Federal Aviation Administration

Airport Visual Aids

Illuminating Engineering Society

October 17th – 21st, 2010

Seaview Resort

Galloway, New Jersey

Presented by Alvin Logan

FAA AAS-100

Outline

- FAA Advisory Circular Updates
- Changes To Engineering Brief 67B
- RWSL
- RWSL RELs/SMGCS Simulation
- Delta Airlines Taxiway M Landing at ATL
- Assessment of Changing Runway Centerline Lights From Alternating White/Red to White/Yellow

150/5340-30E, Design and Installation Details for Airport Visual Aids

- Paragraph 1.4 is added to provide additional guidance regarding the mixing of light emitting diode and incandescent lights on the same lighting circuit.
- Paragraph 4.2a(3) is added to clarify the purpose of color coded taxiway centerline lights.

150/5340-30E, Design and Installation Details for Airport Visual Aids

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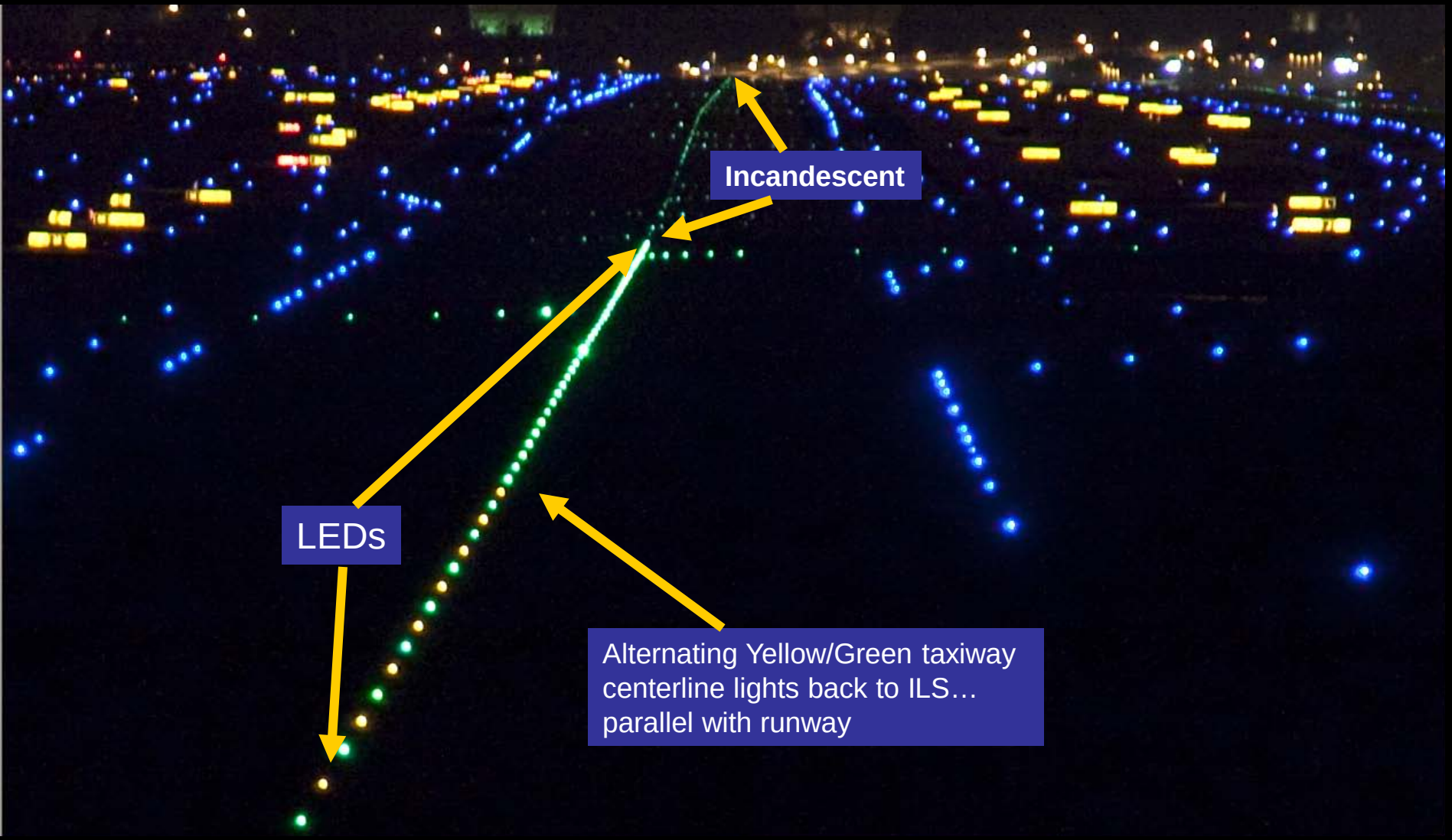
Incandescent
LEDs
Alternating Yellow/Green taxiway centerline lights back to ILS… parallel with runway

