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PROSPECTS FOR INCREASING SUSTAINABILITY OF SHIPPING THROUGH THE NEW TRENDS IN THE USE OF NATURAL LIGHT INDOORS

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Abstract: *In this context, the paper aims to assess and warn the impact of using new solutions and future possibilities related to artificial lighting of working spaces, technical spaces and living spaces on board of merchant vessels.*
Key words*: natural lighiting, merchant vessels.*

Generalities

The continuous evolution of human society have also founded an increasingly consume of resources and energies. Global developments have produced large imbalances on a global scale, human activity reaching ecological and climatologically affected balance. Warnings of specialists often neglected due to economic interests and ignorance unfortunately became true, generating new approaches to human activity by creating new supranational bodies and organizations that develop, enact and pursue implementation and continuous monitoring of the application of these regulations. Currently, large amounts of money invested in all areas to find solutions to human progress but with smaller effects on living environment. By implementing modern natural lighting techniques, can reduce significantly electricity consumption, plus along with a significant increase in environmental quality interior light. In addition, the use of electric lighting presents direct or indirect environmental impacts as a result of electricity generation, consumption of energy and natural resources, or disposal of used products.

In this context, the paper aims to assess and warn the impact of using new solutions and future possibilities related to artificial lighting of working spaces, technical spaces and living spaces on board of merchant vessels

The human body has adapted over time to natural environmental conditions in which sunlight was and is an essential component to maintaining life and physical condition, mental and emotional. The results of studies and research conducted internationally have shown that a fully electric light environment is not able to respond to the physiological, mental and emotional man. Current technology is not capable of producing electric light source to reproduce the spectrum of visible and invisible radiation corresponding incident sunlight at the earth's surface. In the context of an increasingly concern the control carbon emissions, global warming and prolong the life of the building, as well as higher energy efficiency of buildings, lighting design must take into account the criteria of improving energy efficiency by streamlining electric lighting more recently, the use of natural light, able to contribute to reducing the need for electric lighting.

Background of the problem

In the field of shipping, vessels differentiate and classified primarily by type of goods carried and transported cargo capacity (displacement). For shipping, regardless of cargo carried and ship displacement, meet three areas that require relatively high power consumption to floodlight with differing levels of functioning in the 24 hours of the working day.

Engine room, which is a vital space ship, distinct, usually arranged at the stern, which are, located all technical equipment, and propulsion engines for ensuring safe movement of the vessel, ensuring the functioning of systems that ensure optimal living condition for crew and conditions for the type of cargo.

This compartment is totally isolated from other compartments, need to be illuminated permanently filled with individual lighting, for each locations or intervention. To assess the effectiveness of the solution, consider a ship with a displacement of 55000TDW. In the engine room, equipment and technical facilities are located on four floors guidance on level surfaces about 36X40 feet, results need to be illuminated area of about 2400 m2. With a minimum of 1,5W / m^2, specific fuel consumption for relatively optimum ambient environment fluorescent tubes, result in a consumption of about 135kW / h.

In this usual consumption considering an average consumption of a generator (DG) of fuel 0.2 kg / kW / h, resulting 27Kg diesel consumption per hour. If considering a weighted average of 10 hours of direct solar energy utilization, resulting fuel savings of 270kg / day.

The accommodation includes workspaces and crew cabins, which by design don't have direct illumination, only in restricted spaces. Access hallways, stairs and other spaces of different services can not be directly illuminated during the day, making it necessary artificial lighting.

Access tunnel is constructed along the length of the ship, from machine compartment to the bow, allowing the crew to inspect or intervene when necessary to perform adjustments or repairs of some technical components placed in this space.

As this tunnel is perfectly closed to all other compartments it is equipped with artificial lighting.

