PROCEEDINGS OF THE 20TH IALA CONFERENCE
30TH MAY – 2ND JUNE 2023
RIO DE JANEIRO, BRAZIL

VOLUME 5

4TH IALA HERITAGE SEMINAR
SESSIONS 202 – 206
27TH – 28TH MAY 2023

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International Association of Marine Aids to Navigation and Lighthouse Authorities
Association Internationale de Signalisation Maritime

FOREWORD

This volume is one of five volumes of conference proceedings, including the 4th IALA Heritage seminar proceedings, and contains abstracts, biographies and full papers, where these have been prepared and provided. We hope they enhance your conference experience and act as a useful reference source for future discussion and research in the Marine Aids to Navigation sector.

The volumes are compiled as follows:

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is session event 2.4 and the unique paper number is 153. Any sessions with numbers 1 to 16 formed the main auditorium programme, whilst sessions starting 101, 102 etc. formed the Speaker's Corner programme held

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concurrently. Papers, where submitted are included, otherwise the paper abstract only is included. These can be found by session number through the main table of contents or by their unique conference paper number via the index at the back of the document.

Tenga en cuenta que a lo largo de las deliberaciones, el título del documento está precedido por el número de evento de la sesión de la Conferencia y seguido por el número único del documento entre paréntesis, por ejemplo:

"Estudio de caso S2.4 – Inspección de AtoN flotante por dron (153)"

es el evento de sesión 2.4 y el número de papel único es 153. Las sesiones con los números 1 a 16 formaron el programa principal del auditorio, mientras que las sesiones que comenzaron 101, 103, etc. formó el programa Speaker's Corner celebrado simultáneamente. Los artículos, cuando se presentan, se incluyen, de lo contrario solo se incluye el resumen del artículo. Estos se pueden encontrar por número de sesión a través de la tabla de contenido principal o por su número de conferencia único a través del índice en la parte posterior del documentos

SESSION 202 – UNDERSTANDING HERITAGE VALUE

S202.1 UNESCO process for Cordouan Nomination (195)

Michael Cosquer, Cerema, Ports and Navigation Department Deputy Director, France
Solange Majourau, National referent for the promotion of maritime heritage at the French directorate for maritime affairs, fishing and aquaculture, France

ABSTRACT

The paradigm of the future marine environment is changing with the rise of the 4th industrial revolution. In response to this trend, the Ministry of Oceans and Fisheries of the Republic of Korea is promoting a strategy to make maritime and fisheries smart, strengthening overall capabilities such as MASS, smart ports, and smart maritime logistics. In this regard, smart AtoN, light intensity measurement technology using drones, customized virtual digital AtoN service technology, and AtoN monitoring system applied with S-200 are being developed in the field of AtoN in Korea. Smart AtoN is a study to collect, integrate, and analyze maritime information by combining technologies such as big data and AI, and to build a maritime traffic infrastructure that can provide new services to users.

Light intensity measurement technology using drones is a study that uses drones to measure the light intensity of medium and large light lanterns installed in lighthouses based on image processing technology to make the measurement process efficiency. The customized virtual digital AtoN service technology is a study that provides services such as digital navigation routes and dangerous areas made of virtual AtoN according to the operating conditions of each ships. The AtoN monitoring system applied to S-200 is a study to develop a system that can manage and search information on AtoN based on the S-200 specification being developed by IALA.

This paper introduces the future marine environment in which the AtoN technology being researched in Korea is applied.

(No paper submitted)

AUTHOR BIOGRAPHY

Michel Cousquer has been working for 19 years at Cerema which is the technical partner for the French Aids to Navigation authorities. As an electrical and electronics Engineer, he first had been involved in electrical and automation matters for AtoN. After 8 years as the head of the AtoN division, he has held in 2021 the position of Ports and navigation Department Deputy Director. He has been an EEP and then ENG committee member since 2006. Michel has also been the IALA ENG committee vice-chair since 2018.

Solange Majourau is a Doctor in civil engineering geology and senior engineer in State Public Works, she is the national referent for the promotion of maritime heritage at the French directorate for maritime affairs, fishing and aquaculture. Since 2012, Solange has also been responsible for maritime signaling and the enhancement of the heritage of lighthouses and beacons on the French South Atlantic seaboard. She is responsible for the authorization for temporary occupation of the lighthouse and rocky plateau of Cordouan entrusted by the State to the Syndicat Mixte de Développement Durable de l'Estuaire de la Gironde (SMIDDEST) intended to develop a management project, tourist promotion and animation of the Cordouan site.

Since 2016, solange has had the chance to participate in all the steps that have allowed the Cordouan lighthouse to be inscribed on the list of World Heritage Sites in 2021 for the year 2020.

S202.2 Salvador – a city centered around its lighthouse (196)

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ABSTRACT

This paper develops a brief history of the installation of the first lighthouse built by the Portuguese Administration in the Colony of Brazil in order to meet the safety of navigation in the main port of Portuguese America at the turn of the 17th and 18th centuries. It also intends to demonstrate that the loss of relevance of the fortification on which the lighthouse was built, the Fort of Santo Antônio da Barra, for its primary function of defense did not affect the operation of the lighthouse, which continued to receive periodic maintenance and improvements over the years.

KEYWORDS: Brazilian Colonial History – City of Salvador – Portuguese Colonial Administration – Santo Antonio da Barra Lighthouse

RESUMEN DEL ARTICULO

Este artículo desarrolla una breve historia de la instalación del primer faro construido por la Administración portuguesa en la Colonia de Brasil con el fin de satisfacer la seguridad de la navegación en el principal puerto de la América portuguesa entre los siglos XVII y XVIII. También pretende demostrar que la pérdida de relevancia de la fortificación sobre la que se construyó el faro, el Fuerte de Santo Antônio da Barra, por su función primordial de defensa, no afectó el funcionamiento del faro, que continuó recibiendo mantenimiento periódico y mejoras a lo largo de los años.

PALABRAS CLAVE: Historia Colonial Brasileña – Ciudad de Salvador – Administración Colonial Portuguesa – Faro Santo Antonio da Barra

RESUME DE L'ARTICLE

Cet article développe un bref historique de l'installation du premier phare construit par l'administration portugaise dans la colonie du Brésil afin de répondre à la sécurité de la navigation dans le principal port de l'Amérique portugaise au tournant des XVIIe et XVIIIe siècles. Il entend également démontrer que la perte de pertinence de la fortification sur laquelle le phare a été construit, le Fort de Santo Antônio da Barra, pour sa fonction première de défense n'a pas affecté le fonctionnement du phare, qui a continué à faire l'objet d'un entretien périodique et améliorations au fil des années.

MOTS CLÉS: Histoire coloniale brésilienne – Ville de Salvador – Administration coloniale portugaise – Phare de Santo Antonio da Barra

1 HISTORY

The City of Salvador, the seat of the General-Government of the State of Brazil for just over two centuries, faced a storm coming from the South on the evening of May 5, 1668. Built on elevated territory on the eastern bar of Todos-os-Santos Bay from the first occupation on Porto-da-Barra Beach, the city was the point where the commercial fleets converged that supported the exclusive circulation of goods between Portuguese America and the colonizing metropolis.

That afternoon, the Fleet of the Companhia Geral do Comércio do Brasil arrived in the city with about fifty merchant ships protected by large warships of that Company, whose flagship was the Galleon Santíssimo Sacramento. In an attempt to enter the Bay in the midst of the storm, the Galleon Sacramento collided with one of the various elevations of the Bank of Santo Antônio, drifting damaged to the Northeast until it capsized across the Red River, seven kilometers north of the city of Salvador and three kilometers from the coast. [MELLO-NETO, 1976, p. 8] In this shipwreck, in addition to the cargo and official correspondence coming from the mainland, more than 400 crew members and passengers lost their lives [Documentos Históricos (1663-

1677), v. 6, 1928, p. 92], in what was identified by the highest authority of the colonial administration at the time, the Governor-General of the State of Brazil Alexandre de Souza Freire, as “the most unfortunate success that Brazil has seen.”[Documentos Históricos (1663-1677), v. 6, 1928, p. 97]

Although the Bank of Santo Antônio, which extends, with varying depth, for about four nautical miles from North to South and one nautical mile from East to West, next to the bar of Todos-os-Santos Bay, [EDELWEISS, 1969, p. 4] in the words of the Governor Alexandre Freire was “so well known and known by all sailors” [Documentos Históricos (1663-1677), v. 6, 1928, p. 92], perhaps it was precisely the wreck of the Galleon Sacramento that was the best argument to demonstrate the need to install night signals on land to warn about that obstacle to safe transit to the port of Salvador. This is what the Bahian historian and bibliophile Frederico Edelweiss suggests in his study dedicated to the Santo Antônio da Barra Lighthouse published in 1969. [EDELWEISS, 1969, p. 4]

The lighthouse to alert sailors of the presence of the Bank of Santo Antônio was only installed thirty years after the wreck of the Galleon Sacramento. The chosen place was Ponta-do-Padrão, the geographical site that demarcates the eastern entrance to the Todos-os-Santos Bay, where a Portuguese expedition would have left a landmark in 1501 and, decades later, one of the first forts of the city of Salvador. At the end of the 16th century, the construction of a simple fortification began on that same site to defend the port of the city of Salvador, which had been established at Porto-da-Barra Beach in 1549 with the arrival of the first Governor-General of the State of Brazil.

The oldest document about the Fort, which was dedicated to Saint Anthony dates from May 1598, when the King of Portugal granted, by charter of May 21, “the captaincy of the fort named Santo Antonio, which is built on the edge of that city” the Bastion of Brito Correa. [Charter of May 21, 1598] However, the fort built of stone and lime in the form of an octagonal tower (or hexagonal, as some specialists point out[1]) kept its small dimensions and sparse armament (no longer four guns) until the major reconstruction initiated in the last decade of the 17th century.[OLIVEIRA, 2008, p. 62-67] It is precisely this reconstruction that interests us to define the origin of the Santo Antônio da Barra Lighthouse.

The efforts to rebuild and expand the Fort of Santo Antônio da Barra were due to the new governor-general of the State of Brazil, d. João de Lencastre, who arrived in Salvador on May 22, 1694 with royal orders to increase the defensive system of the city that hosted the colonial administration. However, the diligent administrator went against the royal orders that determined the construction of new fortifications. The new Governor preferred to rebuild and expand the existing forts, especially the one built in Ponta-do-Padrão.

In August 1694, he commissioned the military engineer José Pais Esteves to carry out the expansion project proposed in 1687 by another military engineer based in Brazil, João Coutinho. The hiring of the master mason André Francisco for the works, through a public auction, only took place in April 1696, although the earthworks on the land had already begun. [OTT, 1959, p. 143]

Right at the beginning of this reconstruction, the construction of a lighthouse was planned over the Fort. This would be the first lighthouse built by the Portuguese State in Brazil, as pointed out by Captain Ney Dantas, a Brazilian Navy officer specialized in Hydrography and, possibly, the greatest researcher in the history of Brazilian nautical signaling. [DANTAS, 2000, p. 213-224] The reform of the fortification system that protected the port of the headquarters of the Portuguese colonial administration in America, was increased with the construction of the first permanent structure to serve as a lighthouse, which would make night navigation in the Todos-os-Santos Bay much safer.

The Governor-General communicated to the Crown the beginning of the construction of the tower with a square section over the Fort of Santo Antônio da Barra by letter of June 23, 1697. The King of Portugal himself, d. Pedro II (1667-1706), replied the Governor in the letter of December 10 of the same year, thanking d. João

1 Archaeologist and Professor of Ethnology Carlos Ott (Karl Borromaeus Ott) describes the original fort as “hexagonal in shape, measuring 10 meters in length on each side.” [OTT, 1959, p. 140]

de Lencastre for his zealous concern with the defense and safety of navigation in the capital of the Colony. On November 22 of the same year, 1,500 pieces of glass and 48 pounds of lead caulking arrived from Lisbon for the assembly of a metallic structure to protect the lighthouse's light apparatus, consisting of oil lamps.

Although the complete renovation of the Fort of Santo Antônio was only completed in the first half of 1702, in the last year of d. João de Lencastre, there are reports that the lighthouse was already in operation years before. On March 23, 1699, the English explorer and corsair William Dampier recorded in his diary the signaling lights of the lighthouse at Fort of Santo Antônio da Barra during his approach to the Brazilian coast north of the city of Salvador:

It has the convenience of a good harbour that is capable of receiving ships of the greatest burden: the entrance of which is guarded with a strong fort standing without the harbour, called St. Antonio: a sight of which I have given as it appeared to us the afternoon before we came in; and its lights (which they hang out purposely for ships) we saw the same night. [DAMPIER, 1729, p. 48]

When Dampier was in Bahia, the lighthouse tower was already up, but the metal structure that would protect the light apparatus had not yet received the glass requested by the Governor-General. Probably several of the 1,500 pieces of glass arrived in Bahia broken and useless after the long crossing of the Atlantic Ocean. Even so, the lanterns on the tower were lit at the end of the afternoon and provided the expected help to the navigators. In a letter dated January 11, 1701, the King of Portugal informed the Chief Provider about sending more glass for the lighthouse. This time the glasses came mounted on metal frames and with their lead caulks, a method of transport that increased protection against the weather of the transatlantic trip. [Letter from d. Pedro II, King of Portugal, to Francisco Lamberto, Chief Provider. Apud: DANTAS, 2000. p. 216]

Since the end of the reconstruction of the Fort of Santo Antônio da Barra, in 1702, the lighthouse functioned regularly, receiving periodic maintenance, as informed by the royal ordinance of September 28, 1735, which determined the maintenance of the tower by the Chief Provider. [Documentos Históricos (1734-1736), v. 76, 1947, p. 200] In 1753, the glazed structure that protected the light apparatus was repaired. Six years later, plans for the Fort, designed by engineer José Antônio Caldas, showed that the lighthouse's square-section tower was still in good condition. [OTT, 1959, p. 148]

In 1763, the headquarter of the colonial administration was transferred to the city of Rio de Janeiro, motivated by the expansion of gold exploration in the captaincy of Minas Gerais. The city of Rio de Janeiro became the main port for shipping these precious goods to Portugal, as it was closer than Salvador to the gold and diamond mines explored in the interior of the Colony. Thus, the fortification system that defended the port of Salvador fell into decay, with the forts, including Santo Antônio da Barra, receiving fewer soldiers and cannons. However, the lighthouse continued to receive care from the colonial administration, as the movement of merchant ships in that port was still high.

The lighthouse appeared on the plan of the Fort of Santo Antônio da Barra made by the professor of greek Luís dos Santos Vilhena between 1798 and 1799. Vilhena, an intellectual born in the Colony, portrayed all the fortresses, forts and artillery batteries of Salvador, as well as several other social and economic aspects of that city and the captaincy of Bahia in a series of letters later published. In the caption of his drawing, Vilhena describes that on the quadrangular tower in the center of the Fort, there was the “bronze lighthouse with glass panes to certify the vessels that come to the harbor at night.” [Caption to fig. 2, Letter VI. VILHENA, 1969] After a century of the beginning of its operation, the lighthouse had not suffered significant changes in its shape and was still operating to aid navigation in the Todos-os-Santos Bay.

It was only in 1836, with Brazil already independent from Portugal for more than ten years, that the cornerstone of a new lighthouse was placed in the Fort of Santo Antônio. The square tower built between 1696 and 1699, by order of d. João de Lencastre, the 31st Governor-General of the State of Brazil, would be replaced by a 22-meter-high tower. The new truncated conical pyramid-shaped tower was designed by English engineer Henry Palmer Phillips. The new lighthouse was inaugurated on December 2, 1839, on the 14th birthday of the young Emperor of Brazil, d. Pedro II, with a new catoptric light apparatus with a range of 18 nautical miles. [DANTAS, 2000, p. 219-220]

Sitting on the old Fort that had its first walls erected in the 16th century, this “new” 183-year-old lighthouse received, in 2020, the title of Heritage Lighthouse of the Year from the International Association of Marine Aids to Navigation and Lighthouse Authorities and it is one of the greatest symbols of the relevance for the national culture of the preservation of the centenary nautical signaling structures that safeguard navigation on the Brazilian coast.

Santo Antônio da Barra, which was for the population of the city of Salvador in colonial times the name of the Fort that protected that city, today is, for Brazilians and for you who fight for the preservation of lighthouses, the name of the oldest lighthouse in Brazil.

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AUTHOR BIOGRAPHY

In 1998, Commander Lopes-da-Silva graduated in History at the State University of Rio de Janeiro (Universidade do Estado do Rio de Janeiro - UERJ), completing a master's degree in Social History at the Federal University of Rio de Janeiro (Universidade Federal do Rio de Janeiro - UFRJ) in 2012. He obtained the degree of specialist in Brazilian Military History at the University Federal of the State of Rio de Janeiro (Universidade Federal do Estado do Rio de Janeiro - UNI-RIO). He is an emeritus member of the Institute of Geography and

Military History of Brazil (Instituto de Geografia e História Militar do Brasil – IGHMB) and member of the Laboratory of Military Studies in Politics (LEMP-UFRJ). Since December 2000, he has been a researcher for the Directorate of Historical Heritage and Documentation of the Brazilian Navy (Diretoria do Patrimônio Histórico e Documentação da Marinha – DPHDM). He published several articles in journals specializing in Military History and Maritime History. Currently, he serves as head of the Department of History at DPHDM and is the Editor of the specialized magazine "Navigator: Subsídios para a História Marítima do Brasil" (https://www.portaldeperiodicos.marinha.mil.br/index.php/navigator).

S202.3 Embracing history and the future, the rebirth of the National Lighthouse Museum (192)

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ABSTRACT

This paper examines the exhibition and directing media following the reorganization of the National Lighthouse Museum of Korea. Through this case, our museum to share the exhibition direction and development direction of Aids to navigation (A to N) heritage museum. 1)Exhibition Space: after September 1. 2021, the National Lighthouse Museum of Korea newly completes construction a building (3,864 ㎡). The new building mainly consists of the permanent exhibition Hall, the special exhibition Hall, and the Lighthouse Science Hall. Cultural spaces such as the archive Hall, cafe and event hall are located. In addition, The existing exhibition hall has been transformed into an educational space including. 2)Exhibition Contents: Today's Lighthouses have become navigation aids and cultural heritages embracing memories of the past.

In particular, that attracts visitors as a maritime cultural space where various interesting performances and exhibitions are held. Lighthouse becomes closer to us. 3)Exhibition directing technique: First, The national Lighthouse museum's permanent exhibition oftells a story of the sea's traffic lights and people that lit up the brilliant light on the path behind history. Especially, media art demonstrates how effectively the advancement of technology can convey the beauty of the sea and Lighthouse to the visitors. Second, utilize participatory experiential media and experiences fairy tales, These help From Hands-on to Minds-on. Our museum communicates with visitors, such as virtual reality, high-definition image mapping technology, interactive media and storytelling.

KEYWORDS: National Lighthouse Museum, exhibition, media art, museum visitor, A to N, Heritage

1 INTRODUCTION

In February 7, 1985, the National Lighthouse Museum was opened in Homigot, Pohang, established by the Ministry of Oceans and Fisheries of Korea to collect, manage, preserve, investigate, research, exhibit, and educate on navigation aids and maritime and marine traffic under Article 44(2)Preservation and Management of Aids to Navigation- of the 「Aid to Navigation Act」 for the development of marine culture, maritime arts, and sciences, as well as to promote cultural enjoyment for the general public. It aims to preserve navigation aids and equipment permanently, promote the importance of navigation safety for the ocean, and spread the love for the sea and its spirit.

Due to the disappearing significance of A to N for maritime safety in modern industries, a major expansion project was launched from 2019 to December 2021 to construct a new exhibition hall, and the museum successfully reopened as the world's largest lighthouse museum on July 1, 2022. By reflecting the new exhibition trends and remodeling the existing artifact hall into an education center, it contributes to the leisure activities and cultural enjoyment of the people and establishes a foundation for transforming into an international exhibition space for the world's heritage and related industrial legacy through the collection of maritime and industrial heritage.

This paper aims to introduce the reopened museum and examine how to improve the unsatisfactory aspects of the existing exhibition to enhance visitor satisfaction, focusing on ① space and layout issues, visitor flow ② exhibition contents and staging methods ③ exhibition operation types.

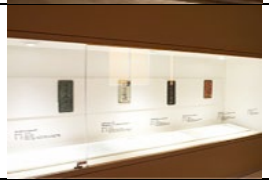
2 CHANGES AND REBIRTH OF THE NATIONAL LIGHTHOUSE MUSEUM

2.1 Survey and Analysis of Existing Permanent Exhibitions_LIghthouse Heritage Hall

The Artifact Museum is located on the basement level and two above-ground levels with a floor area of 1,857m^2. It was completed in May 2001 and consists of a storehouse, a permanent exhibition hall, and an information resource room and the exhibition was remodeled in 2013. After remodeling, The permanent exhibition is spread across the first and second floors with a total area of 1,129.85 ㎡, with the first floor covering 632.12 ㎡ and the second floor covering 497.73 ㎡.

The exhibition configuration is shown in the table 1.

Table 1. Composition of the existing permanent exhibition hall (Pohang Regional Office of Oceans and Fisheries. (2018) (National Lighthouse Museum expansion feasibility study and basic plan establishment. p. 124)

Type of Hall	Exhibition Status	Exhibition Content
Aids to Navigation History Hall		Introduction of the origin and historical development of lighthouses, including the world's first lighthouse, the Pharos lighthouse, and other major domestic and international famous lighthouses, through dioramas, photographs, 3D videos, and more.
Aids to Navigation Relics Hall		Comprised of visual, sound, radio AtoN equipment, and showcases related artifacts(Types of K-AtoN), information, and functions through the collection of artifacts and illustrated panels.
Lighthouse Keepers Hall		Introduces the lifestyle of Lighthouse keepers from the past to present day, including employment, salary, and duties through various materials and diorama models utilizing digital holograms.
Lighthouse Archive Hall		Introduces the changes in AtoN in Korea through various materials such as government bulletins, maps, and annual reports related to the history of Lighthouses.

At the National Lighthouse Museum, the core exhibition space displays a total of 274 artifacts. Despite the space being long and narrow, the artifacts are intensively arranged using wall partitions and column panels to secure space. Additionally, the route from the second floor to the first floor is concise, allowing visitors to view exhibits by historical vaiue theme.

However, the high exhibition density per area, including large lanterns, leads to repetitive displays of artifacts and panels, and the lack of interesting exhibition techniques can make the viewing experience simple and dull. Furthermore, the visitor route is structured as a u-turn to the right from the entrance, with exhibition spaces on either side, which can cause visitors to miss exhibits on the left side of the entrance. Additionally, the structure of having exhibition spaces exposed on both sides from the entrance can visually perceive the exhibition space and exhibits without even entering, lowering the anticipation and ultimately reducing the visitor's dwell time.

It is undoubtedly difficult to allow visitors to enjoy and view all the exhibition artifacts and content in a museum. However, according to Ady Milman's research, an increase in activity time is related to the realism of the place, where visitors' perception becomes more realistic as they spend more time exploring the details.

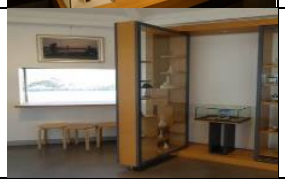
(Nak-Hyun,Jung. (2017). A Study on the spacial Construction Factors by Positional Meaning for Continuous Experiences in the Museum. P.3. Reused)

Although various actual artifacts related to navigational signs are displayed, the lack of attraction due to the aging of exhibition content and facilities, the absence of experiential content, the repetition of most large-volume fixed displays (showcases, wall displays), and the high exhibition density compared to the space area, result in a lack of exhibit explanations, a simple viewing method leading to boredom, overlapping visitor routes, and difficulty in providing a comfortable viewing environment due to the absence of idle spaces and a shortage of rest areas where visitors can sit and relax. (Korea Institute of Aids to Navigation. (2020.11.).National Lighthouse Museum Expansion Exhibition Content Planning Service. p.18.) The problems with outdated videos and dioramas that fail to capture the visitors' attention also require improvement. However, as the architectural structure cannot be changed, it is determined that the space can no longer be used as an exhibition space and should be converted into an educational room and a playground for children.

2.2 Survey and Analysis of Existing Permanent Exhibitions_Lighthouse History Hall

As the oldest building when the National Lighthouse Museum was first established in 1985, the building has two floors with a total floor area of 345㎡. In 2018, it underwent remodeling, with the first floor (286.45㎡) displaying the history of the lighthouse and the second floor being used as a resting area and observation deck. However, it is scheduled to be converted into a lighthouse office through the Homigot Lighthouse Improvement Project in 2024. The exhibition configuration is shown in the table 2.

Table 2 Composition of History Museum ((Pohang Regional Office of Oceans and Fisheries. (2018). p. 126)

Type of Hall	Exhibition Status	Exhibition Content
The Beginning of Voyage		Introduction to the development process of sea routes and civilization, from ancient navigation to the age of great voyages.
History of Lighthouse		Introduction to the development and changes inthe technology of lighthouses from ancient times to the present, including South Korea's lighthouses and major lighthouses around the world.
Construction of Lighthouse		Three-dimensional representation of the diversity and structural characteristics of lighthouse architecture by showcasing panels, lighthouse models, and slide vision.
Lighthouseria		The resting space featuring domestic and international lighthouse models, craftwork made of lighthouses (music boxes, bookmarks, etc.), and a view of the scenery of Homigot Sea.

One of the major issues with the current exhibition is that the artifact hall and the history hall are located in different buildings, causing inconvenience in viewing the exhibition and a lack of natural linkage. Additionally, the exhibition's explanatory displays, such as panels and videos, and the simple display of lighthouse-related craftwork reduce the interest of visitors. (Korea Institute of Aids to Navigation. (2020.11.).p. 19).

3 NEW LEAP OF THE NATIONAL LIGHTHOUSE MUSEUM

3.1 Development of Exhibition Improvement Plans and Direction of Presentation

Until the 20th century, the traditional image of a museum was characterized by values such as knowledge, authority, relics, and preservation. However, in the era of post-modernism, influenced by social changes and environmental factors such as global culture, multiculturalism, knowledge-based societies, and the digital age, the paradigm of museums is undergoing fundamental changes. (bo-Kyung,Goo.(2012).Changes in Museum Visit in Digital Environment.p.3.)

Therefore, museum exhibitions require continuous improvement of their environment and contents, with the cycle of improvement projects becoming shorter and shorter, ranging from 10 years to 7 years, and 5 years.

The exhibition environment refers to everything related to the exhibition facilities, display shelves, viewing areas surrounding the exhibition items, equipment, and tools. Ultimately, the exhibition facilities are designed to enhance the visual efficiency and protect the environment of the exhibition items (Pohang Regional Office of Oceans and Fisheries). (2018.1.). p.112.). An exhibition environment that is suitable for the exhibition theme is a direct condition that increases the immersion and interest of the visitors. Therefore, the space and flow should be designed with the visitors at the center.

Also Storytelling in museum exhibitions applies various techniques to show the story behind the artifacts, the space that showcases them, and the methods used to express the stories. (Yeon-hee, Kim.(2011). A study on the Structure of Museum Exhibition by Applying Storytelling Method. p.124). To move away from the traditional display of artifacts and shift towards storytelling, the focus is on the historical background of the artifacts, hidden stories, and relationships with other artifacts. To showcase the story, interactive media, mapping, signal-responsive videos, and various media arts are utilized. Additionally, interactive and experiential exhibits are placed throughout the exhibition area to increase visitor participation and extend their stay. However, to use these presentation media, the traditional self-guided tour is discarded, and the exhibition is designed to be dynamic and engaging, with exhibition guides stationed at each experiential exhibit. The museum aims to utilize the lighthouse as a representative navigational aid and a learning facility for maritime safety. However, understanding the exhibition artifacts is crucial, so a separate archive room is provided for visitors to search for displayed artifacts and read books related to lighthouses. Also, considering the target audience for the museum, a play area for infants and toddlers is included to prevent families with young children from feeling excluded. Sufficient rest areas, cafes, and nursing rooms are also provided to complement visitor convenience.

A museum exhibition plan is needed to make the lighthouse and its maritime cultural heritage more accessible to the general public, beyond its original function as an artificial structure for maritime safety. (Pohang Regional Office of Oceans and Fisheries. (2018.1.). p. 109). The exhibition improvement points are as shown in the table 3.

Table 3 The improvement ponts for the new exhibition

Category	Contents
Space Planning and Arrangement	- Assign names to each building by usage - Optimize the flow of visitors
Exhibition Contents	-Set direction for storytelling exhibition focusing on the emotions, history, and lighthouse keepers of the lighthouse - Promote interactive experiential exhibitions on the scientific principles applied to the lighthouse - Utilize interactive media art for information delivery
Exhibition Operation	- Set up a photo zone - Have exhibition guides stationed to assist with the operation of media art and interactive exhibits

3.2 Permanent Exhibition Space Configuration and Storyline

The exhibition hall was completed in 2021 and has a total floor area of 3,864 ㎡, spanning from the basement first floor to the second floor. The permanent exhibition space includes the 1st permanent exhibition room "Lighthouse of Time" with an area of 884.5 ㎡, the 2nd permanent exhibition room "Lighthouse and Science" with an area of 383.3 ㎡, and an archive room with an area of 47.4 ㎡, among others.

The focus of the permanent exhibition is to integrate the emotions and science of the lighthouse, convey the value of lighthouse ocean culture, and transform the lighthouse into an experiential museum that is easy to understand. It showcases the emotional aspects of the lighthouse, such as the "light" from sunset to sunrise and the "night sea" that becomes dark after the sun sets, as well as the light and sea that serve as a guide for ships, drawing visitors into the story.

In the first instance to increase the comfort of visitors, it was necessary to lower the exhibition density, so a cube-shaped sculpture representing the killer content of the museum was placed in the lobby.

