USMC Expeditionary Airfield Lighting Update

LED Approach and Runway Lighting Systems

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Reasons for Change

- ***Obsolescence***
  - **Unique incandescent fixtures**
  - **Antiquated manufacturing processes**
  - **Mechanical flash timers**
  - **Xenon flash tubes**

"Legacy" Runway Edge Light

- ***USMC Requirement to Support Deployed CAT-I Operations***
  - **Portable ASR/PAR system (ATNAVICS)**

- ***Non-standard Approach Light Configurations***
  - **Could not support IFR flight operations during OEF/OIF**

Program Objectives

- ***Priority = Approach Lighting Systems***
  - **Refurbished Legacy runway lights could support for short term**
  - **Leverage COTS technologies and processes as much as possible**
  - **Develop power and control infrastructure**
  - **Apply any "lessons learned" to future runway lights**
  - **"System" to include complete MALSR, REIL and CCR**

"Legacy" Approach & Strobe Barrette

- ***USMC Challenges***
  - **Visible and covert capability**
  - **Weather-proof and "lightweight" CCR**
- ***USMC Advantages***
  - **No requirement for "backwards compatibility"**
    - **Power, control or fixture form factor**
  - **Trained on constant-current circuits**

Approach Light System (ALS) Design Approach

- ***MALSR Threshold & Steady Burner Fixtures***
  - **Base light engine on existing L-862(L) technologies**
  - **Add near-wave IR emitter**

- ***MALSR SFL - REIL***
  - **Base light engine on existing L-849(L) technologies**
  - **Add near-wave IR emitter**

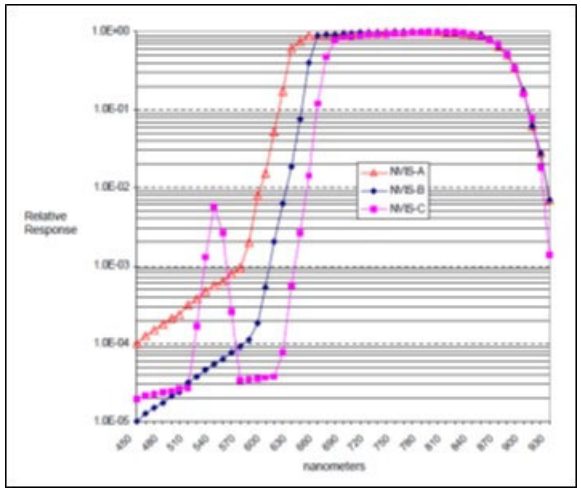
- ***CCR***
  - **Base performance on existing L-828 technologies**
  - ***Fixture Centric* approach**
    - **Intensity & Mode commanded by signal sent by CCR**
    - ***Amplitude Shift Key* (ASK) chosen**

Night Vision Device Compatibility Design Approach

- *"Entire Airfield" Strategy to Address Intensities*
  - Approach > Runway > Taxiway

Risk Mitigation test fixture

- *Specification Evolution*
  - Historic Navy shipboard data
  - Unit of Measure = NVIS Radiant Intensity (NRI_B) (SAE-ARP-5825)
    - USMC flies both Class B & C NVGs
  - IR λ towards high end of linear response to reduce power requirement
  - "Risk Mitigation" testing
    - Fixed observers at Lakehurst Test runway
  - "Order of Magnitude" dimming profile
    - High ≈ $1x10^{-1}$ W/sr
    - Med ≈ $1x10^{-2}$ W/sr
    - Low ≈ $1x10^{-3}$ W/sr
- *Control Provided Combined IR + VIS Output*



from MIL-STD-3009

ALS Components
MALSR Threshold and Steady-Burn

- ***MALSR Threshold and Steady-Burn Fixture***
  - ***Identical except for Light Engine (LED color)***
  - ***Automatic heater gasket on window***
  - ***Center IR LED***
  - ***~ 30-W per fixture***

ALS Components
REIL / MALSR-SFL

- ***REIL / MALSR-SFL Fixture***
  - ***Flash synchronization regulated by CCR output waveform***
  - ***REIL or SFL function (internal DIP switch setting)***
  - ***Automatic heater gasket on window***
  - ***Center IR LED***
  - ***~ 150-W per fixture***

