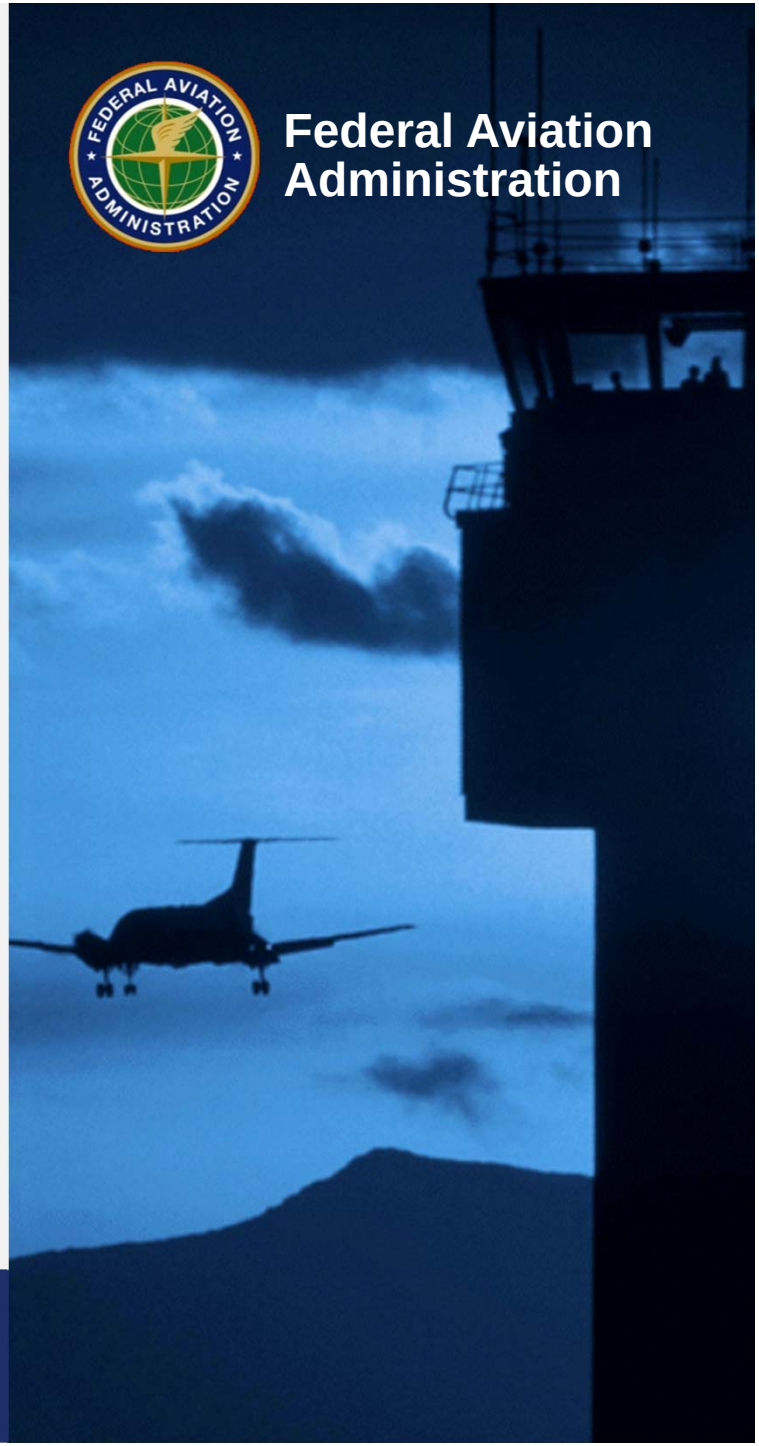
FAA Airport Safety Technology

Research & Development

Presented to: IESALC

By: Holly Cyrus, Project Manager

Date: October 15, 2012



Visual Guidance/Runway Incursion Prevention Projects

- Vertical Flight
- Standards for Internally Lighted Wind cone
- Improved Signage, Marking, & Lighting of EMAS Beds
- Evaluation of Light Emitting Diode (LED) Airport Pavement Linear Source Visual Aid
- Electrical Infrastructure Research Team
- Effective Intensity Study
- New Technology

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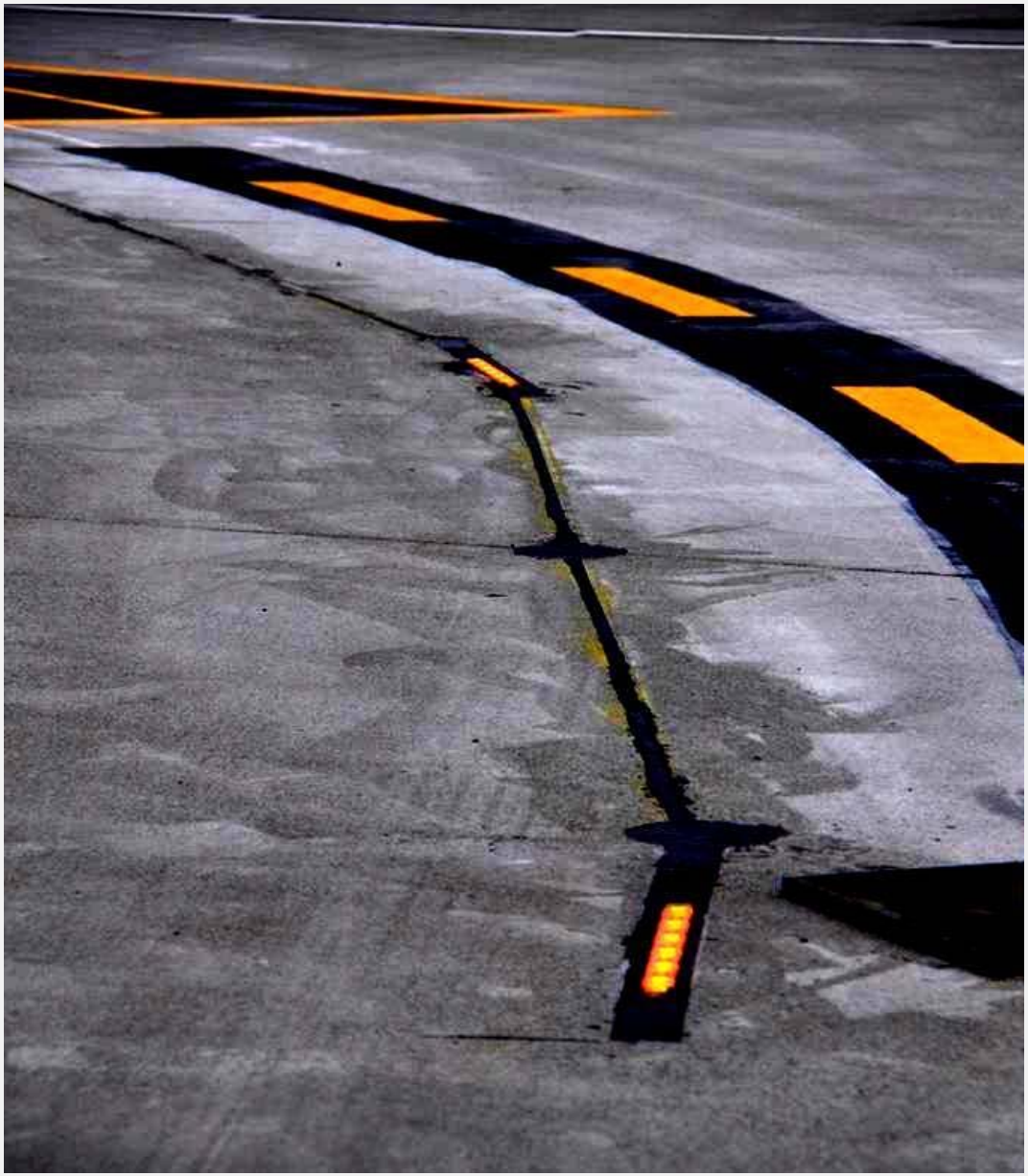
- Effective Intensity Study
- New Technology
  - Alternatives to direct emission LEDs
  - Method to determine end-of life for LED fixtures
  - Understanding LED Degradation in Sealed fixtures due to VOCs

