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PRESERVATION OF HISTORICAL LIGHTHOUSES

"Safe Navigation Through Systems Technology"

"La technologie au service de la sécurité de la navigation"

SAUVEGARDE DES PHARES DE VALEUR HISTORIQUE

PRESERVATION OF HISTORICAL LIGHTHOUSES
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"100+" Most Historically Important Lighthouses Throughout the World

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Summary

The paper describes the various criteria used to select the "100+" most historically important lighthouses. This was a task given to a sub group of the IALA Advisory Panel on the Preservation of Historic Lighthouses, Aids to Navigation and Related Equipment.

"100+" Most Historically Important Lighthouses Throughout the World

1. Advisory Panel

At the meeting of the Preservation of Historical Lighthouses, IALA Interim Working Group in March 1996 at Pointe Saint Mathieu, France, a draft work programme was prepared. This formed part of the proposed terms of reference for an advisory panel on the Preservation of Historical Lighthouses, Aids to Navigation and Related Equipment.

The tasks for the period 1996-98 were agreed as:

- prepare a bibliography on literature and documents on lighthouses and aids to navigation in co-operation with Mrs. Ville.
- prepare a list on national and international organisations, instructions and contacts for possible cooperation in preservation matters.
- prepare a list of 100-200 lighthouses of most particular historical lighthouses, etc.
- prepare an information paper on possible public/private use of:

  (a) lighthouses not in operation
  (b) operational lighthouses
  b_1 manned
  b_2 unmanned

- prepare an international inventory on museums etc. especially dedicated to lighthouses and aids to navigation.
- prepare a presentation for the 1998 IALA Conference.

The formation of the advisory panel was established by the IALA Council at its 15th session in June 1996. The first meeting took place at IALA headquarters, St Germain-en-Laye in October 1996.

During this meeting the task of producing a list of 100-200 lighthouses of most particular historical lighthouses was given to sub group 2.
This paper deals with this particular task.

2. Definition of a Lighthouse

The returns from an initial questionnaire sent out in June 1996 were considered and it became apparent that one of the first tasks to be done was to establish a definition of a 'lighthouse' that would be suitable for the work of this group.

It would also be used by the other groups to ensure commonality in the level of information handled.

The dictionary definition of a lighthouse - "a permanent tower-like structure built at danger points on sea-coasts and provided with a very powerful light to serve as a warning to ships." This is rather general and needed to be more specific.

For a station to be considered a 'lighthouse' the advisory panel decided that any two of the following criteria needed to be satisfied:

- height of the tower be greater than 10m (this is the true height of the tower)
- range of the light be greater than 15 nautical miles. (This would require a light intensity greater than 11,000 cd when measured using Schmidt Clausen formula and T = 0.74).
- the station consists of, or has originally consisted of, several buildings and has been designed to be manned
- the light be used for general navigation

This may seem rather restrictive but has proved quite adequate.

3. Nominations

Each country had been asked to nominate up to five lighthouses with the purpose of including them in a booklet. Returns were of a good standard and were received from 49 countries. This includes nil returns. The quality of them varied considerably, the basic requirement being that the submission for each lighthouse should consist of:

- a photograph
- details of its construction
- date when it was built
- name of the architect/builder
- brief details of its technical equipment
- current use

This then gave an opportunity for the group to classify the lighthouse using a crude weighting system.

4. Classification

Figure 1 gives an example of the assessment sheet used and the weighting put against each criteria.

Figure 1

HISTORIC LIGHTHOUSES - ASSESSMENT

STATION

COUNTRY

Select the most appropriate category for each line and record in total column.

									MARK
AGE	CATEGORY	BEFORE 1600	1600-1699	1700-1799	1800-1849	1850-1899	1900-1950	AFTER 1950	
	WEIGHTING	20	18	15	13	10	5	1	
ACHIEVEMENT	SCALE	MAJOR 10	TO	AVERAGE 5	TO	MINOR 1			
DESIGN OF STRUCTURE	ARCHITECTURAL	CATEGORY	TRADITIONAL	SIMPLE	UNIQUE	FUTURISTIC			
		WEIGHTING	10	5	15	15			
	USE OF MATERIAL	CATEGORY	GRANITE/STONE	MASONRY	STEEL	WROUGHT IRON	CONCRETE	WOOD	
		WEIGHTING	10	8	5	10	5	10	
	HEIGHT OF TOWER	CATEGORY	GROUND LEVEL	UP TO 5M	5 TO 15M	15 TO 25M	ABOVE 25M		
		WEIGHTING	2	4	6	8	10		
LOCATION/ EXPOSURE	LOCATION	CATEGORY	ON ROCK	SMALL ISLAND	LARGE ISLAND	MAINLAND			
		WEIGHTING	15	10	5	5			
	EXPOSURE	CATEGORY	SERVERE	MEDIUM	SHELTERED				
		WEIGHTING	15	10	5				
LOCAL IMPORTANCE		CATEGORY	LISTED		NOT LISTED BUT IN CONSERVATION AREA		CULTURALLY IMPORTANT		
		WEIGHTING	20		15		20		
CURRENT USE		CATEGORY	NOT IN USE	AUTOMATED	MANNED	MUSEUM	ALTERNATE USE		
		WEIGHTING	5	10	15	15	5		
								STATION TOTAL	

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4.1 Age

Maximum marking was given to structures built before 1600 and minimum after 1950. This represented purely the age of the structure.

4.2 Achievement

This was the second factor and represented an indication of how advanced its construction was in its day. This would also consider how difficult it would have been to establish this type of structure considering the technical competence of the country at the time.

4.3 Design of Structure

This was separated into:

- Architectural
- Use of material
- Height of tower

Architecturally the maximum rating was given to structures that were either unique or futuristic.

Use of materials was weighted to reflect the skill level required.

The tower was weighted proportionally to its height, the maximum being given to structures over 25 metres.

4.4 Location Exposure

The difficulty of construction and the strength of the structure was assessed under location/exposure. Maximum weighting was given to a lighthouse built on a rock with severe exposure to the elements.

4.5 Local Importance

This reflected the countries' own assessment of the lighthouses' importance to the countries' heritage. It became obvious when considering the submissions that it was more of a reflection as to individual countries' own degree of recognition of their historical past. It was also found that all 'lighthouses' would tend to be listed independently of their individual worth.

4.6 Current Use

Finally, it was felt necessary to review each station's current use. Maximum weighting was given to a station that remained manned or was now a

museum. This was considered important as it promoted public awareness and preserved tradition.

5. Publication

From the very start it was proposed that a publication should be produced by IALA of the "100+" Lighthouses. It would not be practical to select them in order as so many variables have to be considered in making such a choice. In any case who has the right to make such a choice?

It was only practical to include countries who had provided adequate information, photographs of a printable quality and adequate details of the lighthouses, in the first publication. They would be printed in the order proposed by the country and if not then the sub-group would use the weighting system to arrive at an order of priority.

Discussions were held by IALA with a French publisher and as a trial, details of the Trinity House and South African submissions were sent to the publisher to produce a mock up.

It was agreed that each country's entry would consist of:

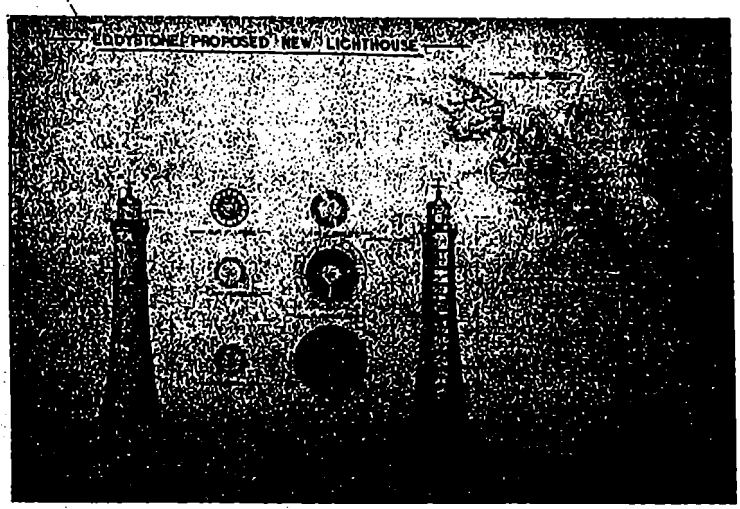
- a location map
- a brief history of their Lighthouse Service
- photographs and descriptions of each lighthouse with basic facts.

The publisher used his expertise to lay out the pages. Extra drawings and photographs of equipment were supplied which were used as watermarks and infills to enhance the appearance of what would otherwise have been a rather repetitive layout.

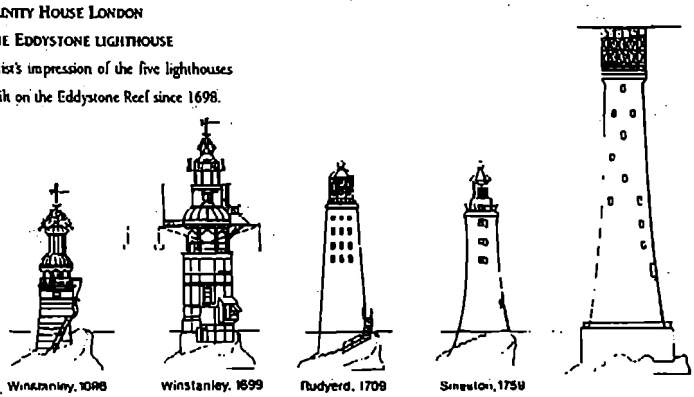
An example page is included (figure 2).

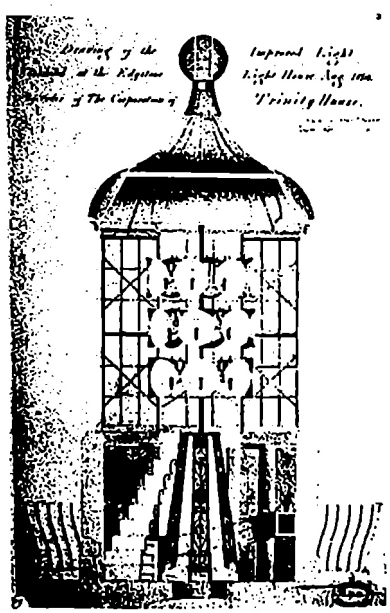
The first examples were very encouraging although not fully proof-read. Unfortunately the French publishers were not able to print an English version due to government restrictions unless they went into a joint venture with either an English or American publisher.

The target was to have the book published in time for the IALA Conference 98 which left a tight timescale to be met. All submissions, including the French translation, had to be completed by the end of December 1997.



TRINITY HOUSE LONDON
THE EDDYSTONE LIGHTHOUSE
Artist's impression of the five lighthouses built on the Eddystone Reef since 1698.





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TRINITY HOUSE LONDON
THE EDDYSTONE LIGHTHOUSE
Artist's impression of the five lighthouses built on the Eddystone Reef since 1698, including (far right) the present-day structure incorporating the helicopter landing pad constructed in 1980.

TRINITY HOUSE LONDON
THE EDDYSTONE LIGHTHOUSE
Artist's impression of the five lighthouses built on the Eddystone Reef since 1698, including (far right) the present-day structure incorporating the helicopter landing pad constructed in 1980.

EDDYSTONE LIGHTHOUSE

Geographical position Latitude 52° 25' 00"N
Longitude 04° 17'18"W North Cost of Anglesey
Commisionned : 1835
Architect/Builder Jesse Hartley, engineer to Mersey Docks and Harbour Board
Construction material Masonry
Tower Height 11 metres

General : As early as 1766 the need was felt for a station on Anglesey where ships making for Liverpool could pick up pilots. At first the early pilots used a farmhouse as their lookout post. The lighthouse was built in 1835 by the Mersey Docks and Harbour Board. In 1879 a telegraph station was established and the site extended to include two additional cottages and the boundary wall extended to encompass the whole site. Entry to the site is via gates below a suited archway; the boundary wall is castellated. The original wall along the north elevation has an inner wall-walk carried on recessed arches. this latter work was designed by Geoge Lyster. The Lighthouse was electified in 1952 and Trinity House took over responsability for the light in 1973. The station was automated in 1992.
An important work of Jesse Hartley with Lyster's extension maintaining a similar character. The design bears a distinctive hallmark and is quite different from those associates with Trinity House. A distinctive exercise in neo-gothic, forming a tightly designed and highly integrated compound. The lighthouse is of an unusual type in which the lantern is on the ground flour.
Description : The ligthouse is set to the rear of the Principal Keeper's cottage, white rendered over rubble, a rectangular tower with a higher and narrow tower at its north end housing the telegraph room and look-out in its upper flour. The lantern projects from the north elevation at ground level. the semi circular cast iron lantern is carried on a wide masonry platform enclosed by a ditch. The second order 140mmm catadioptric fixed lens dates from 1879 and has an occulting character of white of white every 10 seconds with a range of 20 sea miles

Figure 2

6. Preparation

The receipt of the various countries' submissions was coordinated by the IALA Secretariat and assessed by members of the subgroup at its meetings.

The first main meeting took place in June 1997 when all the submissions gathered so far were assessed and placed in individual portfolios. If the task was to be successful then it was necessary for each country to submit the information in a form that could be passed directly on to the publisher. It was beyond the resources of the working group to re-write the publication. Also the way each country handled the content of its submissions provided additional variety.

Each submission was looked at to determine what additional information was required and which lighthouses were to be included.

It was also agreed at that stage that each country's submission would include a map or chartlet to pin point the location of each lighthouse and a brief history of their lighthouse service. This work took two days to complete and considered submissions from 42 countries. At that stage approximately 50% of the material supplied was considered adequate for our needs. Each country was again written to, requesting additional information and/or improved quality photographs.

At the October meeting of the subgroup all the responses were trawled through and it was found by then 27 countries had submitted sufficient information giving a total of 106 stations to be included. However, returns were still being received by IALA Secretariat so hence the numbers should increase.

The publisher was also keen to receive extra material such as old drawings, photographs of optics and other equipment of a more general nature that could be used to enhance the pages of the publication.

In particular a request was made for photographs showing lighthouse keepers from the various countries, a theme that we were keen to promote.

Only time will tell whether we have made the deadline and what the finished product will look like.

7. Participation

Whatever the outcome, thanks must go to everybody who took part in the sub group meetings:

Philip Hyde (Chairman of the sub group), Arturo Aguado (Spain), Nouhom Diop (Senegal), Waldemar Hofmann (Chile), Spiros Liaropoulos (Greece), Fausto Pompa (Cuba), Toshio Shioyama (Japan), Guy Cunty (France), Li Wen (China) and in particular, the considerable effort put into the project by Marie-Hélène Grillet and the IALA Secretariat.

The Effective Management and Preservation of Lighthouse Property

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SUMMARY

The Lighthouse Service of the Corporation of Trinity House (THLS) operates and maintains 72 lighthouses and minor lights in England, Wales, the Channel Islands and at Gibraltar, many of which are classified as being of historic interest. By the turn of the century all these will have been converted to unattended operation with a substantial reduction in requirements for accommodation in most cases. In addition, a decline is forecasted over the next 25 years or so, in the number and ranges of conventional short-range aids to navigation. This paper details initiatives taken to adopt and implement a strategy, in common with the General Lighthouse Authorities for Scotland and the Republic of Ireland, with the aim of managing environmental and heritage responsibilities, transferring onerous maintenance liabilities and increasing public awareness of this important aspect of our national heritage. It proceeds to give an insight into the experiences of Trinity House in implementing innovative management schemes that seek to exploit the uniqueness and the underlying potential of these valuable assets, whilst retaining their primary purpose and charactersistics as aids to navigation.

Contents

1 Introduction

1.1 Lighthouses are a unique part of our maritime heritage. In common with many other lighthouse authorities worldwide, Trinity House has a responsibility both legally and morally to preserve the cultural significance of lighthouses and to enable their conservation both for aids to navigation use and as historic structures. Over the previous five years we have made the effective management and preservation of our lighthouse properties an integral part of the systems and processes established to deliver our service to the mariner.

1.2 Lighthouse modernisation has provided the opportunity for an innovative strategy on the future of lighthouse property, looking ahead to changes projected over the next 25 years or so which anticipate a reduction in requirements for conventional short-range aids to navigation. In 1994, the Trinity House Lighthouse Board agreed a strategic framework for the effective management, preservation and exploitation of its lighthouse properties. The basis of this was to achieve a balance between :-

- effectiveness and economy in the continued provision of aids to navigation requirements
- ongoing sensitivity to cultural, heritage and environmental factors
- public support from the local communities and the media.

1.3 Planning the future of our property assets and historic artefacts is occupying an increasing amount of time on the agenda of our Board. The impetus on this has grown even more since we secured a change in legislation in 1997 to enable us to exploit spare capacity in our assets, in the interests of the General Lighthouse Fund. This paper gives the background to the initiative taken in 1994 and progress made and experiences since that date.

2 Why have a strategic framework?

2.1 Trinity House currently operates and maintains 72 lighthouses and minor lights. These buildings are of varying design and construction and many - about 60% in England and Wales are designated as historically important and most are situated in or near environmentally sensitive areas. This can result in onerous levels of historic preservation and restrictions on working practices with a relative increase in costs at the expense of the General Lighthouse Fund.

Lighthouse modernisation

2.2 The Trinity House lighthouse automation and de-manning programme comes to an end with the automation of North Foreland Lighthouse at Dover in November 1998. Targets for reductions in logistics support, manning requirements and rationalisation of our property holdings are being met. However, difficulties have been experienced with:-

a. selling redundant property in remote or environmentally sensitive areas

b. lack of clear evidence of ownership

c. access and the high cost of upkeep which has deterred some potential buyers

d. surrendering unwanted leased property

e. enforcing protective covenants included in the sale of redundant property

f. recovering or apportioning the costs of maintaining shared facilities

g. an increased risk of vandalism at unattended stations

h. the lack of a coordinated policy on site-sharing with external organisations

i. concerns expressed by heritage and conservation bodies over preservation issues

j. maintaining good relations with the public and local communities.

2.3 Options other than outright freehold disposal need to be considered in these cases which includes, as a last resort, possible demolition of those structures which are of little historical significance or considered impracticable or uneconomical to maintain in the future.

2.4 The formulation of a definitive strategy on the future of our lighthouse property seemed both appropriate and desirable to ensure, as far as practicable, the best use and sensitive disposal of lighthouse property within our statutory and economic framework. A common funding base has meant that Trinity House has found it beneficial to work with the Northern Lighthouse Board and the Commissioners of Irish Lights in determining the nature and characteristics of the strategy.

3 Where to start?

3.1 The legal and financial operating framework of Trinity House as a General Lighthouse Authority (commonly known as Trinity House Lighthouse Service or THLS) was critical in defining the scope for any new strategy and to provide a firm basis and clear guidance on the necessary restrictions and controls. The first step therefore was to clarify the relevant duties, explain the limitations and identify all the options to help select the right option for each property.

Legal Framework

Statutory provisions

3.2 The question of what can and should be done is largely determined by the fact that:-

a. Trinity House is restricted in the lawful exercise of its lighthouse powers by the scope of Part VIII of the Merchant Shipping Act 1995 (MSA 1995)

b. the functions of THLS are funded from the General Lighthouse Fund which is made up from income received from light dues charged on commercial shipping for the purpose of providing marine aids to navigation in the UK and Ireland

c. where there is any specific prohibition contained in MSA 1995 against a particular course of action proposed and THLS put into effect that course of action, then it would be outside its powers.

Titles and Covenants

3.3 Generally, lighthouse property falls into one of the following categories:-

- no deeds or other clear documentary evidence of title is held although possessory or prescriptive rights can be shown (which may not rule out another party's claim to title)
- the property is leasehold - short or long term - with enforceable restrictive covenants as to use and a ban against assignment or sub-letting
- the property is freehold with restrictive covenants as to use of the property (e.g. "for the purposes only of a lighthouse within the meaning of the Merchant Shipping Acts")

- deeds are held which convey the freehold of the property but include provision for a pre-emptive right of re-purchase of either whole or part of the property by the original owner on any cessation of its use for lighthouse purposes

- deeds are held showing a clear unrestricted title and complete freedom as to use or sale (or assignment, sub-letting, licensing in the case of a leasehold title).

3.4 There are real responsibilities and obligations on THLS, particularly in relation to our listed buildings. It is important therefore to establish a modern integrated strategy on the preservation of historic lighthouses. This can be applied to modernisation programmes and maintenance cycles alike, taking into account the need to provide clear guidance to contractors who are required to carry out work at lighthouses.

3.5 A range of legislation is in force which can lead to criminal and civil liability for environmental damage with the heavy financial penalty of clean-up costs. Other remedies can include injunctions, revocation of consents, enforcement and prohibition notices and the selective use of planning powers.

3.6 Titles and rights held in relation to our various lighthouse properties are invariably old - occasionally over 350 years - and can be very complex. In some cases there is simply no clear evidence of title, while in others expert modern interpretation of the key provisions is necessary. Legal action with serious financial consequences might result from not observing the legal force of certain requirements.

3.7 By their nature, most lighthouses are in remote locations with difficult access - often via a long narrow approach road running across a number of private rural interests off the public highway. Successful negotiation of an apportionment of responsibility for the costs of maintaining access ways and approach roads was seen as central to any plans either for complete sale or divided occupation of lighthouse property.

Financial Control Framework

3.8 Essentially, THLS is required to identify and dispose of redundant real property usually by competitive tender, seeking the best price. This can be a time consuming and complex process with the need to include restrictions as to future use and development where there remains a continuing operational requirement at the site.

3.9 We decided to identify the main factors which had made redundant lighthouse property difficult to sell and assess to what degree these could either be resolved or an alternative scheme adopted :-

- prevailing market conditions

- problems with terminating subsisting agreements and apportioning responsibilities

- retention of a fog signal

- lack of proper services including modern foul drainage facilities

- retention of the lighthouse tower for operational use

- isolation from local amenities

- need for adequate safeguards and restrictions in any assignment to protect the operation of the lighthouse

- limitations imposed by statutory heritage or environmental designations.

3.10 This has enabled lighthouse property to be divided into certain categories according to their relative potential for disposal or future exploitation by THLS, as part of an overall management scheme for the site. Before this, a confirmation of known and possible future needs is essential, as regaining title to property could be an unnecessary and expensive procedure in the event of a change in requirements.

4 The importance of the planning framework

4.1 Lighthouse modernisation has meant determining and constantly reviewing navigational requirements and designing engineering solutions which, in each case, examine all the options - including the viability of an independent smaller lighthouse installation. Preventive maintenance schedules are aligned to tight cash limits applied by the DETR. This has led to a tendency for more onerous work on historic preservation to be either delayed or simply disregarded, resulting in a gradual erosion of some of the architectural and other distinctive features of lighthouse property.

4.2 Our aids to navigation forward plans provide the best indication as to the future operational use and availability of our lighthouse properties for disposal or shared occupation. They form the primary basis for the examination of options as to the improved preservation and utilisation of our lighthouse buildings.

4.3 Ideally, the processes of lighthouse modernisation and property planning - having regard to historical and environmental factors - should converge to provide lasting and more timely solutions. Occasionally an opportunity might arise for a GLA to divest itself of a major ongoing civil maintenance commitment without loss of facility for the aids to navigation installation; the result usually compares favourably with any economic appraisal for an independent smaller lighthouse installation.

4.4 The planning framework should take into account title restrictions, environmental factors, rights of access and the nature of services to the site. Strategic planning helps to improve the management of lighthouse property, reduce maintenance liabilities and assist the disposal of assets in the future.

4.5 By looking 3-5 years ahead, we can:-

- plan future needs and make timely decisions to meet service requirements
- combine navigational and operational requirements into compact and practical property solutions which take into account any restrictions regarding use or disposal
- take steps to help preserve the life of important lighthouse structures.

4.6 The key outline planning process undertaken at the outset was to list all the Trinity House Lighthouses and their status in terms of age of the structure, ownership, environment designations and adjacent site occupiers, to determine the scope or otherwise for disposal or leisure and amenity development. The next logical step was to select those stations with the most potential and categorise them to show the present position and also our future aspirations for exploitation of the tourist and amenity value of the site in each case.

4.7 Individual projects were then taken forward such as the one at South Stack in North Wales for which an outline management framework for the scheme was produced with the following objectives :-

- To apportion maintenance costs for the areas of South Stack no longer operationally required.
- To conserve the buildings and protect the natural beauty, wildlife and amenity of the environment having regard to the statutory environmental designations assigned to the area.
- To allow controlled public access to the Island and the Lighthouse in conjunction with other Council and Royal Society for the Protection of Birds tourist amenities on Holyhead Mountain.
- To develop a suitable cultural and educational centre based on the heritage, environment and other important aspects of the area.

