Visual Guidance/Runway Incursion Prevention

Research & Development

Update

IESALC Spring meeting May 4, 2017
Washington DC

PROJECTS

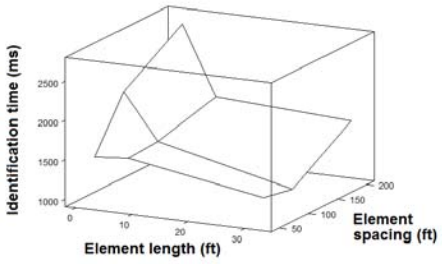
1. Airport Linear Source Visual Aid
2. Frangible Connections and Structures
3. In-Pavement Light Fixtures
4. Electrical Infrastructure Research
5. Infra-Red Requirements for LED HIRLs for use with EFVS
6. Infra-Red Requirements for Red Obstruction Lights for use with NVGs
7. Elevated Runway Edge Fixture Light Output

Airport Linear Source Visual Aid

Research Studies

- **Both Static and Dynamic Laboratory studies were conducted.**
- **Field Testing at Ohio State's airport was conducted utilizing Prototype linear light source segments were built in 2-ft, 4-ft, and 8-ft lengths.**
- **Simulation Studies were conducted using Chicago O'Hara as the airport.**

Developed Predictive Response Time Equation



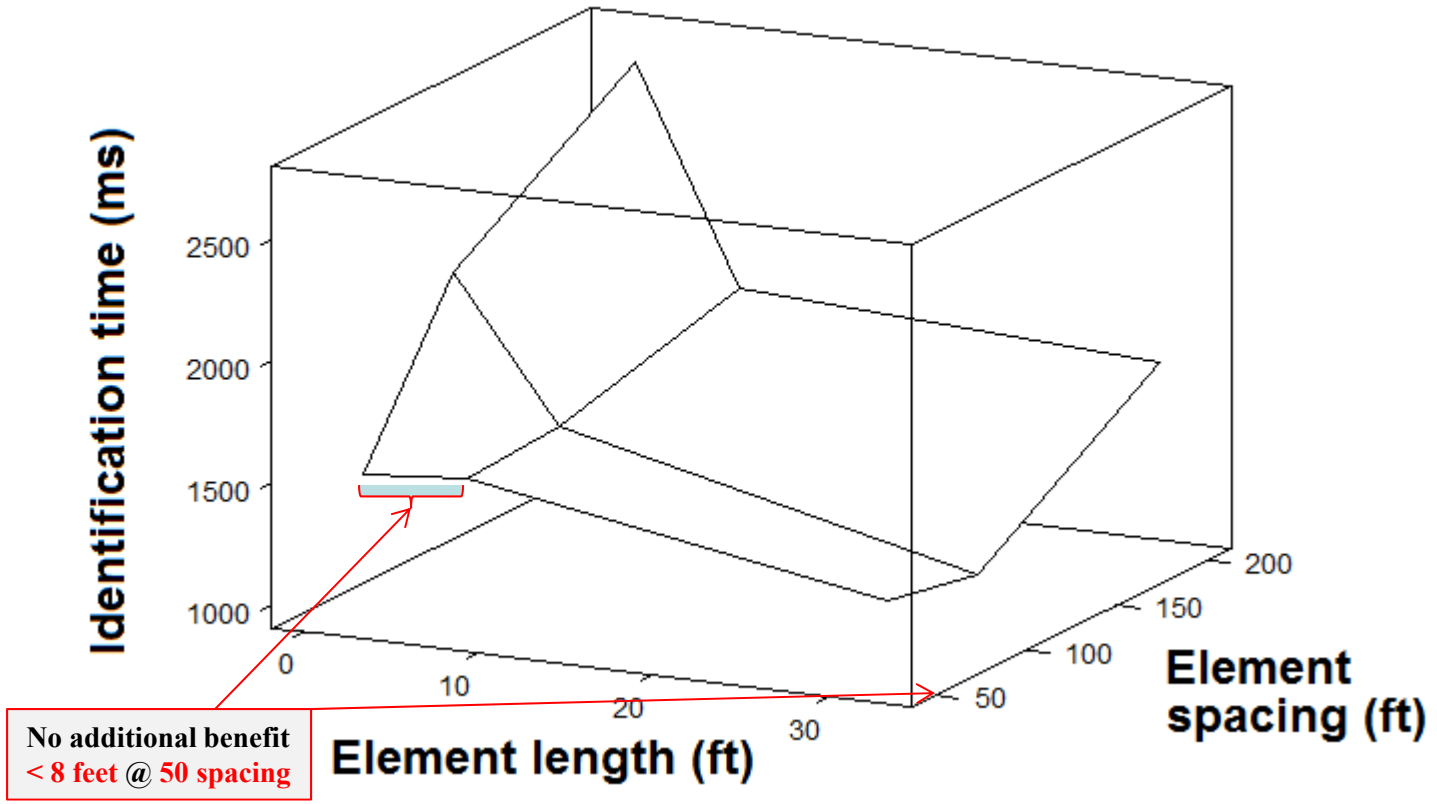
$$RT\ (ms) = 286 - 607 \log L + 989 \log S$$

