CAPE LEEUWIN LIGHTHOUSE – A GUIDING LIGHT IN THE WEST FOR EAST COAST SHIPPING

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ABSTRACT

The Cape Leeuwin lighthouse, completed in 1896, was a particularly important link in the development of coastal lights that eventually circled mainland Australia. It is a fine example of stone lighthouse construction typical of the late 19th century. The lighthouse is located on rocky ground only 20 metres above sea level, necessitating a tall tower to lift the light to the operational height necessary to make it visible for 20 miles out to sea in order to warn passing vessels of the dangers of the rocky coast that extend some distance from the mainland. A number of technical innovations were needed to achieve this at the time, including the specially designed large (and heavy) optics, and the first implementation by the lighthouse specialists, Chance Brothers, of a mercury bath bearing to accommodate the weight of the optics while allowing for an unusually high flash frequency.

1 INTRODUCTION

The Cape Leeuwin lighthouse is one of only four remaining intact and operating stone lighthouse structures on the west coast, the others being at Cape Naturaliste (1903) and two on Rottnest Island (Wadjemup, 1894 and Bathurst, 1900). The other extant lighthouses were fabricated from steel, concrete and brick, sometimes replacing earlier stone lighthouses. The Cape Leeuwin lighthouse is the tallest light tower (footing to apex) on mainland Australia. The location and operation of the lighthouse necessitated a number of interesting engineering developments.

The features that comprise Cape Leeuwin lighthouse are a stone lighthouse tower and oil store together with three stone cottages with detached stone laundries to accommodate the lighthouse keepers. Maurice Davies and John Wishart constructed these buildings in 1896 for the Western Australian government. Davies and Wishart were also responsible for the erection of a waterwheel that lies approximately a kilometre away from the lighthouse complex, which supplied that complex with water. Other buildings associated with the lighthouse are: two asbestos cement garages (1953), an asbestos cement office (former fuel room, 1954), an asbestos cement office (former power house, 1954), an asbestos cement weather room (former radio hut, 1954) and a new brick power house and beacon room (1970s). These buildings were constructed for the Commonwealth Government.

2 HISTORY

The first lighthouse erected in Western Australia was on Rottnest Island. Henry Trigg, the superintendent of colonial works, began work on that lighthouse in 1842 but it was not until 1851 that the building was completed.[1] The colony's second light was constructed on Breaksea Island, near Albany, in 1858.[2] Both of these lights served Western Australia's two main ports: the one on Rottnest, the colony's main port of Fremantle and the one on Breaksea, the colony's secondary port at Albany. Figure 1 identifies these and other locations referred to in this paper.

Western Australia, in comparison with the eastern colonies, was very slow to construct lighthouses along its coastline. In contrast with the eastern colonies, Western Australia was established as a free settlement with little financial assistance from the British Government. The incentives initially provided by Britain for new settlers proved to be inadequate and the colony grew only slowly. Limited numbers of settlers and limited finances led the colonial government to grasp an opportunity for assistance from the British government in 1849 by agreeing to become a penal colony. When the first convicts arrived in 1850 the colony comprised slightly less than 5,000 settlers. Becoming a penal colony provided three important incentives: free labour for public works, the promise of free settlers for every convict sent and importantly, access to British financial assistance.

