AIRPORT TECHNOLOGY R&D
LIGHTING RESEARCH

Federal Aviation Administration

Presented to: IES ALC Government Contacts Mtg.

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Airport Technology R&D Lighting Research

- **Technical Evaluation of Electrical Infrastructure for Light Emitting Diodes.**
- **Lightning Protection Counterpoise Literature Review**
- **In-Pavement Light Fixtures**
- **Evaluation of Solar Lighting Systems on Airports**

Electrical Infrastructure Research Team (EIRT)

- **The EIRT was formed in 2011 to investigate optimal ways that power could be delivered to airfield fixtures that use Light Emitting Diode (LED) components.**
- **The EIRT is made up of the following:**
  - FAA Researchers
  - Lighting Manufacturer Product Design Engineers
  - Academic Researchers
  - Airfield Lighting Subject Matter Experts

EIRT Electrical Infrastructure Concepts

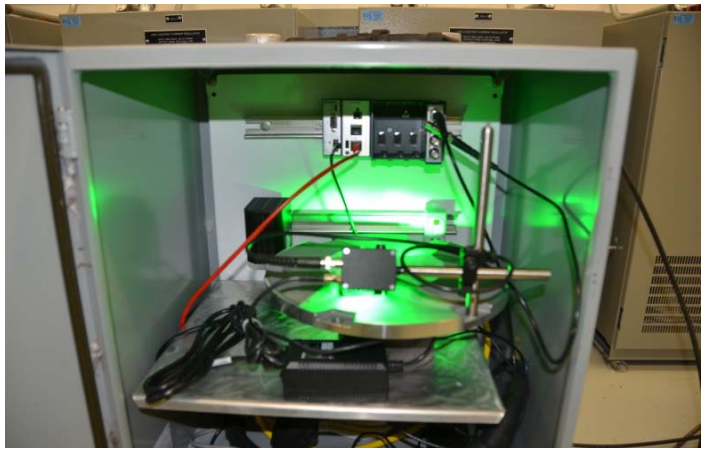
- **Two LED infrastructure concepts were selected for further evaluation:**
  - "Vault-centric": Light intensity is controlled by a power source for the entire circuit. The fixtures are passive and directly track circuit current.
  - "Fixture-centric": Each fixture controls its intensity level after digital intensity information is conveyed to it.

Project Approach

- **Each LED lighting infrastructure concept is being tested under a series of stress conditions to assess the operational margins and overall suitability of the each concept for the airport environment.**
- **Testing is being conducted at the FAA's Research Taxiway at Cape May County Airport.**

Vault-Centric Infrastructure

- **150 LED light fixtures installed along FAA Research Taxiway including taxiway centerline and runway edge light fixtures.**
- **All light fixtures are connected in series.**
- **Three fixtures instrumented with photometric sensors to measure relative light output and current probes to measure fixture current.**
- **Each instrumented fixture is mounted in a separate mobile cabinet that can be connected at various points in the circuit, depending on requirements of specific tests.**