Combinations of delineation element length and spacing to achieve the same relative response times expected from 2-ft-long delineation elements spaced at 50 ft and 100 ft.

Base Case 1	Element length	2 ft	**6.2 ft**	**12.0 ft**	**19.2 ft**
	Element spacing	50 ft	100 ft	150 ft	200 ft
	Relative response time	1784 ms	1784 ms	1784 ms	1784 ms
Base Case 2	Element length		2 ft	**3.9 ft**	**6.2 ft**
	Element spacing		100 ft	150 ft	200 ft
	Relative response time		2081 ms	2081 ms	2081 ms

Experiment Results

Accuracy was always > 90%



Results

- All results were consistent with the original laboratory experiments.
- A linear source of 2 feet or less, especially when viewed at a small angles, is equivalent to point source.
- A linear source, especially when viewed at a small angles, of less than 8 feet in length at standard spacing does not provide a significant advantage over a point source.
- Final report being prepared.

Frangible Connections and Structures

Research on Frangible Connections and Structures

Due to the wide variety of test methods/procedures utilized in the past, it is necessary to Standardize FAA Requirements for Frangibility Testing.

This will enable a path to simplification/ standardization of testing procedures and identify potential areas that require clarification.

The FAA Frangibility Guidebook will provide standardized procedures eliminating the large variety of differences in test procedures and allow comparison between all tests performed on different products.

Frangible Structures

- Equipment located in Airfield Safety Areas (e.g. RSAs and TSAs) must be mounted on frangible supports.
- Frangible mechanisms can be designed to withstand high wind loads but remain very sensitive to impact loads.
- Frangible mechanisms tend to be directional in strength, i.e. they carry high tension and bending but very low shear.

Types of Frangible Connections

Application of Fuse Bolts

Examples of Frangible Couplings

Frangibility Research Objective

- The overall research objective is to develop a standardized methodology for measuring and evaluating the frangibility characteristics of connections/structures intended for use on Airport Runway Safety Areas (RSAs) and Taxiway Safety Areas (TSAs).
- The FAA Frangibility Guidebook was Developed to Prescribe these Methodologies for Measuring and Evaluating Frangible Characteristics in Connections/Structures Located in RSAs and TSAs.