And the permanent exhibition of the museum is divided into two rooms, and the 1st floor's 1st exhibition room, "Lighthouse of Time," progresses with a story in four themes, including the history and types of navigational aids, stories of lighthouse keepers, and lighthouses that have become cultural heritage. In the navigational aids history zone, an 18-meter large circle video displays the development of lighting and ships over time with an animation, and artifacts and related stories are richly arranged. In the AtoN type zone, a 12-meter large interactive video explains the shapes, lights, sound, and radio Aids to navigation. The lighthouse keeper corner presents emotional exhibitions through the belongings of lighthouse keepers and oral videos. Finally, in the lighthouse that has become a cultural heritage zone, there is a live sketch corner where visitors can touch the video screen with their own drawings displayed.

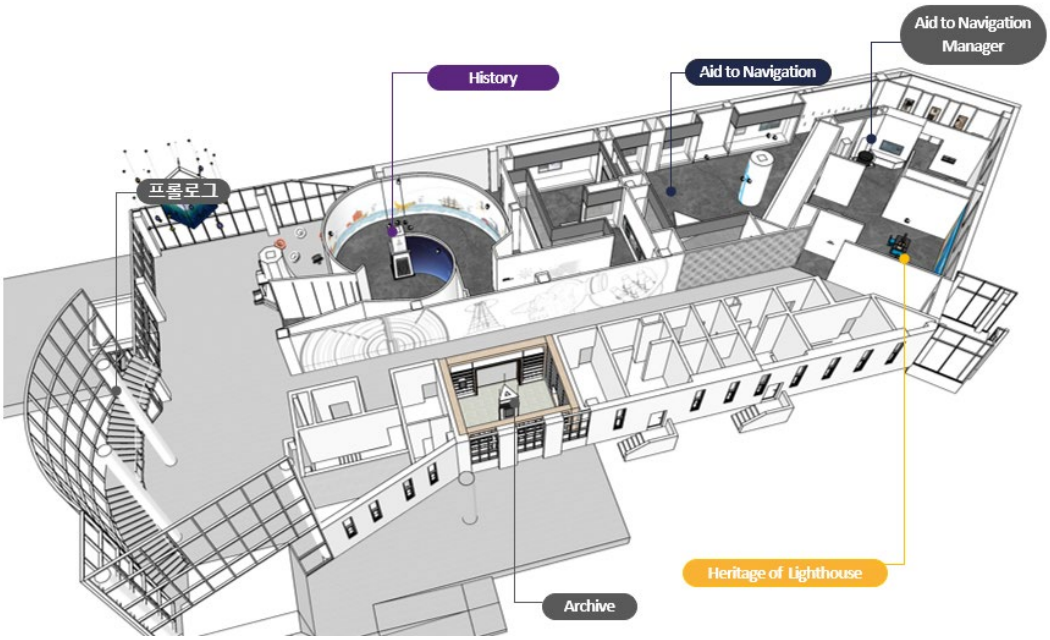


Figure 1: 1st Permanent Exhibition Room "Lighthouse of Time" Floor Plan

The 2nd permanent exhibition room on the 2nd floor, "Lighthouse and Science," is an experiential exhibition space targeting elementary school students and families. To showcase the sea outside the window, operational exhibits were installed without controlling the lighting. The space is designed to explain and experience the principles of the lighthouse by characterizing the five villages of Lighthouse Nation (LIght, Sound, radio Ais navigation, Energy, Navigation village) and fairies living in each village.

Figure 2: 2nd Permanent Exhibition Room "Lighthouse and Science" Floor Plan

3.3 Media Art that Communicates with Visitors

The representative interactive video of the permanent exhibition, "Promise of Meeting," induces visitor participation by having specific reactions occur on the sea route markers and lines when the wall is touched, displaying explanatory text. The floor's sea mapping video reacts to the visitors' movements, transmitting effects such as sound or light. The system that communicates with visitors provides opportunities for active participation and selectively acquires experiential information according to the users' needs. The content is rich, and visitors can approach the exhibition through personal experiences. However, the cost of hardware is high, and the rapid development of technology shortens the equipment replacement cycle, and there are criticisms that it focuses on experience over substance. Nevertheless, media technology is gaining attention as a new exhibition technique that overcomes these limitations and enables the display of the essence of the museum exhibition experience without interfering with the viewing of artifacts, and it is evident that media technology will continue to be integrated into exhibitions in the future.

Moreover, since setting up an environment to focus on exhibitions is essential, designing an environment that emphasizes media is necessary and positive effects based on interaction lead to visitor participation. The space that was designed to maximize aesthetic and sculptural beauty is being replaced by media-centered spaces.

4 CONCLUSION

The perception and scope of the functions and roles of museums are expanding in accordance with the social trends of global culture and the digital age. Our museum also attempted various approaches in this exhibition to perform various functions as a complex cultural space and to be more accessible to the public, rather than just sticking to the traditional function of exhibiting artifacts. To widely publicize the importance of sea route markers, the exhibition environment was improved, facilities were expanded, and the contents were arranged in an interesting way through storytelling. The experiential exhibits contributed to enriching visitors' experiences. Furthermore, using media art to maximize communication with visitors and the approach of exhibition guides actively involving visitors in the exhibition contributed to improving visitors' exhibition satisfaction.

In the future, the National Lighthouse Museum will continue to make efforts to improve exhibition planning and become a world-renowned specialized museum of Lighthouses.

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AUTHOR BIOGRAPHY

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S202.4 Fresnel – the lenses that changed the world of lighthouses (197)

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Jean-Marie Calbet, Phares de France, Treasurer, France

ABSTRACT

Augustin Fresnel (1788 - 1827) was a French physicist and engineer who made significant contributions to the field of optics, especially in the development of lenses and the theory of light. Despite the shortness of his life, the excellence and importance of his work were immediately recognized by his contemporaries. The invention of step lenses by Augustin Fresnel completely revolutionized the lighting of lighthouses.

Fresnel made important contributions to the understanding of the nature of light and the behaviour of waves. He was elected a member of the French Academy of Sciences in 1823, and was awarded the Rumford Medal in 1825 for his work on diffraction and polarization by the Royal Society of London.

Fresnel is best known for his invention of the Fresnel lens, which revolutionized the construction of lighthouses, making them much more efficient and effective, and since then there have been only improvements in details.

Fresnel's first step lens apparatus with a rotating system, an application of Augustin Fresnel's invention, was tested at the Cordouan Lighthouse July 25, 1823. A program of events is planned in France to celebrate the 200th anniversary, and to give a general public dimension to this event.

You are cordially invited to accompany in your country the events organized in France, to submit a video capsule to introduce the Fresnel lens of one of the lighthouses of your country, and to participate in the seminar. All useful information is included in the flyer which is available.

KEYWORDS: Fresnel – step lens –anniversary – 2023 events

RESUME DE L'ARTICLE

Augustin Fresnel (1788 - 1827) était un physicien et ingénieur français qui a apporté d'importantes contributions au domaine de l'optique, notamment dans le développement des lentilles et la théorie de la lumière. Malgré la brièveté de sa vie, l'excellence et l'importance de son œuvre furent immédiatement reconnues par ses contemporains. L'invention des lentilles à échelons par Augustin Fresnel a complètement révolutionné l'éclairage des phares.

Fresnel a apporté d'importantes contributions à la compréhension de la nature de la lumière et du comportement des ondes. Il a été élu membre de l'Académie française des sciences en 1823 et a reçu la médaille Rumford en 1825 pour ses travaux sur la diffraction et la polarisation par la Royal Society of London. Fresnel est surtout connu pour son invention de la lentille de Fresnel, qui a révolutionné la construction des phares, les rendant beaucoup plus efficaces et efficaces, et depuis lors, il n'y a eu que des améliorations de détails.

Le premier appareil à lentilles à échelons avec un système rotatif, application de l'invention d'Augustin Fresnel, a été testé au phare de Cordouan le 25 juillet 1823. Un programme de manifestations est prévu en France pour célébrer le 200e anniversaire de cet évènement, et lui donner une dimension grand public.

Vous êtes cordialement invités à accompagner dans votre pays les événements organisés en France, à soumettre une capsule vidéo pour présenter la lentille de Fresnel d'un des phares de votre pays, et à participer au séminaire. Toutes les informations utiles sont reprises dans la fiche d'information qui est disponible.

MOTS CLEFS : Fresnel – Lentilles à échelon – Anniversaire - Manifestations 2023

1 INTRODUCTION

Ladies and gentlemen, dear colleagues,

I am very honoured to have been invited to speak today, to inform you and answer your questions, if necessary, on the celebration of the 200th anniversary of the installation by Augustin Fresnel of the first step lenticular device at the Cordouan lighthouse, with a rotating system, July 25, 1823.

Augustin Fresnel, born May 10, 1788, in Broglie and died July 14, 1827, in Ville d'Avray, was a French physicist and engineer who made significant contributions to the field of optics, especially in the development of lenses and the theory of light. The invention of step lenses by Augustin Fresnel completely revolutionized the lighting of lighthouses, and since then there have been only improvements in details. He died at the age of 39. Despite the shortness of his life, the excellence and importance of his work were immediately recognized by his contemporaries.

2 DEVELOPMENT

Fresnel made important contributions to the understanding of the nature of light and the behaviour of waves. Fresnel's work in optics began in 1814, when he submitted a paper on diffraction to the Academy of Sciences in Paris. Based on the concepts put forward by Christian Huygens at the end of the seventeenth century, and by carrying out his own experiments, he independently found the observations made a few years earlier by Thomas Young on interferences and gave them the physical and mathematical foundations, who won the support of the physicists of his time. In this paper, he proposed a new theory of light, which treated it as a wave phenomenon rather than a particle one. This theory helped to explain various optical phenomena, such as the interference and diffraction of light, how light waves bend and spread out when they encounter an obstacle, and he also showed that light waves could be polarized, or made to vibrate in a specific direction, and developed a theory of double refraction in crystals. His research in optics led to the definitive acceptance of the wave theory of light in replacement of the corpuscular theory which had imposed itself since Newton.

He was elected a member of the French Academy of Sciences in 1823, and was awarded the Rumford Medal in 1825 for his work on diffraction and polarization by the Royal Society of London. Humphrey Loyd, professor of physics at Trinity College, Dublin, considered Fresnel's wave theory to be "...the noblest invention that has ever graced the field of physical science, with the single exception of Newton's System of the Universe."

In 1822, Fresnel was commissioned by the French government to improve the country's lighthouses. He designed the Fresnel lens, which was a complex system of concentric prisms that allowed lighthouses to produce a much more focused and powerful beam of light. The lens was quickly adopted by lighthouse builders around the world and became a standard component of many lighthouses.

Fresnel died in 1827 at the age of 39 from tuberculosis, but his legacy in the field of optics continues to this day. Fresnel's work on optics was highly influential in his own time and continues to have a profound impact on modern physics and engineering. The Fresnel lens is still used in many applications, including traffic lights, airport runways, and large-scale projection systems.

Fresnel is best known for his invention of the Fresnel lens, a type of lens that is made up of several thin, concentric rings that together form a large, flat surface, which revolutionized the construction of lighthouses and made them much more efficient and effective. This design allowed for a much larger surface area and a shorter focal length than traditional lenses, making it ideal for use in lighthouses and other applications where a powerful, concentrated beam of light is needed.

Fresnel's first step lens apparatus with a rotating system, an application of Augustin-Jean Fresnel's invention, was tested in Cordouan in July 1823. It took him three years almost day after day to go from the idea stage to the final realization.

The optics he established that day consisted of a central octagonal drum fitted with eight stepped lenses of 0.90 cm focal distance. At the bottom of the set, he installs crowns of metallic mirrors responsible for reflecting the extreme rays towards the sea. At the top, he places eight small stepped lenses which take up the upper

rays to reflect them on mirrors directed towards the horizon. The glass optic is held by a metal frame arranged around an axis of rotation. In the centre of the optics, there is another important innovation: a lighthouse lamp equipped with 5 wicks. Finally, to prevent the heat from destroying the welds, he pumps out excess vegetable oil using a small clockwork mechanism invented by Bertrand Guillaume Carcel in 1800.

The device was stored in Bordeaux for the winter, then reassembled at the Cordouan lighthouse under the supervision of Fresnel, partly by his own hands-on July 25, 1823.

This first "Fresnel lens" is currently visible at the Lighthouses and Beacons Museum, on the island of Ushant (Finistère, France).

The Phares de France association, with the support of the French State (DGAMPA) and of IALA, has decided to celebrate the 200th anniversary of the lens experimentation at the Cordouan lighthouse by Augustin Fresnel on July 25, 1823, and to give a general public dimension to this event.

Initially, three lighthouses (Cordouan, Grave and La Coubre) will celebrate this anniversary, then they would be relayed to the four corners of the world playing on all registers: Fresnel, UNESCO, lighthouses, lenses, local, regional, national, international, demonstration on the Cordouan site, simultaneous lighting of lighthouses in a form to be defined, exhibition panels, etc. We wish to highlight the lighthouses of the French maritime facades and share this event at the international level because it is obvious that beyond French territory, lighthouses from other horizons would gladly join us in Europe, the United States, in Asia, etc. : a whole network of headlights agrees, everywhere the world!

The program of events planned in France in 2023 is as follows:

- A conference at the Marine Academy, March 29, 2023, "Fresnel, the Academies and the invention of modern lighthouses", by Vincent Guigueno
- An exhibition on the Fresnel brothers, presented as a temporary exhibition at the School Library at Polytechnique (Palaiseau), then as a temporary exhibition at the National Archives
- Events and exhibitions in lighthouses affiliated with "Phares de France", throughout the season, on the theme of the Fresnel lens.
- A series of 5 webinars. The first on May 16, 2023, “Augustin Fresnel, his main contributions”, by Professor Pierre Lena and Alain Aspect. The second on June 20, 2023, on "Light sources", by Pierre-Yves Blanchard of CEREMA. The third, July 25, 2023, on "The Fresnel lens - from reflection to refraction", by Vincent Guigueno. The fourth, August 22, 2023, on "The use of Fresnel's work and the lens in our daily life", by Patrick Palus. And the fifth, on September 19, 2023, on “Glass” by Didier Roux from Saint Gobain.
- The fourth seminar on lighthouses heritage, organized on May 28 & 29, 2023, at the opening of the 20th IALA Conference, in Rio de Janeiro, during which this presentation on Fresnel is delivered.
- The "IALA DAY", July 1, 2023.
- Of course, on July 25, 2023, the celebration of the bicentenary of the installation by Augustin Fresnel of the first step lenticular Fresnel device with a rotating system, in Cordouan
- French Heritage Days, September 16 and 17, 2023
- The meeting of the IALA Engineering Committee, ENG17, from October 16 to 20, 2023 at IALA headquarters, with in particular the work of sub-group 4 "Heritage Forum"
- And finally, the technical seminar at Verdon-sur-Mer, on October 23 and 24, 2023, with visits to the Cordouan lighthouse in particular on October 23 and 25, 2023.

The seminar closes the events organized in France around the bicentenary, celebrated on July 25, 2023 with the network of lighthouses at the national and international level to get in tune with the International Lighthouse Day of IALA and Lighthouse Week in early July offered by Phares de France. Each country is invited to submit a short video capsule to introduce one lighthouse lens, the most in relation with Fresnel celebration being presented during the closure of the events, on Tuesday 24 October 2023.

The seminar is scheduled in October, just after the ENG17 meeting of the IALA Technical Commission "Engineering, sustainable development of aids to navigation", at IALA headquarters in St Germain-en-Laye, from October 16 to 20, 2023 , which will also host the meetings of “Working Group No. 4, Heritage Forum”. Participants in ENG17 could thus easily extend their stay in France to take part in the seminar.

The weekend of Saturday 21 and Sunday 22 October 2023 will be organized visits, receptions, events on the sites of four lighthouses (Cordouan, Grave, Hourtin, and La Coubre) taking advantage of the possibility of ensuring more easily the actions and accommodation by scheduling them outside the peak summer tourist season.

3 CONCLUSION

You are cordially invited to accompany the events organized in France in your country, to submit a video capsule to introduce the Fresnel lens of one of the lighthouses of your country, and to participate in the seminar. All useful information is included in the flyer which is available.

Thank you very much for your attention.

AUTHOR BIOGRAPHY

Mr. Jacques Manchard was born in 1949 in France. He obtained his degree in Public Works from the French State in 1974, was promoted to Chief Engineer of Public Works from the State in 2011 and claimed his retirement rights in 2012. As head of the French Lighthouses and Beacons office, he has been from 1998 to 2011 the representative of France at the International Association of Marine Aids to Navigation and Lighthouse Authorities Council. From 2012 to 2022, as a consultant, he has been IALA Senior Adviser (part-time), in charge of the implementation of the IALA Global Academy's strategy for capacity building and training in Africa. He is a member of the “Phares de France” Association.

Mr. Jean-Marie Calbet was born in 1951 in France. He obtained his degree in Public Works from the French State in 1976 at the same time as a degree in law and economics of international maritime transport. He was promoted to Chief Engineer of State Public Works in 2005 and claimed his retirement rights in 2011. Within the International Association of Marine Aids to Navigation and Lighthouses Authorities, he sat as a member of the Engineering committee from 1983 to 1994, then as vice-president of this committee from 1994 to 1996. He then created the advisory committee for the preservation of historic lighthouses, which he chaired until 1998. He then left the field of lighthouses and beacons professionally to devote himself to that of Civil Aviation. He is an honorary member of IALA, president of the Cordouan and Grave Lighthouses Association, of the Richard Lighthouse Municipal Association and treasurer of the Lighthouses of France Association. Mr. Calbet is dedicated to showcasing the lighthouses of his region, and especially the Cordouan lighthouse, to which he is very attached. His association manages the Cordouan lighthouse and Lighthouses and Beacons Museum installed in the premises of the Grave lighthouse, which is one of the Cordouan's promotional tools.

SESSION 203 – UNDERSTANDING HERITAGE VALUE (CONTINUED)

S203.1 Not just a tower – the ancillary structure that tell the lighthouse story (198)

Thomas Arculus, Trinity House, UK
Peter Hill, Trinity House, UK

ABSTRACT

When we think of lighthouses, many of us will straight away think of towers - in all their designs. Perhaps a beautiful square-plan tower such as is displayed at this year's terrific IALA Heritage Lighthouse of the Year – Cap Spartel Lighthouse in Morocco. Or perhaps a more classic round tower such as at the equally wonderful Santo Antônio da Barra Lighthouse in Brazil. Or perhaps one of the myriad of other shapes that they come in. But almost certainly a tower. Yet, in and around our lighthouse towers may be all sorts of other associated structures – some still in use for their original purpose, some re-assigned or redundant, others partially demolished or abandoned to decay. In the Trinity House estate such structures include mysterious pathways and steps seemingly leading nowhere, the puzzling remains of unusual redundant outbuildings and a cacophony of other mysterious structures.

Through these ancillary structures, a fuller and richer tale may be told of lighthouse heritage and culture. Insights into changing technologies, requirements and construction methods. And of the long-lost lifestyles of lighthouse keepers and their families – as well as the support teams behind them. This presentation examine some of those ancillary structures and draws out some of the stories that they have to tell. The examples are English and Welsh lighthouse sites, but every nation will have their own ancillary lighthouse structures that tell their own tale. Through this presentation, participants are encouraged to celebrate their own wonderful (but often overlooked) structures and to arrive at a fuller appreciation of their value – that they may be understood, conserved, and recorded for the benefit of future generations.

(No paper submitted)

AUTHOR BIOGRAPHY

Thomas Arculus is the Head of Legal and Risk at Trinity House, the General Lighthouse Authority for England and Wales. Thomas is a member of the Royal Institution of Chartered Surveyors and has worked for Trinity House since 2007. He has knowledge and experience of the range of historic properties across Trinity House's estate. He is also a member of the IALA Legal Advisory Panel.

Peter Hill has been Estate Manager to Trinity House in the UK since 2015 and is a chartered member of the Royal Town Planning Institute. With a previous professional background assessing applications for new development and for alterations to protected heritage buildings, the heritage aspect of lighthouses inevitably drew his interest. Since 2019, Peter has been Chair of Working Group Four (Heritage & Culture) of IALA's Engineering Committee.

S203.2 Lighthouse Heritage Strategy, Assessments and Management Plans (199)

Greg Hansen, Australian Maritime Safety Authority, 82 Northbourne Avenue, Canberra, Australia
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ABSTRACT

This paper examines how Australian Maritime Safety Authority (AMSA) manages Heritage assets from strategy through to major maintenance works. Using practical examples, the author will examine how major maintenance works are taken from concept to completion and the approval processes required along that path.

KEYWORDS: Heritage, aids to navigation, projects, heritage strategy, heritage plans.

1 INTRODUCTION

The Australian Maritime Safety Authority manages approximately 480 aids to navigation across some 360 locations, guiding mariners around Australia's 34,000 kilometres of coastline and through sensitive areas such as the Great Barrier Reef.

AMSA has 62 sites of heritage significance, listed on either Commonwealth, State or Local registers, 25 sites included on the Commonwealth Heritage list, 16 heritage sites open for tourist operation.

AMSA has developed a detailed process for the management of heritage assets, this includes a heritage strategy, individual heritage management plans, and has implemented specific maintenance and refurbishment programs. The maintenance and refurbishment programs are aimed at the removal of hazardous materials, maintaining safe access, while keeping heritage assets in good order.

AMSA's organisational planning cycle and associated budgeting process is used to allocate funding and manage delivery of maintenance activities at heritage places.

We provide coastal marine aids to the navigation network which includes heritage assets to the commercial shipping industry. The cost of operating and maintaining this system is recovered with the marine navigation levy (MNL). The levy is a charge against commercial shipping used to recover the cost of operating and maintaining marine aids to navigation systems.

Commercial shipping, where the vessel is longer than 24 metres, is required to pay the MNL. Commercial shipping is where a vessel earns revenue by transporting cargo or paying passengers. The amount to pay is calculated according to the net tonnage of the vessel.

2 HERITAGE STRATEGY

The Australian Maritime Safety Authority (AMSA) is the Commonwealth agency responsible for coastal aids to navigation (AtoN). This AtoN network includes a number of heritage lighthouses which continue to operate as critical aids for mariners at sea. Legislation requires AMSA to prepare a written heritage strategy for managing the places to protect and conserve their Commonwealth Heritage values. Rather than just compliance with a legislative requirement, AMSA has focused on ensuring documentation and strategies are both useful and can easily be applied operationally. A copy must be provided to the Australian Heritage Council and the Minister for the Environment for endorsement.

The Heritage Strategy is intended to guide AMSA in the management of the sites of cultural and natural heritage value for which it is responsible. The Strategy has served to demonstrate to the AMSA Board that our legislated, corporate, and social responsibilities are being managed well, and have been directing funding wisely to ensure an efficient operational AtoN network in line with levy payers' expectations.

Heritage Strategies must be reviewed every 3 years, and an Update Report must be submitted to the Minister for the Environment. AMSA's heritage strategy was last updated in 2022 and will be due for review in 2025.
A copy of the AMSA Heritage Strategy is readily available on AMSA's website and can be found in the link below.
https://www.amsa.gov.au/amsa-heritage-strategy-2022-2025

3 HERITAGE MANAGEMENT PLANS

Heritage Management Plans (HMP's) are documents created to identify in detail the heritage values of a place and the conservation policies to be followed. The EPBC Act requires AMSA to prepare and publish HMPs for all sites listed on the Commonwealth Heritage List, and these plans must be reviewed every 5 years.

The HMP's generally follow a sequence from description to analysis of operational requirements, to implementation, and comprise of the following sections.

- Executive summary
- Introduction
- Site details
- History
- Fabric
- Heritage significance
- Opportunities and constraints
- Conservation management principals and policies
- Policy implementation schedule
- Appendices

AMSA has currently completed 12 HMP's, with a further 13 currently being drafted.

AMSA has ensured that the intent of the HMP's have been upheld, while focusing on tangible, achievable and practical management principals. The Plans have had lots of positive impacts, they have assured the wide spectrum of stakeholders have been consulted from traditional owners (Aboriginal and Torres Strait people), passionate lighthouse conservationists, government departments and local communities. This has been an important step in bringing together all historical information of the sites in a readable format.

A copy of the AMSA heritage management plans can be found in the link below.
https://www.amsa.gov.au/safety-navigation/navigation-systems#collapseArea638

4 MAINTENANCE AND REFURBISHMENT PROGRAMS

Apart from regular repairs and maintenance which is outsourced, AMSA has developed several specific repair and maintenance programs relating to the heritage assets.

1. First being the installation of LED technology into traditional optics. Where AMSA has completed 29 sites, 17 rotating and 12 flashing optics.

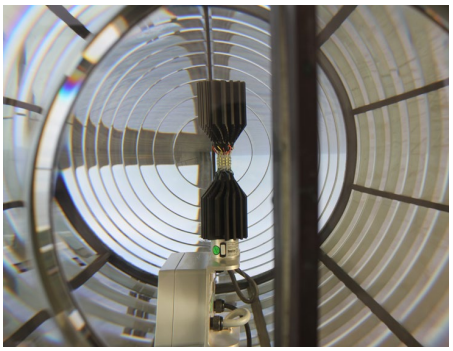


Figure 1: LED light installed in traditional optics

2. The second being major refurbishment of heritage structures. Where AMSA has completed 21 of 62 sites.

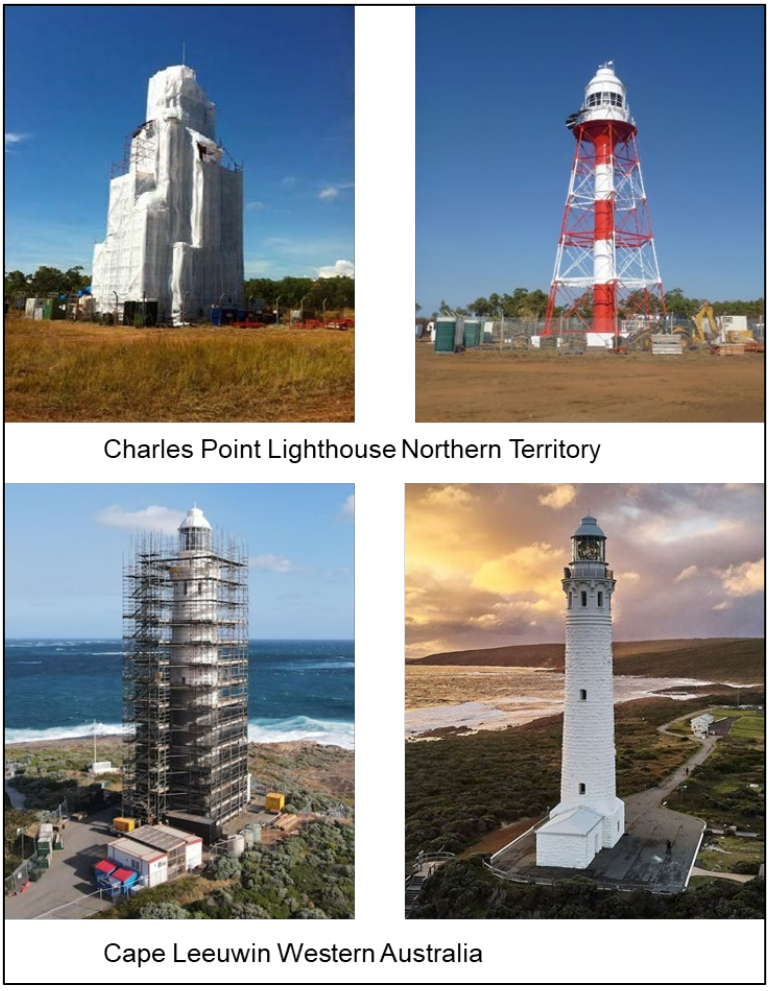


Figure 2: Examples of lighthouse refurbishments before and after

From concept to completion AMSA is required to carefully scope these projects to ensure the correct balance between preservation, removal of hazardous materials and durability are achieved. At times AMSA has needed to demonstrate to heritage departments that enhanced durability can be a better outcome for the asset.

Over many years AMSA has developed a detailed protective coatings specification, this includes coatings and treatments to some of the unique substrates a heritage asset may include.

This can also involve development of a heritage impact statement which is used to seek government department approvals. The heritage management plan can be utilised as a reference in the approval; therefore it is important that the management plan isn't overly restrictive and practical.

AMSA currently spends half of its capital works budget on heritage assets.

4.1 Technical challenges - common issues

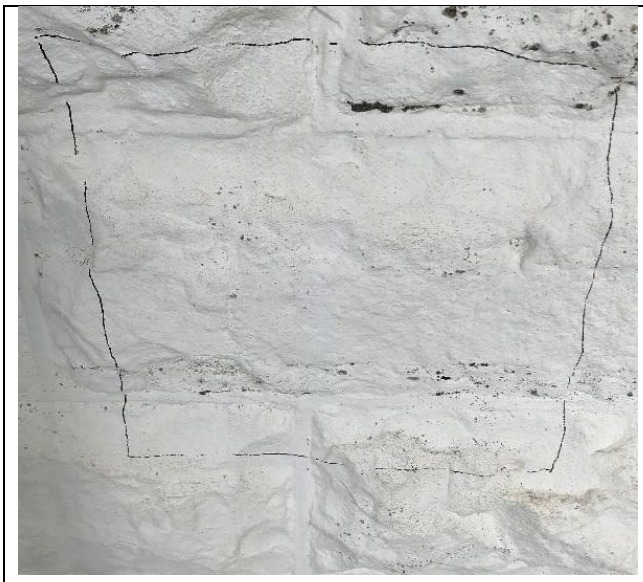
Many heritage lighthouse refurbishments have technical and unique challenges that need resolving. The common issues AMSA finds and implements solutions to are:

- Stone with retained moisture and salt
  - Issue – deterioration of the stone substrate and corrosion of steel components embedded within the stone.
  - Solution – ventilation, removal of internal coatings to stone to allow drying, steel works repairs and replacing steel components with stainless steel where suitable for heritage purposes.