Evaluation of Light Emitting Diode (LED) Airport Pavement Linear Source Visual Aid

1. Determine if a linear light source can provide significant advantages versus a point source as a visual aid.

2. If it is determined that a linear source has advantages, determine what applications would benefit from this source.

3. Evaluate LED Linear light source applications through field tests.



Evaluation of Light Emitting Diode (LED) Airport Pavement Linear Source Visual Aid

Activity	Completion
Test Plan	02/28/12
Phase 1	09/30/12
Analysis/Decision Point	10/31/12
Phase 2	01/30/13
Analysis/Decision Point	02/30/13
Phase 3	05/31/13
Final Report to Sponsor	06/31/13

Effective Intensity Study

- For many years there has been differences in the equations used for calculating effective intensity of a flashing light both within the FAA and with ICAO.

- We were tasked with:
  1. Examining the equations used in AC 150/ 5345-43F and ICAO in order to determine the correct equation to be used for conventional flashing lights.
  2. Determine if a different equation should be specified for new technologies such as LEDs.

Effective Intensity Study

Status item #1: Completed.

- **Research has been completed and a revision to the AC is being prepared.**

Status item #2: On going.

- **The conventional flashing light uses a xenon flash tube to generate the visual cue desired.**

- **LED flashers have different pulse characteristics then xenon flashers.**

Effective Intensity Study

- For a single LED flash the revised equation going into the AC would be correct.
- Research being conducted with the use of LED flashers in the ability to change the flash characteristics which may improve the visual cue.
- This may result in a separate equation for this light source.

New Technology
Human Factors and Vision Research

- Conduct research studies into the effects of factors such as spectrum, intensity, spacial distribution, and modulation frequency on visibility of new sources.
- These studies include characterization of new technologies, development of test methods for evaluating system performance.
- Test methods are developed for selecting and analyzing products in their airfield applications.

New Technology

- Most direct emission COLORED LEDs decrease in light output and shift in peak wavelength with increasing temperature at the p-n junction (where LED is attached to circuit board).

- Yellow, and Red LEDs (AlInGaP-based LEDs) have greater sensitivity to heat compared with Blue and Green (InGaN-based LEDs). This attribute of direct emission, COLORED LEDs could affect the performance of airfield lights.

New Technology

- As an alternative to the direct emission colored LEDs, an InGaN-based blue LED together with an efficient down-converting material, such as nanophosphor or nanocrystal quantum dots, can be used to convert the blue light to green, yellow, or red light.

- Since the external quantum efficiency of the blue LED is high (greater than 60%) compared with direct emission green or yellow LEDs (below 15%), and the blue LED has high stability under high temperatures and driving currents, a blue LED together with an efficient down-converting material can potentially result in more efficient and higher stability colored LEDs.

Method to determine end-of life for LED fixtures

- One of the challenges of using LED technology is the time at which the light source needs replacement.
- Unlike, traditional light sources, the light output of LEDs may degrade over time and depreciate below the minimum light level needed for the application.
- Incandescent sources degrade however they burn out before much loss of light occurs.
- Since the LED light source may not completely cease to produce light the maintenance crew may not know when to change the light sources.

Method to determine end-of life for LED fixtures

- The objective of this research is to investigate the change in electrical parameters of an LED as a function of time and as it degrades.
- By detecting these changes a method can be developed that can be used for signaling end-of-life.
- The project period of performance is 18 months.

LED Degradation in Sealed fixtures due to VOCs

- VOC (volatile organic compound) contaminations in LED lighting systems have become a concern in the lighting industry.
- Chemical incompatibility often happens in a sealed environment inside the system where LEDs operate at a high temperature with little or no air movement .
- The incompatible chemicals can be introduced during electrical and mechanical assembly processes.

LED Degradation in Sealed fixtures due to VOCs

- It is difficult to identify the chemical contaminant because there are many chemicals used in electrical and mechanical assembly.
- It is important to understand and prevent the incompatibilities of chemicals used in an LED system during assembly.
- A white LED is discolored to yellow or blue due to VOC outgassing after a few hundred hours of operation.
- The impaired performance of the LED can change the visibility of the light source and influence flight safety significantly.

LED Degradation in Sealed fixtures due to VOCs

Scope:

- **Investigate and verify how different encapsulant materials, such as silicone, acrylic and epoxy, and how different types of LEDs including blue, green, white, amber and red are affected by VOC contaminations.**

- **We will follow the chemical compatibility guidelines published by leading LED companies like Cree and Philips LumiLEDs to select several representative chemicals used in mechanical and electrical assembly that can cause contamination for further investigation.**

LED Degradation in Sealed fixtures due to VOCs

- We will analyze the root causes of the VOC contamination in the LED system and propose recommendations to avoid VOC outgassing in the LED system.

- The project period of performance 12 months.

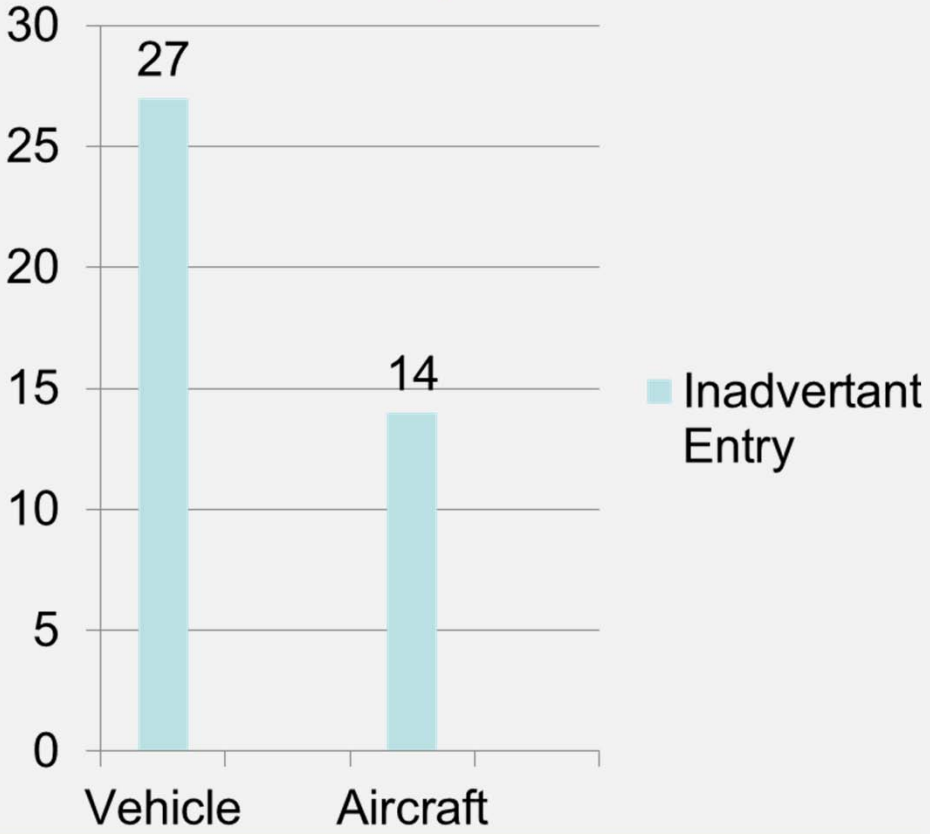
EMAS Marking/Signage

Project Description:

