal light.



Conspicuity

The G1073 Conspicuity of AtoN Lights at Night addresses the conspicuity of a marine signal light when viewed against a background of general lighting or rival lights. As mentioned before, for guidance on daytime lights refer to R0202 and for guidance on daymarks, refer to G1094 Daymarks for AtoN. It was also discussed the methods for improving the conspicuity of AtoN lights.

It was also explained that related to the condition factors, it is worth noting that the national countries should keep an annual spread of visibility register and AtoN providers can consult it.

User LED light sources and sectors

LEDs are electronic semiconductor devices that produce near monochromatic light. The semiconductor junction is typically encapsulated in a clear plastic housing that usually incorporates a lens. An LED is not a lamp, but rather a solid-state light source that emits monochromatic radiation in the infrared, near ultra-violet or visible spectrum when a current is passed. Spectral power distribution is narrow in the order of 50nm, except for white. Therefore, there is not a direct change from an incandescent lamp to a LED.

Light measurements

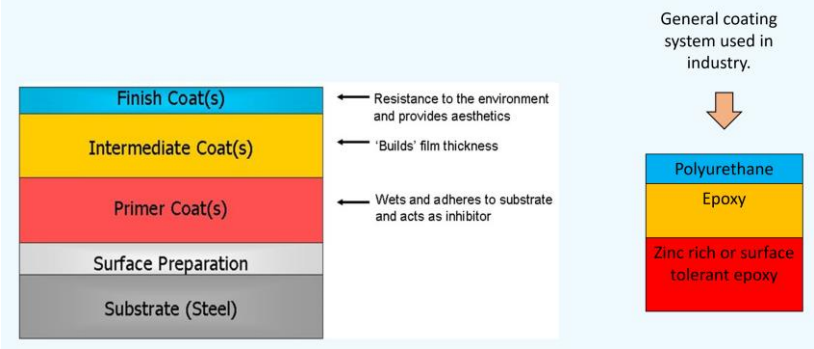
The AtoN competent authority or Service provider can develop the means and procedures to effectively implement the measurement facilities in house. This can be achieved by the investment on less complex devices to more demanding ones aiming at having a register for quality check and measurement degradation. Building or dedicating a separate area as a lab measurement will allow the service provider to analyse azimuth profiles, shaping codes with a software, calibrate light sources. There are recent studies of the use of drones for measurement, however, some legal and operational aspects can limit the use of them.

11.2 Technical discussion group – Coatings, corrosion and maintenance – Daniel Atkins, AMSA

Daniel Atkins led a panel discussion on coating, corrosion and maintenance together with Greg Hansen.

He provided background and context of selection protective coating systems. Purpose or protective coatings to protect a substate from damaged caused by environmental or other factors.

Daniel presented typical steel coating system in the Figure below:



Key topics discussed included the selection of coating systems:

- AS2312.1 – 2014 Guide to the Protection of Structural Steel Against Atmospheric Corrosion Part1: Paint Coatings.
- Australia's primary standard for protective coatings for steel substrates.

Daniel also mentioned the environmental classification, that presented in the Figure below:

TABLE 2.1

ATMOSPHERIC CORROSIVITY CATEGORIES

Corrosivity categories	Former AS/NZS 2312 Category	Corrosion rate for steel µm/year	Corrosion rate for zinc µm/year	Typical exterior environment	Examples of interior environments
C1: Very low	A	<1.3	<0.1	Few alpine areas	Offices, shops
C2: Low	B	1.3 to 25	0.1 to 0.7	Arid/rural/urban	Warehouses, sports halls
C3: Medium	C	25 to 50	0.7 to 2.1	Coastal	Food processing plants, breweries, dairies
C4: High	D	50 to 80	2.1 to 4.2	Sea-shore (calm)	Swimming pools, livestock, buildings
C5-I: Very high (Industrial)	E-I	80 to 200	4.2 to 8.4	Within chemical plants	Plating shops, chemical sites
C5-M: very high (Marine)	E-M	80 to 200	4.2 to 8.4	Sea-shore (surf)/ offshore	—
CX	—	200 to 700	8.4 to 25	Shoreline (severe surf)	Adjacent to acidic processes
T: Inland Tropical	F	—		Non-coastal tropics	

Several questions were raised, including considerations for colour and appearance:

- Colour – navigation or heritage requirements.
- Colour retention and colour matching.
- Appearance/finish quality – aesthetics and durability.