Using solar light tubes

No matter what solutions can be proposed the shipping vessels are subject to national rules (imposed by countries) and international particularly rigorous, whose violation is sanctioned drastically. As such these proposals must be well documented and brought into line with all rules and regulations. From case to case, can adapted existing rules and regulations to new solutions that were not known at the time of preparation of these rules.

a

b

Fig.1

Solar light tubes (TDGS - Tubular Daylight Guidance Systems [2]) is one of the newest and perspective solution witch realizes extremely high transport outside sunlight to indoors (isolated from the outside). The main goal is to ensure the optimal ambient environment using that space.

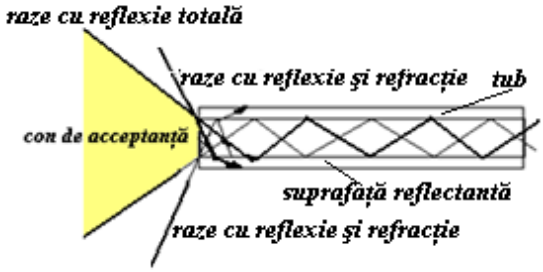


Fig.2

The principle of the solution is shown in Figure 1. This solution is already known and widely used by architects and increasingly proposed by their beneficiaries.

To substantiate these solutions in ship building, will briefly present the most important conceptual and structural aspects underlying light tubes. How resulting from fig1.a, illumination from the sun is transported from the outside in isolated areas through special tubes with transport performance.

These tubes are an extrapolation of the principle underlying optical fibers. In literature this principle called total internal reflection. This theory is based on the fact that an incident beam, depending on the angle of incidence and characteristics of the environment in contact with the body may suffer a reflexion and refraction, or only a reflexion. As shown in Figure 2, all waves which fall within the cone of acceptance will undergo total internal reflection tube scrolling with maximum efficiency. How resulting from figua1.b, intraday the angle of incidence of sunlight changes all the time, more so in the case of a ship. Therefore the values of this acceptance cone angle significantly influence efficiency of the transmission. The angle of acceptance is given by the reflectance of the inner surface of the tube. For this reason, there may be significant differences in performance depending on the angle of the cone of acceptance that it has inner surface of the tube. Lately, the inner walls of the tube are plated micron layers of expensive materials but which satisfy the condition that the majority of waves that reach the inner surface of the tube to undergo total reflection. The principle of total reflection can be seen in fig.1.b. In figure 3 is shown influence of the superficial layer of cladding materials for different producers.

Being an advertising article output from a manufacturer, it is considered useful to avoid mentioning those companies. Using the same principle on the market today there are already many competitors who managed to diversify and optimize continuous and constructive solutions to continuously improve the ratio of price and performance.

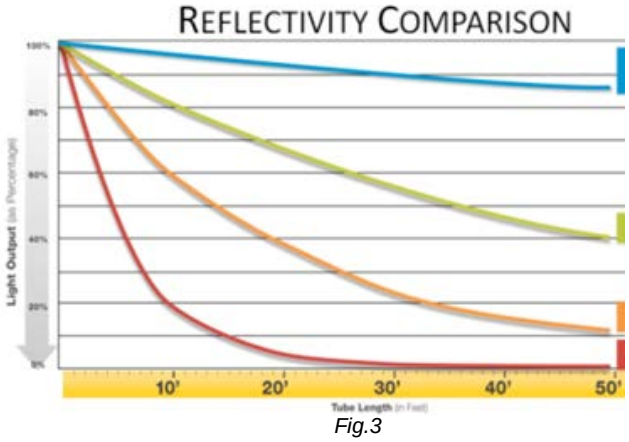


Fig.3

4. Constructive aspects of light tubes

When mounting and operating conditions require can use a simpler solution, which is flexible light tube is made of a reflective foil inside. In order to maintain the cylindrical shape, as well as to provide a certain rigidity of the tube the solution of Figure 5 may be used. This solution enables the adaptation of the usable length of the tube to the concrete conditions. Interested companies were able to design and produce three main types of light tubes:

- ✓ Anodized aluminum tube (Fig.4);
- ✓ Aluminum tube with polymeric multilayer optical film deposited on the inside 3M (Fig.4);
- ✓ Flexible tube of aluminum foil mounted on spring coiled wire spring steel made (Fig.5).

