ENG6-4.3

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REPORT ON IALA WORKSHOP ON SUSTAINABLE LIGHT AND POWER FOR THE NEXT GENERATION (IALABATT/ IALALITE)

Koblenz - Germany, 20 to 24 March 2017

24 March 2017

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Report of the IALA Workshop

On

Sustainable Light and Power for the Next Generation

Executive Summary

An IALA workshop on the subject of Sustainable Light and Power for the Next Generation in the IALABATT / IALALITE series was hosted by the German Federal Waterways & Shipping Administration in Koblenz, Germany from 20 to 24 March 2017.

The workshop was attended by 78 delegates, representing 23 countries, including 57 delegates from national members, 3 associate members, 10 industrial members, and 5 from other organisations (see ANNEX B).

The workshop theme was supported by a comprehensive programme of presentations from manufacturers, AtoN providers and users which informed the workshop of current experiences and emerging technology. The workshop was structured with presentations on relevant topics on days 1 and 2 with a technical study tour on day 3 followed by working group sessions on days 3 and 4. Output work was reviewed and highlights were agreed on day 5. Attendees enjoyed a welcome reception on day 1, and a visit to the Deinhard Champagne Caves on day 2.

Topics covered included lights & signalling; communications; PV solar, wave, wind and fuel cell power generations; hybrid power systems; battery storage; theft & vandalism, mercury replacement; solar calculation design; the mariners perspective and climate change.

Anthropogenic climate change was presented to set the scene for the need for environmentally responsible AtoN provision.

Developments in battery storage technology combined with improving solar PV cell performance offer improved energy capacity which, when adopted alongside sound design and maintenance practices, promote the most environmentally responsible AtoN provision.

Lower energy requirements for lights and communications systems provide opportunities for enhanced monitoring and lower operating costs while practical applications to deter theft and vandalism were explored to support the improved availability of AtoN.

Participants attended a most informative technical tour of the German Federal Waterways and Shipping Administration laboratories in Koblenz and a range of demonstrations covering light measurement, sector lights, radar assessment, colour and environmental aging were given to the delegates, all of whom were impressed with the facility and the technical competence and generosity of the hosts.

The workshop generated seven highlights.

1. Batteries employing new technology are a viable option for AtoN power systems but there are important storage, transport, maintenance, disposal and safety considerations, particularly the control of charging and cell temperature.
2. Whole life cost of AtoN can be reduced and environmental sustainability improved by considering a location-specific service condition factor that is based on local environmental conditions, maintenance regimes and user needs at the design stage.
3. Visibility Adaptive AtoN Light (VAAL) can improve conspicuity in poor visibility and can reduce AtoN light energy requirements.
4. While the quality of PV solar panel manufacture is maturing providing reliability and performance, current standards for solar PV units are generic and do not cover all the needs of AtoN applications and there is therefore a need for guidance on what constitutes a high quality marine grade PV panel for AtoN use.

5. Theft and vandalism can be successfully countered by innovative security measures, and community engagement.
6. New low energy monitoring equipment makes remote control and monitoring viable for use on solar powered AtoN. Where satellite communication is necessary short data messaging can play a role in reducing the cost of monitoring.
7. It is essential to carefully consider the location of PV solar panels in solar installations to avoid any shading of direct sunlight which will significantly reduce solar panel output even from small amounts of shading.

The output documents were forwarded to the ENG Committee 6th session (ENG6) for further development and completion.

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IALA WORKSHOP ON SUSTAINABLE LIGHT AND POWER FOR THE NEXT GENERATION (IALABATT/IALALITE)

1. INTRODUCTION

An IALA workshop on Sustainable Light and Power for the Next Generation in the IALABATT / IALALITE series was hosted by the German Federal Waterways & Shipping Administration (WSV) in Koblenz, Germany from 20th to 24th March 2017. The workshop was attended by 78 delegates, representing 23 countries, including 57 delegates from national members, 3 associate members, 10 industrial members, and 5 from other organisations.

A list of participants is at ANNEX B.

2. OVERALL PROGRAMME

The overall programme is shown in the following table.

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3. HIGHLIGHTS

Following a discussion, the workshop agreed to the following seven highlights:

1. Batteries employing new technology are a viable option for AtoN power systems but there are important storage, transport, maintenance, disposal and safety considerations, particularly the control of charging and cell temperature.
2. Whole life cost of AtoN can be reduced and environmental sustainability improved by considering a location-specific service condition factor that is based on local environmental conditions, maintenance regimes and user needs at the design stage.
3. Visibility Adaptive AtoN Light (VAAL) can improve conspicuity in poor visibility and can reduce AtoN light energy requirements.
4. While the quality of PV solar panel manufacture is maturing providing reliability and performance, current standards for solar PV units are generic and do not cover all the needs of AtoN applications and there is therefore a need for guidance on what constitutes a high quality marine grade PV panel for AtoN use.
5. Theft and vandalism can be successfully countered by innovative security measures, and community engagement.
6. New low energy monitoring equipment makes remote control and monitoring viable for use on solar powered AtoN. Where satellite communication is necessary short data messaging can play a role in reducing the cost of monitoring.
7. It is essential to carefully consider the location of PV solar panels in solar installations to avoid any shading of direct sunlight which will significantly reduce solar panel output even from small amounts of shading.

Annexes to the Report

ANNEX A OPENING OF THE WORKSHOP AND TECHNICAL SESSIONS

4. SESSION 1 - OPENING

Chaired by Simon Millyard, Trinity House Lighthouse Service, UK, and Chairman of the IALA ENG Committee.

All presentations form part of the output of the workshop.

4.1 Address by Christian Forst, Head of the German Federal Waterways & Shipping Administration

Christian Forst, Head of the German Federal Waterworks and Shipping Administration, welcomed all the participants.

Seafarers have been relying on visual Aids-to-Navigation for a very, very long time. Considering the future of visual Aids-to-Navigation such as lighthouses, beacons, leading lines, light buoys he concluded that shipping continues to need visual Aids-to-Navigation in the digital age.

He noted the work of IALA in providing AtoN standards that form a framework, the implementation of which by all coastal states will harmonise marine aids to navigation world-wide. He noted particularly the work of the ENG Committee.

Sustainable lights and power for the next generation displays an initiative to utilise up-to-date technology to improve the performance of lights and power sources. He also noted the contribution of IALA to training through the IALA Word Wide Academy. He noted the programme to replace the buoys and monitoring systems along the coast of Germany.

He thanked all those involved in the organisation of this workshop. The Steering Committee, the Chairs and members of the Engineering Committee, the IALA secretariat as well as Rainer Strenge and Jörg Unterderweide and their team.

He wished delegates a successful and fruitful workshop and hoped that they would have the opportunity to enjoy the hospitality of the city of Koblenz.

4.2 Address by Rainer Strenge, Head of Traffic Technologies Centre

Mr Rainer Strenge, Head of Traffic Technologies Centre (TTC), welcomed all participants to the workshop and thanked IALA for choosing Koblenz as the venue for the workshop. Koblenz is located at two international waterways and gives an insight into an impressive inland waterway traffic. Ship movements in the Rhine are comparable with many major ports. He further explained some tasks carried out by his office with regard to the workshop programme and highlighted the light lab as a key element for obtaining up to date expertise. The introduction of LED applications in conjunction with suitable power supplies will remain an ongoing business for some years and offers a variety of innovative AtoN light solutions. Due to the rapid progress in this field, the exchange of international experiences is very much appreciated.

He thanked all delegates for bringing their expertise and knowledge to the workshop. He wished all delegates an interesting, productive and enjoyable stay in Koblenz.

4.3 Address by Michael Card, Deputy Secretary-General of the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA)

Michael Card, IALA Deputy Secretary-General, welcomed all participants to the workshop. He thanked the German Federal Waterworks & Shipping Administration for hosting the workshop and the hard work of preparing for the event.

He recalled the IALA strategic vision 2014-2026 and noted that work to update the strategy is in progress. ENAV Committee work on e-navigation data modelling and maritime service portfolios (MSP) is on-going. Coast route trials of autonomous vessels are planned in Norway, marking a possible new era in shipping. IALA needs to assist administrations with the transition to e-navigation services. He noted that the need for short range aids such as AtoN lights will continue for the foreseeable future.

