EEP12/9/14

Formerly EEP11/WG4/WP9

Formally EEP11 / 09 / 16

Comment [S1]: "Structures" may not be the best expression as structures are illuminated amongst others to indicate them as obstacles."Objects and Obstacles" instead of Structures maybe more appropriate.

International Association of Marine Aids to Navigation and Lighthouse Authorities

IALA

Association of Internationale de Signalisation Maritime

AISM

IALA Guideline No. XXXX

On

Illumination Of Structures

Draft

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1 INTRODUCTION

This guideline does not address architectural illumination, instead it focus on navigational aspects. Illumination can be an important AtoN function. It can help the user to improve his location visually, also allow him to have access to information noted on the AtoN, eg marking.

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What
Applicable to fix or floating aids, generally less than 1nm

Why
To transfer the daytime information visibility to the night time condition.

To estimate the distance between the object and an observer
To improve the conspicuity between two atons with similar characters
To make obstacles like pillars, moles, dolphins or wind turbine visible as an obstacle to the mariner.

Where
Narrow and restricted channels or high lighted background

How
Illumination, **backlighting or contour lighting**

Deleted: Floodlighting

Definition:
Illumination: Technique based on projectors used to illuminate from a variable distances, structures or objects….

Deleted: Floodlighting

Backlighting: where lights source is behind a screen or transparent panel to improve the conspicuity of a structure …

Contour lighting: Strips of lights are used to profile the shape of a structure or an object to be seen….

Limitations. Where and why would you use floodlighting. Managerial decision making aid. Benefits – spatial awareness, perception of distance and bearing. Confined waters application.

Japan contour lighted floating aid

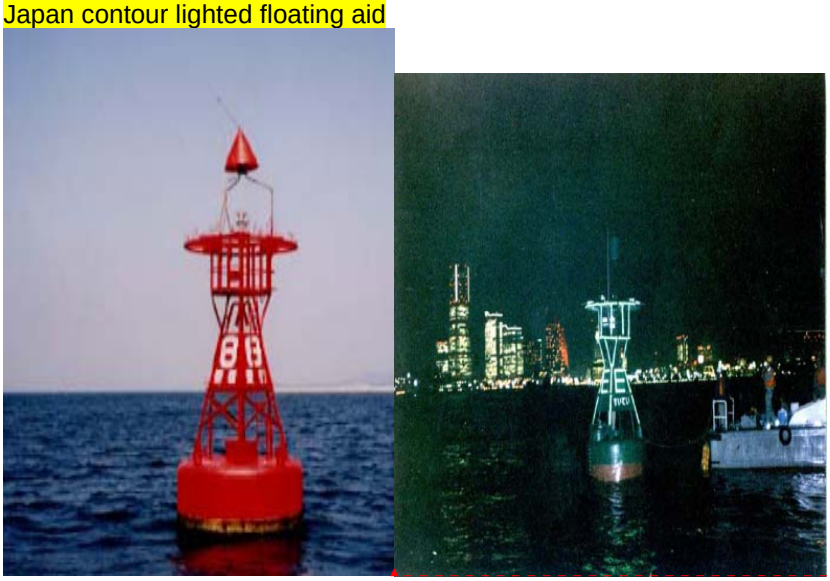

fig. 1

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Sweden floodlighted lighthouse

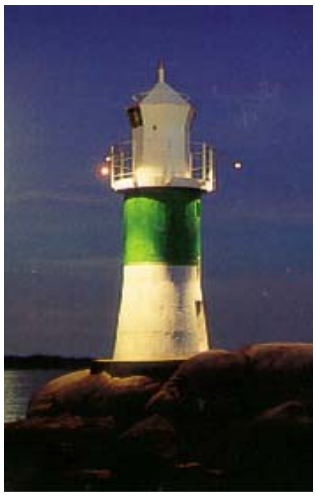

fig. 2

titles to pictures.

2 MAIN APPLICATIONS

2.1 Lighthouse

Floodlighted lighthouses are today an appreciated feature, some times even regarded as more important than the traditional flashing light of the lighthouse. The floodlight has to be considered as a complement to the main AtoN light.