4.8 The success of these projects requires collaboration with the local communities in each case. Overall control remains with THLS under a sub-lease granted to the local council to allow development of a heritage, cultural and educational facility on the Island.

4.9 As part of the joint venture at South Stack, THLS provides :-

- ⇨ advice regarding the external maintenance of the buildings and other structures, with cooperation towards a joint approach to painting programmes
- ⇨ coordination of health and safety requirements in relation to visitor access to the Island and Lighthouse
- ⇨ background information on the Lighthouse and Island including copies of plans, historical documents, some artifacts, publications and handouts.

5 Developments elsewhere

5.1 We felt that it was (and continues to be) highly important to learn from the experience of other authorities, many of whom are facing exactly the same sorts of problems and issues. For instance, we knew that in order to reduce vandalism and the costs of maintenance, some authorities had experimented with leasing and licensing of lighthouses to non-profit making groups who assume responsibility for maintenance of all the lighthouse except the lighting equipment and major structural repairs. This has met with varying degrees of success, mainly because their dealings have not been confined to established, self-sufficient and responsible bodies concerned with preserving their national heritage or conserving the environment.

IALA

5.2 An International Association of Lighthouse Authorities' (IALA) Workshop on the Preservation of Historic Lighthouses was hosted by the Japanese Maritime Safety Agency between 10 and 13 September 1991 in Tokyo and attended by representatives from the United States, France, Norway, Japan and the United Kingdom. The Workshop concluded that:-

a. while some lighthouses were still important as aids to navigation for mariners, they were also a valuable heritage for mankind from the viewpoint of their architecture, technology, history and culture

b. that an IALA working group should be established to determine a method for identifying and preserving historic lighthouses which would overcome the associated legal, budgetary and policy problems.

5.3 Since then an IALA Advisory Group has been established on the Preservation of Lighthouse Property with clear terms of reference including a remit to identify alternative uses for historic lighthouses. The Group has collated some valuable information from lighthouse authorities worldwide and believes that lighthouse preservation and exploitation of the amenity value of such properties should be an integral part of the management processes of a lighthouse authority.

The European Union

5.4 In Europe, the Maastricht Treaty introduces the principle that European Union (EU) policy should aim at a high level of environmental protection and be based on the precautionary principle. Since the initial formulation of the EU's Environmental Policy, about 300 items of environmental legislation have been agreed. EU developments in aids to navigation are also progressing through the Commission's safe seas and satellite programmes which are likely to reduce the requirement for conventional short-range aids such as lighthouses in the longer-term.

United Kingdom and the Republic of Ireland

5.5 In the last 5-10 years, the outright disposal of redundant lighthouse property in the GLAs areas has netted revenue well in excess of £3.5 million for the General Lighthouse Fund. Most of these properties have been sold to private buyers, but in England and Wales, two complete lighthouses with dwellings and two sets of lighthouse

dwellings (but not the actual lighthouses) have been sold to the National Trust and a complete lighthouse with dwellings has been sold to a local authority; while in Scotland, one complete lighthouse, one set of lighthouse dwellings and a few rock lighthouse shore station dwellings have been sold to local authorities and an island, complete with lighthouse dwellings (but not the actual lighthouse) has been sold to the Nature Conservancy Council for Scotland.

5.6 A number of specific property sharing projects are either underway or being examined, most notably at South Stack, Lizard, Start Point, Portland Bill, Pendeen and Lundy Island. However, these were all being progressed outwith any coordinated policy or agreed strategy until more recently. Those sold to private occupiers generally have not been maintained properly and difficulties have arisen in recovering their agreed proportion of costs for the maintenance of accessways and common areas.

5.7 Gradually more attention has been given to:

appropriate disposal of lighthouse buildings with a view to their future preservation

evaluation of the risk of vandalism and the operational value of a live-in attendant or a responsible private resident

environmental forces at unmanned stations

avoiding contravention of listing requirements by improving the specification of contracted-out work for repairs, alterations or other changes to lighthouse property

the future of redundant equipment at lighthouses

loss of amenity, trade and jobs for local communities

occupiers' responsibilities and liabilities.

6 Key elements of the strategy - challenges and opportunities

6.1 The main considerations for THLS are to:-

a. ensure adequate control over service operational areas to protect the aids to navigation functions in all cases

b. maintain the existing *ownership and present use* of any lighthouse property required within the scope of our statutory responsibilities, with consideration as to alternative uses

c. sell (or surrender in the case of leased property) as an immediate priority if the whole of the lighthouse property becomes redundant

d. grant leases or licenses under full repairing terms for the part-disposal of certain lighthouse property where a higher degree of protection is required for the retained aids to navigation, or where the outright disposal is not immediately practicable

e. secure the best price on disposal of property but, wherever possible, encourage trustees of the national heritage to bid for redundant lighthouse property, particularly where part of the site is to be retained for aids to navigation use

f. reduce maintenance obligations on any part disposal by transferring costs for the areas no longer required, and apportioning expenses for maintaining shared areas

g. adopt the most cost-effective and viable solutions within the scope of the statutory framework for maximising the underlying potential of our lighthouse property

h. ensure that our resources are not unduly committed to any wider venture and that the terms of any assistance include, as a minimum, full cost recovery

i. safeguard historic buildings and the natural beauty and amenity of the immediate environment within the scope of any statutory designations and develop the ideals of historic preservation of lighthouse property where compatible with the operation of an efficient, reliable and economical lighthouse service

j. Consider licensing options and applications for grant aid, wherever appropriate, to reduce the cost burden of non-productive preservation of historic lighthouse buildings

k. allow controlled public access, where reasonably practicable, to exhibit aspects of the lighthouse heritage and create a wider understanding of the modern role of the lighthouse service

l. avoid creating an improper charge on the General Lighthouse Fund.

Policy Statement

6.2 Against the background of the strategic framework THLS has adopted a policy statement on property and related environmental issues which helps to identify and develop property solutions under a set of common base criteria, helping to determine the merits or otherwise of particular options in each case. A copy of the statement appears at Annex A.

Property Management Schemes

6.3 An individual scheme is prepared for each property and various options presented, in a common format, to the Trinity House Lighthouse Board for approval, with a cost benefit analysis and photographs and drawings.

6.4 Each case needs to be examined on its merits within the broad policy framework. In the case of redundant property, time should be taken to determine:-

a. the marketability and saleable value of the property

b. the present and future requirement for land, accommodation and access

c. whether the time, effort and cost of marketing the property and arranging the separation of accommodation and services - to enable sale of the surplus area - would be uneconomical compared to the low cost of maintenance or demolition (subject to any requirement for statutory consent)

d. the type of activities that could reasonably be permitted alongside the aids to navigation functions and the identity of the parties who might be allowed to carry on those activities

e. whether leasing, licensing or other options should be considered, where appropriate, pending possible outright sale if no practical options exist for immediate disposal of the property

f. the need for any vacant dwelling to be occupied at least occasionally to reduce the risk of vandalism or structural deterioration in the time taken for disposal.

6.5 At the same time, care needs to be taken not to enter into binding commitments which either prevent the GLAs from disposing of their interest or diminish the future sale prospects or value of a particular lighthouse property.

6.6 In certain circumstances, it is justifiable for us to limit our adjacent occupiers, tenants or licensees to organisations of good repute who are by the nature of their function and status, unlikely to change over time, such as:

major national charities

crown agents

heritage and conservation agencies

local authorities

major tourist bodies.

6.7 Bodies of this nature are expected to take a more responsible and long-term view of their commitments which will assist us in safeguarding our aids to navigation functions.

6.8 Important factors which count against a private occupier or assignment to commercial organisations are doubts as to:-

a. track record and ongoing commitment to the property

b. their financial stability, integrity and the risk of insolvency

c. the position on a change of control in relation to a company's affairs or the effect of a change in the nature individual's private circumstances or profitability of the business over time

d. the effect on future viability of the scheme if major operational changes were required to the aids to navigation

e. the level of goodwill and cooperation (over and above any commercial considerations) needed at operational sites.

6.9 Most organisations will require a medium to long-term arrangement if based on a lease or licence, particularly if they were expected to pay for repairs, conversion costs or other works.

6.10 Except in cases where outright sale is the best option, it would be advisable to retain a freehold interest and grant a lease or licence, to maintain the ability to control the property by the imposition and enforcement of covenants; the enforcement of covenants in land conveyed freehold is far more difficult. Any leases could also be made non-assignable.

6.11 Realistic and practical solutions can be developed by selecting interested parties to exploit the potential for:

leisure pastimes / outward bound and activities centres

educational / field study centres

scientific research

bird observatories

weather/wave recording centres

coastguard lookouts

information centres

holiday letting

non-business tenancies.

6.12 More ambitious projects require planned and coordinated implementation with a full feasibility study (including a risk analysis and environmental assessment) being required of any interested party:

general tourism allowing for public access;

business franchises - country workshops, catering, etc;

museums

DGPS reference stations

communications installations.

6.13 As a general rule, developments not related to core lighthouse service activities are self-funding and administered by other parties. Financial risk is avoided in all cases.

6.14 An income stream can be generated for facilities offered to other parties - particularly in the case of site-sharing, but this would generally need to be in the form of periodic licence fees, royalties, etc, to avoid any need for handling (or accounting for) regular cash transactions.

6.15 The ability to transfer risks will be a crucial factor from the outset in deciding whether or not a particular project could be made viable or secure. Liability risks are of particular concern due to the high magnitude of claims associated with such risks.

7 Joint ventures and financing

Grant aid

7.1 In the UK grants are available for Listed Buildings including lighthouses. Other measures can be taken also to reduce the financial cost-burden to the GLF whilst demonstrating a sympathetic and caring outlook in order to meet responsibilities and maintain good relations with relevant public interests.

7.2 Assistance is available to qualifying parties in many different forms, from direct capital incentives to practical help, subject to meeting certain criteria such as the type of business, the number of employees and geographical location. European Regional Development Grant, Regional Selective Assistance and Heritage Lottery Grants are examples.

7.3 Qualification for some grants can depend on a relationship between adjacent amenities. In some circumstances THLS might not qualify directly for capital grants but the necessary benefits could be reflected in a joint scheme made by prospective new occupiers of lighthouse property - particularly in Assisted Areas.

Sponsorship and loans

7.4 Company sponsorships or private financing initiatives should be encouraged for conservation and amenity projects undertaken by responsible authorities.

7.5 European Investment Bank (EIB) loans can be obtained by businesses for certain capital investment projects in industrial infrastructure, particularly in the transport and environment sectors. EIB loans can be up to half the cost of the project based on favourable terms with fixed or floating interest rates and could provide additional incentive to any party interested in lighthouse property.

Tourism - working with the local communities

7.6 New ideas can be coordinated effectively with other parties including tourism and amenity interests such as national and local maritime museums and cultural centres. This could culminate in a heritage or maritime trail which is a widely used concept to provide an integrated and instantly recognisable theme linking a number of tourist amenities either locally or nationally. Eligibility for grant aid can be enhanced by taking this approach. In fact, experience has shown that it is essential to work with local communities to maximise the opportunity.

7.7 Public access to lighthouse property would inevitably demand proper supervision and tight controls in order to prevent accidents and protect equipment. Steps would need to be taken to:

recover the additional cost of resources and utilities

minimise and finance (outside the GLF) additional wear and tear on property and equipment

recoup any net losses.

8 What are the benefits ?

8.1 Greater emphasis on the preservation of historic lighthouses and more sensitivity to environmental constraints will undoubtedly benefit the maritime heritage and help to protect the environment. Apart from the significant revenue to be derived from outright sales of lighthouse property, the financial benefits to THLS take the form of substantial reductions in the costs of maintaining certain lighthouse buildings and a regular income stream from sales, leases, licence fees.

Portland Bill Lighthouse

8.2 The benefits of our management scheme for Portland Bill Lighthouse are considerable, ensuring an integrated approach with the local community which works to the mutual benefit of all the interested parties. An innovative plan was developed in parallel with the automation of Portland Bill Lighthouse which :-

- reduced maintenance costs - through sale of the former keepers' houses, gardens and access ways to the Crown Estate - as part of the projected automation saving of £1.1 million
- produced a sale premium of £120,000 for the redundant accommodation
- provided on-site living accommodation for the Attendant by way of a lease-back of an area from the Crown Estate with the Attendant paying an equivalent rental to THLS to that payable by THLS to the Crown under the principal tenancy
- enabled the establishment of a unique visitor centre by Weymouth and Portland Borough Council and catering facilities by the Crown Estate, as part of an environmental and heritage education project
- enabled the Lighthouse to remain open to visitors under the grant of a non-exclusive five-year licence to the Crown Estate from May 1996
- resulted in sundry income to the GLF in the order of £20,000 per annum from licence fees (mainly from charging visitors)
- provided additional full-time employment for

  a former Lighthouse Keeper who performs the Attendant's duties for THLS and acts as custodian of the visitor facility for the Crown Estate

  at least two other people to staff the visitor centre and assist with the supervision of public access to the Lighthouse.

Planning and Management issues

8.3 Planning issues are having a greater effect on THLS due to the increasing number of lighthouses being entered on the national register of buildings of special architectural and historic interest.

8.4 Some lighthouses have relatively little historical value, but many in the THLS area have real potential for tourism, amenity and educational projects. Systems are being developed to record and maintain all relevant information about the major lighthouses and procedures established (as part of the Trinity House ISO 9001 Management Systems for Quality Programme) to ensure proper evaluation and control of the time, effort and money spent on the management (including disposal) and preservation of lighthouse property. It was determined that projects should not be pursued where they are not self-financing or where the advantages - having regard to the GLAs' statutory and economic framework - are outweighed by the cost of GLA resources necessary to put them into effect, as the GLF is not a trading fund for speculative investment.

Public relations

8.5 The reputation of the GLAs is of the utmost importance to ensure the necessary ongoing cooperation, goodwill and support from Government and other bodies, companies and organisations.

8.6 Every opportunity should be taken to increase public awareness about the GLAs activities and promote a better understanding of their work. Insofar as property management is concerned, the profile of the GLAs can be raised in a positive manner by:

issuing press statements and distributing other information on major aspects of work of general and special interest such as automation and modernisation schemes

contributing to selected external publications, exhibitions and the provision of school materials in relation to property and the environment

cooperating with trustees of the national heritage to further the ideals of preserving historic lighthouses

acting to fulfil environmental responsibilities

continuing arrangements for public, press and media visits to lighthouses where reasonably practicable.

9 Conclusions

9.1 Lighthouse modernisation opens up opportunities to develop innovative property management solutions within the framework of an overall strategy, to help reduce costs, secure the future of a unique part of maritime heritage and reduce the impact of automation.

9.2 The preservation of certain lighthouses for continued aids to navigation use and as historical structures is both appropriate and desirable. Operational efficiency can be achieved economically hand-in-hand with environmental sensitivity if coordinated properly and dealt with responsibly.

9.3 THLS has legal authority to dispose of its redundant lighthouse property. This can be extended to leasing or licensing out these properties (or certain facilities) for a wide range of suitable activities, in cases where outright disposal were precluded or considered uneconomical.

9.4 Many of our operational lighthouse properties (probably some 40%) are likely, ultimately, to provide adequate attraction for responsible bodies under joint venture management schemes. However, the high cost of maintaining these structures against the limited financial return from any associated enterprise combined with operating constraints, means that care must be taken to ensure the long-term viability of any joint ventures to exploit the tourism and amenity value of the properties.

9.5 Efforts are being made towards minimising the cost-burden on the General Lighthouse Fund of the civil and historic maintenance of lighthouse structures and their ancillary buildings. This can be achieved through improved management coordination to ensure that the aids to navigation functions remain the focus of attention and are fully protected in all respects.

9.6 In many cases it will be possible to generate a supplementary income stream from certain licensing activities in relation to joint ventures, site-sharing or other facilities at lighthouse property.

9.7 Trinity House is severely constrained as to the resources we can properly devote to activities outwith our aids to navigation business. Furthermore, experience has already shown that the time and effort involved in even minor licensing projects can far outweigh any prospective maintenance savings or the amount of any income stream.

9.8 Before proper consideration can be given to application of the principles contained in the proposed policy framework, a clear view is required of all the relevant aspects of a lighthouse property including title, covenants, rights of access and other claims to title. Work is required to collate and update the necessary details to provide a firm basis for an integrated property management strategy.

1 POLICY STATEMENT ON REAL PROPERTY ASSETS

1.1 Trinity House Lighthouse Service (THLS) shall hold, manage and properly maintain adequate real property as required for the operation of an efficient and economical lighthouse service, seeking General Lighthouse Fund (GLF) financial sanction and supplementary grant aid where appropriate.

Property Disposal

1.2 Redundant property shall be disposed of by the most beneficial and expeditious means available, having due regard to:-

a. the need to transfer or reduce maintenance outgoings or service charges;

b. the operational, historical and cultural significance of lighthouse buildings (and their equipment) as part of the national industrial heritage and as a feature of the natural beauty and amenity of the coast environment.

Lighthouse Property

1.3 Schemes may be developed for the wider utilisation of operational lighthouse property provided that they are viable, self-funding and only developed under arrangements with established, responsible and self-sufficient conservation, environmental or planning bodies, taking account of the essential requirements to safeguard the aids to navigation functions and avoid any improper charge on the GLF.

2 SCOPE

This policy applies to all real property and associated major plant, machinery and equipment of historic value held and maintained by THLS. It shall accordingly apply to all persons concerned with the management and use of property in THLS.

3 INTER-GLA COOPERATION

The development and pursuit of this policy - as it relates to the future of lighthouse property - will be coordinated among the General Lighthouse Authorities (GLAs).

4 CONTROLS

4.1 THLS shall hold and maintain a register of properties containing details of restrictive covenants, rights of way, statutory designations and other essential information.

4.2 Auditable records shall be maintained in respect of all property transactions including acquisitions.

NATIONAL PLAN FOR PRESERVATION OF LIGHTHOUSES IN NORWAY

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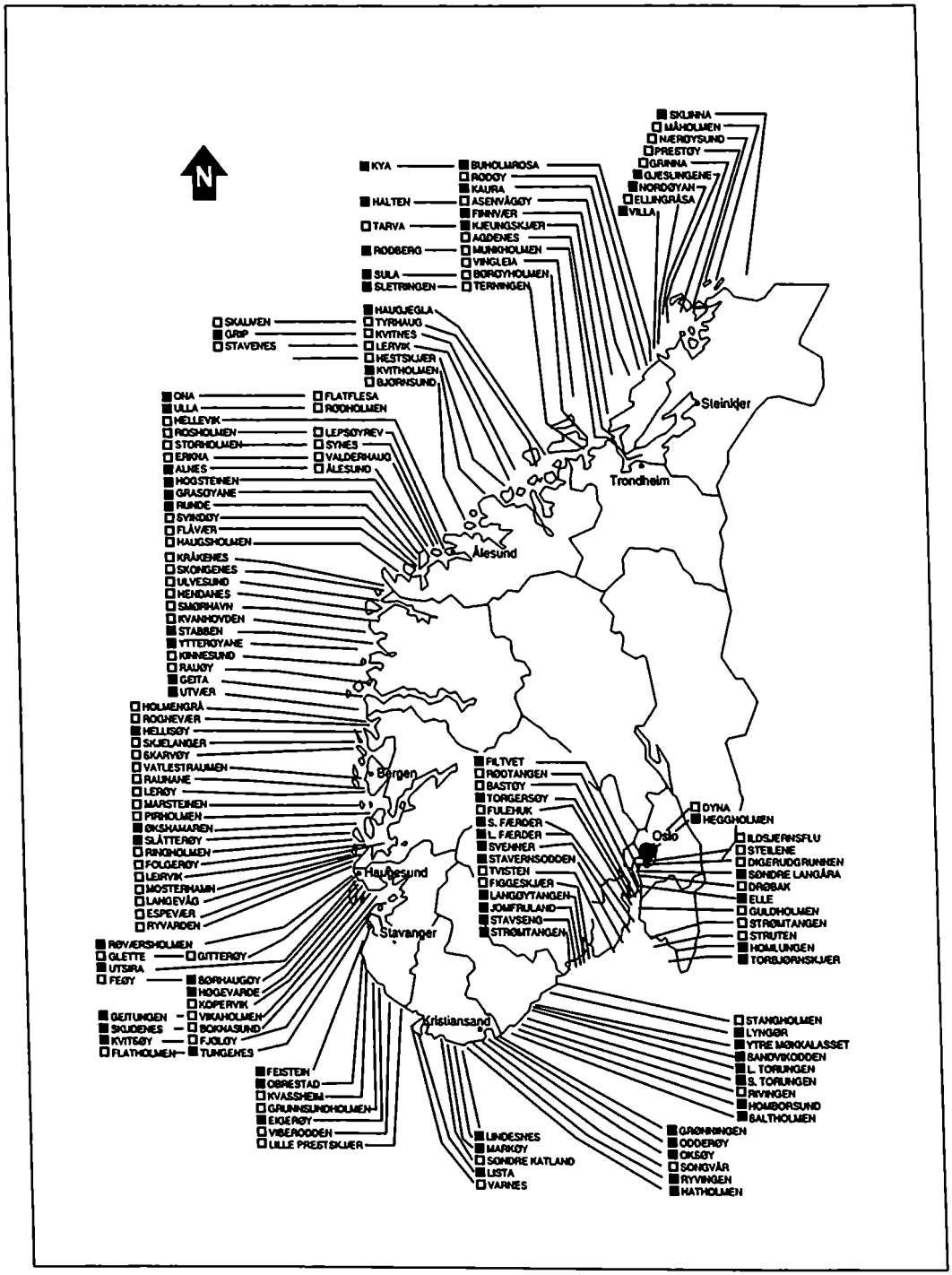
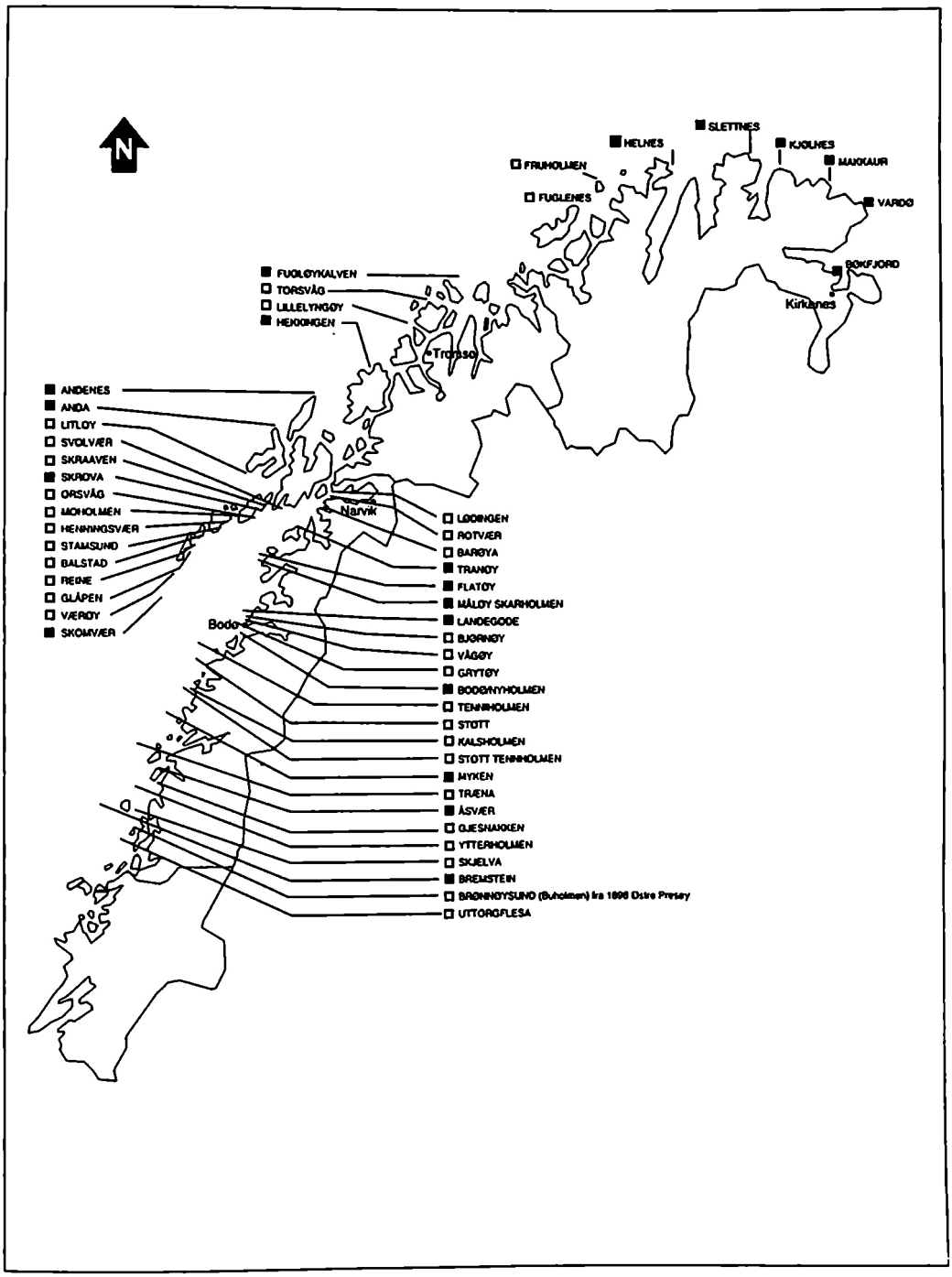
Summary:
Since far back in history the fairway along the extensive Norwegian coast has been the major traffic artery of the country. Marking this fairway by lighthouses and beacons is considered to be an important part of the national history and heritage.