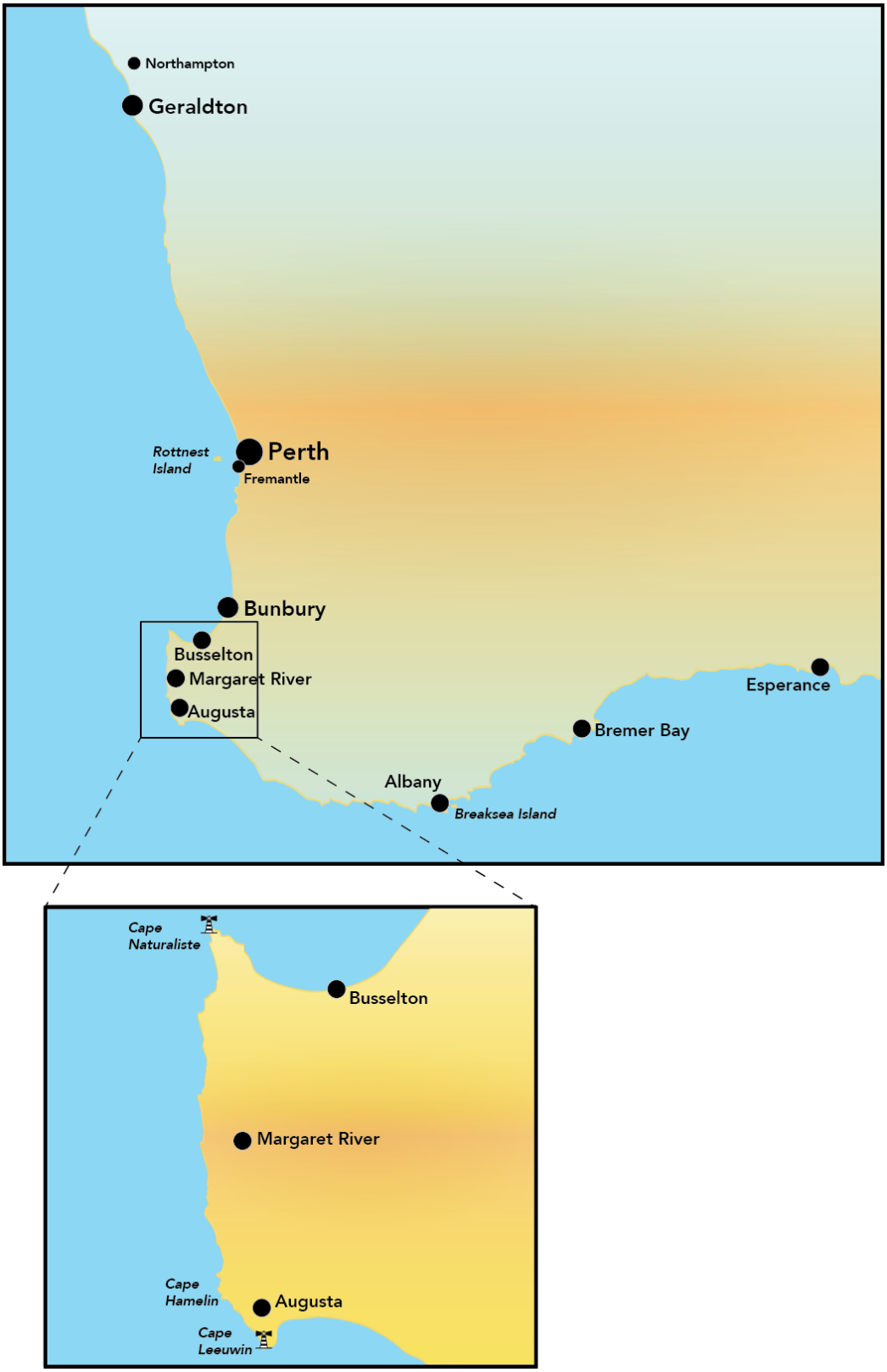


Figure 1. Key locations referred to in this paper

The need for a lighthouse was directly linked to the amount of shipping in any given area, thus the monies expended on the Rottnest and Breaksea lights were justified for safe colonial shipping within Western Australian waters. During the latter part of the nineteenth century, as most shipping bypassed the south-western corner of the continent on its way to the eastern colonies, the impoverished colonial government of Western Australia considered that there was no justification to spend money on building lighthouses in remote areas of its coastline that would have little direct benefit to its own economy. It was not until 1878 that a third light was erected by the colonial government specifically to serve Western Australian development. This light, on Point Moore at Geraldton was constructed to service the expanding agricultural district to the north of Perth and also the important mineral field at nearby Northampton. The erection of the light took place at the same time as the colony's first government railway was being constructed between Northampton and Geraldton.[3] This third light was a pre-fabricated steel tower produced by the lighthouse specialists, Chance Brothers and Co Ltd of Birmingham. They supplied all of the components for the lighthouse, except the foundations.[4]

At an inter-colonial conference held in Sydney in 1873 to discuss the management and maintenance of coastal lights, it was determined that twenty-four new lights were required Australia-wide. Two new lights were suggested for the Western Australian coast, one at Cape Naturaliste and the other at Cape Hamelin (near Cape Leeuwin). The delegates agreed that the construction and maintenance of lighthouses would remain the responsibility of the colony in which the lighthouse was situated, unless the light was specifically sited for the benefit of another colony. In those instances, the cost of erecting such a light would be borne by the other colony (or colonies) affected. The light proposed for Cape Hamelin was considered to be one of those 'lights maintained especially for the use of vessels of another colony', as it would be situated primarily to assist shipping passing by the south-west corner on its way to the eastern colonies.[5] However, none of the other colonies put forward the money to erect a light, at that time, so no light was constructed.

By the 1870s the south-west of Western Australia was still only sparsely settled. The nearest settlement to Cape Leeuwin was Augusta. Colonial settlers first arrived in the area aboard the *Emily Taylor* in May 1830.[6] However, by 1834 the majority of these settlers had moved north to Busselton where farming conditions were considered to be less harsh, and the Augusta area was largely abandoned.[7] A second wave of settlers arrived in the region in the 1860s.[8]

The presence of tall stands of timber tempted some of the early settlers into trying to establish a timber industry. However, Augusta's isolated location made this resource difficult to exploit.[9] It was not until Maurice Coleman Davies settled in Augusta in the 1880s, that the timber industry became a major force in the district. Davies established a number of mills in the area and constructed a tramway between his mills. Jetties were established at Hamelin Bay (used in summer) and Flinders Bay (used in winter).[10] A number of small townships grew up around the timber mills including Karridale, Boranup, Hamelin and Jarrahdene.[11] Davies grew up on the Victorian goldfields and became a building supplier and contractor. He moved to Adelaide where he went into partnership with John Wishart. In 1875 Davies moved to Western Australia where he established his timber milling business.[12]

Davies saw a need for a light near the south-west cape as his timber mills exported large quantities of timber from ports in this area. He began urging for the construction of a light in 1881.[13] The Western Australian governor and some members of the Legislative Council were also in favour of a light and during 1881 the site for the new light was hotly debated.[14] However, when the Council sought monetary support from the eastern colonies for the erection of a light, which would be of major benefit to the eastern colonies as noted at the earlier inter-colonial conference, it found them unwilling to assist.[15] During 1883, many avenues for monetary assistance were tried, such as Lloyds of London and a proposal to establish an Imperial Act authorising the collection of light dues. None were successful.[16] In 1884 when Malcolm Fraser (former Surveyor General) represented Western Australia at the Australasia Conference held in Sydney, he remarked that a light at Cape Leeuwin would be most desirable, 'a work of Federal importance.' He also noted that the Western Australian government felt that the cost of incurring the sole expense of the erection of this light was unfair as it was agreed that a light at this cape would be beneficial to all colonial shipping.[17] As had happened in 1873, no offers of financial assistance from the eastern colonies were received.

Western Australia achieved self-government towards the end of 1890. Despite the fact that the problem of paying for a new light remained unresolved, letters were sent to Chance Brothers requesting optical designs for a new light. The first design reached the new government in February 1891. The final set of drawings was received in July 1893.[18]

The discovery of gold during the 1890s saw the States' coffers begin to fill, and by 1893 the Western Australian government was able to afford the cost of erecting a light. The debate over where to locate the light was finally settled, with Cape Leeuwin being chosen, rather than Cape Hamelin as previously proposed in 1873.[19] In

deference to those who considered that a light on Cape Leeuwin would be hazardous, due to the presence of rocks and shoals near the Cape, a secondary, red warning light was incorporated into the Chance Brothers' design, although the government received considerable adverse comments on the advisability of this secondary light.[20]

Advice for the construction of the lighthouse was sought from the English consulting engineer, William T. Douglass. His design was received by the government in 1894. It comprised a 115 ft stone tower with a small secondary light linked to the tower by a small fuel room.[21] The original design drawings for the lighthouse are shown in Figures 2 and 3.