Considerations for coating application/selection:

- Colour.
- Structure is physically difficult to access for maintenance.
- Complex structure geometry.
- Multiple substrates.
- Lead content of ages coatings.
- High film thickness of existing coatings.
- Inspection by coatings/corrosion specialist determined best course of action was full removal of exiting coatings as opposed to overcoating.

Daniel also mentioned the process of coating removal, that illustrated in the Image below:

Greg Hansen presented on AMSA Application of Protective Coatings in hot and humid conditions. Key topics discussed included:

- Managing major protective coating repaint projects in hot and humid environments.
- Discuss standards and practical considerations to maximize durability and protection.
- Project example Booby Island lighthouse – north Queensland.

Greg highlighted that determining the coating system for an intended protection interval suggests:

- Identifying substrates.
- Determining the environment (corrosivity category – very high marine).
- Deciding on durability range (coating life to first major maintenance 15-25 years).

Key aspects of protective coatings include:

1. Specification (Basic):
    - Surface preparation.
    - Coating system.
    - Coating materials.
    - Application method.
    - Inspection requirements.
    - Specific comments.
2. Onsite works:
    - Surface preparation.
    - Paint application.

Greg mentioned that the method of application and conditions which paints are applied have a significant effect on the quality and durability of the coating. Key outcomes:

- As an asset owner AMSA want to capitalise on investments and ensure maximum time between major works.
- Many things can reduce the durability and performance of protective coating system.
- Having a thorough paint specification and monitoring that paint is being applied within suitable conditions are extremely important.

12. SESSION 11 – TECHNICAL DISCUSSION FORUM

12.1 Technical discussion group – Power systems and monitoring – Peter Dobson, Trinity House

This session was chaired by Peter Dobson, representative from Trinity House.

The group revealed important insights on main topics:

- Generators are still needs as sources for generating offshore and onshore.
- Solar panels, wind turbines and fuel cells are also used.
- Degradation of the acrylics on the surface of the solar panel due to the high UV is a problem.
- Changes of parts like solar panels and light power units in an aggressive environment.
- The use of maximum power point tracking on the solar panel was discussed.
- Use of lithium and lead acid batteries in different climate conditions discussed and the problem when lithium batteries run flat on solar systems.
- Batteries expected lifetime.
- The use of monitoring was explored, with the challenges of offshore communication.
- What the future use of monitoring might look like. More data to be captured to predict issues.
- The idea around the guideline A Harmonised IoT Protocol For Visual AtoN was outlined and it potential discussed.

12.2 Technical discussion group – Radio Navigation services and technologies – Jeffrey van Gils, Ministry of Infrastructure and Water Management

This session was chaired by Jeffrey van Gils. Jeffrey van Gils moderated the technical discussion with a wide range of stakeholders (industry, competent authorities, service providers and academics).

The first question raised was the future seen for PNT sources. The signal of opportunities, the use of alternative constellations such as LEO satellites used for providing PNT, the use of Earth Observation and the need to secure the frequencies are keys to providing resilient PNT.

The question of the budget for resilient PNT was also raised and the need to explain to the policy makers that the service should be seen on a holistic basis, not only for a specific domain.

The performances reached by terrestrial radionavigation services independent to GNSS were also addressed. The limited-service area of the MF R-Mode for the nighttime caused by the skywave interference was analysed, however, differential R-Mode can reduce the skywave fading during the night.

The question on other PNT systems based on other radio systems was introduced: geomagnetic, CCTV and EO, visual aids for positioning, system based on bathymetries or neutron particles for positioning (GMV positrino project) were presented. The purpose is, at the end, to build a system of systems with no common vulnerabilities. This should be also accompanied by awareness activities of failures of PNT.

Another matter was the use of AI for PNT, Earth observation can benefit from AI and currently the project in ROK using AI algorithms for the generation of ASF correction maps for eLoran.

The question on AtoN synchronization with no availability of GNSS signals was addressed. The timing operational requirements are keys to permit synchronization.

13. SESSION 12 – IALA WORLD-WIDE ACADEMY

13.1 WWA achievements to date

This session was chaired by Omar Frits Eriksson, Deputy Secretary-General. He explained the main objectives and procedure of work during this session.

Latifa Oumouzoune started by the update on World-Wide Academy.

Firstly, Latifa thanking international foundation and national members for sponsorship WWA. I'm sorry for looking one of those, and we are grateful for the ownership working for it.