As the the demanning of lighthouses from the 1960s, with lack of regular maintenance as a consequence threatened the coastal heritage, the Directorate of Cultural Heritage and the Coast Directorate started a process that in 1995 led to the National Plan for Preservation of Lighthouses. 84 lighthouses and 5 fogbell-stations were selected for listing as historical monuments. The methods created for the purpose were based on various aspects of representativity. Apart from the procedures of the listing, attention has in recent years been paid to drawing up guidelines for adjusted maintenance and alternative use of the selected lighthouses.

Even if the national aim has been obvious in this process, the international aspect has been highly recogniced. The seamarks creates a worldwide structure that has to be dealt with in an international perspective with participation from both the maritime and the heritage authorities. The initiative taken by IALA in establishing the advisory panel is an important step.



Lighthouses in S. Norway. Lighthouses selected for preservation marked in black.



Lighthouses in N. Norway. Lighthouses selected for preservation marked in black.

Introduction

The main topic of this paper is the preservation plan for lighthouses in Norway, beginning with a brief account of the historical development of lighthouses in order to establish the necessary background. The methods used in the work on the preservation plan are then described, with special emphasis on the system of criteria for selection. Present challenges will be pointed out and the necessity of international cooperation in this matter will be discussed.

Different countries seem to define the word «lighthouse» in different ways. In this paper, as in the preservation plan, a rather simple definition is used - a lightstation that has or had a resident staff.

History

It is not known when the first light was lit to guide ships safely to port in Norway, but it can safely be assumed that way back bonfires have been lit on rocks and shores when ships were expected, even if the written history is silent. The first official lighthouse, however, was erected in 1655. This is suprisingly late, taking into consideration that Norwegian seafarers must have been familiar with the benefits of navigational lights several hundred years before that. A lighthouse or a ligihtbeacon should at least have been expected at the entrance to the busy Hanse port of Bergen at an earlier stage.

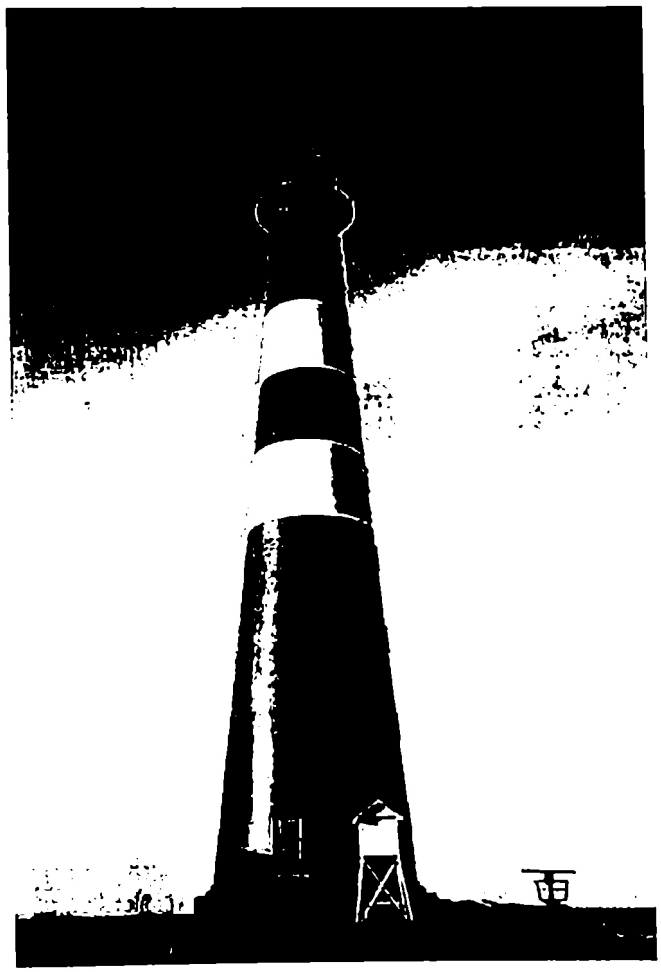
The fact that most of the sailing was done in the summer half-year with long days and light nights indicates that daymarks were more important – and the history of daymarks can be traced far back in time. As early as around AD 800 stone beacons are reported along the west coast, and according to the 15th century Venetian traveller Pietro Querini, who was ship-wrecked on the Norwegian coast, a system of such beacons seems to have existed in the Middle Ages. In his description of a voyage along the northwest coast in 1432 he says: «We sailed according to the cairns on the top of the islands which indicated the best and the deepest passage.»

But, as already mentioned, written sources are silent concerning lighthouses until 1655, when a citizen of the new city of Kristiansand obtained a royal privilege to erect a lighthouse at Lindesnes, at the very south point of Norway. The shape or size of this construction is unknown, but judging from the inventory of materials used, it must have been a wooden tower with a coal basket on the top. When they ran out of coal the first winter, the coal basket was replaced by a lantern with wax-candles. After the second winter, the light was put out and not lit again for nearly 70 years. It can rightly be said that the history of lighthouses in Norway had a hesitant start.

The second lighthouse in Norway was built in 1687 on the island of Færder outermost in the Oslofjord, and until 1828 when the lighthouse service was reorganized only 12 lighthouses had been established, all of them in the southern part of the country. In 1841, when the service once more was reorganized, there were 27 lighthouses. From then on, the development was very rapid and by the turn of the century the country had approximately 160 lighthouses. After the first two decades of the present century the development declined and in 1932 when Anda lighthouse was built as the last manned station, the total number had reached 209. In the same period several thousand daymarks and smaller lights were also put up. The tremendous

development of lighthouses and other aids to navigation from 1840 onwards was a remarkable effort for a country with such a small population. It was an important part of creating the the young nation's infrastructure and as far as lighthouses were concerned, Norway had become a great power.

During the same period, lighthouse technology had developed at an amazing pace. Candles, wood and coal were replaced firstly with liquid fuel, and later on with gas and electricity. The various arrangements of mirrors were replaced with lenses; flashing or coloured sectors were developed to distinguish different lights; and fog cannons and bells were replaced with various types of pneumatic signals. Structurally, lighthouses began to reflect new building materials such as concrete and cast iron.



Slettenes Lighthouse *The 39m high tower was erected in 1905 as one of about 40 cast-iron towers in Norway. The lighthouse is still manned.*

As this development has been essentially the same in most coastal nations, only features that are typical for Norway will be commented on in this paper. As the country was united with Denmark from the Middle Ages until 1814, it is not suprising that the early phase of the lighthouse history was highly influenced by Denmark. In fact, every little detail was decided in Copenhagen. Prominent Danish lighthouse constructors like Poul Løvenørn left his solid mark on the Norwegian development. From 1814 to 1905, which is the most important period in the development of lighthouses, Norway was united with Sweden. Despite the invention by Admiral von Otter of a clockwork-driven flashing device and the revolutionary inventions of Gustaf Dalén that rapidly spread all over the world, it is not easy to trace strong Swedish influence on Norway in this period.

None of the great technological inventions was made in Norway, but the country was extremely quick to take the new developments in use. When Augustine Fresnel constructed his dioptric lens in the 1820s, Norway was the third country in the world to adopt this revolutionary system when a second order lens was installed at Oksøy lighthouse in 1832. As for energy, a huge steam-powered electric power station was installed at Ryvingen lighthouse in 1897, which is very early.

Homlungen Lighthouse *was established in 1867 and is a typical example of a Norwegian small white-painted wooden lighthouse. The lighthouse is still in function but was demanned in 1952*

In 1842, the first big cast-iron lighthouse-tower was produced in London to be put up in Jamaica. Some ten years later, the 40m high tower for Eigerøy lighthouse was cast at the Bærum Værk foundry, outside Oslo. This was the start of a production for the home market without parallel in Europe. By 1950, when the last cast-iron tower was erected, more than 40 cast-iron towers had been produced by a handful of Norwegian foundries. They all still exist, except for a few that were blown up in 1944 by the German occupying forces.

Another peculiar fact is that in contrast to many other countries, in Norway very few lighthouses were drawn by trained architects. While some of Denmark's most prominent architects were responsible for designing lighthouses in that country, in Norway they were often designed by the lighthouse engineers. Even if Norway was in the lead concerning technological development, at one point the lighthouse service were for unknown reasons a long way behind normal development: coal continued to be used as fuel for a very long time. When Villa and Kvitesøy lighthouses were rebuilt in 1859, probably the two last coal-fired lighthouses in the world were put out.

Nothing has so far been said about lightships. This is because they have only played a minor role in Norway's navigational history. In fact, there were only two and neither of them were very successful. The topography of the coastline with islands far from shore made it possible to build lighthouses on solid rock. There was simply no need for lightships.

The history of lighthouses is complex and exciting, not just because it has often been dramatic, but also because it reflects in a concentrated way the technological, economic and social developments of our culture. It is at one and the same time the history of building materials, of structural techniques, of sources of light and energy, of optics, mechanics, pneumatics, electronics and a whole range of other aspects. It is not least the history of how man has managed to accommodate himself under extreme natural conditions.

Present situation

The lighthouse history has had its specific phases. Today the development is in an automation and demanning phase an man is becoming superfluous at the lighthouse. In principle, this is not entirely new, because throughout the entire history of lighthouses one has striven for forms of operation that could take care of themselves. Gustaf Dalén made a start; modern electronic technology has made this one hundred percent possible.

Since the early 1980s the Norwegian Coast Directorate has systematically automated and demanned lighthouses. The last plan for demanning was completed in 1994 and today only 31 lighthouses are still manned. In 1997 The Norwegian Government stated that this number should not be reduced further.

The implementation of these plans has in a dramatic way changed the conditions for the lighthouses. Some stations have been completely shut down, many isolated buildings and structures are no longer in use, some have already been taken down. For the rest the present situation is most insecure. At the demanned stations the buildings lack daily attention and regular maintenance. Without a resident staff they quickly deteriorate as they are often located on very exposed sites. An essential element of the cultural history of the country and some spectacular elements in the coastal landscape were in the process of disappearing.

As mentioned before, the last manned station in Norway was erected in 1932 and there will never be built another manned lighthouse in Norway, probably not in the rest of the world for that matter. There will be built new churches, town halls, residences, university buildings, factories, bridges etc., but no new lighthouses. This is quite a unique situation that gives an obligation to take well care of this given heritage.

Preservation plan for Lighthouses

Against this background the idea of a national preservation plan came about with great force. A national preservation project was established in 1991. To have the opportunity to develop and test a suitable method on a small scale, the county of Vest-Agder was chosen. This pilot project, which resulted in the report «*Bevaring og fremtidig bruk av fyrstasjoner*» [Preservation and future use of lighthouses] formed the basis for the subsequent national project.

In May 1995, the Directorate for Cultural Heritage, in collaboration with the Coast Directorate concluded the first stage of the National Lighthouse Preservation Plan. In all, 84 lighthouses and 5 fog warning stations were selected for preservation. These installations form the basic stock or nucleus of lighthouses in a national heritage perspective.

Basically, most lighthouses are worthy of preservation, since each single lighthouse is part of a closed structure that has a high historical value in itself. However, it would be neither practical nor politically possible to preserve every installation. The main objective of the plan has therefore been to arrive at a selection of lighthouses that together will provide a picture of the nation's lighthouse history that is valid and sufficiently detailed.

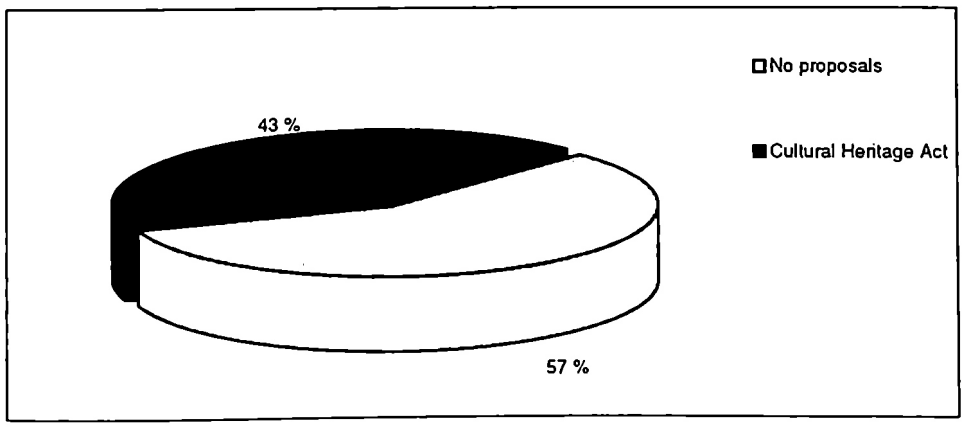
In order to manage the vast amount of information that was available, a database was established at an early stage in the project for recording the historical, environmental and technical details of every lighthouse along the coast. As a result of a preliminary evaluation of the recorded data, 164 lighthouses were chosen for further investigation. These lighthouses were then visited and the previously collected data were checked and supplemented. Each site was also systematically photographed. On the basis of a renewed evaluation, which also included the views of the local conservation authorities, 89 sites were chosen to form the nucleus of the national preservation plan. During the whole process there was a close collaboration between the Coast Directorate and the Diectorate of Cultural Heritage.

In this project it was necessary to evaluate the lighthouses from two main angles – from the preservation value of the site seen in itself and from a consideration of its situation in a wider context. Representativity has been a key concept and emphasis here has been placed on the following aspects:

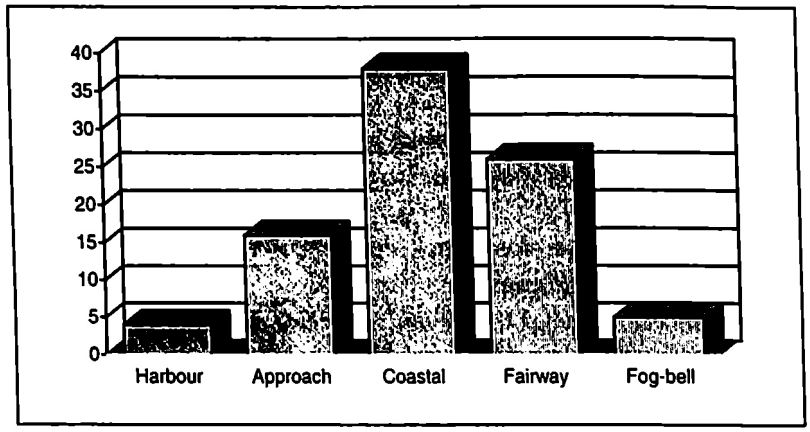
- ***Age*** – it has been a major aim to have the entire lighthouse history fully represented and consequently both the very old ones and the newer lighthouses will be on the list;
- ***Authenticity*** – the survival of original material has been stressed, but also later alterations have been accepted where these reflect the development;

- ***Types*** – the large coastal lighthouses are relatively over-represented, but efforts have been made to include a reasonable selection of lights ranging from exposed coastal sites, fairways and harbour installations;
- ***Technological development*** – technical equipment such as the type of light source, the lenses, the shutter mechanism, fog warning systems, radio-beacons, etc., have all been given special weight;
- ***Construction material*** – wood, stone, brick, concrete, iron;
- ***Building traditions and architecture;***
- ***The relationship between the lighthouse and its environment,*** its connection with other lights or seamarks, its situation in the cultural landscape, other historical sites in the area, etc.;
- ***Aspects of cultural history,*** such as its role in the great seasonal fisheries, connection with industrial development, its role in wartime, and so on;
- ***Lighthouses as workplaces and other social aspects;***
- ***Geographical distribution;***
- ***Accessibility and the possibility of alternative use.***

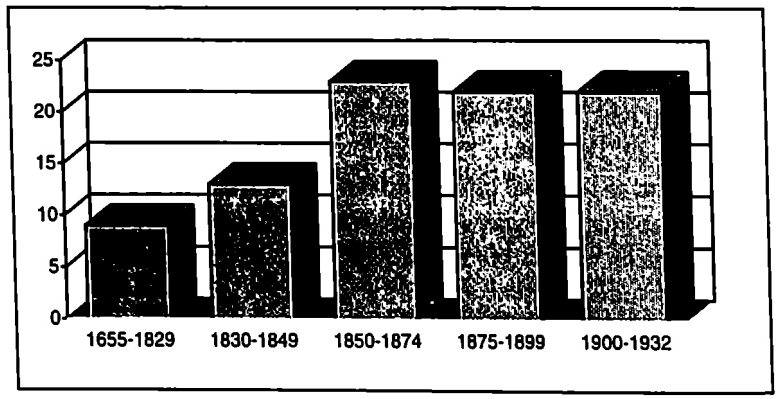
It is important to emphasize the nature and limitations of the national preservation plan. In this project, Norway's long coastline has been regarded as a single entity, regardless of regional and municipal boundaries. This means that a national preservation plan like this could never be identical with the sum of regional preservation plans. It should therefore be pointed out that there may be very strong local or regional arguments for preserving other lighthouses than the 89 sites that have been selected to form the national nucleus. That will however be up to the municipal authorities to judge.



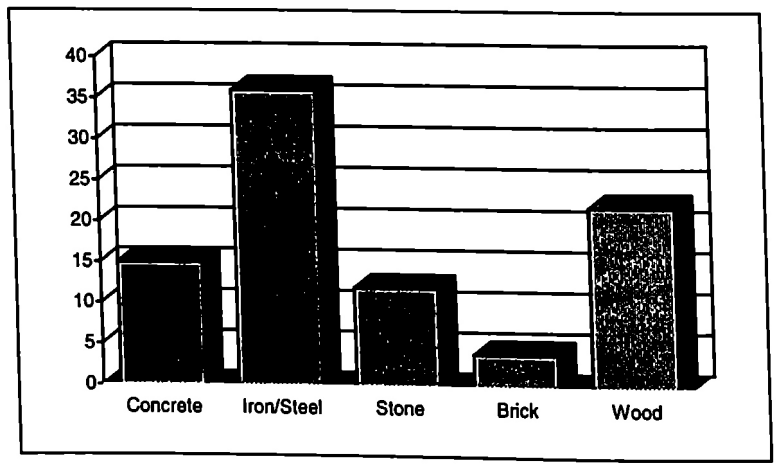
Proposed status for 209 lighthouses



Lighthouses selected for preservation - function



Lighthouses selected for preservation - age



Lighthouses selected for preservation - building material

The realisation of a national preservation plan for lighthouses will be a long process. For each site a detailed protection order must be prepared under the terms of the Cultural Heritage Act in which the various conditions are met and the boundaries of the site carefully defined. These will vary of course from site to site. In every single case it must be considered whether the protection order should cover the interior as well as the exterior and which features are to be included. Another important point is to ensure that the imposition of a protection order will not hinder the continued or possibly renewed use of the site as a manned lighthouse. Then there are the formalities of allowing submissions from owners and from regional and local municipal authorities and possibly having to take these into account. By the end of 1997 30 lighthouses were listed as protected monuments. By 2000 we believe that all the sites that make up the nucleus of the national preservation plan will be formally protected.

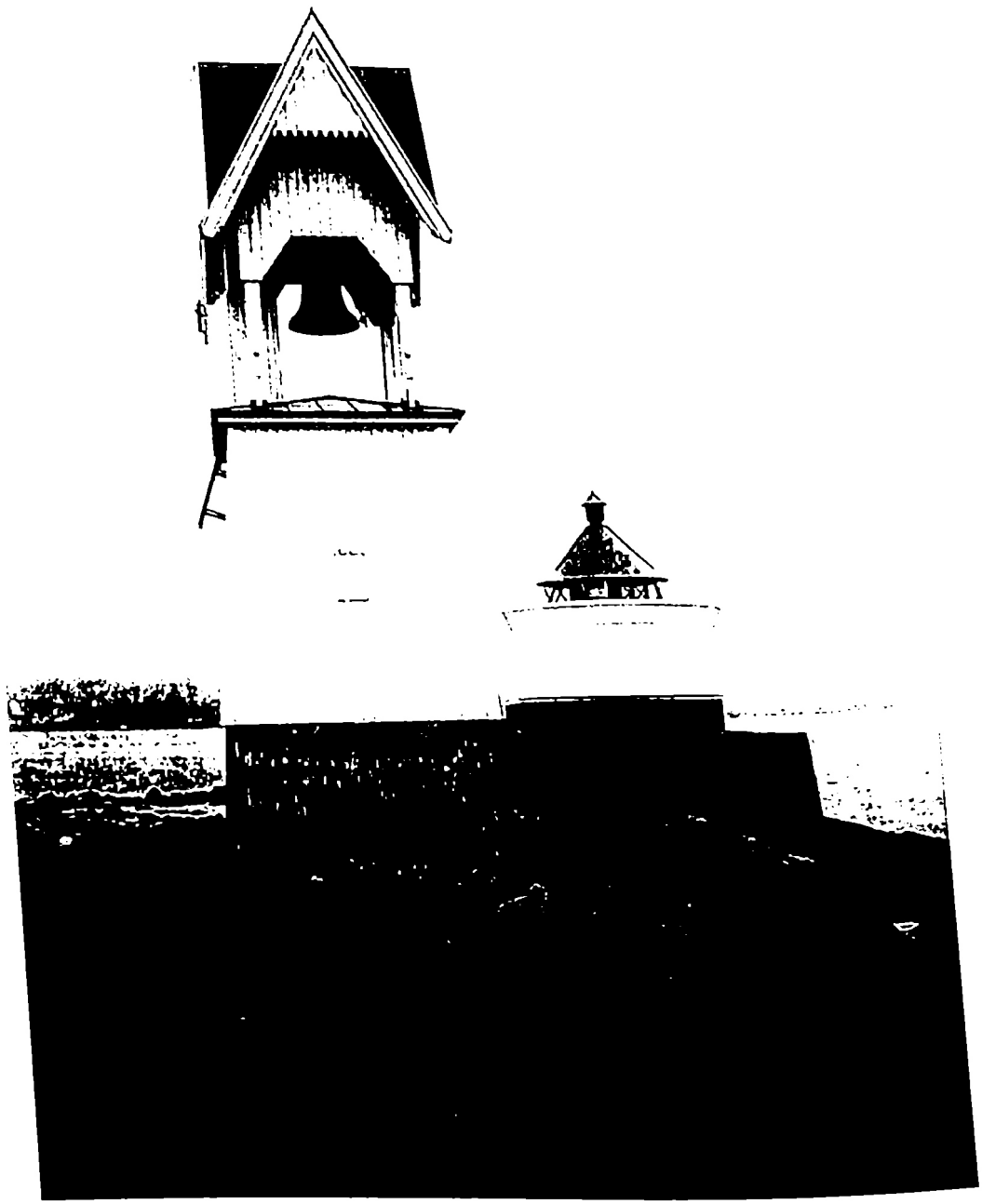
A protection order is a formal resolution, but it is not sufficient in itself to guarantee a meaningful preservation, which should be the main objective of a protection order. Many of the lighthouses are in immediate need of maintenance and repair. It is important that this is done soon and with techniques and materials suitable for the specific lighthouse. To ensure this, the two Directorates are in the process of setting up specific guidelines. A general handbook for maintenance has already been produced and specific plans for the maintenance of some of the listed stations will be on the 1998 agenda.

Alternative use

The preservation plan has also a financial aspect. According to Norwegian policy, it is the owner of a historical monument who is responsible for its maintenance. In this case the Coast Directorate will be responsible for maitaining any lighthouse that is in their possession and protected under the Cultural Heritage Act. At present the maintenance budget is not adjusted to this reality. Apart from increasing the budget it is also necessary to look for other sources of income. It will be proper to consider whether preservation may be achieved by alternative use. With regard to lighthouses that are no longer manned, a significant challenge will be to find possible and acceptable alternative uses, which may secure their regular maintenance, while at the same time enable them to be presented to the public as historical monuments and a part of the lighthouse history.

Lighthouses have recently received much attention, which among other things has led to several suggestions for their future use. Not all of these proposals are equally realistic, but some of them have already proved to be quite successful from both an economic and a heritage point of view. Among these are museums, coastal culture centres, art galleries, information centres, diving clubs, residences for writers and summer resorts for frozen lighthousekeepers. Experience with lighthouses adapted to small-scale tourist activity has proved particularly interesting.