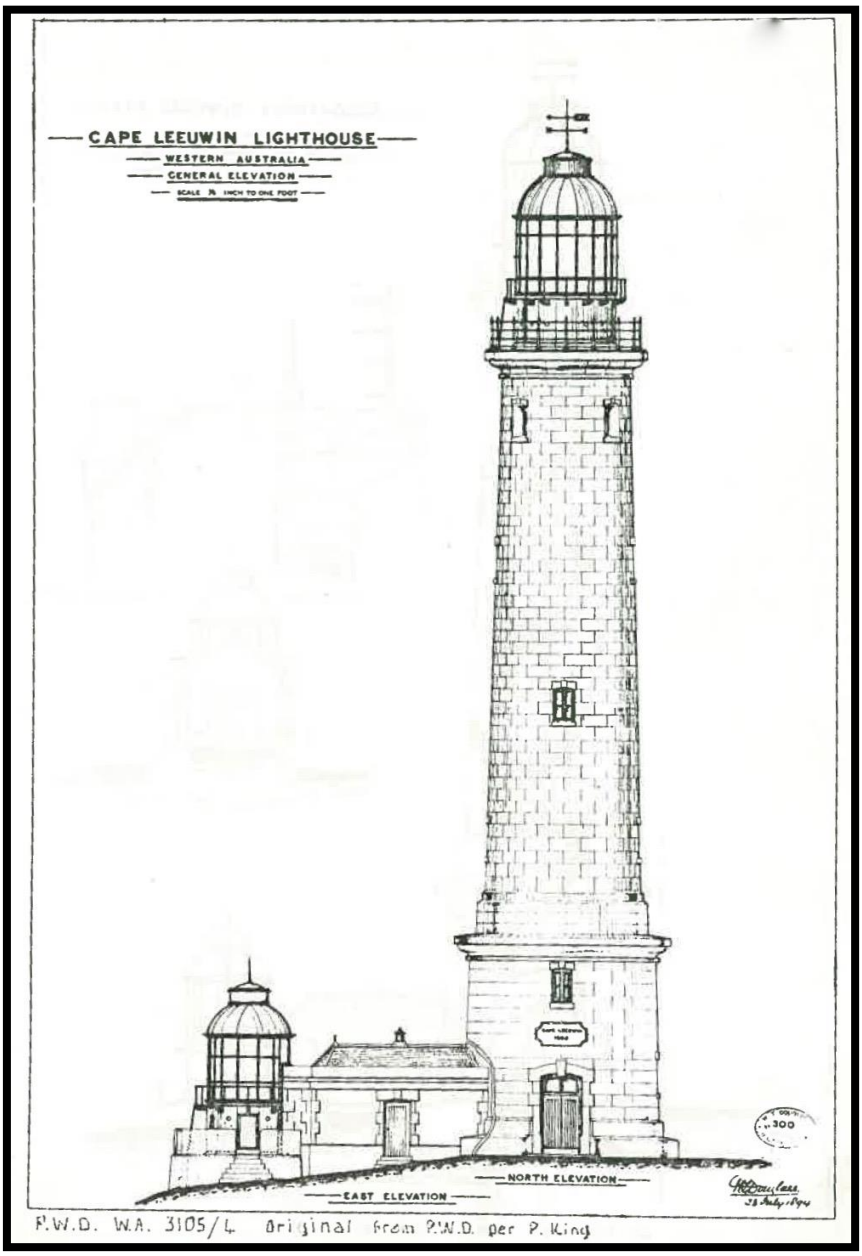


Figure 2. The original design elevation drawing, showing the additional smaller lighthouse originally planned to house a red warning light, separated from the main tower by the fuel store. The second lighthouse was never built. (The image has been taken from: Watson, p. 19)