Research Elements

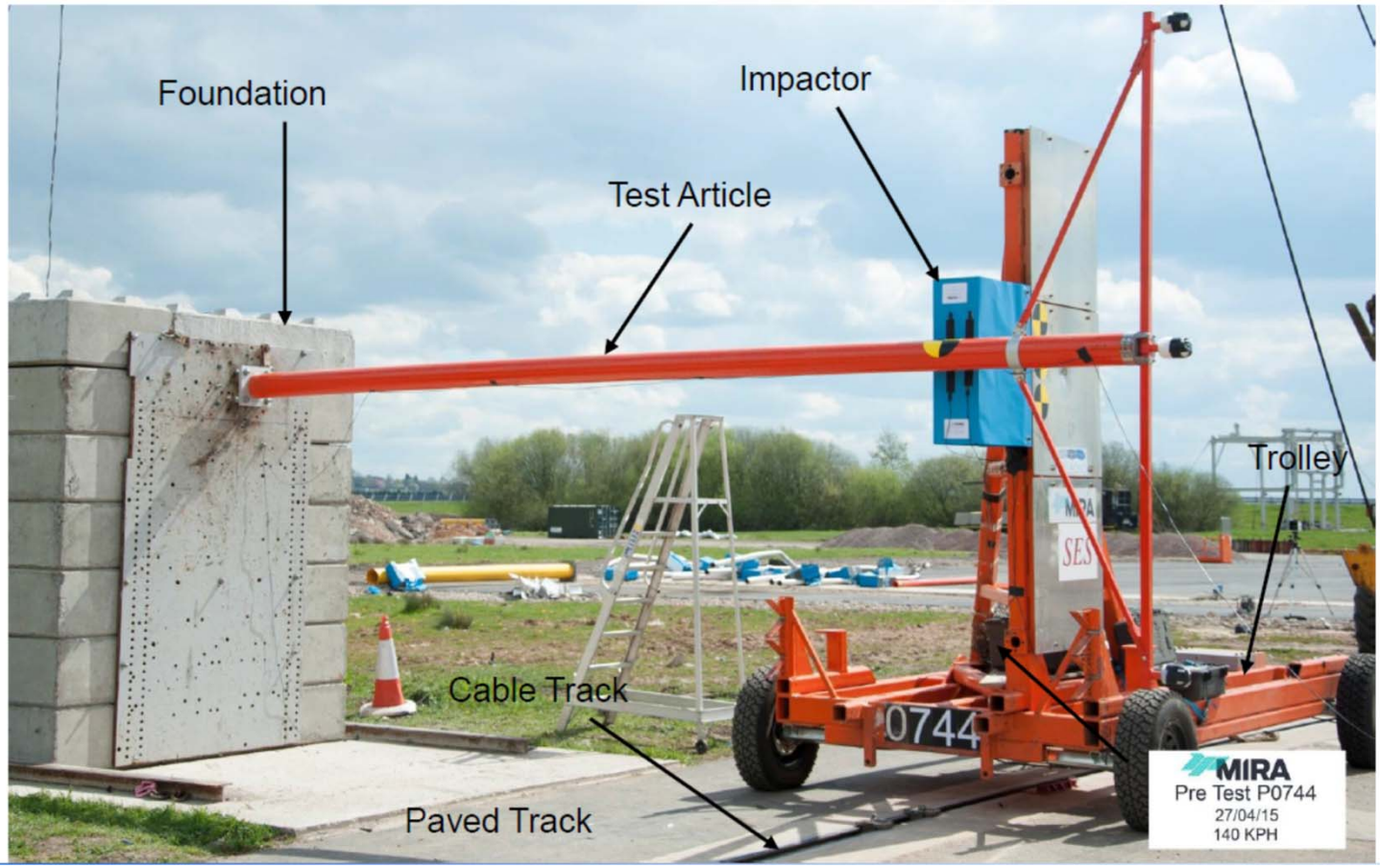
- FAA Frangibility Requirements Review
- Full Scale Testing
- Finite Element Simulation
- Development of FAA Frangibility Guidebook

Frangibility Structures Included in Testing

- FAA Approved Approach Lighting Systems
- Frangible Configuration of the End Fire Glide Slopes (EFGS)
- Mounting Configuration of Approach Lighting System located in the EMAS.

Frangibility Testing

Full Scale Testing



FAA Frangibility Guidebook

- Guidebook Contains Instruction for Airfield Product Manufacturers in Design, Testing and Qualification of Products.
- Guidebook Provides Direction Relating to Testing of Frangible Connections Currently Referenced to the National Cooperative Highway Research Program (NCHRP) in FAA AC 150/5220-23 “Frangible Connections”.

FAA Frangibility Guidebook Status

- Frangibility Guidebook Currently Under Review at FAA Headquarters
- Anticipate Publication of Frangibility Guidebook in 2017.

In-Pavement Light Fixtures

Evaluation of In-Pavement Light Fixtures

- In-Pavement Light Fixture Assemblies Utilize a Circle of Six (6) Bolts and Two-Part Locking Washers to Secure The Light Fixtures to the Light Bases or Light Base Extensions.
- Incidents Have Occurred at Certain Airports Where In-Pavement Light Fixture Bolted Connections Have Failed Resulting in Light Fixtures Completely Separating from the Light Bases or Light Base Extensions.
- Possible Root Causes of the Bolted Connection Failures Include Inadequate Bolt Clamping Forces for Resisting Impact Forces Generated by Modern Commercial Aircraft and Improper Installation/Maintenance of Bolted Connections.