a

b

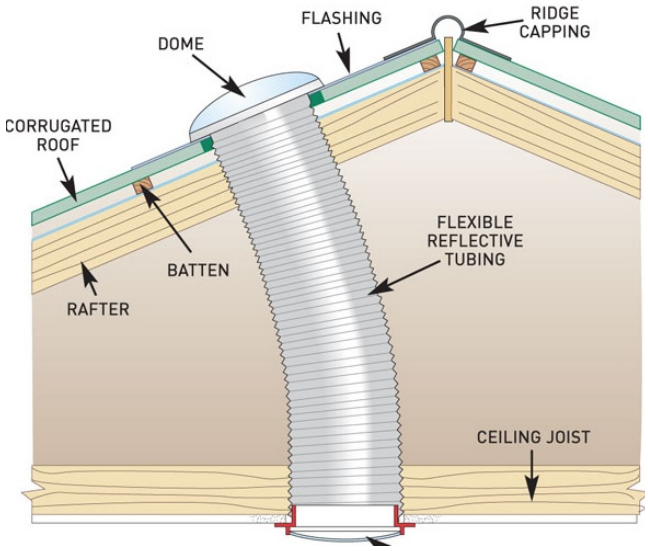
Fig.4

The growing interest of architects and specialists in technology tube light led to strong competition between the major manufacturers, resulting in the production of the most reflective material and thus best performance highlights. A modern, recently launched a UK company is called Super Silver Sun Pipe - solar tube super silver (SSSP) and consists of a 0.5 mm thick aluminum tube, mirror on the inside by impregnation with pure silver and stabilized by vapor deposition, having reflectance 0.98.

Following the experience accumulated by architects from concrete cases relative arrangement of surfaces on which are mounted respective ends of the collection and dissemination of light, you can use the solutions described in the figures below. In Figure 4, there are shown rigid pipes solutions. In Figure 4a, the case of a straight tube which is the most simple, high throughput and possibilities to make the lengths that can be reached in some firms and 20 to 30 meters. For a light distribution according to the actual needs and to provide a path imposed by the construction where the tube is placed broken tubes can be used. An example is shown in 4b.

Also, constructive simplicity allows connections of two or more tubes, which increases the usable length of the light transfer.

To ensure tightness and insulation tube interior from dust and substances that can negatively influence light reflection rubber o-rings can be used as shown in fig.5.b. Installation costs are lower in this case.



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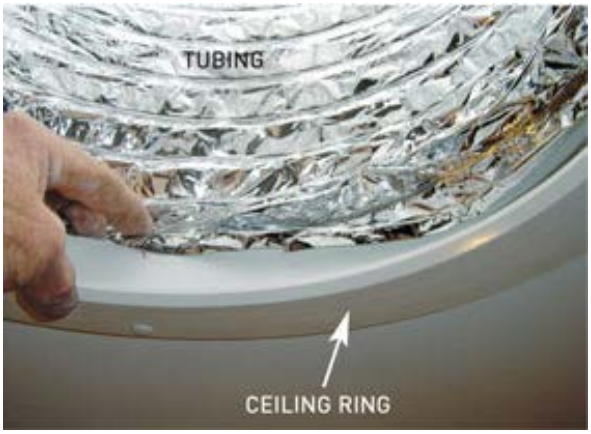


b

Fig.5

In Fig. 6, there is shown a solution where we have a rigid tube, in which the radius of curvature has been made of several sectional ring with inclined planes. In this case, can be achieved by capturing light on a part of the construction side, and if the arrangement is favorable in relation with path of the sun. In this case can be placed, in multi level constructions capture devices on more sides extending the duration of illumination for different relative positions of the sun in relation to the building. A summary of the various ways of taking and distributing natural light is shown in Figure 7. In this drawing may be noticed opportunity to cross one or more levels of the building which is an important advantage. In the case of performing solution according to the diagram of Figure 3, the losses are quite low.