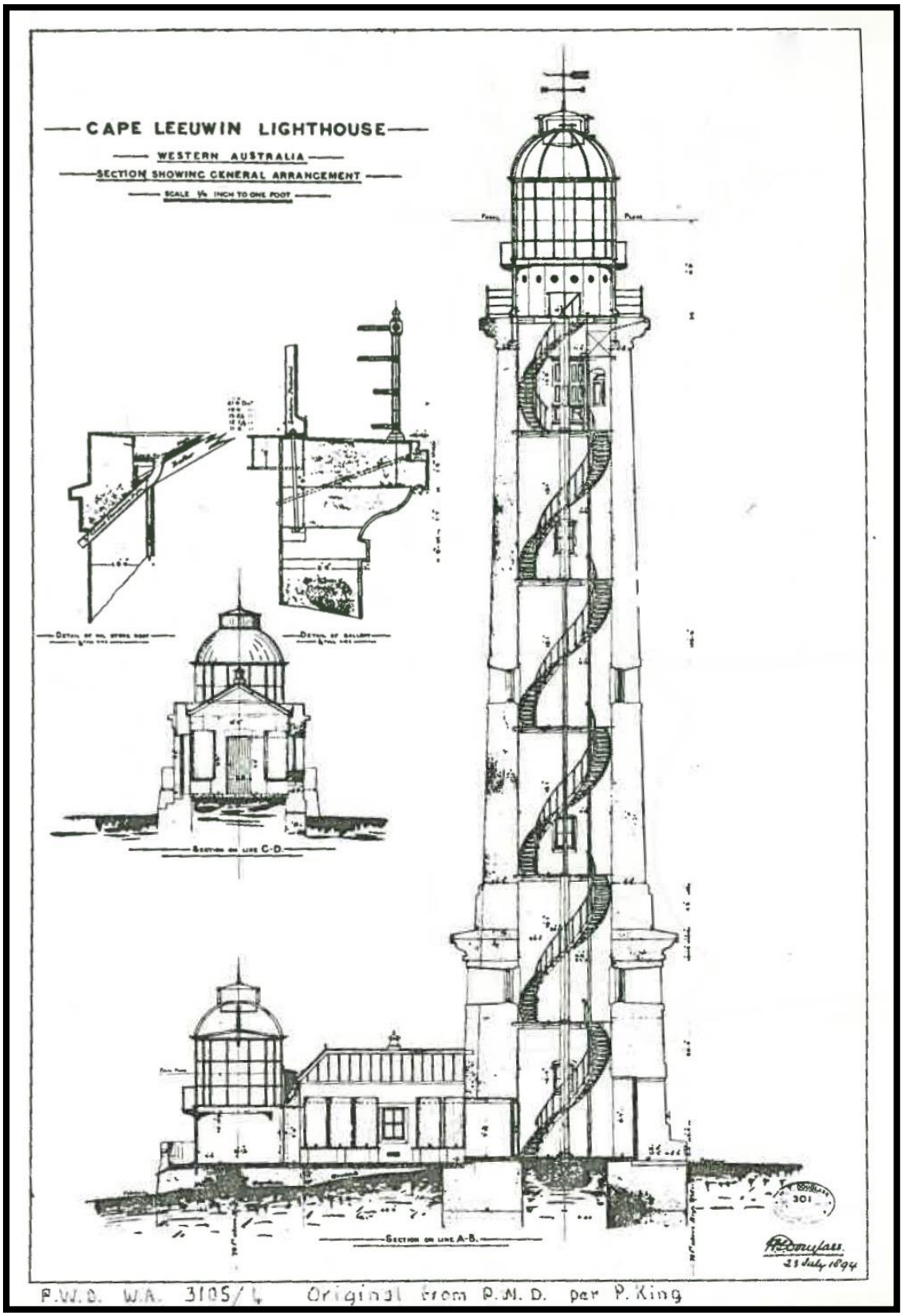


Figure 3. The original design section drawing showing the general arrangement. (The image has been taken from: Watson, p. 20)

Based on Douglass' design, George Temple Poole, Western Australia's government architect, drew up the plans for the tender document. The designs included plans for the light tower, three keepers' quarters and a waterwheel that would supply fresh water to the lighthouse site.[22] Tenders for the work were gazetted on 18 January 1895 and were supposed to close by 26 February. The tender notice continued to appear in the local papers well into March 1895. By April it was reported that Davies and Wishart were the successful tenderers with a sum of £7,782.11s.6p.[23] The contract period was to run from 2 April 1895 to 1 February 1896. The cost of the waterwheel was not included in the bid, as Davies and Wishart negotiated to omit some items from the building schedule in exchange for bearing the cost of the construction of the waterwheel themselves.[24] However, a dispute over this arrangement apparently arose, as a letter from the Inspector of Works, J.J. Harwood, to Davies and Wishart noted that 'You offered to provide this water supply – in a letter dated 27/4/1895 – for £340.0.0. in lieu of various items in the schedule, amounting to £258.2.6 and this offer was accepted by letter dated 8/5/1895.'[25] This appears to have settled the matter.

Once work commenced on the construction of the lighthouse tower, problems were encountered when digging the foundations. The specifications for the foundations had been based on bores that had terminated after 6 – 8 feet on granite rock. However, the bores had encountered granite boulders, not solid bedrock. Solid rock was not reached until 22 feet. This required extra digging to reach bedrock, which not only slowed the construction of the tower but also increased the cost of the tower.[26]

The Western Australian Premier, John Forrest, laid the foundation stone for the lighthouse on 13 December 1895. A jar containing newspapers of the day, coins and other documents was placed under the stone.[27] While the main light tower was under construction, arguments continued to rage over the suitability of the secondary light. In the end it appears that the "anti-light lobby" won the day as only the foundations for the secondary light were constructed.[28]

Local limestone, which was quarried from nearby Quarry Bay, was used in the construction of the tower and the two southern residences. The northern residence was constructed from granite, quarried on site.[29] Once construction of the tower commenced, reports began to circulate in the newspapers that suggested that Davies and Wishart were using inferior quality stone. The issue raged for some months with conflicting reports. It was not until the opening ceremony that the true facts were revealed. The accusation over the use of inferior stone had been reported by the site Supervisor, Mr R. Bushby, who apparently had had a difference of opinion with the contractors. The remarks at the opening ceremony indicated that the accusations had been false and no inferior quality stones had been used.[30]

Figure 4 shows the lighthouse precinct as it exists today. Figure 5 highlights the remote location of the lighthouse, sitting on the boundary between two great oceans. The lighthouse tower is shown in Figure 6. Figure 7 shows the precinct as viewed from the observation deck on the lighthouse.

Figure 4. The precinct as it exists today. Image courtesy Google Maps, 2017

Figure 5. The remote Cape Leeuwin and its lighthouse, marking the boundary between the Southern Ocean (left and distance) and the Indian Ocean (right). The waterwheel and pump are located at the small inlet visible in the foreground below the Keepers cottages. The larger bay in the foreground is Quarry Bay.