The project for IALA to transition from NGO to IGO status is progressing with a preparatory diplomatic conference planned for 18th and 19th April in Paris. This will strengthen to influence of IALA documents and the importance of the work of the IALA Committees. Information is available on the IALA website. All participants were invited to attend. It is hoped to sign the diplomatic convention in 2018.

The IALA Conference is planned for May 2018 and information is available on the IALA website. Following this IALA will commence a new work period. It is considered that connectivity and information transfer are the areas where IALA can provide most relevant input. e-Navigation may be a mix of public and private services. It is envisaged that VTS will move from a voice service to a more digital communications system. The future impact of autonomous ships on AtoN and VTS is uncertain.

He briefed the Committee on the draft IALA Position Paper which is presently being prepared and will ultimately be uploaded to the IALA website. The preparation of a revised IALA document structure with Standards, Recommendations and Guidelines is progressing. Seven initial Standards will be considered for approval by Council 64 in June 2017 and will be approved by General Assembly in May 2018. Standards are high level documents which will refer to Recommendations which may be normative or informative. Some Recommendations are in need of updating while some new Recommendations are required.

Mr Card noted the contribution of the Committees to IALA and thanked the National Members, Industrial Members and Associate Members for their support.

4.4 Administrative and safety information

Administrative and safety information was provided by Jörg Unterderweide, WSV.

4.5 Workshop aims and objectives

The presentation was made by Simon Millyard, Trinity House Lighthouse Service and Chairman of the IALA Engineering and Sustainability Committee (ENG).

4.5.1 Presentation abstract

Recalling the service provided by IALA through provision of international standards to enable safe and environmentally responsible navigation, Mr Millyard outlined the purpose of this workshop to gather technical knowledge and experience in the field of sustainable aids to navigation and to develop greater understanding of emerging technology for AtoN lights, power generation, power storage and the application of these technologies. In addition it is planned to develop Recommendations and Guidelines with the information gleaned during the workshop in line with the Engineering & Sustainability Committee's work plan.

5. SESSION 2 – EMERGING TECHNOLOGY

The session was chaired by Malcolm Nicholson, Sealite, Australia and Chair of WG1 of the IALA ENG Committee.

5.1 Presentation: Application of sustainable light sources in AtoN

The presentation was made by Alwyn Williams, GLA R&RNav, UK & Ireland.

5.1.1 Presentation abstract

Light sources used for marine aids-to-navigation have undergone a transformation in recent years as LED technology has become more reliable, powerful and cheaper. Dr Williams provided a brief history of LEDs as a light source in marine aids-to-navigation and what the future might hold. He considered the effects of in-service condition arising from local environmental conditions and maintenance regime. He also reviewed methods for calculating the effective intensity of a visual signal, with a particular focus on the Modified Allard Method. Recent research has found that the model should be reviewed to fit with observations more closely, and Dr Williams showed this in more detail.

5.1.2 The key points of the presentation were:

1. Visual signalling.
2. Sustainability and efficiency.
3. Technology.

5.1.3 Discussion

In discussion it was noted that R&RNAV research on service factor will be finished in April 2018.

Technology to transmit data by laser lights exists but the problem is receiving this data so that practical transfer of AtoN data by laser is unlikely in the near future.

5.2 Presentation: LED composite light signalling

The presentation was made by Aivar Usk, Sabik OÜ, Estonia.

5.2.1 Presentation abstract

LED light sources provide significant advantages such as high power efficiency, higher conspicuity, and long maintenance free lifetime. At the same time, due to rapid luminous intensity changes in flash (rectangular profile), typical LED lights have removed certain useful effects of traditional lighthouse signals like the “halo” and rough ranging capabilities available to the mariners. Smart manipulation of luminous intensity of LED based light signals can bring this back by introducing a controlled low-intensity light signal during the eclipses and slowing down the intensity increase in flash. Use of Fixed and Flashing rhythmic characters is gaining popularity and is recommended in detail by recent IALA publications (updated Recommendation E-112 and new Guideline on Selection of Rhythmic Characters prepared by the ENG Committee).

Implementation of AtoN telematics enables additional benefits like increasing the luminous intensity of lights in adverse meteorological or heeling conditions, helping to increase marine navigation safety by extending the geographic range of the light signals. At the same time, power economy can be achieved in excellent visibility conditions while maintaining accountable control by the AtoN authority. Relevant trials undertaken in Estonia were reported. A set of Key Performance Indicators for floating AtoN performance evaluation were proposed.

5.2.2 The key points of the presentation were:

1. LED light sources can be manipulated to bring back useful side effects of traditional lighthouse signals.
2. Combined Fixed and Flashing rhythmic characters have gained approval by mariners and IALA.
3. Use of meteorological visibility data for luminous intensity control increases marine navigation safety.
4. Buoy light intensities can be increased at high heeling angles to compensate for narrow vertical profile.

5. Definition and regular review of Key Performance Indicators increases quality of AtoN service.

6. SESSION 3 – EMERGING TECHNOLOGY

The session was chaired by Adam Hay, Nawae Construction & M-Nav Solutions, Papua New Guinea and Chair of WG2 of the IALA ENG Committee.

6.1 Presentation: The challenge of charging new technology batteries

The presentation was made by Jonas Lindberg, Sabik, Finland.

6.1.1 Presentation abstract

The introduction of modern lithium ion based batteries has resulted in lighter, long-life batteries with high energy density. However, the handling and safety aspects are more demanding than before and the batteries are more complex with electronic safety circuits now a necessary integrated part of batteries.

Mr Lindberg shed some light on the handling and safety of lithium ion batteries and described a typical battery protection circuit.

6.1.2 The key points of the presentation were*:*

1. Lithium ion battery introduction.
2. Battery management system.
3. Charging and maintenance.
4. Handling and safety

6.1.3 Discussion

In discussion it was noted that lithium ion batteries are very well suited to AtoN applications so long as charging is carefully controlled. Lithium batteries should not be operated in temperatures exceeding 55^{o}C and relative humidity should also be considered. Setting state of charge to a maximum of 85% allows operation at higher temperatures.

6.2 Presentation: Developments in battery technology

The presentation was made by Dirk Kaisers, Exide, Germany.

6.2.1 Presentation abstract

Mr Kaiser described the Exide M5 BAT project and a number of large battery applications.

6.2.2 Discussion

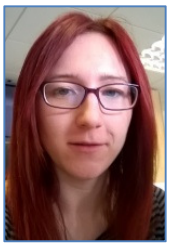
In discussion it was noted that lithium ion batteries are preferable to lithium polymer due to the cost difference.

For utility mains supply, a transition from centralised power generation to distributed local renewable sources generation is envisaged with battery storage to maintain supply and grid stability. The present method of large energy storage is through pumped water storage systems.

6.3 Presentation: Short burst data communications

The presentation was made by Kay Barber, Wireless Innovation, UK.

6.3.1 Presentation abstract



Ms Barber provided an introduction to satellite communications with a focus on the Iridium Constellation. She provided an insight into the capabilities and functionality of the Iridium network and the Short Burst Data (SBD) services available. Attendees were guided through the fragments of the Iridium network from ground infrastructures to satellites and the handover process to allow for the monitoring of assets worldwide. The advantages of short burst data include simple development and integration, modems are small and low power, small low profile omnidirectional antennas, messages can be sent globally with single flat rate global pricing and low latency duplex system (typically less than 10 seconds)

6.3.2 The key points of the presentation were*:*

1. Introduction to satellite communications.
2. The Iridium Satellite Network.
3. What is Short Burst Data?
4. How can Short Burst Data be utilised globally?
5. What's NEXT for satellite communications?

6.3.3 Discussion

In discussion it was noted that low power is typically 300mA at 9 volts for an Iridium transceiver. Iridium system availability is rated at 99.998% while cyber security is provided through SBD protocols rather than IP, use of a VPN directly to the Iridium Gateway and, where possible, direct SBD to SBD modem communications.

6.4 Presentation: Certification and developments in solar photo voltaics

The presentation was made by Bruce Cross, GB-Sol Ltd, UK.

6.4.1 Presentation abstract

Mr Cross described the background to PV modules, the history of their development, and their operation in remote battery charging applications.

He reviewed how PV modules are certified and how the application of PV in aids to navigation is not well covered by the international standards available today.

He also reviewed more advanced materials and methods of construction that might lead in the future to improved PV modules specifically for AtoN applications. This includes composite foam construction and transparent polymeric films which may eventually remove the need for glass in the construction.