	
Mould due to moist stone	Mould removed and external coatings replaced to prevent moisture ingress

Figure 3: Stone issues and rectifications

- Lead based paints and removal
  - Issue – Lead, remnants, health concerns
  - Solution – removal method trials to ensure they do not damage substrates, trials are generally undertaken to prove that minimal impact to the substrate, method utilised have included chemical stripper, abrasive blasting with various media, power tool, laser trialled but was not successful



Before trialling chemical stripper

After stripping and hot water wash

Figure 4: Paint removal to stone

- Asbestos
  - Issue – asbestos has been found all over lighthouses, sheeting's, sealants, putty, floor tiles, roofing
  - Solution – detailed hazardous materials surveys are required prior to any major works

Asbestos sealants

Asbestos dome sheet sealants

Figure 5: Asbestos examples

- Porosity in cast steel
  - Issue - traps moisture, grime, if not filled paint will not provide a protective layer, will enhance pin holes, and leads to premature corrosion and lower durability
  - Solution – use of epoxy filler is required to provide a uniform substrate prior to painting

Porosity in cast after blasting

Epoxy fillers used to fill holes prior to paint

Figure 6: Cast steel porosity and treatment

- Internal steel stairs and landings
  - Issue – corrosion of structural members can be hidden when embedded in stone / concrete walls which can impact on safety
  - Solution – replacement with stainless steel replicating original appearance, and exposing beam ends and relacing corroded with newly welded end sections

Imbedded beam corrosion

Beam repaired with end section replaced

Figure 7: Floor beam repairs

- Copper corrosion
  - Issue – normally associated with dissimilar metals where copper is in contact with cast iron
  - Solution – repaired by brazing or replacement of severely affected components

Copper corrosion on dome ventilator

Replacement ventilator

Figure 8: Copper corrosion

5 CONCLUSION

Heritage assets are culturally significant however it can be challenging to find the optimal balance between preservation, safety and durability.

AMSA's strategy is to eventually remove all lead-based paint and asbestos from the network, this comes at a large cost, removal of the paints requires specialist skills and at times remnants remain.

Major works can close a lighthouse down for 6-12 months and can be a challenge to local tourist operations and businesses, optimal time to paint for good durability is within the summer periods, this coincides with peak tourist season.

Heritage Lighthouses can be utilised as important operational AtoN structures, traditional optics still provide a reliable and feasible technical solution for AtoN lighting. Finding a feasible technical solution for 1st order rotating optics with mercury bath continues to be a challenge, IALA cooperation internationally is important to knowledge-share on this issue.

A practical approach has allowed AMSA to progress with maintenance and refurbishment programs by implementing a durable outcome and being sympathetic to heritage values and fabric. Once heritage structures were seen as a maintenance liability, this trend has now reversed with the adaption of modern maintenance applications and technologies.

AUTHOR BIOGRAPHY

Greg Hansen is Principal Advisor AtoN Engineering at Australian Maritime Safety Authority, and manages the asset management, engineering, and project delivery functions relating to AtoN and emergency response assets. Greg has 30 plus years' experience in the engineering sector primarily in the maritime field, covering areas such as marine aid to navigation, defence ordnance, ship construction / repair and renewable energy.

Greg holds a Bachelor Engineering specialising in Marine & Offshore Systems (which incorporates mechanical, electrical, systems, and civil engineering disciplines). And has achieved chartered engineering status in, Marine and Offshore Systems, and Marine Engineering.Greg has been working with AtoN for over 15 years, has been involved in the renewal of major maintenance services contracts, development of strategic asset management plans, heritage asset refurbishment programs, implementation of new technology, standardisation and building resilience of structural assets. Greg represents Australia at IALA Engineering and Sustainability Committee.

S203.3 The first plan of conservation of the historical and cultural heritage of Marine AtoN in Brazil (200)

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ABSTRACT

This study presents the initial stages to be observed for the implementation of a Plan for the Preservation of Historic Lighthouses in Brazil. Based on a survey of information on all existing lighthouses on the Brazilian coast, parameters were established for choosing the most outstanding lighthouses that will be proposed to be included in the Plan for the Preservation of Historic Lighthouses in Brazil.

From this preliminary survey based on the history of each lighthouse, considering lighthouses with at least one hundred years of existence, 21 lighthouses were selected that have characteristics that recommend their physical preservation and/or promotion, dissemination and preservation of the intangible heritage related to them. In conclusion, a proposal is presented for actions to be undertaken guarantee the minimum preservation and dissemination of the Heritage of these lighthouses, suggesting that specific surveys be continued for each of these lighthouses in the face of peculiarities and potentials in this regard inherent to each one.

KEYWORDS: Brazil; Aids to Navigation; Lighthouses; Heritage; Preservation

RESUMEN DEL ARTICULO

Este estudio presenta las etapas iniciales a ser observadas para la implementación de un Plan de Preservación de Faros Históricos en Brasil. A partir de un levantamiento de información sobre todos los faros existentes en el litoral brasileño, se establecieron parámetros para la elección de los faros más destacados que serán propuestos para ser incluidos en el Plan de Preservación de los Faros Históricos de Brasil.

A partir de este relevamiento preliminar basado en la historia de cada faro, considerando faros con al menos 100 años de existencia, se seleccionaron 21 faros que presentan características que recomiendan su conservación física y/o promoción, difusión y conservación del patrimonio inmaterial relacionado con ellos. Como conclusión, se presenta una propuesta de actuaciones a realizar para garantizar la mínima conservación y difusión del Patrimonio de estos faros, sugiriendo que se continúe con los estudios específicos para cada uno de estos faros ante las peculiaridades y potencialidades al respecto inherentes a ellos

PALABRAS CLAVE: Brasil; ayudas a la navegación; faros; Herencia; Preservación

RESUME DE L'ARTICLE

Cette étude présente les premières étapes à observer pour la mise en œuvre d'un Plan de Préservation des Phares Historiques au Brésil.Sur la base d'une enquête d'informations sur tous les phares existants sur la côte brésilienne, des paramètres ont été établis pour choisir les phares les plus remarquables qui seront proposés pour être inclus dans le Plan de préservation des phares historiques au Brésil.

De cette enquête préliminaire basée sur l'histoire de chaque phare, en considérant des phares ayant au moins 100 ans d'existence, 21 phares ont été sélectionnés qui présentent des caractéristiques qui recommandent leur préservation physique et/ou la promotion, la diffusion et la préservation du patrimoine immatériel qui leur est lié. En conclusion, il est présenté une proposition d'actions à entreprendre afin de garantir la préservation et la diffusion minimale du patrimoine de ces phares, suggérant que des enquêtes spécifiques soient poursuivies pour chacun de ces phares face aux particularités et potentialités en la matière inhérentes pour eux.

MOTS CLÉS : Brésil ; aides à la navigation ; phares ; Patrimoine; Préservation

1 LIGHTHOUSES

Lighthouses are just "piles of stones" topped with a light source, and their primary function is to serve as a reference to anyone navigating nearby and are therefore located at the water's edge.

Over time, to improve the efficiency and effectiveness of its primary function, improvements were added to its structure, with the use of more resistant and resilient materials to more severe environmental conditions, providing greater durability, as well as motivating them to be built in places of even more aggressive nature, in the middle of the ocean, for example.

Likewise, the architecture of the lighthouses adapted to these adverse conditions and also contributed, through their shapes and colours, in harmony with the environment, so that they became more visible during the day.

The luminous range was being increased as the technology for energy sources and their storage was being developed, as well as in the field of optics, with the use of mirrors, prisms and lenses. The development of these technologies provided a fantastic historical collection of equipment that was used in lighthouses.

In addition to these improvements in the field of architecture, the specific materials and equipment used to improve the efficiency and effectiveness of lighthouses, I would like to emphasize the development of a specific culture around the singular activity of keeping lighthouses in operation, in great often in places far from normal human contact.

I can say, without fear of making a mistake, that this peculiar culture enriched, even more, the already vast maritime culture, transforming the image of a lighthouse into an iconic and recognizable figure by most people. The silhouette of a lighthouse is a strong image of maritime culture, as much as the anchor or the rudder wheel.

Even more than that, the image of lighthouses has been associated with very subjective philosophical concepts in the popular imagination, symbolizing and associating directions and decisions to be taken with the idea of security, shelter, protection, even of a religious nature.

It is this unmistakable symbol, already rooted in society's imagination that can and should, in my opinion, be exploited to the maximum to simply represent what it is in fact associated with since its origin, the Navigation Aids, in spite of the fact that the vertiginous technological development applied to Navigation Aids that places it, in a synthetic vision, as extending “from the weight to the satellite”, passing through the fields of materials technology, optics, electronics, telecommunications, information and many other fields of human activity.

Lighthouses continue to be piles of stones, but they are also a powerful symbol, already ready and always recognized in a positive way, serving perfectly to be the maximum representation of our Navigation Aids in general. I do not remember anyone ever telling me that they didn't like lighthouses, even without knowing them, on the contrary, they are often used in logos of companies whose activity has no connection with Aids to Navigation.

It is about the preservation of this formidable potential for information and dissemination, composed of physical or non-physical elements that I want to address. It is certain that this stupendous heritage must be preserved and expanded in favour of future generations, but also, and mainly, in the present, to translate and symbolize the capital importance of the Aids to Navigation in general for the development of nations and the well-being of all humanity.

2 BRAZILIAN LIGHTHOUSES AND CHOICE PARAMETERS

There are more than two hundred lighthouses on the Brazilian coast, of which thirty-six were lit for the first time over a century ago, although some towers have since been replaced. Two of these lighthouses are bicentennial, and one is tricentennial and is the oldest in the Americas in operation, until records are found that prove otherwise. Ten of these lighthouses are located on oceanic islands and are not accessible to the public. The other lighthouses are located on the mainland, often in places that are difficult to access.

From this preliminary analysis, twenty-one lighthouses were selected, which have the characteristics shown in the Table 1 “Brazilian Heritage Lighthouses”, which were used for their choice, to serve as a test project for the 1st Plan of Conservation of the Historical and Cultural Heritage of Maritime AtoN in Brazil.

Table 1 Brazilian Heritage Lighthouses

Lighthouse	Lit	Access	Fresnel Lens	Structure
Santo Antônio da Barra	1698	Easy	1st Order	Cast-iron
Barra	1820	Medium	2nd Order	Masonry
Ilha Rasa (1)	1829	Difficult	Meso-Radial	Stonework/Masonry
Ilha da Moela (1)	1830	Difficult	1st Order	Masonry
Salinópolis	1852	Easy	2nd Order	Skeletal
Morro de São Paulo (1)	1855	Easy	3rd Order	Stonework
Itapuã da Lagoa	1860	Easy	--- (2)	Masonry
Abrolhos (1)	1861	Difficult	Meso-Radial	Cast-iron
Cabo Frio (1)	1861 (3)	Difficult	1st Order	Cast-iron
Santa Luzia	1871	Easy	4th Order	Cast-iron
Conchas (1)	1872	Medium	--- (2)	Cast-iron
Itapuã	1873	Easy	--- (2)	Cast-iron
Ilha do Arvoredo (1)	1877	Difficult	2nd Order	Cast-iron
São Tomé	1882	Easy	3rd Order	Skeletal
Bailique (1)	1890 (4)	Difficult	--- (2)	Skeletal
Santa Marta	1891	Easy	Hyper-Radial	Stonework
Ponta do Mel	1898	Medium	3rd Order	Cast-iron
Ponta do Boi (1)	1900	Difficult	3rd Order	Masonry
Castelhanos (1)	1901	Difficult	3rd Order	Masonry

Table 1 Brazilian Heritage Lighthouses

Lighthouse	Lit	Access	Fresnel Lens	Structure
Macaé (1)	1902	Difficult	4th Order	Masonry
Ilha da Paz (1)	1906	Difficult	4th Order	Stonework/Masonry

(1) Lighthouse in an island;
(2) The original Fresnel lens was replaced by a modern flashlight for operational reasons;
(3) The first tower opened in an unsuitable location in 1836;
(4) Only historical and strategic importance, several towers have already been replaced due to being in a very hostile environment (Using the concept of "intangible cultural heritage").

All the lighthouses listed above are in full operation, some of them serving as the basis for more modern Navigation Aid equipment, such as DGNSS, for example.

The age of the lighthouse was the primary parameter used to define the Heritage Lighthouses in the country, however, other parameters were also considered, with greater or lesser weight, such as:

- Location considering the possibility of public visitation (restricted or opened);
- Ease access for open public visitation;
- The overall state of preservation of its structure;
- Existence of original equipment remaining from the inauguration, with special attention to the lenticular apparatus and its rotation apparatus, if any;
- Importance of the lighthouse for navigation in the vicinity, especially for the time when it was installed;
- Whether or not the lighthouse is manned;
- Proximity to urban centres;
- Degree of security of personnel that allows public visitation;
- Existence of items that evoke cultural heritage related to the lighthouse, such as stamps, postcards, specific books, ... etc.;
- Existence of periodical cultural events that use the lighthouse or adjacent area;
- Positive perception of the local community (if any) about the lighthouse;
- Existence of artistic manifestations related to the lighthouse, such as songs, poetry, painting, making handmade models, ... etc.;
- Positive perception of the lighthouse with municipal authorities, if any;
- Architectural characteristics in the historical context and its harmonization with the environment in which it is located.

In Figure 1 "Heritage Lighthouses along the Brazilian coast", the lighthouses preliminarily chosen to be considered as Brazilian Heritage Lighthouses are located on the map of Brazil, in the "Amazônia Azul" space. It should be noted that the spatial distribution is not homogeneous and privileges the regions in which population concentration and commercial hubs became denser during the period of Colonial Brazil (lighthouses Santo Antônio da Barra in Bahia in 1698; and Barra in Rio Grande do Sul in 1820), and the Empire of Brazil (from 1822 to 1889, with the Rasa, Cabo Frio, and São Tomé lighthouses in Rio de Janeiro; Moela in São Paulo; Salinópolis in Pará; Morro de São Paulo, Abrolhos and Itapuã in Bahia; Itapuã da Lagoa in Rio Grande

do Sul; Santa Luzia in Espirito Santo; Conchas in Paraná; and Ilha do Arvoredo in Santa Catarina. The lighthouses Bailique, Santa Marta, Ponta do Mel, Ponta do Boi, Castelhanos, Macaé and Ilha da Paz was built on early republican period.

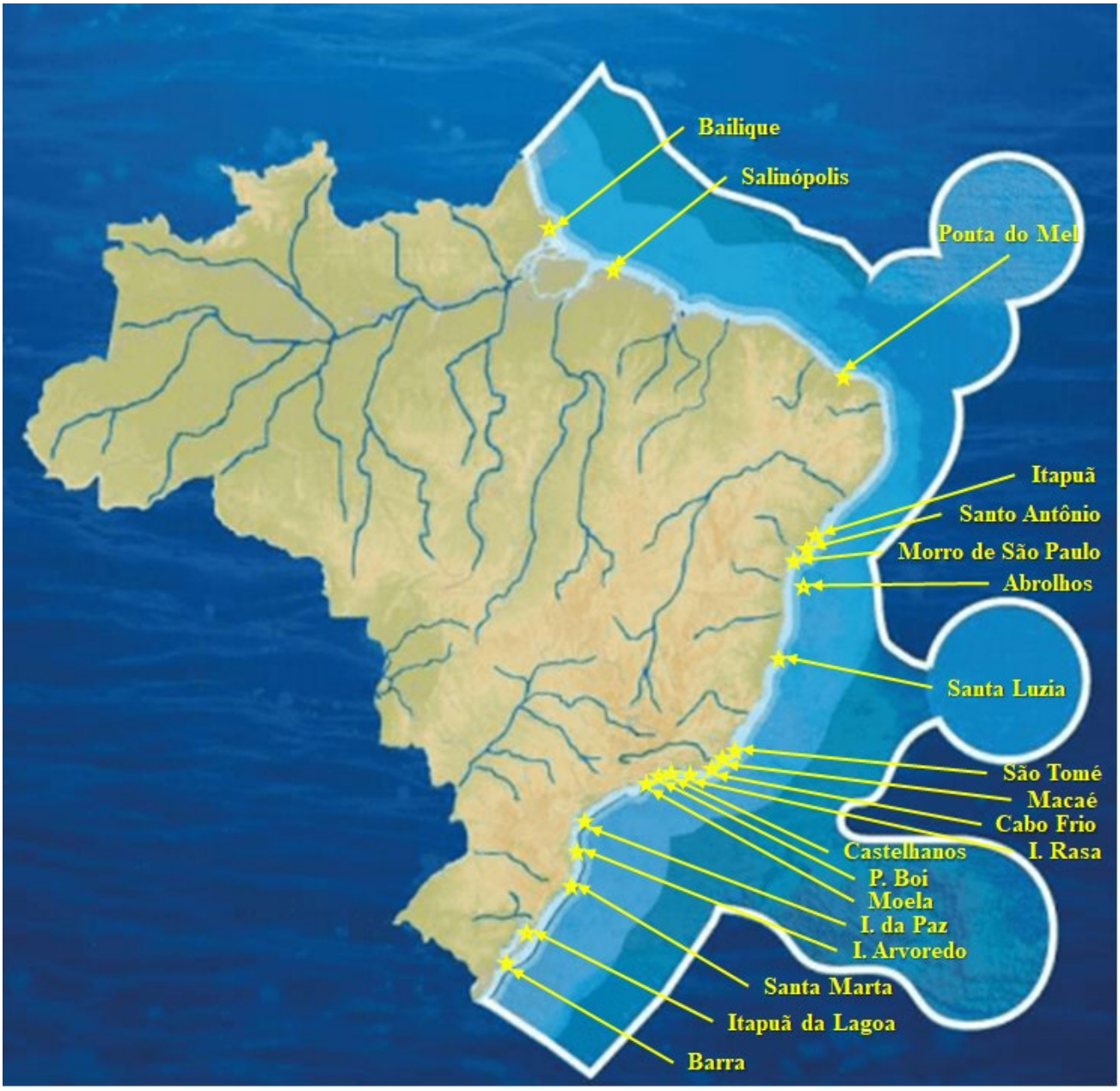


Figure 1: "Heritage Lighthouses along the Brazilian coast"

3 ACTIONS TO UNDERTAKE – SUGGESTIONS

In an environment where resources are scarce, and the priority for investment in historical preservation actions is low, it is imperative that a Plan of Conservation of the Historical and Cultural Heritage of Maritime AtoN be established in detail, and permanently updated to face opportunities that may arise, especially in raising extra funds through sponsorships.

However, despite this scenario of financial difficulty, it is worth noting that many actions do not depend, or depend little, on a high level of financial investment, being more linked to issues of awareness, especially of the personnel who operate and maintain the lighthouses , usually more attentive to the operational issues of

these Aids to Navigation. In the specific case of Brazil, in which the romantic figure of the Lighthouse Keeper linked to a lighthouse, in particular, was replaced by military lighthouse keepers who, due to career requirements, are not normally linked to a particular lighthouse, where they spend short periods, this issue is more relevant and needs to be mitigated by other means and initiatives.

Of the actions to be undertaken, there are many to list to improve the preservation of these symbols of Aids to Navigation:

- Identify, through rigorous inspection based on available historical records, the historical elements of each lighthouse that, while still in place, should be listed as an 'element to be preserved. Likewise, identify elements that have been removed and try to locate and restore them if appropriate, or forward it to a central location to be designated for dealing with these historical elements;
- Identify and report all actions that are necessary for the preservation of the structure and all equipment that require financial resources;
- Identify and relate elements of a cultural nature related to these lighthouses such as songs, poetry, paintings, stamps, postcards, books, newspaper and/or magazine articles, historical photographs, ... etc, existing since the inauguration of these lighthouses;
- Identify events that are held periodically or sporadically on the lighthouse premises or close to it, to link the lighthouse to these events, if this can bring some advantage to the task of putting the lighthouse in evidence with the local community, which can, including generate opportunities to attract sponsorships;
- Identify in the local community, if any, person(s) who have an affective relationship with the lighthouse and who may be willing to collaborate in the creation of publicity elements for the lighthouse in question, such as books and articles for the media, as well as free video documentaries;
- Develop an awareness program about the importance of preserving these lighthouses and their organic elements for the military personnel who operate and maintain these lighthouses;
- Always take advantage of the date of the lighthouse's anniversary to publicize commemorative articles in the media, identifying ephemeris, such as, for example, 100, 150, 200 years, ... that may give rise to the making of stamps, postcards, articles, documentaries and other promotional instruments that can serve as a historical record, preserving the memory of the lighthouse;
- Evaluate the possibility of the lighthouse being open to restricted or open public visitation, identifying the need to implement personal safety measures against accidents, such as safety nets.

4 CONCLUSION - PROPOSAL

Too many other solutions to create elements of preservation of Heritage Lighthouses can still be created, as for example the exhibition of photographs of Fresnel lenses inserted in the 20th IALA Conference.

The preservation of the structures and component elements of the Heritage Lighthouses is extremely desirable, there is no doubt about this, but in addition to the restriction of financial resources, the low priority, and even the omission or negligence in this matter, unfortunately, there is also the possibility of damage or even total destruction due to adverse natural conditions, such as the Bailique Lighthouse, the first built at the mouth of the Amazon River, in 1890, and which has already had to replace numerous towers, damaged by the force of nature in that region, and I am witness to this reality after serving for 5.5 years maintaining Aids to Navigation in that area. From the first Bailique Lighthouse, there is nothing left to physically preserve, the solution is to motivate the development of elements that can approach the concept of "intangible cultural

heritage", so that, with these elements, reach what in fact is the main objective which is to promote the importance of the entire structure of current and future Aids to Navigation.

Another proposal to made in the case of Brazil is to recreate a character that existed at the end of the Empire period, who was called Director of the Lighthouse, and was assigned to a Retired Navy Officers. At present, however, the Director of a given Heritage Lighthouse would have the sole and exclusive task of frequently inspecting "his" lighthouse, focusing on the issue of heritage preservation, proposing measures to meet this demand. It is necessary to point out, however, a basic difference between the Director of the Lighthouse of old and the Director of the Lighthouse to be recreated. This service would also be performed, in principle, and initially, by a Retired Navy Officer, who lives in the lighthouse region, but on a voluntary basis, without remuneration, without any charge to the Public Treasury.

AUTHOR BIOGRAPHY

Alberto Piovesana is graduate in Naval Sciences by the Brazilian Naval Academy and postgraduate in Hydrography Survey – Category "A" by the Directorate of Hydrography and Navigation. Doctorate degree in Naval Sciences by the Brazilian Naval War College. MBA on International Management by the Federal University of Rio de Janeiro. Performed operative duties aboard an Oceanographic Research Vessel for 7 years.

Commanded a Buoy Tender and was Head of an Aids to Navigation Regional Service responsible of the Aids to Navigation structure in the delta of Amazon River, for five and a half years. Commanded a Hydrographic Survey Vessel for one year. Executive Officer in a Clipper Sail Training Vessel for two years. Performed administrative duties for three and a half years, including as Head of the Centre for Aids to Navigation "Almirante Moraes Rego" (Lighthouse Authority), when was Member of IALA Council from 2001 to 2002.

Currently is Adviser of the Director of Hydrography and Navigation for IALA affairs and Adviser of the IALA Councillor representing Brazil since 2008. Participant in the IALA Heritage Forum since 2020.

SESSION 204 – MEETING MODERN REQUIREMENTS WHILE RETAINING HERITAGE VALUE

S204.1 Traditional revolving optic reengineered for continued operation without mercury (201)

Jørgen Royal Petersen, Danish Maritime Authority, Senior Engineer Aids ot Navigation Denmark
Jan Thorn, Danish Maritime Authority, Director, Safety of Navigation National Waters, Denmark

ABSTRACT

In 2008 The Danish Maritime Safety Administration (DaMSA), now Danish Maritime Authority (DMA) had thirteen (13) operational lighthouses with mercury bath system or technical devices including mercury. An increased focus from the working environmental authority in Denmark on use of mercury in general resulted in a plan for decommissioning mercury bath systems in Danish lighthouses.

The decision includes two technical solutions:

- Installation of a high intensity LED-flashing lantern and de-commissioning the genuine optic and technical supports
- Alternatively for listed and classified lighthouses a re-engineering solution implementing a mechanical bearing system into existing revolving system.

The chosen mechanical construction taking into account that Danish Agency for Culture permitting no changes of the original construction at listed and classified lighthouse. The final re-engineered solution implemented in four (4) lighthouses in Denmark and one (1) lighthouses in Faroe Island – all lighthouses belonging to Danish Maritime Authority. By presentation of excellent result, other countries adopted the mechanical system for decommissioning mercury bath systems including Sweden and Norway respectively having four (4) and nine (9) lighthouses converted. The concept of this mechanical solution shows a way to obsolete the use of mercury but continuing the functionality of the authentically revolving optic.

KEYWORDS: Working environment, Nature protection, Heritage and preservation, Preserve authentically functionality, Development of mechanical solution, Mercury free lighthouses

1 INTRODUCTION

In 2008 The Danish Maritime Safety Administration (DaMSA), now Danish Maritime Authority (DMA) had thirteen (13) operational lighthouses with mercury bath system or installed devices including mercury.

From 2001 to 2008, the Danish Working Environmental Authority (DWEA) increased focus in use of mercury in Denmark. Spillages of mercury at Nakkehoved lighthouse caused by an earthquake in Sweden in December 2008 tighten up the focus on use of mercury at Danish lighthouses. The environmental aspect and agreement between Danish Working Environmental Authority (DWEA) and DaMSA paved the way for decommissioning all mercury bath systems in Denmark by 2015.

A nautical analysis shows that 11 lighthouses of 13 should be operational but some with reduced light intensity and range.

High intensity LED-flashing lanterns with a range of approx. 18 NM range was in general chosen for retaining the light however at listed and historic lighthouses consideration should be taken for retaining the revolving optic.

In co-operation with the Danish Technical University (DTU), efforts for design and re-engineering took place on the revolving system at Nakkehoved Lighthouse (lighthouse museum and listed lighthouse). The major ambition for the project was to avoid significant change on the original construction and preserve the authentically expression of the unique installation at an operational lighthouse.

At the end of 2012, DaMSA presented a draft project approved by the Danish Agency for Culture. In January 2013, a specific detailed design project took place and the new mechanical system commissioned in second half of 2013.

Excellent results from the first re-engineered lighthouse resulted in successive efforts to decommissioning remaining three lighthouses in Denmark and one lighthouse at Faroe Island with historical and/or with local interest.

Today other countries have adopted the mechanical system for re-engineering mercury bath systems including Sweden and Norway respectively four (4) and nine (9) lighthouses.

2 INTRODUCTION TO THE MERCURY BATH SYSTEM

The old lighthouse optic was heavy and the weight of metal and glass rotating machinery can be up to five tons. Revolving Optic systems designed before 1889 had to turn on a roller carriage. The speed was slow and the flashes infrequent due to the friction in the system. See figure 1.

The low speed of the optic requires small narrow and ineffective optical panels to obtain a reasonably frequent repetition of the flash.

Figure 1: Revolving optic system with roller carriage – at right details from a roller carriage system.

In 1889, the French Lighthouse Service designed the Mercury Bath System. The first system was operational in 1892 and designed for large optics supported upon an iron floater floating in a circular mercury bath.

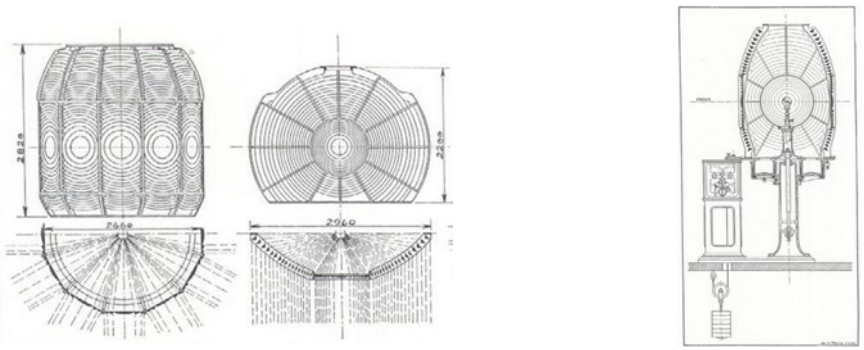


Figure 2: From left to right – optic for roller carriage – optic for mercury bath system – example of mercury bath system.

Major advantages of Mercury Bath System:

- Significant less friction compared to the roller carriage system
- The weight machine could be smaller and operate all the night on a few windings.
- Higher speed of the optic cause possibility enlarging the area of the lens and still obtain a reasonably frequent repetition of the flash. See figure 2.
- Greater area of the optic provides higher intensity with the same light source.

Several lighthouse services worldwide implemented a large number of these mercury bath systems and today many are still in operation.

Unfortunately, the mercury is a toxic fluid – spillage and evaporation from the mercury bath internal lighthouses affecting the working environment and nature.

Due to this, The Danish Working Environmental Authority (DWEA) and DaMSA agreed to decommission mercury bath systems in a period of five years.

DMA agreed to find a solution to preserve the functionality of the light by implementing systems or new technologies without mercury.

3 A FUTURE WITHOUT MERCURY

Some of the Danish lighthouses with mercury bath systems are listed or preserved lighthouses. The classification allows no re-construction or changes of building constructions and technical installations.

Thus, two solutions meet the nautical requirements for maintaining the light and taking in account heritage classification:

- For lighthouses without heritage classification and minor public interest high intensity LED flashing lanterns with a range of approx. 18 NM. (Mercury subsequently drained and the lens table locked in a suitable position. Float and bath cleaned) See figure 3.
- For heritage listed/preserved lighthouses a customised designed mechanical and reversible system for preserving the original revolving optic for remaining the authentically sweeping light. (Mercury subsequently drained. Float and bath cleaned). See figure 3.

Shown below at left a high intensity LED lantern (on stock) with an optical range of 18 NM and at right a customised mechanical solution for retaining the revolving optic without mercury.

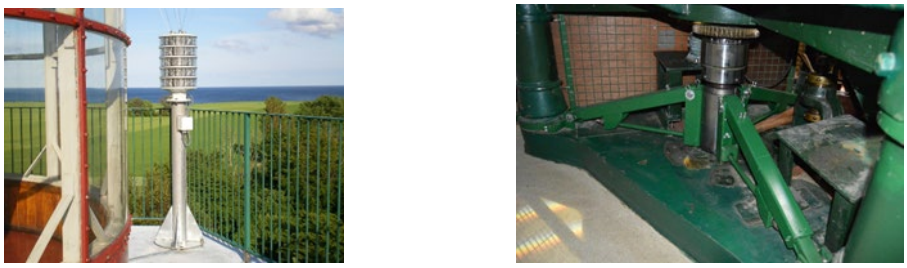


Figure 3: From left to right - high intensity LED flashing lanterns - customised mechanical and reversible system

4 DESIGN OF THE MECHANICAL SYSTEM

The design of the mechanical system includes following considerations:

- The design should completely maintain the existing functionality of the mercury bath system including level of friction and use of present gear drive.
- The design should be reversible, thus the genuine constructions elements most not be re-constructed or damaged.
- Assessment of the existing mechanical components in the mercury bath system e.g. strength of pillars, strength of main vertical shaft etc.
- Assessment of the strength of building construction elements e.g. consideration of the floor separation strength, wall strength etc.

