

Producing Exceptional Solutions by Fusing Technology and Expertise

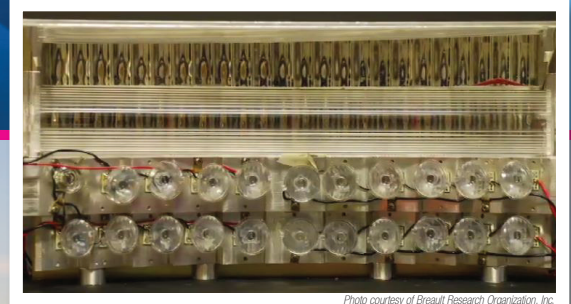


Photo courtesy of Brest Research Organization, Inc.



Navy Deck Lamp aka Ship Board Lighting System

History of Aircraft Carrier Lighting

Aircraft carriers have evolved since their inception in the early twentieth century from smaller converted vessels that could carry a handful of aircraft to nuclear-powered warships that accommodate dozens of aircraft, including fighter jets and helicopters. As ship and aircraft technology evolved, so have the lighting systems that play a vital role in ship operations.

The Navy was actively seeking to upgrade the on-deck lighting systems of aircraft carriers and other amphibious war ships. As part of the upgrade, the new lighting systems would need to be retrofitted into cruisers and destroyers to support helicopter operations. The incandescent lighting systems, established during World War II, were still being used well into the new century. These outdated lighting systems were creating a number of problems for both pilots and crew. The legacy lighting systems of the 1940s created shadows on the ship's deck, making it difficult to spot debris and forcing pilots to remove night-vision goggles to land on the ship. Also, that lighting was difficult to maintain. A single outage created a change in the lighting pattern on the deck and, thus, hazards for crew and pilots.

After several years of study, the Navy produced an extensive document isolating the exact specifications that would need to be met for the design of a new lighting system for the fleet. These new lighting specifications were intended to take full advantage of the newest technologies, including LED lighting.



Project Overview

The goal of the project was to develop a new solid-state deck floodlight that met the Navy's irradiance and uniformity requirements. In addition, the new deck flood lights had to be night-vision-goggle (NVG) compatible and have a lower lifecycle cost than traditional incandescent floodlights.

All components, circuitry and casings for the new Ship Board Lighting System also had to be designed to interface with the Advanced Lighting System controller (ALS). The ALS would supply the lights with power and control the on/off functions of each of the lighting fixtures as well as dim the fixture or take it from zero to full intensity.

In addition, the fixtures had to meet detailed specifications required for an unsheltered environment and not increase the already established voltage load on the ship. Additional requirements included:

- Total fixture weight could not exceed 50 lbs.
- The new lighting system had to be able to be retrofitted to the ships currently in use, some of which were commissioned in the 1970s, and also work with the ships being built using the latest technology.
- The lighting solution would need to be run with the same controls to keep the voltage and current in the same range as the previous lighting system. This system allows dimming of the lighting through a VarAC to compensate for sunrise, sunset, moonrise, moonset and various mission requirements.
- All equipment had to be in modular or LRU (line replaceable unit) form, and the module and LRUs needed to be completely encapsulated, potted or embedded.
- A single LED subsystem failure could not cause the entire lamp to fail.
- Lifecycle had to withstand 10 hours a day for an 18-month cycle.
- All design was to be focused on simplicity, accessibility, fault location, system test provision, component interchangeability and availability.
- Equipment had to be designed to be maintained with basic and common tools.

The electronics of the Navy deck lamp had to be designed to withstand a number of environmental and weather-related concerns, such as extreme temperature, humidity, vibration and shock. Plus, unsheltered components had to function with no sign of corrosion or other deterioration, which could affect the performance or lifecycle.

In total, the Navy produced some 200 very specific requirements that the new lighting system would have to meet in order to be implemented on its fleet.

MJS Designs Role

Breault Research Organization, Inc., the primary manufacturer of the Navy deck lamp, engaged with MJS Designs to provide the following key elements of the overall system:

1. Design and develop an electrical design for new-age LED driver circuitry.
2. Design and develop the power supply for the lighting system.
3. Provide a design of fault-tolerant redundancy so that no single component or subsystem would be responsible for more than 50% of light output or coverage.

In order to deliver on the objectives MJS Designs conducted a trade study to evaluate overall feasibility of the project requirements, determine available vendors for the sourcing of specific wave length LEDs and the types of LEDs that were available.

The study also revealed the types of semiconductor packages that were available to drive the optical power and how many LED units were required to meet the lighting specifications.