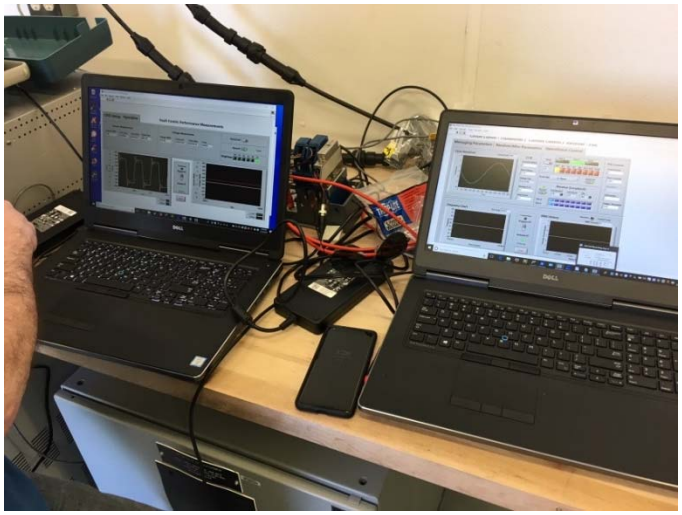


Fixture-Centric Infrastructure

- **Approximately 150 LED fixtures, supplied by three manufacturers, installed on 3 respective sign pads along FAA Research Taxiway.**
- **Light fixtures mounted on each sign pad are connected in series consistent with current airport circuits.**
- **Three light fixtures instrumented with current probes to measure fixture current and count occurrences of successful intensity commands.**
- **Each instrumented light fixture is mounted in an orange electrical panel located adjacent to one of the groups of fixtures.**

Vault-Centric and Fixture-Centric Test Interfaces

- **Test data recorded on laptop computers and oscilloscopes located in lighting vault.**
- **Vault Centric Performance Data from photometric and current sensors recorded during testing.**
- **Fixture Centric Data consists of successful intensity messages also recorded during testing.**
- **Remote Data from field instrumentation uses the existing Cape May fiber network.**



EIRT Testing Schedule

Milestone	Date
Complete Lighting System Installations	January 2018 Complete
Data Collection	February-June 2018 Underway
Complete Data Collection	June 2018
Data Analysis	June-August 2018
Complete Final Report	September 2018

Lightning Protection Counterpoise for LED Lighting

- **The Office of Airport Safety and Standards tasked the Airport Technology Research and Development Branch (ATRD) to review two reports from studies conducted by Mississippi State University and University of Florida on Lightning Protection Counterpoise.**

Background

- **In order to prevent damage to airfield lighting system components from lightning strikes, the FAA currently specifies that counterpoise systems be installed for airport lighting components.**

- **The guidance for these counterpoise systems are specified in Advisory Circular (AC) 150/5340-30, Design and Installation Details for Airport Visual Aids.**

Background (cont.)

- **As stated in paragraph 12.5 of AC 150/5340-30, the purpose of counterpoise lightning protection systems consists of the following**

- **“To provide a low resistance preferred path for the energy from lightning discharges to enter the earth and safely dissipate without causing damage to equipment or injury to personnel. The counterpoise system is installed on airfields to provide some degree of protection against the energy induced from lightning strikes to underground power and control cables.”**

Lightning Protection Counterpoise for LED Lighting

- **Two concepts for lightning protection counterpoise currently are in use:**
  - Equipotential Lightning Protection System: Connects the counterpoise to the light bases for runway edge lights - both the light bases and the counterpoise are at equal potentials or “equipotential”.
  - Isolation Lightning Protection System: Does not connect the counterpoise to the light bases or mounting stakes for the runway edge lights and uses the counterpoise conductor as a barrier that is located between the runway edge and the edge lights.

Project Objectives

- **Evaluate the technical merits of each report.**
- **Provide recommendations as to which report(s) should be posted on the FAA website**

Reports Reviewed

- **“Study of the Counterpoise Lightning Protection System for a Scale Model Runway”, May 2015, C. Taylor.**

- **“Engineering Analysis of Airfield Lighting System Lightning Protection”, January, 2006, V.A. Rakov, M.A. Uman.**

Report Overview

- **"Study of the Counterpoise Lightning Protection System for a Scale Model Runway" (Miss. State U.)**
  - Constructed and tested a 100: 1 scale model and Circuit Simulation Modeling of pavement, shoulder, soil, lighting base, cable, and counterpoise.
  - The report analyzes simulated lightning strike data from the scale model and simulations
  - Report studies simulated impact of lightning to an edge light configuration, where lights are not installed in pavement.

Report Overview

- **"Engineering Analysis of Airfield Lighting System Lightning Protection" (U. of Florida)**
  - This study consisted of an evaluation of multiple previous publications regarding counterpoise protection for airfield lighting
  - These include FAA ACs, Army, Navy and Airforce reference documents, and industry research and papers
  - Describes and provides a comprehensive analysis of equipotential and isolation methods of counterpoise protection and variants, and the advantages and disadvantages of each.