4.1 Types of Mercury Bath System

The mercury bath system mainly produced in two different designs:

- Design with a centre shaft (French design)
- Design without centre shaft (British design)

The different designs illustrated on below sketches showing at left the construction with a centre shaft. The illustration explains the shaft with bearings (red) centring the float into the bath. A limitation/stop device in the lower end of the shaft aims to keep a correct horizontal floating position of the optic.

The right hand side shows the construction without a centre shaft. The illustration explains the centring of the float and aims to keep a correct horizontal floating position by rollers (red).

See illustration at figure 4.

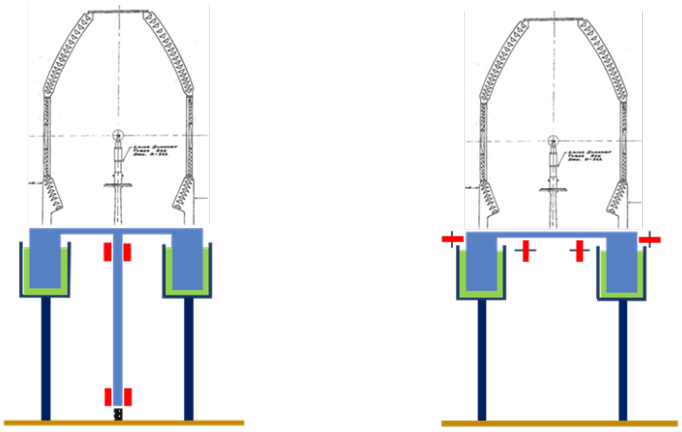


Figure 4: From left to right – mercury bath system with shaft – mercury bath system without shaft.

The shaft type is the most common in Denmark (four of five lighthouses re-engineered in Denmark have shaft type)

5 CASE STUDY ON THE RE-ENGINEERING PROJECT AT NAKKEHOVED LIGHTHOUSE

Figure 5: Nakkehoved Lighthouse, at left the building structure and at right the first-order catadioptric Fresnel lens.

The project at Nakkehoved lighthouse (see figure 5) is the initial re-engineering project in Denmark. Due to different construction and size of constructing elements differing between lighthouse-to-lighthouse customising design needs.

5.1 Technical specification:

- Established 1772 as a coal fired lighthouse – mercury bath system and optic installed 1898
- First-Order Catadioptric Fresnel Lens (focal distance 920 mm)
- Weight of optic and support approx. 5 Tons
- Fl(3)W.30s
- Optical range 20 NM

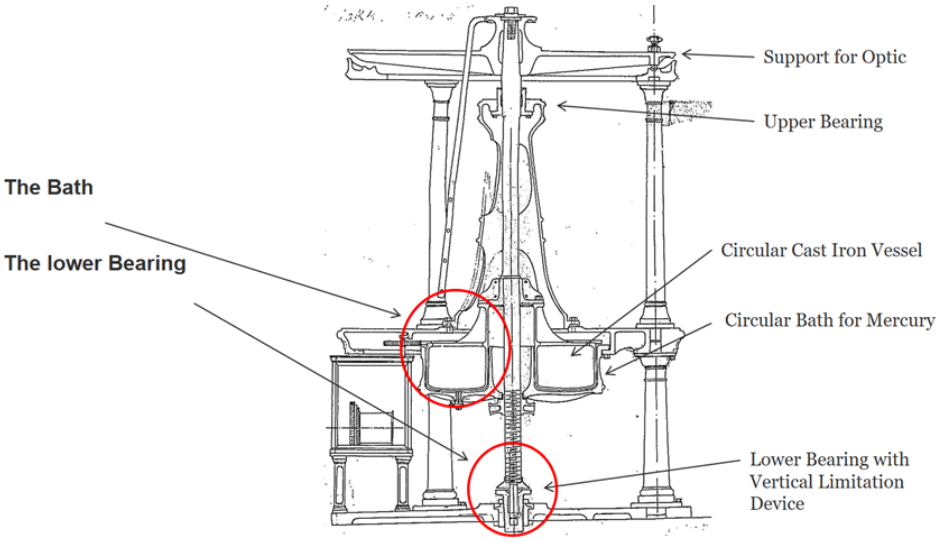


Figure 6: Original Mercury Bath System at Nakkehoved lighthouse

The drawing at figure 6 shows a cross section drawing of the original optic with mercury bath system at Nakkehoved Lighthouse.

The arrangement is a shaft type with a bath and float situated between an upper bearing, just below the support for the optic (lens table), and the lower bearing installed at the floor separation. Combined bearings centring the float to maintain a correct position in the circular bath. The clearance between the bath and the float is limited, thus a correct horizontal position is crucial for a smooth drive. To secure a correct vertical position of the shaft the lower bearing has a vertical limitation device which adjustment corresponding to a correct level of mercury in the bath.

5.2 Consideration and choice of solution

After a comprehensive investigation on the existing construction including assessment of the strength of the vertical shaft and the floor separation, the result concluded that following design and scheduled measures were appropriate for the re-engineering project:

- Replacing lower bearing arrangement by a standard spherical bearing acting as a combined radial and axial bearing supporting the total weight and side-wards movement of the vertical shaft.
- Installing adjustable supports between two existing beams below the floor separation for withstanding load from the vertical shaft (weight of optic, supports and shaft)
- Before initiation of the project carrying out relevant technical calculations to verify the durability of the combined construction and lifetime calculation.
- Initial trials with mercury still in the bath to evaluate for correct and smooth drive of the revolving system.

- After implementation and trials drainage of mercury from the bath followed up by a deeply cleaning of bath and float (cast iron with a porous surface).
- A deeply cleaning of all surfaces at the revolving system and all surfaces at the entire lantern room (wall and floor surfaces)
- Perform mercury concentration measurements for securing proper working environment for lighthouse staff/technicians and guest and visitors.

5.3 Construction details

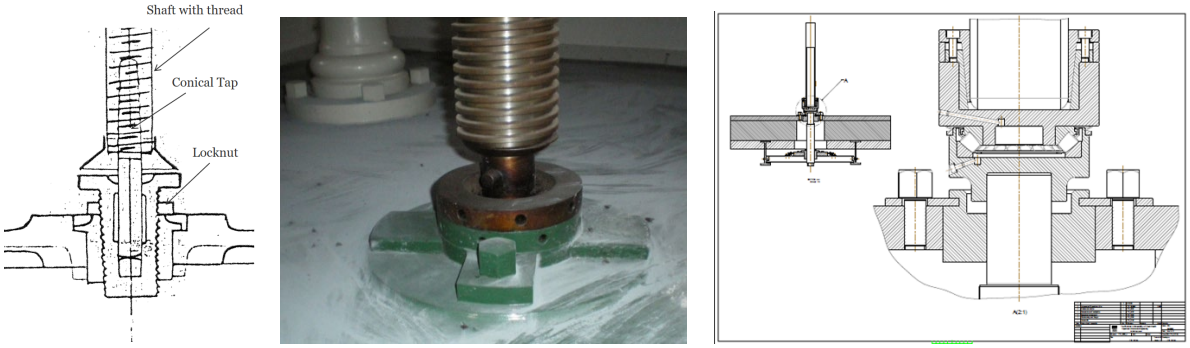


Figure 7: From left to right – cross section drawing – photo - drawing of the new mechanical bearing support.

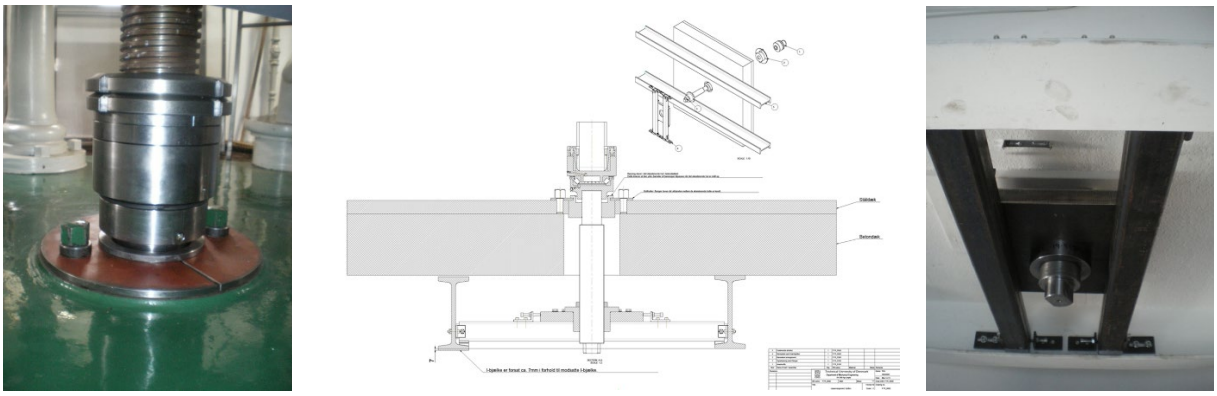


Figure 8: From left to right – new bearing attached on shaft end - adjustable support for new bearing cross section – photo of adjustable support below floor separation.

Figure 7 and 8 shows original and new construction elements implemented in Nakkehoved Lighthouse.

Figure 9 below shows two different types of systems developed – one type where the load from the shaft transferred to three/four pillars supporting the bath and one type for a bath system without shaft (drawing right hand).

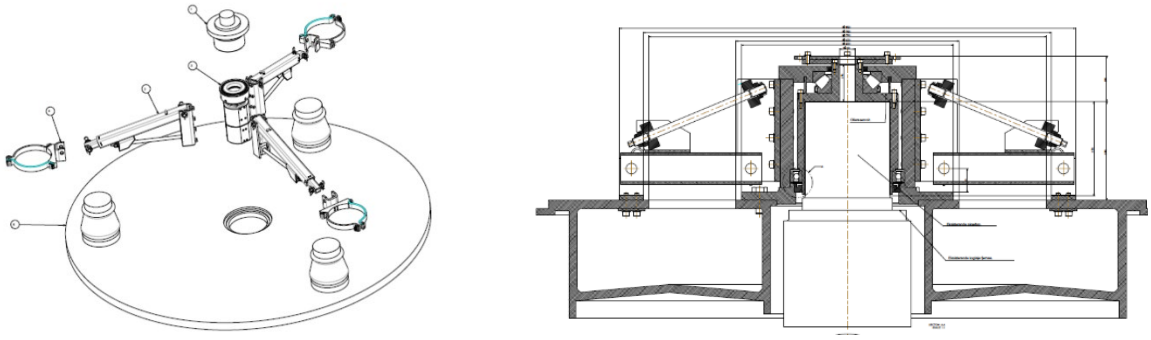
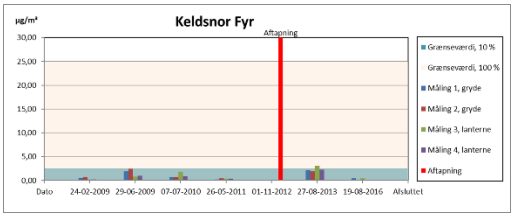


Figure 9: From left to right – mechanical arrangement for a three-pillar system - system without shaft.

6 CONTAMINATION BY MERCURY

Dato	Samlet vurdering af kviksølvforureningen i % i forhold til grænseværdien, der er 25 µg/m³ luft	Måling 1 µg/m³	Måling 2 µg/m³	Måling 3 µg/m³	Måling 4 µg/m³	Forureningsgrad %
20.01.09	Nakkehoved, 1. måling	210,00	200,00	240,00	220,00	960,00
06.02.09	Mon	0,28	0,27			1,12
11.02.09	Skagen	0,34	0,92	0,31	0,33	3,68
18.02.09	Blåvandshuk	0,20	0,15	0,20	0,34	1,36
18.02.09	Lyngvig	0,46	0,47	0,26	0,42	1,88
23.02.09	Gedser	0,36	0,34	0,38	0,31	1,52
24.02.09	Keldsnor	0,57	0,76	0,20	0,23	3,04
24.02.09	Fornæs, værdien kan ikke måles	< 0,1	< 0,1			0,00
03.03.09	Hammerodde	0,17	0,14			0,68
03.03.09	Svaneke	0,19	0,14	0,09		0,76
04.03.09	Rønnæs	2,60	2,50	0,18		10,40
05.03.09	Nakkehoved fyrmuseum, 1. måling	1,10	1,30	1,30	1,20	5,20
26.03.09	Nakkehoved efter rengøring, 2. måling	1,10	0,96	1,00	1,00	4,40
26.03.09	Nakkehoved museum d. 26/3	0,24				0,96
udestår	Myggenæs					
	Opdateret: d. 15/4-09					

Figure 10: Tabel shows different contamination levels and at right an arrangement for measurering mercury concentrations in air.



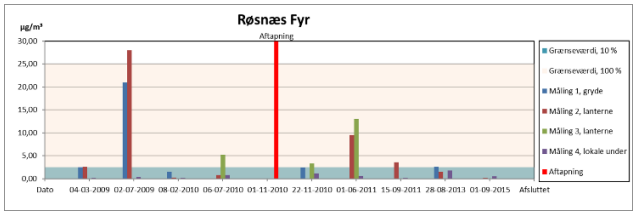


Figure 11: Mercury concentration overview

The contamination level of mercury in air should be considred during the re-engineering project. Danish experience shows that the contamination level can have an unacceptable level even before initiation of the project. See figure 10. Spillage over time has often polluted the lighthouse inviroment. The European accepted contamination level of mercury is 25 µg/m^3 – Danish Working Environmental Authority accepted only 2.5 µg/m3 at lighthouses. Above tabel shows measurements before re-engineering at Danish lighthouses. E.g. at Nakkehoved Lighthouse the level is nine times more than accepted level.

Measurements from Keldsnor Lighthouse and Røsnæs Lighthouse shows the timeline including level of contamination before drainage (red vertical line) and beyond drainage. A high level of contamination is shown at Røsnæs Lighthouse. Experience shows that some places intensitive and two-three times re-cleaning actions necessary. See figure 11.

7 CONCLUSION

- Injunction by authority strengthen the development of mercury-free systems.
- Measurements reveal contamination by mercury in lighthouses – often more than expected.

- Experience shows that by efforts in the engineering work it is possible to find a sustainable and reliable solution that take care of heritage, working environment, nature, costs and reliability.
- Experience shows that final cleaning of bath, float, structure, floor, walls etc. beyond removal of mercury is crucial to bring down the contamination. Some lighthouses demanded two-three times repeatedly and intensively cleaning with successively measurements.
- Lighthouse authorities and owners of lighthouses with mercury bath systems strongly recommended consider and prepare a de-commissioning plan for mercury bath system due to the toxic influence on the human body and the nature.
- Administration and authorities worldwide have recognised and shown interest for the Danish solution and some have adopted and implemented the solution.

AUTHOR BIOGRAPHY

Jørgen Royal Petersen has worked as an AtoN engineer at the Danish Maritime Authority for more than 30 years. Jørgen has a keen interest in historical aspects of Aids to Navigation and was responsible for developing a solution for replacing mercury bath rotation systems with a durable mechanical system, allowing continued operation of large revolving historical optics.

Jan Thorn is director of Safety of Navigation National Waters at the Danish Maritime Authority (DMA). He has a background as an officer in the Danish Army with experience from various commands and management positions. He has been a director at the DMA since 2011. His area of responsibility is mainly safety of navigation, pilotage authority and management of Aids to Navigation in the waters of Denmark, Greenland and the Faroe Islands.

S204.2 The replacement of a mercury rotating bearing system for a large Fresnel lens (026)

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ABSTRACT

Irish Lights and many other lighthouse authorities have used mercury to rotate large revolving Fresnel lenses in lighthouse applications since the late 1800s. The system provided a near frictionless environment for the rotation of these large lenses. Mercury is a toxic substance, and, despite the many years of reliable service, there is increasing European and International legislation restricting its use, storage and transport. Where major re-engineering works are being carried out at lighthouse stations, Irish Lights is taking the opportunity to remove mercury from these stations. With modern LED developments, there is now the option to flash or rotate beacons which no longer need the large Fresnel lens to achieve the required range. There are locations though where the large rotating Fresnel lens is being maintained for heritage and visitor experience purposes. For these situations Irish Lights is implementing a solution of a low friction mechanical slew ball bearing system that can be installed underneath the Fresnel lens as the rotation mechanism in replacement of the mercury. This bearing has been trialled at Tory Island Lighthouse for a hyper-radial rotating Fresnel lens, rotating at 2 RPM, and will be installed at Rathlin East and Rathlin West lighthouses in first order Fresnel lenses in 2021.

KEYWORDS: Lighthouse optic, Fresnel lens, heritage, mercury removal, ball-bearing system

1 INTRODUCTION

This paper discusses the recent mercury removal projects by the Commissioners of Irish Lights. For a number of years Irish lights have been removing mercury from operational equipment and systems, the majority of this has been from rotating Fresnel Lens optics.

While it is now technically possible to provide visual AtoN using modern technology, Irish Lights have installed new mechanical ball bearing systems, combined with a new light emitting diode (LED) light sources, to preserve the heritage of these magnificent optics. This paper will provide an overview of these developments.

2 HISTORY – ROTATING LIGHTHOUSE OPTICS

The Fresnel Lens was invented by the French physicist Augustin Fresnel in 1821. Though in fact consisting of concentric glass prisms, it mimics the operation of a lens. This projects light from a light source located at the focal point of the lens to a maximum distance, in practice out towards the horizon.

Despite over 200 years' of technological progress, it is a tribute to the invention that almost 200 years later one can still be found in most of the world's lighthouses.

The light sources within the lenses have on the other hand changed dramatically. From candles, to burning oils and gasses, to electricity, and now to low energy LED technology.

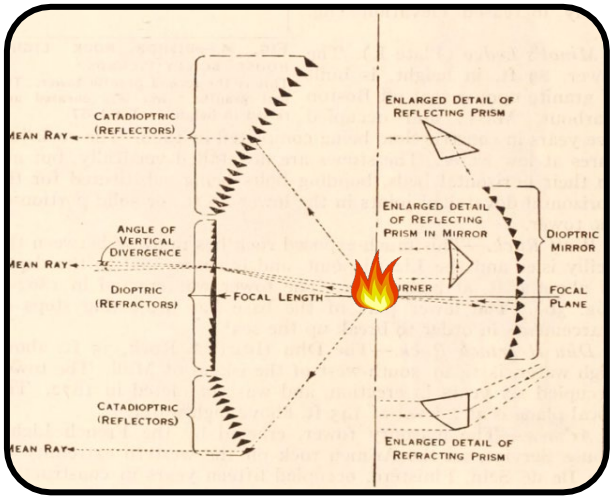


Figure 2: Fresnel Lens (shown in section)

Many of the first Frensel Lenses rotated on rollers, or ball bearings, or featured a stationary lens with a flashing light source inside. Although Fresnel suggested the concept of a mercury-based rotational mechanism in the 1820s, it wasn't actually developed until the 1890s, when another French engineer, Leon Bourdelles,

developed the first working mercury bath. This invention allowed the heavy glass Fresnel lens to float and rotate in mercury, a dense and almost frictionless metallic liquid. The solution also features rollers which keep the lens level and prevent it from moving horizontally relative to the fixed light source. Like the Fresnel lens itself this simple solution was a work of genius, and retaining a number for heritage purposes, and with suitable precautions, should be considered.

3 MERCURY REMOVAL

Today however, mercury and its compounds and vapours are known to present considerable safety issues to humans. These include toxic effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes, and is of particular concern for children and expecting mothers [1]. As a result there is increasing legislation internationally limiting its use, storage, and transportation [2].

Since 2013 Irish Lights have been actively removing mercury from lighthouses, the bulk of which is contained in the rotational mechanisms of the rotating Fresnel Lenses. In these projects the new visual AtoN was provided by:

- New flashing or rotating LED optics located on lighthouse balconies
- New flashing or rotating LED optics located in the lantern rooms, either mothballing the existing lenses in situ or removing them to local museums or similar
- New flashing or rotating LED optics located on new platforms on top of lighthouse domes
- For smaller lenses (3rd Order) ball-bearing systems were installed to replace mercury as turn-key projects

For larger optics, including first order and hyper-radial Fresnel Lenses which weigh several tonnes, it was considered that the replacement of mercury rotation with ball bearing systems would be too problematic. Suppliers for larger systems were also more limited and more reluctant.

However, due primarily to heritage concerns from local communities, tourism purposes, and advice from local authorities, Irish Lights decided to attempt to design and install a suitable system.

4 DEVELOPMENT OF ALTERNATIVE ROTATING MECHANISM – TORY ISLAND

In 2012, Irish Lights installed a number of flashing LEDs on Tory Island to replace what was previously a bi-form (two-story) hyper-radial lens and mercury bath. This system was in operation for 7 years. During this time, there were a number of discussions about the potential to retain existing Fresnel Lens optics around Ireland. As such it was decided to use the redundant Fresnel Lens optic at Tory as a test location for a new rotation mechanism for rotating the existing bi-form Fresnel Lens, similar to that shown below.

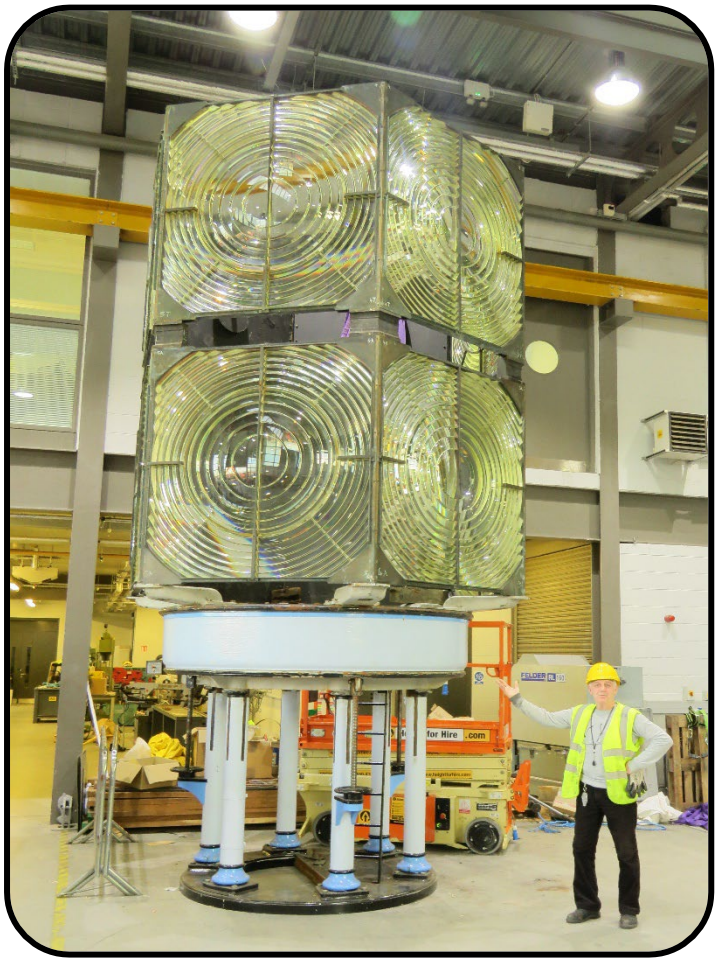


Figure 3: Hyper-radial Fresnel lens and pedestal

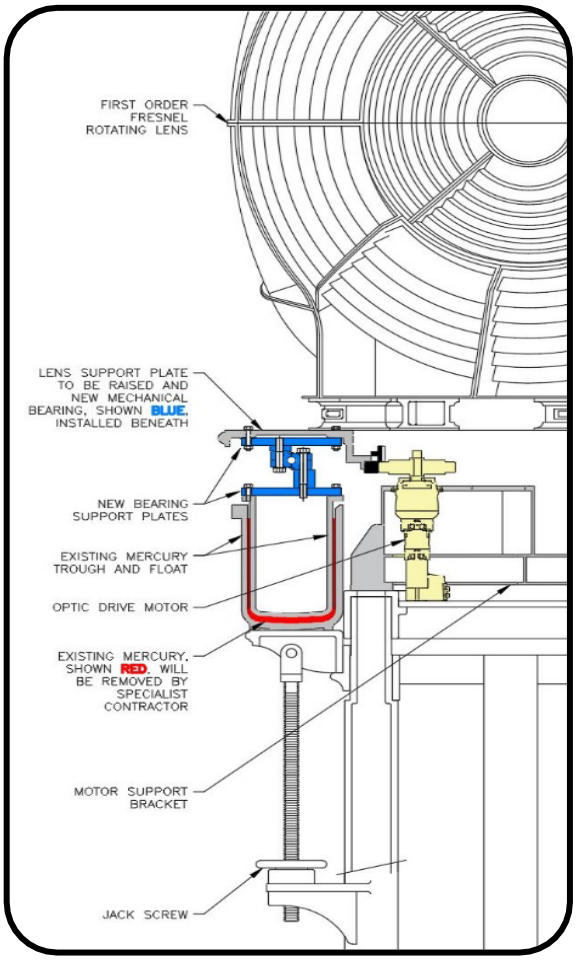


Figure 4: Section through bearing

After much design, and trial and error, a new slew bearing system shown in blue in **figure 3** was installed to replace the previous mercury, shown in red in the mercury bath. The new drive system is shown in yellow. This allowed an 18 month trial period, during which the AtoN was still provided by the flashing LEDs on the lighthouse balcony. Upon successful completion of this trial, a new LED light source was provided at the focal point of the existing lens, and the much-loved rotating light was reinstated.

5 ROLL-OUT OF NEW BEARING SYSTEM - RATHLIN EAST, RATHLIN WEST

The next stages were to bring the systems and experience from Tory Island into practice for other large operational rotating optics around the Irish coast. The first of these were at two “first-order” rotating optics on Rathlin Island, Northern Ireland, namely Rathlin East lighthouse and Rathlin West lighthouse.

The goal of these projects was to remove mercury and diesel backup power generation from the lighthouses, and to replace them with a new mechanical bearing and battery backup respectively. Other objectives were to ensure the ongoing and reliable operation of the AtoN, to deliver a low-energy and cost effective solution, to ensure safety was paramount at all times, buildability and ongoing operation of the systems into the future.

Both projects were completed between May 2021 and March 2023. Rathlin West is an “upside-down” lighthouse, with its near-inaccessible lantern room half-way down the western cliffs on the island. This was the more challenging project of the two, and most of the information provided is from this project.

Figure 5: Rathlin West Lighthouse – Aerial View

There are a number of aspects to consider in projects such as these. They are listed in approximate chronological order over the course of the project as follows:

5.1 Engineering Solutions

Unsurprisingly, the most challenging aspect of the project was the design and installation required to change from mercury rotation to a ball-bearing system, and the change from diesel generation to battery backup. There was added pressure as one of the first project stages was draining mercury, after that there was no going back.

The AtoN design was also unusual, with an 18 Nautical mile all-round red light provided by transmitting white light through a historic red filter. This required viewing trials and testing to ensure compliance with range requirements and IALA colour boundaries.

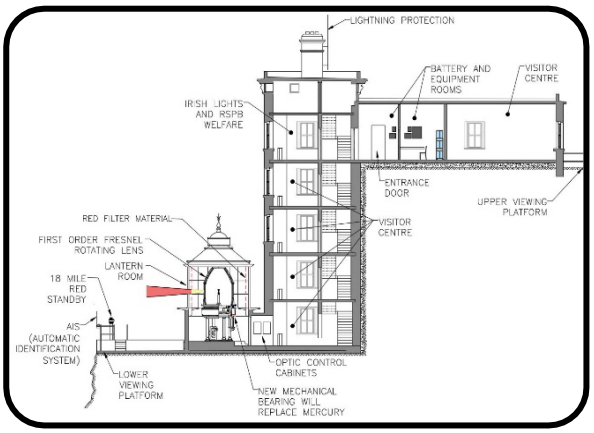


Figure 6: Rathlin West - Section

There was considerable mechanical engineering input to the project. The lens needed to rotate as before, but on a new slew bearing consisting of approximately 200 No. 25mmØ steel ball bearings located within the previous mercury bath of the historic pedestal. It also included the mechanical aspects involved in the support structure for the new light source and drive assembly (consisting of duplicated servo motors and gearboxes), and a duplicated greasing system.

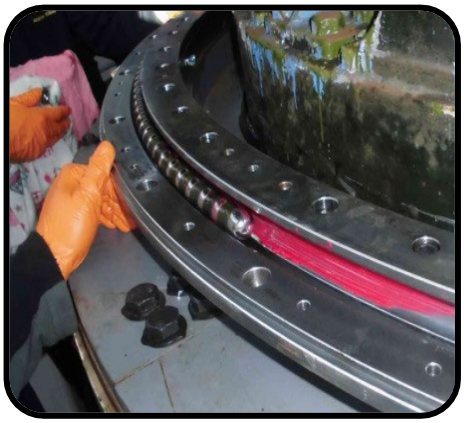


Figure 7: New Ball-Bearing Race

The electrical and electronic input was also considerable. The new light source is an LED which includes redundancy provided by main and standby LED strings. This light source, lens rotation, and electronic AtoN needed to have an 8 day electrical reserve in the event of a power failure. This necessitated a large battery and equipment room in the upper level of the tower. Individual monitoring and control cabinets for the lights and rotation drive systems were also required.

5.2 Consent Processes & Communications

Rathlin West lighthouse was constructed between 1912 and 1917 by carving a reinforced concrete lighthouse into the face of a Rathlin cliff. It was designed with the lantern room at the base of the cliff in an effort to keep the optic below low-lying fog on the cliffs.

