In-Pavement Light Fixture Bolts

Federal Aviation Administration

Presented to: IES ALC Government Contacts Mtg.

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In-Pavement Light Fixtures Bolts

- **FAA Engineering Brief (EB) 83A, In-Pavement Light Fixture Bolts.**
- **In-Pavement Light Fixture Installation, Instrumentation, and Testing in NAPTF.**
- **Planned Horizontal Shear Force Testing to Evaluate Coatings Applied to Light Base and Spacer Ring Faying Surfaces.**

FAA Engineering Brief 83A

- **FAA EB 83A Developed to Include the Following Criteria:**

- **Selection of Bolt Grades and Installation Torques/Clamping Forces Based on Resisting Governing Commercial Aircraft Maximum Wheel Loads/Traction Forces at Individual Airports.**
- **Light Fixture/Base Faying Surfaces Treated as Friction Connections Based on Governing Aircraft Wheel Loads and Associated Traction Forces.**
- **Joint Slippage Influenced By Quantity/Overall Thickness of Spacer Rings and Coating of Faying Surfaces.**
- **Utilization of Bolt Tension Calibrator (Skidmore-Wilhelm or Equivalent) with Assembly Mock-Ups to Accurately Determine Bolt Installation Torques Based on Required Clamping Forces.**

Engineering Brief 83A Highlights

- **EB83A Applies to Bolts Connecting Light Fixtures to L-868 Light Bases.**
- **Bolts Shall be Capable of Generating a Minimum Clamping Force Capable of Resisting Traction Forces Generated by Governing Commercial Aircraft at Individual Airports.**
- **Bolt Clamping Forces Limited to 75% of Bolt Material Proof Load (Approximately 85% of Yield Strength).**
- **Maximum Governing Commercial Aircraft Determined to be A380-800 Requiring a Bolt Clamping Force of 4,900 Pounds/Bolt.**
- **Light Fixture Manufacturers Must be Consulted to Confirm that Their Light Fixtures can be Safely Installed with Bolt Clamping Forces Exceeding Manufacturer's Published Guidance.**