Photos courtesy of Breault Research Organization, Inc.

The Challenges & Solutions

While the trade study pre-determined the manufacturers and feasibility, MJS Designs was still faced with a number of challenges to address in the power and LED circuitry design:

THE CHALLENGES

Finding “Dimmable LEDs”

The legacy lighting systems that were currently on board the ships would glow at low-voltage settings. However, the current LED lighting technology would drop off at low voltage, posing a challenge to address the specifications required for dusk and dawn lighting on the ships.

Size of the Electronics Systems

It was required that the new lighting system fit in the same space and casing size as the old system. The circuitry layouts required a new level of innovation to fit in the enclosures.

LED Heat Dissipation

While LED technology addressed the illumination requirements, LED lighting designs are more sensitive to the heat in the fixture than the previously used incandescent bulbs. MJS had to employ more advanced technology.

Continual Lighting During a Failure

The existing lighting system had two incandescent lamps per fixture. When one light went out, the lighting pattern was disrupted and shadows were created on the deck of the ship.

Budget Constraints

The Navy's timeline allowed for extensive review and testing but also continually taxed the already limited budget.

THE SOLUTIONS

Supply Chain Research

MJS Designs' deep research found manufacturers and sources of LED drives for AC applications that were adapted to provide for low dropout, no flicker at low-voltage extremes.

Collaboration & Expertise

MJS Designs' team, along with other project engineers, worked together seamlessly to ensure that the design fit into the existing deck lamp space with ease of replacement and serviceability in mind.

Development of Metal Core Circuit Board

With true engineering innovation, MJS Designs utilized metal core PCB technology to draw heat to the aluminum heatsink and direct the heat away from the LEDs, eliminating heat dissipation concerns.

Dual Systems

The MJS LED system was designed with dual power supplies, dual LED drivers, and multi-laced lighting patterns to provide an equal lighting pattern even with single points of failure.

Communications Systems

MJS Designs' engineers participated in weekly conference calls to review, budget, progress and develop next steps for a period of close to two years. Communication was ongoing while all elements of the lighting and optics were being developed and reviewed.

Schematics

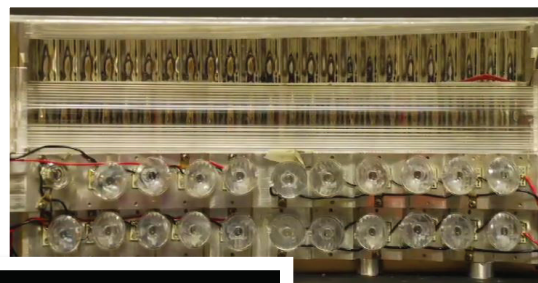
Once the system block diagram was approved by the Navy, schematics were generated for each control element, LED boards, LED driver boards and power supplies. The schematics were highly scrutinized by the Navy. Mechanically and optically, every component — down to the washer, gasket and grommet — was evaluated to meet the rigorous requirements needed for sustainability in the extreme onboard environment of shipboard applications.

Prototypes & Testing

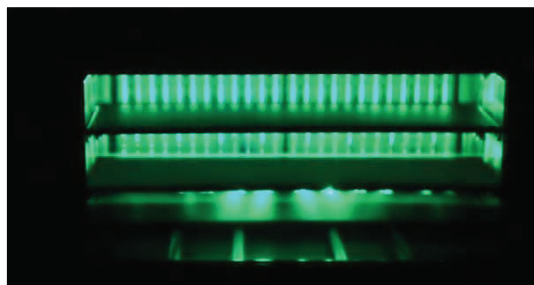
After several iterations of the schematics, prototypes were built and tested. The Navy sent a step-down transformer to replicate the onboard electronic system to test the prototypes. Testing was conducted in a laboratory that recreated the environmental conditions faced by the power and circuitry over many years of use. In addition, four deck lamps were installed and successfully operated at sea for over two weeks on the USS Wasp during the F-35 demonstration test #1 (DT1).

Final Deliverables

- System Block Diagram
- Schematics, BOMs, PCB source files, and assembly instructions for each PCB
- System Wiring Diagrams
- Test Reports including luminous output over voltage range
- Prototype Lighting System



Photos courtesy of Brevitt Research Organization, Inc.



Turn to MJS Designs for high-quality and accuracy in electronic system engineering, complex printed circuit board CAD design, prototype build, box / system build, cable assembly, component procurement, volume assembly, test development, testing and fulfillment.

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