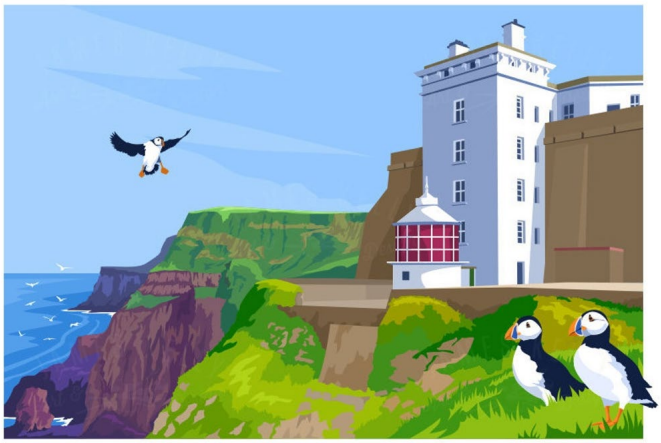


Figure 8: Rathlin West Lighthouse – Visitor Attraction

The lighthouse is a Grade A listed building. It is located in an Area of Special Scientific Interest, a Marine Conservation Area, including a Special Area of Conservation for sea cliffs and the underwater reefs below, and Special Protection Area for birds. As such it has the highest level of protection from a listed building and an environmental perspective.

The lighthouse is open to the public as a Great Lighthouses of Ireland tourist attraction operated by the Royal Society for the Protection of Birds, with the lighthouse and the nearby seabird colonies as the joint attraction.

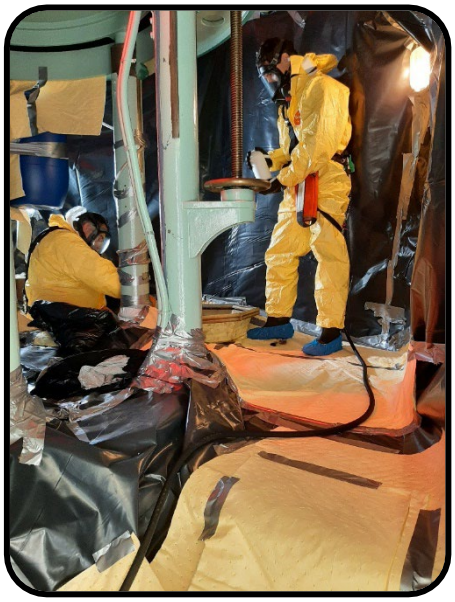
All of the above required constant communications with the Rathlin islanders, the operators of the visitor centre, the Department of the Environment, and with the local authorities. Much of the work was scheduled outside of the tourist and birds season to minimise the impact of the work. Listed Building Consent was required, as was the engagement of an industrial archaeologist during the design process.

5.3 Continued AtoN service

In the case of an operational lighthouse there is obviously a need to maintain the existing visual and electronic AtoN over the course of the project. In this case this was achieved by installing 18 nautical mile flashing LED optics on the external balcony of the lighthouse, with a small temporary battery supplying each. This temporary optic later became the standby light when the Fresnel lens optic was reinstated.

Notices to Mariners and radio-navigation warnings were required over the course of the works for any changes to the visual appearance of the light, it was also important to have teams on the island almost back to back to attend the AtoN in the case of any issues during the initial proving periods.

5.4 Construction & Safety Management



Once the temporary light was installed and operational the next stage was to remove the approx. 30 litres of mercury from the baths at each of Rathlin East and Rathlin West. This work was completed by a specialist environmental contractor, using breathing apparatus and isolated working environments. This contractor was also responsible for the transport of the mercury to a safe disposal facility and for certifying the air as within tolerance at the end of the removal. There will be ongoing measurement for a period, particularly in hot weather, to ensure no residual sources of mercury vapour exist.

The works were carried out under the Northern Ireland (UK) construction regulations. It was completed to Irish Lights' design and with Irish Lights as the Principle Contractor, and with Irish Lights direct labour on site for the majority of the project.

It was necessary to outsource a number of aspects to the works under various contracts for supply and installation, listed as follows.

- Helicopter support contract
- Mercury removal contract
- Bearing supply and installation contract
- Contract for light source and control cabinet
- Contract for lighting protection
- Contract for painting the lighthouse

Most of the construction work was completed on site in the winters of 2021 and 2022. As the lighthouse is located at the end of a long and winding road on an island it wasn't possible to get any lifting equipment into position, this necessitated a number of airlifts from Rathlin East lighthouse using a heavy-lift helicopter.

Figure 11: Delivery of new materials and removal of old from Rathlin West with heavy lift helicopter

5.5 Other Challenges

There were another number of unforeseeable challanges and delays during the works. During the Covid-19 Pandemic and lockdowns Irish Lights held an exemption from the general restrictions for essential work and travel. However, it was felt that capital works such as this would have been difficult to justify should an outbreak of Covid-19 occur on the island. As such commencement was delayed by almost six months. Even when restrictions were relaxed there were still issues getting basic facilities such as food and accommodation for those working on Rathlin Island.

There were a number of supply chain issues, particularly for the bearings themselves which were manufactured in China and took over a year from placing the order to delivery. Much of the equipment was also manufactured or delivered to the UK, and there were other customs delays due to Brexit.

Inflation, particularly for materials and construction works, also increased significantly from when the budgets were set.

Communications with the islanders regarding delays etc. was ongoing, but there were a number of queries regarding the lights (the temporary flashing LEDs) from mainland Northern Ireland. As the first in a number similar proposed projects these were also in the public eye further afield.

Figure 12: Working within the Fresnel Lens at Rathlin East

6 CONCLUSION

Though still in their infancy, these projects have been successful in retaining the Hyper-Radial and 1st order rotating Fresnel Lenses at Tory Island, Rathlin East, and Rathlin West. They have also successfully met the objectives of removing mercury and diesel power generation from the lighthouses.

The final costs for both projects at Rathlin East and Rathlin West was in the region of €450,000 per site.

7 REFERENCES

[1] World Health Organisation, 2017, Mercury and health (who.int)

[2] Environmental Protection Agency, 2023, Mercury | Environmental Protection Agency (epa.ie)

AUTHOR BIOGRAPHY

Clodagh Hanratty joined the Commissioners of Irish Lights in early 2023 as Director of Coastal Operations. Clodagh is a Chartered Civil Engineer with expertise in Contract Law, Design, Environmental, Safety and Quality Management.

Clodagh has an extensive career both in Ireland and overseas including the UK, Hong Kong, Thailand and the UAE working at senior level for Civil contractors, Design Consultant and within the Public Sector. She has a wealth of experience in large Civil Engineering projects including Metros, Road Infrastructure and Marine works together with public works building projects.

Clodagh leads the Coastal Operations, Property Management, Safety and Quality, Support and Planning and Commercial Services teams in Irish Lights.

S204.3 Lighthouse modernization and removal of mercury-based rotation systems (042)

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ABSTRACT

The shipping assistance division of the Flemish Government is responsible for the management and maintenance of the fixed AtoNs in the ports of Nieuwpoort, Oostende and Blankenberge. Nieuwpoort is the biggest marina of Northern Europe and has more than 2.000 berths. During the past years all fixed AtonNs have been modernized. As a final project, the lighthouses were modernized and the traditional lamps were migrated to LEDs.

1 INTRODUCTION

The Shipping Assistance Division of the Flemish Government is responsible since 2011 for the management and maintenance of the fixed AtoNs in the ports of Nieuwpoort, Oostende and Blankenberge. Nieuwpoort is the biggest marina of Northern Europe and has more than 2.000 berths. The fixed AtoNs on the maritime access routes to and from Flemish sea ports of Zeebrugge and Antwerp are managed by other organizations.

The existing infrastructure consisted of a variety of AtoNs often installed in earlier years by various organizations and end-users, this resulted in a complex inventory of equipment and rising maintenance costs with little benefit for pleasure and professional shipping. There was no uniformity. If a maintenance plan was available, the maintenance was carried out based on a basic preventive maintenance schedule and an on-demand corrective maintenance.

There was a strong need for a consistent structural and modern approach to meet the current IALA guidelines and recommendations combined with the climate ambitions of the Flemish Government.

2 HISTORY

Within the coalition agreement of the Flemish government and the policy memorandum of the Flemish Minister for Mobility and Public Works, sustainable and economically responsible maritime accessibility of the Flemish maritime ports is a priority. To guarantee safe and efficient shipping traffic, investments are made in projects for technological innovations and navigational supporting systems done by the Shipping Assistance Division of the Agency for Maritime and Coastal Services (MDK). This includes systems for Vessel Traffic Services (VTS) and shipping assistance in a broad sense such as the Scheldt Radar Network (SRK).

Also within the coalition agreement of the Flemish government and the policy memorandum of the Flemish Minister for Mobility and Public Works, modern navigation-supporting systems must be used in order to optimize the use of the waterway capacity. Beside this, the Flemish government has set itself as an operational objective to provide sustainable and innovative procurement.

Starting from this situation and needs, a framework contract was set up, in order to rationalize, optimize and standardize the existing network of AtoNs. This approach additionally required more attention for innovation, integration of cost-efficiency in design, the development of a long-term vision and the interaction with the end user. In addition, there was a strong need for a more structural approach to comply with the current IALA guidelines and recommendations.

Following objectives were determined in this tender :

- Development of a structured organization;
- Development of a cost efficient maintenance plan and approach to reduce TCO;
- Installing a control and monitoring tool for remote control of AtoNs;

- Integrating IALA guidelines and recommendations throughout the entire system;
- Integrating sustainability en energy efficiency in the system;
- Interaction with the end user ;
- Organization of knowledge management and transfer.

During the past years, all fixed AtoNs have been modernized, based on the IALA guidelines and recommendations. As a final project, the lighthouse installations were modernized and the lamps were migrated to LEDs.

3 LIGHTHOUSES

There are 3 working lighthouses in Flanders. These are located in the harbours of :

- Nieuwpoort
- Oostende
- Blankenberge

The lighthouses of Nieuwpoort and Oostende are the only 2 lighthouses where the lamp burned continuously and where the specific light signal is obtained by rotating the lens. In the lighthouse of Blankenberge, the lens is fixed and the light character is obtained by the flashing of the lamp.

Figure 13: Location Lighthouses

3.1 Lighthouse of Nieuwpoort

The lighthouse of Nieuwpoort is located on the right bank of the river Yser, in the middle of the nature reserve “De IJzermonding”. The lighthouse is a familiar sight for those who set sail or return from the sea.

In a succession of four lighthouses, the current one is the most recent lighthouse for the shipping traffic to and from the port of Nieuwpoort. The three predecessors, including the medieval “Vierboete”, were all lost in the war during the first half of the 20th century.

The current lighthouse was officially inaugurated on March 21, 1949. The light installation comes from it’s predecessor and therefore dates from the years 1923-1926. The lighting mechanism was timely transferred to Paris during World War II, survived the destruction of the third tower and was subsequently installed in the current tower. The lighthouse was protected as a monument in 2004.

Figure 14: Lighthouse of Nieuwpoort

The lighthouse has a height of 29 meters. The construction is painted with two white and red bands, so that it can also serve as a landmark during the day. The light is located at 28 meters. The tower emits two red flashes every 14 seconds.

The lighthouse installation of Nieuwpoort was based on mercury. This installation is the most authentic lighthouse installation we have in service.

Table 1 Technical data lighthouse Nieuwpoort

Light no.	014 – B0074
Nautical range [NM]	16
Height light [m]	28
Light characteristic	Fl(2)R.14s fl 0.2; ec 2.6; fl 0.4; ec 10.6
Type lamp	Orbitec halogeenlamp – 230 Vac – voet G9.5
Power lamp	1.200 Watt

3.2 Lighthouse of Oostende

This lighthouse, popularly known as 'Lange Nelle', is the fourth lighthouse in the history of Oostende and the third at that location. It is located at the east side of the harbour.

Figure 15: Lighthouse of Oostende

It was built in 1947-1949, is 65 meters high and has 324 steps. The light signals - three times long, the Morse sign "O" (from Oostende) - appear every 10 seconds.

The lighthouse works fully automatically. In the past, gas-powered emergency lighting would come on automatically if the electricity failed. This was the case, for example, with the flood of 1953. This gas-powered emergency lighting was replaced - partly because of the risk of explosion - by a system with an automatically spare lamp, linked to an electric emergency group on a diesel engine. In 1994 the tower was completely restored and painted after a design by Ignace Van Isacker.

In September 1998, the drive of the lighthouse of Oostende was completely renewed. A completely new motor with a rotor and a frequency inverter was used. The drive speed was identical to the old situation and a new frequency controller was installed for fine control.

The Fresnel lenses were driven by an outdated and complex mechanical drive. The lighthouse of Oostende works on the basis of a bearing with oil, no plans were available of this construction. As a result, it was not possible to carry out a correct and adequate maintenance.

The lighthouse was protected as heritage in 2004.

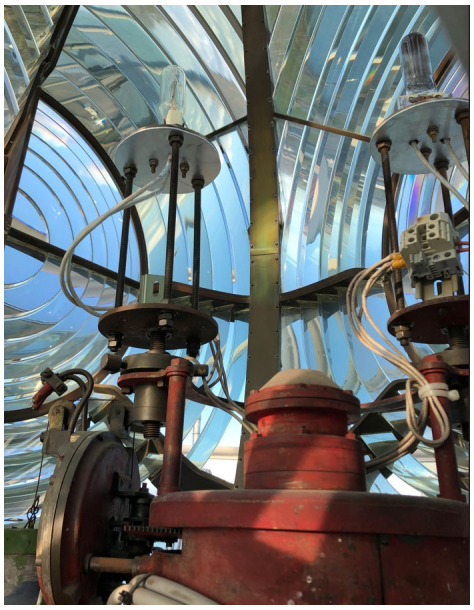

Figure 16: Fixture of halogen lamp Oostende

Table 2 Technical data lighthouse Oostende

Light no.	0440 – B0092
Nautical range [NM]	27
Height light [m]	65
Light characteristic	Fl(3)W.10s fl 0.2; ec 1.4; fl 0.2; ec 1.4; fl 0.2; ec 6.6
Type lamp	Halogeen – Orbitec – 230 Vac – 3200 K – voet G22
Power lamp	2.000 Watt

3.3 Lighthouse of Blankenberge

The oldest information about this lighthouse dates from the beginning of the 14th century.

With the construction of a shelter, a lighthouse was built, which was inaugurated in 1872. The building was destroyed during World War II in 1944.

The current lighthouse dates from 1951. This lighthouse contained, among other things, a living and office space for the lighthouse keeper and his family. The style is reminiscent of the afterwar period. The lighthouse was protected as heritage in 2003.

The lighthouse has a height of 32 meters. The tower emits two flashes every 8 seconds.

Figure 17: Lighthouse of Blankenberge

Table 3 Technical data lighthouse Blankenberge

Light no.	0462 – B0112
Nautical range [NM]	20
Height light [m]	32
Light characteristic	Fl(2) W.8s
Type lamp	Halogeen – OSRAM – 3200 K – 230 Vac – voet G22
Power lamp	1.200 Watt

4 APPROACH

4.1 Lighthouse lamp

When our organisation became responsible for the fixed AtoNs, most of them were initially installed by various organizations and end-users, resulting in a complex inventory of equipment and rising maintenance costs, with little benefit for the users.

Starting from this situation and needs, we rationalized, optimized and standardized the existing network of AtoNs. From a cost-efficient point of view, we made product groups and strived to limit the number of suppliers. For most the fixed AtoNs we had selected SABIK as our supplier.

Based on our needs, we did a market survey and finally chose the SLU-36 lighthouse unit of SABIK for this migration, also motivated by cost efficiency and uniformity of management.

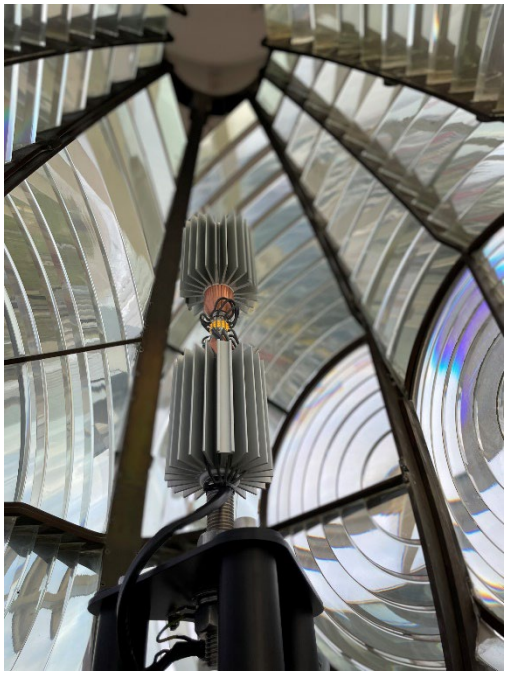

Figure 18: SLU-36 LED light

Table 4 Technical data lighthouses nautical range

Lighthouse	Nautical range calculated [NM]	Nautical range chart [NM]
Nieuwpoort	21	16
Oostende	23	27
Blankenberge	17	20

4.2 Revolving mechanism

The story started at the IALA conference in South Korea in 2018 where we saw the presentation of the Danish Maritime Authority (DMA) regarding the renewal of the rotating mechanism and migration of their lighthouse lamps to LEDs.

Following this conference, we visited the DMA and the “Nakkahoved” lighthouse to find out how they realized this project and to investigate the applicability for our installations.

To optimize their mechanical drive, the DMA had developed its own concept in collaboration with the “Danmarks Tekniske Universitet Mekanik” (DTU).

The starting points of this concept were:

- Maximum preservation of the original construction (heritage value);
- Operational functioning had to be the same as before (maintain nautical character);
- Attention to an energy-efficient and low-maintenance drive.

Their entire design and engineering was carried out in collaboration with the DTU. The replacement of the drive and the installation of the additional supports was carried out in one day without having to make major structural changes and without having to put the lighthouse out of service.

During the first test run after 3 months, no vibrations or atypical reactions were observed in the pedestal or optics. The energy consumption of the renewed electric drive was reduced by 17% compared to the mercury bath system.

Based on these positive findings, other Scandinavian countries have adopted this concept.

Because we did not have this expertise in Flanders, and paying attention to the positive conclusions of this concept, we asked the DTU if they were able to carry out this migration in Flanders. They accepted the challenge, and for our organization it was a privilege to call on their expertise en knowledge.

Given its innovative character, our organisation had defined this as a strategic project to set a good example as a government of how we could introduce energy efficiency and sustainability in complex installations such as lighthouses.

After study and preparation, and the delay due to corona, the DTU was able to come to Flanders in October 2021 to visit the lighthouses for the first time and to measure the revolving mechanism.

5 RENEWAL OF THE REVOLVING MECHANISM IN OOSTENDE

In collaboration with the DTU, the existing construction was replaced by a guiding system with a mechanical bearing. To completely renew the installation, following items were replaced:

- The engine;
- The frequency converter;
- The gear box;
- The steering.

This renewal was performed in 4 steps:

- Inspection and measurement of the existing installation;
- Design of a new bearing and drive for the rotation of the lens;
- Production of the various components;
- Removal of existing installation and assembly of the new structure.

5.1 Inspection and measurement of existing installation

On October 11, 2021, a site visit was made together with the DTU. The current installation was fully inspected, measured and an action plan was drawn up to renew the lens drive. Back in Denmark, a technical design was made up.

During this inspection, all practical actions were also checked, such as the placement of scaffolding, the possible opening of the transit hatches, anchor points, etc…

Figure 19: Measurement of light Nieuwpoort

5.2 Design of a new bearing and drive for the rotation of the lens

A temporary support structure was used to lift the current guidance system (shown in figure 8). This was brought into the lighthouse in small parts, after which it was assembled on site.

The structure was placed around the current installation. Once the installation of the new structure was completed, this temporary support structure was dismantled and removed.

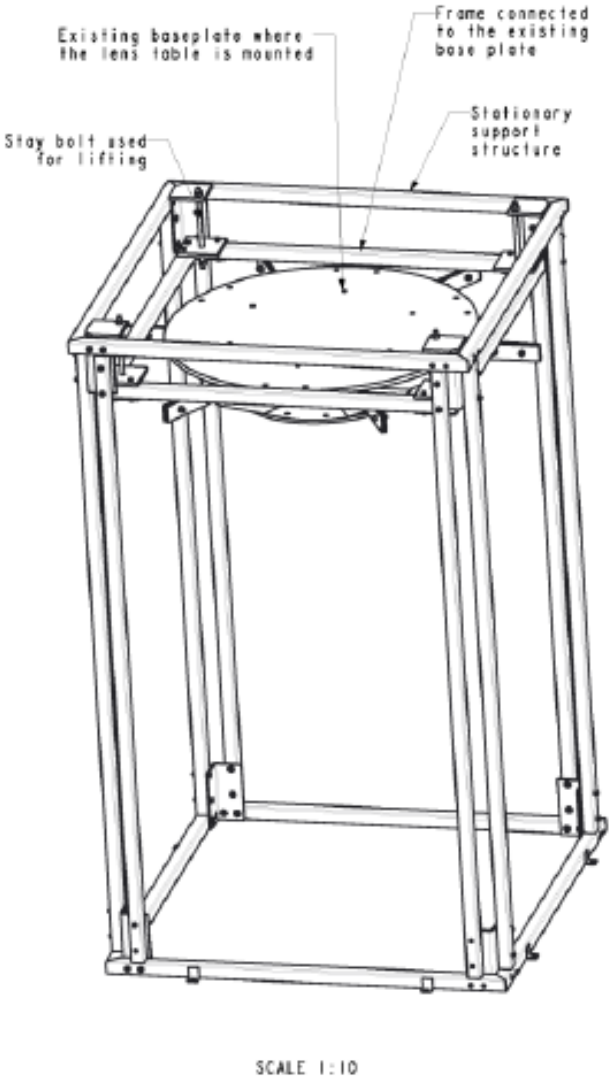

Figure 20: Temporary support

With the stay bolts on the temporary structure, the current installation could be lifted (to a height of approximately 50mm). The bolts on the corners of the structure were lightly tightened one by one so that the lens was carefully lifted in steps. In addition, the lens was also attached to the structure of the lighthouse by the using of several straps.

The straps were placed at the bottom and at the top of the lens. This could keep the lens stable when lifted up. Once lifted, the lower part of the installation was removed and replaced by the new structure shown in figure 9.

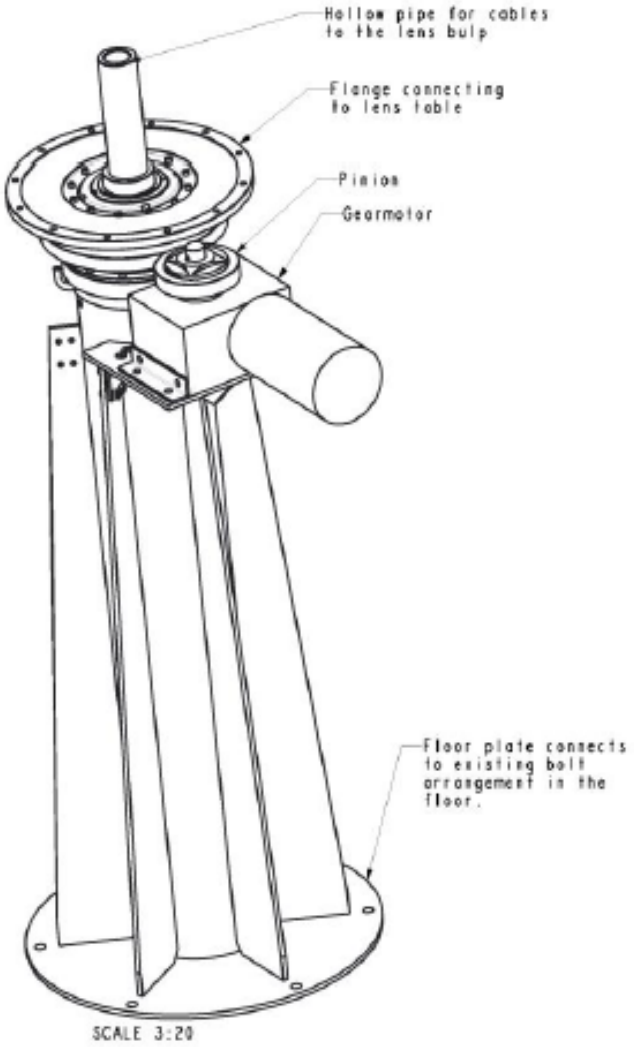

Figure 21: New revolving mechanism

When installing the new revolving mechanism, the drive that ensures the rotation of the lens, was also renewed. This was placed on a support that is mounted on the new structure. Furthermore, the control of this drive was also adjusted.

The box with contactors that is already in the lighthouse was moved and replaced by a new box with a more modern control. This new cabinet is placed on the floor lower in the 'technical room', aiming for maximum available workspace around the lens and removing all peripheral equipment from the lens room.

This cabinet will house both the control and power elements for the motor drive and the power supply for controlling the renewed light source. This way everything is bundled in the same place and space can be created around the lens, which will benefit maintenance in the future.

6 RENEWAL OF THE REVOLVING MECHANISM IN NIEUWPOORT

The lighthouse of Nieuwpoort was the only lighthouse with a mercury bath. The construction of the mercury bath was kept in place, the rotating mechanism was replaced by a guiding system with a mechanical bearing. After the renewal the mercury was removed.

Because of the heritage value, only the central console was removed and replaced with a new construction.

The initial console is shown below.

Figure 22: Existing console

The weight of the lens rests entirely on the outer ring of the structure. Since this outer ring remains untouched, no temporary support structure was needed to support the lenses during the works. There are several bolts on the base of the lens which could be tightened so that the lens could rest on these bolts. As soon the structure supported on to these bolts, the existing central console was dismantled.

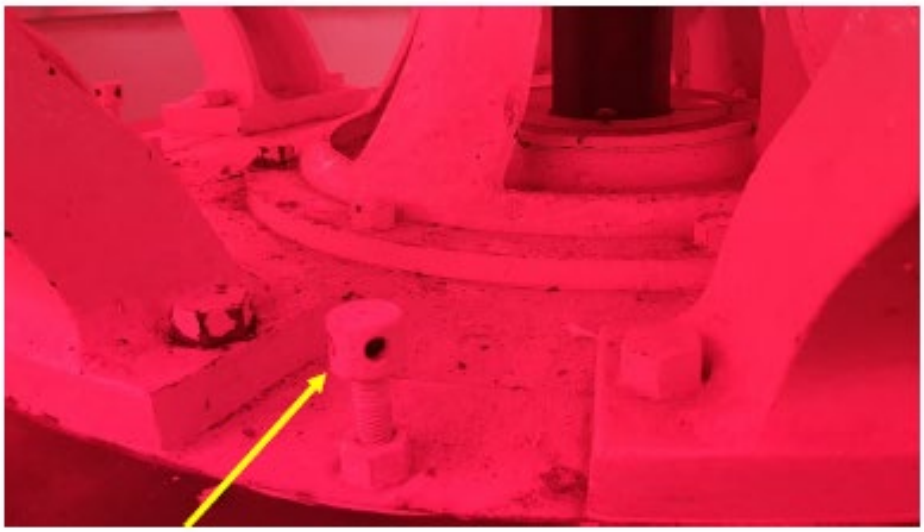

Figure 23: Stay bolts

Once the central console had been removed, the new structure was mounted in its place. This is shown in figure 12. The following parts are shown in this figure:

- All current rotating parts in green;
- All current stationary parts in blue;
- New rotating parts in red;
- New stationary parts in gray.

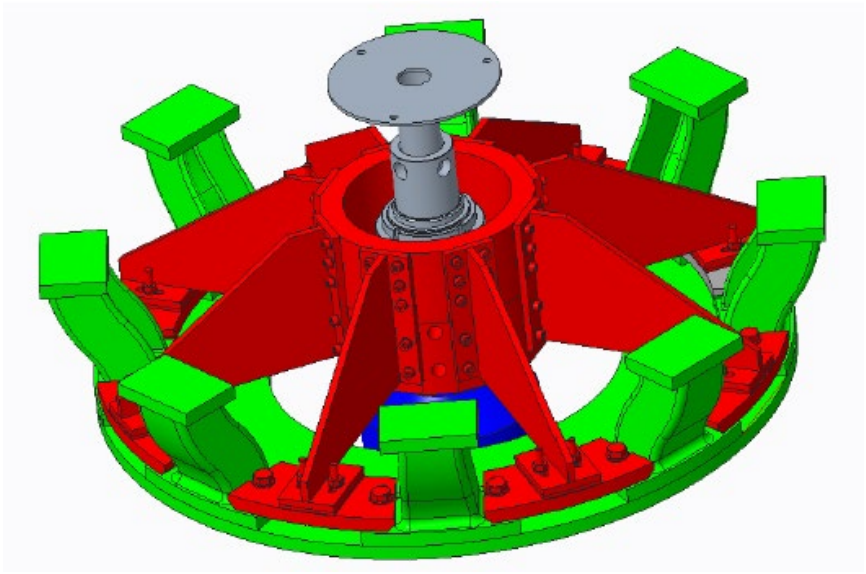

Figure 24: New revolving mechanism

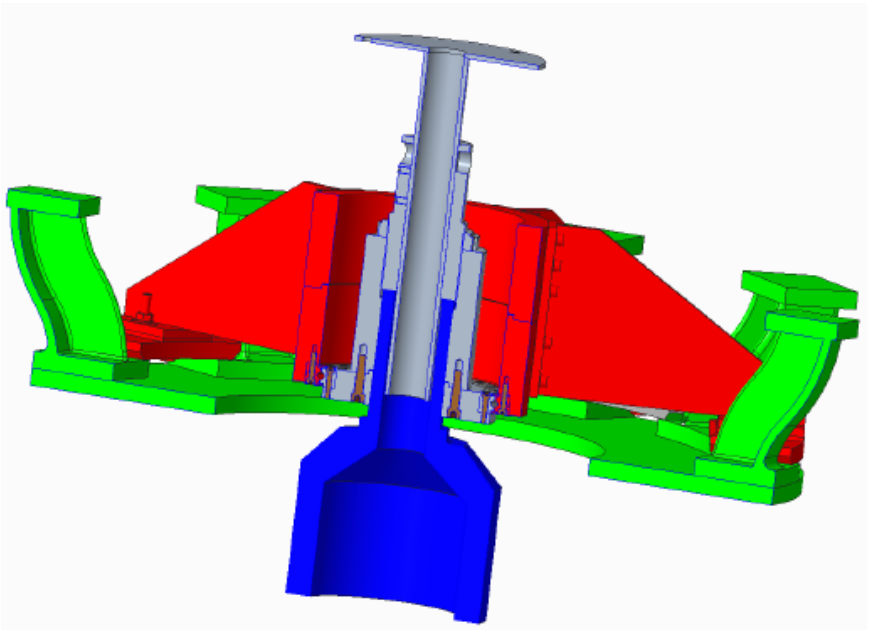

Figure 25: New revolving mechanism

This new central console consists of several parts which were mounted on site. This new console also features a vertically adjustable platform. Thanks to this adjustable platform, the lamp can always be placed in such a way that it is perfectly located in the focal point of the lamp.