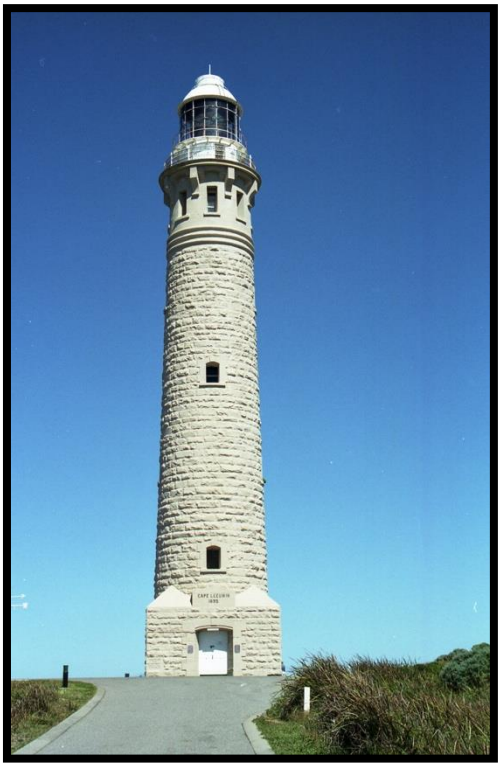


Figure 6. The Cape Leeuwin Lighthouse tower

Figure 7. View of the precinct from the top of the lighthouse, looking north. The Indian Ocean is to the left, the Southern Ocean to the right. The bay in the distance is Quarry Bay, the source of some of the stone used in the construction. The waterwheel and pump are located on the beach in the small inlet just to the south of Quarry Bay.

The Chance Brothers' design for the optical apparatus specified a large lens consisting of a small number of large optical panels, which needed a powerful burner and that the apparatus should rotate at high speed.[31] Up until this time lighthouse optical apparatus was typically supported on a “chariot-wheel” system. These wheels were rollers that, even when regularly lubricated, required a powerful clockwork motor to keep the lens rotating evenly, even at a slow speed. As lenses became larger and heavier the rotation time for the light became longer. French designers developed a solution to this problem in the late 1870s when they invented a mercury bath to replace the rollers. The French called this new system ‘feu écalir’ or 'lightning flash'.[32] Chance Brothers soon adopted and adapted this type of mechanism. The Cape Leeuwin light was their first implementation of this technology.[33] The optical system designed by Chance Brothers is still in operation today (see Figure 8).

The light was described as having the following characteristics:

> a bivalve optical apparatus, the first of this size and this arrangement yet made….the two panels, separated by a space of 114 inches, are mounted on a carriage made to revolve by clock work at such a manner that the flash from each lasts one-fifth of a second…. The time of revolution ten seconds. This represents double the time of the French ‘feu éclair’ arrangement hitherto adopted.[34]

Following Federation, Commander Brewis was employed by the Commonwealth to inspect the Western Australian lighthouses that would be taken over by the Commonwealth. When he visited the Cape Leeuwin

Lighthouse in 1912 he described the light as being a first order, white dioptric lens with a quarter second flash every 5 seconds.[35]

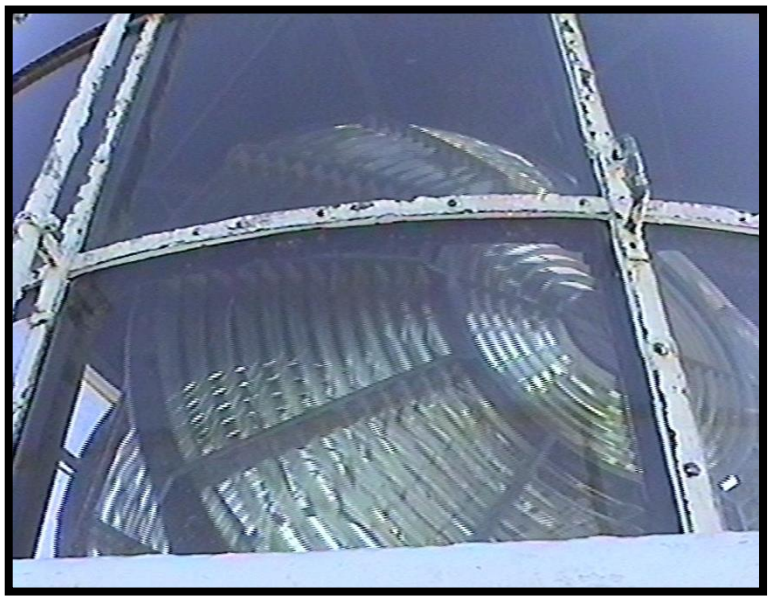


Figure 8.

The unusually large Chance Brothers optical system is still in service today.

The circular steel staircase, and all of the other iron fittings were manufactured in England by Chance Brothers. The lighthouse was also connected to the colony's telegraphic system.

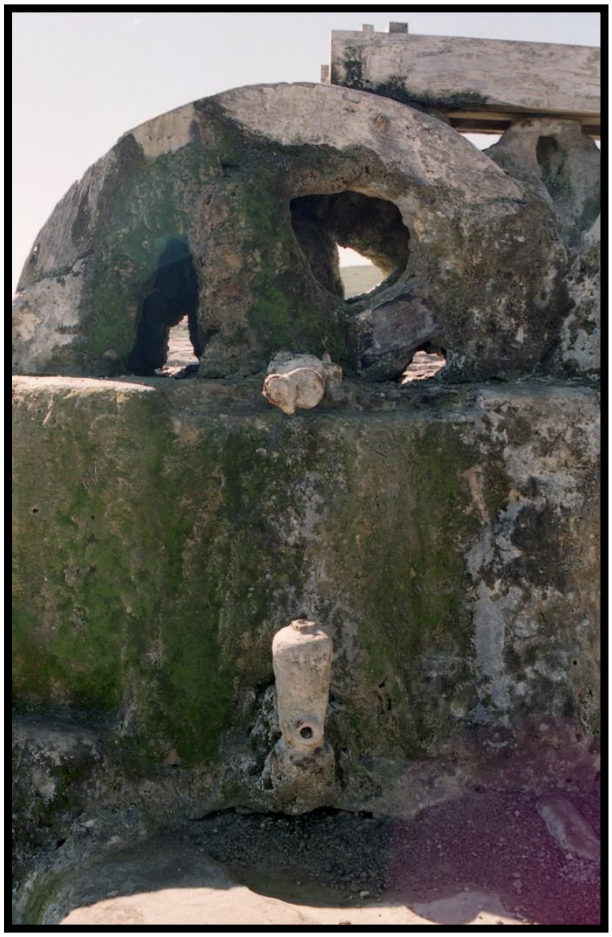
When the Cape Leeuwin light came online, illumination was provided by an Argand lamp that operated on a system of concentric wicks that burnt kerosene or mineral oil. The burning wick produced a light intensity of 200,000 candelas and was visible for approximately 20 nautical miles. The higher the number of wicks used, the greater the illumination.[36] At the time of its installation, the Cape Leeuwin light was the most powerful light in Australia.[37] The power of the smokeless lamp was further enhanced by the use of a system of concentric prisms within the panels around a central light. The prisms reflected and refracted the light, greatly enhancing its natural power.[38] Lights could be made to 'flash' by revolving both the light and the prisms. The revolving mechanism (containing the mercury) utilised a heavy weight on a chain (like a