150/5340-30E, Design and Installation Details for Airport Visual Aids

- Paragraph 12.5 is updated and rewritten for clarity of counterpoise requirements. Exothermic weld requirements for zinc coated light bases are added.
- Paragraph 12.6 requirements are updated for light base grounds

150/5340-30E, Design and Installation Details for Airport Visual Aids

- All references to “zero distance remaining” signs are deleted in applicable figures.
- Figures 76 and 84 for MALSF layout are corrected and redrawn.
- Appendix 7, Runway Status Lights (RWSL), is updated with current changes from Engineering Brief #64D to include Runway Intersection Lights (RIL).

AC 150/5340-18F, STANDARDS FOR AIRPORT SIGN SYSTEMS

- All figures are redrawn for better clarity and detail.
- Figure 3 is corrected to show a boundary sign on left side taxiway B in the runway exit direction.
- Paragraph 5.b is reworded to include additional details and to clarify holding position signs for runway/runway intersections.

AC 150/5340-18F, STANDARDS FOR AIRPORT SIGN SYSTEMS

- Paragraph 5.b is reworded to include additional details and to clarify holding position signs for runway/runway intersections.
- Paragraph 8 is updated to prohibit collocating taxiway direction signs with boundary signs.
- Paragraph 11 is updated to include a runway holding position roadway sign used on vehicle roadways that enter or intersect runways.

AC 150/5340-18F, STANDARDS FOR AIRPORT SIGN SYSTEMS

- Paragraph 12 is updated to include VOR sign. The text of this VOR sign is originally from AC 150/5340-1J.
- A NOTE is added to paragraph 13a to clarify taxiway direction sign location when a boundary sign is present on the right side of an exit taxiway.
- Paragraph 13p is updated to include angle requirements for a canted sign.

AC 150/5340-18F, STANDARDS FOR AIRPORT SIGN SYSTEMS

- Figures 14 is updated to show a standard L-858R, Size 1, Style 4, holding position sign to the left of the “STOP/DO NOT PROCEED” signs.
- Figure 19 mandatory instruction signs at RWY 18-36, taxiways E and F are updated. Mandatory instruction signs at taxiways A and G are updated to RWY 9-27.

5345-12F, SPECIFICATION FOR AIRPORT AND HELIPORT BEACONS

- Chapter 2 is updated to include Engineering Brief #67.
- Paragraph 3.4.3 is updated to include a reference to Engineering Brief #67.
- Paragraph 4.2.2.4 is updated to include reference to Engineering Brief # 67.

150/5345-51B, SPECIFICATION FOR DISCHARGE-TYPE FLASHING LIGHT EQUIPMENT

- Added FAA Engineering Brief #67 as a reference to provide requirements for light sources other than incandescent and xenon

