Discussion Paper
Human Vision & Lighting

INTRODUCTION

The lighting of crew spaces should facilitate visual task performance and the movement of crew members within a space. It should also aid in the creation of an appropriate visual environment. Lighting design involves integrating these aspects to provide adequate illumination for the safety and well-being of crew as well as for the various tasks performed on board vessels.

The selection of appropriate illuminance levels for specific tasks and crew spaces is an important consideration in the design of lighting systems. There is a difference of opinion as to what levels of light is considered best for visual tasks. Since illuminance recommendations are generally consensus values, for any task, a range of illuminances may apply.

Since visual tasks performed within habitable spaces on board a vessel are generally similar to tasks encountered ashore, requirements for illuminance on vessels generally correspond to those tasks performed in living, working, and recreation areas on shore.

Visual tasks encountered on vessels vary widely. In addition to the illuminance level, external factors, such as contrast with respect to the background, object size, brightness, time available for viewing or recognition, and reflectance determine the visibility of an object within the visual field. Other considerations for visibility include task duration, task criticality, visual fatigue, discomfort, glare, veiling reflections, shadows, flickering, and the age and visual acuity of the observer. From a subjective viewpoint, aesthetics, color, and the psychological effects of lighting should also be regarded during lighting design. These external and subjective factors are interrelated and should be considered together with objective qualities during the process of selecting illuminance levels, but do not have to be separately quantified.

TERMS/DEFINITIONS

Adaptation: The process by which the eye becomes accustomed to more or less light than it was exposed to during an immediately preceding period. It results in a change in the sensitivity of the eye to light.

Diffuser: A device which redirects or scatters the light from a source.

Direct glare: Glare resulting from high source luminance in the field of view. It is often caused by insufficiently shielded light sources in the field of view. It is also associated with bright areas (such as light fixtures, windows, and so forth) that are adjacent to the visual task area.

Direct lighting: Illuminance by light fixtures directing 90 to 100 percent of their emitted light in the general direction of a visual task surface. In a typical space, it refers to light emitted in the downward direction.

Disability Glare: Glare which reduces the ability to perform a visual task.

Discomfort Glare: Glare which produces viewer discomfort, but which does not interfere significantly with visual task performance or visibility.

Footcandle, fc: A measure of illuminance on a surface.

General Lighting: Lighting designed to provide a substantially uniform level of illuminance throughout an area, exclusive of any provision for special, localized task.

Glare: The discomfort or impairment of vision experienced when parts of the visual field are excessively bright in relation to the general surroundings.

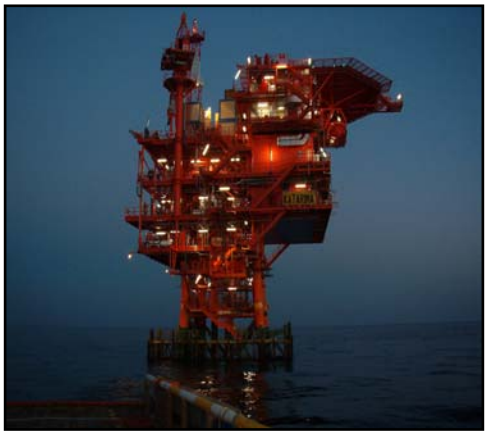
Illuminance: The amount of light falling on an object or surface.

Indirect lighting: Illuminance produced by lighting fixtures distributing 90 to 100 percent of their emitted light onto a surface.

Local lighting: Lighting which provides illuminance for a small area or confined space without providing a significant contribution to the general illuminance of the space. (See also task lighting.)

Lumen: The International System of Units describing a quantity of light emitted by a source or received by a surface.

Luminaire: A complete lighting unit consisting of a lamp(s) together with the parts designed to distribute the light, to position and protect the lamp, and to connect the lamp to the power supply.



Luminance: The photometric brightness of an illuminated surface (or the amount of light emitted by, or reflected from, the surface).

Lux: a unit of illumination equal to the illumination produced by luminous flux of one lumen falling perpendicularly on a surface one meter square.

Low-level Red or White Illumination: Lighting provided to accommodate efficient low light vision in areas where visual tasks are performed during low light conditions. At sea this is typically lighting on a navigational bridge to help keeping a suitable lookout.

Task Lighting: Lighting provided to meet the illuminance requirements of a specific task. Task lighting refers to the lighting requirement that can be obtained by supplementary lighting provided in addition to the general illuminance.

Visual field: The location of objects or points in space that can be perceived when the head and eyes are kept fixed.