Creating alternative or additional use for the lighthouses will be one of the most important challenges in the near future. In this matter it is vital to create long term solutions by following the simple rule that it is the new use that shall be adapted to the lighthouse, not vice versa.



Torgersoy Fogbell *was established in 1911. It was shut down in 1983 but the clockwork mechanism is still in working order. It is one of the five fogbells selected for preservation.*

Other Aids to Navigation

The different aids to navigation in addition to the lighthouses - cairns, beacons etc. - make a complete navigational system. In 1997 the Directorate for Cultural Heritage in collaboration with the County of Aust-Agder and the Coast Directorate made a survey of all such installations along the shores of that county to obtain a view of the whole complexity within a limited area. In the near future the preservation plan for lighthouses will hopefully be followed by plans for the preservation of the other navigational elements as well. However, their multitude and character call for another, less detailed form of preservation plan.

International perspective

For the lighthouse preservation plan, the national perspective has been paramount. But lighthouses are also part of a greater, global scheme, where the installations in one country are linked to the next in an almost endless chain with neither beginning nor end. Tecknology and systems have been developed across national boarders. It is therefore natural to view the work on preserving lighthouses in an international perspective and the coastal nations of the world should thus collaborate in this work. Even though lighthouses the world over have obviously similar features, they also have their special national characteristics. In a world-heritage context, it is important that these features are recognized and preserved.

The establishment within IALA of the Advisory Panel for the Preservation of Lighthouses, Aids to Navigation and Related Equipment of Historical Interest is a major event in this connection. The fact that this panel is a part of IALA, an organisation that primarily works with the navigational tools of tomorrow, is remarkable. It demonstrates that IALA is showing responsibility towards history and the past that is quite in accordance with present charters of the United Nations. It also shows an awarness of the fact that the history and the fate of the lighthouses are very much on the agenda all over the world.

Preserving lighthouses and other aids to navigation call for a close cooperation between the maritime and the heritage authorities in the different countries. Both professions are needed to get results that are beneficial for society. In many countries these authorities have no tradition in cooperation; in fact one may talk about different cultures and languages. Nevertheless - cooperation is necessary. The Norwegian example has shown that is possible and fruitful.

Changgigot Lighthouse Museum (Summary)

The Changgigot Lighthouse, which opened on December 3, 1903, contains the tallest tower in Korea, standing at a height of 26.4 meters. The lighthouse safely guides ships at sea by providing audible, radio, and visual aids to navigation through the bay waters. A four member staff works at the lighthouse, in charge of managing unmanned light nearby.

Not only does the Changgigot Lighthouse play a very important role in safe mavigation, but because of its unique architectural style and historical value, the lighthouse was designated Cultural Property No. 39 of the Kyongsangbuk-do Province on August 4, 1982, by the Cultural Property Management Act.

As Korea uses more and more advanced aids to navigational equipment, much of the traditional equipment used as aids to navigation has been disappearing. Thus, in order to preserve such cultural relics of aids to navigation and related equipment, the lighthouse museum was built at the site of Changgigot Lighthouse in April 1985, the only existing lighthouse museum in Korea. The purpose of the museum is to preserve the rich history of the development of aids to navigation and heighten the public awareness of the importance of aids to navigation and other maritime activities in Korean.

The Changgigot Lighthouse Museum was built in a two-story, blue roof tiled, concrete building with a floor space of 494 sq. meters. The site of the lighthouse museum covers an area of 4,958 sq. meters. In the exhibition hall, 720 items of 135 different types, which were used as aids to navigation both in Korea and overseas are on display. The museum was allotted national museum status when it was designated as Museum No. 16 of the Ministry of Culture and Public Relations on April 16, 1986. Concurrently, the municipal government of Pohang was assigned to be in charge of the operation of the museum.

The number of visitors to the museum has increased every year from 200 thousand in 1986 to 380 thousand people in 1997.

On July 1, 1996, the responsibility for the operation of the museum was transferred from the municipal government of Pohang to the Ministry of Maritime Affairs and Fisheries. The Ministry then proceeded to make improvements to the museum, making the existing exhibits more dynamic, expanding the museum to secure space for new exhibit items, and renovating to create a more comfortable and relaxing seaside atmosphere. Basic and detailed designs for the expansion were completed in 1996 at the initial cost of US $54 thousand dollars. The Ministry will invest a total of US $5.1 million dollars into the museum for additions and renovations.

These renovations will include expanding the site of the museum to 5,872 sq. meters with the addition of a new outdoor exhibition ground, convenience facilities, and a new, two-story concrete exhibition hall. The second exhibition hall, Exhibition Hall No. 2, will consist of a theater and various exhibit halls and facilities. The first floor will include a marine-safety hall, a sea hall and a storage room, and the second floor will have a lighthouse hall and a library. When the new building is completed, the Lighthouse Museum will truly serve as an educational and historical site to learn how aids to navigation and related equipment have developed, attracting its own tourists as well as those visiting the nearby ancient city of Kyongju.

Changgigot Lighthouse Museum

1. Current Status

Changgigot Lighthouse is located at Taebo-ri, Taebo-myon, Nam-gu, Pohang in the Kyongsangbuk-do Province, and is the second oldest lighthouse in Korea(Fig. 1). The lighthouse, which started its operation on December 3, 1903, is the location of the tallest tower (the lighthouse tower) in Korea standing at 26.3 meters above sea level. With its unique and bold architecture, the lighthouse is as beautifully built and as impressive as any other lighthouse in the world.

Changgigot Lighthouse, built on the site covering 13,572 sq. meters, was designed by an Englishman and constructed by a Korean constructor(Photo. 1). An octagonal brick lighthouse, it is unique in that concrete was not used in its construction. The inside walls and front gate of the lighthouse were built in 18th century Renaissance style, with octagonal columns. Elaborate designs of pear tree flowers decorate the inside of the tower.

Photo. 1. A View of Changgigot Lighthouse

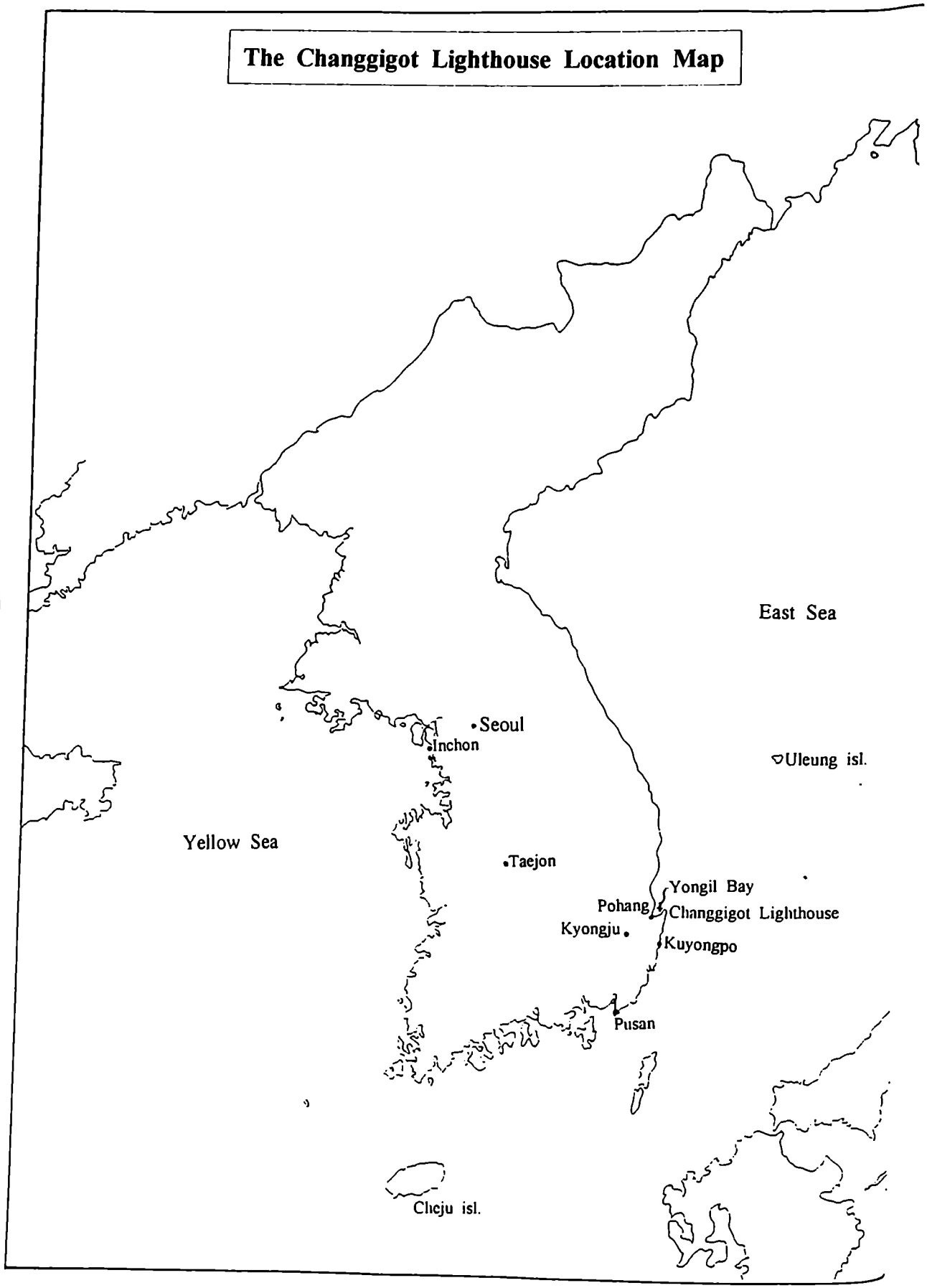


Fig.1 The Changgigott Lighthouse Location Map

The coastal area of the Yongil Bay is famous for its dramatic rock structures, strong winds and unforgiving currents, and the history of the area, accordingly, includes a number of large and small marine accidents. For example, before the lighthouse was built, some 30 students and teachers died in 1901 when a Japanese ship of the Fisheries Vocational Institute was wracked on a rock.

During the initial stage of its operation, the lighthouse at Changgigot only used a simple Lanse clock lantern with a Fresnel lens and oil lamp. Then in 1947, the lighthouse was installed with an electric power generator and oil lamp. These were then replaced by an electric bulb with a nominal range of 16 miles. At present, the lighthouse is equipped with a permanent electric power supply system that uses a rotating 610m/m lantern with a 1000 watt light bulb, increasing a nominal range to 22 miles.

The radio beacon station at Changgigot was established in 1973. From the station, ratio beacon is sent to service areas within 100 miles from the lighthouse. Currently, the GPS reference station is in operation in cooperation with the DGPS transmitter station, which was established in 1996.

Since foggy conditions are common in the coastal areas around the lighthouse, a fog signal station was installed at the lighthouse in 1925 to prevent accidents by small ships. There are four people working at the lighthouse. They are also in charge of maintaining nearby unmaned lights.

The Changgigot Lighthouse is located at the entrance of the port city of Pohang, where POSCO, one of the world's largest iron and steel companies, is located. Thus, the lighthouse serves as a very important guide for the numerous passing small ships, as well as for the continuous flow of 250 thousand ton-class ships transporting iron ore.

2. Construction of Lighthouse Museum

Recognizing the historical value of the Changgigot Lighthouse, as well as its functional importance for safe navigation, the lighthouse was designated as Local Cultural Property No. 39 of Kyongsangbuk-do Province on August 4, 1982.

As Korea comes to use more and more advanced aids to navigation and related equipment, much of the traditional equipment used aids to navigation has been disappearing. Thus, in order to preserve such cultural relics of aids to navigation, the need arose to construct a lighthouse museum. The function of a lighthouse museum

would be to preserve the rich history of the development of equipment used as aids to navigation at sea, and to heighten the public awareness of the importance of aids to navigation and a lighthouse for safety of maritime transportation.

To this end, the local government of Kyongsangbuk-do Province and Pohang Regional Maritime Affairs and Fisheries Office, which had jurisdiction over the Changgigot Lighthouse, decided to construct a lighthouse museum nearby the Changgigot Lighthouse in May 1985, in consideration of the geographical proximity between Pohang and the ancient city of Kyongju.

The lighthouse museum, Korea's only lighthouse museum, was built on the site that includes the Changgigot Lighthouse. A total of US $180 thousand dollars was invested to build an exhibition hall at the museum. The exhibition hall was designed with the intent of creating a harmony between the sea, the lighthouse, and ship at sea. The shell-shaped exhibition building has eight columns along its exterior, designed as a visual complement to the lighthouse tower. The entrance of the hall was built in Renaissance architectural style, and the entire exhibition hall, a two story concrete building, has a floor space of 494 sq. meters.

Pohang Regional Maritime Affairs and Fisheries Office collected some 720 items of 135 types which were used as aids to navigation for the museum. On the first floor, various equipment and devices used as aids to navigation, a model lighthouse, 68 panels showing aids to navigation, publications, and 184 pictures are displayed. On the second floor, other publications and 153 pictures of lighthouses of other countries are displayed.

The Changgigot Lighthouse Museum was designated Museum No.13 of the Ministry of Culture and Public Relations museums on April 16, 1986. Four officials of the municipal government of Pohang, Kyongsangbuk-do Province are assigned to work at the museum. The museum is closed on Mondays.

The number of tourists visiting the museum has increased from 200 thousand in its early days to some 380 thousand people in 1997.

3. Expansion of the Lighthouse Museum

On July 1, 1996, the operation of the lighthouse was transferred to the Ministry of Maritime Affairs and Fisheries. Until then, the local government of Pohang city was responsible for the operation of the museum. The Ministry then saw to the rearranging of the exhibition to make it more lively and dynamic. In addition, to

create a new recreational space and secure an exhibition room to display newly collected items, the Ministry decided to expand the museum. Initial designs have already been completed at the cost of US $54 thousand dollars. We can see a Bird's Eye View of Changgigot Lighthouse Museum(Photo. 2)

Phto. 2 A Bird's Eye View of Changgigott Lighthouse Museum

Changgigot Lighthouse Museum is located on southeast coastal area of Korea. If you want to visit the museum, you must first go to Kuyoungpo, located 30 kilometers south of Kyongju or Pohang. Next, proceed another 20 kilometers northeast with the East Sea on your right until you reach Changgigot. From this point, you will able to see a fantastic view of a ship (a model of the new building) sailing to the port under the guiding light of Changgigot Lighthouse.

The new exhibition hall was designed to be located lower than existing exhibition hall so as not to obstruct the view of the Changgigot Lighthouse.

A total of US $5.5 million dollars was invested in 1997 for the purchase of land

sites needed for the expansion of the museum (5,874 sq. meters), the construction of new two-story concrete building with floor space of 1,634 sq. meters, and recreational facilities and additional outdoor exhibition sites covering 5,882 sq. meters(Fig. 2,3,4)

At the entrance of the museum exhibition grounds, you will find a monument to the lighthouse and marine sculptures on your left. Then, as you enter the Exhibition Hall No. 1, you are greeted by the view of the Changgigot Lighthouse and the surrounding bay in mosaic tiles covering the wall. On the walls of the hall, there is a map of Korea, as well as an information sign of the museum.

When you first enter the hall the first thing you see is a wide screen color television showing a information video about Youngil Bay, the local culture, tourist attractions, and the sea and all its wonders. Here, you will find a resting place, where graphic panels on distribution of ports and aids to navigation, and how aids to navigation system operate in Korea, displays about marine life and fisheries, maps of ports and marine transportation routes, and information on foreign Aids to navigation affairs can be found.

On the first floor, there is a 60 seat theater covering 131 sq. meters, where short movies are shown. There are 24 movies shown here, with a different movie for different times of the year. The movies cover a wide range of maritime related topics: how aids to navigation help ship come and go safely from a port, major lighthouses in Korea, the life of a lighthouse keeper, how unmaned lights are maintained in Korea and the people who run them, lives of Korean fishermen, and the history of aids to navigation and major ports of the world. These movies are run on a large, multi-tube system and each movie lasts about eight minutes.

If you walk to the right from the movie screen, you will see the Sea Hall exhibition. Complete with an aquarium with a floor space of 331 sq. meters, the Sea Hall was designed to give you the impression of being under the sea.

Models of various ship from the ancient times to today, graphic panels and models depicting the function of ports and fisheries activities are displayed here to help you better understand marine affairs and fisheries. In the spirit of sea exploration to come, a futuristic ship model will be also displayed.

After the Sea Hall, you go up a ship bridge to see various displays of aids to navigation equipment. A simulation program allows you to experience the operation of a ship on the East Sea, firsthand. After the simulation, you may well learn to appreciate the value of aids to navigation at sea, and might think to thank those working on ships and the importatnce of aids to navigation.

From there, if you go to the Safety Hall. In this hall, there are displays of the

tremendous damage marine accidents can cause to human lives and property, and by the way of sea pollution. The displays are geared towards heightening the public awareness of the prevention of marine accidents. The museum displays photographs and illustrations on the causes of marine accidents, the huge impact and losses that can result from such accidents, and measures that can be taken for prevention and cleanup of accidents. In this way, visitors are forced to think seriously about marine safety and sea pollution.

From the observatory, you can see the Lanse clock lantern with class 3 lens, a single white light flashing for 20 seconds, from the top of the lighthouse tower. Visitors can then go up the spiral stairs to the second floor to enter the Lighthouse Hall, the main exhibition hall of Changgigot Lighthouse Museum.

The Lighthouse Hall, covering 277 sq. meters, is divided into three kinds of displays, those for audio aidible, radio and visual aids to navigation. The hall displays some 86 items of visual aids including the lighthouse lantern, the bulb, a solar cell, a battery charger, and a gas generator. There are 14 radio aids items including a Loran C transmitter, and 15 audible aids to navigation on display. A diorama model is used to display the items to produce dynamic effects and help visitors better understand how the lighthouse is operated.

Publications, documents and photos related to lighthouses are also exhibited to show Korea's 100-year and the worlds 200 year lighthouse history. In the Lighthouse Hall, there are computers for use to retrieve information on aids to navigation, marine affairs, and fisheries in both Korea and abroad. By providing such access, the museum contributes to the distribution of informationon aids to navigation, a major function of the lighthouse museum.

Coming out of the Lighthouse Hall brings you to an open air to view of Exhibition Hall No. 2, as well as various outdoor exhibitions on the ground level. You will be able to better understand aids to navigation as you see the outdoor model of Yongil Bay and a ship in operation in a simulated situation. The model is complete with a mermaid carrying a torch, the symbol of IALA.

In Exhibition Hall No. 2, the various lighthouse tools and the 260 items of large lighthouse equipment allow you to feel the pleasure, sorrow, love, and anger that is felt by lighthouse keepers. Pictures of lighthouses from both at home and abroad will be displayed throughout the new hall.

Activities related to surveys to marine affairs done at lighthouses will be displayed in photos and models. Adventures in marine exploration and related activities will be depicted with diorama models.

After the new exhibition hall, you may visit Outdoor Exhibition Ground No. 2. Here, you can enjoy the open waters of the East Sea and take in the refreshing natural environment. Small models of various aids to navigation equipment can be found here, and recreational facilities are provided to allow you to refresh yourself while reflecting on the importance of the sea and lighthouse.

Exhibition Hall No. 1 has a storage room where newly collected goods are stored and items are repaired. There is also a library open to the public.

In 1999, when the expansion of Changgigot Lighthouse is completed, the museum is expected to attract many tourists both from other parts of Korea and abroad. In particular, tourists visiting the ancient city of Kyongju, the most famous tourist attraction in Korea, should find the Changgigot Lighthouse a delightful as well as enlightening addition to their visit to Korea.

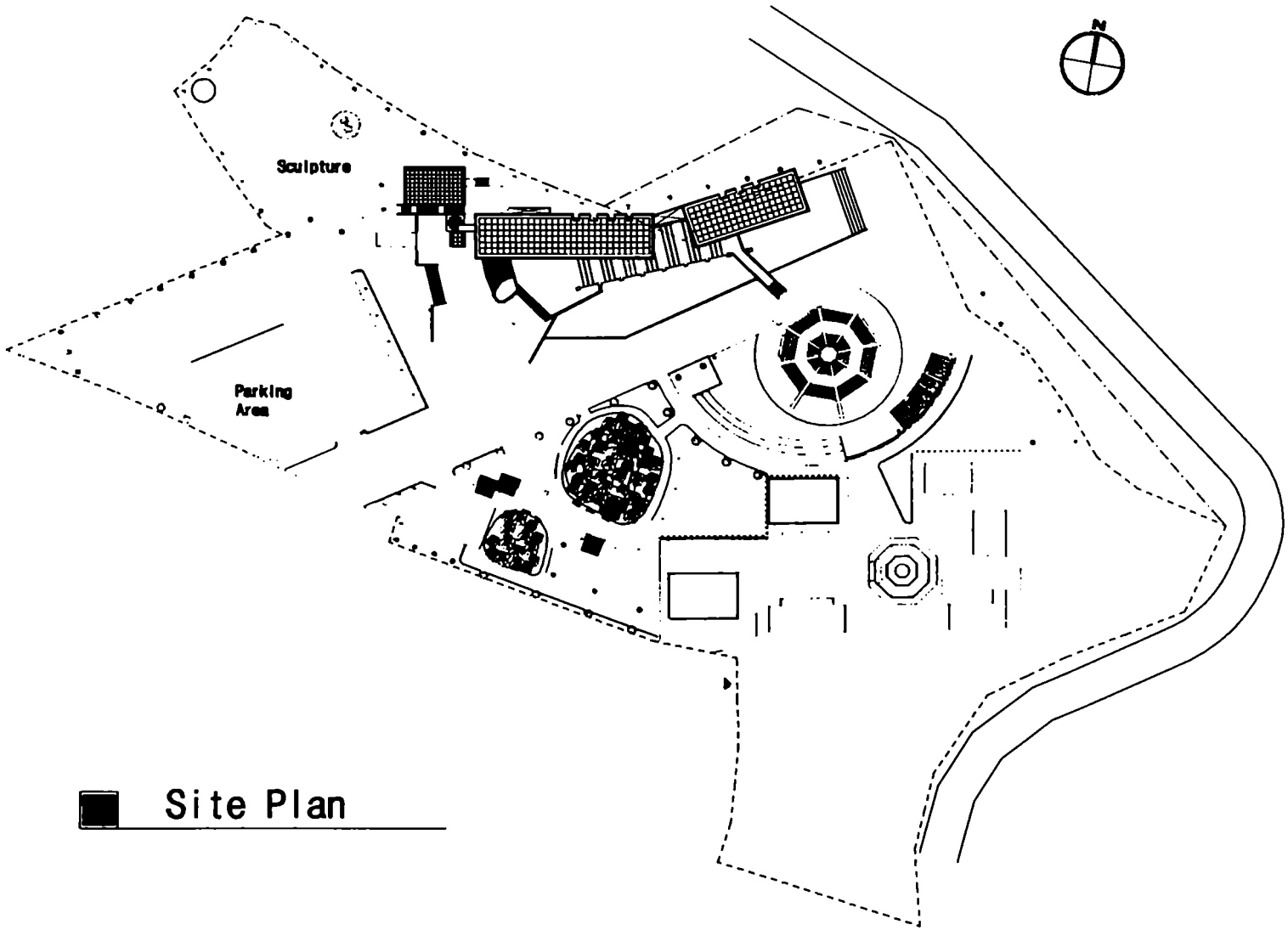
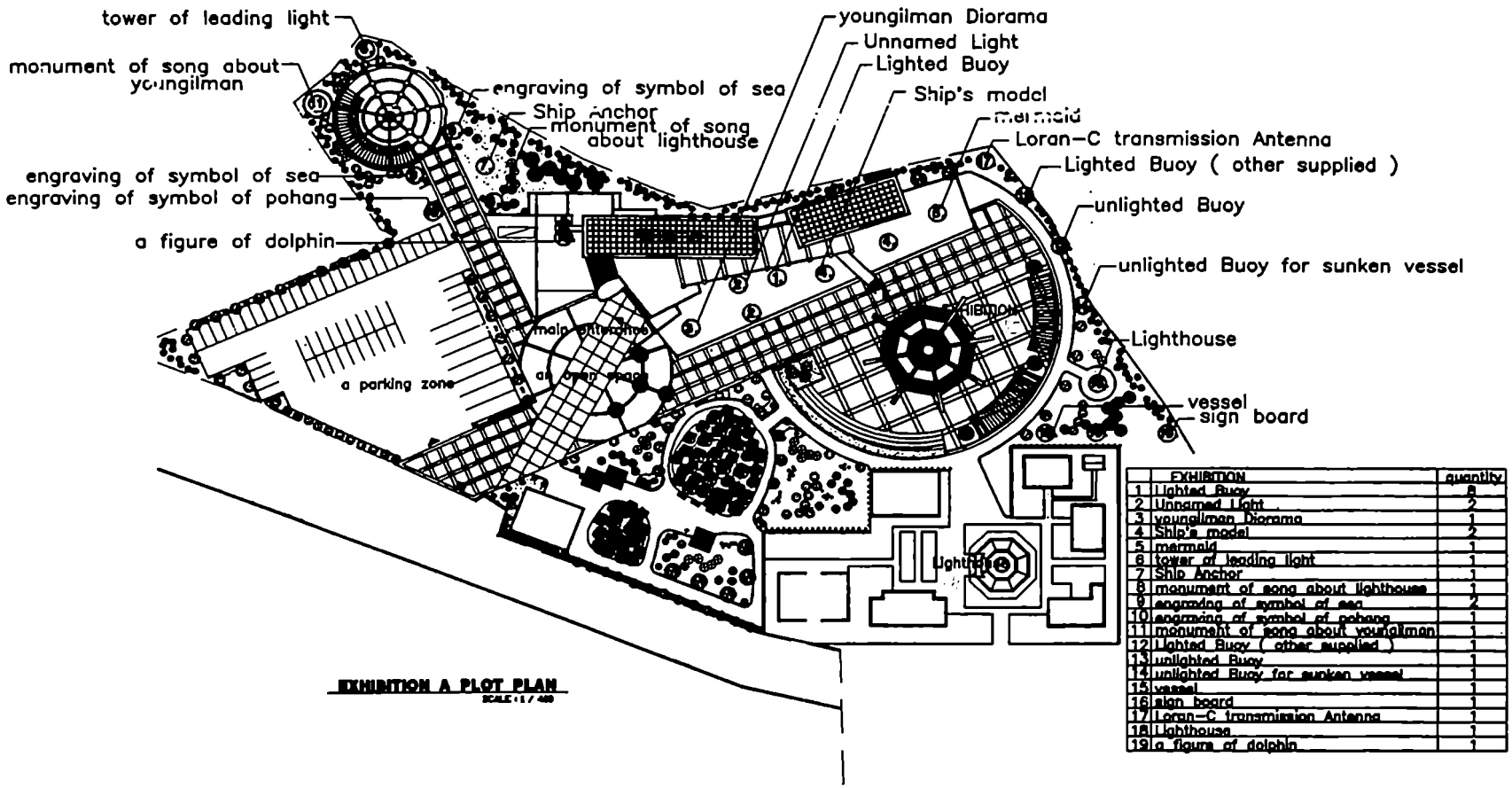