She mentioned that Academy aims to ensure that all coastal States can fulfil the obligations related to Marine Aids to Navigation placed upon them in SOLAS Chapter V and that all coastal States can claim conformance with the relevant IALA Standards.

Latifa highlighted key outputs from WWA Capacity Building:

- Conducts workshops and seminars to raise the awareness of high-level decision makers with respect to their international obligations.
- Undertakes analytical missions to identify gaps between current practices and international standards and provides advice on how to bridge these gaps.
- Arranges follow-up activities to review progress made towards conformance with international standards.
- Collaborates with sister organizations in capacity building activities.
- Provide sponsorship opportunities to participate in the academy training programmes and events.

Latifa noted that WWA facilitates continuous training for the development of Marine Aids to Navigation professionals through alumni activities and other initiatives, and key aims are:

- Supports the development of IALA Model Courses in close cooperation with the IALA technical committees.
- Oversee the effective implementation of the IALA training accreditation scheme.
- Supports the development of a network of accredited training organizations world-wide and their delivery of the IALA Model Course Level 1.1.
- Delivers the IALA Model Courses for Level 1.2 and Level 1.3.
- Facilitates continuous training for the development of Marine Aids to Navigation professionals through alumni activities and other initiatives.

13.2 Organisations who benefit from WWA

Omar Frits Eriksson, Deputy Secretary-General mentioned goals of the Academy, which consist in “all coastal States can fulfil the obligations related to Marine Aids to Navigation placed upon them in SOLAS Chapter V; and that all coastal States can claim conformance with relevant IALA Standards”. He highlighted that aims of WWA is to bring coastal States to a place where they can fulfil their obligations as separated and then be able to claim conformance to IALA standards.

Omar mentioned WWAs’ kind of thinking in regional terms. Academy had some activities in the Caribbean, but still needs for more, and Africa is clearly a place for step up.

He emphasized that in June 2022 Council 7 decided to establish the World-Wide Academy Disaster Recovery Fund (DRF) aimed at assisting coastal States, who are stuck by disaster, to re-establish and strengthen further their ability to ensure safety of navigation in their area of responsibility, that also was kicked off by a donation from AMSA, especially to help Ukraine. The IALA DRF shall be independent funded by sponsorships.

13.3 Wrap up and establish working groups

The primary objectives and procedures of the working groups were clarified by Omar Frits Eriksson. The groups were tasked with reviewing the current modules of specific WWA model courses at level two and level 1.1, with a slight check and refreshment in response to the guidance updates.

14. SESSION 13 – WWA COURSE CONTENT REVIEW

WG continued their work in accordance with the scheduled technical tasks.

15. SESSION 14 – WG FEEDBACK WWA COURSE CONTENT REVIEW

15.1 WG1 feedback

WG1 – L2 C2001 series and C2002 series (Buoys and Power).

This session was chaired by Mahdi al Mosawi, from Middle East Navigation Aids Services – MENAS.

WG1 went through general scanning of the following model courses:

- L2.1.8 Aids to navigation – Technical training Module 1 Element 8 Level 2 – Buoy cleaning.
- L2.1.5-6 Aids to navigation – Technical training, Module 1 Elements 5 and 6.
- LEVEL 2 – Buoy handling and safe working practice.
- L2.1.10 Aids to navigation – Technical training Module 1 Element 10 Level 2 – Maintenance of Plastic Buoys.
- L2.1.3 & L2.1.4 Aids to navigation – Technical training Module 1 Elements 3 and 4.
- Level 2 – Introduction to Aids to navigation – Buoyage.
- Level 2 – Technician Training Introduction to Aids to Navigation Module 1 Elements 1.1 to 1.2.

During the discussion, members agreed on the following recommendations:

- Explore how the L2 model courses are delivered, discuss different experiences and propose best approaches.
- Continue the general review of all Level 2 model courses, check redundancy in some topics, repetition, learning hours, content, and provide template of procedures as annexes.
- Start with a Comprehensive review of "Module 1 Elements 3 & 4 Level 2 – Introduction to Aids to navigation – Buoyage", invite to submit inputs from MENAS (level 3), WWA, France, TH (level 3), MSM.
- Consider the review withing ENG committee working program.

15.2 WG2 feedback

WG2 – L2 C2003 series and C2004 – C2011 (Lights and Various)

This session was chaired by Monica Herrero, from Mediterraneo Señales Maritimas SL (MSM).