Project Schedule

Milestone	Completion Date
Draft Memorandum	May 31, 2018
Final Memorandum	July 2, 2018

In-Pavement Light Fixtures

- **Draft of FAA Engineering Brief (EB) 83A, In-Pavement Light Fixture Bolts.**
- **In-Pavement Light Fixture Installation, Instrumentation, and Testing.**

FAA Draft Engineering Brief 83A

- **FAA Airport Engineering Division (AAS-100) Letter dated April 27, 2018 Circulated Draft EB 83A to Interested Industry Associations for Review and Comments.**
- **PDF Version of Draft EB 83A Available on FAA Website at https://www.faa.gov/airports/engineering/engineering_briefs/.**
- **Comments Requested to be Submitted by May 25, 2018.**
- **Comments to be Submitted to Raymond Zee, P.E., FAA Airport Engineering Division (AAS-100) at Raymond.Zee@faa.gov.**

Engineering Brief 83A Highlights

- **EB83A Applies to Bolted Connections Addressed in AC 150/5345-42.**
- **Bolts Shall be Capable of Generating a Minimum Clamping Force of 4,900 lbs. While Not Exceeding 75% of Bolt Material Proof Load or Yield Strength.**
- **Minimum Clamping Force Based on Resisting Governing Aircraft Wheel Loading Generating a Maximum Horizontal Shear Force of 11,760 Pounds.**
- **Minimum Clamping Force will Equate to use of 3/8 Inch Diameter Bolts with Strengths Equivalent to a SAE J429 Grade 5 or ASTM F593P Bolt Materials.**
- **Light Fixture Manufacturers Must be Consulted to Confirm that Their Light Fixtures can Be Safely Installed with a Clamping Force per Bolt of 4,900 Pounds.**

Engineering Brief 83A Highlights

- **Recommended Industry Best Practices that Bolting System Mock-Up be Tested Utilizing a Bolt Tension Calibrator (Skidmore-Wilhelm or Equal) and Calibrated Torque Wrench to Establish the Bolt Installation Torque Based on Required Clamping Force.**
- **Testing with Bolt Tension Calibrator will Account for Bolt Lubricant or Coating, and Mechanical Properties of Materials in Grip (Light Fixtures, Bases, Locking Washers (if Used), and Bolts).**

Engineering Brief 83A Highlights

- **Recommended Industry Best Practice for Future Light Fixture Modifications to Include No More Than 3 Spacer Rings (Including Flange Ring) with L-868 Light Cans.**
- **Spacer Ring Stacks with L-868 Light Cans Shall Not Exceed 2 3/16” In Height.**
- **Extension Cans Shall be Used in Installations Where Spacer Ring Height Requirement Exceeds 2 3/16”.**
- **Manufacturers of Two-Part Locking Washers Must Demonstrate Performance in Vibration and Embedding Tests Per ISO 16130, Dynamic Testing of the Locking Behavior of Bolted Connections Under Transverse Loading Conditions (Vibration Test).**
- **Changes to Applicable FAA Advisory Circulars to Reflect Changes in EB 83A.**

Testing of Instrumented, Installed In-Pavement Light Fixtures in the FAA National Airport Pavement Test Facility (NAPTF)