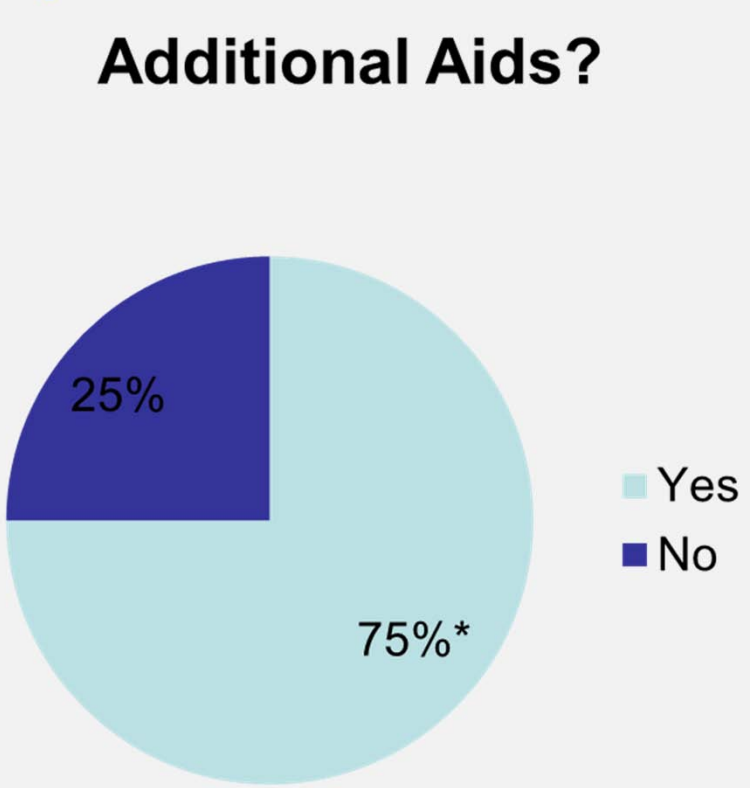
- Determine if additional EMAS markings are required for pilot awareness, especially when other visual cues are more dominant (blast fence)
- Determine if additional EMAS markings are required for preventing inadvertent vehicle and aircraft entry

EMAS Marking/Signage

Total Inadvertent Entry Incidents Reported



Airports with Visual Aids

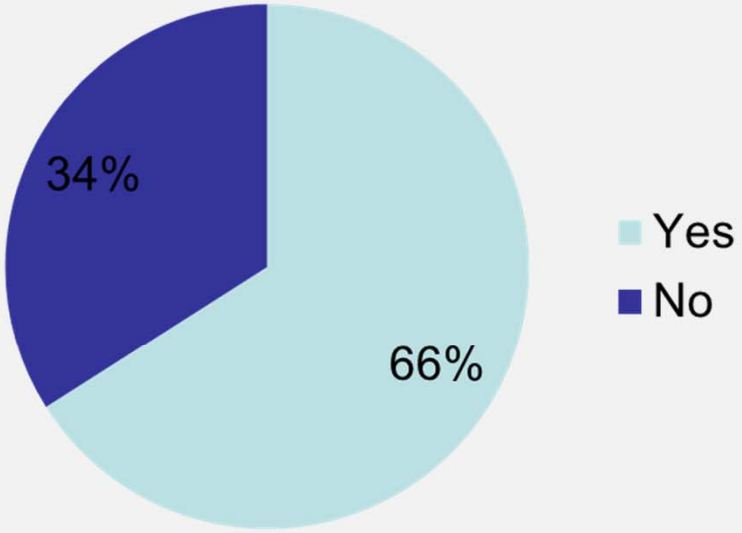


* 91% are retroreflective markers

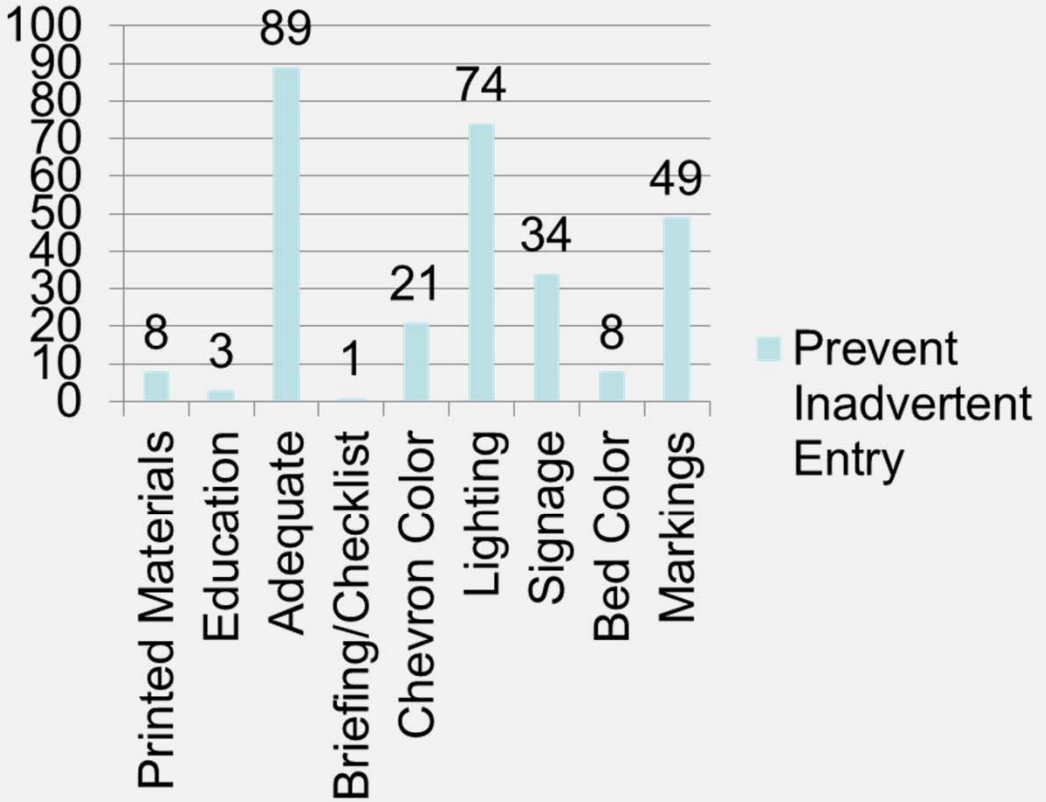
EMAS Marking/Signage

Pilot Results

Current EMAS Markings Adequate?



