



A LIGHTHOUSE IS A TALL SIGNALING TOWER NEAR THE COAST TO GUIDE SHIPS AT SEA AND WARN THEM FROM DANGEROUS CALAMITY

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How to cite this Article: *Prof. Dr. Dhrubo Jyoti Sen (2026). A LIGHTHOUSE IS A TALL SIGNALING TOWER NEAR THE COAST TO GUIDE SHIPS AT SEA AND WARN THEM FROM DANGEROUS CALAMITY. World Journal of Advance Pharmaceutical Sciences, 3(8), 91-95.



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Article Info

Article Received: 21 June 2026,

Article Revised: 11 July 2026,

Article Accepted: 01 August 2026.

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DOI: <https://doi.org/10.5281/zenodo.22115435>

ABSTRACT

A lighthouse is a tower, building, or other type of physical structure designed to emit light from a system of lamps and lenses and to serve as a beacon for navigational aid for maritime pilots at sea or on inland waterways. The primary purpose of a lighthouse is to serve as a navigational aid and warning beacon for ships at sea. It features an integrated system of heavy foundations, living or service quarters, a central spiral or straight staircase, an upper lantern room, and optical lens arrays designed to withstand extreme wind and wave action. The primary purpose of a lighthouse is to serve as a navigational aid and warning beacon for ships at sea. They help mariners avoid dangerous rocks, reefs, and shallow coastlines, guide vessels safely into harbors, and act as a reliable visual backup when modern electronic navigation systems fail.

KEYWORDS: lighthouse, beacon, cupola, Fresnel prism.

INTRODUCTION



Figure-1: Lighthouse.

Lighthouses mark dangerous coastlines, hazardous shoals, reefs, rocks, and safe entries to harbors; they also assist in aerial navigation. Once widely used, the number of operational lighthouses has declined due to the expense of maintenance and the advent of much cheaper, more sophisticated, and more effective electronic

navigational systems.

A lighthouse is a tall tower with a bright light at the top built to guide ships and warn them of dangerous rocks.

Lighthouses Work

Bright Beams: They shine a strong light out to sea so boats can see it from far away.

Special Lenses: A special glass setup called a Fresnel lens makes the light bigger and brighter.

Flash Patterns: Every lighthouse has a unique flashing pattern so sailors know exactly which place they are seeing.

Fog Horns: Many have loud horns to warn ships when it is too foggy to see.

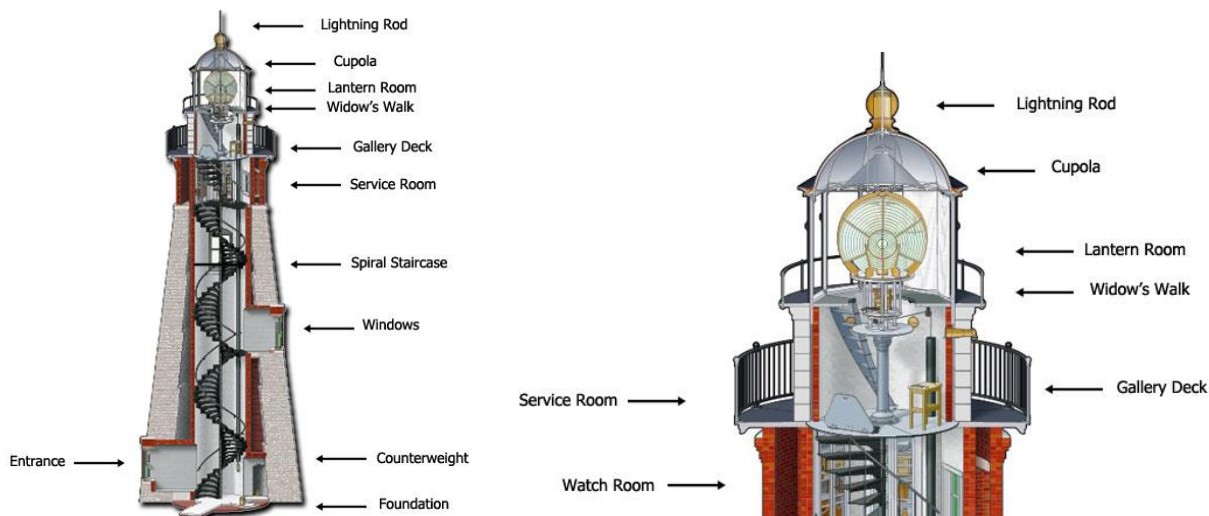


Figure-2: Cupola & Beacon.

History and Today

Old Fires: Long ago, people lit wood fires on hills or tops of towers to help guide ships.

Famous Start: One of the very first big ones was the Pharos of Alexandria in Egypt, built around 280 BC.

Keepers: In the past, a person called a keeper lived there to take care of the fire or lamp.

Automatic Now: Today, most lighthouses work by themselves using computers and sensors.