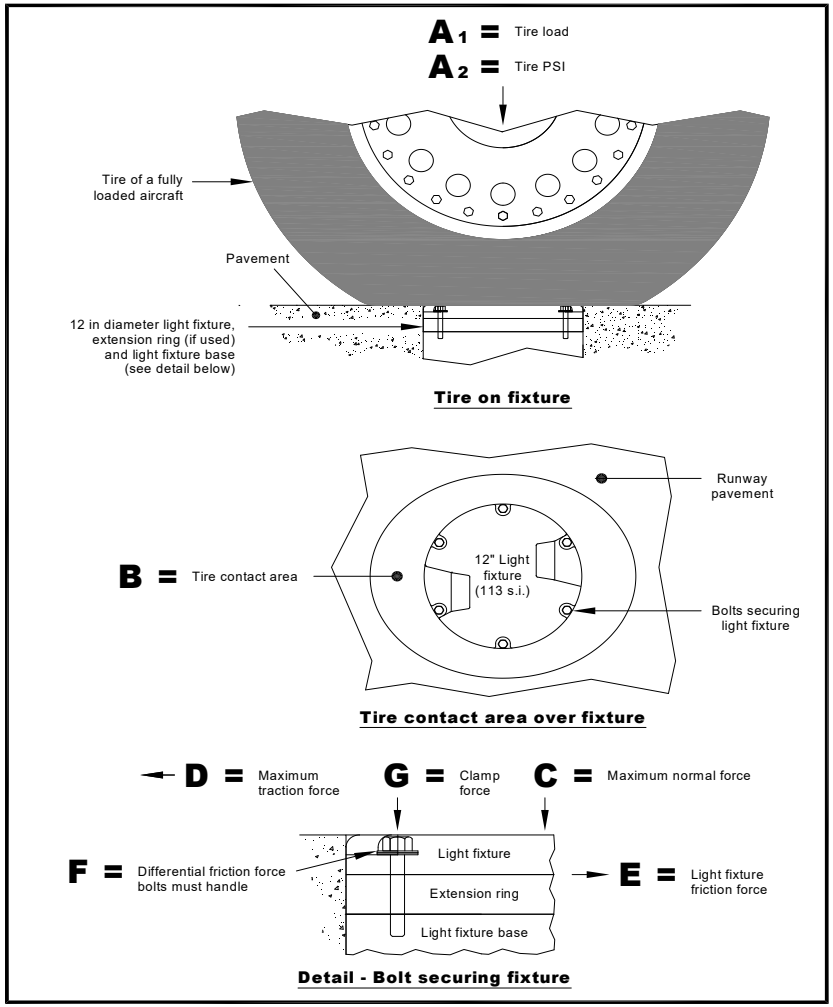
Engineering Brief 83A Highlights

- **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 Testing per FAA AC 150/5345-46.**
- **Changes to Applicable FAA Advisory Circulars to Reflect Changes in EB 83A.**

Aircraft Forces Acting on In-Pavement Light Fixtures



Bolt Clamping Force/Torque Calculation Example (A380-800 Aircraft)

- **A1: Tire Load = 59,400 pounds**
- **A2: Tire Pressure = 218 psi**
- **B: Tire Contact Area = A1 / A2 = 272.5 inches square**
- **C: Maximum Normal Force on the in-pavement light fixture = A1 × (113/B) = 24,632 pounds**

  (Contact Area of 12” Diameter Light Fixture Taken as 113 in. sq.)
- **D: Traction Force imparted to the light fixture = C × 0.8 = 19,706 pounds**
- **E: Resisting Frictional Force between the light fixture and light base = C × 0.37 = 9,114 pounds**

  (Static Friction Coefficient at Faying Surfaces Taken as 0.37)
- **F: Differential Force the in-pavement light fixture bolts must handle = D – E = 10,592 pounds**
- **G: Clamp Force = (F/6)/0.37 = 4,771 pounds**

Bolt Clamping Force/Torque Calculation Example

- T = K × 0.375 × G = 322 inch-pounds
- = 26.8 foot-pounds
- Friction Coefficient (K) Assumed to be 0.18 for Coated SAE J429 Grade 5 Bolt based on FAA Testing.

  (Actual Airport Bolt Installations Shall Utilize Bolt Tension Calibrator with Assembly Mock Ups to Develop Accurate Torque-Tension Relationship.)
- The Grade of the 3/8″ bolt selected must be able to withstand 4,771 pounds of clamp force and a torque of 322 inch-pounds or 26.8 foot-pounds.
- A 3/8” SAE J429 Grade 5 Bolt has a Rated Clamping Force of 4,941 Pounds (75% Proof Load).

