



Proposed Minimum Luminous Range for Existing Lighthouses in This Age of Global Navigation Satellite Systems by Using the Correlation between Light Intensity and Luminous Range

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Introduction

- Global Navigation Satellite System (GNSS) changed the navigational practices of mariners.
- Eliminated the change in phase of navigation from open sea to coastal by using the same method to fix the position in both areas and achieve the same level of accuracy.
- This trend cause UK General Lighthouse Authority reviewed operation of major lighthouse from 2010 to 2015.
- Results as follows:
 - 41 reduced luminous range
 - 6 discontinued operation
 - 14 transfer to local authorities,
 - 1 replaced by Port Entry Light
 - No changes for 76 lighthouses (reviewed before)

Problem Statement

- The review did not mention the use of any specific method to reduce the luminous range.
- Therefore, this research proposed a new method for determining the minimum luminous range for lighthouses based on the height of the existing structure and the linear correlation between the intensity of the light and the luminous range achieved.

Research Methodology



1. Modified the Geographical Range Formula

GR is the maximum distance at which an object can theoretically be seen over the horizon.

Range $(nm) = 2.03 \times \sqrt{e+h}$ Eq.1where:e = elevation, in metres, of the objecth = height, in metres, of the observer's eye.

Range $(nm) = 2.03 \times \sqrt{e}$ Eq.2

Refer as Geographical Range of a particular lighthouse according its height

2. Determine Minimum Luminous Range







Muka Head Lighthouse (Penang) Luminous Range 25nm Observation from distance 46 nm, Observer Height 4.6 m – Not flashing



Muka Head Lighthouse (Penang) Luminous Range 25nm Observation from distance 46 nm, Observer Height 4.6 m – Flashing



Muka Head Lighthouse (Penang) Luminous Range 25nm Observation from distance 58.5 nm, Observer Height 4.6 m – Not Flashing



Muka Head Lighthouse (Penang) Luminous Range 25nm Observation from distance 58.5 nm, Observer Height 4.6 m – Flashing



Results of Verification of the Proposed Minimum Luminous Range

Distance	Luminous Range of 25 nm	Luminous Range of 14 nm
Observed (nm)		
36	Easily sighted and identified.	Easily sighted and identified.
41	Easily sighted and identified. Horizon height	Easily sighted and identified. Horizon height
	lower than 36 nm.	lower than 36 nm.
46	Easily sighted and identified. Horizon height	Easily sighted and identified. Horizon height
	lower than 41 nm.	lower than 41 nm.
51	Easily sighted and identified. Horizon height	Easily sighted and identified. Horizon height
	lower than 46 nm.	lower than 46 nm.
56	Easily sighted and identified. Horizon height	Easily sighted and identified. Horizon height
	lower than 51 nm.	lower than 51 nm.
58.6	Poorly sighted and identified.	Barely sighted and identified. Horizon
		height lower than 51 nm.
58.7	Barely sighted and identified.	Not sighted.
61	Not sighted.	Not sighted.

Conclusion

- Simulation shows the difference in the performance of the light between luminous ranges 14 nm and 25 nm was very small and insignificant.
- However, the difference in the light intensity between 14 nm and 25 nm, which was 9,000 cd and 700,000 cd, respectively, was huge.
- The dipping of the lighthouse light with the increase of range from lighthouse is realistic