Prevent Inadvertent Entry



EMAS Marking/Signage

Next Steps:

- **Field Evaluations – October 2012**
  - Retroreflective Markers at BTR airport
  - “EMAS” painted on BUR blast fence
- **AFTIL Evaluation – November/Dec 2012**
  - Surface painted “EMAS” in front of bed
  - Yellow informational signs at end of runway and at 1,000 and 2,000 RDR signs
- **Final Report – January 2013**

Airport Technology Research
Taxiway

Project Summary

- **Memorandum of Agreement between the FAA and DRBA**
  - November 15, 2010 through September 30, 2030.
  - Grants the FAA the “right to construct, operate, and maintain research infrastructure” at the Cape May County Airport (WWD).

Project Summary

Project Summary

- **The objectives of the project are to:**
  - Rehabilitate former Taxiway C to develop a state of the art research test bed.
    - Design, install, test, monitor, and report on new technologies with signs, lighting, and markings.
  - Allow for other airport safety and pavement research needs to be conducted.
  - Be utilized as a taxiway by the airport when the FAA is not actively conducting research on the test bed.

Work Completed - Schedule

- 30% Design submitted October 2011
- 60% Design submitted January 2012
- 90% Design submitted April 2012
- Final Bid Package submitted May 2012
- Bidding and Award
  - Summer 2012
- Construction
  - Fall 2012 – Spring 2013

Recent Milestones

- 7460 form submitted to the Harrisburg ADO
- Soil Erosion and Sediment Control Plan application submitted and approved
- Stormwater Construction General Permit application submitted
- Finalizing Interagency Agreement with the Philadelphia District US Army Corps of Engineers

Electrical Infrastructure Research

Electrical Infrastructure Research Team (EIRT)

A team of FAA and Industry experts formed to design an Airport Lighting Infrastructure to take full advantage of new lighting technologies.

Co-Chairs:

Alvin Logan - FAA Regulatory

Don Gallagher – FAA Research

Improved Airfield Electrical Infrastructure

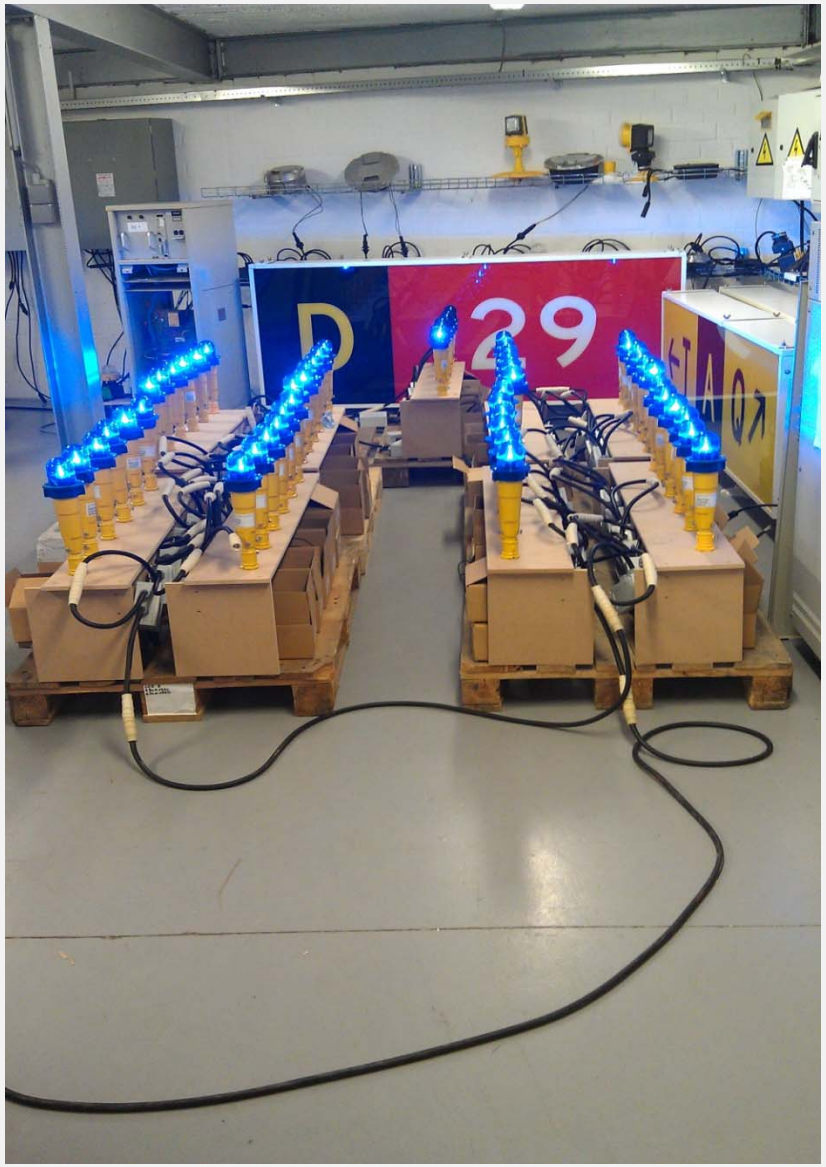
- Circuits considered:
  - 450 V, AC Parallel Circuit
  - 2 Amp, DC Series Circuit
  - 2.8 Amp, AC Series Circuit
  - AC Series Circuit w/ Control and Monitoring
- Currently conducting small scale circuit testing

Improved Airfield Electrical Infrastructure

- Installed a 50 fixture reference configuration of the test lighting systems at the FAA Tech Center Lighting Test Bed

- Small scale installations of all four test circuits under consideration are being tested and evaluated sequentially


VIS 5000
PONTA DELGADA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Electrical Test

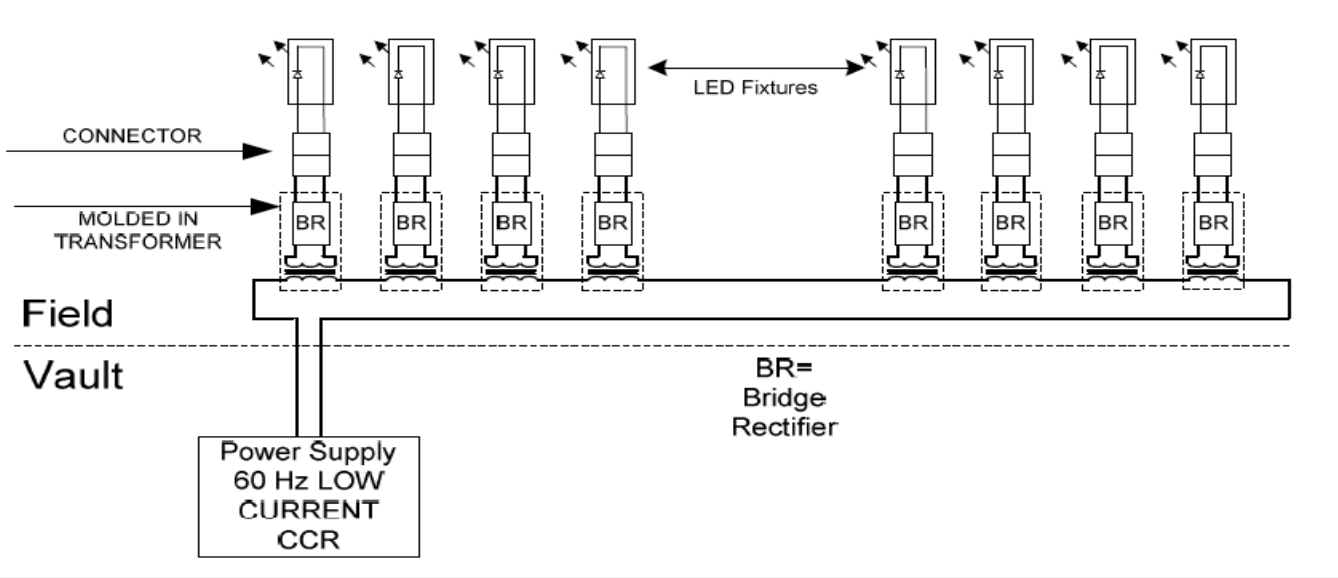
- 50 Fixture test bed in reference circuit configuration
- Measurements collected at 5 different intensity levels