This construction also houses the new bearing, which will ensure that the lens will rotate with minimal friction. This allowed the existing mercury bath to be emptied.

7 RENEWAL OF THE LIGHT IN BLANKENBERGE

The lighthouse installation in Blankenberge is the only one with a fixed lens where the nautical character is obtained by flashing the lamp. At this location, therefore, only the halogen lamp was removed and replaced by a completely new LED light source.

Figure 26: New LED light source Blankenberge

8 CONCLUSION

With this paper we wanted to share our story and emphasize once again how important it is to share knowledge and experience with each other. The IALA conferences are an absolute added value in order to discover the experiences of other organizations. We would therefore like to expressly thank the DMA, and in particular Jørgen Steen Royal Petersen, for their support.

Thanks to this collaboration, it was possible to preserve the existing maritime heritage as much as possible while still focusing on sustainable and energy-efficient techniques.

With these innovations, we as a government set a good example and in this way contributed to the climate objectives of our organization.

AUTHOR BIOGRAPHY

Ing. Nick Goethals graduated from the VIVES school in 2000 as a master in electromechanics. He started his career in the Flemish Government where he was responsible for the design and roll out of the fiber network and backbone. In 2009 he decided to join the Shipping Assistance Division where he became responsible for the management of equipment external to the Scheldt Radar Chain, such as the Maritime Rescue and Coordination Center (MRCC) in Ostend, or projects associated with the VTS investments in the Flemish maritime ports. From 2012 he became also responsible for the management and maintenance of the fixed AtoNs in the Flemish Coast harbors.

S204.4 Santo Antonio da Barra Lighthouse – challenge and solutions associated with public access (203)

Reuben Bello Costa, Museum Administrator, Nautical Museum of Bahia, Brazil

(No paper submitted)

AUTHOR BIOGRAPHY

Reuben Costa has been the Museum Administrator for the Nautical Museum in Bahia since 2000. He has experience in wide aspects of business, financial and museums administration with an MBA in the Management and Valorization of lighthouses. He previously served in the Brazilian Navy and was Head of the Maintenance and Personnel department at the Brazilian Naval Academy.

SESSION 205 - RELEASING HERITAGE AND CULTURE POTENTIAL

S205.1 Improving the experience of opening lighthouses to the public (202)

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ABSTRACT

Since the 17th century with the commissioning of the Cordouan lighthouse in 1611, France has set up more than 200 lighthouses along its coasts, in Metropolitan France and overseas. Most of these establishments are still in operation. All are now automated. As soon as they were put into service, the lighthouse keepers ensured the visit of the lighthouses under certain conditions. With automation, they were relieved of their duties and visits stopped. Public demand being strong, several lighthouses have been reopened to visitors over the years, the French Administration signing agreements for this mission with local non-profit associations, communities or private companies.

To have a uniform view of the structures in charge of visits, the Ministry for the Sea wanted an associative structure to be created with the aim of coordinating the network of managers of French lighthouses open to public visits.The Phares de France association, created in 2018, coordinates this network. Since then, every year in mid-October, a 3-day seminar is organized in the form of meetings open to all lighthouse managers under contract. Organized each time in a different lighthouse, the "Lighthouse Days" deal with issues around the management of lighthouses. Numerous exchanges between managers, State services, communities and partners thus make it possible to define the outlines and challenges of the lighthouses open to visitors. In addition to these days, social networks allow the animation of the network throughout the year.

More recently, Phares de France is heavily involved, in collaboration with the Ministry of the Sea and IALA, in the organization of the events of the FRESNEL 2023 project.

KEYWORDS: visit – network –animation – lighthouse keeper

RESUMEN DEL ARTICULO

Desde el siglo XVII con la puesta en marcha del faro de Cordouan en 1611, Francia ha instalado más de 200 faros a lo largo de sus costas, en la Francia metropolitana y en el extranjero. La mayoría de estos establecimientos siguen en funcionamiento. Ahora todos están automatizados. Tan pronto como se pusieron en servicio, los guardianes de faros aseguraron la visita de los faros bajo ciertas condiciones. Con la automatización, los guardianes fueron relevados de sus funciones y se detuvieron las visitas. Dado que la demanda pública es fuerte, varios faros se han reabierto a los visitantes a lo largo de los años, y el Estado francés firma acuerdos para esta misión con asociaciones locales sin fines de lucro, comunidades o empresas privadas.

Para tener una visión uniforme de las estructuras encargadas de las visitas, el Ministerio del Mar quería que se creara una estructura asociativa con el objetivo de coordinar la red de gestores de los faros franceses abiertos a la visita pública. La asociación Phares de France, creada en 2018, coordina esta red.Desde entonces, cada año a mediados de octubre se organiza un seminario de 3 días en forma de encuentros abiertos a todos los gestores de faros bajo contrato. Organizados cada vez en un faro diferente, los Journées des phares tratan temas relacionados con la gestión de los faros. Numerosos intercambios entre gestores, servicios estatales, comunidades y socios permiten así definir los contornos y los desafíos de los faros abiertos a los visitantes. Además de estos días, las redes sociales permiten la animación de la red durante todo el año.

Finalmente, Phares de France está fuertemente involucrada, en colaboración con el Ministerio del Mar y la IALA, en la organización de los eventos del proyecto FRESNEL 2023.

PALABRAS CLAVE: visita - red - animación - guardián del faro

RESUME DE L'ARTICLE

Depuis le 17ème siècle avec la mise en service du phare de Cordouan en 1611, la France a mis en place plus de 200 phares le long de ses côtes, en Métropole et Outre-mer. La plupart de ces établissements sont encore en activité. Tous sont aujourd'hui automatisés. Dès leur mise en service, les gardiens ont assuré sous certaines conditions la visite des phares. Avec l'automatisation, les gardiens ont été relevés de leurs fonctions et les visites arrêtées.La demande du public étant forte, plusieurs phares ont été réouverts à la visite au fil des ans, l'Etat français signant pour cette mission des conventions avec des associations locales à but non lucratif, des collectivités ou des sociétés privées.

Pour avoir un regard homogène sur les structures en charge des visites, le ministère chargé de la Mer a souhaité qu'une structure associative soit créée avec pour objectif d'animer le réseau des gestionnaires de phares français ouverts à la visite du public. L'association Phares de France, créée en 2018, assure l'animation de ce réseau. Depuis, chaque année à la mi-octobre, un séminaire de 3 jours est organisé sous forme de rencontres ouvert à tous les gestionnaires de phares sous contrat. Organisées chaque fois dans un phare différent les « Journées des Phares » traitent des problématiques autour de la gestion des phares. De nombreux échanges entre gestionnaires, services de l'Etat, collectivités et partenaires permettent ainsi de définir les contours et les enjeux des phares ouverts à la visite. En complément de ces journées, les réseaux sociaux permettent l'animation du réseau au long de l'année.

Enfin, Phares de France est largement impliqué, en collaboration avec le ministère de la mer et l'AISM, dans l'organisation des évènements du projet FRESNEL 2023.

MOTS CLES : visite - réseau - animation – gardien

1 INTRODUCTION

Among the 150 lighthouses that line the coasts of France, about sixty are highlighted by public or private structures. Most lighthouses are open to visitors, a few are used for artist residencies and a minority are maintained by volunteers for the sole benefit of their structure.

2 DEVELOPMENT

Lighthouses no longer of nautical use have often been sold by the Administration to local authorities and some to individuals.

For those who still have a proven nautical utility, the lantern and its light are still maintained by the State, Maritime Affairs Department, Lighthouses and Beacons Department, but in some cases the tower is transferred to a para-public structure: le Conservatoire du Littoral et des Rivages Lacustres. In both cases, the management of the site and its tourist development are entrusted to voluntary associations, local authorities or private companies.

This multitude of stakeholders very quickly posed problems in guaranteeing uniform treatment across the entire French coastline, and the State encouraged the creation of an association responsible for bringing together all lighthouse managers regardless of their status.

This is how the **Phares de France** association was created in 2018.

To animate the network of lighthouse managers, the association quickly set up a website www.pharesdefrance.fr and a Facebook page ***pharesdefrance***.

It has also organized annual seminars, the ***Journées des Phares***, bringing together all the stakeholders: lighthouse managers, owners, State services in charge of maritime navigation, those in charge of historical monuments, those in charge of archives, and more generally anyone concerned with the enhancement of lighthouses and their heritage.

These days are held each year during the month of October over three days, hosted by a lighthouse manager member of the association, different each time.

They revolve around plenary sessions to take stock of the past season and address topics of general interest at the request of one or more members, and more convivial moments promoting direct exchanges between participants.

Local establishments are visited, and for those who wish, the seminar can end with more touristic visits during the weekend following the seminar.

The Phares de France association is also associated with more general reflections such as, for example, on the future of objects present in lighthouses that are no longer useful for their operation, or with the organization of national events such as the commemoration of the bicentenary of the invention by Augustin Fresnel of the optics which revolutionized the technique of modern headlights.

3 CONCLUSION

The Phares de France association, exclusively made up of volunteers interested in the preservation and enhancement of French lighthouses, has made it possible to network all lighthouse managers, associations, local authorities and private bodies, in order to develop in a harmonious way and homogeneous this activity on all the French coast.

AUTHOR BIOGRAPHY

Mr. Jean-Marie CALBET was born in 1951 in France. He obtained his degree in Public Works from the French State in 1976 at the same time as a degree in law and economics of international maritime transport. He was promoted to Chief Engineer of State Public Works in 2005 and claimed his retirement rights in 2011.

Within the International Association of Marine Aids to Navigation and Lighthouses Authorities, he sat as a member of the Engineering committee from 1983 to 1994, then as vice-president of this committee from 1994 to 1996. He then created the advisory committee for the preservation of historic lighthouses, which he chaired until 1998.

S205.2 National plan for the study of historical characteristics and inventory of historical optics for their preservation (102)

Javier Martin Santo Domingo, Puertos del Estado, Deputy Director Port Operations & Aids to Navigation Spain

ABSTRACT

Most actions in the preservation of historic lighthouses are aimed at the conservation of the buildings, towers, environment, civil works in general, while the optical rotation mechanisms and other technical elements of significant historical value, don´t receive the same attention.

Over time, successive adaptations to new light sources, energy sources, characteristics, etc. of the equipment, together with the lack of sensitivity by those responsible for service, more concerned with improving this service and its delivery, than the heritage conservation, has led to the disappearance of many of the historic features, losing much part of the industrial heritage of this area.

Our commitment, is to keep using all optical and foundations that are possible, adapting to new sources of light and energy, to achieve the current service requirements, while retaining most of the existing historic equipment, including original rotation mechanisms as a backup system. We understand that the best way to preserve the heritage, is to keep the equipment in its historical setting, providing the service for which they were designed to, and facilitating, as far as possible, their approach to society, for example through visits.

To achieve these objectives, three years ago, Puertos del Estado (State Ports) developed a project which has, as one of its main targets, checking the status of optical-bright facilities of the lighthouses. This project involved two aspects: firstly, an inventory of historical and technical condition of the facilities and, the other, checking the technical characteristics of the lighthouses light systems [2].

RESUMEN DEL ARTICULO

Habitualmente, la mayoría de las actuaciones en materia de preservación de faros históricos están orientadas a la conservación del edificio, torre, entorno, en general la obra civil, mientras que a las ópticas, mecanismos de giro y otros elementos técnicos de importante valor histórico, no se les presta la misma atención.

Las sucesivas adaptaciones a lo largo del tiempo a nuevas fuentes de luz, fuentes de energía, características, etc. de los equipos, unido a la falta de sensibilidad por parte de los responsables del servicio, más preocupados por la prestación y mejora del servicio que por la conservación del patrimonio, ha provocado la desaparición de muchos de los elementos históricos de su entorno, perdiendo gran parte del patrimonio industrial de este sector.

En España, Puertos del Estado emprendió una iniciativa con el fin de mantener en uso todas las ópticas y los basamentos que fuera posible, adecuándolos a las nuevas fuentes de luz y de energía, de forma que se puedan alcanzar los requisitos de servicio actuales, conservando la mayor parte de los equipos históricos existentes, incluso los mecanismos de rotación originales como sistema de reserva. Entendemos que la mejor forma de preservar el patrimonio es mantener los equipos históricos en su entorno, prestando el servicio para el que fueron diseñados facilitando, en la medida de lo posible, su acercamiento a la sociedad como, por ejemplo, a través de visitas.

Para conseguir estos objetivos, Puertos del Estado desarrolló un proyecto hace pocos años que tenía como uno de los principales objetivos, comprobar la situación de las instalaciones óptico-luminosas de los faros. Este proyecto contemplaba dos aspectos: por una parte, disponer de un inventario técnico de elementos históricos y del estado de conservación las instalaciones y, por otra, la comprobación de las características técnicas de los sistemas luminosos de los faros [2].

RESUME DE L'ARTICLE

Habituellement, la plupart des actions en termes de préservation des phares historiques sont orientées vers la conservation du bâtiment, de la tour, de l'environnement et des travaux de génie civil en général, tandis que l'optique, les mécanismes de rotation et d'autres éléments techniques de valeur historique importante, Ils ne obtenir la même attention.

Les adaptations successives dans le temps à de nouvelles sources lumineuses, sources d'énergie, caractéristiques, etc. des équipes, conjuguée au manque de sensibilité des responsables du service, plus soucieux de la fourniture et de l'amélioration du service que de la conservation du patrimoine, a conduit à la disparition de nombreux éléments historiques de son environs, perdant une grande partie du patrimoine industriel de ce secteur.

En Espagne, Puertos del Estado a entrepris une initiative afin de conserver autant d'optiques et de fondations en service que possible, en les adaptant aux nouvelles sources de lumière et d'énergie, afin de répondre aux exigences de service actuelles, en conservant la plupart des équipements historiques existants , y compris les mécanismes de rotation d'origine en tant que système de réserve. Nous comprenons que la meilleure façon de préserver le patrimoine est de maintenir les équipements historiques dans leur environnement, en rendant le service pour lequel ils ont été conçus, en facilitant, dans la mesure du possible, leur approche de la société, par exemple par des visites.

Pour atteindre ces objectifs, Puertos del Estado a développé il y a quelques années un projet dont l'un des principaux objectifs était de vérifier la situation des installations optiques-lumineuses des phares. Ce projet envisageait deux aspects: d'une part, disposer d'un inventaire technique des éléments historiques et de l'état de conservation des installations et, d'autre part, vérifier les caractéristiques techniques des systèmes d'éclairage des phares [2].

1 NATIONAL PLAN

To establish the Historic Optics Conservation Plan, the following stages were followed:

1. Data file design
2. Evaluation of the state of the lighthouse´s optics
3. Analysis of the results
4. Inventory and classification of equipment
5. Action plan

1. Data file design, where to collect in detail, both the technical inventory, as well as the necessary parameters for the verification of the technical characteristics of the lighting systems and the result of the calculations.

2. Evaluation of the state of the lighthouse's optics

To check the technical lighting systems, we developed a computer program based on the methods described in the recommendations of the IALA (series E-200, 2008) and the Book of Standards (1986). This tool allowed the calculation of a fast and simple features that could be achieved by testing different types of lamps at each facility, to choose the most appropriate or, if necessary, correct the current deficiencies.

To carry out the work, training sessions were held in the management of the calculation program distributed in five areas of the Spanish coast, attended by the technical staff of all the Port Authorities, making real examples of rotating optics and horizon optics in lighthouses.

3. Analysis of the results

As a result of this project, we found that, in most of the facilities was totally feasible to maintain historical equipments if we act, primarily, in the light sources.

From the information received, in addition to the individualized analysis for each lighthouse, the following general technical aspects were identified, result in most of the cases of an historical process inherited of

previous times, and that requires a revision with object to adapt, in its case, the facilities to the service that they must render.

An important consideration is that, throughout the years, the technological advance has allowed the automation of lighthouses and their original light sources were replaced by other available ones or made to size. Thus, although they have been modified the luminous sources, from petroleum or the gas to the present lamps of incandescence or metal halide lamps, in most of the lighthouses of Spain has stayed the old optical system. The compatibility of the traditional optical systems with the new lamps presents some aspects that make a previous analysis necessary of the new lamps, on the other hand the present conditions of the market do not allow the manufacture of lamps to size, reason why we must adapt to us with the models of existing commercial lamps.

The main problem that has been identified is that the optical were designed for light sources with greater dimensions than the present ones, especially in optical with big focal length, so we were forced to take care several aspects.

2 ASPECTS ANALYZED IN THE STUDY.

2.1 Vertical Divergence

The original height of the light source was of the order of the 80 - 40mm, in the case of the of vaporized petroleum systems or gas systems. Nowadays, with the halogen lamps the height is only 10-15mm, that causes a considerable reduction in vertical divergence (less the greater the focal length), which, in some cases, can cause coverage problems, especially in lighthouses located at high altitudes above sea level.

2.2 Flash Length

Also, with the reduction of the dimensions of the light source, in this case due to the reduction of its width, a reduction of the horizontal divergence is produced. This reduction causes a decrease of the duration of the sparkle in the rotating optical. As an acceptable compromise solution, it was settled down that the minimum duration of the flash never must be inferior to 0.15s.

2.3 Lighthouses with solar energy system

Due to the limitations of consumptions, these facilities need low powered and high light efficiency lamps; they are generally metal halide lamps, with powers between 35-150W, that have dimensions of light even smaller, reason why the problem of the divergences worsens, mainly in optic systems that have a big focal length.

2.4 Metal Halide Lamp Coated Bulb

In some occasions the use of coated bulb lamps can be a good solution to extend the duration of the flash, because the wide one of the luminous source is increased, although it must be used carefully, since the distribution of the flow is not totally uniform (it exists more in center than in the periphery), its performance is lower and in case of having to use high powers, its size could be excessive.

2.5 Light range

The election of the type of lamp, based on the distribution of the luminous flux, is determining to obtain a good performance of the optic. There are different discharge lamps which having the same power differ in the form of the arc tube. The cylindrical ones have more flux in the horizontal plane. These lamps would be appropriate to achieve good optical performances with little or no catadioptric surface. However, the laps with the spherical arc tube that distribute the flux uniformly are more suitable to optics with a bigger catadioptric surface.

2.6 Uniform distribution of the luminous flux

The distribution of the luminous flux of the lamps used in AtoN must be always uniform in the horizontal plane, when this is not possible differences in the range and in the beam, divergence will take place according to the zone from where the signal is observed.
This implies that the halogen lamps with grid or horizontal position filaments, should be avoided for their use in AtoN, as they don´t have uniform distribution of the flux in the focal plane. Anyhow, in some cases, this has not been possible due to having to adapt to existing business models.

2.7 Background lighting

On many occasions the urban development in the areas near the AtoN, has caused an increase of the background lighting, producing a reduction of the visual range. It was therefore necessary to check the luminous range in facilities in which these circumstances occurred, applying the appropriate coefficients to the new circumstances and in some cases, it was necessary to change the installation to obtain the required range.

2.8 Color temperature

It was also verified that the lights with high color temperatures, as the Metal halide ones, are more conspicuous in zones where there is great background lighting. In urban areas most of these background lighting comes of the streetlights, composed mainly by sodium steam lamps with yellowish light, therefore, the whiter we use our light the more contrast we get. In these conditions the flashing lights are more conspicuous that those of occulting lights.

2.9 Angle of uncertainty

The angle of uncertainty of a sector light, represents the transition zone that exists between two different colors or color and darkness, where is not possible to clearly differentiate a color from another one. This sector must of being smallest possible. To obtain this, it must be reduced, as far as possible, the breadth of the luminous source, whereas the distance to the filter must be increased.
The lamps used for sector lights must be always made of vertical filament; the grid filaments, or those with horizontal position, do not have to be used in lights of sectors. This has not always been possible to perform by the lack of availability of suitable lamps in the market.

3 STAGE 4 - INVENTORY AND CLASSIFICATION OF EQUIPMENT

Table 1 : Number of Lighthouses with Heritage Value and Optics for each type of technology implemented by Autonomous Regions

Most common technologies by Autonomous Regions	Number of lighthouses by type of technology				
	Mercury cuvette	Weight system	Sautter optics	Lepaute system	Létourneau system
Cataluña	3	3	2	7	0
Baleares	4	1	7	10	1
Canarias	7	4	0	6	0
Andalucía	8	8	3	7	0
Ceuta	1	1	0	1	0
Melilla	0	0	0	0	0
Murcia	0	0	0	3	0
Valencia	4	2	1	5	1
País Vasco	2	2	2	4	1
Cantabria	0	0	2	3	0
Asturias	4	4	5	1	0
Galicia	11	9	2	0	9
Total	**44**	**34**	**24**	**47**	**12**

Table 2: Number of Lighthouses with Heritage Value and Optics for each type of technology implemented

Relevant technologies	Number of lighthouses
It includes, in the original project, the optical system of the firm "Sautter, Lemonier et Cia", whose initial technical direction was A. Fresnel	24
It includes, in the original project, the turning system of H. Lepaute, collaborator of G. Eiffel	47
It includes, in the original project, the optics and the turning system of the firm "Létourneau" (Théodore Létourneau)	12

4 STAGE 5 - ACTION PLAN

Among other aspects, work has been done on improving the width of the light source in rotating optics, to increase the horizontal divergence and lengthen the duration of the flash, the use of metal halide lamps with spherical bulbs in optics with a large surface area of rings. reflectors, to improve their performance.

Also, the need to improve the information provided by lamp manufacturers has been identified, which on some occasions is not sufficient in aspects such as luminance, font width, etc.

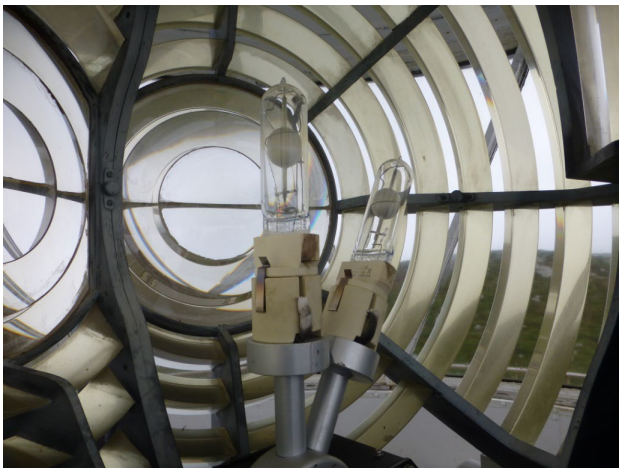
In this study, various actions were carried out in many lighthouses, among which the improvement of light sources to make them compatible with historical optics stand out, which had an impact on increasing the ranges and divergences of the light beams or reducing the uncertainty angles in sector lights, for example, improvement actions were also carried out in the electronic control equipment or turning and energy systems.

5 EXAMPLES

In the area of Galicia, in the northwest of Spain, the Vilagarcía Port Authority manages AtoN in a wide area [1]

Among these signs we can highlight the Sálvora, Punta Insua and Corrubedo lighthouses for their complexity and uniqueness.

Due to the existence of dangerous shallows in the area, historically the three used an otter displays system, which worked differently in each of the lighthouses.

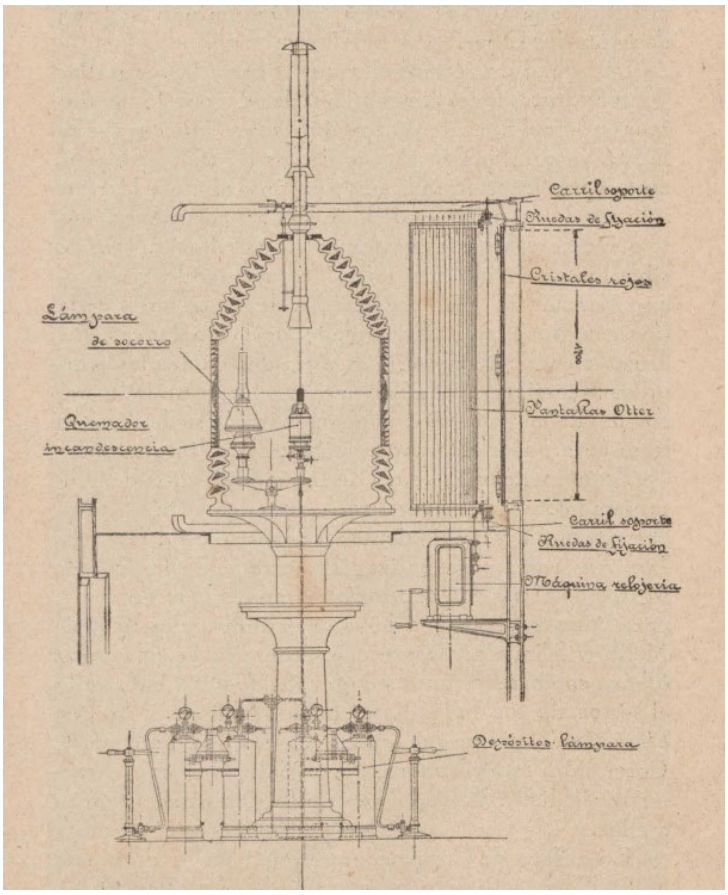


5.1 Punta Insua Lighthouse

This lighthouse is in an area where it was essential to mark several groups of shallows with different characteristics, very dangerous for navigation, and some of which are quite far from the coast.

Formerly the configuration of the lighthouse was quite complex. A mechanism of occulting lights with screens Otter was installed.

The optic, in this case, has no rotation at all. Red colour filters and Otter displays, arranged vertically and independent of the lens could be found also in the lantern. The mechanism of action of these displays was carried out by clockmaking machinery, of engine weight, triggering a wheel of characteristics like those commonly used in optic rotation.



So, by the combination of these elements it was possible to achieve:

- Red sector with three occulting lights
- White sector with three occulting lights
- White fixed light
- Red fixed light.

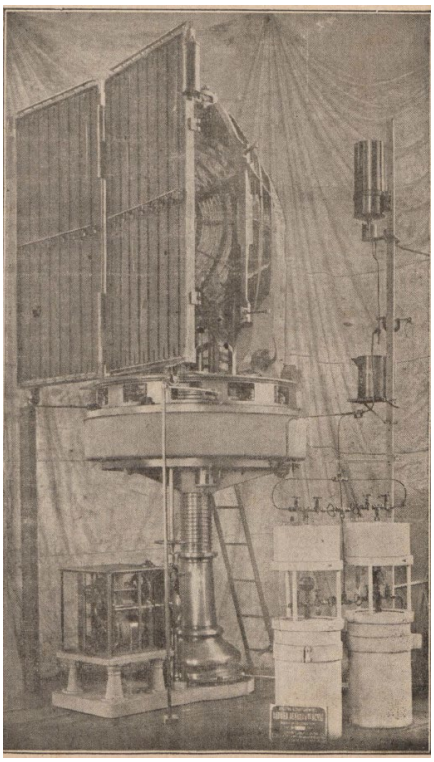
Following the resolution of the lighthouses Commission in 1987, the Otter shutters, were eliminated and the rhythms in the lighthouse was simply transformed into a Fl(3), being either red or white depending on the sector in which we find ourselves, and that was achieved through a red filter.

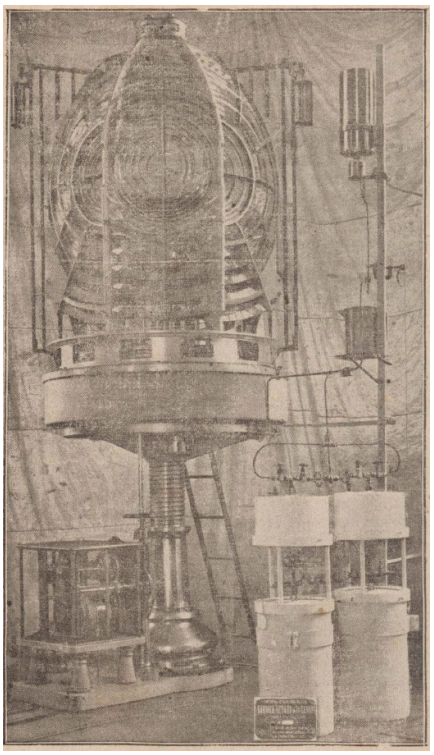
The same Optic is still staying, and groups of flashes are accomplished by power-lamp.

5.2 Corrubedo Lighthouse

This lighthouse, built in 1852 was historically known as "the Red Lighthouse". The reason was its light was red in all sectors.

With rotating lens, in two of its optical panels there were two Otter displays, so that they were just closed in the sector which was intended to indicate danger. In this case, the mechanism triggering these screens, was part of the same system of rotation of the optic.





In this case, the Otter shutters had a vertical configuration.

In the past, the appearance of the lighthouse was fl (3 + 2) in free sector and fl (3) in the danger sector.

After the resolution of the lighthouses Commission in 1987, both Otter shutters and red light were retired, placing red panels in the danger zone, withdrew so now the appearance is Fl (3+2) being white or red depending on the sector in which we find ourselves.