6.4.2 The key points of the presentation were*:*

1. PV Module Operation.
2. International standards for PV.
3. Developments in future materials for PV modules.
4. PV Module background and history.

6.4.3 Discussion

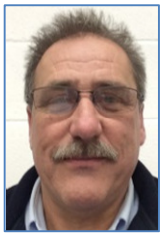
In discussion it was noted the maximum efficiency of GaAs PV solar cells is 35% and 32% for Si. Cost and complexity are the limiting factors in PV solar cell applications.

The performance of PV solar cells does not degrade over time due to UV radiation (tests on 17 year old cells indicate less than 5% degradation). Dirt on PV solar panels has a large effect and can cause hot spots if bypass diodes are not fitted to isolate cell strings. Cell output can by reduced by 80% due to dirt.

6.5 Presentation: Port Entry Lights – new developments

The presentation was made by Bruce Holliday, Sealite, UK.

6.5.1 Presentation abstract



The new Royal Navy aircraft carriers HMS Queen Elizabeth and Prince of Wales are to be based at Portsmouth, UK. The port required an innovative solution to safely navigate the largest vessel ever to enter Portsmouth. A clearly defined and stringent list of requirements influenced the design which encompassed differing operational modes, a central control location and both remote telemetry operation and reporting. Fifteen off-shore locations were identified where individual steel piles would be erected to support both fixed range lights and sectored port entry lights.

The port entry lights are programmed with different characters at each location and are specifically for use by QEC. When QEC movements are completed the system reverts to an All Vessels configuration. The entire package is controlled via a telemetry system controlled from port control in Semaphore Tower.

6.5.2 The key points of the presentation were*:*

1. Project requirements.
2. Project restrictions.
3. Locations.
4. Telemetry.
5. Operational control.

7. SESSION 4 – SUSTAINABILITY

This session was chaired David Jeffkins and Vice-Chair of the IALA ENG Committee.

7.1 Presentation: Wave power generators

The topic was presented by Yoku Santo, JANA, Japan.

7.1.1 Presentation abstract

Mr Santo described the history of the development of a wave power generator in Japan from commencement to termination. He noted the benefits of the Wells Turbine for wave power generation.

7.1.2 The key points of the presentation were:

1. Power supply for aids to navigation.
2. Wells turbine wave activated generator.
3. Solar power generator.
4. Multifunctional floating buoy.
5. Re-emergence of the necessity of wave power generators.

7.2 Presentation: Wind generation – Different types, experiences & developments

The topic was presented by Michel Cousquer, CEREMA, France.

7.2.1 Presentation abstract

Wind energy is a renewable source of energy that can be considered in order to power aids to navigation. When installing a wind generator, it is necessary to consider several matters. Even if wind energy can be used as a primary source, it cannot be the only power source. It is necessary to take care about the wind's potential and environmental impact of the site.

Different technologies of wind generators are available. Horizontal axis wind generators dominate the majority of the wind industry. They are appropriate for applications to produce as much power as possible at all times. Vertical axis wind generators, less reliable and cost-effective, are more suitable in turbulent winds and are easier to maintain.

France has been using wind generators on aids to navigation for a long time. The 1970's and 1980's where the golden age for this power source technology. During these decades, more than 150 wind generators powered all kind of AtoN. Today, because of the decrease in total electric loads on AtoN and after some development attempts, there are only 25 micro wind generators in use on French lighthouses, principally installed in Brittany.

7.2.2 The key points of the presentation were:

1. Wind generators.
2. Wind generator installation restrictions.
3. Wind turbine technologies.
4. French experiences with wind generators.

7.2.3 Discussion

In discussion it was noted that the S350 wind generator referred to in the presentation is supplied with a charge controller and the total package cost is in the order of €1,200

7.3 Presentation: Energy management – the low energy AtoN (Where the watt went). Power for communications transmissions

The topic is linked to 7.4 and was presented by Peter Dobson, Trinity House Lighthouse Service, UK.

7.3.1 Presentation abstract

Mr Dobson touched on the drivers for having telemetry and the infrastructure that Trinity House have implemented to ensure resilience. He highlighted the improvements in equipment efficiency that have allowed Trinity House to fit telemetry systems in ever more demanding locations.

Two examples of low power monitoring on solar buoys, where energy is sparse, were presented, along with some of the approaches adopted to manage energy consumption. Mr Dobson presented a summary of some of the challenging areas experienced, where energy can be saved and possible areas of future energy demands in the e-navigation arena.

7.3.2 The key points of the presentation were:

1. Why have telemetry systems?
2. Experiences of monitoring on buoys.
3. Communications and the challenges offshore.
4. The future and challenges that it will bring.

7.3.3 Discussion

In discussion, it was noted that VDES/ AIS is not designed for RCMS application and does not fit well with the communications requirements of low power PLCs.

7.4 Presentation: Energy management – the low energy AtoN (Where the watt went). Comparison of energy efficient RTUs/PLCs for remote control and monitoring of renewable powered lights

The topic follows from 7.3 and was presented by Peter Schneider, WSV, Germany.

7.4.1 Presentation abstract

Within the next few years nearly 900 lights on the German coast will have to be renewed (light source and outstation control unit). They will be migrated into “MTTS“ (marine traffic technology system) and remotely controlled / monitored by the “VIF-service“ (VIF means fixed visual aids to navigation).

Most of lights are powered by utility mains, but small lights and lights in positions where no utility mains power is available, are powered by renewable energy sources. At present some of them are not monitored or are monitored by systems with limited performance. The goals are:

- Enhancement of outstation control features;
- Improvement of remote control and monitoring functionality;
- Reduction of energy consumption.

Considering this, two RTU´s and a standard PLC have been tested for suitability as an outstation control unit for renewable powered lights. The tests were carried out, both theoretically (data sheet comparison) and practical (measurements). The presentation showed the results and provided a preview of how to use them.

7.4.2 The key points of the presentation were:

1. Remote control and monitoring of lights.
2. General requirements for an outstation control unit.
3. Implementation of a low power outstation control unit.
4. Comparison of different RTU´s/PLC.
5. Conclusion of energy efficiency tests.

7.4.3 Discussion

The driver for providing monitoring on all 900 German buoys is centralising operations into fewer centres.

7.5 Presentation: Lifetime assessment of self-contained lanterns in the Mediterranean sea area

The topic was presented by Joël Tourbot, DIRM / SPBM, France.

7.5.1 Presentation abstract

Self-contained lanterns have now been used for years in the French aids to navigation services. These lanterns are very practical and useful, and so they invaded the workshops over the last 10 year and were installed on the French coast, particularly in the Mediterranean area.

Industry and institutes published many studies and results about lifetime assessment for these products. Most of the time, these studies are related to particular conditions due to the standards needed to qualify the lantern (laboratories, specified conditions, etc.).

These standards are really necessary to enable comparison of tenders in an objective way, but it is necessary to know if the advertised lifetime is verified in real conditions. With more than 350

self-contained lanterns in use in the French Mediterranean area, more than one third of the aids to navigation managed by the service are fitted with self-contained lanterns. It is interesting to know the real lifetime assessment of this equipment in real conditions and to analyse the main problems that may be encountered.

- How many lanterns breakdowns have been listed?
- What were the causes of the breakdowns?
- What were the fault causing the breakdown?
- Was it possible to repair?
- What are the benefits of this technology?
- Which characteristics need to be improved?

7.5.2 The key points of the presentation were:

1. Self-contained lanterns became a standard in French Mediterranean area.
2. Good lifetime assessment.
3. Excellent reliability of self-contained lanterns.
4. Principal listed breakdowns in self-contained lanterns.
5. Requested improvements in self-contained lanterns.

7.5.3 Discussion

In discussion it was noted that 80% of failures of self-contained lanterns arise from battery failures. However it was felt that higher quality batteries could substantially reduce this rate of failure.

8. SESSION 5 – SUSTAINABILITY

This session was chaired by Peter Schneider, WSV, Germany.

8.1 Presentation: Assessment and cost effectiveness of old solar panels

The topic was presented by Julian Schüren, Sunware GmbH & Co KG, Germany.

8.1.1 Presentation abstract

Mr Schüren explained typical faults encountered with solar panels that should be examined when inspecting solar panels for defects. Some typical installations were used to describe the effect of non-optimal use of solar panels.