The group revealed important insights on of the model course C2003 (Lights) and C2004-11 (Various):

- Review of changes to the Table 5 Teaching Syllabus Module 3 – Lights and Marine Lanterns in part of total duration (hours) for each subject.
- Modifying subjects model course C2003 (Lights).
- Continue the general review of C2004-11 (Various).

15.3 WG3 feedback

WG3 – L1.1 Modules:

This session was chaired by Sarah Robinson, Advisor to the IALA World-Wide Academy.

The group revealed important insights on main topics:

2A (2a.1): Visual AtoN:

- Further explanation to effective intensity.
- Modifying term relating to astronomical events.
- Rearrange background lighting/contrast/glare.

2A (w2a.6): Channel design:

- Review with reference to newly updated Design of Fairways Guideline.
- Channel design and mix of AtoN change to Comprehensive Channel Design.

2B (2b.1): Types of Radio AtoN; New Technology Radars and Racons:

- New Technology radars change to Types of Radar including New Technology Radars.
- Check if ship's radar independent of GNSS.
- Add Cross-sectional area of radar reflectors.

2B (2b.7): Remote Control and Monitoring:

- Remote monitoring system design considerations.
- Harmonised remote monitoring protocol (MQTT).

E-Navigation:

- Change title to Digitalization.
- Include line on S-100/S-200 product specifications.

15.4 WG4 feedback

WG4 – C1004 Aids to Navigation Management Training Level 1 – Global Navigation Satellite Systems and e-Navigation. Reference to 2B (2b.6) in Level 1.1 Model course.

Jaime Alvarez reported about the working group chaired by Hideki Noguchi, the participants' expertise, advice and way forward was very appreciated.

The roadmap on the digitalization of SOLAS was presented through different systems, some of them in development in the IALA committees (DTEC, ENG, ARM):

- NAVDAT;
- S-100 ECDIS (mandatory deadline in 2029);
- VDES;
- MASS mandatory code;
- SBAS recognition as a WWRNS;
- VDES R-Mode; and
- Digital Voice Communications.

The group revised Lectures 27 and 28 of the AtoN Management courses:

- E-Navigation and e-Navigation and Maritime services.

The group agreed on maintaining the definitions and aims of e-Navigations as stated in the Strategic Implementation Plan for e-Navigation and keep the aspects that are more related to the IALA scope as:

- Electronic Navigation Chart;
- PNT; and
- Communication.

Related to Communications, it was suggested to involve Maritime Communication engineers to deliver and review in deep the MARCOM Manual (equivalent to the NAVGUIDE for comms.)

Related to the Common Maritime Data Structure as stated in IMO, S100 is the standard to share information as part of the digitalization strategy. The group also agreed to propose the changes.

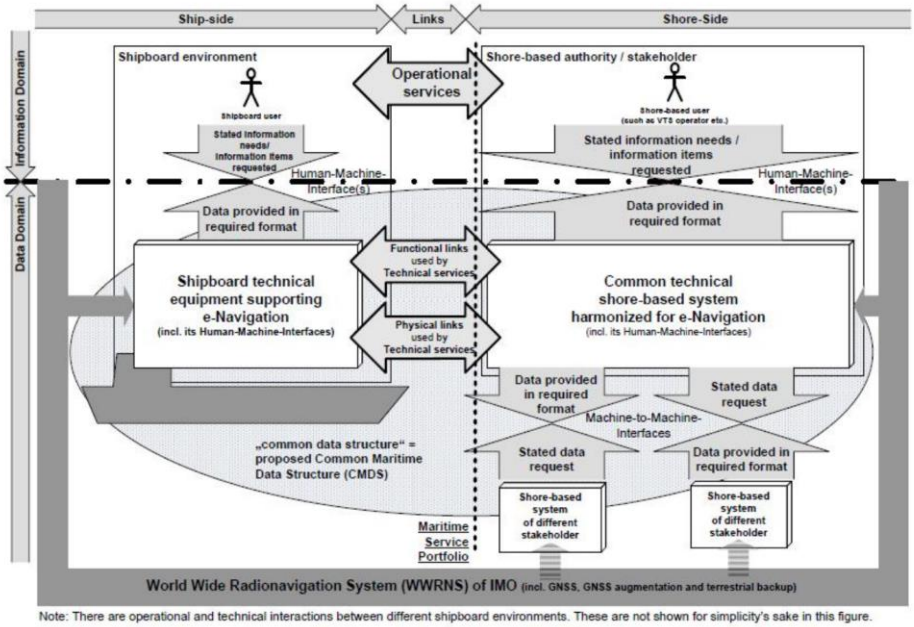
An update to consider the new Maritime Services in the context of e-Navigation is needed:

- MS1: VTS.
- MS2: AtoN.