Light Assembly Bolt Clamping Force Requirements and Limitations

- FAA Criteria Requires Combined Clamping Force of Bolt Circles be Capable of Resisting a 3,000 Pound Horizontal Shear Force, Simulating a Braking Aircraft Tire.
- FAA Currently Assessing Adequacy of 3,000 Pound Horizontal Shear Force Criteria Based on Current Generation Transport Category Aircraft Developing Greatest Wheel Loading.
- Bolt Clamping Forces Must Also Be Adequate to Prevent Significant Fluctuation in Bolt Tension When Subjected to Aircraft Wheel Loading.
- Significant Fluctuation in Bolt Tension Can Result in Fatigue Failure of the Bolts.

Research Strategy

- **Project Phase I: Laboratory Testing**

  - Determine Strength Limitations of Light Fixture Assemblies for Resisting Increased Bolt Clamping Forces.

  - Evaluate Performance of Light Fixture Assemblies using Bolts Prescribed in FAA Engineering Brief (EB) 83 and Bolts Having Greater Strengths and Larger Diameters.

  - Evaluate Light Fixtures over a Range of Commercially Available Strengths.

  - Conduct Horizontal Shear Force, Compressive Load, and Vibration Testing Including Assessing Influence of Spacer Rings.

  - Evaluate Corrosive Properties of Coated Carbon Steel Bolts and Black Oxide Coated Stainless Steel Bolts.

Research Strategy (Continued)

- **Project Phase II: Field Testing**

- Instrument and Install In-Pavement Light Fixtures in the FAA National Airport Pavement Test Facility (NAPTF) and on ACY Runway and/or Taxiway.

- Evaluate Performance of Installed Light Fixture Assemblies under Controlled Aircraft Wheel Loading/Tire Pressure Conditions.

- Controlled Wheel Loading with Test Vehicle in the FAA NAPTF and Instrumented FAA Aircraft (B727 and Smaller Size Aircraft) at ACY.

- In-Pavement Light Fixtures will be Installed and Evaluated in Both Asphalt and Portland Cement Concrete (PCC) Pavement.

End Product

- Identify Torque-Tension Relationships of Various Bolt-Light Base Flange Tapped Hole Combinations.
- Identify Limiting Bolt Clamping Forces that Can Be Safely Applied to Light Fixture Assemblies.
- Evaluate Performances of Various Light Fixture Assemblies based on both Laboratory and Field Testing.
- Identify Changes for Incorporation into FAA Engineering Brief No. 83 “In-Pavement Light Fixture Bolts” Regarding Selection, Installation, and Maintenance of Bolts.

Research Status

- Laboratory Testing is being Conducted under an FAA Contract with Intertek of Cortland, NY (FAA Accepted Third Party Certification Body in Accordance with FAA AC 150/5345-53).
- FAA Laboratory Testing Scheduled for Completion in August, 2017.
- FAA Contract for Installation and Testing of Installed In-Pavement Light Fixtures in the NAPTF is Planned for Award in Spring 2017.

Electrical Infrastructure Research

EIRT Testing Team Recommended Two Paths

- **Path # 1:**
  - **Fixture Centric**
    - **An airfield lighting architecture where the fixture controls its intensity**

- **Path # 2:**
  - **Vault Centric**
    - **An airfield lighting architecture that directly controls the fixture intensity from the power source in the vault(same as the traditional 6.6 amp)**

Roadmap Testing Phase

- Ongoing Testing of Fixture Centric at PEGASAS Airport (Purdue U.)
  - Larger circuit
  - Legacy mode available in case there is an issue with the circuit
  - Data collection to end no later than August 2017
  - Data collection so far has not seen any faults, system working well
  - Planning EIRT meeting Summer 2017
- Conduct Vault Centric Testing at FAA's New Research Taxiway Facility located at Cape May County Airport, New Jersey in Starting in May 2017

FAA's New Research Taxiway Facility

Cape May County Airport, New Jersey


Atlantic Ocean
Cape May, NJ
Delaware Bay
Cape May Canal
Cape May Ferry Dock
Garden State Parkway
Fishing Creek Road
9
Route 9 Shore Road
Breakwater Road
5000 Ft Runway
5000 Ft Runway
3,000 ft
S
W
E
N
19
Cape May County Airport (WWD)
Karl Richeson Photography

Significant Safety Issues (SSI)

Significant Safety Issues

- **The FAA Safety Management System (SMS) Executive Council agreed to apply** *cross-organizational resources to conduct comprehensive safety risk assessments for the top two SSIs*, **of which one was "Light Emitting Diode (LED), Lighting of Airfields, Obstacles, and Aircraft", or "FAA LED SSI" for short.**

