



Fluorescent
Lighting Survey =
12.6 Ft-Candles



3M LED
Lighting Survey =
22.8 Ft-Candles

Navy Combatant LED Lighting by 3M

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Development Background/Status

- Designed for minimum TOC, maximum performance
 - Interviews with Chiefs, Sailors, Officers, Shipyards
 - Input from OPNAV-N45, ONR, PEOs, PMSs
 - Ownership cost model reviewed by
 - NAVSEA-05C
 - Deputy Under Secretary of Defense (Installations & Environment)
- Development and testing paid for entirely by 3M shareholders
- Fixtures passed/exceed requirements of MIL-DTL-16377J
- Cd-free Battery Backup system in last stages of testing
 - Already passed Watertight, Grade A Shock, Vib, Battery Operation
 - Balance of tests complete this month

DoD Sustainability Pilot Fact Sheet

(Led by Paul Yaroschak, OPNAV N45 Involved)

Sustainability Analysis Pilot Project Results LED Lighting for Littoral Combat Ships

What is a Sustainability Analysis?

A Sustainability Analysis assesses the life cycle costs and human health and environmental impacts of design choices. The purpose is to compare alternative designs in order to reduce Total Ownership Costs and minimize risks to human health and the environment.

How was the Sustainability Analysis tested?

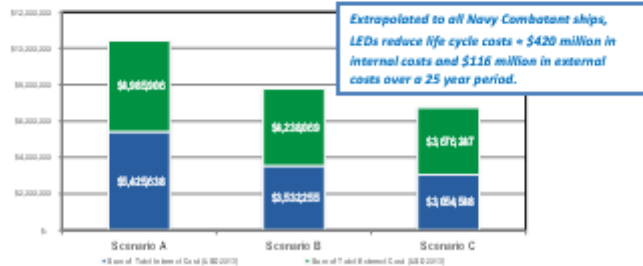
The Department of Defense (DoD) partnered with companies 3M and Enviance on a pilot project to test DoD's Sustainability Analysis method. The pilot project compared 3M's LED light fixtures in a Navy Littoral Combat Ship (LCS) to traditional fluorescent light fixtures. The pilot demonstrated that the DoD Sustainability Analysis is a thorough and rigorous assessment more easily performed than traditional Life Cycle Assessment.

What were the results of the 3M pilot?

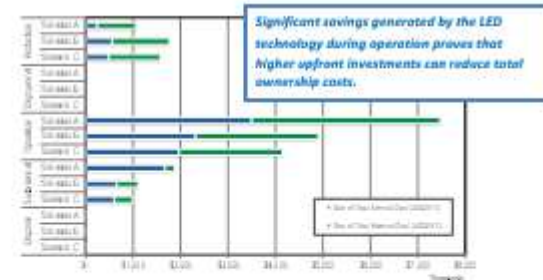
The pilot tested 3 scenarios:

- **Scenario A (baseline)** – fluorescent fixtures with **NUCA** battery backup units
- **Scenario B (drop-in replacement)** – replace all fluorescent fixtures with the equivalent LED fixture and use NIMH backup units
- **Scenario C (new design)** – use the appropriate number and type of LED fixtures for optimal lighting performance with NIMH back up units

The Sustainability Analysis shows that over 25 years, life cycle costs, per ship, are reduced from the baseline by = \$2.6M (Scenario B) and = \$3.6M (Scenario C).¹ Life cycle costs are divided into internal (DoD) and external (societal) costs. Internal costs impact the DoD's budget and accounted for in traditional business case analyses. External costs are costs borne by society and are frequently excluded from the DoD's financial decision making (e.g., social cost of carbon).



¹ Savings are discounted using standard financial discounting method, with 1.8% internal discount rate and 7.05% external discount rate (DOD Circular A-94). Nominal dollar savings will be significantly higher.

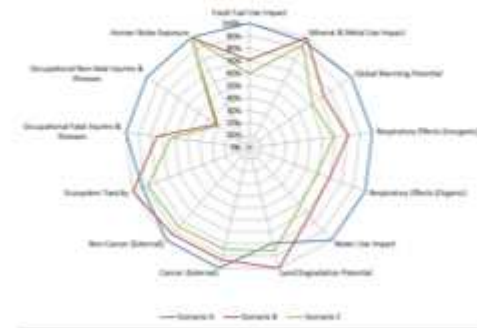


What drives the life cycle cost differences?

Despite a higher upfront cost, the enhanced efficiency of 3M's LED light fixture saves energy during the operation of the LCS. Also, the longer lifespan of LED strips requires fewer labor hours to sustain the light fixtures. The analysis also uncovered a number of "intangible" benefits, such as improved safety due to lower profile fixtures and better overall lighting.

What are the impact differences?

The chart below shows the relative percent differences across 13 impact categories. The outer ring represents the largest impact. For example, the 3M LED light fixtures reduce = 2.6M and = 3.7M kg of CO₂ equivalents in Scenarios B and C, respectively (20-30% reduction). Greenhouse gas emissions are one of the impacts for which the Sustainability Analysis can highlight differences among alternative designs. These important impacts and associated costs are often overlooked in more traditional business case analyses.