8.1.2 The key points of the presentation were:

1. PV solar panels faults.
2. Part shading in PV solar arrays.

8.1.3 Discussion

In discussion it was noted that the performance of PV solar cells does not degrade over time but other parts of solar panels do degrade such as browning of EVA coatings and internal connector corrosion. Visible inspection is adequate as a maintenance procedure and complex measurements are not required as part of the maintenance schedule.

Quality of solar panel manufacture is now mature providing reliability and performance has increased with improvements in PV cell technology.

Glass is considered to be the best material for the front of PV solar panels as it is fully moisture proof and its thermal expansion coefficient is close to that of the PV cells.

8.2 Presentation: Assessment and cost effectiveness of old solar panels

The topic was presented by Leif Arne Larsen, Norwegian Coastal Administration, Norway.

8.2.1 Presentation abstract

Mr Larsen provided a brief introduction on how global warming will result in climate change and the impact these changes may cause. He discussed how solar energy is distributed today and how climate change can affect future changes in transmissivity and solar gain.

Climate changes will also lead to a change of design criteria for AtoN. Examples of typical design criteria that will be affected by climate change were described. Mr Larsen discussed some of the technical challenges faced and concluded with some examples of design of AtoN placed in an extreme environments in the northern hemisphere for testing.

8.2.2 The key points of the presentation were:

1. Climate change.
2. Consequence of climate change.
3. Changes in transmissivity and solar gain.
4. Technical challenges.
5. Example of sustainable AtoN designs on the northern hemisphere.

8.2.3 Discussion

In discussion it was noted that the requirements for AtoN in a global warming world are reduced energy consumption, better tolerance of extreme weather conditions, reduced contribution to global warming in manufacturing and transport, and reinforced structures to withstand storms. Maintenance is tending towards module replacement rather than on-site repair to reduce on-site time and consequently reduce costs.

8.3 Presentation: Vandalism innovation for battery boxes on light-buoys

The topic was introduced by Capt. Mohamad Halim bin Ahmed, Maritime Attaché at the Malaysian High Commission in London, Malaysia and presented by:

Mrs. W.Norhayati binti W.Ibrahim	-	Marine Officer
Mrs. Noranita binti Md Saleh	-	Marine Officer
Mr. Mohd Azhari bin Mohd Salleh	-	Assistant Engineer
Mr. Muhamed Zamri bin Yaacob	-	Assistant Marine Officer
Mr. Mohd Zikri bin Abdul Wahab	-	Assistant Marine

8.3.1 Presentation abstract

In 2012 alone Malaysia Marine Department (MMD) had to tolerate the cost of nearly RM1.078 million or USD 243,400 for repairing, replacing, fuel consumption, overtime and allowances due to vandalism on battery boxes. These figures were based on the complaints made by customers regarding buoy vandalism that caused damage to the buoy's battery box, light and locks.

W.Norhayati Noranita Mohd Azhari Muhamed Zamri Mohd Zikri

MMD introduced the first prototype of the bolt fastener and battery box. The Bolt Fastener is to fasten the bolt to prevent the nut from vandalism activities and battery box that works as battery protector. After 2 prototypes, MMD developed the best fit-for-use bolt fastener along with a durable battery box. After 4 years, there is no record of complaints regarding buoy damage or battery theft.

In 2013, operational cost was reduced by nearly RM1,104,668 or USD228,333.

In 2016 a patent application resulted in only the bolt fastener having proof of novelty.

Established in January 2011, Sinar Selatan is a small group activities initiative called innovative and creative circles. Consisting of 10 volunteers from various departments, the Innovative and Creative Circle Convention department won the convention in 2013 and 2014 and successfully joined the convention to the next Ministerial Level and the National Level with the invention of Tri-Secure Lock and Robust Battery Box.

8.3.2 The key points of the presentation were:

1. Types of vandalism are theft and damage to battery boxes.
2. Analysis of the types of vandalism identified the need for improvements in locks and battery boxes.
3. Both inventions submitted for patent from Malaysia Intellectual Property Organization (MyIPO) are still patent pending.
4. Benefits gained from the inventions are reduced operating cost of repair, servicing and maintenance.

8.3.3 Discussion

In discussion it was noted that the construction of the robust battery box is sufficient to withstand attempts to pull the entire box off an AtoN structure.

8.4 Presentation: Experiences in different battery types

The topic was presented by Paul Hudson, Northern Lighthouse Board, Scotland.

8.4.1 Presentation abstract

The Northern Lighthouse Board completed its long term project of automating it's 200 plus lighthouses in 1998. The resulting estate is heavily dependent on the use of batteries either to provide a backup power supply or to provide a means of storing energy generated by photovoltaic solar cells or diesel generators.

Over the ensuing 20 years the Board has gained a wide knowledge of managing the Board's battery systems with 95% of the Board's lighthouse estate employing Nickel – Cadmium (Ni-Cd) batteries.

The remaining 5% of the battery estate employed within lighthouses are made up of Nickel Metal Hydride (NiMH) batteries. Generally modules are configured as ten cells with capacity of 500Ah at 24 volts. On a number of occasions modules or strings of modules have been discovered to have overheated during their charge cycle. Mr Hudson summarised the current use of Ni-Cd batteries and discussed the potential causes of heat damage to the NiMH batteries.

8.4.2 The key points of the presentation were:

1. Current battery systems used within the NLB lighthouse estate.
2. Problems uncounted with the use of Nickel Metal Hydride (NiMH) batteries.
3. Possible solution to prevent overheating of Nickel Metal Hydride (NiMH) batteries.

8.5 Discussion

In discussion it was noted that individual cells in a string may not be well balanced and the first cell to reach saturation triggers termination of charge of a battery. Incidents of NiMH cells overheating are not age related.

9. SESSION 6 – APPLICATION OF TECHNOLOGY

This session was chaired by Colin Day, Commissioners of Irish Lights, Ireland.

9.1 Presentation: Hybrid power systems - Killiniq Sustainable Energy and Refurbishment Project

The author of the presentation was Adam Wettges, Superintendent for the Central and Artic Region of the Canadian Coast Guard, Maritime and Civil Infrastructure division.

The topic was presented by Jordan Lane-Beveridge, Canadian Coast Guard, Ottawa, Canada.

9.1.1 Presentation abstract

The Killiniq Marine Communications & Traffic Site (MCTS), located in one of the Canadian Coast Guard's (CCG) most remote sites, is a vital link to CCG coverage of the increasing traffic in Canada's arctic regions and the Northwest Passage. Killiniq underwent a major refurbishment at the beginning of 2009 to install sustainable energy systems, replace obsolete electronics, and new building infrastructure. The project, while ultimately successful, provided invaluable learning opportunities for the CCG in the areas of sustainable energy development and project implementation in remote regions.

9.1.2 The key points of the presentation were:

1. Sustainable Power in remote sites.
2. Significant fuel savings can be realised.
3. Legislation requirements can drive monitoring and infrastructure.

9.1.3 Discussion

In discussion it was noted that 600mm of insulation and heaters are used in Canada to insulate battery rooms in extreme conditions.

Tests are required to determine the additional usable solar radiation from snow when using vertical PV solar panels.

Vertical axis wind generators are used in Canada because severe blow back of the blades in horizontal axis machines has caused problems in the past.

9.2 Presentation: IALA Solar Model - demonstration

The topic was presented by Jörg Unterderweide, German Federal Waterways and Shipping Administration, Germany.

9.2.1 Presentation abstract

In 2001 the IALA ENG Committee developed a functional specification for software to carry out design calculations for solar PV systems. Based on these requirements an Excel-based model for calculation solar generator and battery was designed and described in IALA Guideline 1039 in 2004.

The model was presented in a live demonstration showing typical examples. Known restrictions in the model were pointed out.

After more than 10 years the model should be revised and updated. The ENG Committee carried out comparisons with other models which are also used by administrations and a list of amendments was prepared.

Workshop participants were requested to give feedback on their experience and propose ideas and suggestions to improve the model. The proposals were coordinated in the workshop and incorporated into the revision.

9.2.2 The key points of the presentation were:

1. Idea and origin of the PV solar design calculator model.
2. Limitations of the solar calculator model.
3. Keep it simple!!!
4. Proposals and new ideas for the solar calculator model.

9.2.3 Discussion

In discussion it was noted that the effects of temperature are not included in the IALA PV solar calculator. The calculator will be available from the IALA website when the model is updated at the workshop. User instructions are available from IALA Guideline 1039.