It helps the mariner to keep track of the bearing to the lighthouse in the characters dark period by have an permanent illuminated object to look at.
It makes the aton more recognisable (It helps the mariner to confirm he is looking at the right aton)

A lighthouse e.g. with white and black stripes can show its white stripes during the night. These stripes are illuminated from the inside by fluorescent lamps.
Encase of fog, floodlights with low pressure sodium lamps on the top of the tower are switched on to illuminate the tower and the mole structure as well. By the use of the yellow light the mole is indicated an obstacle.

Picture: Example Nordermole in Travemünde will follow

2.2 Illumination of Obstacles

2.2.1 Pillar Lighting
If necessary, the pillars of a bridge are illuminated. For these purposes low pressure sodium lamps are used. There yellow light mark the pillars as an obstacle for the mariner. The luminaire is mounted on the pillar and emits its light downwards to the base of the pillar. By a careful adjusting the amount of the light that is reflected on the water surface can be minimised.

Deleted: *,minor lights and piles of bridges*

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Deleted: Additional information to the existing signage to approximate the distance to the object eg bridges's piles¶

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2.2.2 Mole Lighting

Important points like moles that have to be indicated to the mariner as an obstacle can be marked with a white plate that is illuminated by a luminaire with a low pressure sodium lamp. The yellow light indicates this point as an obstacle.

Picture: size of the plate: 1050 x 760 mm, lamp: low pressure sodium lamp 90W

2.2.3 Marking of a Dolphin

At the Kiel Canal the dolphins are marked by night with back lighted yellow pyramids. Inside the yellow plastic pyramid a low pressure sodium lamp with 35 W is mounted.

Picture: An acrylic pyramid is illuminated from the inside to mark a dolphin

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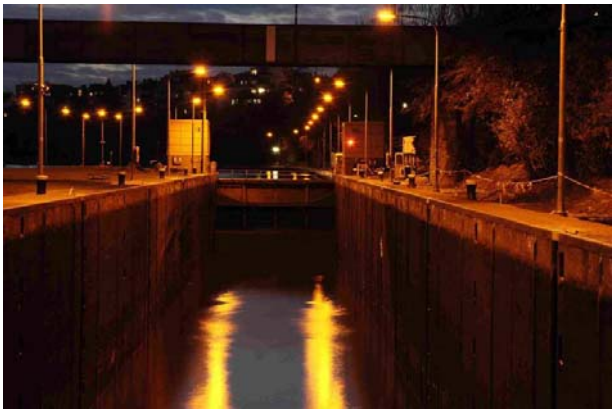
2.2.4 Illumination of locks

To enssure the navigation during the night through locks, especially on inland waterways, the locks are illuminated during the night. For this purpose the plant and its parts like gates, chamber walls and platforms are illuminated to make them visible to the mariners eye. As the lock represents an obstacle and colour vision is not necessary the yellow light of the low pressure sodium lamp is used.



Picture: Illumination of a lock at night

2.3 Signs

2.3.1 Illumination

Countries with extended inland waterways may want to present the mariner further information by installing signs. These signs can show different colours, sometimes with a pictogram and sometimes with an additional written information like “400”.
If necessary the sign is illuminated by a luminaire to show the information at night.

Picture: A sign with different colours. The luminaire for the illumination can be seen on the top.

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2.3.2 Back Lighting

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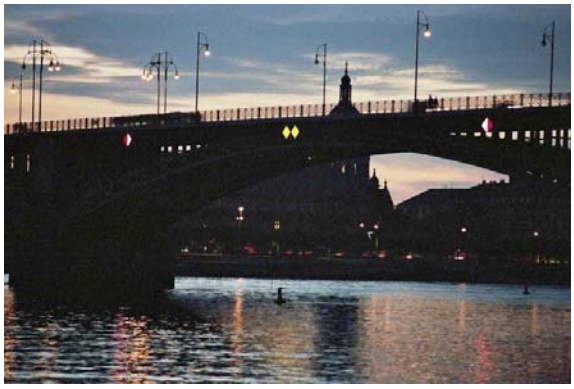
Especially the signs with information to move through different bridge arches are more and more illuminated by back light. Behind an acrylic plate which can be covered by a red or yellow sheeting the LEDs are equally mounted. By the use of this technology a high uniformity and a defined level of luminosity and luminance contrast between different colours can be archived. This leads to a high distance of recognition.