Eight Key Features of 3M LED Fixtures

1. Cost savings in ship construction process

- Flat lens + transparent protective film - eliminate “construction phase lenses”
- Potential for one mounting stud vs. two (allowed for sub-ten-pound fixtures)

2. Longer LED life for minimum maintenance, minimum TOC

- LEDs driven at < 50% rated current - extend expected lifetime to > 80,000 hours
- Life-of-fixture power supplies

3. Higher corrosion resistance aluminum alloys

- 3M uses A360 Al end-cap castings and 5052 sheet Al
- Legacy fixtures use more corrosive A380 and 3003 sheet alloy (or similar)

4. Decreased ship's weight

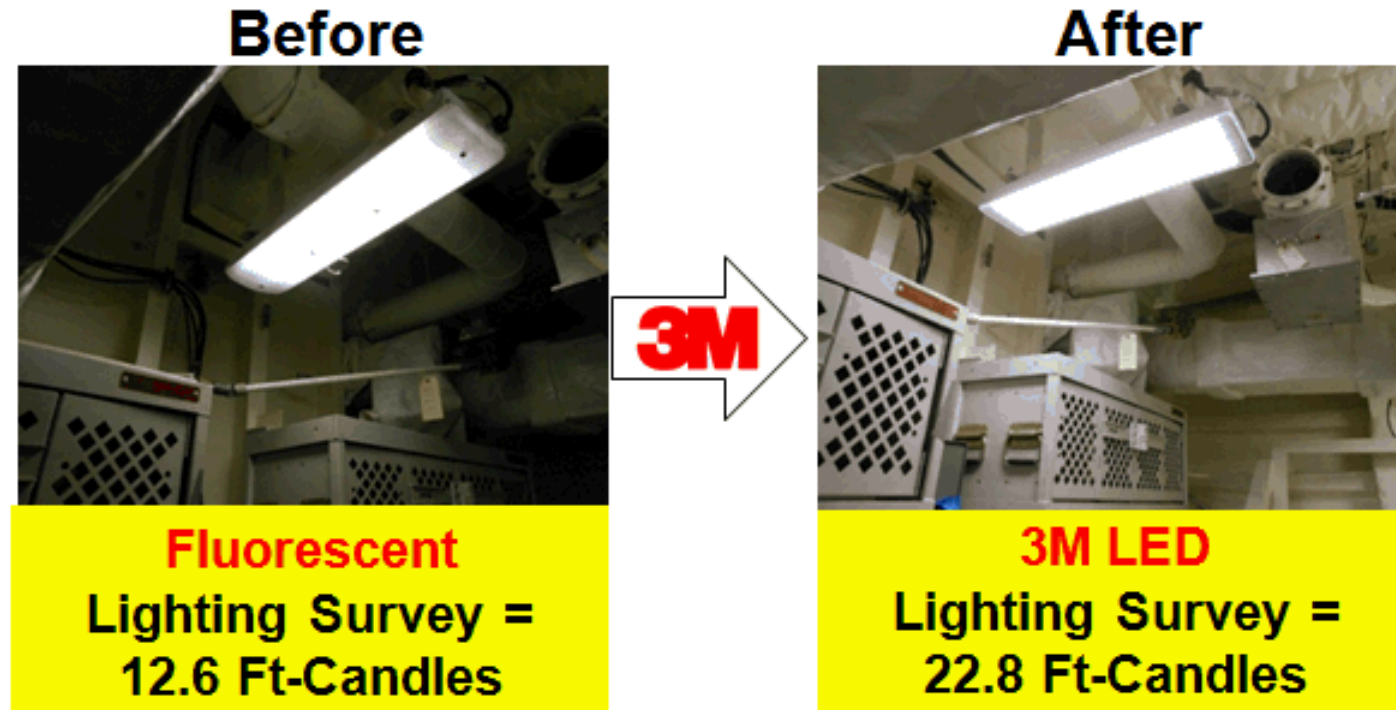
- 3M 77.4 = 8.7 lbs vs. 12 lb fluorescent
- 3M 333.1 = 9.4 lbs vs. 15.7 lb fluorescent
- NiMH MBBS battery backup = 1.7 lb vs. 4 lb for NiCAD legacy NEALS

Features of 3M LED Fixtures

5. Elimination of all Hg and Cd from the system
 - Legacy battery systems use obsolescent NiCAD batteries (Cd HAZMAT)
 - Battery backup for 3M lighting used modern NiMH batteries
6. Reduce size/cost/weight of lighting power transformers
 - 24.5W for 77.4 vs. 45.3W for Fluorescent (Symbol 77.4 type)
7. Increased head-space due to lower-profile flat lenses
 - Reduced potential for head injuries, lens breakage
8. Improved light levels and quality
 - Potential improvement on worker health, safety, productivity
 - Lower glare (<8000 Cd/m² vs. <15,000 spec)
 - Higher color rendering index (84% vs. >75% spec)
 - Improved use of available light from superior light distribution
 - Demonstrated in ship's space, December 2013.

DEMONSTRATION:

LM and 3M temporarily installed two fixtures in a Ship's space to demonstrate effectiveness (Dec. 9, 2013)



Distribution Statement A: Approved for public release, distribution is unlimited.

Illumination improved by more effective distribution of light, not by making more lumens.

3M

Summary...

- After 3 years and over \$2M commercial investment, these fixtures are available to the Navy.
 - Optimized for TOC with small additions to acquisition cost
- Fixtures save millions of dollars over life of the ship.
 - Savings for an LCS-Freedom Variant over 25 years are
 - \$4.4M from 3M Non-discounted cost model (SEA 05C Reviewed)
 - \$2.6M to \$3.6M Discounted savings according to DOD Sustainability Analysis Pilot Project

Thank you!