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

The National Airport Pavement Test Vehicle

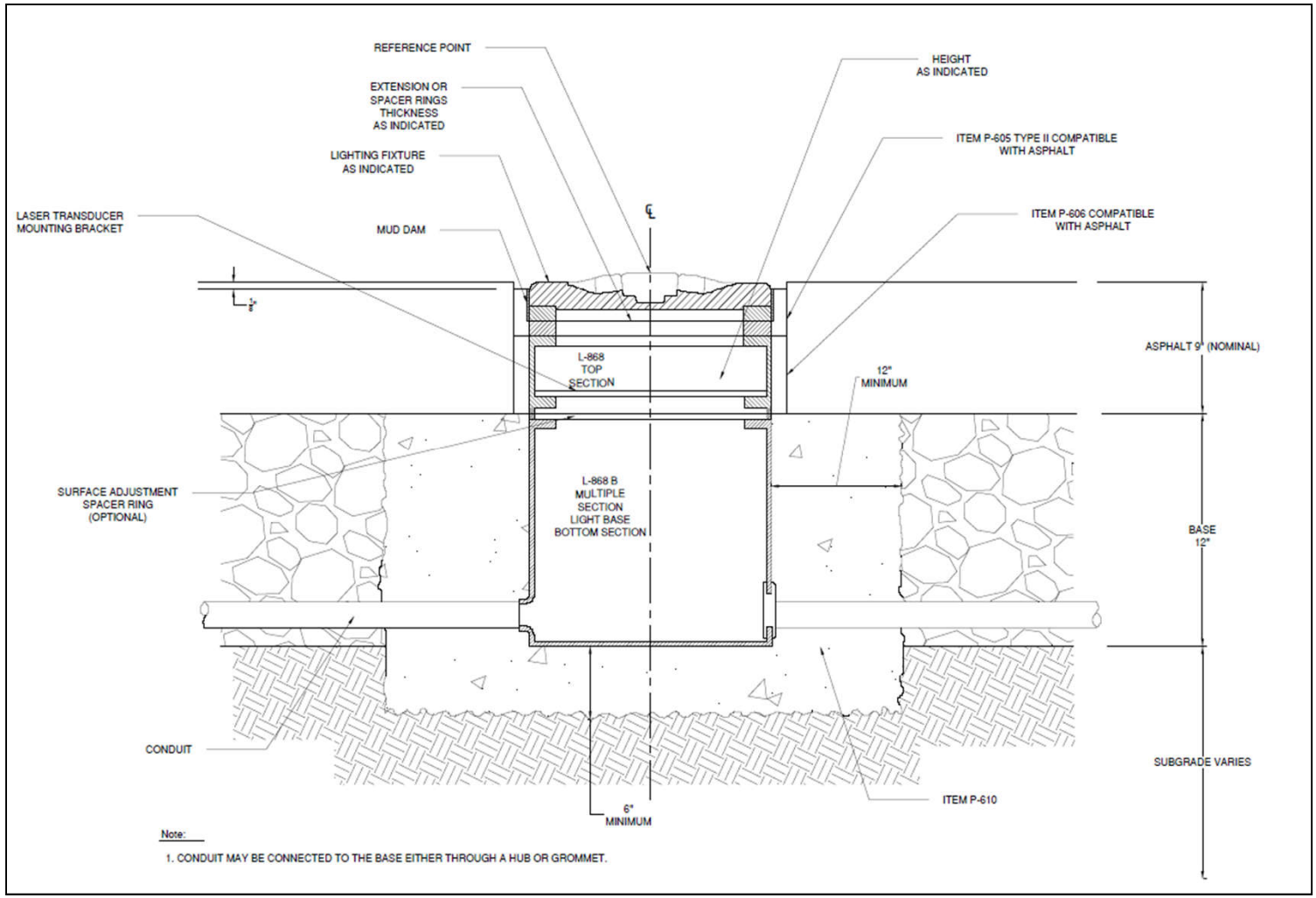
Light Fixture/Instrumentation Arrangement