Picture: Red/white and yellow signs at a bridge in Germany for the passing of the bridge arches

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2.4 Lock Entrance Navigation Aid

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To support the mariner when approaching a lock special marks are applied near the gate: the so called entrance navigation aids. Different solutions are possible. The most popular one is a sign with a white rectangle and a black contrast border around it. In the night the white part is illuminated by a luminaire with a fluorescent lamp., which is of the same length as the white part. As it is mounted on the left and right side of the gate it shows two white lines at night to guide the mariner to the axis of the entrance canal.

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Picture: The entrance lock navigation aids can be seen to the left and right of the lock gate.

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2.5 Beacons and marks

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For this application fixed or flashing lights are not applicable. By floodlight a beacon or a mark the mariner will be able to have a better appreciation of the distance and the direction to the AtoN.

Picture to be added from Germany

Example of a floodlighted mark

2.6 Obstacles: breakwater, rocks, etc

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For this application, traditional way of marking e.g. lantern or beacon on the location is not practically or economically feasible.

Picture coming from Japan

picture

3 DESIGN

Flood-lighted, back-lighted or contour lighted objects are normally used within generally a distance up to 1 NM. Beyond this range, the flood-lighted or back-lighted structure tends to become more like a point source and the luminance becomes too low to be detected.. It has to be kept as a lighted area giving a minimum of 3 minutes (0.05 degree) as stated by ????……see physiological behaviour of the eyes)

For the contoured lighted structure it is a little bit different because of the two dimensional effect which is difficult to address because there is no reference book ???? Road signs reference?

3.1 Performace Requirements

Deleted: *Type of light sources*

3.1.1 Light Sources

Deleted: <#>Lamps and housing¶

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For the illumination of a single sign (size between 1 and 2 m²) with different colours a fluorescent lamp with a power consumption of 40 W can be used. The colour rendering should be as high as possible, at least a colour rendering group of 2B.
To implement a lock entrance navigation aid a luminaire with a fluorescent lamp of 65 W is used to illuminate the plate. LED-technology may also be possible.

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For the illumination of the white plate to mark moles and to illuminate objects like pillars low pressure sodium lamps between 35 W and 90 W can be used.

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For the back lighting of signs LED-technology is used. By the use of this technology a high uniformity and a defined level of luminance and contrast between different colours can be

archived. This leads to a far better distance of recognition as by the application of fluorescent lamps.

Remark: LED for illumination?

If a surface has to illuminated and the colours of the surface are important to the mariner a light source with a high colour rendering during the whole lamp life is very important. A high efficacy and high life time of the light source is useful. Furthermore the cost for the light source should be low. When comparing these features a fluorescent lamp shows more advantages than the LED-technology.

Remark: LED instead of low pressure sodium lamps?

A low pressure sodium lamp is the light source with the highest efficacy between 100 lm/ W and 120 lm/ W. It is has a very long life time of more then 10.000 h and is a very reliable, well proven and tested lamp.
The high power LEDs have an efficacy of about 50% of a low pressure sodium lamp and produce a lot of heat that must somehow be managed so that the luminaire shows no failure. The cost of a low pressure sodium lamp is far lower than a matrix of LEDs.

efficiency (Lum/w), Power consumption, Life, Colour rendition, spectral distribution, intensity

3.1.2 Light distribution

For the illumination of objects (signs, pillars etc.) a direct, symmetrical or asymmetrical light distribution characteristic should be used for the luminaire. A direct distribution means, 100% of the light is directed downward to the object. According to the size of the object to be illuminated a wide or small beam distribution should be chosen. A flat and clear front glass is recommended.
Glare:

The light emission of the luminaire to the eye of the observer must be reduced. Furthermore the scattered light incident on the water surface should be minimised as well. Accessories like an adjustable hood (adjustable anti glare frame) or a louvre (grid shield) may be helpful to reduce or avoid glare.