Fig. 2 The Site Plan of Changgigott Lighthouse Museum



	EXHIBITION	quantity
1	Lighted Buoy	8
2	Unnamed Light	2
3	youngilman Diorama	1
4	Ship's model	2
5	mermaid	1
6	tower of leading light	1
7	Ship Anchor	1
8	monument of song about lighthouse	1
9	engraving of symbol of sea	2
10	engraving of symbol of pohang	1
11	monument of song about youngilman	1
12	Lighted Buoy (other supplied)	1
13	unlighted Buoy	1
14	unlighted Buoy for sunken vessel	1
15	vessel	1
16	sign board	1
17	Loran-C transmission Antenna	1
18	Lighthouse	1
19	a figure of dolphin	1

Fig. 3 The Plot Plan of Changgigott Lighthouse Museum

E·L·E·V·A·T·I·O·N

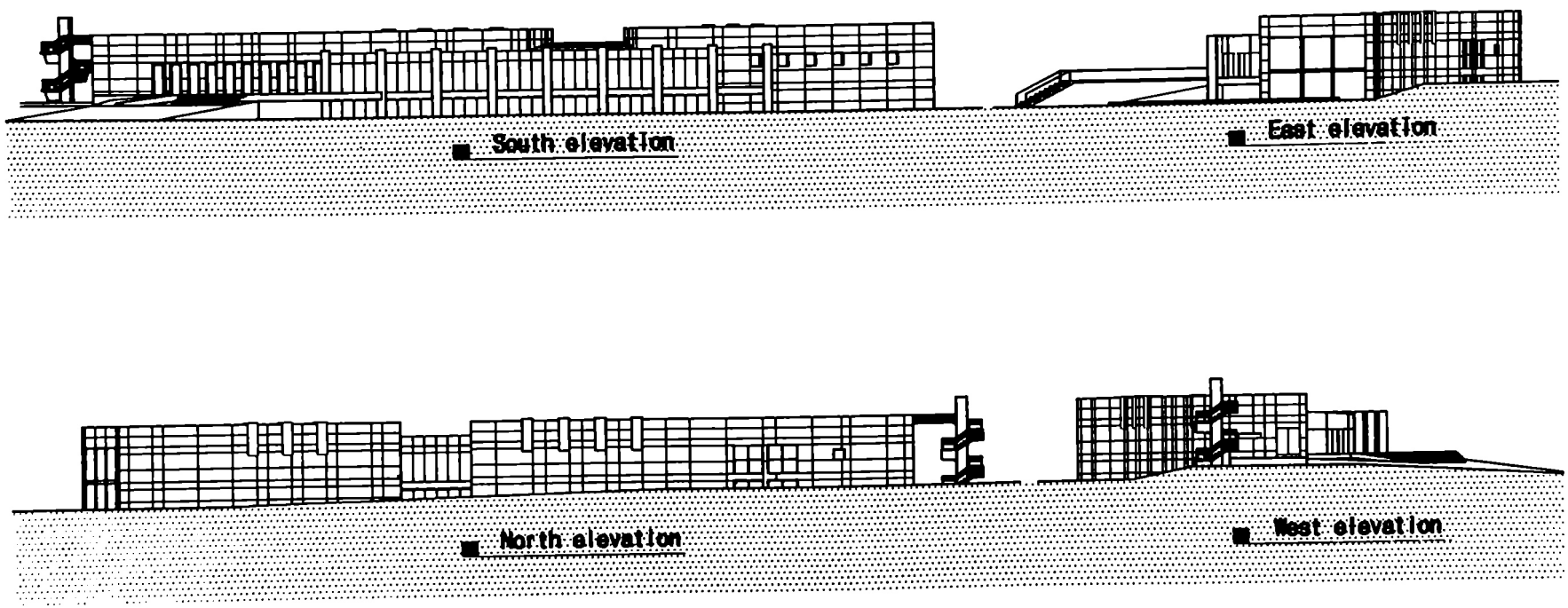


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Fig. 4. The Elevation of Changgigott Lighthouse Museum

Repair of Historically and Culturally Valuable Lighthouse

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Summary

Japan's feudal Shogunate Government at Edo collapsed and the new Meiji Government was established during the latter half of the 1860s. It was the dawn of modern Japan. Major reforms occurred in all areas of Japanese society, including its political system, culture and economy. The country also worked to revolutionize its lighthouse technology by actively adopting Western technology and culture.

Japan built 132 lighthouses during the Meiji Era. Sixty-seven of these are still in use today throughout the country, strategically important to maritime traffic with their function as aids to marine navigation maintained. During the time of this construction most structures in Japan were built using wood. Lighthouse construction, which used not only stone and brick, but also even concrete and iron structural materials, proclaimed the beginning of modern engineering in Japan.

Today, over a hundred years later, these lighthouses have already exceeded their life expectancy as architectural structures. Their structural capability is being questioned in this age where we have a Building Standards Act, and, survey results indicate that there are many lighthouses that require reinforcement to make them earthquake-resistant.

Lighthouses, which we could call the legacy of modern Japanese architectural history, have great value from the standpoints of the historical study of architecture and history in general, as well as as industrial cultural assets. Consequently, JMSA established the Lighthouse Survey Committee, composed of knowledgeable people from the Japanese architectural world and other relevant fields, such as industrial archaeology, to properly preserve lighthouses constructed during the Meiji Era. To this end, the committee spent three years assessing the value of the lighthouses. It submitted a report stating that lighthouses given high evaluation ratings be repaired in a manner that would not ruin their original forms. Based on this report, JMSA is handling the repairs through the Lighthouse Preservation Committee, composed of knowledgeable people from the architectural world, which it established to carefully review repair methods that retain the lighthouses' original forms. This paper introduces two representative methods of preservation based on this review, the "joint replacement method" for masonry and the "carbon-fiber reinforcement method," which uses new materials.

1. Background to the Construction of Western-Style Lighthouses

In 1858, the Shogunate Government at Edo abolished the seclusionist policy that it had followed up until then, through the Treaty of Friendship and Trade concluded with the U.S., the Netherlands, Russia, Britain and France. It opened three ports, Yokohama, Nagasaki and Hakodate, to foreign trade and established diplomatic relations with the aforementioned five countries. The aids to marine navigation Japan had been using until then were called "light stands." They were small in size and aided small vessels in Japanese coastal waters. Their luminous was weak and they looked nothing like present-day lighthouses. For the large motor-powered sailing vessels from the great Western powers, navigating irregular and dark sea areas studded with reefs was immensely dangerous, and ensuring navigational safety was essential.

After opening up to foreign trade Japan began to construct modern aids to marine navigation for its major sea routes, acting upon demands from the powerful Western countries that had begun to sail the Japanese coastline. This all began with the battle of Shimonoseki. The four powers, Britain, France, the U.S. and the Netherlands, fought the Choshu clan in a battle that took place in the Shimonoseki Strait. The Western victors demanded the construction of Western-style lighthouses in place of reparations. One of the stipulations of the Reformation Tax Agreement (Kaisei Yakusho), signed in 1866, obligated the Shogunate Government to construct navigational aids for foreign trade. This was the beginning of the construction of Western-style lighthouses in Japan.

The new Meiji Government took over and continued with the construction of lighthouses after the collapse of the Shogunate Government. Since Japan of that time did not have the technology to construct Western-style lighthouses, the Government asked the British Government, which possessed leading-edge technology in the field of lighthouse construction, to help it acquire the engineers and lighthouse equipment required. Acting upon this request, the British Government selected a three-man team led by R.H. Brunton and sent them Japan.

A group led by Verny, a French engineer, built the first Western-style lighthouse in Japan. They completed the construction of the Kannonzaki Lighthouse, a brick structure at Kannonzaki, the entrance of Tokyo Bay, in 1868. Thereafter they built three lighthouses for Tokyo Bay, but none of them are standing today. Britain also undertook the construction of lighthouses in earnest under the leadership of R.H. Brunton, concentrating mainly on lighthouses required in accordance with the aforementioned agreement. R.H. Brunton undertook the construction of a total of 28 lighthouses and two lightships over a period of about nine years from 1869 - 1877. He came to build the foundation of Japanese lighthouse construction technology. After R.H. Brunton returned to Britain in 1877, and the British engineer who took over after him also returned in 1879, lighthouse construction by Japanese engineers expanded to areas throughout Japan.

Lighthouse construction, which began with the adoption of Western technology, left important historical structures that are valuable not only from the perspective of modern architectural and engineering history, but from the perspective of modern Japan as well.

2. Establishment of Lighthouse Survey Committee

The lighthouses built during the Meiji Era have become superannuated under exposure to the harsh natural environment and have already exceeded their life expectancy as architectural structures. However, because of their long history, separate from their function as aids to marine navigation there are not a few that are highly valuable historically and as industrial and cultural assets. In addition, lighthouses have established themselves as regional landmarks; therefore the maintenance of lighthouses has a great impact upon regional society.

JMSA created the Lighthouse Survey Committee, composed of authorities and knowledgeable people from the Japanese architectural world and the field of industrial archaeology, to preserve historically valuable lighthouses. It established four ranks, described below, to assess the value of lighthouses from historical and technological perspectives. In particular, the ranks 'A' and 'B' indicate structures reported as being especially valuable. They are as listed in Table 1. Preserving their original form must be an essential condition when repairs are carried out on them.

A: An especially valuable facility; the Preservation Committee is consulted and repair methods are studied when repairs are to be carried out.

B: A valuable facility; repair methods are studied to satisfy function and strength requirements without altering the existing form and materials, as much as possible, when repairs are to be carried out. The Preservation Committee is consulted and repair methods are studied.

C: A facility following 'A' and 'B' in value; as a rule repair methods are studied that have taken into consideration preservation of the existing condition, as much as possible, when repairs are to be carried out.

D: A facility following 'C' in value; consideration is given to partial preservation retaining the original form, when repairs are to be carried out.

Table 1 Rank of Historically and Culturally Valuable Lighthouse

Year	Name	Main material	Main material	Rank	Architect/Builder
1870	Mikomoto-Shima Lighthouse	Stone		A	R.H.Brunton
1871	Esaki Lighthouse	Stone		A	R.H.Brunton
1872	Hesaki Lighthouse	Stone		A	R.H.Brunton
1872	Tomoga-Shima Lighthouse	Stone		A	R.H.Brunton
1872	Nabe-Shima Lighthouse	Stone		A	R.H.Brunton
1873	Tsuri-Shima Lighthouse	Stone		A	R.H.Brunton
1873	Shuga-Shima Lighthouse	Brick		A	R.H.Brunton
1874	Omae-Saki Lighthouse	Brick		A	R.H.Brunton
1874	Inubo-Saki Lighthouse	Brick		A	R.H.Brunton
1876	Tsuno-Shima Lighthouse	Stone		A	R.H.Brunton
1876	Shiriya-Saki Lighthouse	Brick		A	R.H.Brunton
1876	Kinkasann Lighthouse	Stone		A	R.H.Brunton
1878	Shiono-Misaki Lighthouse	Stone		A	
1883	Rokkou-Saki Lighthouse	Stone		A	
1884	Kura-saki Lighthouse	Concrete		A	

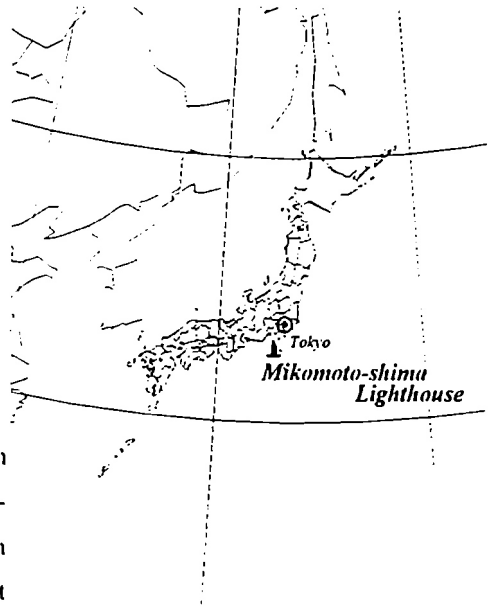
1895	Ogi-Shima Lighthouse	Stone		A	
1896	Hime-Saki Lighthouse	Iron		A	
1898	Mihonoseki Lighthouse	Stone		A	Yoshitaka Kuroda
1898	Kyoga-Misaki Lighthouse	Stone		A	
1899	Muroto-Misaki Lighthouse	Iron		A	
1903	IzumoHino-misaki Lighthouse	Stone	Brick	A	Ayahiko Ishibashi
1904	Mizunoko-Shima Lighthouse	Stone		A	
1912	Shimizu Lighthouse	Reinforced Concrete		A	
1870	Kashino-Saki Lighthouse	Reinforced Concrete	Stone	B	R.H.Brunton
1871	Muture-Shima Lighthouse	Stone		B	R.H.Brunton
1880	Kuchinotu Lighthouse	Brick		B	
1896	Yokohama-kitasuitei Lighthouse	Iron	Concrete	B	
1897	Yaku-Shima Lighthouse	Brick		B	
1897	Kakezuka Lighthouse	Iron	Concrete	B	
1900	Shira-su Lighthouse	Iron	Stone	B	
1901	Seki-Saki Lighthouse	Iron		B	
1903	AkiShiraishi Offshore Fixed Light	Iron	Stone	B	
1904	Hime-Shima Lighthouse	Stone		B	
1881	Tateishi-Saki Lighthouse	Reinforced Concrete	Stone	C	
1893	Hiraisho Offshore Fixed Light	Concrete		C	
1894	Nakano-Hana Lighthouse	Stone		C	
1894	Oohama-Saki Lighthouse	Stone		C	
1894	Kosaki-Shima Lighthouse	Stone		C	
1894	Koune-Shima Lighthouse	Stone		C	
1894	Hyakkan-Shima Lighthouse	Stone		C	
1897	Kamimate-Shima Lighthouse	Stone		C	
1898	Tera-Shima Lighthouse	Stone	Concrete	C	
1898	Uma-Shima Lighthouse	Brick	Stone	C	
1900	Nakato-Shima Light Signals	Stone		C	
1903	Nakano-Se Offshore Fixed Light	Concrete		C	
1908	Ishikari Lighthouse	Iron		C	
1909	Fuku-Se Offshore Fixed Light	Concrete		C	
1911	Tsutsu-saki Myo-se Projector	Concrete		C	
1894	Mebaru-Saki Lighthouse	Stone		D	
1894	Chodayu-Sho Offshore Fixed Light	Stone		D	
1894	Koune- Shima Lighthouse	Stone		D	
1895	Habushi-Iwa Offshore Fixed Light	Stone		D	
1895	Oomoji-Iwa Offshore Fixed Light	Stone		D	
1897	To-Shima Lighthouse	Stone		D	
1898	Tobase-Shima Lighthouse	Stone		D	
1900	Daiba-Bana Lighthouse	Brick		D	
1900	Morie-Kou Offshore Fixed Light	Brick		D	
1902	Nenashi-Sho Offshore Fixed Light	Stone	Concrete	D	
1903	Omodakashira-Se Lighthouse	Concrete		D	
1903	Kudako-Shima Lighthouse	Stone		D	
1904	Gotu-SeOffshore Fixed Light	Concrete		D	
1904	Nishigobanno-Bae Offshore Fixed Light	Stone		D	
1904	Yakata-Ishi Offshore Fixed Light	Stone		D	
1909	Izu-Misaki Lighthouse	Concrete	Stone	D	
1912	Kanou-Saki Lighthouse	Brick		D	
1912	Toba Front Light	Iron		D	
1912	Hutaoi-Shima Lighthouse	Concrete		D	

3. Lighthouse Repairs

1) Carbon-Fiber Construction Method (Mikomoto-Shima Lighthouse)

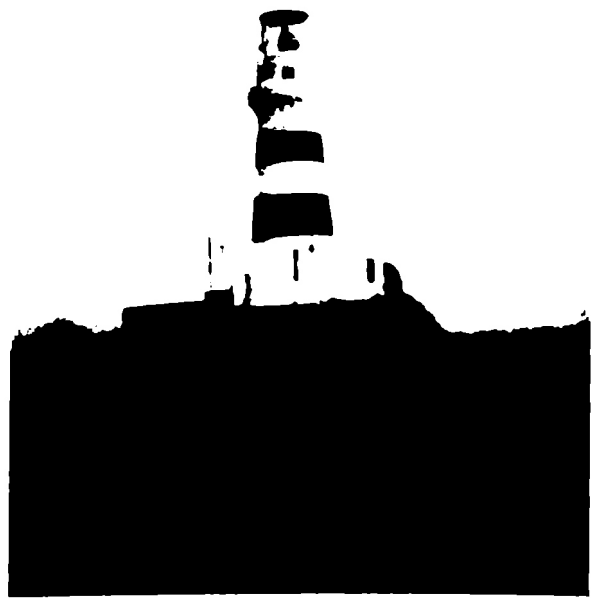
(1)Outline

Position	:	34-34-19.2 N 138-56-41.0 E
Commissioned	:	1 8 7 0
Main Material	:	Stone
Tower Height	:	16.0m
Lanterns	:	1st Lanterns Housing
Lends	:	3rd Ordered Frenel Lends
Range	:	19.5 M



(2) History Leading to Reinforcement

This lighthouse is located on an uninhabited island in the sea about 10 km from Izu-Shimoda Port, Shizuoka Prefecture. The British engineer R.H. Brunton designed it, and completed it in 1870. Its structure is circular and of stone. It is Japan's oldest existing lighthouse built of stone. This lighthouse, built during the unique historical period of the dawn of modern Japan, has historical and cultural value as a valuable structure. In addition, the island as a whole, including the lighthouse, has been designated a special historic site and natural monument. Therefore, the Lighthouse Preservation Committee assessed its rank as 'A' and judged it to be a "structure of value."

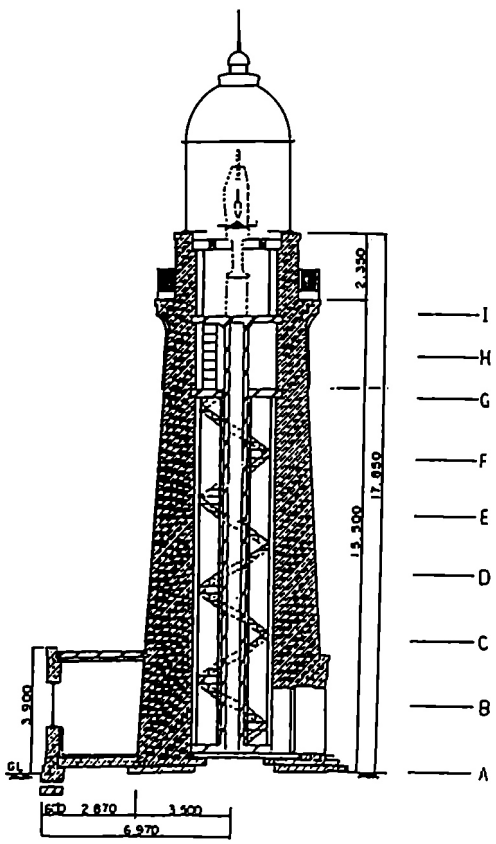


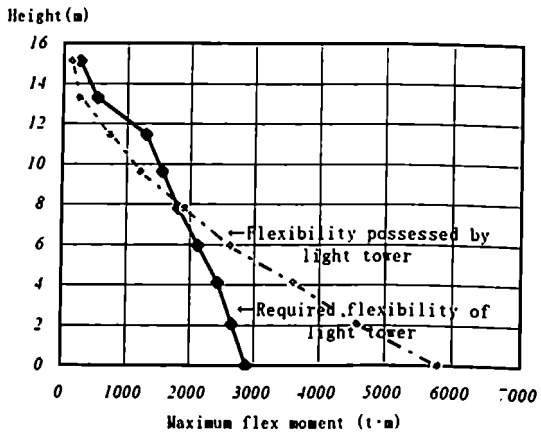
The light tower was built using Yasuyamaiwa Gyokaigan. The double tail method was used to fit the joints of the top section. Since at the time Japan had not yet begun to manufacture cement, Brunton directed that a cement be made quickly by calcination of volcanic ash and limestone, and used it for the vertical and horizontal joints of the middle and bottom sections. This was the earliest use of cement to build a lighthouse in Japan, and it is also valuable from the perspective of the history of cement in Japan.

Over 120 years have elapsed since this lighthouse was built, and it has suffered the effects of harsh weather and sea conditions. Concerns had developed regarding its remaining durability; therefore a study was carried out related to the durability and earthquake-resistance of this lighthouse. As a result, vibration analysis showed that the light tower had the durability to withstand horizontal acceleration of up to about 385 gal. However, since Japan is a country where earthquakes are frequent and this region in particular is one were large earthquakes occur, it is presumed that horizontal acceleration of about 624 gal can be expected. Therefore, the light tower's horizontal durability is short by 239 gal, and it is feared that it will collapse in the event of a large earthquake.

The basic policy regarding the reinforcement of the light tower to withstand earthquakes was to not change its existing structural form, moreover to retain its original form as much as possible. Taking into consideration the conditions of the site, a remote island, from the standpoints of easing the transport burden through the use of light-weight materials and of reducing work on-site, prestress reinforcement was carried out using carbon fiber, an extremely strong new material, and PC bar steel, for the hut adjoining the lower section, where it was not possible to apply the fibers. These were the best materials when taking into consideration that carbon fiber does not stretch very much and there is no weakening of the prestress through relaxation after the prestress is completed. Furthermore, their resistance to salt and cost were also satisfactory. This was the first instance in Japan of a reinforcement method using a combined structure of carbon fiber and prestress.