Scope of the EIRT Test Team

- Test and characterize elements of representative architectures
  - 2 amp Bipolar Pulsing DC System (DC System) – Completed 2011
  - Reduced Current System – March 2012
  - Smart Fixture Low Current System – June 2012
  - Parallel Smart Fixture System – September 2012
- Analyze Data from testing and information purely from analysis
- Evaluate all information and present to EIRT
- Basis: Relative benefit of each architecturally related feature using today's 6.6 amp Circuit as a baseline

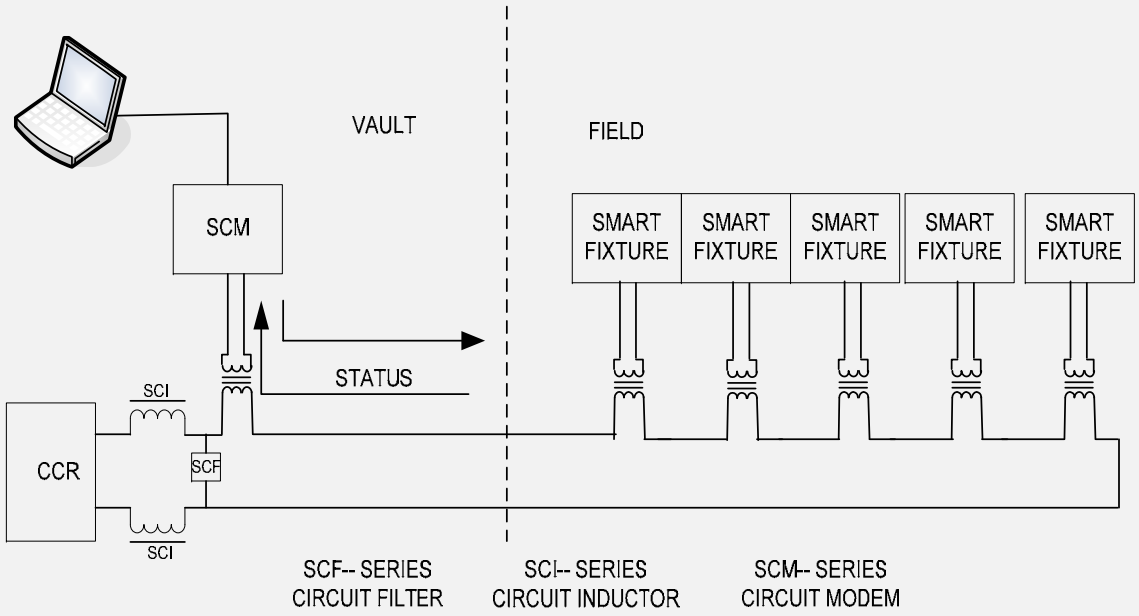
Reduced Current Series System - April 2012

- Taxiway Edge Fixtures
- Step Up Isolation Transformer, with Bridge Rectifier Molded in (1:5 Ratio)
- Field Current drives LED
- 2.2 amp B5; 44mA at B1
- Sinusoidal Power Source



Smart Fixture Low Current Series System - June 2012

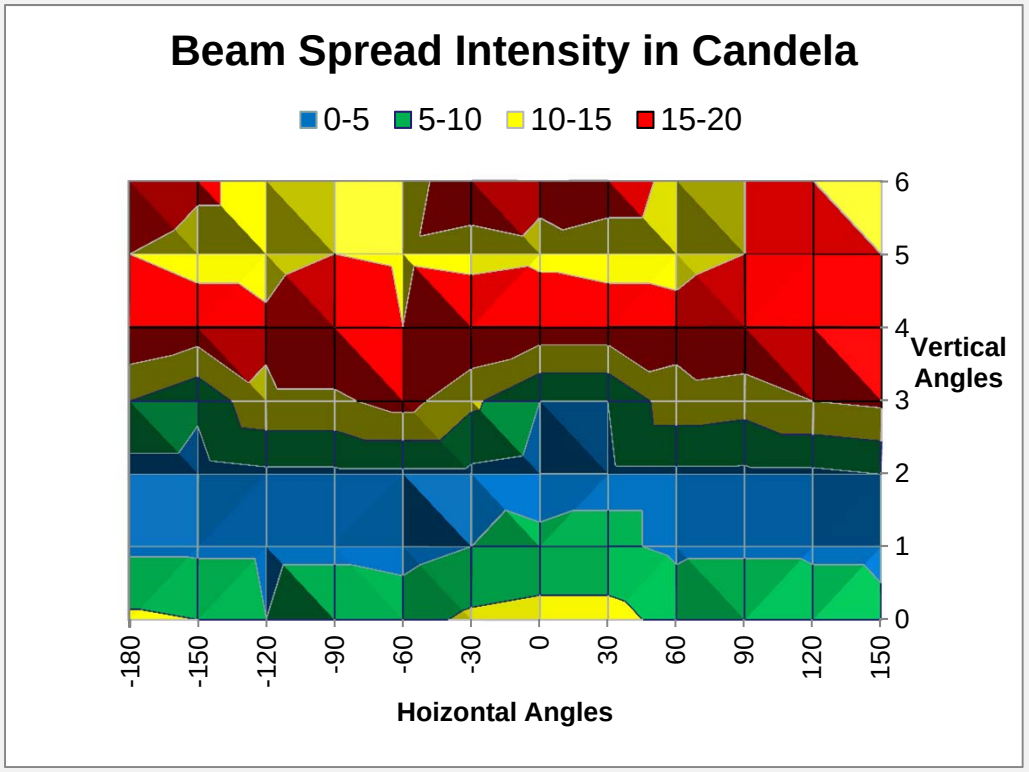
- Smart Fixture, LED Driver in fixture electronics
- Taxiway Centerline Fixtures, Uni / Bi directional
- Brightness levels, commanding and status via Power Line Carrier
- Supports Legacy Mode, Also operates at the 6.6 amp Steps
- Off the Shelf Thyristor CCR used as Power Source