The National Airport Pavement Test Vehicle

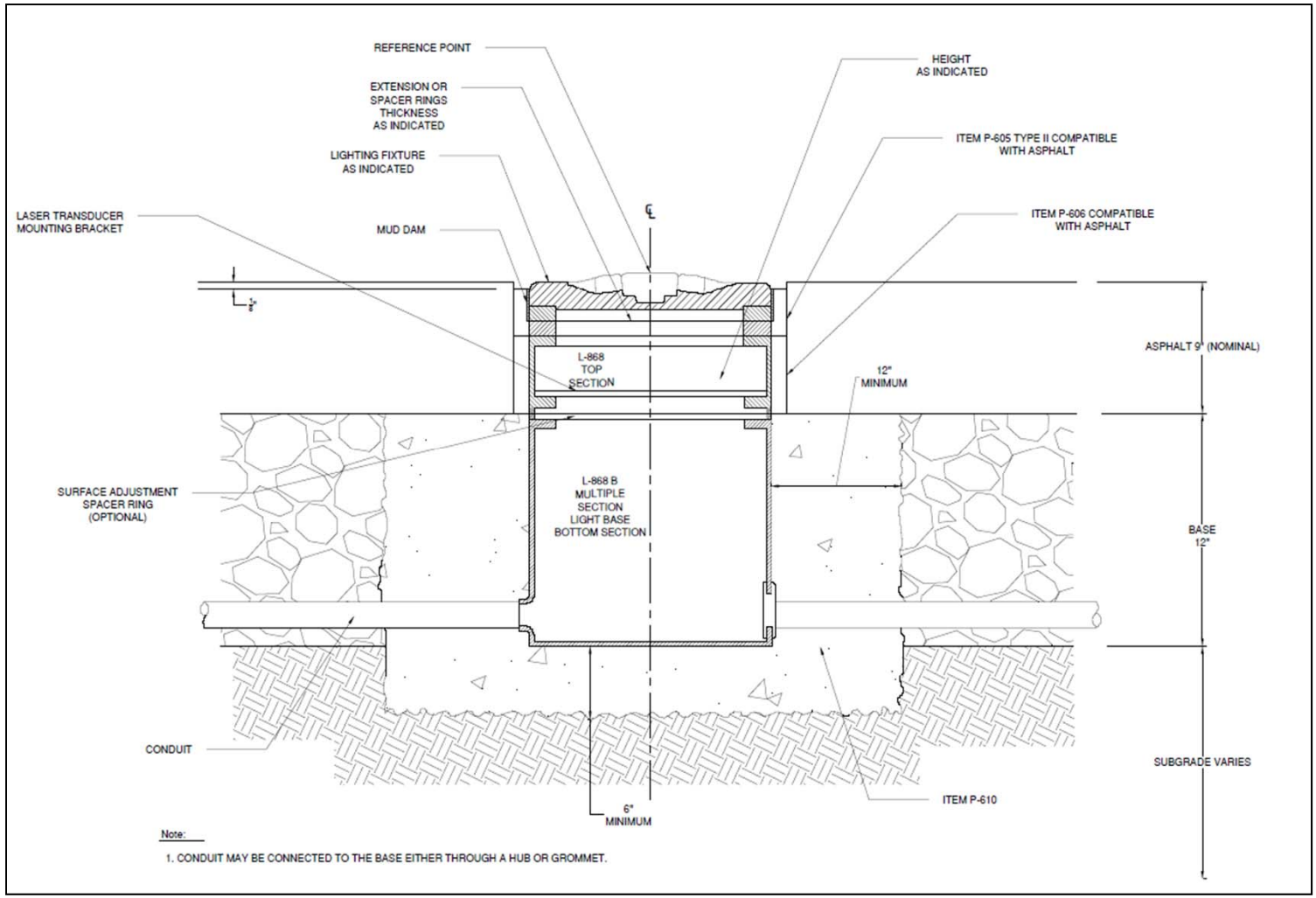
Light Fixture/Instrumentation Arrangement

- **Eight Instrumented Light Fixture Assemblies will be Installed in an Asphalt Pavement Test Section.**
- **Light Fixture Instrumentation to Include the Following:**
  - **Strain Gauges on Light Fixtures, Light Base Top Sections, and Fixture Bolts**
  - **Tri-Axial Accelerometers on Light Fixtures**
  - **Laser Transducers to Measure Horizontal/Vertical Movement Between Light Fixtures and Bases**
- **Light Fixture Assemblies will be Installed in Two Rows of Four Spaced Laterally and Longitudinally on 10-Foot Centers.**
- **Strain Gauges will be Installed in the Asphalt Pavement Around Each Light Fixture to Measure Longitudinal and Transverse Strain in Pavement.**

