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5 December 2007

EVALUATION OF AN LED LIGHTING SYSTEM FOR THE VICTORIA CLASS SUBMARINE ESCAPE TOWERS

Reference: NETE Task IT2214-S FY 2007-2008, approved 4 April 2007

AIM

1. The aim of this letter report is to present the results on the evaluation of a Light Emitting Diode (LED) lighting system that is a potential replacement for the incandescent lights currently installed inside the Victoria Class Escape Towers.

BACKGROUND

2. The Forward (Fwd) and After (Aft) Escape Towers on the Victoria Class submarines are currently fitted with two 24 volt incandescent light bulbs that are sealed inside pressure tight housings. One of the housings is located at the top of the tower and the other at the bottom. The lights are used during hooded tower escapes from a disabled submarine. The 24 volt x 36 watt incandescent filament light bulbs are failing and must be replaced frequently. It is the general consensus that the filament in the bulb becomes brittle due to the heat being generated inside the sealed housing and any jolt or shock to the housing causes the filament to break. After the bulb has been replaced, the pressure tight housing must be recertified.

3. At the Reference, the Naval Engineering Test Establishment (NETE) was tasked by Directorate Maritime Equipment and Program Management Submarines (DMEPM[SM]) 4-4-8 to conduct a market survey and identify a suitable replacement for the 24 volt x 36 watt filament incandescent light bulb.

DISCUSSION

Results of Market Survey

4. Initially, the market survey focused on replacing the 24 volt x 36 watt incandescent filament light bulb with a more durable bulb or an LED type bulb. However, due to the configuration of the light bulb contacts and bayonet type fitting arrangement for the light bulb socket, an off-the-shelf bulb was not available.

5. During the survey, a different type of lighting system, manufactured by HIL-Tech Ltd., was identified (Photograph 1). The lighting system is virtually maintenance free and consists of a series of LEDs that are encapsulated in an impact and chemical resistant plastic that is rated to 300 meters seawater. The lighting systems are available with six and 12 LEDs and have a 30,000 hr life expectancy. If one of the LED fails, it does not affect the other lights. Overall dimensions of the lights are 33 mm wide x 19 mm deep x 400 mm long. The 24 volt Direct Current (DC) power currently being supplied to the escape tower can be used to power the lights. The lights have a North Atlantic Treaty Organization (NATO) commercial code (NCAGE) L4132 Code, and Defense Logistics Agency, Central Contractor Registration (CCR), DUNS No. 254069537.

Photograph 1 - HIL-Tech Ltd Six LED Lighting System

6. Earlier versions of the lighting system met the following specifications:

   a. American Society for Testing and Materials (ASTM) D 635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position;

   b. ASTM E 662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials;

   c. ASTM E 162 Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source; and

   e. National Fire Protection Agency (NFPA) 258 Recommended Practice for Determining Smoke Generation of Solid Materials.

Although the current versions of the lights have not been approved to the test procedures listed above, the plastic used is the same as the plastic used in the earlier versions.

Test Procedures

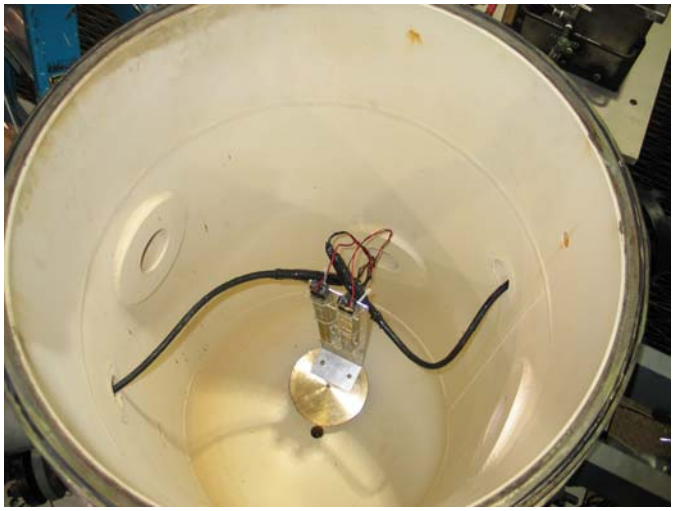
Luminosity of LED Lighting System

7. One 12 and two six LED lighting systems were purchased from HIL-Tech Ltd. for the evaluation. The LED lighting systems were installed inside the Submarine Escape System (SES) Test Bed Escape Tower, which is a replica of the Victoria Class Escape Tower. The two six LED lighting systems were installed in the same position as the incandescent lights currently fitted in the Victoria Class Escape Tower. The 12 LED lighting system was installed in the bottom position of the escape tower. A Lux meter was used to measure the luminosity of the LED lighting systems and the results compared to the existing incandescent lights.