- **The Office of Airports (ARP), as an Office of Primary Responsibility (OPR), is responsible for developing mitigation strategy and risk control for the hazard.**

3 SSI related projects

- Infra-Red Requirements for LED HIRLs
- Infra-Red Requirements for Red Obstruction Lights for use with NVGs
- Elevated Runway Edge Fixture Light Output

Infra-Red Requirements for developing a Elevated LED HIRLs with IR emitter

Infra-Red Requirements for LED HIRLs

- Develop IR requirement based on legacy L-862 incandescent fixture measurement, and use visual light requirements from FAA AC 150/5345-46 (current version), and FAA EB 67D.

- Perform IR measurements (IR power output in watts per steradian, and IR beam pattern) on the legacy tungsten halogen FAA L-862 (HIRL), which current EFVS system's utilizes, to determine current IR output.

Infra-Red Requirements for LED HIRLs

- **Intent to develop an FAA L-862(L) with IR output by:**
  1. **Identifying requirements based on:**
     - **a. Measure the legacy L-862 incandescent HIRL fixture IR output and IR beam pattern.**
     - **b. Utilize the visual light requirements from FAA AC 150/5345-46 (current version), and FAA EB67D.**

Broad Agency Announcement (BAA)

- **Conduct Feasibility Study to determine:**
  - **a. If an L-862 (L) can be developed to incorporate the required IR.**

    or

  - **b. If a standalone IR only emitter can be developed to meet 1.a above.**
- **Build a prototype.**

Infra-Red Requirements for LED HIRLs

Out of 11 submittals 8 Companies were ask to submit Phase II Proposals.

Schedule		
	From	To
BAA Phase I	02/12/16	2/19/2016
Evaluation	02/22/16	3/10/2016
Candidates Notified		3/25/2016
Phase II Submissions	03/28/16	6/25/2016
Evaluation period	6/27/2016	7/25/2016
Award Notification		9/22/2016
Phase II	10/1/2016	4/30/2017

2 Companies awarded a contract.

Infra-Red Requirements for LED HIRLs

- **Prototypes completed**
- **Next Step:**

  Prototype performance for use with EFVS will be validated by the Office of Flight Standards