The upper parts of a lighthouse include the lantern room (housing the lamp and Fresnel lens), surrounded by the widow's walk safety railing, capped by the domed cupola roof with a lightning rod, and sitting atop the exterior gallery deck and interior service room.

Key Upper Components

Lantern Room: The glassed-in, climate-resistant housing at the very top that protects the optical beacon from wind and weather.

Lens/Beacon: The large magnifying optic system (historically a multi-tiered Fresnel lens) and high-intensity lamp that project the warning light far out to sea.

Cupola: The domed or conical metal roof sealing the top of the lantern room. A lighthouse cupola is the dome-shaped roof on top of the lantern room. It shields the light and lens system from rain, wind, and salt water. It often features a metal peak with a lightning rod to protect the tower.

Lightning Rod: A spike and heavy copper wire system running down the exterior to ground the structure safely during electrical storms.

Widow's Walk: A narrow, railed exterior platform encircling the lantern room, allowing keepers to clean glass panes and check equipment.

Gallery Deck: The wider outdoor railed platform circling the tower directly beneath the lantern room.

Service Room: The interior staging room immediately below the light where keepers stored spare parts, oil, and cleaning tools.

Design and Structure

Dome shape: Curved profile sheds heavy rain and wind.

Material: Made of cast iron, copper, or steel.

Ventilation: Includes a ventilator ball on top to let out heat from old oil or gas lamps.

Lightning safety: Connected to grounding cables.

Purpose and Function

- Protects the delicate glass prisms and light bulb.
- Acts as a visible daytime marker (often painted red, white, or black).
- Resists harsh coastal weather.

Lighthouse prisms are part of a special glass system called a Fresnel lens, invented by **Augustin-Jean Fresnel**. This design uses curved glass rings and prisms to catch light from a small lamp and bend it into a bright, powerful beam that shines far out to sea.



Figure-3: Fresnel Prism.

How Lighthouse Prisms Work

- **Center Lens:** A central magnifying glass captures direct light and sends it straight ahead.
- **Inner Prisms (Refraction):** Rings above and below the center bend escaping light rays so they travel in a flat, horizontal line toward the horizon.
- **Outer Prisms (Total Internal Reflection):** Special prisms catch light that would normally go up into the sky or down into the floor. They bounce the light internally at sharp angles and shoot it outward without losing much brightness.
- **Rotation for Signals:** The entire glass cage turns around the lamp. As the beams sweep past, passing ships see a repeating flash that identifies the specific lighthouse.

Augustin-Jean Fresnel (10 May 1788 – 14 July 1827). A lighthouse Fresnel lens, invented by French physicist Augustin-Jean Fresnel in 1819, uses a central magnifying lens surrounded by concentric rings of glass prisms to

capture and focus scattered lamp light into a powerful, far-reaching horizontal beam.

How Lighthouse Fresnel Prisms Work

Dioptric (Refractive) Elements: The inner rings bend and refract light directly from the central lamp into a parallel beam.

Catadioptric (Reflective) Elements: The outer tier of prisms bends the light and uses total internal reflection to redirect stray upward and downward rays horizontally out to sea without heavy, loss-prone silver mirrors.

Weight and Material Savings: By breaking a massive, thick curved lens into segmented prism rings, the design achieves extreme efficiency while reducing weight and thickness by up to 80%.



Figure-4: Augustin-Jean Fresnel [Inventor]

Orders of Lenses: Classified into seven primary sizes (Orders 1 through 6, plus hyper-radiant), where First Order is the largest and most powerful for ocean-class towers, and Sixth Order is the smallest for harbors. Large historical assemblies can contain hundreds or thousands of individually hand-polished glass prisms mounted in bronze or brass frames. If you'd like to explore further, let me know if you want to know about: The history of

Augustin-Jean Fresnel's invention. How medical Fresnel prisms were adapted from lighthouses for eyeglasses. Specific famous lighthouses that still use original lenses.

A beacon is a light, fire, or radio signal used to guide and warn people. Key types include physical navigation markers, digital Bluetooth transmitters, and symbolic guides.

Physical and Navigation Beacons

Signal fires: Ancient fires lit on hills or towers to warn of enemy troops or guide travelers.

Lighthouses and buoys: Structures with bright lights on shores or dangerous waters to warn and direct ships.

Aviation lights: Radio stations or tower lights that mark safe flight paths for airplanes.

Most lighthouses range from 33 feet (10 meters) to 150 feet (46 meters) tall. Their height depends on how far out to sea the light needs to shine over the curve of the earth. The tallest purpose-built traditional lighthouse is the Île Vierge Lighthouse in France at 271 feet (83 meters).

Typical Sizes

Small lights: 10 to 30 feet tall, used in calm waters, rivers, or small harbors.

Standard towers: 50 to 100 feet tall, common along normal coastlines.