- **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**

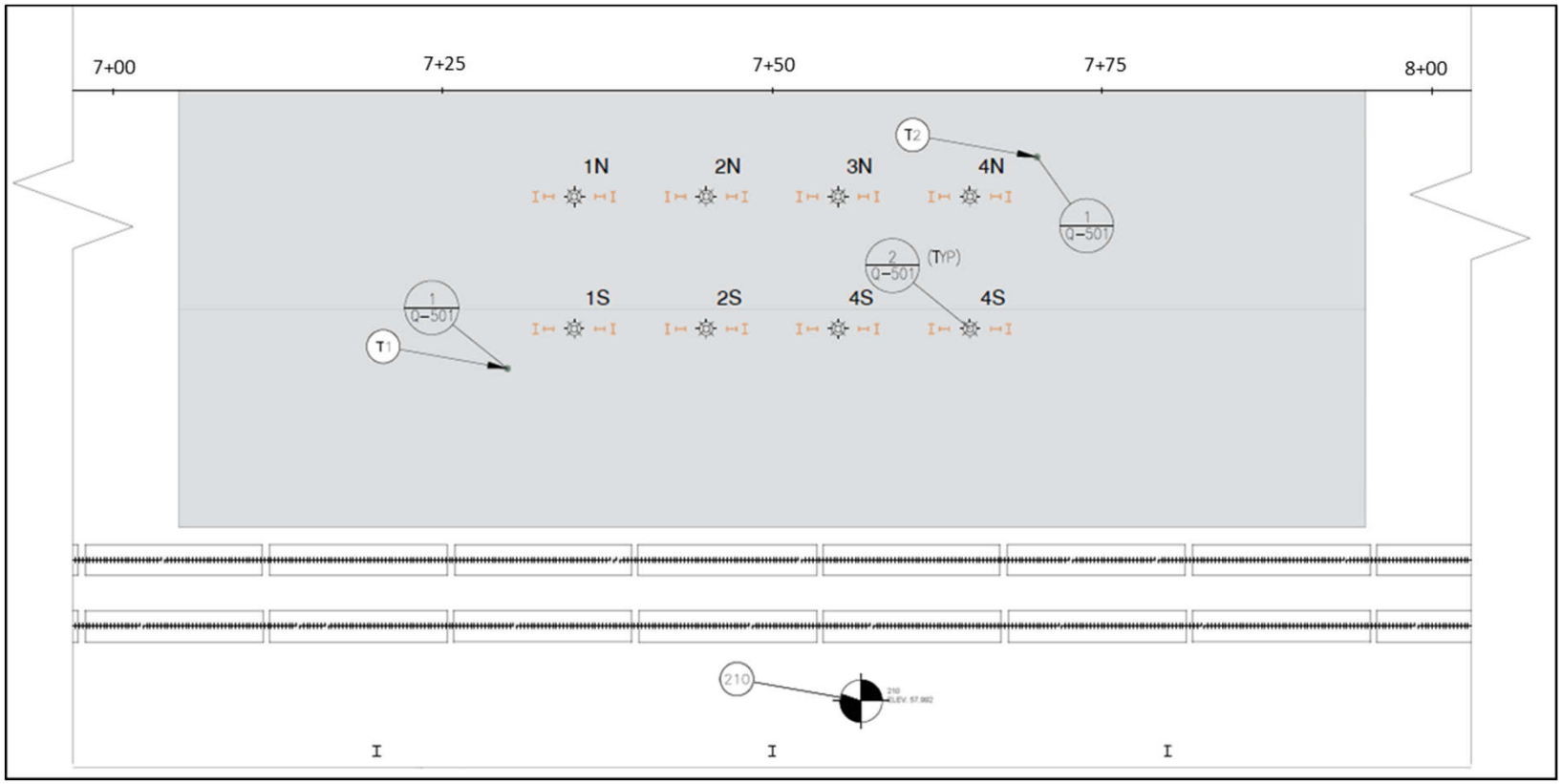
Light Fixture/Instrumentation Arrangement