From the point of view of construction have been made to the improvement of the initial solution. A first apparatus for improving particularly useful with the purposes of this paper is the simultaneous use of electric lamp lighting with natural light (Fig.8.a.). This solution simplifies assembly and interchangeability of the two light sources. For as homogeneous diffusion of light from the tube were designed different ways to increase the level of comfort and ambient light.

Fig.6

In this sense fig.8.b, there is provided a dispersion solution in addition to providing an environment is very pleasant and a great decorative element. Tube making a thermal bridge between the external environment and the interior appears in some cases the need to isolate the heat transfer through the glazing system (fig.8.c) the inner end of the tube, respectively, at the other end domes capture made thermal insulating materials. If the dome capture in addition to the use of special materials with their special optical and thermal performance greatly improved technical and geometrical shapes of cups special components.

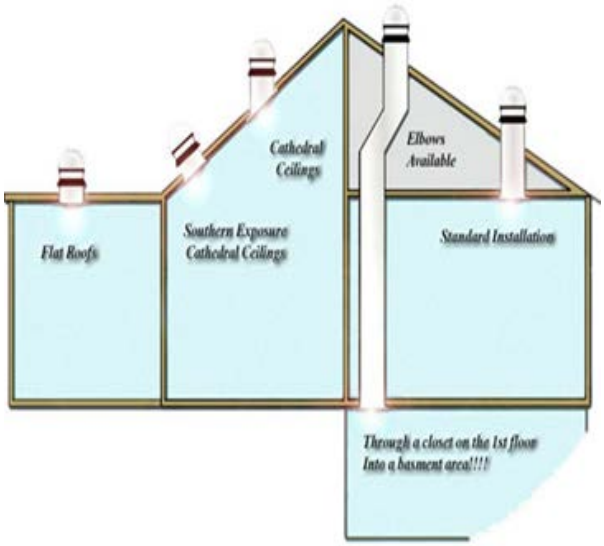
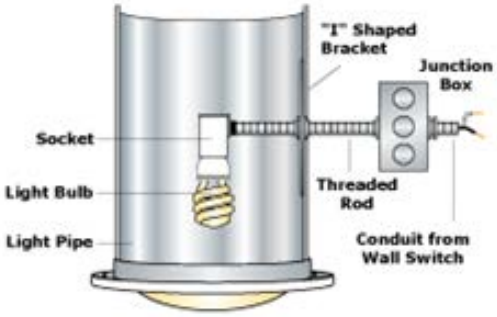


Fig.7

The most modern solutions provides also filtering of ultraviolet radiation and infrared light passing through the tube, ensuring protection of materials sensitive to this radiation. For this reason, it can provide warranty periods for over 10 years, from most manufacturing companies.



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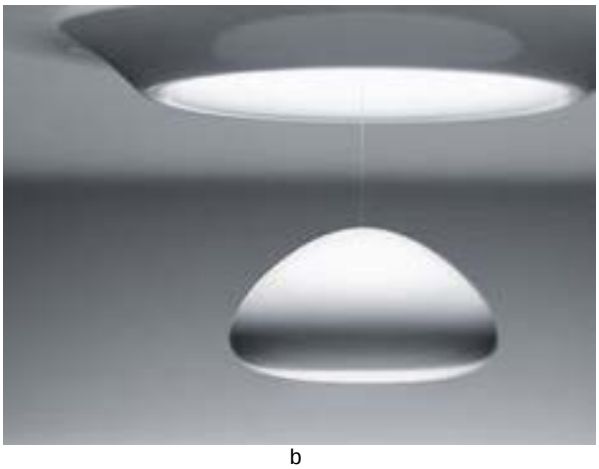


b

c

Fig.8

Because sunlight transferred from tube may be too strong or no longer needed a time, can be done manually or automated systems control the light intensity of light entering the space. In Figure 9 is shown an example with manually operated or automatic blinds. The solutions in this case are already very diverse, improving comfort such lighting solutions.