Table 2 Analysis to Measure Earthquake Resistance



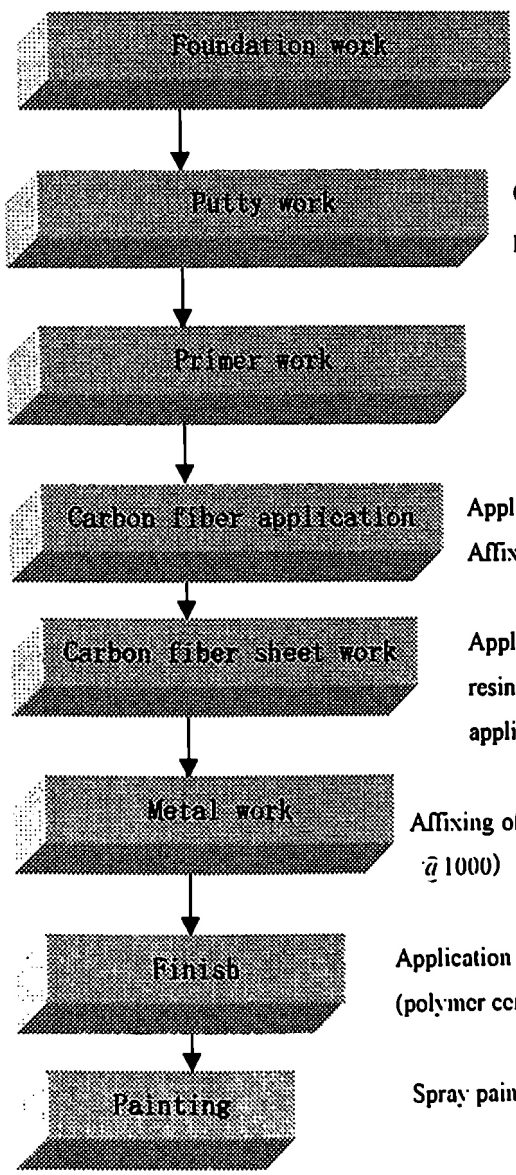


Section	Flex moments (*t·m*)	
	Required flexibility of light tower	Flexibility possessed by light tower
I(15.11)	128	258
H(13.28)	265	534
G(11.44)	744	1305
F(9.61)	1222	1561
E(7.77)	1922	1816
D(5.94)	2622	2127
C(4.10)	3605	2438
B(2.05)	4588	2661
A(0.00)	5797	2884

(3) Amount of Reinforcement

The results of the analysis are as indicated in Table 5-2-1. The calculated pull and flex moments are as they act on the overall light tower. When calculating the amount of carbon fiber reinforcement, the number of laminated fibers can be calculated by converting into the pull and flex moments per fiber unit width (1 m). The results indicate that Section A, which is the first floor, as well as the area requiring the most reinforcement, has insufficient moment per unit width of 2576.8 t·m/m. Therefore, seven carbon fiber sheets (CF cross-sectional area of 1.67 square centimeters) were laminated. As for the other sections, five sheets were laminated for B, three sheets for C, two sheets for D and one sheet for E.

(4) Work Flow



Mortar was removed from the exterior wall surface → Foundation adjustment mortar applied: "a" 10 mm (cation mortar application)

Carbon fiber foundation primer applied (epoxy resin primer)

Application of epoxy resin as adhesive for carbon fiber → Affixing carbon fiber sheet

Application of epoxy resin → Finish (removal of excess resin using a rubber blade (trowel); smoothing and evening of application)

Affixing of metal fittings to hold carbon fiber in place (FB-50×5 @1000)

Application of resin mortar to hold work in place "a" 40mm (polymer cement mortar application)

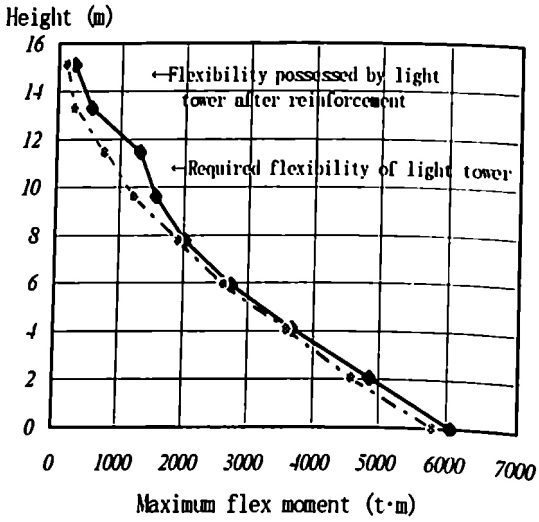
Spray paint finish (spray on fluorine resin paint)

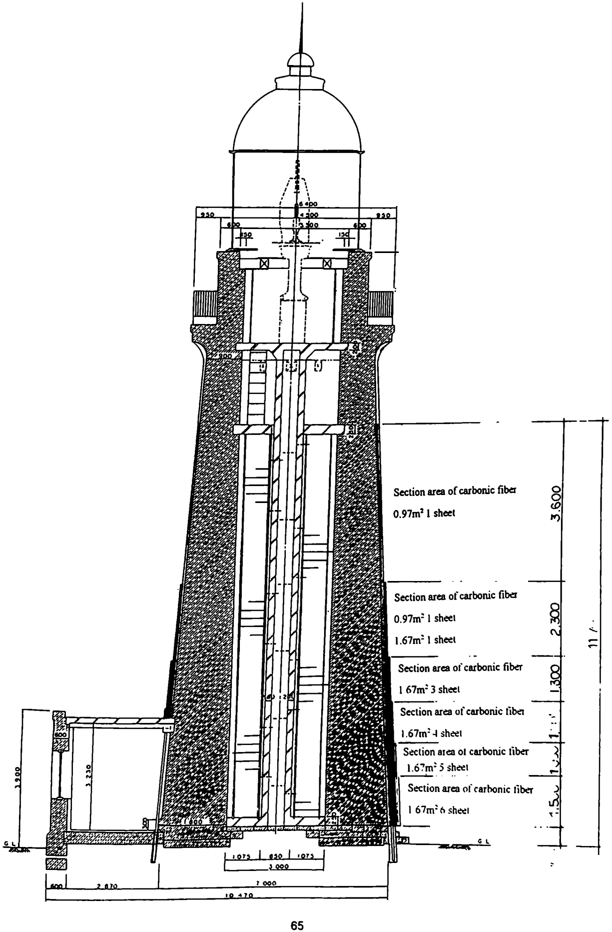
(5) Result of Reinforcement

The result of the reinforcement is as indicated in Table 3 and the graph. Along with achieving the reinforcement goals, the original form was preserved as according to the plan.

Table 3

Section	Flex moments ($t \cdot m$)	
	Required flexibility of light tower	Flexibility possessed by light tower
I(15.11)	128	258
H(13.28)	265	534
G(11.44)	744	1305
F(9.61)	1222	1561
E(7.77)	1922	2028
D(5.94)	2622	2748
C(4.10)	3605	3679
B(2.05)	4588	4865
A(0.00)	5797	6066




Section area of carbonic fiber
0.97m² 1 sheet
Section area of carbonic fiber
0.97m² 1 sheet
1.67m² 1 sheet
Section area of carbonic fiber
1.67m² 3 sheet
Section area of carbonic fiber
1.67m² 4 sheet
Section area of carbonic fiber
1.67m² 5 sheet
Section area of carbonic fiber
1.67m² 6 sheet
3,600
2,300
1,300
3,000
7,000
10,470

Condition of stone surface and joints

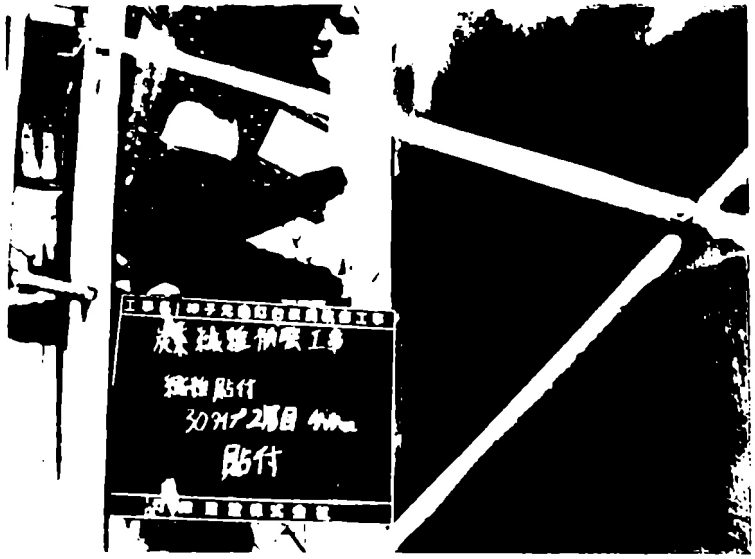
Foundation adjustment mortar applied: "a" 10 mm

(Cation mortar application)

Carbon fiber foundation primer applied

(Epoxy resin primer)

Application of epoxy resin as adhesive for carbon fiber



Affixing carbon fiber sheet

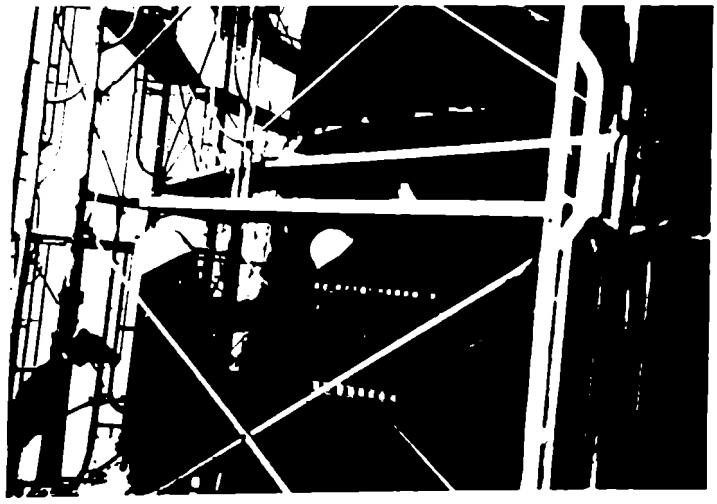
Finish

(Removal of excess resins using a rubber blade (trowel):

smoothing and evening of application)

Affixing of metal fittings to hold carbon fiber in place

(FB-50×6　@1000)



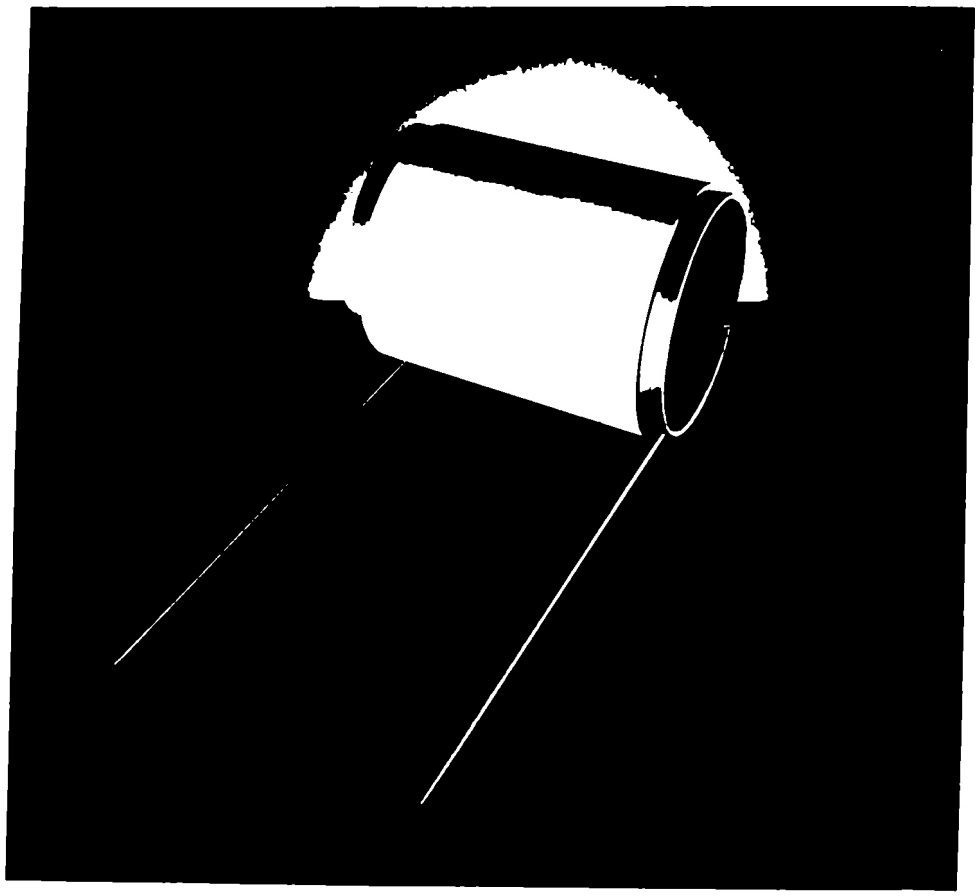
Application of resin mortar to hold work on place "a" 40 mm

(Polymer cement mortar application)

(5) Characteristics of the Material

Carbon fiber is a fiber with a graphite structure in which carbon atoms are linked in a mesh-like network of hexagonal rings. The methods for manufacturing it that have been developed are by burning polyacrylnitol (PAN) fibers and by burning oil called pitch and pitch from coal. Because of the recent improvement in the performance of PAN carbon fiber and the lowering of its cost, besides its conventional uses in the structural materials of airplanes and in sporting equipment, it is increasingly making inroads in the market for use in the construction industry. In particular, it has been used in many cases of reinforcement of the various structures that were damaged by the Great Hanshin Earthquake of 1995.

Comparing carbon fiber and iron, carbon is ten times as strong, has the same elasticity, has one-fourth the weight and has durability because it does not corrode. In addition, it has the excellent qualities of being extremely flexible, allowing reinforcement to be carried out efficiently with the minimum work required, and of involving virtually no increases in weight or measurements after reinforcement.



Characteristics of Carbon Fiber

History	The history of carbon fiber is the history of greatly increased strength. In the early 1980s, aircraft manufacturers asked that a carbon fiber be developed for use as primary structural material for airplanes in the private sector and that the new material have great strength and a medium rate of elasticity with elasticity of 1.8% or more (strength: 5.4 Gpa; elasticity rate: about 300 Gpa). A carbon fiber with strength of 5.6 Gpa was developed in 1984. Then in 1986, a carbon fiber was developed that had a strength of 7.0 Gpa, with rip elasticity of over 2.0%.
Characteristics as a result of manufacturing method	The manufacturing methods for carbon fiber are generally divided according to the raw materials used, PAN, pitch and rayon. Of these, carbon fibers from PAN and pitch are mass-produced.
Thermal resistance	1500° C
Light resistance	Does not change
Ease of processing	Very easy
Absorbency	None

Physical Properties of Carbon Fiber

	Item	Carbon Fiber			
		GP Grade pitch	HP Grade pitch	HM PAN	HT PAN
Physical Properties	Single fiber diameter (μ)	7~20	8~14	7~8	7~8
	Density (g/cm^3)	1.5~1.8	1.8~2.2	1.7~1.8	1.8~1.9
	Tensile strength (MPs)	500~1200	2450~3430	3500~4500	2500~2700
	Tensile elasticity (GPs)	50~100	177~785	230~240	350~400
	Linear expansion coefficient (/°C)	-	-	-0.7×10^{-5}	-0.7×10^{-5}
	Rip elasticity (%)	2.0~2.5	0.4~1.5	1.4~1.5	0.6~0.8
	Absorbency (%)	None	None	None	None
Chemical Resistance	Hydrochloric acid	○	◎	◎	◎
	Sulfuric acid	◎	◎	◎	◎
	Nitric acid	○	◎	◎	◎
	Sodium hydroxide	◎	◎	◎	◎
	Sea water	◎	◎	◎	◎
	Acetone	◎	◎	◎	◎
	Benzene	◎	◎	◎	◎
	Gasoline	◎	◎	◎	◎

◎ : Superb

○ : Relatively good

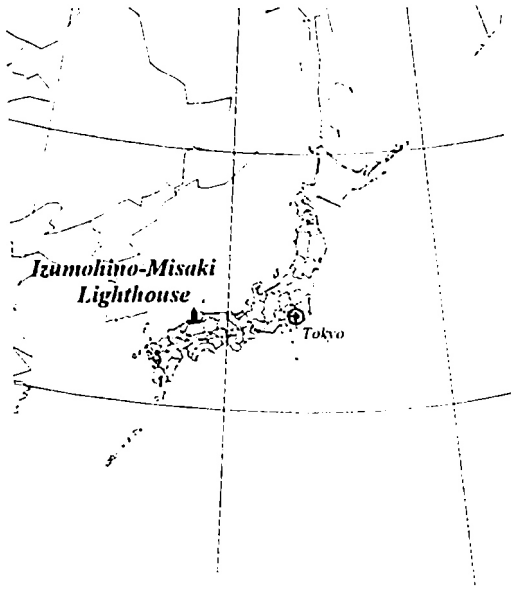
× : Unsatisfactory

2) Construction Method for Replacing External Wall Masonry Joints

(Izumo-Hinomisaki Lighthouse)

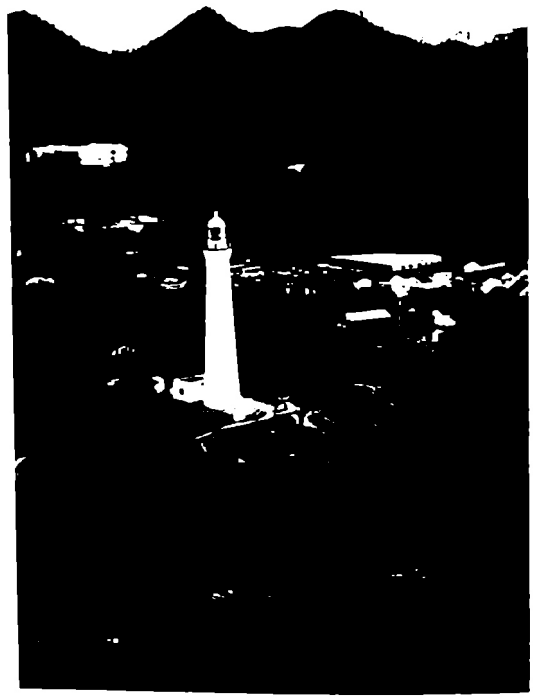
(1) Outline

Position	35-25-51.0 N 132-37-54.0 E
Commissioned	1 9 0 3
Main Material	Stone (Double-wall with stone and brick)
Tower Height	38.80 m
Lanterns	1st Lanterns Housing
Lends	1st Ordered Frenel Lends
Range	21.0 M



(2) History Leading to Reinforcement

This lighthouse is located on Shimane Peninsula, Shimane Prefecture. Ayahiko Ishibashi, a Japanese engineer, designed it. Work began on it in 1900, and it was completed three years later in 1903. Its structure is circular and double-shelled, with the outer cylinder of stone and the inner cylinder of brick. It is Japan's tallest lighthouse. Japan possessed traditional technology in stonemasonry from ancient times through its experience building castles. Nevertheless, a quarter of a century after the British engineer R.H. Brunton introduced lighthouse construction technology here, no cylindrical structure of a height comparable to this had been designed and built by a Japanese engineer.



This lighthouse has great value as an attainment indicating the excellence of the construction technology for building stone lighthouses. Furthermore, since Japan is country of frequent earthquakes, it uses a double-shelled structure, an original structural form that takes into consideration earthquake strength. There are no such examples in either Britain or France. Therefore, the Lighthouse Preservation Committee assessed its rank as 'A' and judged it to be a structure of value.

About 100 years have elapsed since this lighthouse was built, and it has suffered the effects of harsh weather and sea conditions. Concerns had developed regarding its remaining durability; therefore a study was carried out related to the durability and earthquake-resistance of this lighthouse. The results indicated that the tensile strength of the joints was extremely low (0.02 kg/square centimeter). Vibration analysis showed that the light tower had the durability to withstand horizontal acceleration of only up to about 180 gal. Since this is 300 gal less than the maximum earthquake acceleration for a 200-year reoccurrence period, it is feared that the light tower will collapse in the event of a large earthquake.

The basic thinking regarding the reinforcement of the light tower to withstand earthquakes was to not change its existing structural form and to retain its present beautiful appearance, as befitting a landmark of a sight-seeing destination. Therefore, for the first time in Japan the preservation method used to retain its original form as much as possible was the "construction method for replacing external wall masonry joints."

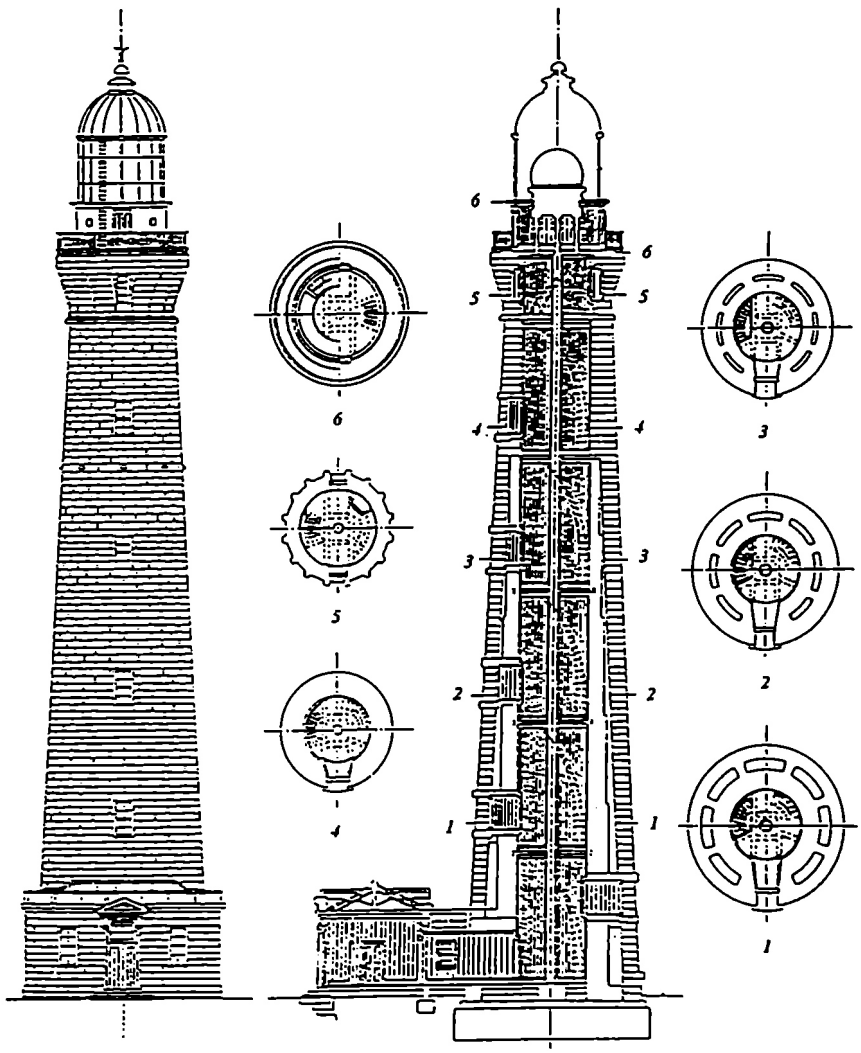
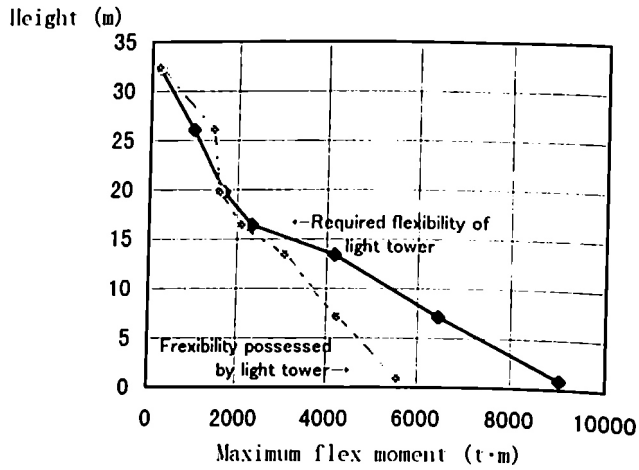


Table 4 Analysis to Measure Earthquake Resistance

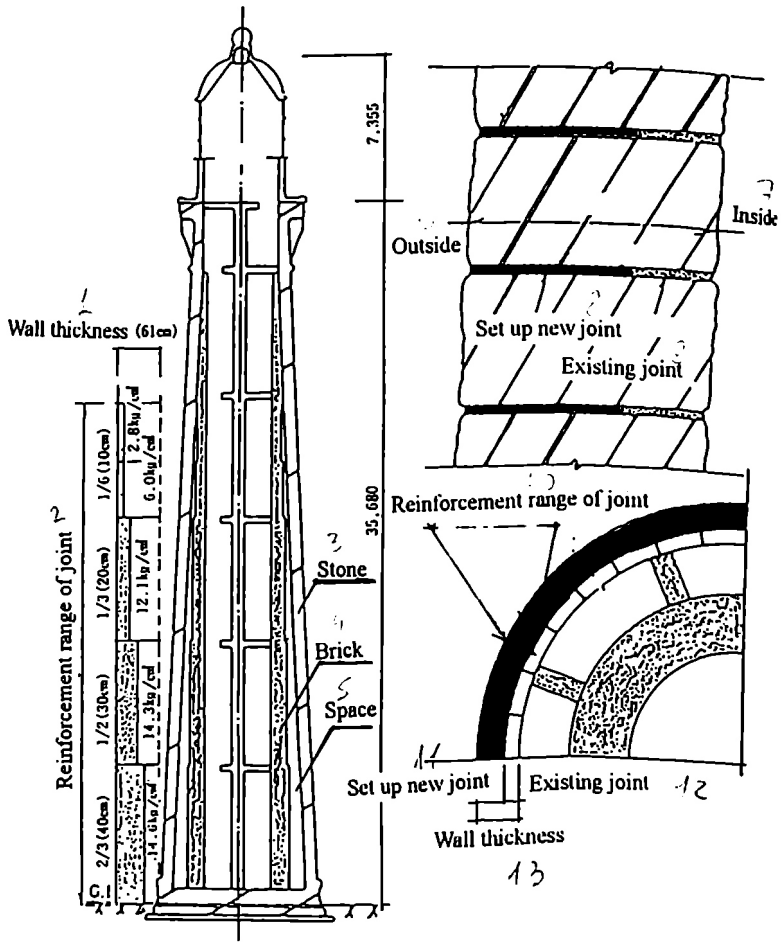
Section	Flex moments (t·m)	
	Required flexibility of light tower	Flexibility possessed by light tower
G(32.37)	174	175
F(26.06)	990	1446
E(19.75)	1694	1592
D(16.40)	2332	2097
C(13.44)	4174	3070
B(7.13)	6456	4226
A(0.88)	9052	5571



(3) Amount of Reinforcement

The results of the analysis are as indicated in Table 4. Sections A - E require reinforcement because they possess insufficient flexibility when compared against required flexibility.