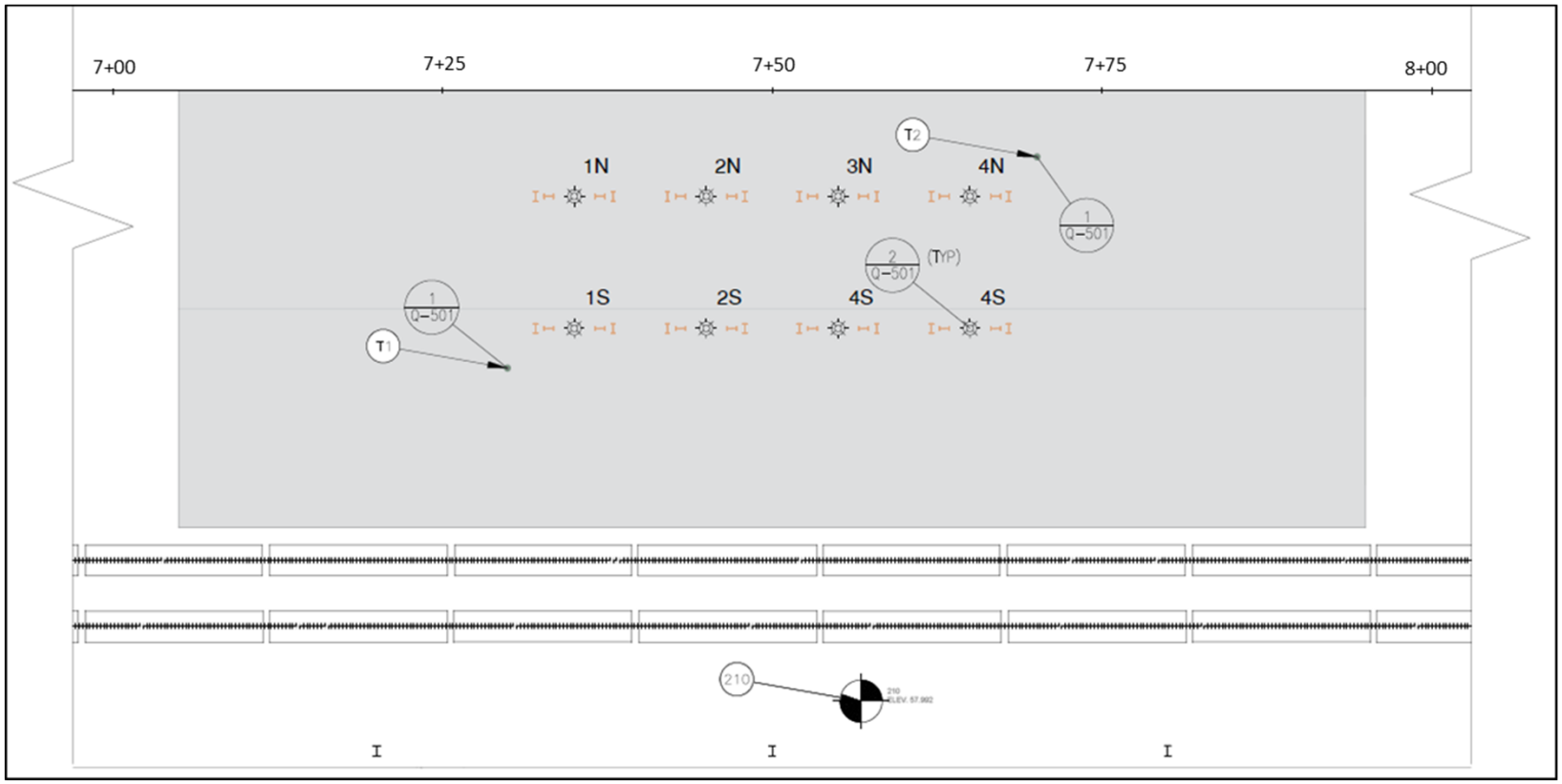
Light Fixture/Instrumentation Arrangement