Changes To Engineering Brief 67B

Light Sources Other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures

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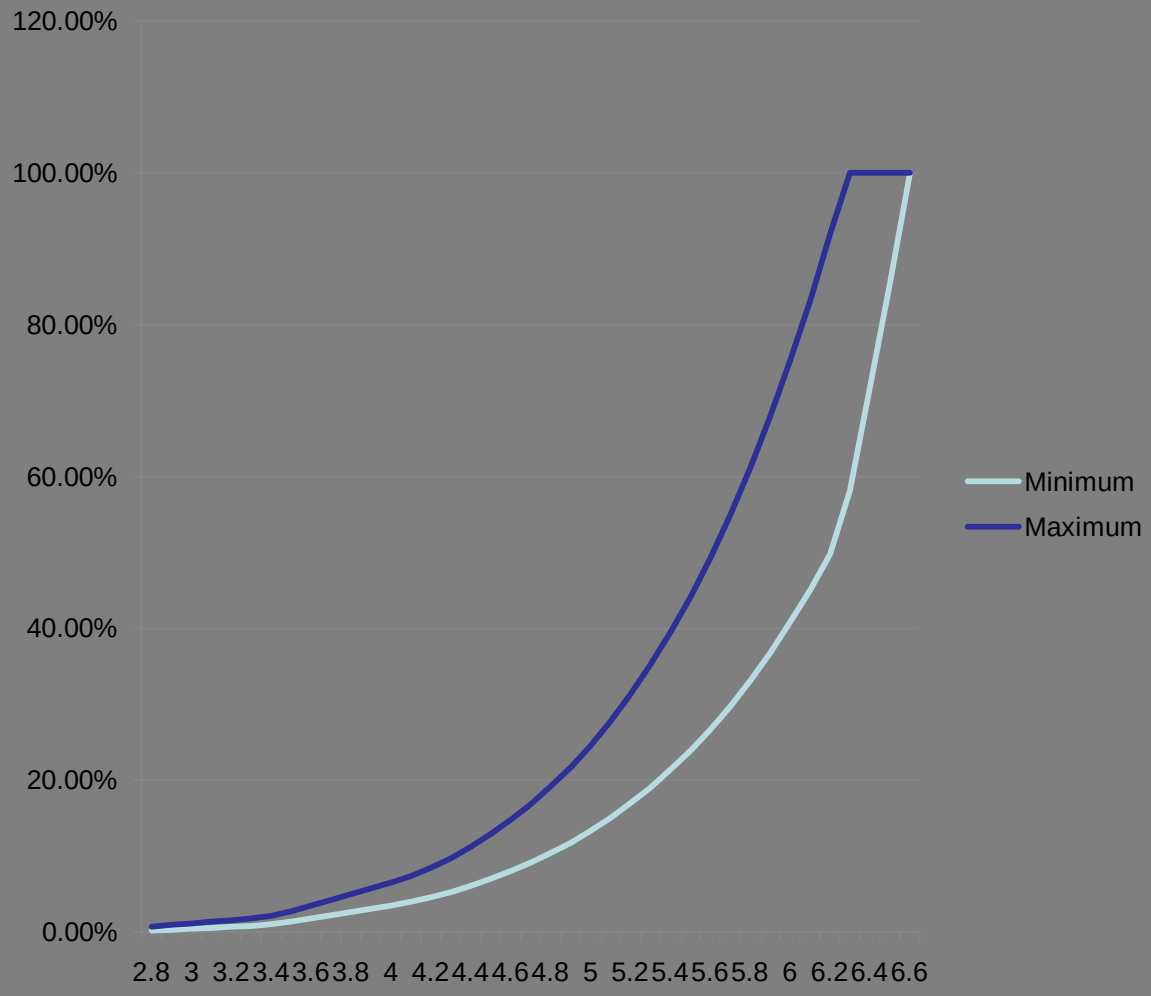
Changes To Engineering Brief 67B

- A minimum power factor of 0.7 is added in paragraph 2.2.
- A rated fixture lifetime is added in paragraph 2.5.
- A life test per AC 150/5345-53C, Appendix V is added.
- Lightning protection is changed from category C1 to C2 in paragraph 2.13.
- Paragraph 2.18 is added for requirement to separate lightning protection system grounds from equipment grounds.