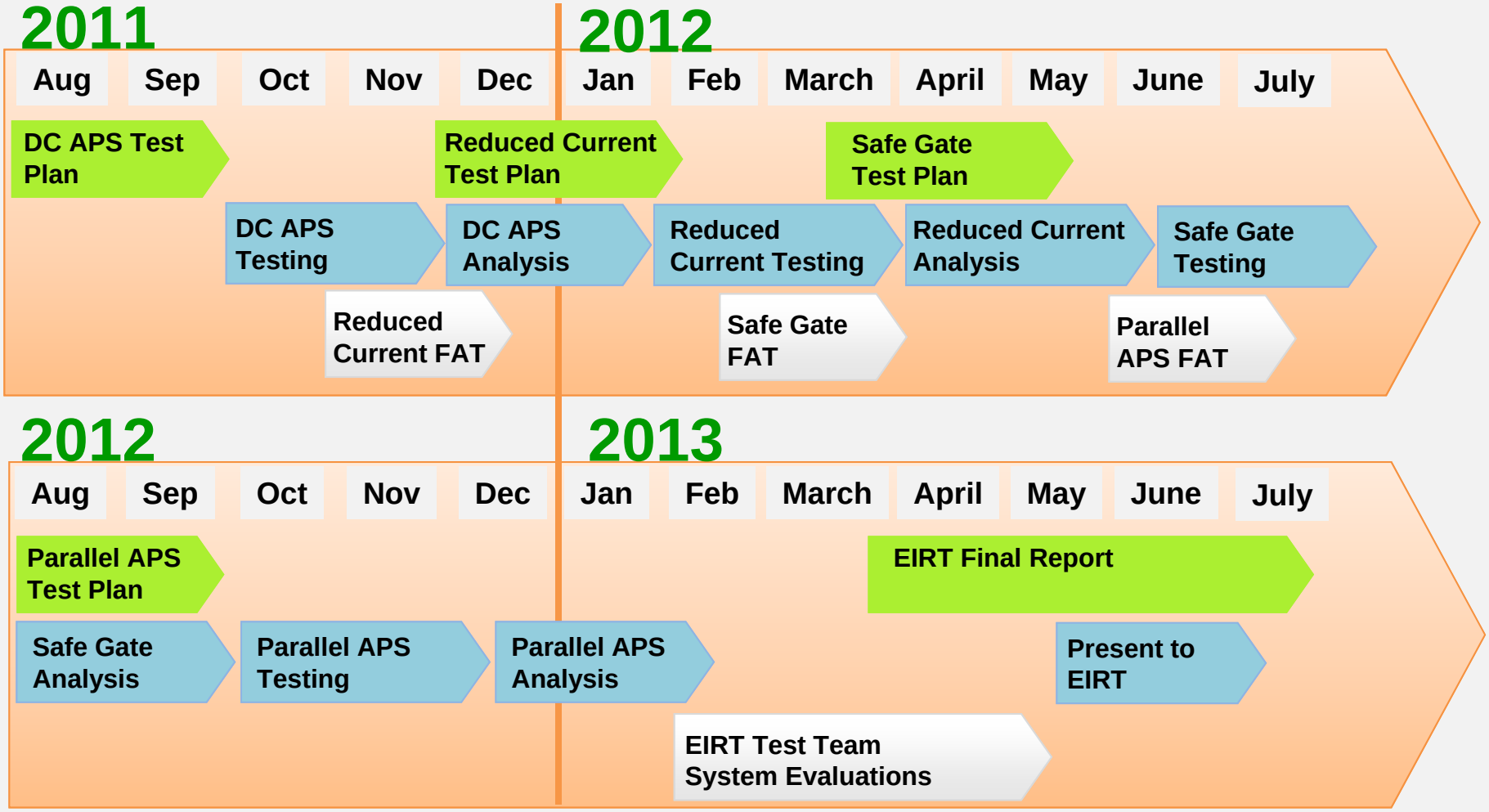
Photometric Test Goals

Measure the following photometric characteristics

- Beam Spread
- Intensity
- Dimming
- Chromaticity



Proceeding Forward



Vertical Flight Research

Vertical Flight

- **Advisory Circular (AC) 150/5390-2B provides guidance for illuminating the heliport landing and taxi areas**

U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: HELIPORT DESIGN | Date: 09/30/04 | Initiated by: AAS-100 | AC No: 150/5390-2B | Change:

1. PURPOSE. This advisory circular (AC) provides recommendations for heliport design and describes acceptable requirements to develop a heliport. This AC applies to anyone who is proposing to construct, activate or deactivate a heliport.

2. APPLICABILITY. This AC is not mandatory and does not constitute a regulation except when Federal funds are specifically dedicated for heliport construction.

3. EFFECTIVE DATE. The effective date is September 30, 2004.

4. CANCELLATION. AC 150/5390-2A, *Heliport Design*, dated January 20, 1994, is canceled.

5. EXECUTIVE SUMMARY. The modern helicopter is one of the most versatile transportation vehicles known to man. Typically, a heliport is substantially smaller than an airport providing comparable services. The helicopter has the capability of providing a wide variety of important services to any community that integrates this aircraft

Findings

Vertical / Horizontal	Intensity
>1° - 15° / 360°	10 candelas min
>15° - 90° / 360°	5 candelas min

The measured minimum may be no more than three times the specified minimum intensity

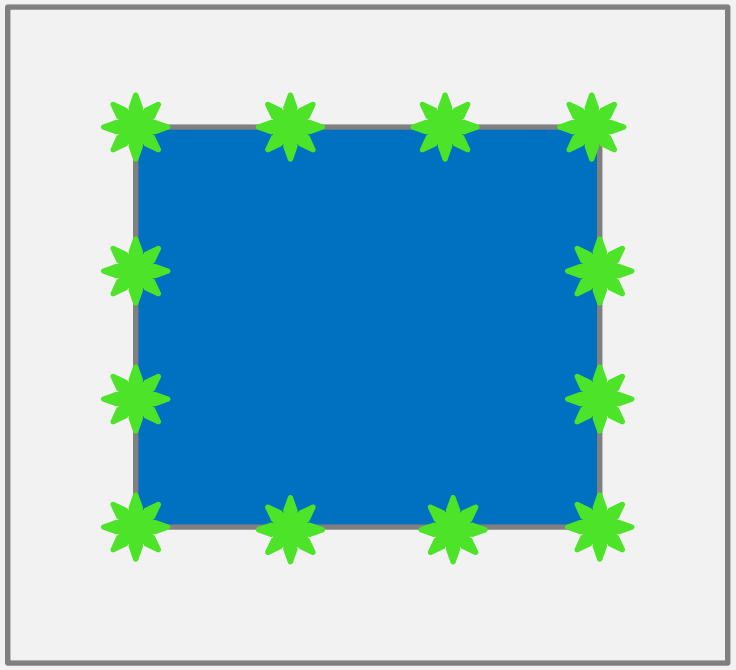
- **Follow-on research to the perimeter lighting study is being conducted with the support of University of North Dakota Aerospace.**

Research Objectives:

- **–Do the pilots need to have both FATO and TLOF lights?**
  - **If not, do they prefer FATO or TLOF?**
- **–How much can we reduce the number of lights and still satisfy the two-mile operational requirement?**
- **–Is there a benefit to toggling the lights in respect to acquisition distance and confidence?**