- **Light Fixture Assemblies will be Installed with the Following 4 Configurations with Associated Mounting Bolts and Washers:**
  - **Two Assemblies each with 12” Base, 8 ¼” Top Section, Flange Ring, and Light Fixture.**
  - **Two Assemblies each with 12” Base, 2 ¼” Top Section, 3 Spacer Rings (2” Each), Flange Ring, and Light Fixture.**
  - **Two Assemblies each with 12” Base, 5 ¼” Top Section, 3 Spacer Rings (1” Each), Flange Ring, and Light Fixture.**
  - **Two Assemblies each with 12” Base, 5 ¼” Top Section, 3” Extension, Flange Ring, and Light Fixture.**

Light Fixture Assembly Installation



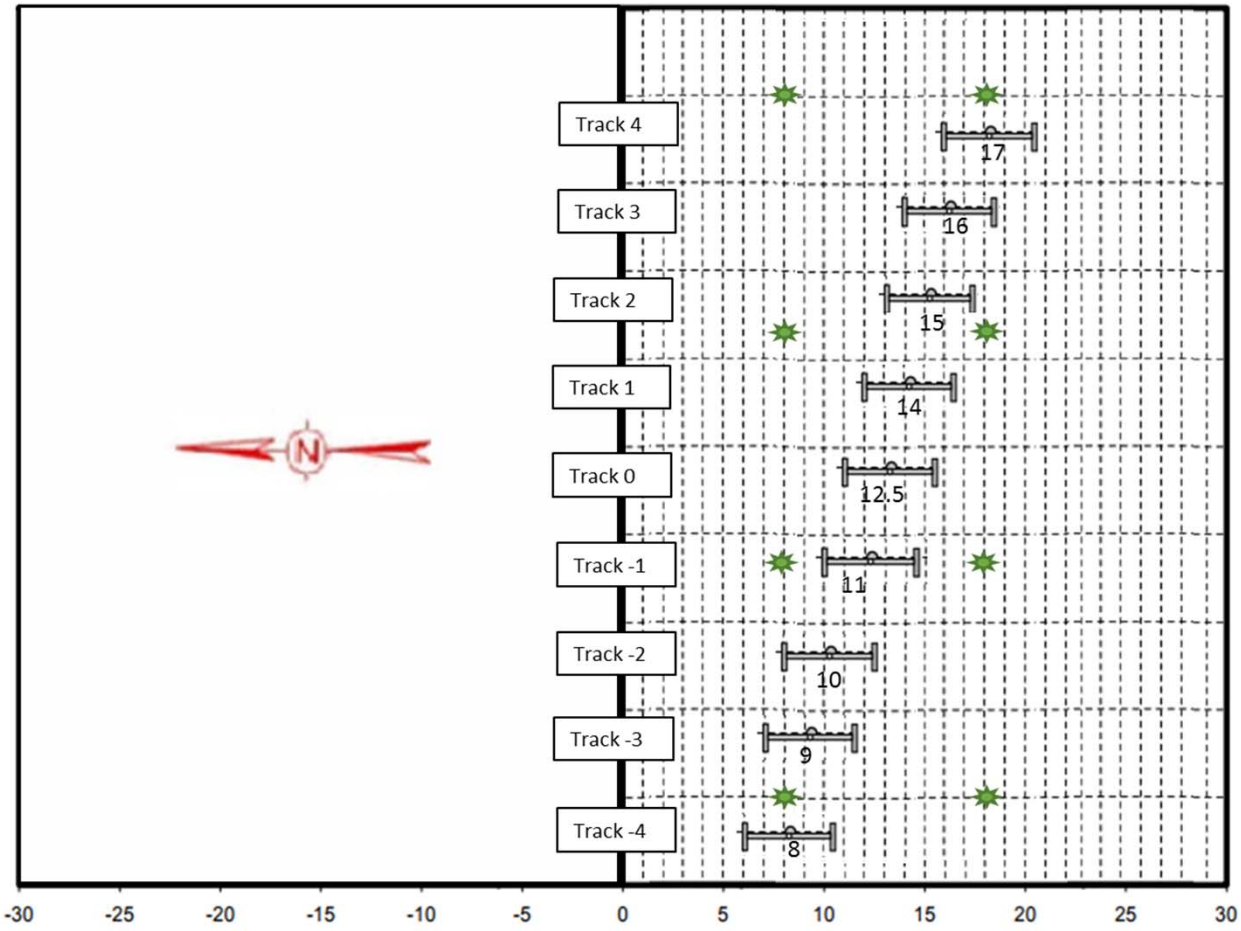
Location of Pavement Strain Gauges in Test Section