ALS Components
CCR & Power Distribution System

- ***4kW Ferro-Resonant CCR w/ QUADCON-based Distribution System***
  - ***De-rated to 3.33kW to allow headroom for ASK operation (fixed 5.5-A)***
  - ***Selectable output to support bi-directional runway ("A" or "B" loop)***
  - ***Environmentally sealed***
  - ***Wired remote***
  - ***< 300-lb***

ALS Testing

- ***Developmental Testing***
  - **FAA-E-2980 and AC150/5345-51-*derived* photometrics**
  - **MIL-STD-810 "qualification" criteria**
    - **Passed with minor corrections**

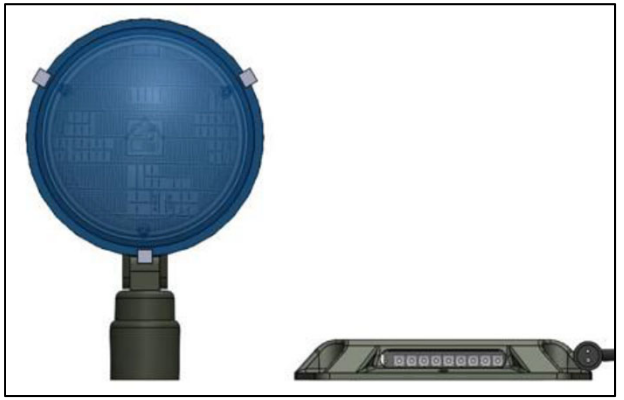
- ***Integration Testing***
  - **Marine Corps Air Ground Combat Center, Twentynine Palms, CA**
    - **8000-ft AM2 Matting runway with taxiways and parking ramps**
  - **Installed prior to "Integrated Training Exercise (ITX)" SEP 2019**
  - **Complete system installation (MALSR r/w 10; REIL r/w 28)**
  - **Limited fixed-wing flights**
    - **No ATC Services**
  - **"NVG operations are VFR only"**
    - **Consideration for the future**
  - **System has remained installed**
    - **Largely VFR operations, but system continues to receive positive feedback**

Runway Lighting System (RLS) Design Approach

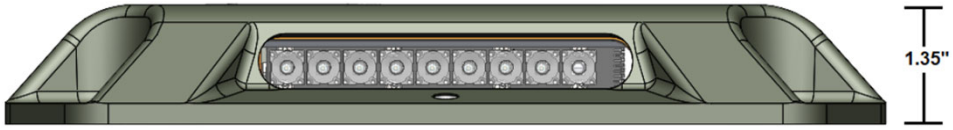
- ***Lessons Learned from ALS***
  - **ASK-controlled infrastructure works**
  - **Simultaneous IR & visible unnecessary**
  - **Further dimming of IR output desirable**
- ***Runway Edge and Threshold/End Light Fixtures***
  - **Meet L-862(L) & L-862E(L) performance**
  - **"O*vert NVD*" to allow "*under the goggles*" viewing ("*<B1*" intensity)**
  - **Maintain a low-profile fixture**
    - **Eliminate frangible couplings**
    - **Allow installation near Arresting Gear**
- ***4kW CCR***
  - **Single design to accommodate both 5-step and 3-step configurations**
    - **No increase to message byte size**
  - **Installs in existing space within Power Distribution QUADCON**
    - **4 total: (1) for approaches; (2) for inter-leaved runway; (1) spare**

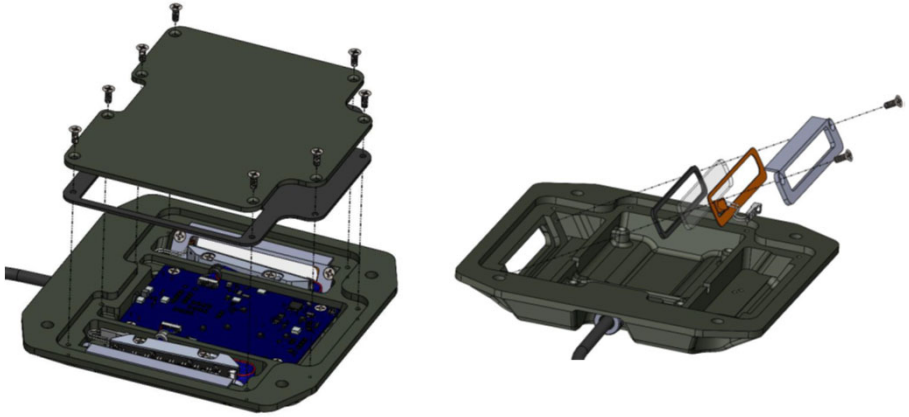
RLS Components
Runway Edge & Threshold/End Light