Tall beacons: 150 to 200+ feet tall, built on high cliffs or flat shores to warn ships of dangerous deep-sea reefs far away.

Tallest overall: The Jeddah Light (Jeddah Port Control Tower) in Saudi Arabia stands at 133 meters (436 feet), though it doubles as a port control structure.



Figure-5: Tallest beacon.

Tallest traditional lighthouse: The Île Vierge Lighthouse in France stands at 82.5 meters (271 feet). The Île Vierge Lighthouse (Phare de l'Île Vierge) in Plouguerneau, Finistère, Brittany, France, is the tallest stone lighthouse in Europe and the tallest traditional masonry lighthouse in the world, standing at 82.5 meters (271 feet) tall.

Structure and Design

- Built between 1897 and 1902. Made of local Kersanton granite and stone.
- Interior lined with 12,500 opaline glass tiles.
- Contains 365 steps to the top.
- Light range reaches up to 50 kilometers (27 nautical miles).

Tallest in India: The giant Jamnagar/Jakhau region or coastal towers reach up to 45 meters (148 feet), like the historic Thangassery. Lighthouse in Kerala at 42–45 meters.

A lighthouse "breadth" can mean the width of its physical tower structure, the width of the light beam angle it projects across the sea, or the total area of water

it sweeps. Most classic stone towers taper from a base width of 20 to 40 feet (6 to 12 meters) down to a narrower top.

Base Width (Breadth): Typically ranges from 15 feet to over 30 feet (4.5 to 9 meters) wide at the foundation to handle heavy winds and waves. **Beam Spread (Angle):** Many lights sweep a full 360-degree radius, though some use directional sector lights spanning specific angles (such as 60° to 80°) to highlight safe channels or warn of rocks. **Visibility Range (Reach):** The light beam typically shines across a distance of 10 to 24 miles (18 to 36 km) depending on bulb power and height above sea level. Modern lighthouses typically use high-efficiency LED bulbs or metal halide lamps ranging from 250 to 1,000 watts. Because they use precision lenses to concentrate energy, a modest power source can produce millions of candlepower or high luminous intensity visible for 20+ miles.

Early days: Open wood fires, coal, and candles.

18th-19th Century: Whale oil, lard oil, and mineral/kerosene lamps using Argand burners.

20th Century: Incandescent petroleum vapor lamps, acetylene gas (Dalén light), and standard grid electricity.

Modern Era: High-output LEDs and compact metal halides powered by grid electricity, diesel generators, or solar panel arrays with battery banks.



Figure-6: Different Beacons.

How Light Power is Magnified

Fresnel Lens: Invented by Augustin-Jean Fresnel, this stepped glass lens captures diverging light and concentrates it into a tight, powerful horizontal beam.

Candlepower Output: Instead of raw wattage making the light visible, optical amplification allows a 1,000-watt bulb (or smaller modern LED) to project beams reaching up to millions of candela.

Conclusion: Lighthouses are tall towers with bright lights at the top built near coasts, cliffs, and dangerous rocks. They act as traffic signs for the sea. They help ships find their way, warn sailors about shallow water or hidden rocks, and guide boats safely into harbors at night or in heavy fog. A lighthouse is a tall, traditionally cylindrical or tapered structural tower built on coasts, reefs, or seabeds to house a powerful beacon.

- **Warning Danger:** They point out sharp rocks, reefs, and shallow sandbars so ships do not crash.
- **Guiding Navigation:** Their flashing lights show ships where they are on a map and lead them to safe ports.
- **Unique Signals:** Each lighthouse has a specific pattern of flashes or colors so sailors know exactly which coast they are seeing.
- **Sound and Radio Help:** When it is too foggy to see the light, they use loud horns or bells. Modern ones can also send radio signals.
- **Daytime Markers:** They are painted with bold patterns or stripes so sailors can spot them easily during the day.

Two common types of lighthouses are land-based lighthouses, which are built on solid ground along a coast or cape, and offshore lighthouses (or wave-swept lighthouses), which stand in open water on dangerous reefs, shoals, or piers.

Location and Design Types:

Land-based Lighthouses: Positioned on cliffs, headlands, or beaches to mark safe landfalls and major coastal turns.
Offshore/Reef Lighthouses: Built directly in the sea on submerged rocks or coral reefs to warn ships of hidden underwater dangers.

Pier head Lighthouses: Placed at the very end of a man-made pier or jetty to guide boats safely into a harbor entrance.

Architectural and Structural Types:

Conical/Round Towers: Tapered or cylindrical stone and brick towers designed to deflect strong winds.

Skeletal Towers: Open steel-frame structures used when a tall, sturdy, and cost-effective profile is needed without heavy masonry.

Integral Lighthouses: Combined structures where the light tower is built directly into or attached to the keeper's dwelling.

CONCLUSION

<https://en.wikipedia.org/wiki/Lighthouse>