EB-67 Dimming Curve



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Changes To Engineering Brief 67B

- 2.5 Rated Life - Alternative light sources must have a minimum rated life of two years (this is inclusive of any electronics).
- 2.6 Life Test A life test (inclusive of any drive electronics) that addresses the light emitter technology shall be conducted per AC 150/5345-53C, Appendix V for all alternative lighting device light fixtures under third party certification body cognizance.

Power Factor Definition

- The true power factor for all fixtures powered by a CCR must not be less than 0.7 when measured at the input power leads of the fixture on all CCR current steps. The true power factor measurement must be done over the frequency range of 0 to 150 kHz. The power factor measurement must not be displacement power factor (cos φ). Test will be conducted using a sine wave source.

Moratorium for LED RCLs/TDZ

Federal Aviation Administration

Memorandum

Date: SEP 17 2010

To: All Regional Airports Division Managers

From: Rick Marinelli, Manager, Airport Engineering Division, AAS-100

Prepared by: Alvin Logan, Airport Engineering Division, AAS-100

Subject: Acquisition & Installation of Light Emitting Diode (LED) Runway Centerline and Touchdown Zone Lighting Systems

The purpose of this memorandum is to announce a moratorium on the acquisition and installation of FAA LED Runway Centerline (L-850A) and LED Touchdown Zone (L-850B) Lighting Fixtures built in accordance with Engineering Brief 67, "Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures" and listed in Appendix 1 of FAA AC 150/5345-53C Addendum, "Airport Lighting Equipment Certification Program".

Flight testing of the subject lighting systems has recently been conducted at Raleigh-Durham International Airport during nighttime VFR. The consensus reached was the lighting intensity of the LED fixtures exhibited bright signals even at the lowest step setting (step 1 of 5) of the constant current regulator.

The Airport Engineering Division is currently coordinating with industry to address this issue. We anticipate subsequent modifications to the Engineering Brief in the near future. Once the issue is resolved, we will notify the Regions of the product updates.

Please contact Alvin Logan at (202) 267-8743 with any questions.

Runway Status Lights (RWSL)

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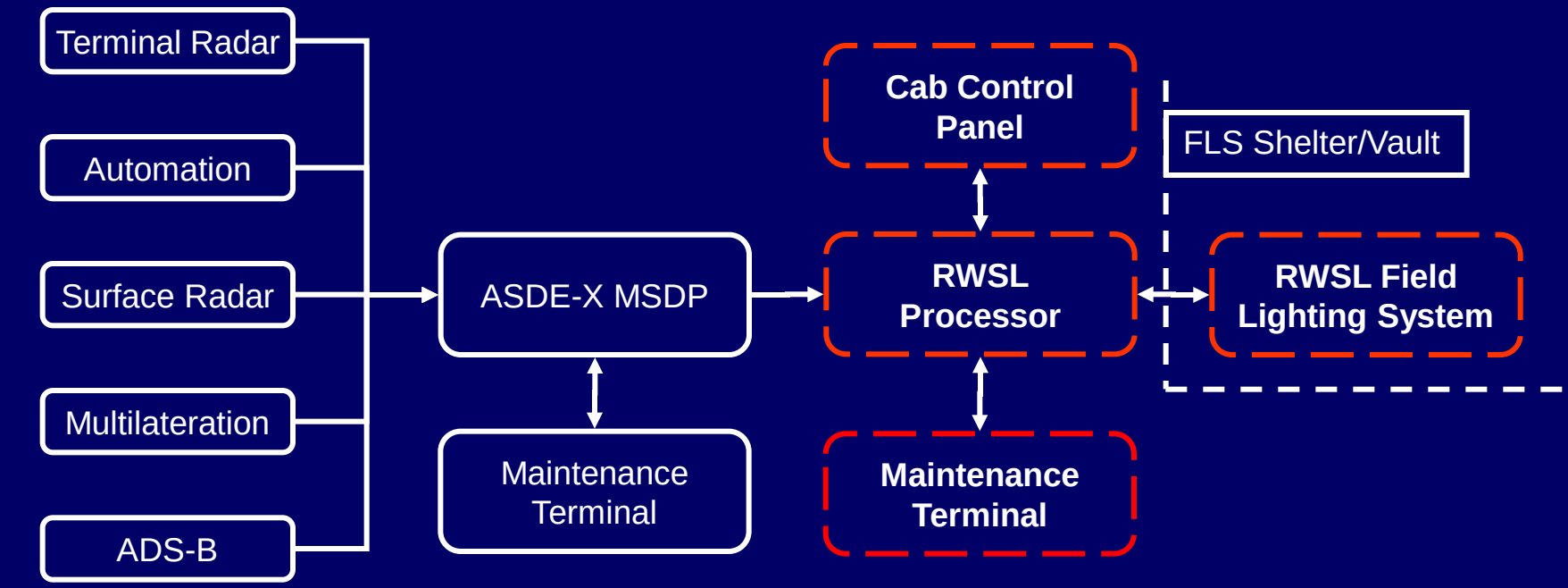
System Description