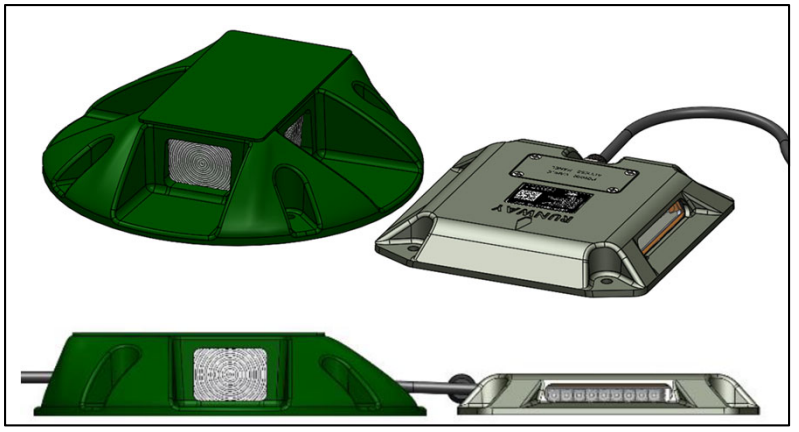
- *"Flapjack" Fixture*
  - **Interchangeable LED modules**
    - **Straight or "toed" mounting**
    - **9-LED Array, 8 vis + 1 IR**
  - **Automatic heater gasket on window**
  - **~50-W per fixture**



"Legacy" Threshold fixture vs. "Flapjack"



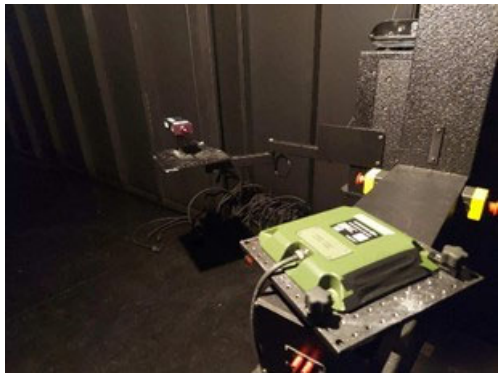


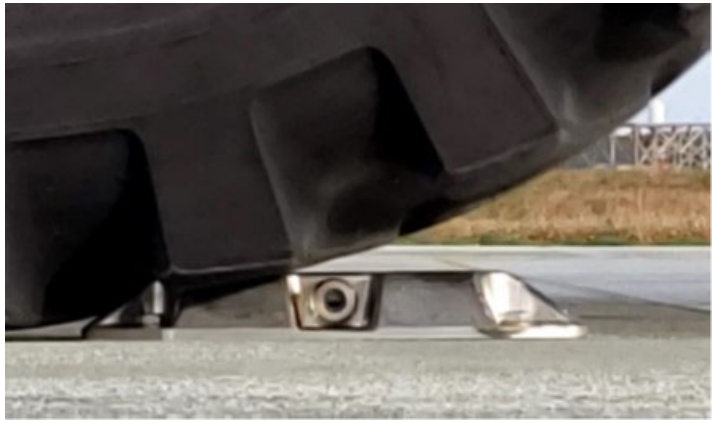


"Legacy Pancake" fixture vs. "Flapjack"

RLS Testing

- ***Developmental Testing***
  - **AC 150/5345-46 photometrics**
  - **MIL-STD-810 "qualification" criteria**
    - **Passed with minor corrections**
  - **Arresting Gear interface evaluation**
    - **Confirmed requirement for "Cable Cover"**





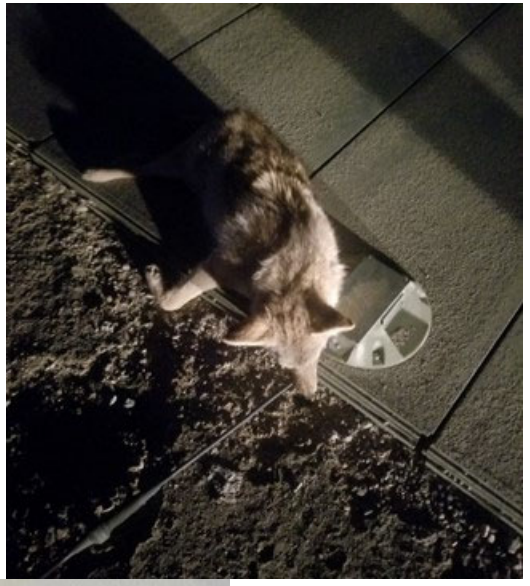
Trafficking evaluation

Arresting Gear Purchase Tape evaluation

- ***Integration Testing***
  - **Expected late 2022/early 2023**
    - **To be installed with ALS at Twentynine Palms**