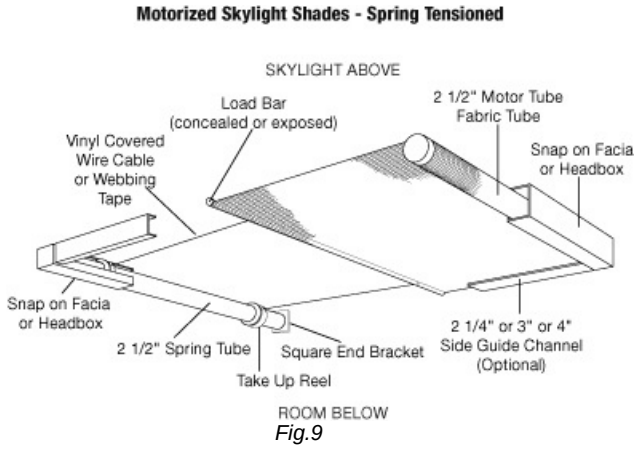


Fig.9

Examples of solutions made by specialized companies that can quickly adapt to vessels transport

Following are presented using solutions made by architects in various locations, solutions whose implementation can be achieved with minimal costs and benefits of outstanding quality of life on the ship.

a

b

Fig.10

It is hard to imagine the ergonomic effect of applying in machine compartment of a lighting system, as in Figure 10a. Installation of such terminals in the central area above the main engine or the central control panel may be looking for in fig. 10b.

Also, imagine these light tubes with terminals on working tables or auxiliary technical systems with maximum utility. In the accommodation with cabins and technical rooms (kitchen, dining room), hallways, outside cabins and especially those without access to the outside environmental light show bathed as the lobby and rooms fig.10.b. Effect of light tubes used for lighting of bathrooms (figure 11) or dining room or kitchen fig.11b is special. In a longer perspective to imagine

a

B

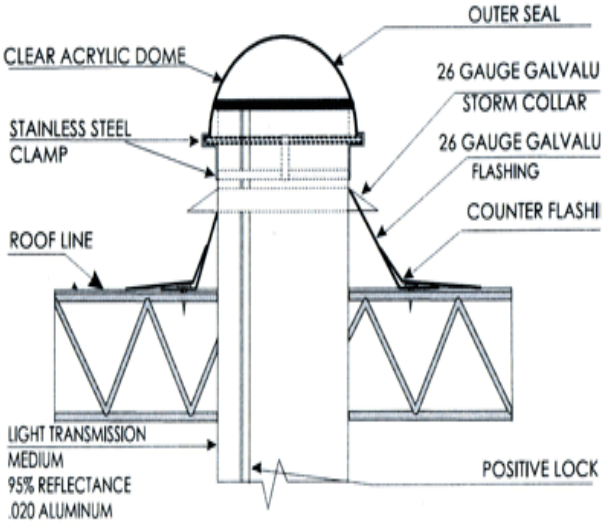
Fig.11

that the solution to augment natural light environment with live ornamental plants that will not only effect but will improve the air quality in this area. The kitchen can arrange green areas, where herbs are grown for consumption.

The implications of such a construction related to the installation of light tubes

A first problem to be solved is particularly importance of checking the rules relating to the technical areas of the board, not creating problems in case of maintenance works and interventions in case of fire, etc.

From this point of view usability of broken pipes or flexible settlement allows easy solutions. In shipbuilding, a mounting solution on the deck to end of capture light is shown in Figure 12 a. The implications of such a solution are relatively small and do not involve major changes.



a

b

c

Fig.12

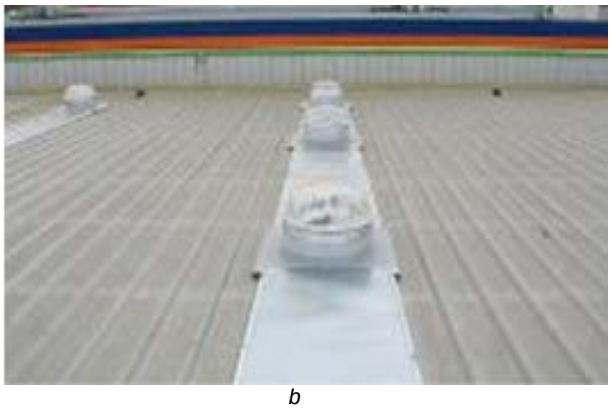
In the naval field can apply the solution used for flat and parallel roofs with ceilings that are mounted tubes dispensers. Solutions can be found to optimize the tubes route from