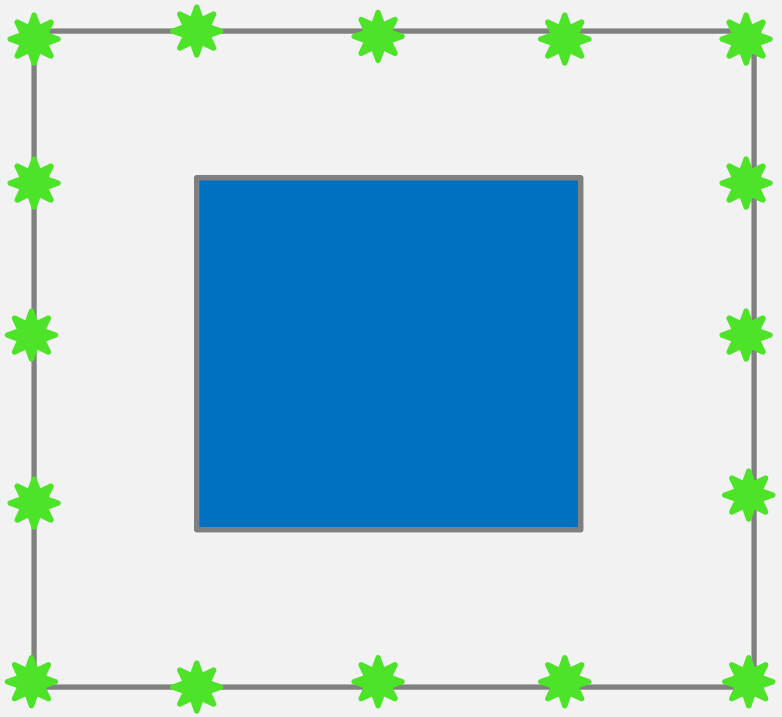
Follow-on Research Data

- **TLOF lit only**
  - 2.25 miles
  - 120 data pts



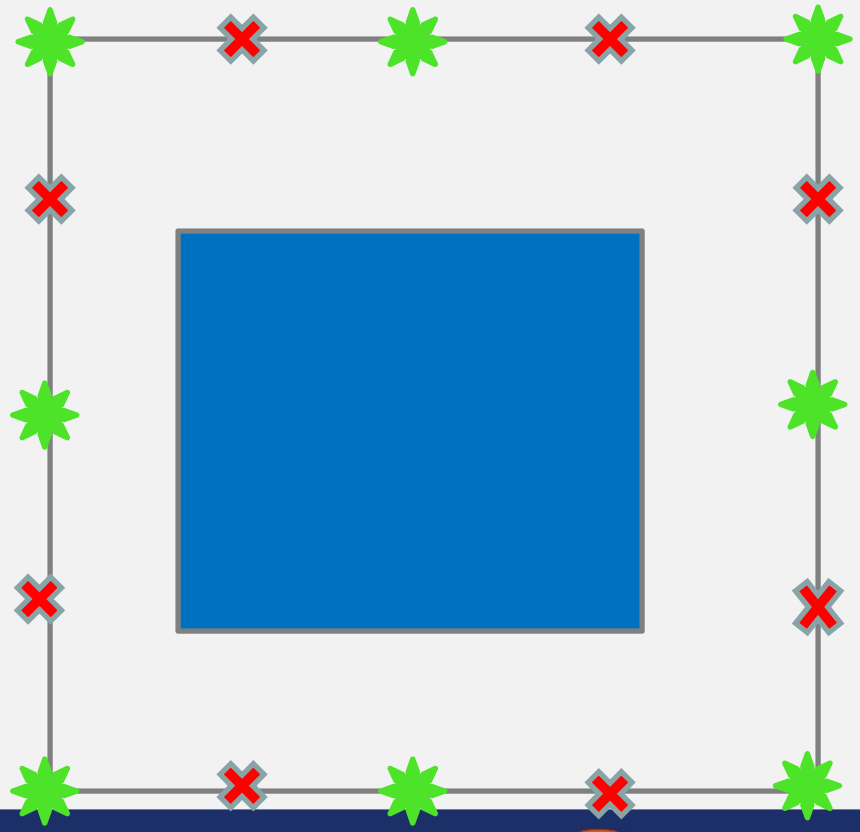
Follow-on Research Data

- **FATO lit only**
  - 2.61 Miles
  - 120 data pts



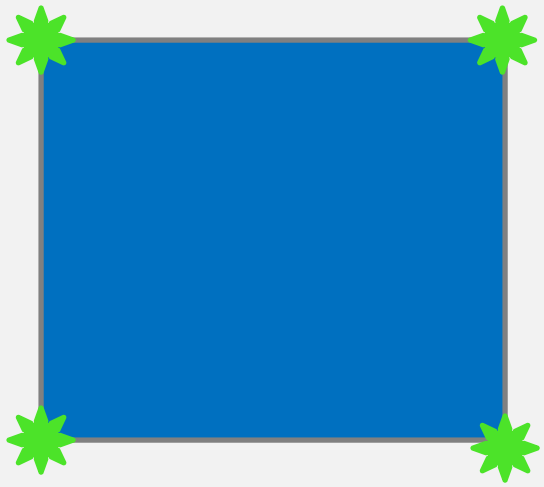
Follow-on Research Data

- **Every other light on FATO, TLOF off**
  - 2.41 miles
  - 144 data pts



Follow-on Research Data

- **TLOF Four Corners, no FATO**
  - 1.39 miles
  - 144 data pts



Follow-on Research Data

- **Pulsing, both rows fully lit**
  - 2.71 miles
  - 240 data pts

Follow-on Research Data

912 Total Data Points

- Only configuration that did not meet two-mile minimum:
  - TLOF Four corners lit, no FATO: 1.39 miles

- **Max distance result:**
  - Pulsing, both rows fully lit: 2.71 miles

Future Research Work

- Circular Lighting Array
- Floodlights
- Supplemental Flight Trials, 2nd Location (Phoenix, Arizona)
- Final Report

Internally Lighted Wind Cone Study

Standards for Internally Lighted Wind cone

1. Review the current FAA standards for wind cones.

2. Evaluate current commercially available internally-lighted wind cones to ensure they provide adequate wind direction and speed information under low velocity wind conditions.

Wind Cone Literature Review

- A literature review was conducted to compare the current FAA standards for wind cones to international standards.