9.3 Presentation: LED thermal management

The topic was presented by Malcolm Nicholson, Sealite, Australia.

9.3.1 Presentation abstract

The use of high powered LEDs in marine aids to navigation has become prolific in recent years. Tighter packaging of junctions and higher currents has meant that thermal management is a key design factor to ensure correct operation and expected lifetime. Because of the rapid technological growth in the LED market, coupled with the long life of LEDs, it is not practical to test LEDs to the end of life. Therefore a method to project the long term lumen maintenance should be used. Mr Nicholson described such a method and how it can be used to ensure expected LED lifetime.

9.3.2 The key points of the presentation were:

1. LED thermal management.
2. LED Lifetime.
3. Long term lumen maintenance with LEDs.

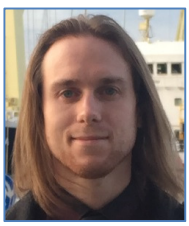
9.3.3 Discussion

In discussion it was noted that copies of the LM80 data sheet are provided with aviation products because of aviation regulations but not with marine products. A heatsink is sufficient to cool LED light sources and more complex cooling systems are unwarranted.

9.4 Presentation: Battery conditioning and power optimisation

The topic was presented by Link Powell, GLA R&RNav, UK & Ireland and Peter Dobson, Trinity House, UK.

9.4.1 Presentation abstract



The presenters highlighted the importance of accurately knowing the capacity of batteries when using a solar model. They discussed the experience of Trinity House with assessing battery capacity for use in solar models. They considered the method used to verify the capacity and the approach to conditioning batteries for peak performance. The battery cycling system used at Trinity House is a custom built system designed by TH and R&RNAV and enables in-house verification and conditioning to be conducted. An overview of this system was given. Experience has shown that capacity of 105% of stated capacity can be achieved using the cycling system.

9.4.2 The key points of the presentation were:

1. Requirements for solar power system performance.
2. Battery charge cycling to optimise battery performance.
3. Verification of battery capacity.

9.5 Discussion

In discussion it was noted that lithium ion cells are supplied in 50% state of charge condition and have a charge efficiency of 1%. Long term effect of the initial charge cycling is not available due to insufficient experience to date. The present cycling system is not portable and therefore not suitable for on-site use. However the system is scalable enabling a more portable system.

Charger controllers have been developed to enable charging from multiple sources.

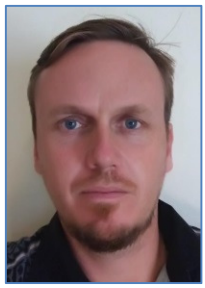
10. SESSION 7 – APPLICATION OF TECHNOLOGY

This session was chaired by Alwyn Williams, GLA R&RNav, UK & Ireland.

10.1 Presentation: Practical experiences of innovative applications, Protection against vandalism & theft

The topic was presented by Adam Hay, Nawae Construction and M-Nav Solutions, Papua New Guinea.

10.1.1 Presentation abstract



Theft of power supplies is an issue affecting remote AtoN sites in many countries in the South Pacific. Theft of solar panels and batteries causes AtoN to fail and severely affects a country's ability to maintain the required AtoN availability levels. Mr Hay detailed a number of different methods used to prevent the removal and theft of batteries, solar panels and even lanterns. The methods include physical hardening, structural upgrades, remote monitoring and also engagement with local communities.

10.1.2 The key points of the presentation were:

1. Theft of power supplies causes AtoN to fail unexpectedly. In remote locations, this is very difficult to monitor and to forecast.
2. Theft and vandalism are one of the major factors affecting AtoN availability in the South Pacific.
3. Physical hardening of solar panel frames and battery boxes can make theft more difficult.
4. Self-contained lanterns are an effective method of reducing theft of power supplies.
5. Engaging local communities in programs to monitor the AtoN can be effective.

10.1.3 Discussion

In discussion it was noted that, in some instances, welding is the only deterrent to theft. As batteries are enclosed in a grp container inside the welded steel case, explosion risk from hydrogen build up is not a hazard.

10.2 Presentation: The Mariners viewpoint of AtoN technology in navigation

The topic was presented by Philip Giertz, WSV, Germany.

10.2.1 Presentation abstract

Mr Giertz presented a mariner's view on the need for and the benefit of aids to navigation (AtoN). He described the basic context and derived the user-related AtoN requirements based on fundamental navigational safety demands. Using several AtoN examples he elucidated the functional characteristics and user-related benefits offered by different kinds of AtoN. Adapted from the key functionalities of visual and electronic AtoN as a source of real-time and directly interpretable navigational information, he closed with a general plea for a possible future AtoN-layout by providing a sustainable mix of both conventional and electronic AtoN.

10.2.2 The key points of the presentation were:

1. Shipping is crucial for the global trade.

2. A safe navigation is important for different subjects of protection.
3. A mariner's action is always determined by safety aspects, sometimes there is a need for AtoN.
4. AtoN offer benefits, e.g. immediate and real-time information.

10.2.3 Discussion

In discussion it was noted that there is no difference between the radar conspicuity of steel and plastic buoys fitted with internal radar reflectors but tests are being conducted to identify if the plastic causes radar interference.

10.3 Presentation: Fuel cell application and practical experience

The topic was presented by Tom Chicken, Fuel Cell Systems, UK.

10.3.1 Presentation abstract

With the increasing use of technology to assist navigation, remote power is becoming more of a problem and the traditional method of using solar panels with battery storage is no longer sufficient. Fuel cells are one of the best solutions to this problem now that the technology has developed and matured. Systems are already in place worldwide in some of the most extreme conditions providing reliable power where once it was not possible. Mr Chicken described the various technologies that are available and provided real examples of where they have been utilised with considerations that have had to made.

10.3.2 The key points of the presentation were:

1. Remote power.
2. Fuel cells.
3. Extreme conditions.

10.3.3 Discussion

In discussion it was noted that solar/ wind/ wave generators are more cost effective than fuel cells for low energy consumption applications but fuel cells are better for higher energy consumption systems.

Life of a small fuel cell is 4,500 hours operating. Methanol is treated as a hazardous substance and transportation is easy including transport by air.

10.4 Presentation: Case study in large optics and mercury bearing replacement

The topic was presented by Colin Day, Commissioners of Irish Lights, Ireland.

10.4.1 Presentation abstract

The Commissioners of Irish Lights operate and maintain over 200 Aids to Navigation around the coast Ireland, including 66 lighthouses. Many of these lighthouses were built in the 19th century as "land-fall lights" and use large traditional revolving Fresnel Optic lenses floating in a mercury bath to create their original long range and unique character. Irish Lights have adopted a policy of removing mercury from their lighthouses and have installed a commercial revolving pedestal system on two small 3rd order (500mm focal length) in place of the mercury bath. However, commercial systems are not available for larger lenses such as the bi-form Hyper-radial (1330mm focal length) lens installed at Tory Island. As part of a consolidation project, the mercury was removed from Tory Island in 2012, the lens de-commissioned and covered up but left in place. A pair of synchronised and flashing LED lanterns were installed on the balcony handrail to continue to provide the Navigational Light.

These lanterns were powered from utility mains charged batteries. Consequently the Tory Island lighthouse site was available to trial a mechanical bearing to rotate the large optic without compromising the AtoN light. Mr Day provided a case study for this project and shared experience with the trial to date.

10.4.2 The key points of the presentation were:

1. Context of consolidation projects.
2. Rationale behind trial bearing.
3. Suitability of Tory Island lighthouse site for the trail.
4. Outline of design issues.
5. Experience gained to date.

10.4.3 Discussion

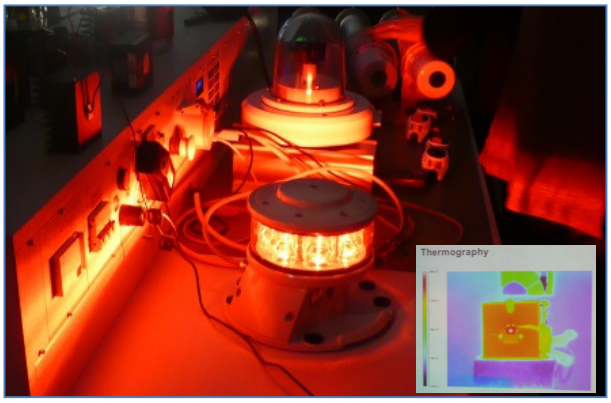
In discussion it was noted that the driver for fitting a bearing system on the traditional biform hyper radial lens was retention of the heritage system without the hazard of mercury. Use of external high power LED lanterns was not feasible due to the unreliability history of the high power LED lanterns used during construction.