It was also proposed to clearly explain the IMO adopted overarching architecture for e-Navigation linking the different maritime services provided on the shore side and the link with ship side and to reference the IALA Guidelines that can be followed to ensure the provision of such services:

The international work on generic architecture at IMO and IALA

Figure 3-1 shows the IMO adopted overarching architecture (IMO 2014, para 28). It shows in particular the interdependency of the different major architectural elements.



Note: There are operational and technical interactions between different shipboard environments. These are not shown for simplicity's sake in this figure.

Figure 3-1: IMO adopted overarching architecture for e-Navigation
(IMO 2014, Figure 1 in para 28)

There are also changes in the naming of e-Navigation terminology (no longer Portfolios, now Maritime Services in the Context of e-Navigation for instance) that need to be reflected in the WWA documentation. Furthermore, some ITU/IMO documents references have also changed and must be reflected.

16. SESSION 15 – WORKSHOP CONCLUSIONS

16.1 Workshop conclusions – Alwyn Williams, Chair of workshop

1. Marine aids-to-navigation remain critical to safe and efficient voyages at sea, and effective protection of the environment.
2. Engineering challenges of varying complexity continue to exist in the provision of marine aids-to-navigation around the world, but the level and scope of guidance provided by IALA is reflective of best practice.
3. Well-implemented modern information and communication systems have proven to simplify the management and engineering of marine aids-to-navigation.

4. Artificial Intelligence has the potential to influence and impact existing marine aids-to-navigation engineering and management practices.
5. AtoN providers continue to strive to install and maintain sustainable Marine aids-to-navigation with minimum environmental impact and maximum cost-effectiveness.
6. The need for Resilient PNT remains critical to ensure the mariner can rely on their electronic navigation systems and Marine Aids-to-Navigation.
7. Visual signals remain a critical part of the marine AtoN service, and IALA's suite of standards, recommendations and guidelines are essential to ensure global practices are harmonised and maintained to a high standard.
8. More efficient and robust solar panels are on the horizon but are currently not available on the commercial market.
9. The use of lithium batteries is on the increase for power storage within marine aids-to-navigation. It is recognised that their use is currently limited by operating temperature range and transportation regulations.
10. Knowledge sharing, collaboration and training continue to be key enablers to harvest the benefits of new technology and deliver high quality and efficient aids to navigation services worldwide.

16.2 Review workshop report

The report was reviewed and agreed upon.

17. SOCIAL EVENTS AND TECHNICAL VISITS

17.1 Welcome reception at Australian National Maritime Museum

On Monday evening, following the workshop's opening day, participants attended a warm reception at the Australian National Maritime Museum. As ever, this gathering was a great success, and all had the opportunity to taste different food and drink.

17.2 Sydney Harbour cruise and dinner

A wonderful dinner was enjoyed on Wednesday evening at the Captain Cook Cruises. The venue was a magnificent environment enhanced by the maritime theme that participants enjoyed. Discussions were continued long into the night accompanied by Australian hospitality.

17.3 Technical visit, Macquarie Lighthouse Sydney

Participants had the opportunity to tour and see Macquarie Lighthouse Sydney. The tour was well received, and many commented on the unusual structure of the lighthouse and beautiful scenery enjoyed.

17.4 Technical visit, SPX Factory Tour Melbourne

On Friday, following the workshop's closing day, participants attended an SPX Factory Tour Melbourne.