Section A, which is the first floor and the area most lacking durability, has insufficient durability of 3,481 t·m; therefore its joints were replaced to a joint-depth of 400 mm. As for the other sections, B required joint replacement reinforcement to a joint-depth of 300 mm, C to a joint-depth of 200 mm, and D and E to a joint-depth of 100 mm.



(4) Construction Method for Replacing External Wall Masonry Joints

1) Joint Removal Work

The "water jet method," using a 1500 kg/square centimeter high pressure water jet, was selected to remove the existing joints, taking into consideration not exposing the structure to unnecessary vibrations.

For joint removal, the horizontal joint material, an important portion of the assembled structure, was removed temporarily. To ensure the safety of the light tower and the efficiency of the work process during repairs, it was necessary to plan and carry out the work for the work execution sections with the following in mind. The results were as indicated in Table 5.

(1) The work execution involves repeated removal --> refilling section by section.

(2) When multiple teams execute the work, a total of only two sections can be worked on at once and they must be working on opposing surfaces. Joint removal must not be carried out in three or more sections concurrently.

(3) The work execution is carried out successively, working on sections farthest from the most recently reinforced area.

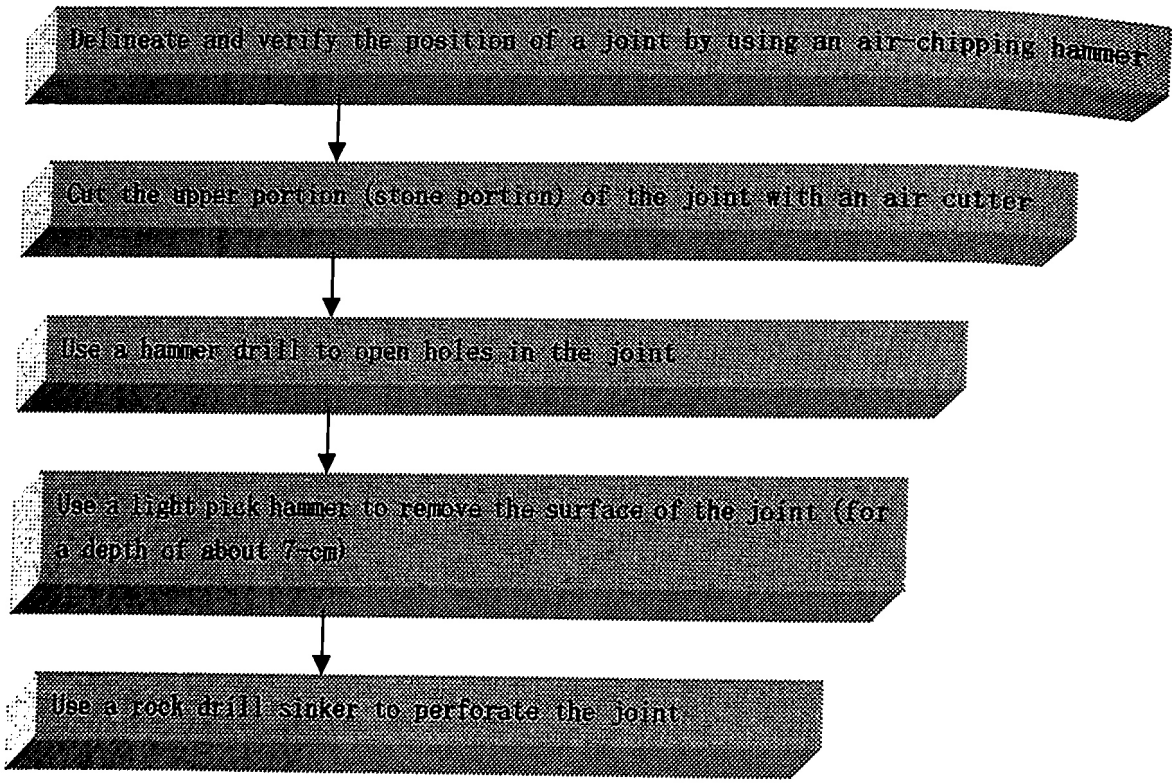
(4) Regarding the direction of the height of the work, after completing the removal --> refilling in each section concerned, in the case of the first floor the upper section is reinforced and in the case of 2nd - 4th floors the lower section is reinforced.

Table 5

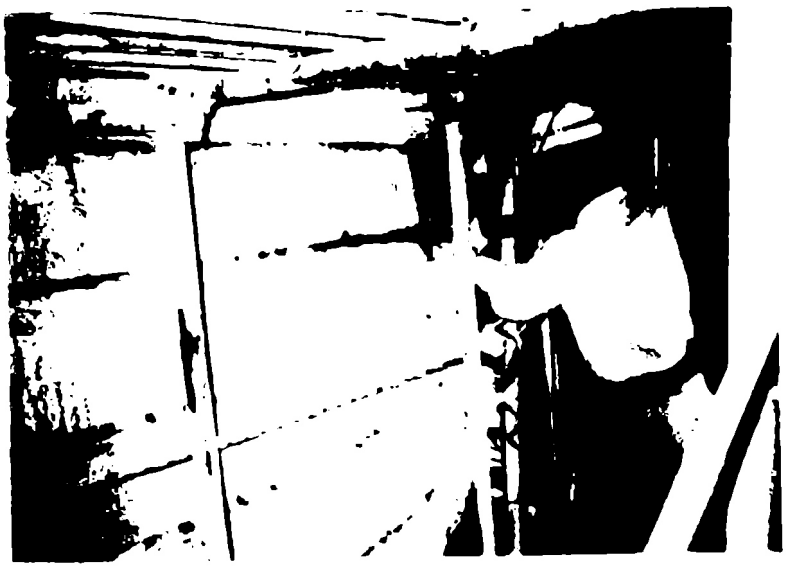
Order	Floor	Height direction	No. of joints (levels)	Ring direction	Execution
1	1	Block 2	A-11.B-12	Step 12	Lower section ・ Upper section
2	2	Block 2	A-9.B-9	Step 12	Upper section ・ Lower section
3	3	Block 2	A-9.B-9	Step 8	Upper section ・ Lower section
4	4	Block 2	A-9.B-9	Step 8	Upper section ・ Lower section

Note: "A" indicates a block in lower section, and "B" indicates a block in an upper section

The width of the exterior surface joints was 10 mm and the width of the interior surface joints was 30 - 40 mm; furthermore, there were extremely particular work conditions because the joint profile also was uneven. Therefore, taking into consideration what would happen within the joint width if the usual 7 to 12-hole rotary nozzle were used, a specially modified one-hole (outer diameter of 15 mm; diamond nozzle diameter of 0.5 mm) rotary nozzle was used when employing the construction method for replacing external wall masonry joints. In addition, an agent to increase viscosity was added to the water to keep the jet of water in a tight stream. However, trials using the execution method concerned revealed that it eroded the stone of the exterior surface and increased the width of the joints much more than expected. This was not desirable in light of the goal of preserving the original form of the lighthouse. Therefore, the following preparatory work was carried out in advance, and this made it possible to keep the amount of original stone material eroded to a minimum (about 30 - 35 mm).

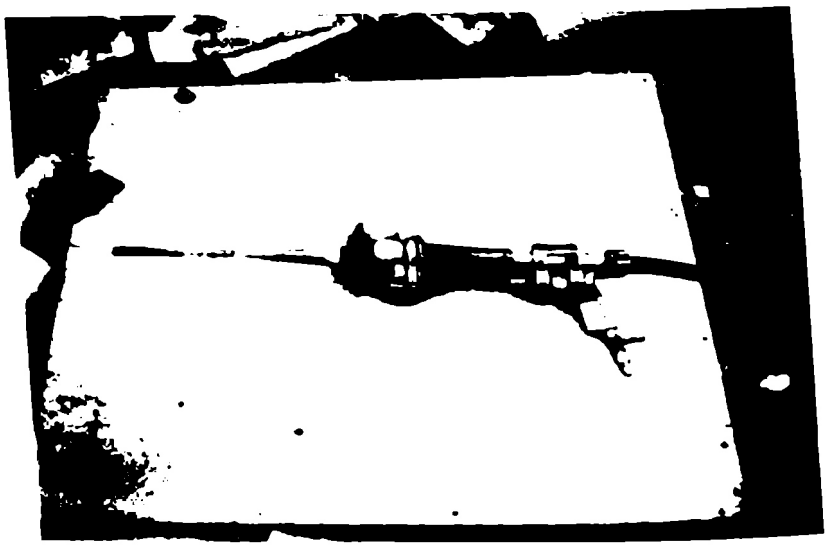


Delineating the position of a joint



Perforating a joint position

Removing a joint



Water gun

(5) Joint Refilling

A special cement mortar that had been premixed was used as the agent to refill the joints. The following procedure was repeated for each step, similar to the removal pattern. Table 6 indicates the results of tests using the joint refill material.

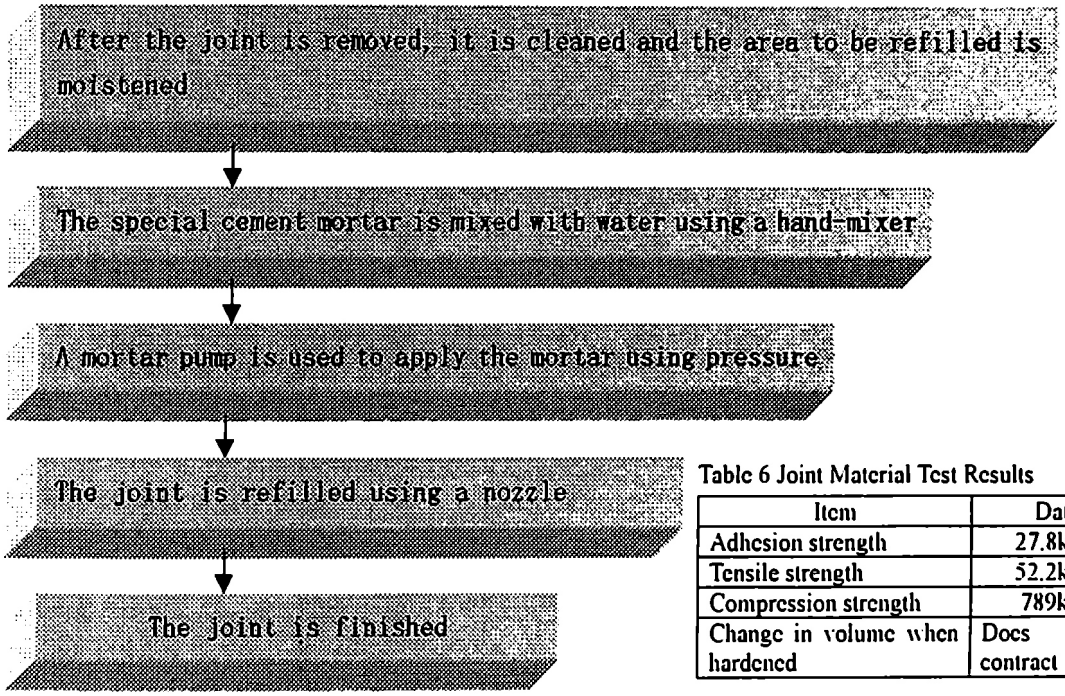


Table 6 Joint Material Test Results

Item	Date
Adhesion strength	27.8kgf/cm²
Tensile strength	52.2kgf/cm²
Compression strength	789kgf/cm²
Change in volume when hardened	Does not contract

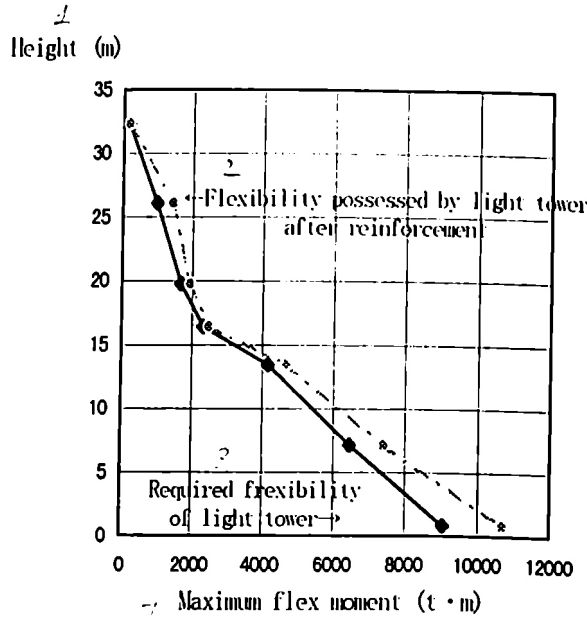
Refilling a joint

(6) Result of Reinforcement

The result of the reinforcement is as indicated in Table 7 and the graph. Along with achieving the reinforcement goals, the original form was preserved as according to the plan.

Table 7

Section	Flex moments (t·m)	
	Required flexibility of light tower	Flexibility possessed by light tower
G(32.37)	174	175
F(26.06)	990	1446
E(19.75)	1694	1950
D(16.40)	2332	2486
C(13.44)	4174	4688
B(7.13)	6456	7401
A(0.00)	9052	10696



RESTORATION PROJECT OF HISTORIC LIGHTHOUSES In The STRAIT OF MAGELLAN

I - HISTORICAL ABSTRACT.-

1.- DISCOVERY

The Magellan Strait, with a longitude of 346 nautical miles, is the natural route which joins the Pacific Ocean to the Atlantic Ocean.

Hernándo de Magallanes, a Portuguese sailor, serving under the King of Spain, the distinguished and visionary Charles V, discovered on October 2 of 1520 the Strait, with only 5 ships and 265 men, thus giving the key to the Pacific to the Spanish Peninsula.

But half century of continuous sailing by the Spanish and visits of skilled corsairs as Francis DRAKE and CAVENDICH had to pass before, the Spanish Kingdom decides to populate and fortify the riversides of the Magellan Strait, a task that was undertaken by Pedro Sarmiento de Gamboa with 20 ships and 5 thousand men, and of which only 550 men on 5 ships reached their objective, who consequently founded the colonies "Nombre de Jesús" in Punta Dungenes and "Rey Don Felipe," which was later called "Puerto de Hambre" due to the fact that after 3 years only one survivor was discovered, thus, indicating the harsh environmental and meteorological conditions of this southern region.

2.- DEVELOPMENT OF MERCHANT SHIPPING IN THE XIX CENTURY

The use of the Magellan Strait for merchant shipping was one of the determining reasons that led the Republic of Chile to occupy the bordering territories in 1843 and establish themselves as the main authority amongst the colonials in this south American region, having formulated the first plans for establishing a tow service for sailboats in 1836, which was later reactivated for the first steamship that sailed through the Strait (1840).

In 1867 The Pacific Steam Navigation Company, opened a regular shipping route service from Liverpool - Valparaíso, with its ports of calls in the colony of Punta Arenas.

From there on, progressively more merchant ships, mainly steam, were beginning to use this new route due to the increase of new shipping companies that were using this route in their interoceanic services. And just for the record, in 1868,

27 ships anchored in Punta Arenas (registering 18,000) and by 1892 that figure had risen to 343 (with 591,289 tons).

At the end of the century, the following steamship companies crossed the Magellan Strait: Pacific Steam Navigation Company, German Company of Steamship Kosmos, English Lamport Holt Company, Greenock Steam Ship, W.R. Grace Co., Compagnie Chargeurs Reunis, Hamburg ~ South American Line and Gulf Line Ltda., which had no less than twenty monthly arrivals to Punta Arenas. It should also be added that to what is being referred to as National Transport also includes ships belonging to the Chilean Navy, that linked Punta Arenas with Valparaíso, Corral and Talcahuano.

Furthermore, hydrographic surveys were not common, this included those carried out by the captains of the Royal British Navy Philip Parker King and Robert Fitz Roy and the increase of maritime traffic were the main causes of most of the catastrophes during that period: 36 between 1869 and 1894, with the loss of ships, human lives and valuable shipments . This situation was very worrying for the authorities, even more so, because of the solemn commitment that the Republic had assumed in 1881, through the signing of a treaty leaving the Magellan Strait under Chile's absolute control, forcing it so to guarantee a safe navigation for the good of all humanity.

Thus, in the early 1870's the work for creating a lighthouse service began , although modestly, with the installation of the first beacons and buoys in places such as Punta Dungeness, Cabo Dirección and southern Punta Arenas. Though works increased significantly during the 1880's, it could be seen that the planning and development of these works was of mayor importance. A lighthouse system that would offer more security for navigation continuously, was indispensable.

During the government of President Jorge Montt (1891~ 1896) works began with much urgency and responsibility, these were successfully continued during the following governments, until the period assumed by Don Pedro Montt (1906-1910), a time in which the second and more important historical phase, concerning safety of navigation through the waters of the Magellan Strait, was completed.

3.- GEORGE SLIGHT, PLANNER AND BUILDER OF LIGHTHOUSES

Due to old and excellent relations that existed between Chile and Great Britain and her high levels of development in maritime activities, the engineer George Slight, born in Edinburgh, Scotland, September 30 of 1859, was selected to carry out this project. He inherited from both his mother's and father's side the vocation for engineering and a special interest in lighthouses. His father, who was also an engineer, was very renown for having invented the rotating machine or "speed governor" of the lighthouses of that time. Later in his career, George Slight entered the reclaimed Trinity House of London, an agency responsible for the

service of lighthouses in Great Britain, and afterwards, he became a member of the Royal Institute of Engineers. His contract with the Chilean Government was initially for five years and its aim was to design and build a lighthouse in the western entrance of the Magellan Strait.

Here with his father (seated) and his brother. Mr. Slight is on the right-hand side.

Once this important work was completed, and his expertise and merit was recognised, George Slight was appointed as Head of the Lighthouses and Beacons Department of the Directorate of the Maritime Territory, that he would be in charge of for the following two decades. During this period, that is to say, from his arrival in this country up to 1914, he designed and directed the building of 44 lighthouses, 17 of them were installed on the seaboards of the Magellan Strait. The most important, for their characteristics and difficulties in construction are: Evangelistas, Guafo and Raper.

For drawing up the designs of the iron towers of some of lighthouses he worked together with the companies Brothers Chance & Co. (Birmingham London), and Ston-Platt, of Nowley, by sending them drawings and their corresponding calculations.

For the Magellan Strait, the maritime lighthouse Service demanded a system of lighthouses of considerable light power, and whose operation and maintenance would supposedly be the responsibility of technical personnel properly qualified for this purpose. For this reason, the facilities had to include certain comforts such as sleeping quarters and a storage area for material, fuels and other supplies.

Due to the hydrographic characteristics of the large channel and previous catastrophic experiences, the points selected for setting up facilities were: the Evangelistas islet, for guiding the western access and exit; Punta Dungeness, Cabo Posesión and Punta Delgada, to secure the eastern access and exit, as well as the entrance to Primera Angostura; Isla Magdalena, in the northern part of Paso Ancho VI of the Straits; the Cape San Isidro, corresponding to Paso del Hambre; and Félix Bay, in the southern part of Paso Largo, next to the Western entrance.

The result was architecturally and operationally successful, to such an extent that a pattern of design for a building with singular characteristics and endurance, limited to the needs of the lighthouse service, was emerging . Thus, from an architectural point of view, a unique form of expression for buildings characterised for their functional needs and individuality of each and every one. And finally, George Slight died in Santiago on June 26 of 1934 after having adopted Chile as his second home.

The construction of these lighthouses began on the "Islote Evangelistas", this building constituted a real challenge due to the extreme difficulty of access and the habitual inclemency of t he weather. For having been the first to be built and for its very laborious construction, much information and detailed anecdotes have been recorded, however, this is not the case with the other lighthouses, whose buildings did not face similar problems nor difficulties. From there on, it was to be exemplified as being the first lighthouse of the Magellan Strait.

The south western islet called Evangelistas was chosen for its location, thus taking on that very name. This group of islets is located in the Pacific ocean in front of the western entrance of the Strait, latitude 52° 23' 05' south and longitude 75° 05' 08' west. These are small islands of stone, lacking vegetation and continuously washed over by waves, as a consequence of winds that sometimes exceeds 150 kms.; for the moment, it only reaches the base of the lighthouse (50 meters height above mean water level). With constant precipitation, totalling up to over 2,000 and 3,000 millimetres annually.

The house and tower of the lighthouse were built of stone, which was extracted from an opened quarry in the port "Cuarenta Días" and cut on the actual islet; a task given to some remarkable Croatian bricklayers who integrated the work team, showing their skills and unique tradition of their native Dalmatia. The circular foundation of the lighthouse was equally made of stone and once the work was finished, and the cement still being fresh , the engineer Slight put a sterling coin in it. As fame has it, nobody has ever stepped on this coin.

The light of the lighthouse was installed 72 meters above sea level, with a tower height of 17 Mts. and a diameter of 7 Mts.

Its original visibility was 25 miles, with a power of 26,000 candelas. The flash is nine seconds apart with an eclipse of 21 seconds and with rotating characteristics obtained from a watch system.

During the two years that it took for the lighthouse to be built, over 80 men took part in its construction, many of them could not endure the hardship and privations which this work required, nor the isolation and inclemency of a place as is Evangelistas.

While this work was in its final phase of execution, and in accordance with the original plans, the Directorate of the Maritime Territory had arranged the building of two more lighthouses, which were Punta Dungeness and Punta Delgada.

Unfortunately, not much information exists on these buildings – this may be due to the fact that their construction was easier and that they lack the magnificence of the Evangelistas Lighthouse, which nurtured and will continue to nurture abundant informative literature - this is why only historical data on the corresponding dates of installation (inauguration) exist:

Punta Delgada Lighthouse	July 15, 1898
Punta Dungeness Lighthouse	February 20, 1899
Cabo Posesión Lighthouse	August 1, 1900
Isla Magdalena Lighthouse	April 15, 1902
Cabo San Isidro Lighthouse	July 15, 1904
Bahía Félix Lighthouse	June 1, 1907

Although all these buildings have maintained their original characteristics over the years, some have undergone technical changes or functional upgrading of equipment, however this has not substantially changed the architectural characteristics that gave them their individuality from the beginning, with the exception of Dungeness lighthouse which in the last few years has suffered important modifications that have slightly altered its appearance and initials characteristic.

II - THE CONDITION OF THE MAGELLAN STRAIT LIGHTHOUSES, 100 YEARS AFTER THEIR CONSTRUCTION

1.- ADMINISTRATIVE AND FUNCTIONAL ORDER.

The Lighthouse System in Chile is under the responsibility of the Chilean Navy, which through the General Directorate of the Maritime Territory controls a Service of Inhabitable Lighthouses, Automatic Buoys and Distributes buoys of over 3.803 nautical miles of oceanic coast, that reaches from 18 degrees of latitude, south from Ecuador until Antarctica.

Most of the inhabited Lighthouses are situated in the Magellan Strait, their functions consist of providing Aid to Navigation, Meteorological Information, Radio Communications Support, Control of Maritime Traffic and National Sovereignty. These are operated by naval personnel, made up of a team of Petty Officers, Sergeants, Corporals and Seamen specialising in Lighthouses and which are relieved every 4 months. Their main characteristics are the capacity of self-sufficiency in order to successfully solve logistical problems and a special ability in being able to handle the isolation, all mixed in with a feeling of love and care for the facilities, which is also a fundamental part in preserving the inhabited Lighthouses of this country.