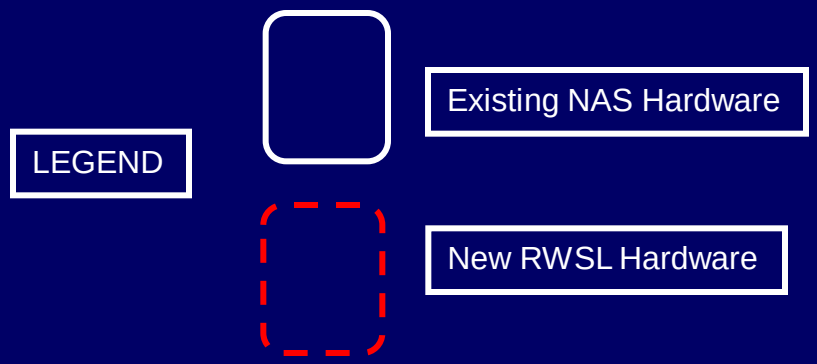
- The RWSL system integrates airport lighting equipment with terminal and surface surveillance systems to provide a visual signal to pilots and vehicle operators indicating that it is unsafe to enter/cross or begin takeoff on runway
- The system is fully automated based on inputs from surface and terminal surveillance systems

System Description

- Airport surveillance sensor inputs are processed through light control safety logic that commands in-pavement lights to illuminate red when there is traffic on or approaching the runway
  - *Runway Entrance Lights (REL)* provide signal to aircraft crossing entering runway from intersecting taxiway
  - *Takeoff Hold Lights (THL)* provide signal to aircraft in position for takeoff