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Deleted: General considerations:¶
- No direct light to the eyes of the mariner¶
- Avoid or minimise any direct light on the surface of the water¶
- Any glass used on the housing must not allow to deviate the light directly in the direction of the eyes of the mariner. A flat glass inside the lamp housing is recommended; ¶

Deleted: Lamp:

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Housing

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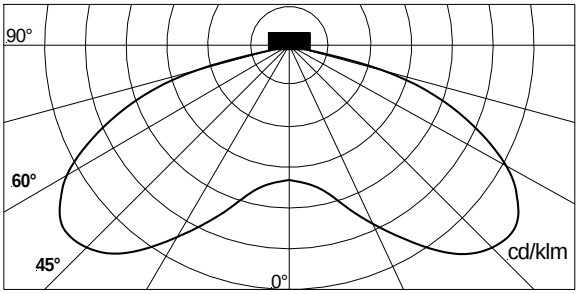

Sketch: Example for direct, symmetrical distribution, wide beam

3.1.3 Housing

non corrosive material, weight, bird repellent, water immersion protection, easy maintainability, shock resistant.

Deleted: - divergence of the light,

~~If the colour of the surface has to be distinguished, one has to take in to account the chromaticity of the light source.~~

3.2 Luminance (illumination level)

Question for optic specialists : What is at the eyes of the mariner the minimum intensity to detect and recognise an illuminated object given the highly illuminated background ….20 Microlux (IALA E200-2)????: Uniform intensity with a ratio of 1 to 5 is applicable ?

Possibly make 2 sections – one for illuminating surfaces and one for contour lighting.

~~Sufficient number of light sources should be used to ensure an adequate luminance, a uniform light distribution and a satisfactory redundancy.~~ Luminance levels from 5 to 100 Cd/sq m ~~are commonly used in architectural floodlight applications.~~ ~~5lux to 50 lux for architectural applications~~.

3.2.1 Illumination of Signs and Plates

For the illumination of a sign or a plate with the size between 1 m² and 2 m² the following value for the illuminance can be recommended:

Average illuminance E_{av}: 200 lx +- 10 % , uniformity u = E_{min} / E_{max} ≥ 1 : 6
(E_{min} : minimum illuminance, E_{max} :maximum illuminance)
(Reference: DIN EN 12899-1:" Fixed, vertical road traffic signs", table 22/ class E2 and table 23/ class UE2)

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3.2.2 Back Lighted Signs by LED-technology

Luminance and Uniformity

Colour	Average Luminance L_{av} in cd/m²	Tolerance	u
White	120 cd/m²	± 10%	≥ 0,5
Red	60 cd/m²	± 10%	≥ 0,5
Yellow	60 cd/m²	± 10%	≥ 0,5

uniformity: $u = L_{min} / L_{max}$
(L_{min}: minimum luminance, L_{max} : maximum luminance)

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3.2.3 Level of Illuminance for Locks:

Area	Horizontal, Average Illuminance E_h	Vertical, Average Illuminance E_v	Uniformity u
Approach Area	1 to 10 lx *		≥ 1 : 6
Lock Platform	≥ 10 lx		≥ 1 : 4
Chamber Wall Height: ≤ 10 m		≥ 2 lx	≥ 1 : 3
> 10 m		≥ 6 lx	
	* increasing to the gates		

Uniformity: $u = I_{min} / I_{max}$
(E_{min}= minimum illuminace, E_{max} = maximum illuminance)

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(Reference: DIN 67500 “Illumination of Locks”)

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The eye of the mariner coming from the dark has to be adjusted to the higher level of illuminance in the lock. This process is called adaptation and needs some time. To achieve a good adaptation the illuminance increases in the approach area until it reaches the highest level in the chamber.

3.2.1 Light absorption and reflectivity of the surfaces

Help ……
(Lighting Handbook?)

3.2.1.1 Type of reflectivity. (Lambertian or Retroreflection)

When light strikes a rough or granular surface, it bounces off in all directions due to the microscopic irregularities of the interface. The exact form of the reflection depends on the structure of the surface. One common model for diffuse reflection is Lambertian reflectance, *in which the light is reflected with equal luminance in all directions*, as defined by Lambert's cosine law.

Some surfaces exhibit retro reflection. The structure of these surfaces is such that light is returned in the direction from which it came. If illumination is used in combination with a retro reflection surface the position of the light is very important but there will be no significant gain from the retro reflective material.

Retroreflective Material

If the object shows colours that the mariner must recognize non retroreflective material is recommended. A retro reflective sheeting reflects the incident light back to the light source and not to the eye of the mariner, so that the effect of the retro reflection shows no advantage to the user.

3.3 Location of light sources

Position ideally all light sources perpendicular to the water surface to avoid reflection or direct light in the direction of mariners. The lower the angle of light is, the higher the probability of direct light or reflection that could blind mariners.