Cyclic Pressure Test

8. The LED lighting systems were then cycled 118 times at an equivalent depth of 215 meters seawater (msw) using the NETE pressure vessel (Photograph 2). A stand was fabricated to support the LED lights inside the pressure vessel and the lights were oriented so they could be viewed through the two sight glasses (Photograph 3). Each cycle was completed within approximately two minutes, which represents a typical escape cycle. At the completion of the 118 cycles at 215 msw, the pressure was then increased to an equivalent depth of 300 msw and held for 15 minutes. A 0 to 500 psi pressure transducer, data acquisition system, 0 to 1,000 psi pressure gauge, a thermometer and stop watch were used to collect the relevant test data. The 118 cycles represent twice the Victoria Class crew complement of 59 and the 215 msw is 20 percent greater than the current escape depth of 180 msw. For both the luminosity and cyclic pressure tests, a 24 volt DC power supply was used as a power source for the LED lights.

Photograph 2 – Test Set-up for Cyclic Pressure Test



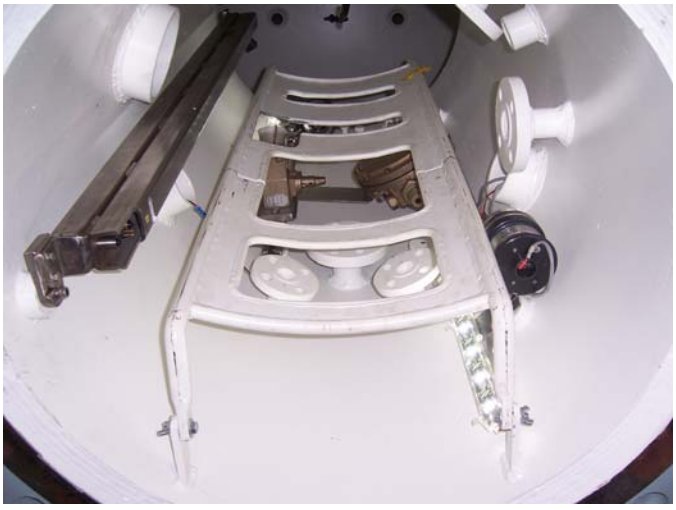
Photograph 3 – Test Stand for LED Lights

Discussion of Test Results

Luminosity of LED Lighting System

9. When the 12 LED lighting system was installed in the SES Test Bed Escape Tower, it was evident that it was too bright. Therefore, the light was no longer included in the evaluation. Visually, the two six LED lighting systems provided a more uniform light when compared to the incandescent lights currently fitted in the escape tower (Photographs 4 and 5). Readings taken with the Lux meter showed that the LED lighting system was approximately 1.5 times brighter than the current lights. In addition, the two six LED lighting system only draw 0.950 amps compared to the 2.5 amps for the incandescent filament lights.

Photograph 4 - Current Escape Tower Lighting
Arrangement With Two 24 Volt x 36 Watt Filament Light Bulbs

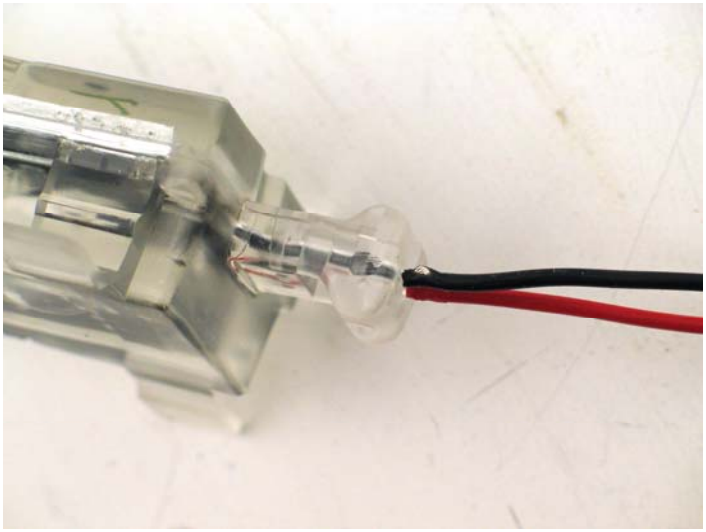


Photograph 5 - Two Six LED Lighting Systems
Installed in SES Test Bed Escape Tower