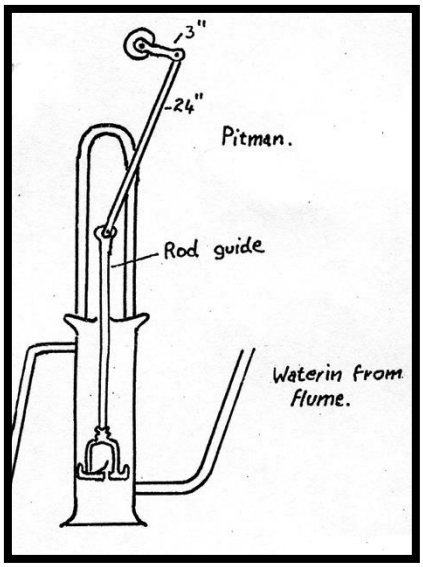
grandfather clock), which fell down the centre of the tower.[39] The mechanism was periodically wound through the night to keep the light revolving. The capability of lights to 'flash' more than once in one revolution was solved by adding additional prisms.[40]

The light began operating on 1 December 1896. A year after Forrest had laid the foundation stone, he returned to Cape Leeuwin to officially open the lighthouse on 10 December 1896. In his official speech Forrest referred to the fact that the light had been completed

> with the colony's own funds (Cheers). It was not a work for this colony, which had no large merchant service of its own. The ships that came here were owned in other parts of the world, and he would therefore repeat that the construction of the Cape Leeuwin lighthouse showed that this colony, with its own resources, had desired to do its duty, not only to its own people, but also to all the nations of the earth. (Cheers). ….. On behalf of the Government and the people of Western Australia I dedicate this lighthouse, erected at Cape Leeuwin, the extreme south west point of the Australian continent, to the world's mariners. [41]

The water wheel had also been completed and after the opening of the lighthouse, the official party visited the site for an inspection of the apparatus.[42] Water was drawn from a freshwater spring lying to the east, located slightly above sea level and carried via a wooden flume to the water wheel. The wheel supplied power to a hydraulic ram type positive displacement pump, which pumped water up to the lighthouse keepers' quarters approximately one kilometre away.[43] The current state of the flume and wheel/pump is shown in Figure 9, together with a line drawing held in the files of the State Heritage Office which shows how the wheel operated.[44]





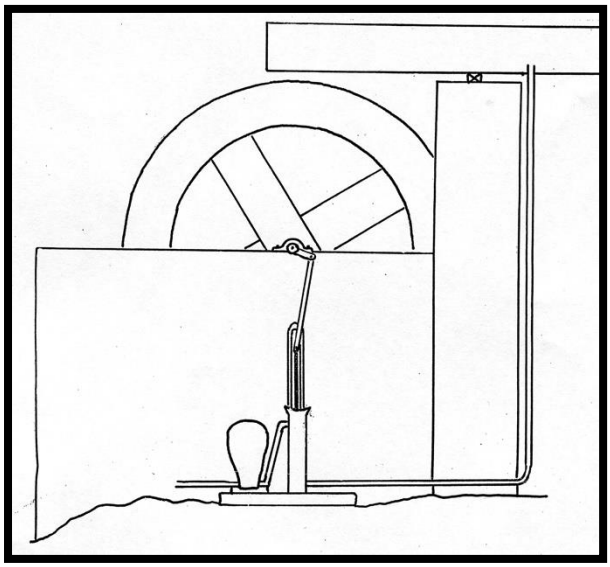


Figure 9. The wooden channel feeding water from the spring to the waterwheel (upper left) and the lime encrusted remains of the wheel and the ram pump (upper right). Sketches of the waterwheel and pump operation are shown in the lower images. (Sketches held by the State Heritage Office of Western Australia, file no. 0106.

Figure 10 portrays another view of the wheel that highlights the distance to the lighthouse, which can be see in the background.

Figure 10. View of the waterwheel looking to the east. The top of the lighthouse is just visible in the distance.

In the mid 1920s an oil engine was used to assist in pumping water up to the keepers' quarters and in later years the wheel was completely bypassed when a motor was directly linked to the hydraulic ram. The waterwheel became redundant in 1978 when the lighthouse site was connected to the Augusta town water supply.

By 1908, it had been decided that an additional assistant lighthouse keeper was required. The successful tenderer for the erection of a new dwelling, at £605, was Mr Longbottom. Unlike the three original cottages the new building was timber framed and clad. The building took three months to construct and was completed by September 1908. It lay to the south of the other three cottages.[45] Other additional buildings which once existed on the site included stables, chaff house and a cart house.[46] Early photographs show that each residence was once surrounded by a timber picket fence.[47]

The early keepers were expected not only to keep the light operational, but they also passed on shipping reports and kept weather records.[48] There have been only two shipwrecks off Cape Leeuwin. The *Pericles* in 1910 and *HMAS Nizam* in 1945. In both instances, the keepers assisted the ship wrecked passengers and sailors to safety and alerted the authorities to the tragedies.[49]

Following Federation, the most important coastal lights were brought under Commonwealth control. As mentioned previously, Commander Brewis undertook the extensive investigation of all existing coastal lights. In his report on the Cape Leeuwin light, he noted that the lantern, tower and dwellings were in good condition. Brewis recorded that the light had an intensity of 450,000 candelas, more than twice its original brightness, and the "illuminant" was pressurised kerosene. The light's intensity indicates that some time prior to 1912, the concentric wicks were replaced with an incandescent mantle. This type of mantle allowed the kerosene to be

burnt under pressure, producing a stronger light. The installation of this new mantle would also have necessitated the installation of a pressurised fuel tank that would force the fuel into the lamp. Brewis also recommended that the flash be lengthened and only three keepers be retained.[50]

General repairs were made to all the buildings in 1915 and on 9 August 1916, the Cape Leeuwin Lighthouse and keepers' quarters were transferred from the Western Australian government to the Commonwealth.