2.- CONDITION OF CONSERVATION

Out of the 7 Lighthouses built towards the end of the XIX Century and the beginning of the XX Century, 3 were manned by Naval personnel, (for the entrance to the next millennium). These are the Punta Dungeness Lighthouse, Bahía Félix and Islote Evangelistas, which structurally are still very well conserved and the high quality of service they render to the Maritime Territory assures them to be maintained as part of our historical heritage.

Different situations affect the other 4 Lighthouses of the Strait. The Lighthouses Cabo Posesión, Punta Delgada, Isla Magdalena and Cabo San Isidro, were automated, and in the same way, many ended up empty in the sixties and seventies; precautionary measures were taken for sealing well all entrances against the climatic changes and the tempestuous storms that continually affect that area, adding to this, the carelessness of some fishermen, tourists and neighbours which have caused serious damage to the roofing, ornamentation and wooden fixtures of the building. The main elements such as the towers and the structural walls are still in very good conditions and have been maintained according to their original architectural design despite of their age.

III - RECUPERATION PROJECT

Being aware of the significance that these stations have to our heritage and how on a global level uninhabited lighthouses suffer damages due to undesired guests and high costs of maintenance, it has been decided that before anything :

a) Any effort made for restoring and conserving the infrastructure of the lighthouses would be useless unless a new purpose for these stations, which would make them valuable in one way or another once again, is to be found

b) Every effort should be made in encouraging the participation of private and public organisations for the use and conservation of these buildings.

Through topics presented during different I.A.L.A. conferences, the Chilean Lighthouse Services, could clearly see the difficulties and successes that

other Americans and Europeans have had in converting old lighthouses in tourist attractions and cultural and historical centres. Such recuperation projects in Chile would be even more so difficult to carry out due to their geographical positions, which are difficult to find and even more difficult to access for being in an area of the planet famous for being uninhabitable and having a hostile climate. As the proverb says: *God exists, He is a sailor, lighthouse keeper, and our friend !*. which has been proven to be true.

1.- ISLA MAGDALENA LIGHTHOUSE

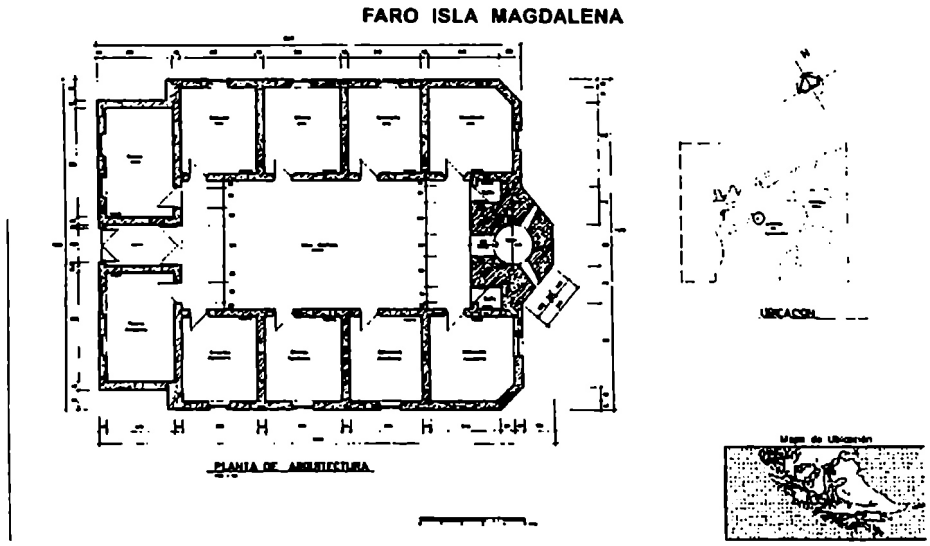
For having been built on an island were Antarctic penguins commonly land on, the Isla Magdalena Lighthouse was declared a "National Reserve" thus preserving a sanctuary of nature, and although once a year a life is lost, it also gives life to thousands of penguins a year seeing that the Lighthouse acts as a centurion to assure the procreation of this species. This is why the Isla Magdalena Lighthouse was accepted by the Governmental Corporation "CONAF" under a contract of loan and restitution, which until this present date it has complied with to its full extent and is now using it as a "Natural Life Museum and a Exposition Room, charging each tourist an cover charge which is used to pay for her upkeep.

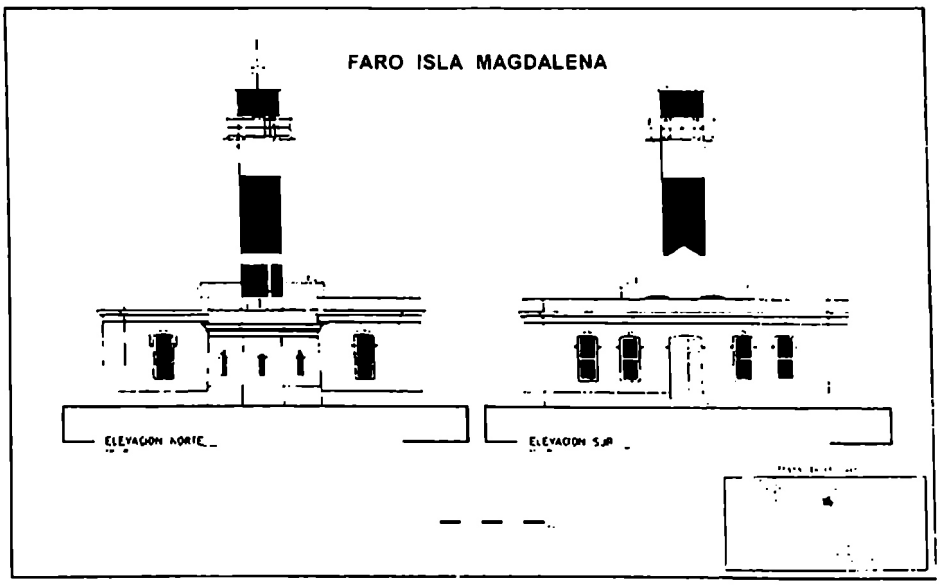
The recuperation of the lighthouse was a slow process but the Central Hall has now been completed, and a *Natural Monument to the Penguin* has been put up in which it describes the island's natural flora and fauna, the history of the first seamen who navigated the Magellan Strait and the use of the penguins as an important part of sustenance for survival on the island, as well as information concerning lighthouses and their builder George Slight.

The lateral rooms have been used as offices for attending to tourists and administrative activities, as well as dinning rooms, sleeping quarters and kitchens for the park rangers.

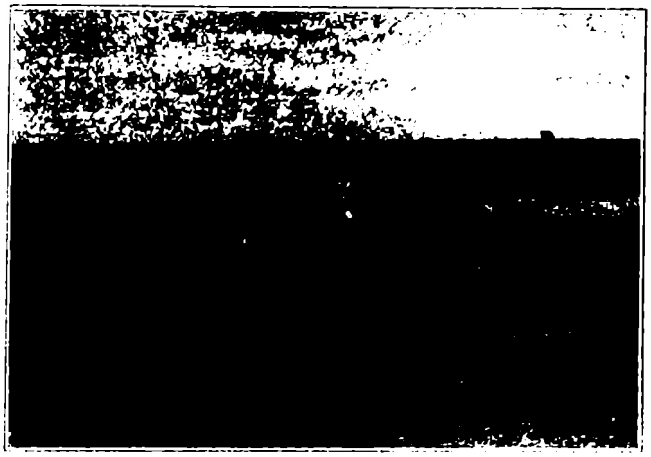
The dome and the tower which is operated automatically and is the responsibility of the Lighthouse Service is open to the public as is the sanctuary dedicated to the image of the Holy Virgin of Carmen.

The project took into account the upgrading of the access to the island from ship to shore, because due to the shallow waters, one had to board small boats or barges which could land directly on the shore.

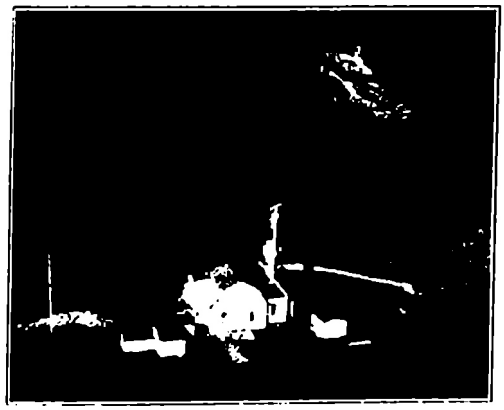




2.- PUNTA DELGADA LIGHTHOUSE



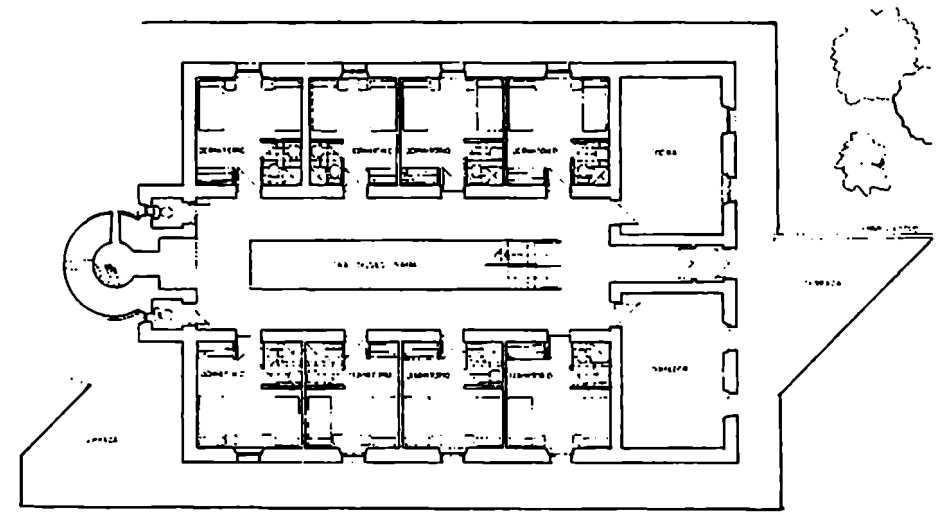
For being located in the outskirts of a ferry quay and a waiting place for passengers it was decided that a "Historic Museum for the Magellan Strait" would be created. Its main task is to inform people about the struggle of the men who through time had to dominate and transform this area into a safe place to navigate in, it also includes the adventures of the first colonials of the brave Spanish and Chileans who tell stories of shipwrecks and the adventures of thousands of seamen who have challenged and conquered the Magellan Strait. It is also meant for showing the perseverance of the Chilean Navy who has, through much effort, converted the channel, with the help of seaman and lighthouse keepers, in virtual roads for navigation, open to be used by any flag of the world.



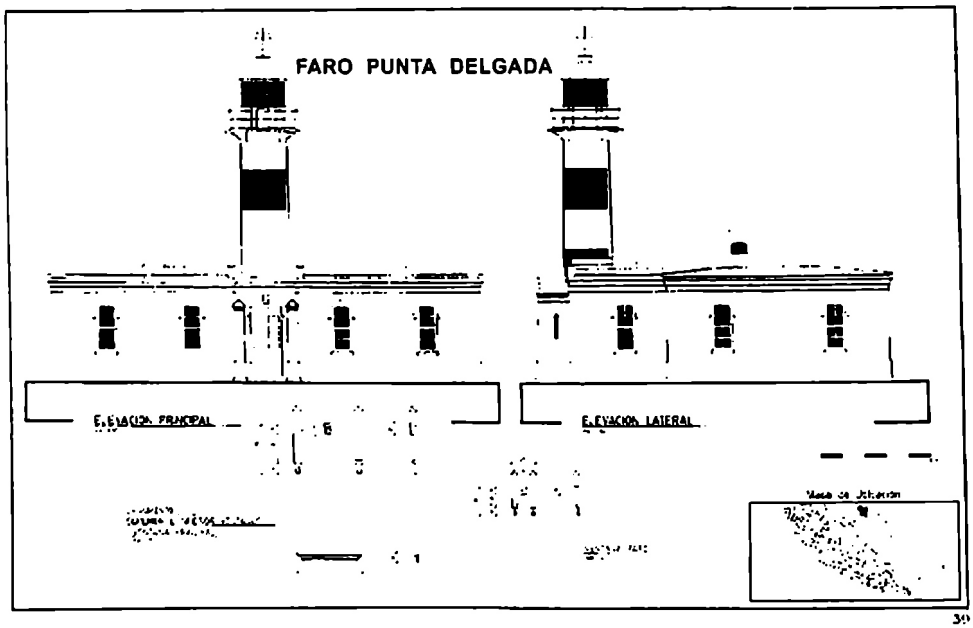
Seeing that improvements to the shore, which the Magellan Strait has actually worn away itself, are vital, the Austral University, the Chilean Navy and a Private enterprise will work together in a venture which will have a cost of over half a million dollars.

In general, this project contemplates the recuperation of exterior roofing and living spaces so to be able to recreate a vision of the life of the lighthouse keeper, improve access ways to the tower, making them safe for visitor, and in the main halls set up a permanent exposition of historic maritime information concerning the Magellan Strait, with a special focus on navigation and lighthouses.

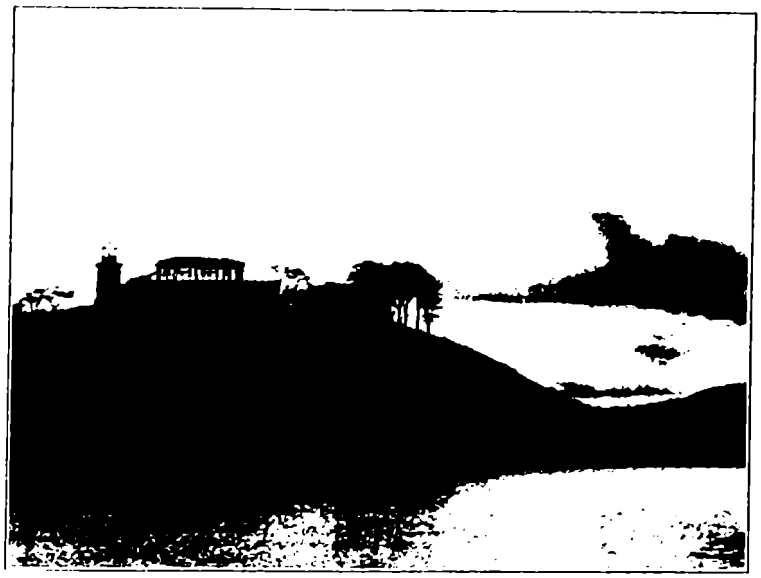
Together with the before mentioned, a café, bathrooms and souvenir shop for visitors, have been considered to be included in the plan.



PLANTA REMODELADA



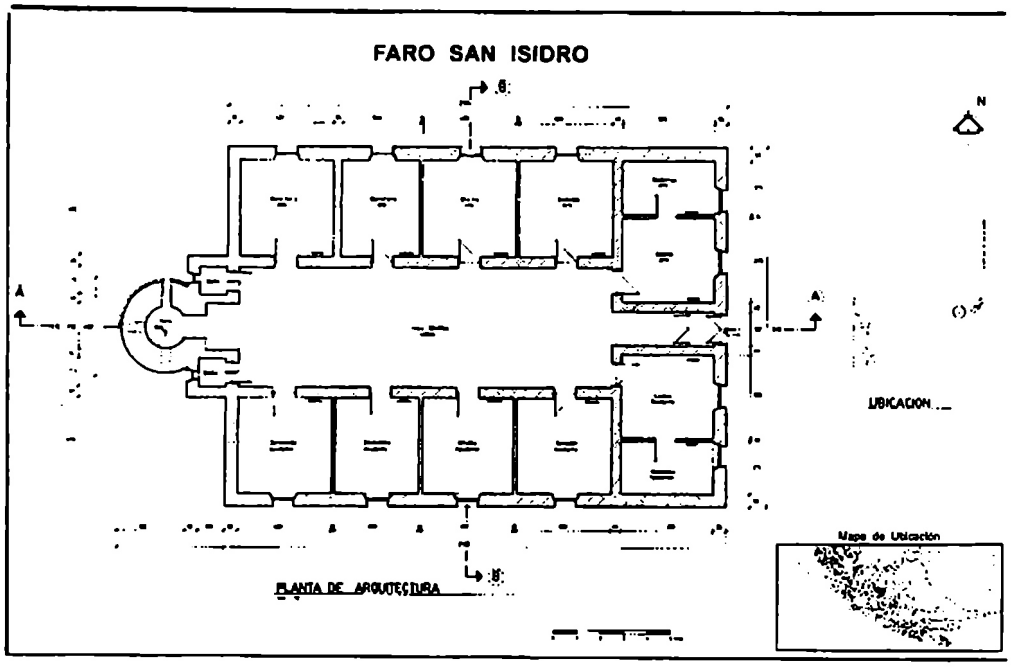
3.- CABO SAN ISIDRO LIGHTHOUSE



The Cabo San Isidro lighthouse is situated three hours away, by sea, from Punta Arenas, in a coastal area of stunning natural beauty, and because of its difficult access for tourists it has virtually been left untouched by man. Apart from being surrounded by a rich marine mammal wildlife it has spectacular sunrises and sunsets, and therefore, it has been decided to be transform it into a hotel, focusing on ecotourism complemented to satisfy the necessities for isolation that some people need to be able to create products and ideas for their enterprises.

Therefore a privately funded project will begin recuperating the lighthouse installations and its 30 hectares, turning it into a tourist complex and a hotel capable in preserving this as part of our architectural heritage and its surrounding environment.

For this, a renewable contract of loan and restitution of 30 years has been issued for the installations and territory, hoping that this project of hotel, cabins, extensions and a wildlife reserve area will be operational within two years. In the same way, a visit to the lighthouse tower and historical dissemination of Magellan and its lighthouse system is also being contemplated.


FARO SAN ISIDRO
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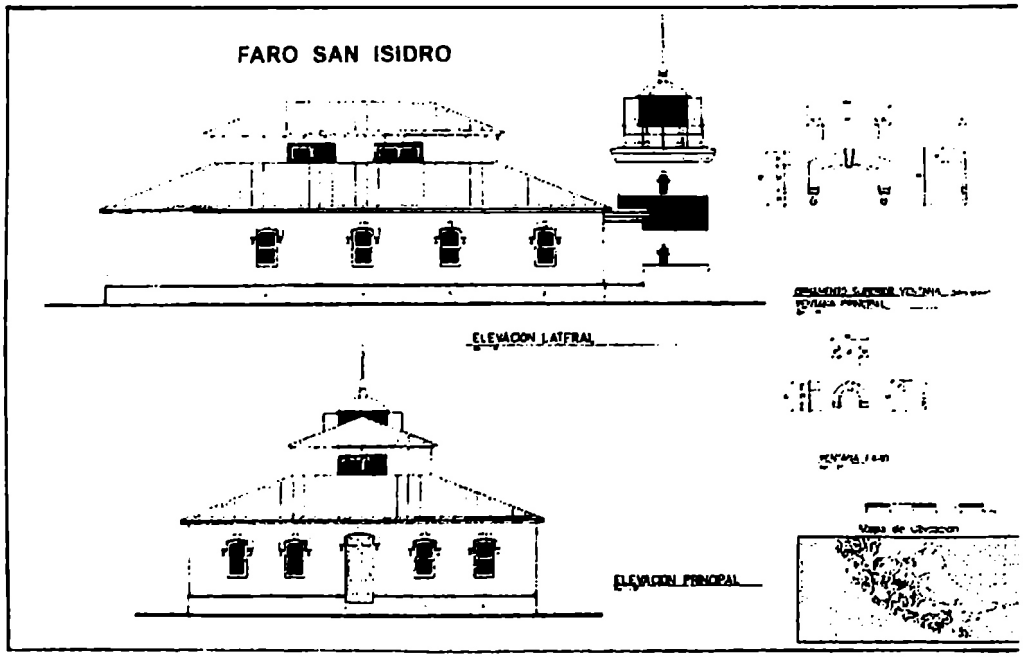
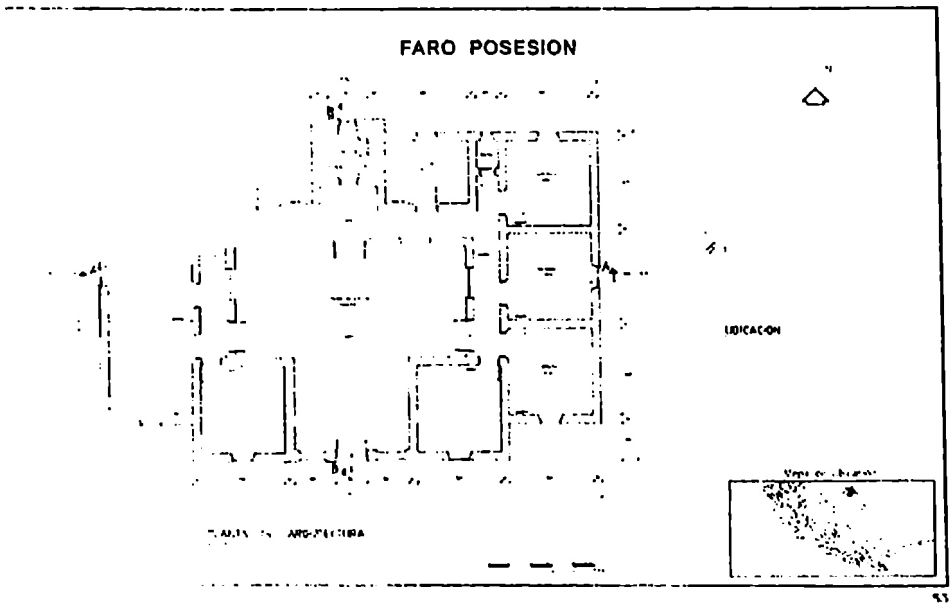
UBICACION
Mapa de Ubicación
PLANTA DE ARQUITECTURA


FARO SAN ISIDRO
ELEVACION LATERAL
ELEVACION PRINCIPAL
Mapa de Ubicación

4.- CABO POSESION

This is be the most beautifully and historically designed lighthouse, that even has a cemetery of those who lived and died there for protecting human life at sea, it is situated in an oil drilling area of the Magellan Strait and more than 4 hours away by land from the closest important urban centre, and in the year 2000 it will be celebrating its 100 year anniversary. This is our present challenge, and we a sure that we will be able to find a use for it as well as be able to recuperate and conserve its infrastructure whether through public or private organisations who are able to recognise its historic value .Perhaps the success of the other three projects in process will be the road and the key to a successful Cabo Posesión lighthouse centenary!.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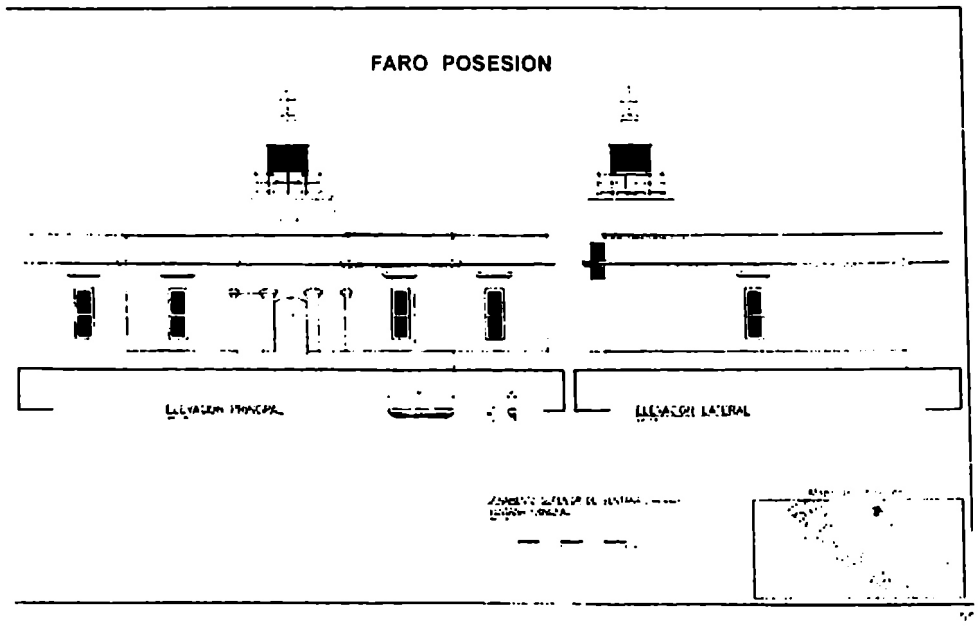
FARO POSESION

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