Avoid any interference with the main signal light

3.4 Examples on Conventional constructions

3.4.1 Light houses and beacons

The light source in these constructions is Seald Beam lamp PAR 36 SB4589 28V 50W. To prolong the lifetime of the lamps they can be runned on a lower voltage, 22V. Normal use is 4 lamps on a beacon (2 m in diameter) and abt. 8–12 lamps on our bigger caisson light houses, i.e.total illumination power 200– 600W.

Picture ?

3.4.2 Marks:

Marks consist in the most cases of a plastic cone, which is illuminated from the top downwards. When yellow light is needed Low Pressure Sodium lamp is used alt. a Mercury Vapour lamp when white light is needed.

3.4.3 Back-lighted structure

Backlighted structure is typically made of transparent material such as fiberglass or glass blocks.

Picture of lighthouse from Japan

3.4.4. Contour lighted structure

In this particular case, strips are positioned on the edges of the structure

Picture of a building from ……

4 FURTHER CONSIDERATION

A large number of lighthouses are externally floodlighted with projected indirect reflection illumination. This important feature rely on mains supply due to the power required, typical 250W continuous 14h/day, the economical implications for new installations are limiting. Also the service and repair of the necessary underwater cables takes its increasing toll of budget.

~~Floodlighted lighthouses are today a appreciated feature by the mariners, some times regarded as more important than the traditional flashing light.~~ ~~Repeat of text.~~
Installations connected to main power sources by sea cables mean high investments and maintenance cost and therefore alternative installations which can run on solar panel would be preferable.

4.1 Alternate solutions

4.1.1 Pipe light LED-floodlighting

An LED pipe light is designed to solve problems connected to traditional AtoN floodlights with need of network electricity, high power consumption and maintenance.

Fig 4, 5, 6, 7 shows the first main installation of LED-floodlighting on an inaccessible lighthouse in the busy approach to Gothenburg, Sweden.

Fig 8, 9, 10, 11 illustrate the individual components.

Fig 12 is a draft drawing of the type of beacons erected, in the new Gothenburg approach channel. All fitted with this type of PV-LED-floodlighting and PV-GPS-synchronised LED-lanterns.

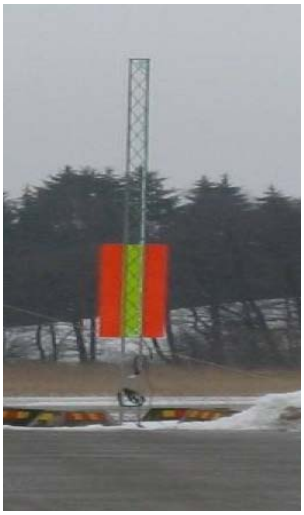
check if this is in Guide on light sources.

4.1.2 Extended light sources

The conventional flood lights are normally fitted with ordinary lights for mercury or sodium vapour lamps to illuminate the mark. The drawback of this method is the confusion of disturbing background lighting from roads and bridges, especially at port entrances or other heavily populated areas

To increase the conspicuity in areas with disturbing background lighting as for example at break water lights, an additional feature is needed.

The outcome is a lighting pole with an illuminated area of 200 x 6000mm = 1.2 m2. The pole is an 8m steel framework hot-dip galvanised lighting mast. The light consists of 1800 LED`s. The power consumption is 150W at 220V AC.



The distinguishing factor for these light poles is the use of lateral colours red/green and the distinct vertical length. In a fairway many red/green fixed or flashing lights can be observed, but few that stick out like an illuminated sore thumb.

For daytime use the pole is fitted vertical narrow day-mark boards at each side of the pole (see fig 5). The boards are lined with fluorescent sheeting red or green.
The calculated service life is at least 8 years and no maintenance is needed.

Due to the LED-technique it's possible to flash the whole lighted area, which further increase the conspicuity with respect to background light. This feature is used particular in leading line applications with character: Rear Oc and Front Q in order to avoid dangerous mirror effects. This application is suitable as leading lights in port area with its special appearance. The range of visibility is at least 2M

4.2 Flood lighting on demand

Flood lighting is very energy demanding and has to be runned by the mains supply. Some installations, which by remote control are switched on when needed can be runned by PV.

5 REFERENCES

Any ?

DIN EN 12899-1: Fixed, vertical road traffic signs