Unique Challenges to EAF - 1

- ***Wildlife Damage to Secondary Cables***
  - **Above-ground installation**
  - **Incidents have *ACCELERATED* in recent years**



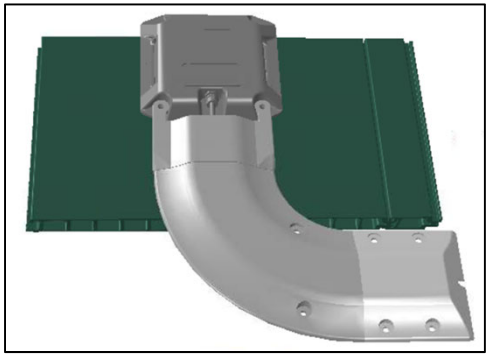
  - **#1 Maintenance concern**

- ***Solutions or Advice?***

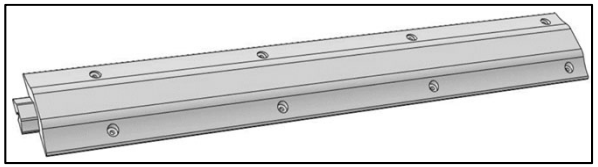
Unique Challenges to EAF - 2

- ***Interface with Portable Arresting Gear***
  - **Difficult to replicate "Legacy" fixture**
  - **Cable Cover concept**

"Legacy Flush-Deck" fixture



AM2 Mat concept



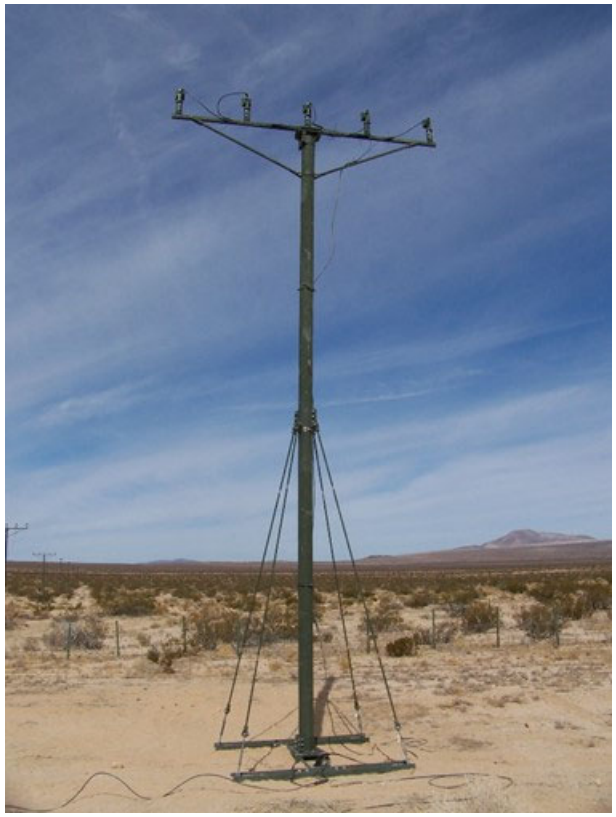
"Bare Base" concept

Purchase Tape traversing Cable Cover

Tape Connector striking fixture

Unique Challenges to EAF - 3

- ***Portable Frangible Towers***
  - **Unique 1980's design based on FAA D-6155 drawing series**
  - **Out-of-date drawing package**



Acknowledgements & Thanks

- ***NAVAIR Lakehurst Photometrics and Laser Labs***
- ***Naval Flight Information Group (NAVFIG)***
- ***Federal Aviation Administration***
  - **Flight Safety R&D**
  - **Lighting Systems**
  - **Flight Operations**
- ***Marines of MWSS-271 and MWSS-374***

MWSS-374 Marines installing REIL