11. SESSION 8 TECHNICAL STUDY TOUR

Participants visited the Federal Waterways & Shipping Administration light range in Koblenz and viewed practical demonstrations of light and colour measurement. Participants were very impressed with the capability of the centre and the welcome and expertise of the staff. They found the visit to be very informative and relevant to the work of both the workshop and the IALA ENG Committee.

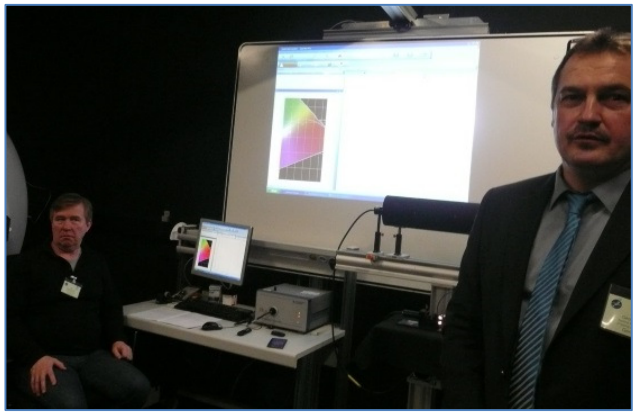
11.1 Thermographic Camera

Comparison of the thermographic signatures of different incandescent and LED light sources using infrared cameras.



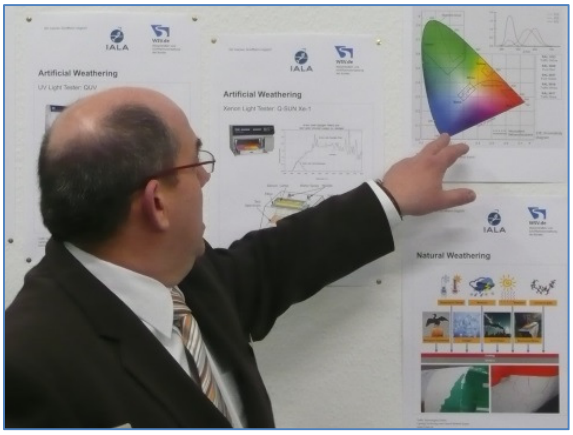
11.2 Luminous flux and spectral distribution within the integrating sphere

The method of measuring the spectral distribution of light using an integrating sphere was explained and demonstrated.



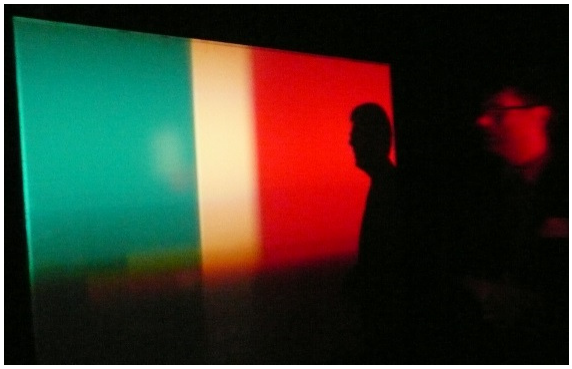
11.3 Rapid weather testing

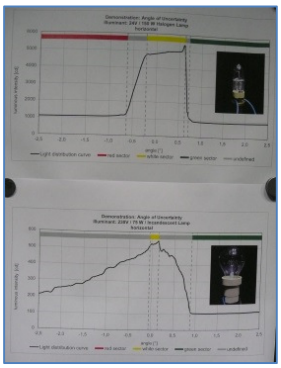
Techniques for rapid weather testing of paint finishes using UV radiation, temperature and humidity with acceleration of 10 times were explained and demonstrated. It was noted that the chromaticity charts used include new paint area within the CIE colour boundary areas used by IALA and that addition of the new paint boundaries might be a useful addition to the IALA E200 Recommendation on colour boundaries.

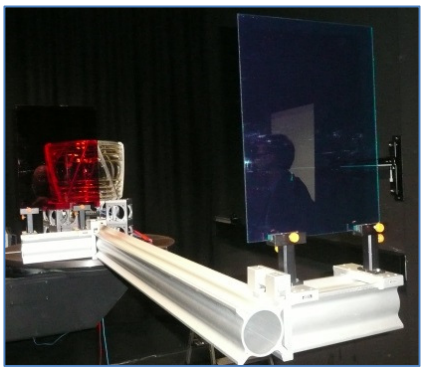


11.4 Goniophotometer - Luminous intensity and sector of uncertainty of a sector light

The effects of light source size and distance between light source and coloured filter on the angle of uncertainty at the boundary between coloured sectors was demonstrated.







11.5 HF laboratory (radar)

Equipment for measuring RF radiation and methods of producing radar reflecting and absorbing (for use on bridges) materials were demonstrated. The SR6 radar corner reflector was examined and upcoming tests to determine the effect of enclosing the SR6 radar reflector within plastic daymarks was discussed.

12. SESSIONS 9 TO 14 - WORKING GROUPS

The workshop broke into two Working Groups (WG) to progress the draft guidelines on AtoN lights and power systems.

WG1	Lights (objective to merge Guidelines 1043, 1048, 1049 (ENG WP 5.1.9) and update Guideline 1073 to include latest light source technology and conspicuity assessment.	Leader: Malcolm Nicholson Link Powell
WG2	Power systems (objective to update Guidelines 1067, 1039 to include new technology and align with IALA documentation structure)	Leader: Adam Hay Peter Dobson Jorg Unterderweide

13. SESSION 15 – REVIEW OF OUTPUT DOCUMENTATION

Chaired by Simon Millyard, Trinity House Lighthouse Service, UK and Chair of IALA ENG Committee.

13.1 Presentation of output documents

Participants split into two working groups (WG) in separate rooms to work on the review and development of draft Guidelines on AtoN lights and power supplies. Both working groups divided into sub-groups to progress the review and development of the IALA documentation.

IALA Guideline 1043 was reviewed and amalgamated with IALA Guideline 1048 to form a revised Guideline 1043. LED details were moved to a new annex. Output paper SLP1-15.1 refers.

A minor review of IALA Guideline 1049 was carried out. It was recommended that IALA Guideline 1049 be retained as a separate IALA Guideline. Output paper SLP1-15.2 refers.

IALA Guideline 1073 was updated. It was proposed that annexes A, B, C be removed from Guideline 1073 and added to the IALA Wiki. Acronyms were removed but it was proposed that the acronyms should be reinstated to comply with IALA policy. Definitions should be removed and transferred to the Dictionary. There is need for further updating. Output paper SLP1-15.3 refers.

A review and general update of Guideline 1069-3 on Electrical Energy Storage was carried out and the updating of the Guideline will be finalised at the ENG6 Committee meeting. Participants were invited to submit appropriate photographs for this work. It was noted that air-depolarised batteries are still in use. Output paper SLP1-15.4 refers.

A review of Guideline 1069-2 on Power Sources was commenced and this work will be continued at ENG6. Output paper SLP1-15.5 refers.

IALA Guideline 1039 was reviewed and updated, with the task to be continued at ENG6. Output paper SLP1-15.6 refers.

The suitability of the Excel based solar sizing program was reviewed and a number of significant improvements and changes to expand its scope, make it more user friendly, and to better define its limitations, were introduced. Output paper SLP1-15.7 refers.

Attendees were invited to advise the workshop if anyone had knowledge of any patents, including pending patents, held either by themselves or by other organisations or individuals, the use of which may be required to practice or implement the content of IALA Documents being developed or worked on in the workshop. It was stated that any information provided to the workshop could not be subject to intellectual property rights claims (IPR) unless the IPR was claimed at time of submission. It was noted that Pharos Marine has a number of pending patents in relation to light sources. Malaysia has patents pending on the Tri-Secure Lock.

The outputs from the workshop will be submitted to the 6th session of the IALA ENG Committee (ENG6) in March 2017 where they will be progressed to completion.

13.2 Panel discussion

A panel comprising Simon Millyard, Malcolm Nicholson, Adam Hay, Jörg Unterderweide, David Jeffkins, Peter Schneider led a discussion considering a number of issues.