Planned Testing in NAPTF

- **NAPTF Test Vehicle will be used for Applying Incrementally Increasing Wheel Loads (67,000 Pounds per Wheel Maximum) at Varying Distances from the Light Fixture Assemblies.**
- **NAPTF Test Vehicle Will be Used to Apply Static and Dynamic Loading on Test Section in 1D (2 Wheel), 2D (4 Wheel), and 3D (6 Wheel) Gear Configurations.**
- **Construction of Asphalt Pavement Test Section and Installation of Instrumented Light Fixture Assemblies Scheduled to Begin in June 2018.**
- **Testing Planned for Fall of 2018.**

Lateral Wander Positions of Test Vehicle 3D (6 Wheel) Gear Configuration



Evaluation of Solar Lighting Systems on Airports

- **Challenges to Photovoltaic (Solar) Powered Lighting Systems have included Limited Geographical Operational Areas, Panel Efficiency Limitations for Recharge, Capacity of Batteries, and Lighting Brightness.**
- **Developments Relating to LED Lighting Systems and Solar Technology Have Made Solar Powered Lighting Systems a Practical Alternative in Certain Airfield Environments.**
- **Solar Technology Advancements Present an Opportunity for Airports to Produce On-Site Electricity and Reduce Long Term Energy Costs.**

Evaluation of Solar Lighting Systems on Airports

- **Literature Review of Solar Power Lighting Technologies and Applications at Airports.**
  - **Applications to Include But Not Limited to Runway Edge, Runway Threshold/End, Obstruction, Taxiway Edge, and Elevated Runway Guard Lighting.**

- **Conduct Evaluations to Determine the Suitability and Reliability of Solar Power Lighting Systems for General Aviation (GA) Airports Across Various Airfield Lighting Applications.**

Evaluation of Solar Lighting Systems on Airports

- **GA Airports, Lighting Systems, and Geographic Locations to be Selected to Allow for Assessment of Varied System Installations and Environmental Conditions.**

- **Evaluations to be Conducted over a Sufficient Period of Time to Allow for Assessment of Seasonal Solar Irradiance and Related Battery Charging Capabilities.**

Evaluation of Solar Lighting Systems on Airports

- **Evaluations at GA Airports Shall Assess the Following:**
  - **Compliance of Lighting Systems with FAA Photometric and Radiometric Requirements;**
  - **Compliance of Lighting Systems with FAA Frangibility Requirements;**
  - **Capacity/Durability of Solar Charged Batteries;**
  - **Effectiveness/Availability of Lighting Systems to Pilots and Airport Users;**
  - **Durability/Efficiency of PV Arrays for Powering Airfield Lighting Systems;**
  - **Orientation/Size of Solar Panels per Varied Airfield Lighting Applications;**
  - **Capability of Lighting Systems to Withstand Jet Blast, Prop Wash, and Surface Wind Gusts;**
  - **Cost Comparison of Solar Power Lighting Systems to Airport Lighting on Commercial Power Lines.**

Evaluation of Solar Lighting Systems on Airports

- **Literature Review to Begin in June 2018.**
- **Selection of GA Airports for Evaluation to Occur in Fall 2018.**

Questions?