FAA and ICAO Certified Internally Lighted L-807 12’ Wind Cone

FAA Certified Externally Lighted L-806 8’ Supplemental Wind Cone

Uncertified Internally Lighted L-806 8’ Supplemental Wind Cone

Controlled Testing

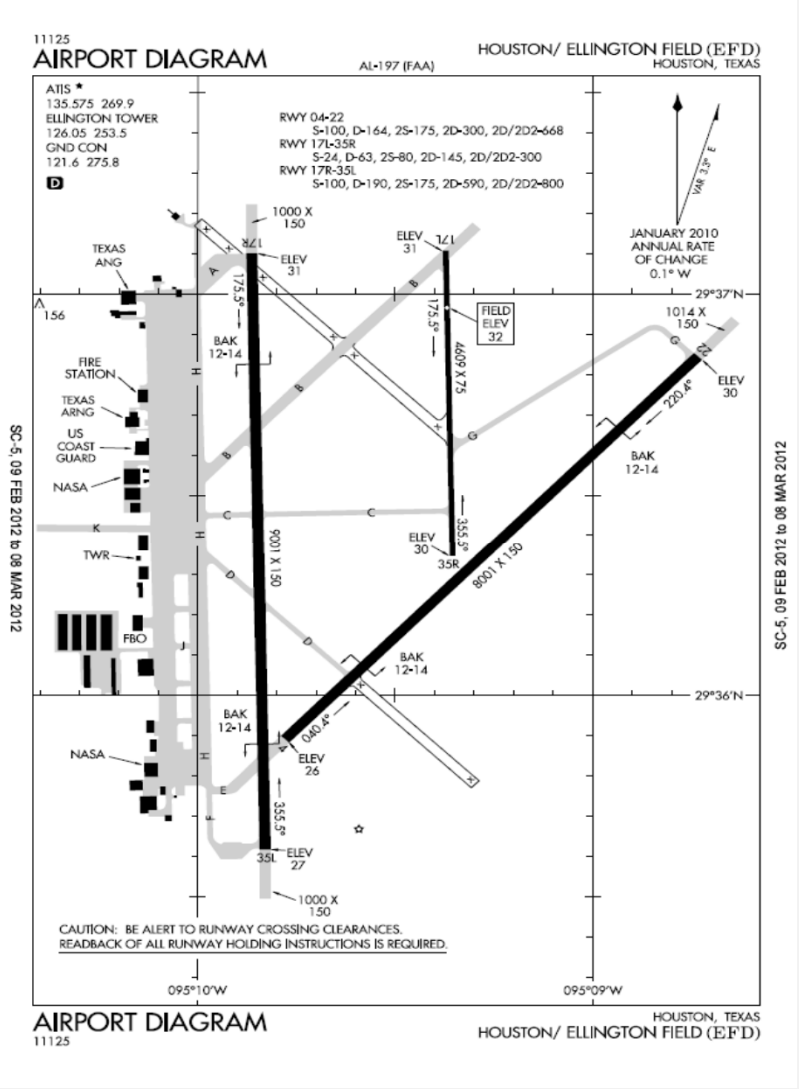
- A series of test were conducted on several commercially available internally lighted wind cones to determine how the products measure up to both FAA and International standards for wind cone movement and wind cone sock extension.

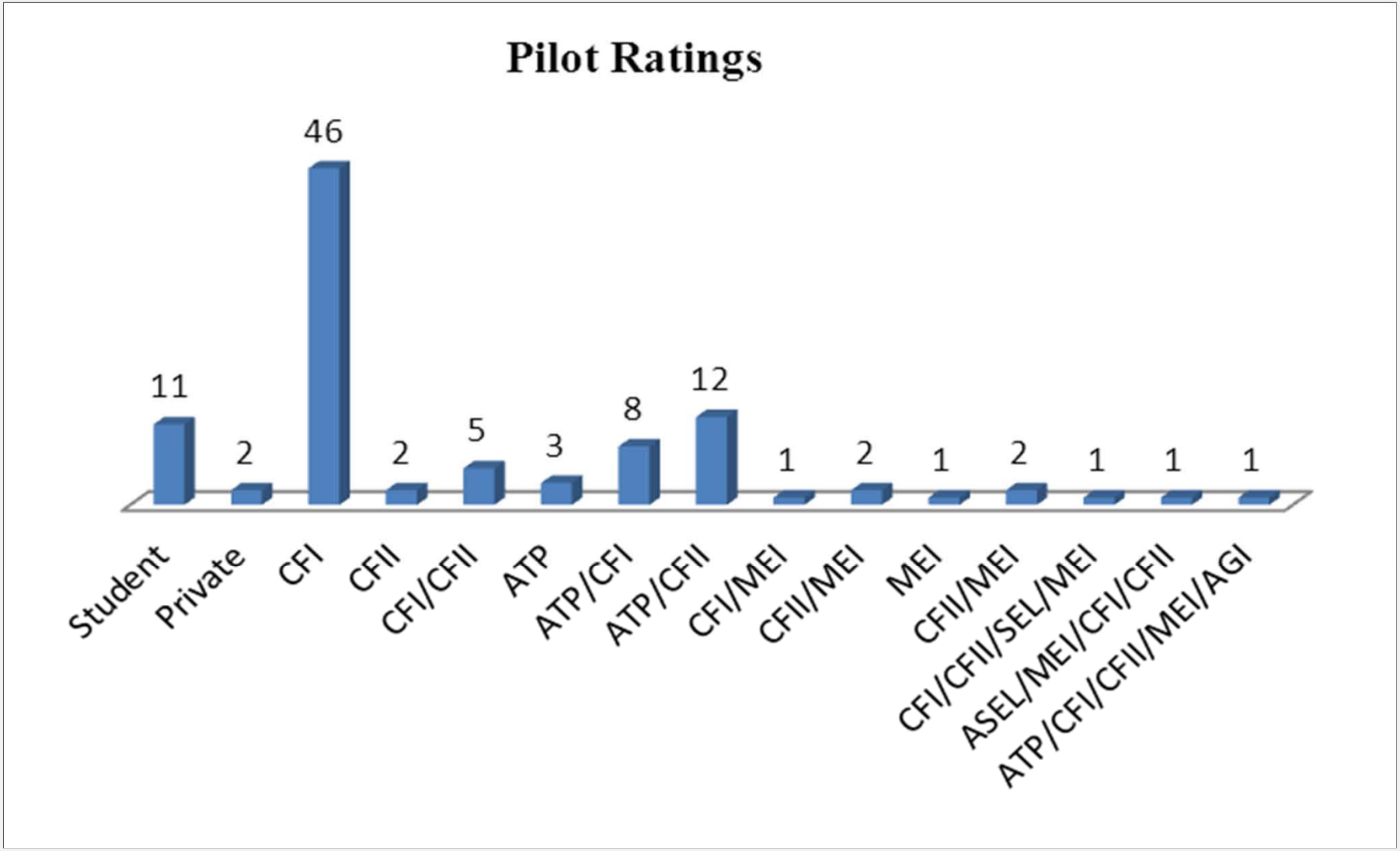
12 Foot Wind Cone Sock Extension Test						
Wind Speeds	0 knts	3 knts	5 knts	10 knts	15 knts	20 knts
FAA	not defined	not defined	not defined	not defined	full extension	full extension
Transport Canada	not defined	not defined	no more than 30º below the horizontal	no more than 5º below the horizontal	full extension	full extension
Test Photos						

Windsock Movement Test

Flight Evaluations

- Agreement reached with Ellington International Airport and their local flight schools Aerosim Flight Academy and Flying Tigers.
- Installed at Ellington International Airport are both 12 foot internally lighted wind cones as well as 8 foot internally lighted wind cones.
- Instructors and trainees will complete questionnaires to evaluate if the 8 foot internally lighted wind cone and the 12 foot internally light wind cone both give an adequate indication of the reported wind speed and wind direction conditions.




Pilot Ratings
11
2
46
2
5
3
8
12
1
2
1
2
1
1
1
Student
Private
CFI
CFII
CFI/CFII
ATP
ATP/CFI
ATP/CFII
CFI/MEI
CFII/MEI
MEI
CFII/MEI
CFI/CFII/SEL/MEI
ASEL/MEI/CFI/CFII
ATP/CFI/CFII/MEI/AGI

Compilation of Pilot Comparative Evaluation

•Question: How do you rate the two wind cones compared against each other?

	Wind cone '8' is better	Both are equal	Wind cone '12' is better
How do you rate the wind cones against each other? Overall	3%	21%	76%
Low wind velocity conditions	4%	23%	73%
High wind velocity conditions	0%	12%	88%

Questions or Comments?

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