ANNEX A WORKSHOP PARTICIPANTS

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TECHNICAL PROGRAMME
AIDS TO NAVIGATION ENGINEERING WORKSHOP
DELIVERING THE SERVICE, DESIGNING THE FUTURE
14-18 OCTOBER 2024
SYDNEY, AUSTRALIA

DAY 1 – Monday 14, October 2024

Time	Activity
0900 – 1030	Registration and morning tea
1030 – 1200	**SESSION 1: OPENING OF THE WORKSHOP**
1030 – 1035	Welcome to Country
1035 – 1040	Introduction and housekeeping
1040 – 1055	Address from AMSA
1055 – 1110	Welcome from IALA
1110 – 1120	Workshop aim and objectives IALA ENG Committee Chair
1120 – 1140	Operating environment for delivering AtoN Services Captain Lawrie Corda, Port Authority of New South Wales
1140 – 1200	Technology changes – impacts on engineering and design Jens Ohle, SPX Aids to Navigation
1200 – 1250	**LUNCH**
1250 – 1420	**SESSION 2: REGIONAL PERSPECTIVE**
1250 – 1310	Pacific Safety of Navigation Project Faranisese Kinivuwai, SPC
1310 – 1330	G1165 Sustainable structural design of marine AtoN Sarah Robinson, IALA World-Wide Academy
1330 – 1350	AtoN in the Great Barrier Reef Bill Morley, Maritime Safety Queensland
1350 – 1410	AtoN solutions in the Pacific region Adam Hay and Adrian Van Boven, M-NAV Solutions Pty Ltd
1410 – 1420	Questions
1420 – 1440	**BREAK**
1440 – 1640	**SESSION 3: A GLIMPSE INTO THE FUTURE**
1440 – 1500	Machine readability and Artificial Intelligence Owain Brennan, Seer BI
1500 – 1520	S201 / S125 and MRN and what it means to AtoN providers Minsu Jeon, IALA
1520 – 1540	Maritime Connectivity Platform implementation Dr Julius Moeller, AMSA
1540 – 1600	MASS update, current thinking on MASS use of AtoN Hideki Noguchi, Japan Coast Guard
1600 – 1620	Complimentary use of AtoN and Tsunami monitoring Mónica Herrero, Mediterraneo Señales Maritimas SL (MSM)
1620 – 1630	Questions
1630 – 1640	Day 1 wrap up and admin – IALA ENG Committee Chair

1800 – 2000 **WELCOME RECEPTION** | SPONSORED BY SPX

Australian National Maritime Museum – Tasman Light Gallery
Darling Harbour
Dress code: smart casual

SPX AIDS TO NAVIGATION
spxaton.com

DAY 2 – Tuesday, 15 October 2024

Time	Activity
0900 – 1050	**SESSION 4: LIGHTS**
0900 – 0920	Review of IALA documentation on lights Malcolm Nicholson, SPX Aids to Navigation
0920 – 0940	LED's with coloured filters Alwyn Williams, General Lighthouse Authorities of the UK and Ireland
0940 – 1000	Replacing obsolete light sources and environmental considerations Daniel Atkins, AMSA
1000 – 1020	Sustainable leading light lanterns and power developments (Peter Schneider, WSV Germany) Link Powell, General Lighthouse Authorities of the UK and Ireland
1020 – 1040	Measurement process and uncertainty Link Powell, General Lighthouse Authorities of the UK and Ireland
1040 – 1050	Questions
1050 – 1120	**BREAK**
1120 – 1250	**SESSION 5: POWER**
1120 – 1140	Photovoltaic technologies and sustainability of materials Dr Moonyong Kim, School of Photovoltaic & Renewable Energy Engineering, UNSW
1140 – 1200	Impact on power systems due to lantern selection Peter Dobson, Trinity House
1200 – 1220	Battery developments and options – Lithium experience Jonas Lindberg, SPX Aids to Navigation Oy
1220 – 1240	Enhancing AtoN System Safety: Remote Diagnosis & Monitoring of Lithium Batteries Tae Uk Chang, Quantum Solution
1240 – 1250	Questions
1250 – 1340	**LUNCH AND WORKSHOP PHOTOGRAPH**
1340 – 1520	**SESSION 6: POSITION, NAVIGATION AND TIMING**
1340 – 1400	Need for Resilient PNT Dr. Kiyeol Seo, KRISO – Korea Research Institute of Ships & Ocean Engineering
1400 – 1420	Resilient PNT Requirements Florin Mistrăpău, GMV
1420 – 1440	Resilient PNT Guideline Kaisu Heikonen, Finnish Transport Infrastructure Agency
1440 – 1500	Timing and synchronisation Stefan Gewies, German Aerospace Center (DLR)
1500 – 1520	SouthPAN – Southern Positioning Augmentation Network Update – Australia and New Zealand's SBAS Vincent Rooke, Geoscience Australia
1520 – 1530	Questions
1530 – 1550	**BREAK**
1550 – 1730	**SESSION 7: PNT CANDIDATE TECHNOLOGIES**
1550 – 1610	ERPS Enhanced Radar position system Paul Mueller, Half-PI Electronic Product Development
1610 – 1630	Development Status of Resilient PNT Younghoon Han, KRISO – Korea Research Institute of Ships & Ocean Engineering
1630 – 1650	New technology racon (NT Racon) Chunhai Liu, Shanghai Navar
1650 – 1710	R-Mode (Michael Schütteler – WSV Germany) Stefan Gewies, German Aerospace Center (DLR)
1710 – 1720	Questions
1720 – 1730	Day 2 wrap up – IALA ENG Committee Chair
Evening	**FREE NIGHT TO EXPLORE SYDNEY**