RWSL System Architecture





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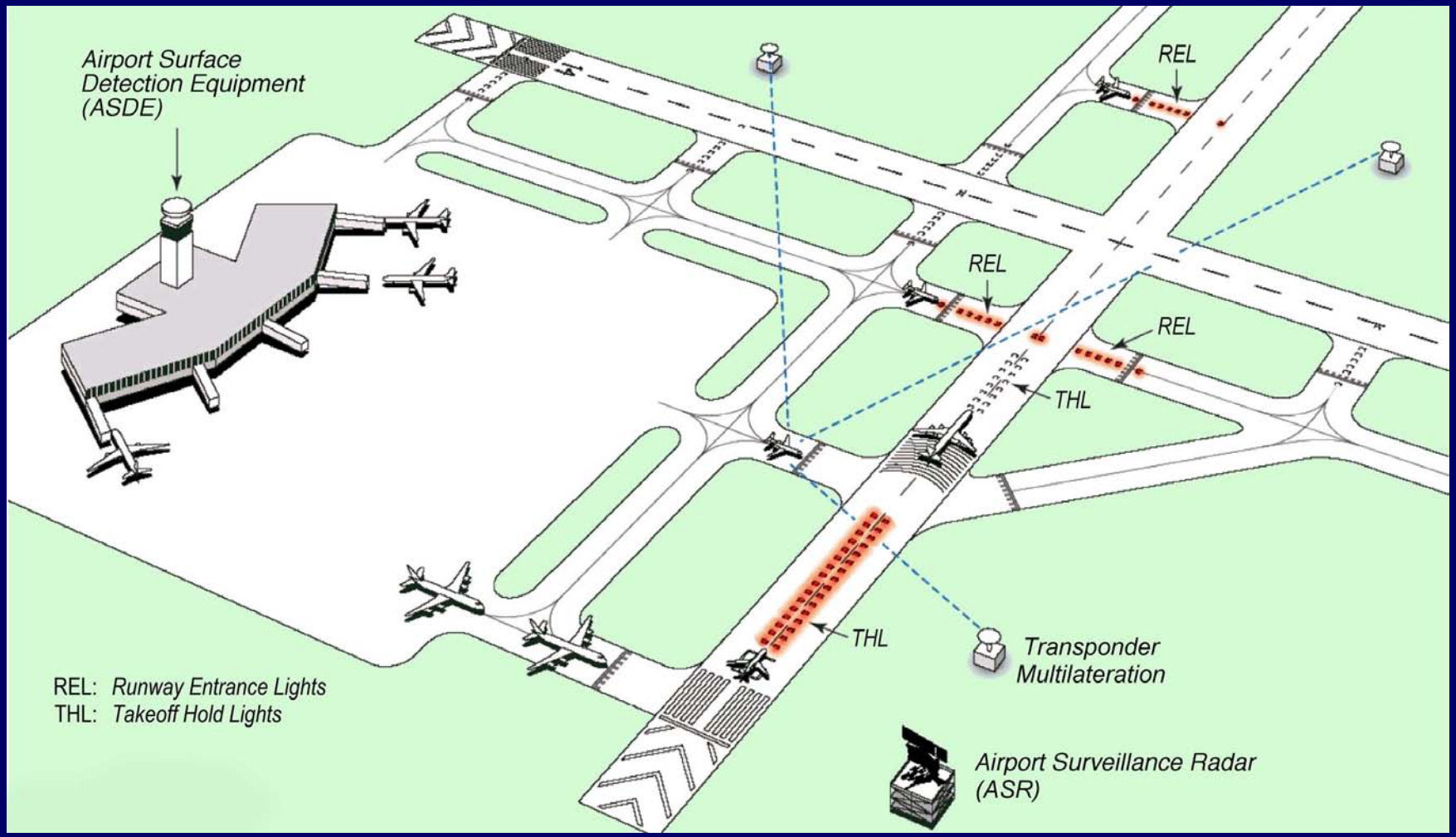
Conceptual Diagram of the RWSL System



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RWSL RELs and THLs

Runway Status Lights integrates airport lighting equipment with approach and surface surveillance systems to provide a visual signal to pilots indicating that it is unsafe to enter/cross or begin takeoff on runway

Runway Entrance Lights (REL) **provide signal to aircraft crossing runway from intersecting taxiway**

Takeoff Hold Lights (THL) **provide signal to aircraft in position for takeoff**

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Other RWSL Technologies

- Runway Intersection Lights (RILs)
  - Same lighting technology as THLs
  - Deployed at selected runway-to-runway intersections

Site	Operational Readiness Date	Construction Type
Orlando	Aug-11	FAA
Phoenix Sky Harbor	Dec-11	FAA
George Bush	Jun-12	FAA
Balt-Wash Intl.	Mar-12	FAA
Las Vegas McCarran	Mar-12	FAA
Charlotte Douglas	May-12	Airport
Los Angeles	Sep-12	R&D
Hartsfield-Jackson Atlanta	Jan-13	FAA
Seattle-Tacoma	Apr-13	Airport
Chicago O'Hare	May-13	Airport
Washington-Dulles	May-13	FAA
LaGuadia	Jun-13	Hybrid
John F. Kennedy	Apr-14	FAA
Denver Intl.	Apr-14	FAA
Minneapolis-St. Paul	May-14	Hybrid
Newark	Jun-14	FAA
Detroit Metro	Aug-14	FAA
Philadelphia	Oct-14	FAA
Dallas/Ft. Worth	Dec-14	R&D
Ft. Lauderdale	Mar-15	FAA
Boston Logan	Jul-15	R&D
San Diego	Oct-15	R&D
San Francisco Intl.	Dec-15	Airport