Fig13

outlets to interior areas that require light. In Figure 12 b is shown an intermediate solution that combines straight and broken pipes with flexible placement spot light to the desired points. To bring the light beam at lower levels can easily combine rigid tube sectors by setting junctions using adhesive tape. Such a solution is shown in Figure 12 c. There are companies that can deliver tubes as shown in Figure 13. Thus the number of sections can be ordered as needed, like elbows and angle values. It is noteworthy that due to the very small thickness of sheet metal they are made of rigid tubes can be easily cut to achieve sectors and sections connecting curves (Figure 6). On the outside, the changes that will occur in the ship's construction will be close to the examples in Figure 14.

In Table 1 are shown the characteristic data related to the length of the tube. These technical characteristics are different from manufacturer to manufacturer, as shown in the graph in Figure 3.

a



b

Fig.14

Issues of efficiency of such light tubes

To achieve the physical efficiency of these light tubes, companies producing similar comparison show the equivalence between the tubes and light classical systems [1]. Annex 1. is an example in which one can see the effectiveness of the tubes depending on the level of solar radiation, the illumination and the illuminated surface.

Tabel 1.

Model Size	Coverage Area	Wattage Output Equivalent	Maximum Light Tube Length
10"	up to 150 sq ft	up to 300 watts	18'
13"	up to 300 sq ft	up to 500 watts	20'
18"	up to 500 sq ft	up to 1000 watts	20'
21"	up to 700 sq ft	up to 1450 watts	20'

Conclusions:

- Advantages
  - The solution of light tubes is a very recent solution with outstanding prospects, especially in the current context;
  - In terms of conditions on board, a work environment close to the natural environment would reduce stress and discomfort given during voyages and acoustic insulation specified;
  - Reduce costs with lighting during daylight;

- Reducing environmental pollution by reducing fuel burned for obtaining electric light;
- Sanitation favorable environment due to the effect of natural light;
- Possibility to focus on specific areas using flexible hoses;
- Investment very low compared with the effects obtained;
- Extremely high reliability;
- Lack possibility of failure;
- Maintenance work negligible;
- Low investment costs;
- It does not require substantial modifications of such tubes installation;
- Fire resistance over two hours;

- Disadvantages can include:
- Construction sensibility on bumps or forms of mechanical impact;
- Protecting from bumps with coating layers will reduce transferred of light;
- Necessity, in some cases to protect light tubes with tubes of metal;
- When the ship is at sea, increasing the efficiency of these tubes during voyages. It is known that in this case the amount of solar radiation is much hig
- her;

Diametru (mm)	Vara cer senin 105.000 lux		Vara cer acoperit 45.000 lux		Iarna cer acoperit 20.000 lux		Suprafața iluminată (mp)
	Nivel de iluminare (lux)	Flux luminos (lumen)	Nivel de iluminare (lux)	Flux luminos (lumen)	Nivel de iluminare (lux)	Flux luminos (lumen)	
230	360	2160	170	1045	65	370	8
300	760	4460	330	1940	130	760	14
450	1820	10770	750	4410	300	1768	22
530	2530	14995	1050	6265	430	2550	30
750	4350	25568	1975	11620	900	5300	50
1000	7700	45300	3850	24650	1425	8390	60
1500	13630	80180	7505	43380	2250	13050	70

Note: valorile nivelului de iluminare sunt măsurate pe planul util, situat la 1,5 m sub planul difuzorului; o lampă incandescentă de 100W generează aprox. 1000 lumen sau 170 lux.

Bibliography

[1] Advertising sites of companies producing and installing of these light tubes (not nominate those firms, not to make public free)
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