Visual performance: The assessment of performance of a visual task based on speed and accuracy.

Visual task: The details and objects that must be seen for the performance of a task.

DISCUSSION

Vision

When discussing lighting to enable optimum visual performance it is important to consider how vision works. On a basic level, the eye is like a camera. Light passes through the pupil, is refracted by the lens, and is brought to a focus on the retina. The retina receives the light stimulus and transmits an impulse to the brain through the optic nerve. The retina consists of two types of photoreceptors; rods and cones. Cones function at high levels of illumination, such as during daylight, and can differentiate between colors. Without cones we could not see any color at all. Rods function at low levels of illumination, such as at night, and can only differentiate between shades of black and white. Rods and cones are not evenly distributed over the surface of the retina. The cones are concentrated near the center of the retina (in the fovea, the center of vision) and the rods predominate in the periphery of the retina with the maximum density at about 10° to 20° from the fovea (Sanders and McCormick, 1993). Motion is detected in the periphery and detail/feature is detected in the fovea. Rods are approximately seven times more sensitive to light than cones (e.g. they function better in low levels of illumination). Also, only approximately five percent of all color receptors (cones) are in the blue spectrum, therefore the reason blue is not recommended as a presentation medium for information.

The physiology of the eye and its capability to garner information is important to understand when discussing visibility. Visibility is a fundamental factor in optimizing task performance. Visibility along with the nature of the tasks performed should inform the design of lighting systems.

Ship and Offshore Installation Lighting

Visual tasks onboard vessels are similar to those found ashore and many of the lighting requirements onboard vessels are similar to those on shore. However, there are special requirements for marine vessel lighting equipment that have to be taken into consideration. The design and selection of equipment for marine lighting must take into account the marine environment, which is substantially more severe than that encountered in typical onshore applications. Marine specific concerns include:

- Electrical shock and grounding hazards (presence of water, metal hulls and other metal structures)
- Vibration, shock, and slam
- Temperature and humidity extremes
- Moisture and corrosion
- Electrical systems with transients and fluctuations
- Presence of water

- Fire resistance
- Limitations on size and weight
- Radio frequency interference

General and Task Lighting

Interior lighting systems are classified into two types: general background lighting, and localized (task) lighting.
There are recommended minimum maintained illuminance levels for both general and task lighting that are referenced in the Lighting Criteria sections of ABS HAB Guides (2013, 2014, and 2013). These should be achieved under specified test conditions prescribed in those documents and require measurement and testing against criteria defined in the ABS guidelines. These recommendations include human factors data when they exist with regard to the recommended lighting levels. It is strongly recommended that these values are adhered to, in order to facilitate efficient and safe task performance above and beyond the minimum required lighting levels. Complete and detailed lighting requirements can be found in the ABS HAB Guides (2013, 2014, and 2013).

In workspaces where red or low-level white illuminance is provided to facilitate dark adaptation, the maintained illuminance levels in the ABS HAB Guides (2013, 2014, 2013) still should be achieved. Lighting in different areas of the bridge should be adjustable in brightness and direction to achieve these illuminance ranges.

Benefits of Adequate Lighting

An improvement in visual performance can yield an improvement in task or work performance, reflected in a higher output and in a lower number of errors. Good lighting can also contribute positively to safety and accident rates, absenteeism, health, and well-being. Over the last two decades science has consistently shown the positive influence of good lighting on health and well-being along with much evidence that bad lighting can cause many health issues, including headaches, sore eyes, and blurred vision.

Good lighting in the workplace and on the task is essential for optimal task performance, especially with a progressively aging workforce. In the metal industry, for example, good lighting can be expected to increase productivity by about sixteen percent.

SUMMARY

The objectives of marine lighting are to provide adequate illuminance for the safety and well being of crew and to enhance the performance of various tasks encountered aboard vessels. Specific lighting criteria in the spaces normally occupied in marine applications can be found in the ABS HAB Guides (2013, 2014, 2013) and IESNA *Recommended Practice for Marine Lighting* (RP-12-97). The lighting levels are based on the need for safety, and on functional and other characteristics of the areas concerned. Values listed in the ABS HAB Guides represent minimum maintained illuminance and are for new lamps. Where human factors data exists, with regard to recommended lighting levels, these values are provided in the ABS HAB Guides (2013, 2014, 2013). It is strongly recommended that these values be adhered to; in order to facilitate efficient and safe task performance above and beyond the minimum required lighting levels.

REFERENCES

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