With climate change there is a possibility of changes in meteorological visibility that may affect AtoN. There is a need to consider and evaluate the impact of such changes. Evaluation of climate change impact needs to be considered on a region by region basis and local meteorological offices have a lot of historical information that would assist this study. It was suggested that relevant IALA Recommendations and Guidelines may need to be updated to take account of changing meteorological visibility.

Participants from Malaysia volunteered to submit input to the ENG Committee in relation to removing mercury from large revolving lens optics.

While mariners prefer to retain visible AtoN, the adoption of digital means of navigation and communication may be driven from the shore side as has happened in the aviation industry. This raised the question of how ready is the maritime industry for transfer of master's responsibility from on-board to ashore.

Considering the value of the "loom" of a revolving lens AtoN light, it was noted that this feature can be retained by utilising LED light sources in traditional lens and thereby reducing energy consumption with improved sustainability. The value of traditional AtoN is recognised in IALA.

Theft of batteries, solar PV panels and lanterns can have a major impact on the availability of AtoN and anti-theft measures are important.

In using coloured AtoN lights, the luminous range of the light must be determined for the colour of light adopted as described in the IALA Guideline. The colour changing effects of lights arising from frequency dependent absorption and scatter must also be considered.

It is essential to use high quality batteries in solar applications including self-contained lanterns. Batteries should be suitable for the environment in which they are used.

It was suggested that IALA should consider issuing a questionnaire to determine the use of IALA documentation to inform the 2018 – 2022 work plan.

14. SESSION 16 – HIGHLIGHTS AND CLOSING

The session was chaired by Simon Millyard, Trinity House Lighthouse Service, UK and Chair of IALA ENG Committee.

14.1 Highlights

Seven highlights were agreed as listed in the main report.

14.2 Workshop report

Seamus Doyle noted that the workshop documents and photographs would be available on the workshop file sharing server on the IALABATT page of http://www.iala-aism.org/file-sharing/ for one month. The draft workshop report was posted on the file share server and the final report will be posted within one week and will be permanently available on the IALA website. It will be forwarded to ENG6 and an executive summary will be forwarded to the IALA Council.

14.3 Closing of the workshop

Noting that the purpose of the workshop was to develop IALA documents, Michael Card thanked everyone for attending and working so hard. He thanked Christian Forst, Rainer Strenge, Jörg Unterderweide, the WSV team, working group leaders, the chair and vice-chair for making the workshop such a great success. He observed that IALA is preparing a Recommendation in relation to the IALA Maritime Buoyage System. He advised that IALA notes areas of possible patent conflict. The workshop has contributed to the knowledge base of solar PV, batteries and remote monitoring. He noted the present work to harmonise data modelling in IHO S-200 series of Product Specifications. He thanked the members of the German Federal Waterways and Shipping Administration for their excellent organisation of the workshop and the informative visit to the light laboratory. Presenting Rainer Strenge with an IALA tie with the new IALA logo, he thanked him for his assistance in making the workshop such a success. The work of the workshop will be completed in the IALA ENG Committee and will then be distributed globally as IALA publications.

Rainer Strenge thanked IALA for arranging the workshop in Koblenz. He thanked the WSV team for arranging the workshop while carrying out their normal duties fully. He thanked the participants for attending and contributing their time and expertise. He presented a model of a solar powered buoy powered from a USB computer port to Michael Card.

The delegation from Malaysia presented gifts to Rainer Strenge, Michael Card and Simon Millyard.

Simon Millyard wished everyone a safe journey home and declared the workshop closed.

14.4 Welcome reception

On Monday 20th March, delegates enjoyed an informal buffet reception hosted at the Koblenz Kongress in Koblenz to welcome delegates to the workshop.

14.5 Visit to Champagne caves with wine tasting

On Tuesday 21st March, participants visited the Deinhard Champagne caves and were informed of the history and techniques of the making of sparkling wine in the Deinhard company. A variety of wines were available for tasting.

ANNEX B LIST OF DELEGATES

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19	Alwyn Williams	GLA R&RNAV, UK & Ireland

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ANNEX D WORKSHOP PROGRAMME

DAY 1 – Monday, 20 March 2017

Time	Activity	
1300 – 1400	**Registration**	
1400 – 1450	**Session 1 - Opening of the Workshop**	**Chair: Simon Millyard**
1400 - 1410	Welcome from host - WSV	Christian Forst, WSV
1410 - 1420	Address from host Head of Traffic Technologies Centre	Rainer Strenge, WSV
1420 - 1430	Welcome from IALA	Michael Card, IALA
1430 - 1440	Administration & Safety Brief	Jörg Unterderweide, WSV
1440 - 1450	Workshop aim & objectives	Simon Millyard, THLS
1450 – 1530	**Session 2 – Emerging technology**	**Chair: Malcolm Nicholson**
1450 - 1510	Application of sustainable light sources in AtoN	Alwyn Williams, GLA R&RNAV
1510 - 1530	LED composite light signalling	Aivar Usk, Sabik OÜ
1530 – 1600	**Break**	
1600 – 1745	**Session 3 – Emerging technology**	**Chair: Adam Hay**
1600 - 1620	The challenge of handling new technology batteries	Jonas Lindberg, Sabik
1620 - 1640	Developments in battery technology	Dirk Kaisers, Exide Germany
1640 - 1700	Short burst data communications	Kay Barber, Wireless Innovation
1700 - 1720	Certification and developments in solar PV	Bruce Cross, GB-Sol Ltd
1720 - 1740	Port Entry Lights – new developments	Bruce Holliday, Sealite UK
1740 - 1745	Discussion	Adam Hay
1745 – 1930	**Welcome Reception, Koblenz Kongress** Dress code casual	

DAY 2 – Tuesday, 21 March 2017

Time	Activity	
0900 - 1045	**Session 4 – Sustainability**	**Chair: David Jeffkins**
0900 - 0920	Wave power generators	Yoku Santo, JANA
0920 - 0940	Wind generation – Different types, experiences & developments	Michel Cousquer, CEREMA, France
0940 - 1000	Energy management – the low energy AtoN (Where the watt went). Power for communications transmissions	Peter Dobson, TH; Peter Schneider, WSV
1000 - 1020	Lifetime assessment of self-contained lanterns in the Mediterranean sea area	Joël Tourbot, DIRM / SPBM
1020 - 1030	Discussion	David Jeffkins
1030 – 1100	**Break**	
1100 - 1230	**Session 5 – Sustainability**	**Chair: Peter Schneider**
1100 - 1120	Assessment and cost effectiveness of old solar panels	Julian Schüren, Sunware GmbH & Co KG
1120 - 1140	Climate change - changes in transmissivity and solar gain	Leif Arne Larsen, NCA
1140 - 1200	Vandalism innovation for battery boxes on lighted buoys	Mohamad Halim bin Ahmed and Sinar Selatan team, Malaysia
1200 - 1220	Experiences in different battery types	Paul Hudson, Northern Lighthouse Board
1220 - 1230	Discussion	Peter Schneider
1230 - 1400	**Lunch & Workshop Group Photograph, Level 0 (Flexible time for photograph)**	
1400 - 1530	**Session 6 – Application of Technology**	**Chair: Colin Day**
1400 - 1420	Hybrid power systems - Killiniq Sustainable Energy and Refurbishment Project	Jordan Lane-Beveridge, Canadian Coast Guard
1420 - 1440	IALA Solar Model - demonstration	Jörg Unterderweide, German Federal Waterways and Shipping Administration
1440 - 1500	LED thermal management	Malcolm Nicholson, Sealite
1500 - 1520	Battery conditioning and power optimisation	Link Powell, GLA R&RNav
1520 - 1530	Discussion	Colin Day
1530 - 1600	**Break**	
1600 - 1730	**Session 7 – Application of Technology**	**Chair: Alwyn Williams**

Time	Activity	
1600 - 1620	Practical experiences of innovative applications, protection against vandalism & theft	Adam Hay, Nawae Construction & M-Nav Solutions, PNG
1620 – 1640	The Mariners viewpoint of AtoN technology in navigation	Philip Giertz, WSV
1640 - 1700	Fuel cell application and practical experience	Tom Chicken, Fuel Cell Systems
1700 - 1720	Case study in large optics and mercury bearing replacement	Colin Day, Commissioners of Irish Lights
1720 - 1730	Establishment of working groups	Alwyn Williams
1800 - 1930	**Evening social event, Champagne caves visit with wine tasting** Dress code casual. 20 minute walk from Koblenz Kongress to the Kellermuseum.	