In 1925, the light's power was increased to 780,000 candelas when a larger kerosene mantle was installed. In 1953, the verandahs on the cottages were enclosed and garages were erected next to each dwelling. It is not known when the fourth cottage was removed although the foundations are still in situ. Tenders were accepted for additional structures in January 1954, which included three timber-framed buildings: a fuel store, a power house and a weather hut. Two years later, in September 1955, a marine radio beacon was installed. Sometime in the late 1970s a new brick power house and beacon room were constructed.[51]

In June 1982, the mantle lamp was converted from vaporised kerosene to a 1,000 watt halogen tungsten filament lamp inside the original Chance Brothers lens. The light's intensity was increased to 1,000,000 candelas with a range of 26 nautical miles.[52] Power was supplied by an on-site diesel engine. When the lamp was converted, it was one of the last coastal lights still operating on pressurised kerosene vapour and mantles.[53] The lighthouse was automated in November 1995.[54]

Cape Leeuwin Lighthouse and the quarters were transferred from the Australian Maritime Safety Authority (AMSA or Commonwealth) to CALM (Conservation and Land Management, now the Department of Parks and Wildlife or DPaW) in 2000.[55] AMSA is still responsible for the functioning of the lighthouse, but the lighthouse precinct itself is vested with DPaW and falls within the Leeuwin Naturaliste National Park.

3. DESCRIPTION

Cape Leeuwin Lighthouse and the keepers' quarters sit on a windy, narrow stretch of land with the Indian Ocean on the western side and the Southern Ocean on the eastern side. The Cape represents the south-west 'corner' of Western Australia. The coastline in this area is rocky and the sea to the south of the lighthouse is strewn with rocky shoals and several small islets. The vegetation that has managed to survive is stunted due to the high winds that this area often experiences.

The site is defined by a sealed car park that lies to the north of the buildings. The lighthouse precinct is enclosed behind a cyclone mesh fence. A sealed bitumen path leads from the entry gates past the western side of the service buildings and up to the lighthouse. Bitumen driveways lead down to the garages. The cottages and service buildings form two separate parallel groups stretching north-south. The eastern line is represented by the three cottages, while the western line contains the new service buildings to the north with the lighthouse at the southern end.

3.1 The Lighthouse and Oil Store

The lighthouse has two parts, the 39 metre tall circular stone tower (foundation to light), which sits on a squared base, and a single storey room, which once served as the oil store, on the southern side. The stone work is undressed limestone with dressed stone to all openings and corners. The main entry is on the northern side through a pair of timber doors (Fig. 6). Windows are alternately spaced around the tower, with a row of windows beneath the parapet. Some of the windows have fixed panes in metal frames, while others have been replaced with glass blocks. Above the parapet is the lantern that opens out onto a circular balcony with an iron floor. An iron balustrade runs around the outer edge of the walkway. An aluminium mesh has been installed around the balustrade. The roof of the lantern dome is covered with copper sheeting. The interior of the tower features a circular iron staircase with ornamental balustrading. Through the centre of the staircase runs the metal casing that holds the clockwork mechanism. The original Chance Brothers dioptric lens remains in place in the lantern room, which has a cast iron floor. The door leading out onto the balcony is cast iron.

The former oil store is accessed through a pair of timber doors. Additional openings lie in the eastern (double doors) and western walls (fixed window). The hipped roof is covered with corrugated galvanised iron.

3.2 Keepers' Quarters and Ancillary Buildings

The three stone quarters are identical in layout and are located on land that slopes gently down to the east. The two southern-most buildings are constructed of limestone, while the northern-most cottage is constructed of granite. The walls of the cottages are constructed using random coursed stone (painted), the hipped roofs

are covered with corrugated galvanised iron and the verandahs have been enclosed with asbestos cement sheeting on a timber frame. The chimney stacks have been removed and replaced with metal flues. Much of the original timber joinery (including doors and windows) has been retained as have the lathe and plaster ceilings and wall finishes. The front doors are located on the western side. The layout of the buildings is two front rooms either side of a central corridor. The east-west corridor leads into a larger room at the back (east) with a slightly smaller room opening off it on the northern side. On the eastern side of the large room, a door leads off onto the rear enclosed verandah, providing access to three rooms lying under the skillion roof. As the ground on the eastern side of the buildings slopes away, stairs permit access to and from the rear verandahs.

Laundries and W.Cs were provided at the same time that the cottages were constructed. The layout is one large room (the laundry) on the western side, with a smaller room (the toilet) on the eastern side. These structures are constructed from painted, random coursed stonework with asbestos cement sheeting on the northern sides. The roof cladding is corrugated galvanised iron, with concrete floors.

All of the buildings constructed in 1953/54 (the garages, former fuel room, former power house and former radio hut) are all timber framed structures clad with asbestos cement sheeting. The roofs are covered with corrugated asbestos cement sheeting.

The power house and beacon room, which were constructed in the 1970s, are constructed with brick and the gable roof is covered with corrugated asbestos cement sheets. The building houses the emergency generator and the radio beacon equipment.