Time	Activity
0900 – 1030	**SESSION 8: ASSET MANAGEMENT AND WORKING ENVIRONMENT**
0900 – 0920	Optimising asset management and information systems Kylie Tully, AMSA
0920 – 0940	Contracting out AtoN upgrade work in New Zealand Ashton McGill, Maritime New Zealand
0940 – 1000	AtoN performance in the field, managing risk and defining nautical requirements Terry Skinsley, AMSA
1000 – 1020	Assessment of the PNG – NMSA AtoN Navigation Network Harvey Lahani, National Maritime Safety Authority of PNG
1020 – 1030	Questions
1030 – 1100	**BREAK**
1100 – 1200	**SESSION 9: IALA AND PANEL DISCUSSION**
1100 – 1120	Overview of IALA guidance Minsu Jeon, IALA
1120 – 1200	Panel discussion on IALA and application for AtoN services
1200 – 1250	**LUNCH**
1250 – 1430	**SESSION 10: TECHNICAL DISCUSSION FORUM**
	Technical discussion group – Lights and vision Malcolm Nicholson, SPX Aids to Navigation
	Technical discussion group – Coatings, corrosion and maintenance Daniel Atkins, AMSA
1430 – 1450	**BREAK**
1450 – 1630	**SESSION 11: TECHNICAL DISCUSSION FORUM**
	Technical discussion group – Power systems and monitoring Peter Dobson, Trinity House
	Technical discussion group – Radio Navigation services and technologies Jeffrey van Gils, Ministry of Infrastructure and Water Management
1630 – 1640	Day 3 wrap up
1800 – 2100	**Evening social event – Sydney Harbour cruise and dinner** **CO-SPONSORED BY MSM and M-NAV SOLUTIONS** Location: Captain Cook Cruises King Street Wharf No.1-2, Darling Harbour Dress code: smart casual m-nav.com mesemar.com

DAY 4 – Thursday, 17 October 2024

Time	Activity
0900 – 1000	**SESSION 12: IALA WORLD WIDE ACADEMY**
0900 – 0920	WWA achievements to date
0920 – 0940	Organisations who benefit from WWA
0940 – 1000	Wrap up and establish working groups
1000 – 1030	**BREAK**
1030 – 1230	**SESSION 13: WWA COURSE CONTENT REVIEW**
	WG1 – L2 C2001 series and C2002 series (Buoys and Power)
	WG2 – L2 C2003 series and C2004 – C2011 (Lights and Various)
	WG3 – L1.1 Modules: • 2A (2a.1): Visual AtoN • 2A (w2a.6): Channel design • 2B (2b.1): Types of Radio AtoN; New Technology Radars and Racons • 2B (2b.7): Remote Control and Monitoring
	WG4 – C1004 Aids to Navigation Management Training Level 1 – Global Navigation Satellite Systems and e-Navigation. Reference to 2B (2b.6) in Level 1.1 Model course.
1230 – 1320	**LUNCH**
1320 – 1450	**SESSION 14: WG FEEDBACK WWA COURSE CONTENT REVIEW**
1320 – 1340	WG1 feedback
1340 – 1400	WG2 feedback
1400 – 1420	WG3 feedback
1420 – 1440	WG4 feedback
1440 – 1450	Overview and comments
1450 – 1510	**BREAK**
1510 – 1610	**SESSION 15: WORKSHOP CONCLUSIONS**
1510 – 1540	Workshop conclusions Michel Cousquer, Cerema
1540 – 1610	**WORKSHOP CLOSING REMARKS - IALA ENG COMMITTEE CHAIR**

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