DAY 3 – Wednesday, 22 March 2017

Time	Activity	
0900 – 1230	**Session 8 – Technical Visit**	**Jörg Unterderweide**
0900 – 1230	Technical study tour to the Federal Waterways & Shipping Administration light range in Koblenz with practical demonstrations of light and colour measurement –	
1230 - 1400	**Lunch**	
1400-1530	**Session 9 – Working Groups (WG)**	**Co-ordinator: David Jeffkins**
1400-1530	WG1 – Lights Merge 1043, 1048, 1049 (ENG WP 5.1.9) and update Guideline 1073 to include latest light source technology and conspicuity assessment.	Leader: Malcolm Nicholson
1400-1530	WG2 – Power systems Update Guidelines 1067, 1039 to include new technology and align with IALA documentation structure	Leader: Adam Hay
1530 - 1600	**Break**	
1600 - 1730	**Session 10 – Working Groups**	**Co-ordinator: David Jeffkins**

DAY 4 – Thursday, 23 March 2017

Time	Activity	
0900 -1030	**Session 11 – Working Groups**	**Co-ordinator: David Jeffkins**
1030 – 1100	**Break**	
1100 – 1230	**Session 12 – Working Groups**	**Co-ordinator: David Jeffkins**
1230 – 1400	**Lunch**	
1400 - 1530	**Session 13 – Working Groups**	**Co-ordinator: David Jeffkins**
1530 - 1600	**Break**	
1600 - 1730	**Session 14 – Working Groups**	**Co-ordinator: David Jeffkins**
1730 - 1800	Meeting of WG leaders	WG leaders, Simon Millyard, David Jeffkins , Jörg Unterderweide, Seamus Doyle

DAY 5 – Friday, 24 March 2017

Time	Activity	
0900 - 1030	**Session 15 – Review of Output Documentation**	**Co-ordinator: Simon Millyard**
0900 – 0930	Presentation of draft documentation WG1	Malcolm Nicholson
0930 – 1000	Presentation of draft documentation WG2	Adam Hay
1000 - 1030	Panel-led discussion on lights and power sources	Simon Millyard, Malcolm Nicholson, Adam Hay, Jörg Unterderweide, David Jeffkins, Peter Schneider
1030 - 1100	**Break**	
1100 - 1200	**Session 16 – Plenary – Conclusions & Closing**	**Chair: Simon Millyard**
1100 – 1130	Highlights from workshop	David Jeffkins

Time	Activity	
1130 – 1145	Closing of the workshop	Michael Card, IALA
1200 - 1300	**Post workshop meeting**	**Steering Group**

ANNEX E WORKSHOP INPUT PAPERS

Including the presentations made during sessions, the following papers were input to the workshop:

Paper Number		Title / Author (if required)	Source	WG
ENG5-	11.2.4	Draft IALA Guideline Ed.1 Maintenance of AtoN Structures	ENG5	WG2
ENG5-	11.2.9	Draft Guideline 1006 on Plastic Buoys 20161013	ENG5	WG2
ENG5-	11.2.12	Draft IALA Guideline 1067-3 Ed.1 Electrical Energy Storage for AtoN May2008 rev5	ENG5	WG2
ENG5-	11.2.13	Draft IALA Guideline 1073 Ed.1 Conspicuity of AtoN Lights at Night June 2011 rev2 WG1 working paper 20161012	ENG5	WG1
ENG5-	11.2.14	Draft Guideline 1043 Ed.1.2 Light Sources used in Visual AtoN December 2011 rev1	ENG5	WG1
ENG5-	11.2.18	Draft IALA Guideline 1067-0 Ed1.1 on Selection of Power Systems for AtoN and Associated Equipment Jun2011 rev3 – 12-10-16	ENG5	WG2
ENG5-	11.2.19	Draft IALA Guideline 1067-1 Ed.1 Total Electrical Loads of Aids to Navigation_May2009 rev3 – 13-10-16	ENG5	WG2
ENG5-	11.2.20	Draft IALA Guideline 1067-2 Ed.1 Power Sources May2009 rev2	ENG5	WG2
Guideline	1039	IALA Guideline 1039 Ed.1 Designing Solar Power Systems for Aids to Navigation December 2004	IALA Secretariat	WG2
Guideline	1048	IALA Guideline 1048 Ed.1 LED Technologies and their use in Signal Lights December 2005 rev2	IALA Secretariat	WG1
Guideline	1049	IALA Guideline 1049 Ed.2 Modern Light Sources in Traditional Optics December 2007 rev1	IALA Secretariat	WG1
		Transition to Wave Power Generators in Japan	Yoku Santo	WG2
Presentation	1.1	Welcome address German Federal Waterworks & Shipping Administration	Christian Forst	
Presentation	1.2	Address from host Head of Traffic Technologies Centre	Rainer Strenge	
	1.3	Welcome from IALA	Michael Card	
Presentation	1.4	Safety briefing and admin briefing	Seamus Doyle Jörg Unterderweide	
Presentation	1.5	Workshop aims and objectives	Simon Millyard	
Presentation	2.1	Application of sustainable light sources in AtoN	Alwyn Williams	
Presentation	2.2	LED composite light signalling	Aivar Usk	
Presentation	3.1	Developments in battery technology	Dirk Kaisers	
Presentation	3.2	Short burst data communications	Kay Barber	
Presentation	3.3	Certification and developments in solar PV	Bruce Cross	
Presentation	3.4	Port Entry Lights – new developments	Bruce Holliday	
Presentation	4.1	Wave power generators	Yoku Santo	
Presentation	4.2	Wind generation – Different types, experiences & developments	Michel Cousquer	
Presentation	4.3	Energy management – the low energy AtoN (Where the watt went). Power for communications transmissions	Peter Dobson	
Presentation	4.4	Lifetime assessment of self-contained lanterns in the Mediterranean sea area	Joël Tourbot	
Presentation	5.1	Assessment and cost effectiveness of old solar panels	Julian Schüren	
Presentation	5.2	Climate change - changes in transmissivity and solar gain	Leif Arne Larsen	
Presentation	5.3	Vandalism innovation for battery boxes on lighted buoys	Sinar Selatan team, Malaysia	
Presentation	5.4	Experiences in different battery types	Paul Hudson	
Presentation	6.1	Hybrid power systems. Security of supply & peak loads	Jordan Lane-Beveridge	
Presentation	6.2	IALA Solar Model - demonstration	Jörg Unterderweide	
Presentation	6.3	LED thermal management	Malcolm Nicholson	

Paper Number		Title / Author (if required)	Source	WG
Presentation	6.4	Battery conditioning and power optimisation	Link Powell	
Presentation	7.1	Practical experiences of innovative applications, protection against vandalism & theft	Adam Hay	
Presentation	7.2	The Mariners viewpoint of AtoN technology in navigation	Philip Giertz	
Presentation	7.3	Fuel cell application and practical experience	Tom Chicken	
Presentation	7.4	Case study in large optics and mercury bearing replacement	Colin Day	

ANNEX F WORKSHOP OUTPUT DOCUMENTS

Number		Title / Author (if required)	Source	Action
SLP1-	15.1	Draft Guideline 1043 on Light Sources used in Visual AtoN rev1 Koblenz (incorporating Guideline 1048)	WG1	To ENG6
SLP1-	15.2	Draft Guideline 1049 on Modern Light Sources in Traditional Optics rev1 Koblenz	WG1	To ENG6
SLP1-	15.3	Draft IALA Guideline 1073 Ed.1 Conspicuity of AtoN Lights at Night June 2011 rev2 Koblenz	WG1	To ENG6
SLP1-	15.4	Draft IALA Guideline 1067-3 Ed.1 Electrical Energy Storage for AtoN 23-3-17 rev e Koblenz	WG2	To ENG6
SLP1-	15.5	Draft IALA Guideline 1067-2 Ed.1 Power Sources 23-3-17 rev b	WG2	To ENG6
SLP1-	15.6	IALA Guideline 1039 Ed.2 Designing Solar Power Systems for Aids to Navigation March 2017	WG2	To ENG6
SLP1-	15.7	IALA PV solar calculator 2017 03 23	WG2	To ENG6
SLP1-	16.1	IALA Workshop on Sustainable Light & Power for the Next Generation Report	Secretariat	To ENG6 To Council

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