3.3 Waterwheel

The water wheel sits just above the high tide line in a small cove approximately one kilometre to the north of the Cape Leeuwin Lighthouse Quarters. This area lies within the Leeuwin – Naturaliste National Park. The lighthouse can just be seen when looking south from the water wheel. The timber flume, which carried the water to the overshot wheel, extends out eastward from the wheel and disappears in the low brush that is found throughout this area.

The flume consists of three timber planks that have been screwed together to form a base and two sides. Cross ties have been screwed to the top of the flume at regular intervals. The wheel assembly is located just above the high water mark. The flume rests on the ground, except close to the wheel where it is supported on limestone piers, as the land falls down towards sea level.

At the base of the water wheel, on the southern side, there is evidence of the remains of the hydraulic ram. The air chamber is still in situ. Beyond the water wheel, to the south, a small portion of concrete remains on the shoreline, displaying a long impression that was probably made by a pipe. This evidence indicates the line that the water pipe took from the water wheel to the lighthouse keepers quarters.

The water wheel's shaft rests between two limestone walls. Both the wheel and the walls have become heavily encrusted with lime that has been deposited over the years by the water that flowed over the wheel. This accumulation has led to the wheel gradually becoming inoperable. Seepage along the wooden flume has also encrusted the limestone piers.

The limestone coating affords the timber wheel some protection. It is considered to be in a stable condition at present. The flume appears to be a recent reconstruction, possibly dating from 1998 when the then Department of Conservation and Land Management (CALM) carried out work to allow water to flow over the wheel again. The timber flume extends some 60 metres into the scrub at which point it is replaced by a fibreglass trough. It is not known how far this trough extends into the scrub.

4. CONCLUSION

The Cape Leeuwin lighthouse is a fine example of stone lighthouse construction typical of the late 19th century in Australia. The tower is 39 m tall, measured from the foundation to the light, taller still to the apex of the structure. It is the tallest lighthouse in Western Australia and third tallest in Australia, but the tallest on the Australian mainland. The inhospitable location necessitated an innovative solution to provide fresh water to the light-keepers' quarters. A regular flow of fresh water from a swamp above a nearby beach was used to power an overshot water wheel on the beach, which drove a ram pump to send a small amount of fresh water under pressure, the approximate one kilometre distance and 20 metres lift to the quarters.

The lighthouse was built to support coastal shipping, making it safer and more reliable, which encouraged the development of local industries and subsequent growth and prosperity of communities. The lighthouse system was particularly instrumental in the growth of the timber industry in south-western Australia, which relied on ships to transport the heavy cargoes.

Today, the Cape Leeuwin light continues to operate to the benefit of coastal shipping and leisure-craft. The lighthouse precinct is owned and managed by the Department of Parks and Wildlife. It is a popular tourist attraction, operated as such by the Margaret River and Busselton Tourist Association, and greatly valued by the local communities of the area.

APPENDIX 1

REFERENCES AND ENDNOTES

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[9] Augusta-Margaret River Municipal Inventory, pp. 21.
[10] Augusta-Margaret River Municipal Inventory, pp. 21.
[11] Augusta-Margaret River Municipal Inventory, pp. 24.
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[13] Watson, p. 4.
[14] Watson, p. 4.
[15] Watson, p. 7.
[16] Watson, pp 4 & 5.
[17] *Albany Mail and King George's Sound Advertiser*, 8 January 1884, p. 3.
[18] Watson, p. 17.
[19] Watson, p. 14.
[20] Watson, pp 28 - 31.
[21] Watson, p. 18.
[22] Watson, pp 14, 18 and 23; Research Note number 619: Cape Leeuwin Lighthouse and Waterwheel, Battye Library, State Library of Western Australia.
[23] *The Daily News*, 6 April 1895, p. 6.
[24] Research Note number 619, Battye Library.
[25] Watson, p. 23.
[26] Watson, p. 24.
[27] Watson, p. 24.
[28] Watson, p. 31.
[29] Creswell, G., *The Light of the Leeuwin. The Augusta-Margaret River Shire History*, Augusta-Margaret River Shire History Group, Margaret River, 2003, p. 96.
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[31] Chance, Toby and Williams, Peter, *Lighthouses: the race to illuminate the world*, New Holland Publishers, London, 2008, p. 172.
[32] Chance, p. 171.
[33] Chance, p. 171.
[34] Chance, p. 172.

[35] Brewis, C.R.W., *Lighting of the west coast of Australia. King George Sound to Cambridge Gulf*, Dept. of Trade and Customs, Victoria, 1912, p. 15. This type of terminology is generally used to describe the characteristics of a lighthouse's light.
[36] Reid, p. xiv.
[37] Danvers, Architects, 'Conservation Plan of Cape Leeuwin Lightstation, Western Australia', September 1992, p. 11.
[38] Reid, pp 189 - 194.
[39] Reid, p. xv.
[40] Reid, p. 194.
[41] *Daily News*, 11 December 1896, p. 3.
[42] Watson, p. 23.
[43] Watson, p. 23.
[44] State Heritage Office of Western Australia File No. 0106. The source of these diagrams is not known.
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[46] Danvers, p. 14.
[47] Danvers, p. 29.
[48] Ayris, Cyril, *Leeuwin Lighthouse: a brief history*, Cyril Ayris, Perth, 1996, pp 23 - 26.
[49] Ayris, pp 27 - 29.
[50] Brewis, p. 15.
[51] Danvers, p. 14.
[52] Reid, p 122.
[53] Cummings, D.A, Glasson, M. & McCarthy, M., 'Lighthouses of the Western Australian coast and off-shore islands, Working File #1: Lighthouses and lightstations A to Z', Dept. Maritime Archaeology, West Australian Maritime Museum, No. 100, 1995, Cape Leeuwin.
[54] Ayris, p. 37.
[55] CALM, 'Leeuwin-Naturaliste National Park: Cape Leeuwin Lighthouse Concept Plan', 15 October 2001, p.1.