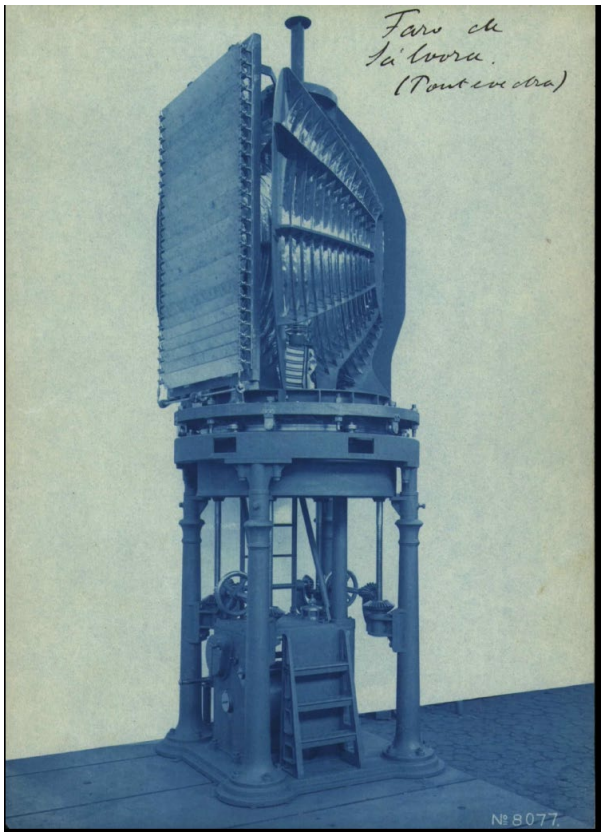
There have not been any changes in the optic which is still rotating.

5.3 Sálvora Lighthouse

This is a rotating headlamp that installs a system of Otter screens in one of its panels and whose purpose is to hide the light of this panel just when it passes through a certain sector to give a different feature in this sector; in the free sector is GpD (3+1) and in the dangerous one is GpD(3).

This lighthouse is located on the island of Salvora, that nowadays belons to the Atlantic Islands Maritime-Terrestrial National Park National.

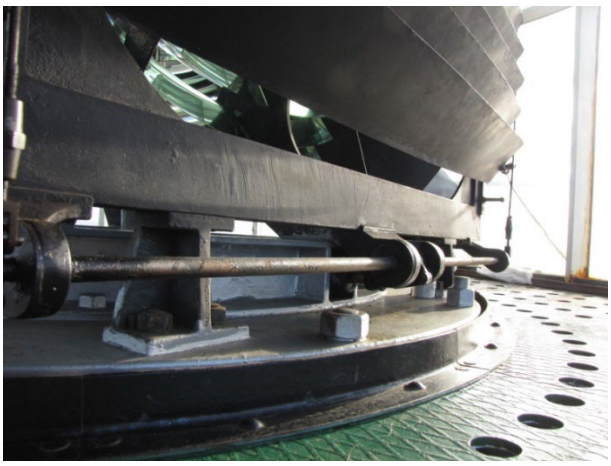
The equipment currently in service is the same as the original one (1921). The only thing that has been modified is the light source, which was originally petroleum vapor incandescent, but is currently electric incandescent with photovoltaic energy and the drive system for rotating the optics since, although the clockwork machine of motor weight, this is not used being an electric motor that produces the rotation movement of that.



It is a facility with a layout similar to that described for the Corrubedo lighthouse but, in this case, it is a single flash to show or hide.

At the Sálvora lighthouse, the Otter shutters, with a total of twenty-five linked sheets, are arranged horizontally.

The movement of the sheets is produced by a mechanism activated by a cam attached to the frame of the optics and making shutters open or close when passing by a selected sector.



Working this way, this Lighthouse features Fl(3+1)w in the free sector and Fl(3)w in the dangerous sector, in an arc of circumference of 34º.

Even though the resolution of the lighthouses Commission of the year 1987, proposed the modification of the characteristic making this system inconsistent, the resolution was never executed. Thanks to this, these shutters could be saved, which are a unique and historical industrial element, by the singularity when it comes to combine different rhythms in a unique luminous facility.

Although this configuration of the system has been maintained and a recent action has fine-tuned the lantern, taking advantage of technological advances to provide a better service to users. The target was to keep the original equipment in operation to preserve its unquestionable technological value and, at the same time, make the information that the lighthouse on the island of Sálvora must provide to the navigator.

To do this, the flash is now hidden in the dangerous sector, but not with the corresponding optics panel, since this will continue to be hidden by the Otter schutters, but with a new equipment of red led projectors that covers the same 34º sector.

This new luminous signal is powered and synchronized by the lighthouse optic but with the precision provided by the current teams with LED technology. Thus, a red color flash is available during the period in which the Otter schutters hide the isolated flash. We believe that a combination of a group of three white flashes followed by a red flash allows a better interpretation of the information that is intended to convey to the user than the previous group of three white flashes.

5.4 Maspalomas Lighthouse

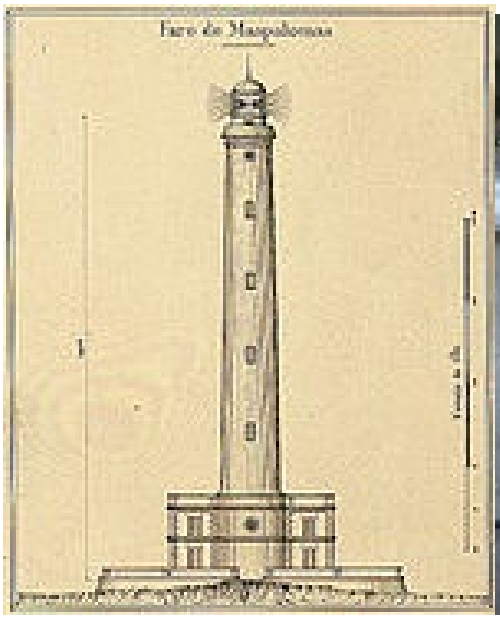
This lighthouse is one of the few in Spain that has kept its original installation (optics and characteristic generation system) since its inauguration in 1890.

The lantern is a glass dome 3.7 meters in diameter, covered at the top. Inside it are the optics, the reflectors and the 1000-watt halogen lamp, which emits a white light at the rate of a group of slow flashes with a frequency of 1+2 of 13 seconds between groups. The flashes have a nominal nighttime range of 19 nautical miles.

In the 90s an unfortunate action eliminated the screens that produced the concealments to be replaced by a 1000W halogen lamp that generated the characteristic through a flasher.

The tower has an average diameter in the upper body of 6.20 meters, a height of 54.70 meters and at its culmination the lantern is located, with which the set reaches a height of 60 m.

As a result of the present study, this action was detected, and the possibility of installing the old rotation system with concealment screens, which fortunately had been preserved in a warehouse, was studied. At present, the lighthouse works with the original system of revolving screens and with a 1000W discharge lamp; In addition, it has been possible to increase the theoretical range by 3 Mn., going from 15 to 18 miles of nominal range.



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[1] Documentary collection Ports of Spain.

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AUTHOR BIOGRAPHY

Javier Martin is the Deputy Director of Port and Operations and Aids to Navigation at Puertos del Estado, Spain. He has a Civil Engineering degree and Masters degrees in the European Union and Ports Management and Intermodal Transport.

S205.3 Valorisation of Lighthouses, the Italian way (173)

Angelo Patruno, Italian Navy Director of National Maritime Signalling Service of Italian Navy Logistic Command, Italy

ABSTRACT

Notes on the Italian Navy National Lighthouses and Maritime Signalling Service, its responsibilities in the management of the majorities of national signals (including all 147 Italian lighthouses) and its organization. Notes on the signalling modernization plan, which involved technological efficiency and a reduction in the necessary personnel. “Lighthouses: a value for the country”, the italian project for the valorisation of the infrastructures (former housing for technical personnel) present in the Lighthouses and no longer useful to the Service. Example of valorisation of the Genoa Lighthouse (so called “Lanterna”) through an agreement with the “Institution of the Sea and Migration Museums” (a public institution embedded into the Municipality of Genoa). Example of valorisation of the Trieste Lighthouse (so called “Faro della Vittoria”) through an agreement with ERPAC – a public institution for the Cultural Heritage of Friuli Venezia Giulia Regional Authority.

(No paper submitted)

AUTHOR BIOGRAPHY

Captain Angelo Patruno was born in Bari in 1967. He graduated from the Naval Academy as Ensign in 1989. In 1990 he achieved qualification in "Naval Artillery" and was assigned as “Gunnery Officer” on board Cruiser Andrea Doria and Corvette Chimera In 1997 he assumed Command of the Ship Tremiti. From 1998 to 2000 he was assigned as Operation Officer on board Frigate Lupo and Frigate Perseo. From 2000 to 2002 he served as “Sea Rider” within the Navy Training Center. From 2003 to 2005 he served in Petty Officer School in Taranto. In 2006 he assumed Command of the Navy Training Sail Ship Palinuro.

SESSION 206 – LIGHTHOUSE HERITAGE AND CONSERVATION CASE STUDIES

S206.1 Restoration of El Gran Roque Lighthouse (105)

Manuel Segredo Alayón, Venezuelan Navy Hydrogrpahic Service, Venezuela

ABSTRACT

Within the contents of the Strategic Plan developed by the Venezuelan Navy Hydrographic Service, It´s included the reconstruction of the "EL GRAN ROQUE" Lighthouse was planned, whose construction dates from 1874. It was located in its current location (Los Roques Islands), at 85 meters above the mean sea level, that warrantees the projection of light beam up to 36 nautical miles away.

The Lighthouse consists in a structure of 14,58 meters in height with a square base of 6.10 meters by side. After 105 years of its last restoration and after a lack of use from 65 years ago, a restoration project was carried out, given its potential as an aid to navigation, not only because of its location, but also because of the robustness of the construction and his great patrimonial value, avoiding his collapse in the next years and in the same way preserving this important building for future generations.

The work consists of external and internal maintenance of the lighthouse, basement recovery operations, maintenance to the surrounding areas of the lighthouse, construction of the inner and upper platform in steel (galvanized) in order to install securely a new state-of-the-art photovoltaic lighting system.

(No paper submitted)

AUTHOR BIOGRAPHY

(No biography submitted)

S206.2 Great Lighthouses of Ireland - Delivering Sustainable Economic Benefits to Coastal Communities (156)

Clodagh Hanratty, Commissioners of Irish Lights, Harbour Road, Dun Laoghaire, Dublin, Ireland
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ABSTRACT

Great Lighthouses of Ireland (GLI) is a collaborative tourism initiative developed by the Commissioners of Irish Lights (Irish Lights) in recognition of the need to protect its Aid to Navigation heritage and enable the development of sustainable tourism in coastal locations throughout the island of Ireland.

This paper will outline the mechanisms through which Irish Lights is enabling the re-use of lighthouses and ancillary structures via collaborative approaches with local authorities, community groups and government agencies. Representing 16 sites, this exciting initiative is aligned with government policy in areas such as tourism heritage and rural development on the island of Ireland, North and South. It will share the results of an independent socio-economic review from 2018 confirming that Great Lighthouses of Ireland delivered an economic benefit impact of €16.86m and supported 409 jobs in coastal communities.

Additionally, it will articulate how Great Lighthouses of Ireland facilitates innovative use of lighthouse heritage, with a mix of visitors' centres, guided tours on land and sea, cafés and accommodation along with stories of people, places and technologies that have protected Ireland's coasts past and present. Through the application of collaborative structures, funding and marketing mechanisms, the paper will outline how this initiative works to protect Ireland's lighthouse and maritime heritage by developing it sustainably and sensitively for the benefit of future generations.

KEYWORDS: Protecting Ireland's marine built heritage; sustainable community cultural and coastal development; positive socio-economic impact

1 INTRODUCTION

Great Lighthouses of Ireland is a valued and applauded, all-island tourism initiative developed by the Commissioners of Irish Lights, the General Lighthouse Authority for the island of Ireland. As the maritime organisation delivering an essential navigation safety service around the coast of Ireland, Irish Lights is constantly transforming the delivery of its services, putting the emphasis on efficiency, cost-effectiveness and sustainability, while exploiting new technology and new opportunities wherever possible.

Throughout its history, Irish Lights has recognised its obligations as a guardian of maritime heritage and by its presence on the coast it seeks to positively impact on coastal communities through the provision of its core services and through the alternative use of its coastal infrastructure for tourism and heritage activity.

Launched in 2015, Great Lighthouses of Ireland (www.greatlighthouses.com) is a key pillar within Irish Lights corporate strategy, *Safe Seas- Connected Coasts*, which recognises the importance of working with third parties to:

- Protect and share its maritime heritage and culture for the benefit of all the people and communities on the island of Ireland.
- Lead engaging coastal community programmes that deliver meaningful socio and economic outcomes for all its stakeholders.
- Deliver exemplar sustainable maritime and tourism experiences.

1.1 Context

Irish Lights has been operating around the coast of the island of Ireland for nearly 250 years. In recent times, advances in technology and automation opened opportunities to consider a range of new uses for existing physical infrastructure and tourism development was the obvious option for a number of lighthouse sites. Therefore, in 2012, Irish Lights took a proactive and strategic approach to invest in number of surplus properties and secured €2.56 million (from EU INTERREG IVA Programme Fund) for the development of an all-island lighthouse tourism initiative. The funding enabled the refurbishment of five lighthouses, located across Ireland's northern coastline and facilitated the establishment and delivery of a brand and partnership model, now known as, Great Lighthouses of Ireland.

This initial investment and effort was cited as an ambitious and imaginative cross-border project when launched in 2015. Positioned as a "**new experience to take your breath away"** with a promise to offer unforgettable experiences, **create a deep appreciation of the role of lighthouses**, past and present and the maritime and seafaring story of the island of Ireland across an initial network of 12 lighthouses.

The building blocks for its development, have provided a robust foundation for its growth over the last eight years and these include;

- A commitment to partnership and collaboration between many coastal communities and organisations, each with different and specialist skills, who collectively have promised to deliver memorable and enriching visitor experiences with lighthouses at their core.
- A shared ambition to ensure the partnership is recognised by funders, agencies and communities as one that is sustainable, creative and innovative.
- An objective to make the Great Lighthouses of Ireland brand a signature experience and part of Ireland's most important regional coastal tourism agency propositions including, Wild Atlantic Way, Causeway Coast and Ireland's Ancient East. [2]

In leading and investing in Great Lighthouses of Ireland, Irish Lights is committed to the development of a sustainable economic model and partnership that facilitates a range of third parties including local authorities and community groups to collaborate for the benefit of many.

[2] Failte Ireland is the state tourism development authority for republic of Ireland. Regional propositions include Ireland's Hidden Heartlands, Ireland's Ancient East, Dublin and Wild Atlantic Way.

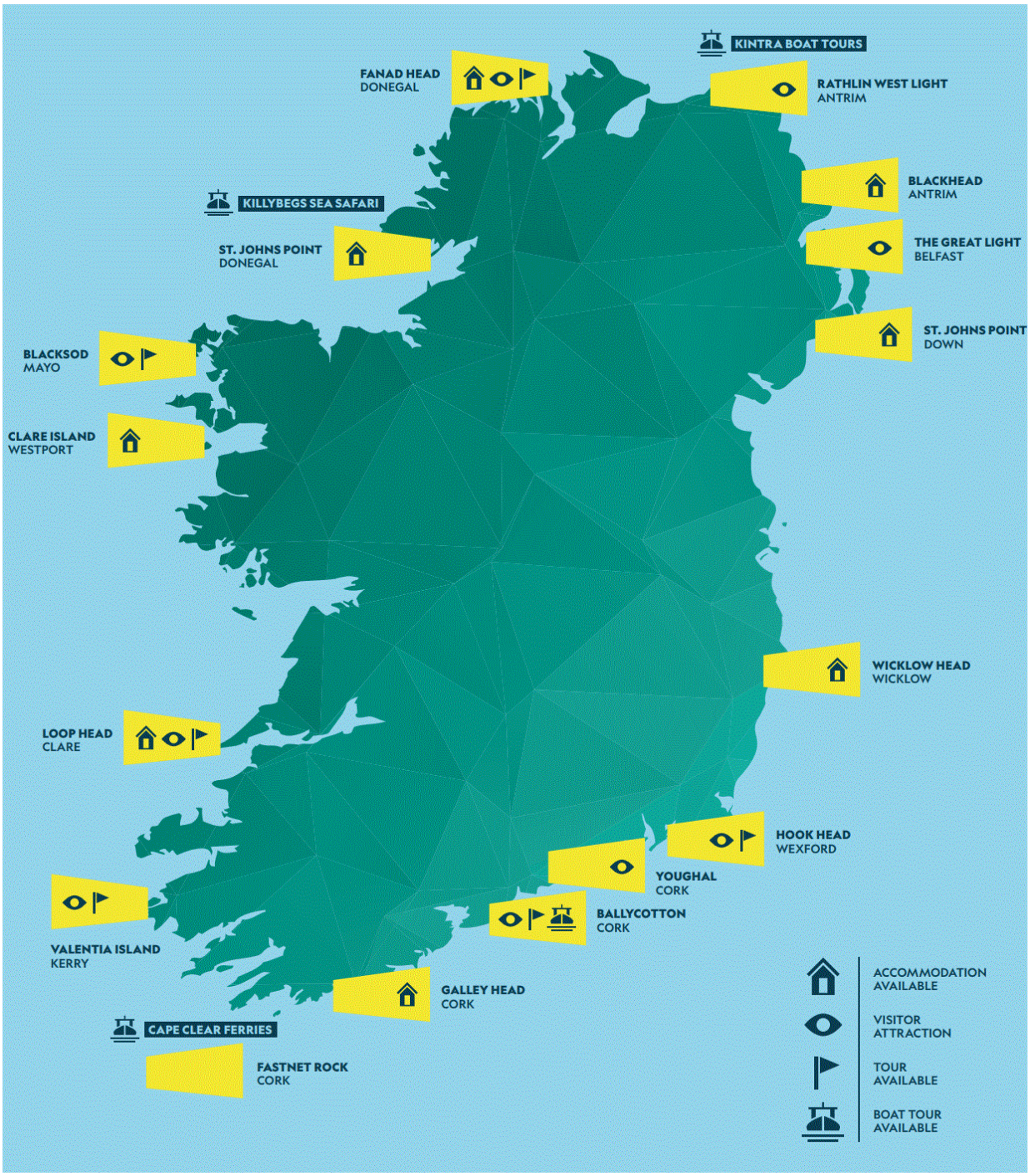

Figure 1 Map of Great Lighthouses of Ireland

2 BRAND MARKETING AND DEVELOPMENT STRATEGY

Tourism is one of Irelands most important economic sectors and despite the turbulence of recent years it remains a key driver of national, regional and local socio and economic benefit, particularly in rural coastal areas within which the Great Lighthouses of Ireland are located.

The tourism sector was one of the hardest hit by the impacts of the Covid- 19 pandemic, however following this, all Great Lighthouses of Ireland partners recognised the opportunity to respond to increased demand for what is known known as slow sustainable rural tourism, as consumers continue to seek experiences that they

believe minimise their impact on the environment and contribute to local economic wellbeing. It is reassuring to note our vision and proposition is highly credible, now and into the future.

Vision

The Great Lighthouses of Ireland experience will be recognised for the warmth and welcome of our people, complemented by the richness and beauty of our places, landscape and heritage all of which are closely intertwined with partners at community, regional and national level - making Great Lighthouses of Ireland a unique experience for the domestic and overseas visitors.

At the core of this vision are the **three key building blocks** of **People** (Story keepers and Communities), **Place** (lighthouse as local destinations) and **Partnership** (national and coastal communities).

2.1 Target Market and Consumer Segments

Great Lighthouses of Ireland is building growth with four domestic and target two international market segments (segments as defined by Fáilte Ireland, Tourism Ireland and Tourism Northern Ireland). The brand marketing strategy is underpinned by aligning its efforts in targeting the international consumer segments identified by the tourism agencies and those that represent the" best fit".

Domestic Market Republic of Ireland (ROI) and Northern Ireland (NI)

- *Connected Families / Family Fun* - families with young children. Their core motivation is to spend quality time together and enrich family life.
- *Indulgent Romantics / Time Together* - couples that are seeking a romantic getaway through which they can reconnect with each other while enjoying wonderful surroundings.
- *Mature Cosmopolitans – NI and ROI markets* -older couples and small groups seeking relaxation and a little indulgence, they want to stay in quality places and explore the sights.
- *Footloose Socialisers* - travel in groups of friends; for those holidays are about sharing experiences with likeminded people and experiencing really local life

International Segments

- *Culturally Curious* - very independently minded people that are interested in places of historic and cultural interest.
- *Great Escapers* - all about getting away from it all, renewing family bonds and spending time together in a beautiful place.

Niche markets

Great Lighthouses of Ireland also seeks to engage with and attract visitors across a number of niche or expert markets, notably international and specialist lighthouse societies, maritime heritage and education groups. In 2022, the US Lighthouse Society (https://uslhs.org/) visited Ireland to experience a number the Great Lighthouses of Ireland and is exploring the potential for future collaboration around some shared initiatives.

2.2 Strategic priority areas

The basis of the brand strategy is focussed on **four strategic priority areas**;

Priority 1: Digital Development

Goal: Great Lighthouses of Ireland is recognised and valued by consumers and partners for its motivating digital campaigns and business impact

Priority 2: Marketing and Promotion

Goal: Data and insights are informing ongoing development and investment in shared consumer promotions and publicity initiatives is delivering more visitors and revenue for all partners

Priority 3: Partnership and Alliance

Goal: Great Lighthouses of Ireland is valued by all its partners for initiating and securing supports that deliver additional resources to support capital investment, experience development, marketing and consumer engagement

Priority 4: Sustainable Tourism Development

Goal: Partners demonstrate a shared and individual commitment to sustainable tourism development in a manner that enhances each business and its contribution to the community and region.

Following recent international tourism research and benchmarking conducted by Failte Ireland, consumer testing, product audits and partner inputs, a new strategic plan is currently being developed for Great Lighthouses of Ireland. This will shape the brand ambition over the next 10 years, inform key pillars of activity for the next 5 years and all for targeted annual plans.

3 PERFORMANCE

For such a young brand and partnership much has been delivered and many development opportunities realised. Great Lighthouses of Ireland now represents, **16 sites** and **19 operating entities** around Ireland, including a mix of local authorities, community groups and government agencies, with a collective delivery ambition that is aligned with Government policy in areas such as tourism, heritage and rural development on the island of Ireland, North and South.

An independent socio-economic report [3] released in April 2019 confirmed that **Great Lighthouses of Ireland delivered economic benefit impact of €16.86m to Ireland's economy** and supported **409 jobs in the wider coastal communities**. 143,580 visitors and guests spent money and time at a lighthouse in 2019 and all partners were optimistic for further growth in 2020, particularly from the overseas market. Lighthouse accommodation sites were also performing well with an **average occupancy of 46%.**

However, in February 2020, Ireland like the rest of the world was impacted by the arrival of COVID-19. Despite the challenges associated with the pandemic, the brand partnership focused on shared initiatives involving collaboration with other sectors, such as heritage and culture. This delivered significant benefits and has positioned Great Lighthouses of Ireland as an exemplar in delivering sustainable maritime and tourism experiences with and by host communities.

The post COVID recovery is underway and Great Lighthouses of Ireland is **well positioned for the future**. **2022** was a good year for the brand partners, with **362,253 visitors. This represents 129,257 ticketed tours (includes boat trips), 4,340 overnight guests with an additional 228,656 people spending time within the lighthouse vicinity.** The estimated **average occupancy** across the accommodation sites was circa **74%** which demonstrates the level of interest in lighthouses as unique and bespoke overnight destinations.

3.1 Unlocking investment

Irish Lights is delighted to be able to support heritage-led regeneration by making its sites available where appropriate and underlines its continued commitment to the protection and preservation of its built heritage, benefitting its historic structures and creating employment for coastal communities. Lighthouses represent a continued and significant boost to the preservation of Ireland's coastal built heritage.

[3] KHSK Economic Consultants 2019- Socio-Economic Impact Review of the Great Lighthouses of Ireland Initiative

The **success of Great Lighthouses of Ireland** to date has encouraged other stakeholders and communities to explore repurposing historic buildings to **create liveable, low carbon and resilient coastal centres**. An example of such an investment currently underway is at Fort Dunree, County Donegal on the Northwest coast. This project has **secured investment of €12.5million** from Fáilte Ireland's Platforms for Growth Investment Grants Scheme for the development of immersive heritage and cultural attractions. It will see the development of a new world-class visitor experience which will include the lighthouse compound and will showcase its considerable maritime, military, social and political history, telling engaging stories across each of these facets. The overall project when completed is **expected to generate €19.5m** in direct tourism expenditure supporting significant job creation in the remote Northwest region of Ireland.

3.2 Alternative value of Lighthouses

In addition to the monetary value of Great Lighthouses of Ireland there are a number of other non-market values that can be attributed to the lighthouses which include conservation, future use, and bequest values.

- Conservation Value- people value the conservation of historic sites and their preservation
- Future Use- preserving the lighthouses for a currently unknown uses to be exercised in the future
- Bequest values- place a value on being able to bequest valuable assets to future generations

3.3 Lighthouses as Beacons for Destination Development

Ireland has experienced unbalanced regional development problems for many years leading to ever congested urban areas, while more remote areas often appear stuck in a cycle of socioeconomic decline. The result is a drain of the population and the most valuable productive resources towards urban areas. However, by providing a core for development in remote coastal areas, projects such as the Great Lighthouses of Ireland initiative provide a mechanism, albeit on a relatively small scale, for the type of intervention to create a positive impact. In this context, the involvement of community organisations with a strong local base and a bottom-up approach are both very important. Therefore, Great Lighthouses of Ireland is creating value through addressing the issues that result in some regions declining and highlights the beneficial impact that arises from the demand that is created by the development of lighthouses.

Additionally, Ireland's heritage is a regionally dispersed resource and is one where the returns to investment accrue to dispersed communities. The sustainable development of Ireland's regions will require that the resources in the regions are translated into value. Investment in the heritage resources is required to achieve this. The benefits are multiplied when the value of people being able to remain in their own areas while attaining a desired standard of living, rather than migrating to congested areas, is recognised. In this regard, public funding programmes such as the Built Heritage Investment Scheme or the Historic Structures Fund will be necessary to provide much needed financial support to Ireland's built heritage.

For more than two centuries, Irish Lights has provided crucial safety and navigation services around the coast of Ireland. The network of lighthouses that form the Great Lighthouses of Ireland is a symbol of this long heritage of innovation, as well as a testament to the loyalty and dedication of the lighthouse keepers. Now, Irish Lights is delighted to offer visitors a glimpse into the role of lighthouses, past, present and future. Together with its partners, it works to shine a light on unique and breath-taking experiences by linking to its past and protecting its future.

Irish Lights do this where land meets the sea by:

- Sharing its heritage and culture with all visitors and stakeholders
- Providing meaningful local jobs and opportunities
- Featuring local food and crafts
- Promoting Leave No Trace - Outdoor Ethics Education Programme
- Developing a shared commitment to sustainable management systems

4 CONCLUSION

Great Lighthouses of Ireland has established itself as a significant and innovative all-island tourism brand partnership that is delivering real sustainable economic benefits to coastal communities. Since its formation in 2015, the combined effort of all partners has ensured that lighthouse visitor experiences are a valued tourism asset for the island of Ireland, showcasing the island's maritime heritage, supporting coastal communities and creating economic benefit for all involved. The objective going forward is to continue to support the delivery of economic benefit to Ireland's economy and support jobs in the wider coastal communities.

The future for Great Lighthouses of Ireland is positive against a backdrop of global uncertainty. The aim is to sustain the growth in visitor numbers supported by a targeted marketing approach to domestic/international markets coupled with the partners' ability to deliver signature experiences that deliver on the promise of Irelands national tourism propositions. While planning in the current climate is difficult, it is anticipated by tourism agencies and industry sources that those who do travel (both local and international) will be looking for wellbeing, credibility and culture. Furthermore, as highlighted previously, slow and sustainable travel, particularly in the more rural and coastal areas of the island, is expected to be in demand and Great Lighthouses of Ireland has much to offer in this regard. Both Irish Lights and the brand partners are committed to working together to become stronger, more versatile to best position the lighthouse sites for the future.

The experience of Great Lighthouses of Ireland to date demonstrates the important economic value that lies in lighthouse heritage and the potentially high returns to investment in these unique buildings in terms of local and community development. The associated employment and the incomes that are created are of real value, both economically and socially. In that context, the brand will be working closely with Failte Ireland (Ireland's tourism agency) to develop the next stage of lighthouse tourism development under their strategic pillar of "Opening the Outdoors". The goal with this is to transform Ireland's outdoors and associated activities to a world class experience with a commitment to environmental sustainability at the heart of tourism development. The objective is to position Ireland's lighthouses to secure investment that reimagines, optimises, and opens the outdoors, and leverages state-owned assets, yet contributes to government objectives for climate action and biodiversity both of which are key priorities.

This ambition has been informed by recent international lighthouse tourism research commissioned by Failte Ireland which highlighted opportunities to design a more significant suite of product development interventions harnessing the appeal and draw of lighthouses around the coast of Ireland and convert the passive visitor into a more active consumer of lighthouse product offerings.

Irish Lights maintain and manage Ireland's lighthouses which provide a critical navigational role while at the same time it protects the heritage and seeks to develop their cultural role and potential for tourism development. In that context, it will continue to lead and support Great Lighthouses of Ireland as a core element of its corporate strategy as an important and strategic outreach initiative. The development of collective partnerships that support lighthouse heritage preservation, contribute to coastal community engagement, culture and social life, help unlock site investment, creativity and reinforces the message associated with sustainable development is a core objective for Irish Lights into the future. Great Lighthouses of Ireland provides the ideal platform for Irish Lights to harness the appeal of its lighthouse network around the island and to showcase all that Ireland has to offer.

AUTHOR BIOGRAPHY

Clodagh Hanratty joined the Commissioners of Irish Lights in early 2023 as Director of Coastal Operations. Clodagh is a Chartered Civil Engineer with expertise in Contract Law, Design, Environmental, Safety and Quality Management. Clodagh has an extensive career both in Ireland and overseas including the UK, Hong Kong, Thailand and the UAE working at senior level for Civil contractors, Design Consultant and within the Public Sector. She has a wealth of experience in large Civil Engineering projects including Metros, Road Infrastructure and Marine works together with public works building projects. Clodagh leads the Coastal Operations, Property Management, Safety and Quality, Support and Planning and Commercial Services teams in Irish Lights.