- **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



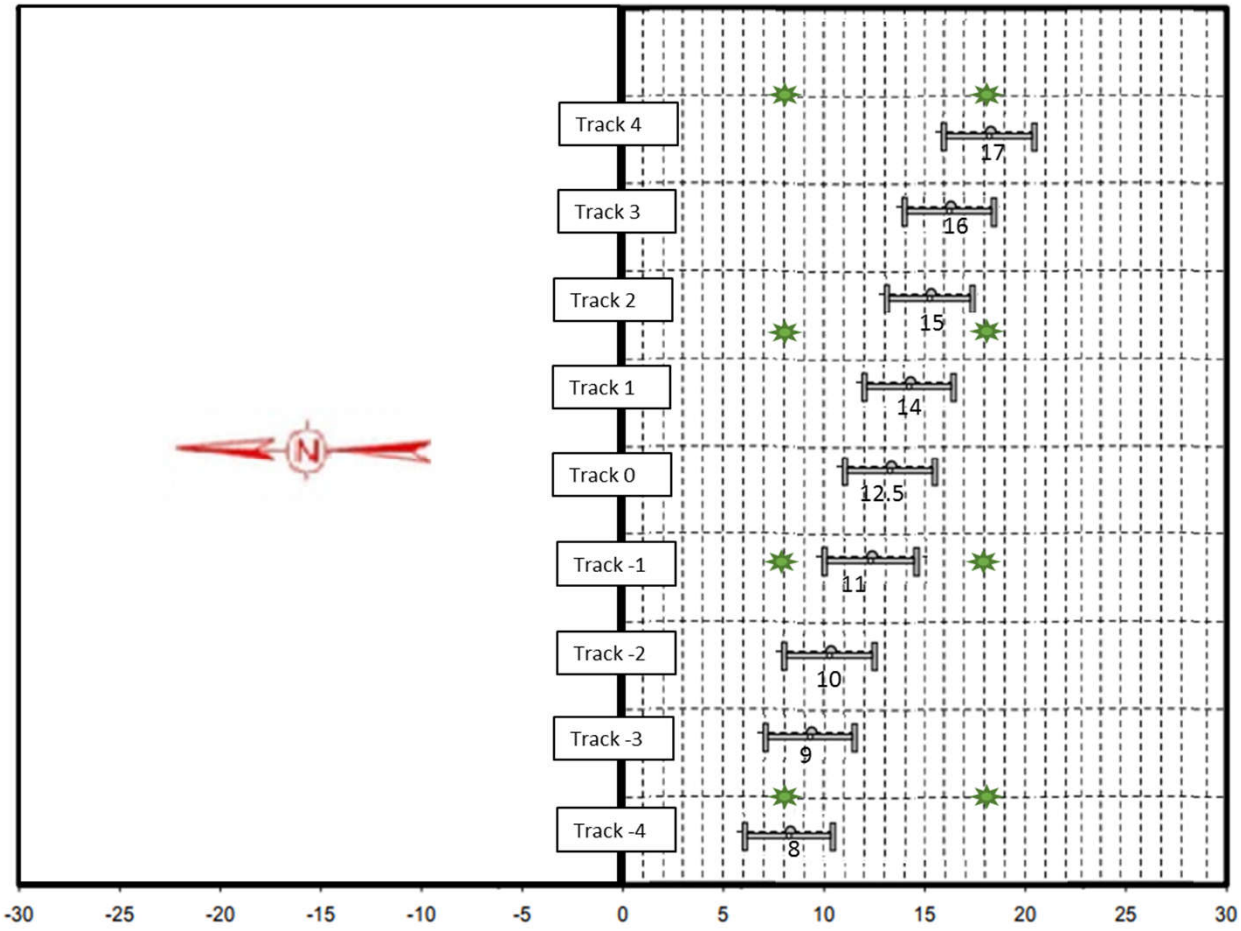
Location of Pavement Strain Gauges in Test Section



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 October 2018.**
- **Testing Planned for January, 2019**

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



Horizontal Shear Force Testing for Coating Evaluation

- **Testing to be Conducted at Intertek in Accordance with FAA AC 150/5345-46.**
- **Testing to Evaluate Influences of Coatings Applied to Light Base and Spacer Ring Faying Surfaces on Static Friction Coefficients.**
- **Coatings Intended to Reduce Risk of Horizontal Movement at Light Fixture/Base Interface and Resulting Bolt Fatigue Failures.**
- **Coatings to have Minimal Impact on Installations and Manufacturing Tolerances.**
- **Tinius Olsen Machine Used to Incrementally Apply Horizontal Shear Forces at Light Fixture/Base Interfaces to Initiate Joint Slippage.**
- **Digital Dial Indicators Used to Measure Joint Slippage.**

Horizontal Shear Force Testing for Coating Evaluation

- **Testing to be Conducted Utilizing a Variety of Coatings on the Faying Surfaces of Light Fixture Bases and Spacer Rings.**
- **Evaluate Influences of Varying Quantities and Thicknesses of Spacer Rings up to 2 3/16” Combined.**
- **Objective to Assess How Coatings at Faying Surfaces will Influence Static Friction Coefficient.**
- **Testing Planned for Early in 2019.**

Questions?