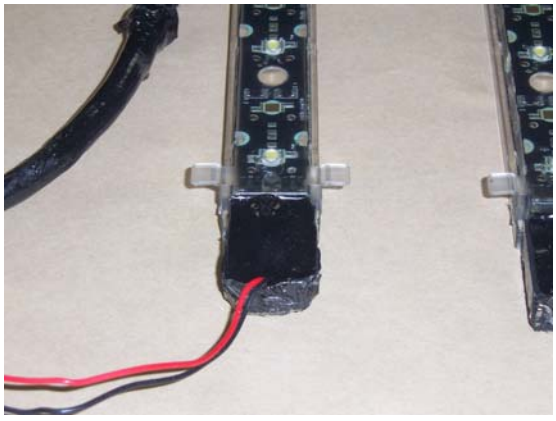
Cyclic Pressure Test

10. The two six LED lighting systems did not fail during the 118 cycles at 215 msw. In addition, the lights did not fail when the pressure was increased to an equivalent depth of 300 msw and held for 15 minutes.

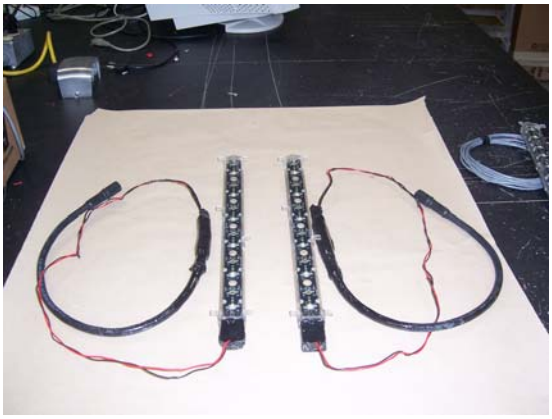
11. During the preparation of the electrical leads for the pressure cyclic testing, it was observed that the insulation for both leads was split just after the plastic housing (Photograph 6). The manufacturer was contacted to determine if this was a common problem with their lights. They claimed that this problem has never been reported. However, after reviewing the photographs, the manufacturer suggested that the splitting of the insulation was probably due to repeated handling. This may have some merit because both sets of lights were handled extensively during the evaluation. In order to continue with the cyclic testing, 3M Scotchcast 2130 Compound was used to form a watertight seal where the electrical leads entered the plastic housing of the lighting system (Photographs 7 and 8).



Photograph 6 - Insulation Breakdown at the
Point Where the Power Leads Exit the Body of the LED Light



Photograph 7 – 3M Scotchcast Covering Insulation Damage



Photograph 8 – Overhaul View of the
Insulation Power Leads and Connectors

CONCLUSIONS

12. The following conclusions are based on the evaluation of the HIL-Tech Ltd. LED Lighting System:

a. Results of the market survey showed that a more durable filament or LED type bulb is not readably available because of the unique configuration of the contacts and bayonet type light socket;

b. An LED lighting system manufactured by HIL-Tech Ltd. was identified as a potential replacement for the current incandescent lights currently fitted inside the escape tower for the following reasons:

(1) The lighting system has a 30,000 hr life expectancy and is rated to a depth of 300 msw;

(2) When the two six LED lighting systems were installed in the same positions as the current incandescent lights, the luminosity was 1.5 times brighter and the light was more uniform;

(3) The two six LED lighting system draws approximately 2.5 times less power when compared to the incandescent lights currently installed inside the escape tower;

(4) The 24 volt DC power currently being supplied to the escape tower can be used to power the lights;

(5) The lights did not fail after 118 cycles at a depth of 215 msw; and

(6) The overall dimensions of the LED lighting system make it suitable for installation inside the Victoria Class Escape Tower.

c. The insulation on the electrical leads split because of excessive handling during the evaluation.

RECOMMENDATIONS

13. The following recommendations are based on the evaluation of the HIL-Tech Ltd. LED Lighting System:

a. The six LED lighting system should be evaluated on board a Victoria Class submarine using a special bracketing arrangement and a temporary power supply; and

b. The insulation on the electrical leads close to the plastic housing should be reinforced before they are installed on board a Victoria Class submarine.

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