S206.3 Historical Homigot (Cape Clonard) lighthouse as a living lighthouse heritage (193)

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ABSTRACT

Homigot Lighthouse is located in Pohang the easternmost of the Korean Peninsula. Homigot became first known to as Cape Clonard in the West through the navigation log by La Perouse, a Frenchman who embarked on a global exploration in 1785. Homigot Lighthouse represents as an outstanding accomplishment of modernization that numerous civilized countries scrambled to attain in the early 20th century. Located where the geographical risk of earthquakes is high, the structure was nonetheless built to be 26.4 m high with brick masonry. Structurally safe and aesthetically graceful, it demonstrates neoclassical ideas superbly in terms of style as well. Although the history of Asian lighthouses is shorter than that of European ones. Homigot Lighthouse, which demonstrates the history of a modern lighthouse along with those in Japan and China, is differentiated by the following characteristics. ① The "living lighthouse heritage" is linked to the largest lighthouse museum in the world. ② Where you can see the earliest sunrise at the easternmost of the Eurasian Continent. ③ The completion of a modern-style lighthouse constructed at the easternmost of the Far East after being initiated in Europe. ④ Differentiated historical, architectural, and aesthetic value. ⑤ The heart of the national marine park.

KEYWORDS: Homigot, Homigot Lighthouse, La Perouse, Cape Clonard, Daehan Empire, John Reginald Harding, Pohang, Living Lighthouse Heritage

1 INTRODUCTION

Homigot Lighthouse is located in Homigot-myeon, Nam-gu, Pohang-si, Gyeongsangbuk-do, in the easternmost of the Korean Peninsula. "Homigot" is the transliteration of its Korean pronunciation which means a cape(*got*) on a tiger's (*ho*) tail(*mi*). Korean people find the Korean Peninsula shaped like a crouching tiger, so the cape is called "*Ho-mi-got*." Homigot became first known to the West through the navigation log by La Perouse, a Frenchman who embarked on a global exploration in 1785. The French government published his journal and book of navigation maps titled Atlas du Voyage de Perouse in 1797, where the cape was referred to as Cape Clonard, as it was to be known widely in the Western world. The Korean Peninsula from the late 19th to the early 20th century was a kind of melting pot of modern civilizations introduced from all around the world. [1] Homigot Lighthouse was built in 1908 to reflect the topographic characteristics along with the will to modernization stirred up by Western powers. The lighthouse has carried out its duty of providing navigational aids steadily and unwaveringly through numerous ups and downs maintaining its beautiful appearance for over 110 years.

2 HISTORIAL VALUE OF HOMIGOT LIGHTHOUSE

2.1 Symbolic values

In the early 20th century, the Korean Empire, which was named then as the predecessor of the present-day Republic of Korea, was struggling to strike a balance between the goals to establish the national status and realize the idea of modernization. The construction of Homigot Lighthouse, however, was beyond the practical conditions of the time, such as mass-produced bricks enabled by modernization, neoclassicism as a new style, the will to form-making beyond functions, the new definition of interior space, accommodation of types of equipment enabled by new technologies, and the like. This is quite remarkable given that most Korean buildings realized ahead of this lighthouse were timber-framed. [2] In addition, it symbolically represents the national idea. The Korean plum flower emblems, standing for the authority and dignity of the imperial family of the Korean Empire, are engraved on the ceilings from the first to the sixth stories. Also the everyday life of

keepers of this lighthouse represents a certain aspect of the global historical landscape formed around the peninsula in the early 20 th century. In Homigot, thus, coexist double sides: the silent high rising figure on solid rocks inside, and the great historical narratives outside.

2.2 Architectural Values

Homigot Lighthouse was conceived in 1903 by John Reginald Harding, an English architect employed by Korean Empire. If European countries such as the United Kingdom and France opened up the international exchange by building lighthouses in the 16 th century, Korea at the easternmost of Far East Asia demonstrated the completion of such European modern lighthouse architecture in the early 20 th century. For this lighthouse, red bricks were used to build the structure while concrete and lime were applied to finish the exterior. Rising from the bottom to the top beautifully, it has the entrance and windows following the neoclassical style, with a high level of perfection in terms not only of construction but also of aesthetics. In technical terms, too, it is 26.4 meters high, which was the highest for a lighthouse at the time of completion. For more than a century, it has endured several earthquakes and remained intact, still operating today with no trace of damage on the masonry walls. [3]Beyond the characteristics of an architectural structure, this lighthouse still maintains its pure form in an elegant linear composition, displaying a perfect harmony between materials, structure, and construction technology.

Figure 27 & 2: Homigot Lighthouse currently in operation

Figure 3: Korean Lighthouses in 1908

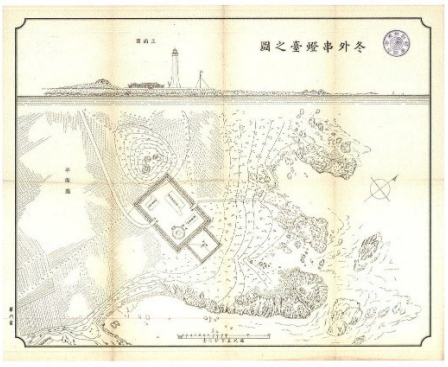
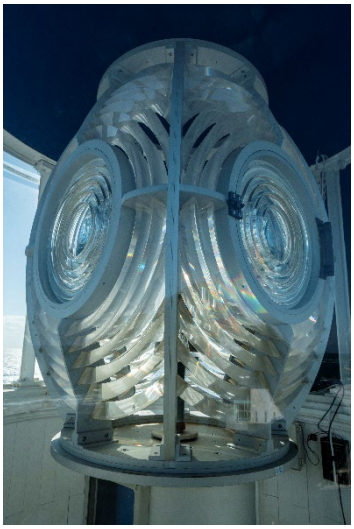


Figure 4: Architectural Drawing in 1908

Figure 5: Homigot Lighthouse in 2022

2.3 Functions

The first beacon at Homigot Lighthouse was the 4 incandescent oil vapor lamps manufactured by the British company Chance Brothers & Co. Every 30 seconds, it paused for 20 seconds and then gave off two consecutive white flashes lasting ten seconds, with a luminous range of 30 km. In 1959, a new aeronautical beacon was installed for the sake of cost and durability. Thereafter, a solar sensor was placed inside the beacon for automatically turning on and off. The beacon used currently is a 750mm large rotating beacon installed in December 2002. It gives off one white flashlight per 12 seconds with a luminous range of 42km. The lantern room of Homigot Lighthouse was the first installed for the grade 4 lamp in 1908 and was used long until the entire lantern, except the walls supporting it, was newly built in 2006. For the audible aids (fog signal), an air siren is used. The siren comes once for four seconds after 56 seconds of silence per minute, and the audible distance is five miles (about 8 miles). Radio Beacon which provides radio aids is equipped with the differential global positioning system(DGPS). Radio Beacon was established in 1965, followed by DGPS in 2000, and the automatic identification system(AIS) is also installed at present. [4]



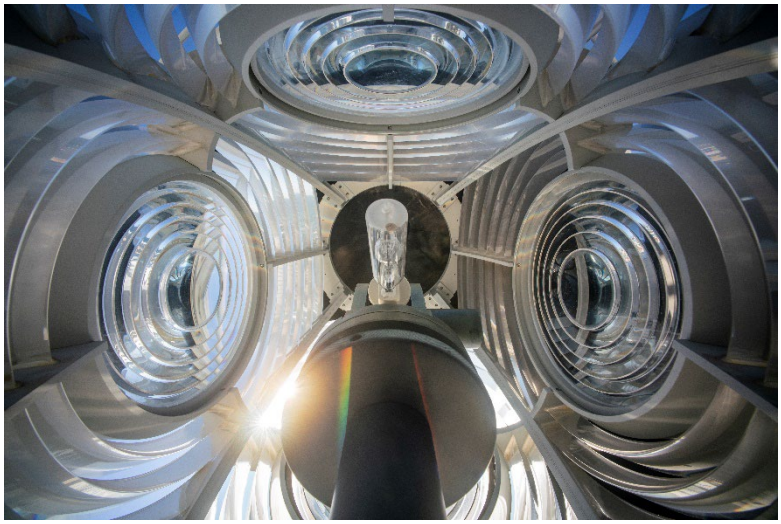


Figure 6 & 7: Beacon inside the seventh floor

Figure 8,9, & 10: Architectural ornaments in Homigot Lighthouse

2.4 Culture and nature around the lighthouse

A tourist area is formed around Homigot Lighthouse with a focus on the cultural heritage and ecosystem. Completed or ongoing development projects around the lighthouse are also aimed at highlighting and promoting its value as a cultural heritage. The comprehensive renovation plan of the lighthouse includes the extension of the National Lighthouse Museum and the establishment of a national marine garden. Still, Homigot Lighthouse remains the center of all these various new facilities.

Figure 11: Pine field and Homigot Lighthouse

Figure 12: Cultural event and Homigot Lighthouse

Figure 13: View of Homigot Lighthouse in 1960s

Figure 14: View of Homigot Lighthouse in 1970s

2.5 Homigot Lighthouse and Heritage

Homigot Lighthouse is designated as Gyeongsangbuk-do MONUMENT No.39 and National Lighthouse Heritage No.10. The Comprehensive study on the Lighthouse Heritage conducted in 2021 highlighted the background and historical context, functions and symbolic values of lighthouse architecture, with its actual structure measured in precision and archived in detail. The drawings based on actual technical precision measurements are also recorded for preservation and repair. 3D scan was used to figure out the interior spatial structure of the lighthouse, leading to the drawing and archiving of not only the elevation but also the floor and section plans. [5]

3 HOMIGOT LIGHTHOUSE AND IALA HERITAGE LIGHTHOUSE OF THE YEAR

It has been confirmed through research that Homigot Lighthouse is quite suitable for the intentions and criteria of the IALA Heritage Lighthouse of the year awarded by the organization to preserve and promote lighthouse heritage:

1) Homigot Lighthouse is the starting point of the Lighthouse Road connecting not only to the Pacific Ocean but also to Asia and the European continent and fulfills the requirements for realizing new future values. The lighthouse welcomes the earliest sunrise at the easternmost of Far East Asia, which can continue through to Fisterra Lighthouse on the northwestern tip of Europe. It can connect the

world split by wars and different ideologies together, significantly announcing the start of one world extended widely. The uniform appearance will assist the reader to read paper of the proceedings. It is therefore suggested to authors use the example of this file to construct their papers.

2) Homigot Lighthouse represents an outstanding accomplishment of modernization that numerous civilized countries scrambled to attain in the early 20 th century. Located where the geographical risk of earthquakes is high, the structure was nonetheless built to be 26.4 m high with brick masonry. Structurally safe and aesthetically graceful, it demonstrates the neoclassical ideas superbly in terms of style as well.

3) The 19 th century IALA Conference held in Incheon, Korea, in 2018, announced the Incheon Declaration resolving to commemorate July 1 annually as the World Marine Aids to Navigation Day and select the IALA Heritage Lighthouse of the Year. In 2019, the first Heritage Lighthouse of the Year went to Cordouan Lighthouse. Brazil, in 2020: and the third to Cape Byron Lighthouse, Australia, in 2021. For 2022, the attention was extended to the Asian region. Although the history of Asian lighthouse, which demonstrates the history of a modern lighthouse along with those in Japan and China, is differentiated by the following characteristics:

3.1 The 'living lighthouse heritage' linked to the largest lighthouse museum in the world

The National Lighthouse Museum built next to Homigot Lighthouse has become the largest of its kind in the world after a new extension in 2022. Archiving and researching the world's lighthouse heritage, the museum is promoting the values of lighthouses through exhibitions and educational programs. It is thus capable of disseminating throughout the world not only the essential roles of lighthouses but also their values as lighthouse heritages.

3.2 Where you can see the earliest sunrise at the easternmost of the Eurasian Continent

Homigot first became known to the West by being specified as Cape Clonard in *Atlas du Voyage de La Perouse*, a collection of navigation maps published in France in 1797 after the voyage of La Perouse. As lighthouse indicate the connections between different countries. Homigot Lighthouse located at the easternmost of East Asia is connected to Fisterra Lighthouse on the northwestern tip of the Liberian Peninsula in Europe in terms of function. Symbolically, this enables us to imagine a new image of the world through the Lighthouse Road. It is deeply significant because a lighthouse becomes a symbol that connects the entire world as one, not just through the sea but also through land routes.

3.3 The completion of a modern style lighthouse constructed at the easternmost of Far Asia after being initiated in Europe.

From ancient times, lighthouses were the footholds of marine cultural exchange, and those built in modern style in the 16 th century played a critical role in marine transportation. Western powers raced to advance into East Asia and built lighthouses in Malaysia, the Philippines, China, and Japan. And finally in Korea at the end of the continent in the early 20 th century. In this context, Homigot Lighthouse can be seen as the completion of modern style lighthouse in terms not only of science and technology but also of aesthetics. Most of all, it shows the unique principles of form-making differentiated from those of Chinese or Japanese lighthouses.

3.4 Differentiated historical, architectural, and aesthetic values.

Homigot Lighthouse has historical, architectural, and aesthetic values differentiated from those of any other lighthouse in Korea. As the highest lighthouse in the country, it is elegant and beautiful with distinctive figures and values that cannot be found in any other. A masonry structure based on red bricks as it has, the lighthouse does not lose the elegance of its pure white linear composition, exhibiting its sublime posture at the height of 26.4 m. Even though it was the highest building at the time of completion, it has firmly endured throughout the years in Pohang, where the risk of earthquakes is high, and maintained its original form intact.

3.5 The heart of the national marine park.

The National Lighthouse Museum, the extension of which was completed in 2022, has become the largest lighthouse museum in the world. In addition, the Korean government developed a general plan to create a national marine garden with Homigot Lighthouse located at its center. If the lighthouse is designated as the Lighthouse of the Year. It will help expedite the implementation of the plan for the nation's marine garden.

4 CONCLUSION

Homogot Lighthouse is located in Pohang the easternmost of the Korean Peninsula. Homogot became first known to as Cape Clonard in the West through the navigation log by La Perouse, a Frenchman who embarked on a global exploration in 1785. Homogot Lighthouse represents as an outstanding accomplishment of modernization that numerous civilized countries scrambled to attain in the early 20th century. Located where the geographical risk of earthquakes is high, the structure was nonetheless built to be 26.4 m high with brick masonry. Structurally safe and aesthetically graceful, it demonstrates neoclassical ideas superbly in terms of style as well. Although the history of Asian lighthouses is shorter than that of European ones. Homogot Lighthouse, which demonstrates the history of a modern lighthouse along with those in Japan and China, is differentiated by the following characteristics. ① The 'living lighthouse heritage' is linked to the largest lighthouse museum in the world. ② Where you can see the earliest sunrise at the easternmost of the Eurasian Continent. ③ The completion of a modern-style lighthouse constructed at the easternmost of the Far East after being initiated in Europe. ④ Differentiated historical, architectural, and aesthetic value. ⑤ The heart of the national marine park.

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AUTHOR BIOGRAPHY

Jonghun Kim is a professor at Paichai University and director of Appenzeller / Noble Memorial Museum. He is an advisor to Cultural Heritage Administration of Korea. He was the 4th President of Docomomo Korea which is the Korean chapter of Docomomo International (International committee for Documentation and Conservation of buildings, sites and neighborhoods of the Modern Movement).

Jonghun graduated with a Ph. D in Architecture from Korea University South Korea, with a thesis on the subject of ' The Development of Korean Transportation Architecture ' and was a visiting scholar at MIT from 2004 to 2006. Jonghun Kim has worked widely for preservation projects of cultural heritages. He has published in various books, magazines, edited conference proceedings. He is the chairman of the Lighthouse Cultural Heritage Committee of Ministry of Oceans and Fisheries in Korea.

S206.4 Protection and development of Huaniao lighthouse as a world historical heritage (086)

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ABSTRACT

Huaniao lighthouse is one of the historical lighthouses in use in China, with important geographical position, large construction scale and the longest history. Its protection and development is distinctive and representative.

Located at the intersection of China's coastal route and the Yangtze River route which is busy with shipping, and facing the open sea in the east where there are many islands and reefs nearby, Huaniao lighthouse is an indispensable navigation facility for many ocean-going international routes like Shanghai Port, Ningbo - Zhoushan Port to Japan, South Korea and so on. Its geographical location is so important that it enjoys the reputation of being the first lighthouse in the Far East. The lighthouse was built by the British in 1870, covering an area of 22000 square meters. It has four rooms for management and work, whose building area are more than 300 square meters. It also has a giant ox-eye lens. It is listed as one of the world's "100 historical and cultural relics lighthouses" by International Association of Lighthouse Authorities (IALA), and is also the first batch of cultural relics lighthouses that have been protected in China.

This paper mainly introduces the work carried out around the protection and development of Huaniao lighthouse, as well as the cooperation between local government and people in culture, tourism, history, education, justice, and other aspects during the process.

KEYWORDS: Huaniao lighthouse; protection; development; historical and cultural relics lighthouse

1 INTRODUCTION TO HUANIAO LIGHTHOUSE

For centuries, lighthouses have played a crucial role in maritime navigation. Huaniao lighthouse is located at the northernmost end of the Zhoushan Islands in China, as shown in Figure 1. It is one of the most important and representative historical lighthouses in China. Its historical and cultural values, as well as its significance for maritime navigation, making it occupy a place in World Heritage List.

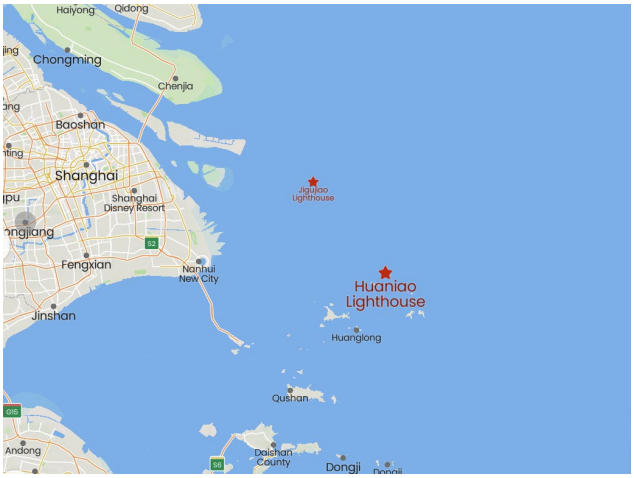

Figure 28: Location of Huaniao Lighthouse

Huaniao lighthouse, as shown in Figure 2, has a height of 16.5 meters. The tower body is a concrete masonry structure, and the lantern part is made of copper and iron plates. The giant ox-eye rotating lens has a diameter of 1.84 meters and a range of 24 nautical miles. The lighthouse covers a total area of 22000 square meters. In

addition to the lighthouse building, four management and work rooms with a building area of over 300 square meters have been well preserved, and a Huaniao lighthouse exhibition hall has been built.

Figure 2: View of Huaniao Lighthouse

The lighthouse was built in 1870, funded by Qing government's customs, and designed, built, and managed by the British. In 1943, after the outbreak of the Pacific War, Japan took over the lighthouse. During that period, the lighthouse was bombed by aircraft, but the damage was slight. Since 1950, it has been under the management of Chinese Army Navy, and was transferred to Shanghai Channel Bureau in 1980. It is now under the management of Donghai Navigation Safety Administration MOT.

2 THE CULTURAL SIGNIFICANCE OF THE LIGHTHOUSE

Huaniao lighthouse has historical and cultural significance and is a symbol of China's maritime history. As a cultural heritage, the lighthouse is an important component of China's cultural and historical heritage, representing China's achievements in navigation, trade, and diplomacy. In addition, the lighthouse also has important architectural value, and its unique design and construction make it a landmark of Chinese offshore architecture.

In August 1997, Huaniao lighthouse was listed as a historical and cultural site protected at the province level. In October of the same year, it was listed as a world historical and cultural relic lighthouse by IALA . In June 2001, it was listed as the fifth batch of major historical and cultural sites protected at the national level by the Chinese government. In June 2017, where the lighthouse is located was approved by the People's Government of Zhejiang Province as a navigation culture and education base for teenagers.

Huaniao lighthouse has been opened as a free tourist attraction. Since 2014, it has received nearly 300000 people to study, visit, and travel there. Five generations of Ye Zhongyang's family have been guarding the tower for over 60 years, and three of them have lost their lives for this cause. Their stories have touched countless Chinese people and have been recommended as "People Who Inspired China".

3 PROTECTION OF THE ORIGINAL EQUIPMENT AND FACILITIES OF THE LIGHTHOUSE

Over the years, Huaniao lighthouse has undergone numerous renovations and improvements to ensure its operation and preservation. However, like any historical site, the lighthouse is subject to wear and tear and human interference. The harsh marine environment, such as strong winds, heavy rain, and salt water corrosion, has caused damage to the structure and equipment of Huaniao lighthouse. Therefore, regular maintenance work is crucial to ensure the continuous operation and preservation of the lighthouse.

To ensure the operation of the lighthouse, a team of professional technicians has been established to carry out routine maintenance and inspection of the electrical and mechanical systems of the lighthouse. This work

includes regularly cleaning and replacing the lenses and bulbs, as well as inspecting and repairing the electrical and navigation equipment. Technicians also check the structural integrity of the lighthouse and make necessary repairs to prevent damage.

In addition to routine maintenance, several major restoration projects have been carried out for Huaniao lighthouse in recent years. These projects aimed to restore the original appearance of the lighthouse and ensure its structural stability. Repair work includes replacing damaged structural elements such as windows, doors, roofs, and repairing and repainting the exterior of the lighthouse.

One of the most important repair projects is to replace the original Fresnel lens (see Figure 3). The giant ox-eye lens weighing up to 6 tons has deteriorated significantly in the past few years and needs to be replaced to ensure its operation. In 2011, a replica of the original lens was reinstalled inside the lighthouse and is still in operation.

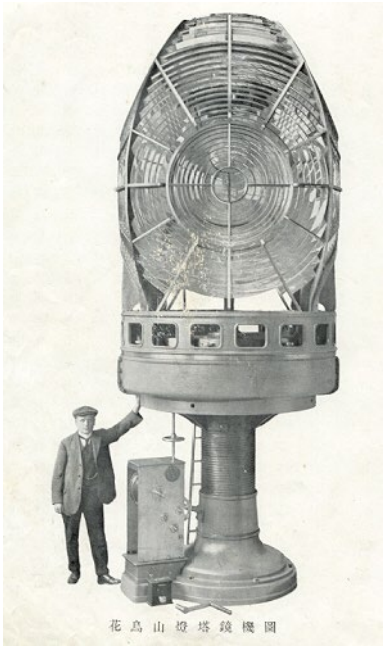

Figure 3: Original Lens of Huaniao Lighthouse

The restoration work not only ensured the continuous operation of the lighthouse, but also improved its appearance and accessibility for visitors. In recent years, the lighthouse has become a popular tourist attraction and an important cultural landmark. The restoration work helps protect the cultural and historical value of the lighthouse, while also allowing tourists to enter the lighthouse.

To ensure the long-term preservation and development of Huaniao lighthouse, sustainable development practices has also been implemented, including the use of environmentally friendly materials and technologies during restoration and maintenance.

4 DEVELOPMENT AND INNOVATION OF LIGHTHOUSE'S NAVIGATION AID FUNCTION

For seafarers drifting on the sea, the lighthouse is a bright coordinate that guides their way home. For over a hundred years, seafarers have been searching for it in the wind and waves, and have been led home by it. With the rapid development of science and technology, Huaniao lighthouse, in addition to playing the traditional role of visual aids to navigation, has installed modern facilities and equipment such as AIS base station, Beidou reference base station, VTS base station, and other modern facilities of meteorology, hydrology, and microwave. Although the visual navigation function of the lighthouse has been increasingly weakened, the ability to provide all-weather comprehensive navigation services for ships at sea has been improved.

5 EXPLORATION AND INNOVATION OF SERVICE VALUE

5.1 Culture, education plan and tourism development

One way to preserve the historical and cultural significance of Huaniao lighthouse is through cultural and educational projects. These projects include guided tours, exhibitions, and lectures, highlighting the history, architecture, and significance of the lighthouse, and educating the public on the importance of protecting historical landmarks and the cultural heritage it represents. Being involved in these projects, the public have increased their awareness and appreciation of the lighthouse and its role in maritime history.

An exhibition hall has been set up for the lighthouse, displaying hundreds of historical materials and physical objects of it. The local tourism department has made special investment and funds to renovate the lighthouse exhibition hall. Through physical objects, photos, models, sculptures and landscapes, the exhibition displays valuable historical materials and physical objects, enhancing the attraction and appeal of the exhibits and showing the unique charm of the beacon culture to the community. Moreover, it disseminates the broad spirit of the beacon culture, and promotes the dedication of the beacon culture, leaving a profound impact on visitors and learners, and becoming a window for the display of the beacon culture.

Huaniao lighthouse has the potential to attract domestic and foreign tourists. The unique location, history, and architecture of the lighthouse make it a valuable tourist destination. In order to promote the tourism industry, the local government cooperates with travel agencies and tour operators to develop tourism packages which includes the lighthouse visit. In addition, Huaniao lighthouse has been marketed as a cultural and historical landmark in Shengsi region, and some activities have been organized to attract tourists, such as lighthouse festival, photography competitions, poetry and painting creation competitions, etc.

Every year, on “World Marine AtoN Day” and “Maritime Day”, the live broadcast activities held at Huaniao Lighthouse are eye-catching. The activities not only introduce the significance of the lighthouse as a navigational auxiliary facility and navigational cultural heritage, display the lives of the tower keepers, but also include photography, poetry and painting competitions, which have gained high reputation and influence in the local area.

Since the opening of the lighthouse as a tourist attraction in 2014, it has received about 300000 people visiting, studying, traveling, and investigating there. In 2019, more than 51000 people were registered and in 2020, 80236 people were registered.

5.2 Community Participation

The protection and development of Huaniao lighthouse requires the participation of local communities. By involving communities in the process, the public awareness and support for the lighthouse are increased. The local government can collaborate with community groups and organizations to organize activities to promote the lighthouse’s culture and historical significance. In addition, communities can participate in the repair and maintenance of the lighthouse, for example launching volunteer programs or fund-raising activities.

There are also educational and cultural activities at different levels for specific audiences, and courses and lectures in areas related to ocean activities, including the first lighthouse culture festival, the fire collection ceremony for the first marine games in Zhejiang Province, the cultural celebrity lighthouse tour in Zhejiang Province, the “Walking Huaniao, True Confessions” activity for hundreds of couples, the launching ceremony of standardized cultural etiquette and the first ritual lighting ceremony for Huaniao lighthouse, and so on.

Figure 4: Fire Collection Ceremony at the Sports Meeting

In 2017, the Walking into the Lighthouse, Illuminating the Voyage" - a media tour of Huaniao lighthouse was held. Journalists from seven major Chinese media gathered at Huaniao lighthouse to provide comprehensive coverage of the people and events of the lighthouse and the "Five Generations of the Ye's Family", achieving good social results.

In 2020, Huaniao lighthouse was selected as one of the "Ten Sceneries of Zhoushan". In the promotional copy of the "Island Style Line" jointly organized by Huaniao lighthouse and the Gouqi island marine ranch, the expression "Stay away from the hustle and bustle, climb onto the towering lighthouse on the island, where generations of islanders have their sustenance for life, as well as the shackles in the minds of tourists" highlights the position of the lighthouse in the brand building of tourism resource image, which has further expanded the cultural dissemination of maritime navigation aids.

6 INNOVATION IN LIGHTHOUSE MANAGEMENT MODE AND PROTECTION FUND SOURCE

In 2016, Shengsi County People's Government invested more than 500000 yuan to support the renovation of Huaniao lighthouse exhibition hall.

In 2022, Shengsi County People's Government allocated another 500000 yuan for the maintenance and protection of Huaniao lighthouse.

Huaniao lighthouse has been developed and managed in cooperation with the local government. Since 2020, it has jointly undertaken the task of guarding the lighthouse, creating a new model of lighthouse protection and management.

Fully mobilizing the enthusiasm of all parties, the local government allocates special funds for the lighthouse, innovating a new model for lighthouse's protection management and fund implementation.

7 CONCLUSION AND PROSPECT

As a famous century-old historical lighthouse in China, Huaniao lighthouse is experienced in rotating traditional optics economically and effectively, redeveloping navigation aids, and integrating historical lighthouses into modernization. Its maintenance and protection experience is very valuable, based on which China has compiled the "Historical Lighthouse Protection Specification", providing Chinese experience and reference for IALA's documents.

AUTHOR BIOGRAPHY

Tang Qingyou is working in Ningbo Aids to Navigation Department of Eastern Navigation Service Center as a head of the unit. He was hired as a chief senior engineer in 2021. Mr. Tang graduated from Dalian Maritime

University majoring in aids to navigation management, and engaged in professional technical aids to navigation management for a long time. Mr. Tang took the lead in mentoring professional technicians to carry out all sorts of forms of technical work such as onsite maintenance of navigation aids, technical management, project implementation, scientific research and development. Over the years, he closely followed the new trend of e-Navigation, uphold the integration of management innovation and technological innovation.

Mr. Tang presided over the drafting of industry standards such as Standards for Professional Skills of Aids to Navigation and Standards for Quality Inspection of Water Transport Engineering, which were well received by domestic maritime sectors and fill the gap in the industry. From July 2020 to June 2022, he was employed as a visiting professor at Maritime College of Ningbo University.Mr. Tang devote himself to the historical lighthouses research, and has done a lot of study in the development of lighthouse culture and the preservation of lighthouse cultural relics. Under Mr. Tang's leadership, Ningbo Aids to Navigation Department, with its 12 heritage lighthouses, becomes the seventh group of protected historic site in China.

Awards:

Anti-theft Aids to Navigation Light Based on Beidou Navigation Satellite System won the third prize of China Navigation Science and Technology Award in 2014;

Research on Key Technologies of Channel and Anchorage Design in Island and Reef Area won the first prize of China Navigation Science and Technology Award in 2019;

The Research Development and Application of Intelligent Water Safety Assurance System Based on AIS Technology won the second prize of China Navigation Science and Technology Award in 2019.

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