Infra-Red Requirements for Red Obstruction Lights for use with NVGs

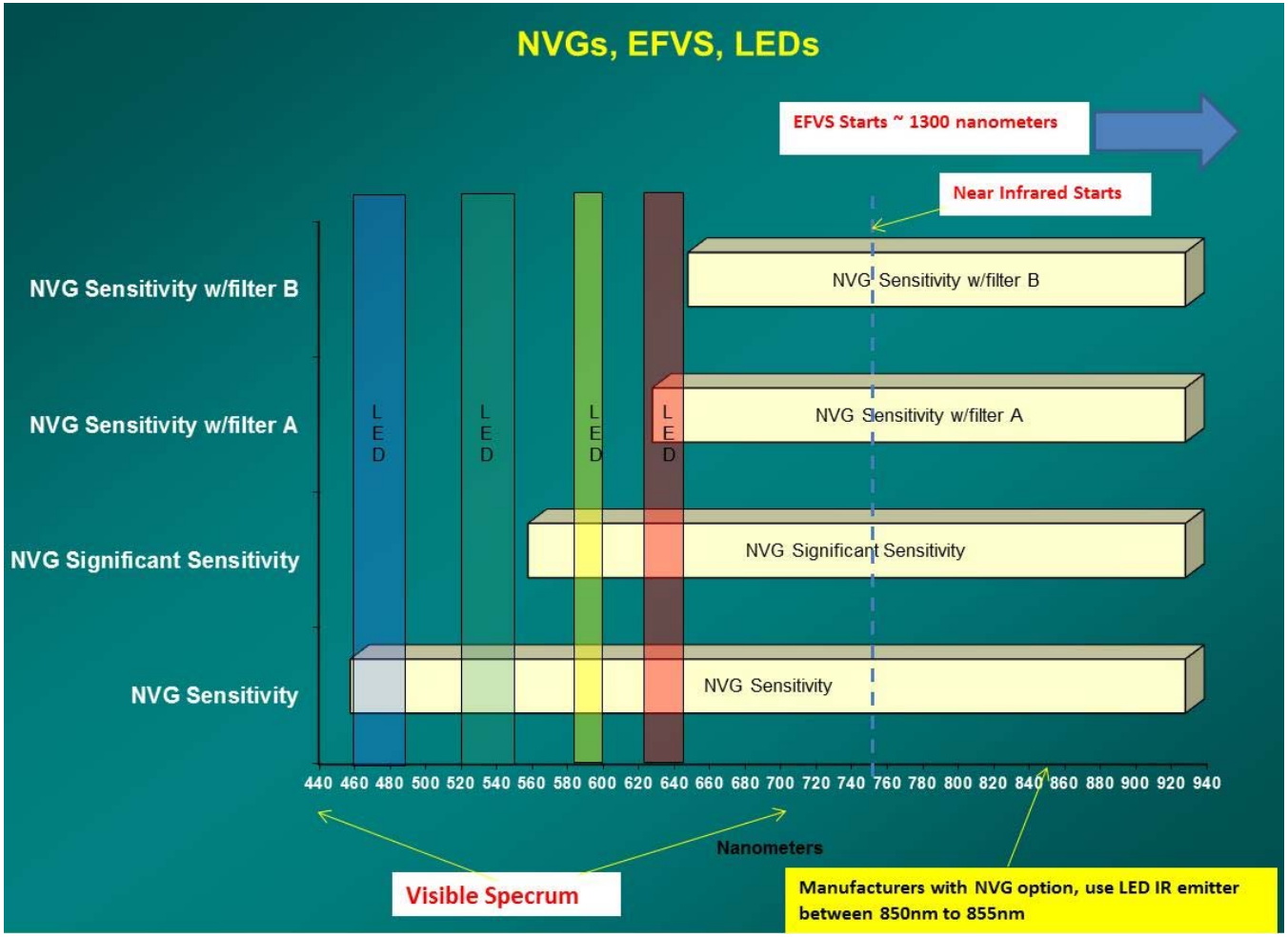
Infra-Red Requirements for Red Obstruction Lights for use with NVGs

- The FAA Significant Safety Issues (SSI) team has identified a SSI associated with red obstruction lights that rely on LED not being visible to pilots when using Night Vision Goggles (NVG).

- The red obstruction lights flashing omnidirectional (L-846) lights and/or steady-burning or flashing (L-810) lights.

- The inability to see certain LED obstruction lights is a result of NVG being equipped with filters to exclude light from the cockpit illumination.

Infra-Red Requirements for Red Obstruction Lights for use with NVGs



Infra-Red Requirements for Red Obstruction Lights for use with NVGs

- Determine performance specifications for Emitters to be incorporated into L-810 and L-864 LED obstruction light fixtures.

- The specifications for the Emitters will be based on the operational requirement for red LED-lit obstruction lights to be visible to operators in AC 7460-1 *"Obstruction Marking and Lighting"*.

Infra-Red Requirements for Red Obstruction Lights for use with NVGs

- The specifications for the IR emitters will include:
  - Specific output wavelength for the IR emitters
  - Minimum IR radiant intensity output (watts/steradian).
  - Beam width

Elevated Runway Edge Fixture Light Output

Elevated Runway Edge Fixture Light Output

- FY15-SSI-LED_06: Loss of Sight of LED Airport Lighting. This hazard description states "LED directionality is more focused than incandescent lighting. During night VFR (e.g., VFR traffic pattern, circling approach), flight crew loses sight of segments of LED airport lights."

- The purpose of this research measure current runway edge light emissions from existing certified incandescent high and medium intensity lights in vertical areas between 15-90 degrees.

Elevated Runway Edge Fixture Light Output

Scope of Work:

- Obtain at least 2 samples of each fixture types, L-862 & L-861, from certified manufacturers.
- Measure lights in vertical areas between 15-90 degrees at 5 degree increments for Vertical scan and 10 degrees increments for Horizontal scan.
- Measurements will be taken at all intensity levels (L-861 Step 3 at 6.6A, 2 at 5.5, 1 at 4.8a and for L-862 Step 5 at 6.6A, 4 at 5.2A), 3 at 4.1A, 2 at 3.4A and 1 at 2.8A)

Elevated Runway Edge Fixture Light Output

Conclusion:

- **Memorandum Report will be submitted to the Office of Airport Safety and Standards containing Luminous Intensity (candela) data for all fixtures tested.**

Questions/Comments?