"Construction Types"

- **FAA is the production system.**
- **Hybrid means that the FAA and airport share construction.**
- **Airport means the airport does all of the construction.**
- **R&D is a prototype system funded by AJP-671**

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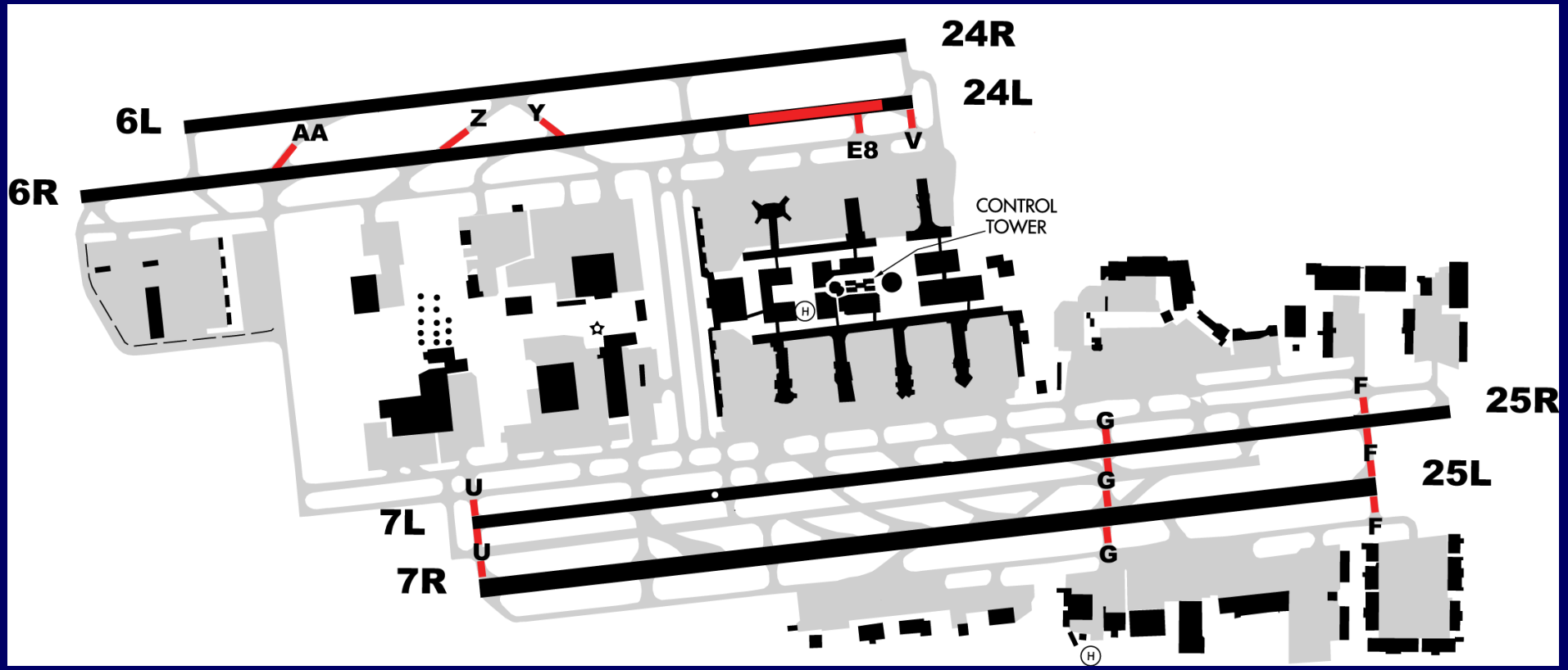
Active RWSL Test Sites

- Dallas Ft. Worth (DFW)
- San Diego (SAN)
- Los Angeles (LAX)
- Boston (BOS)
  - Conducting Shadow Ops
  - First Airport to Get Runway Intersection Lights

LAX



REL s and THLs

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AC 5340-18E Fig 3

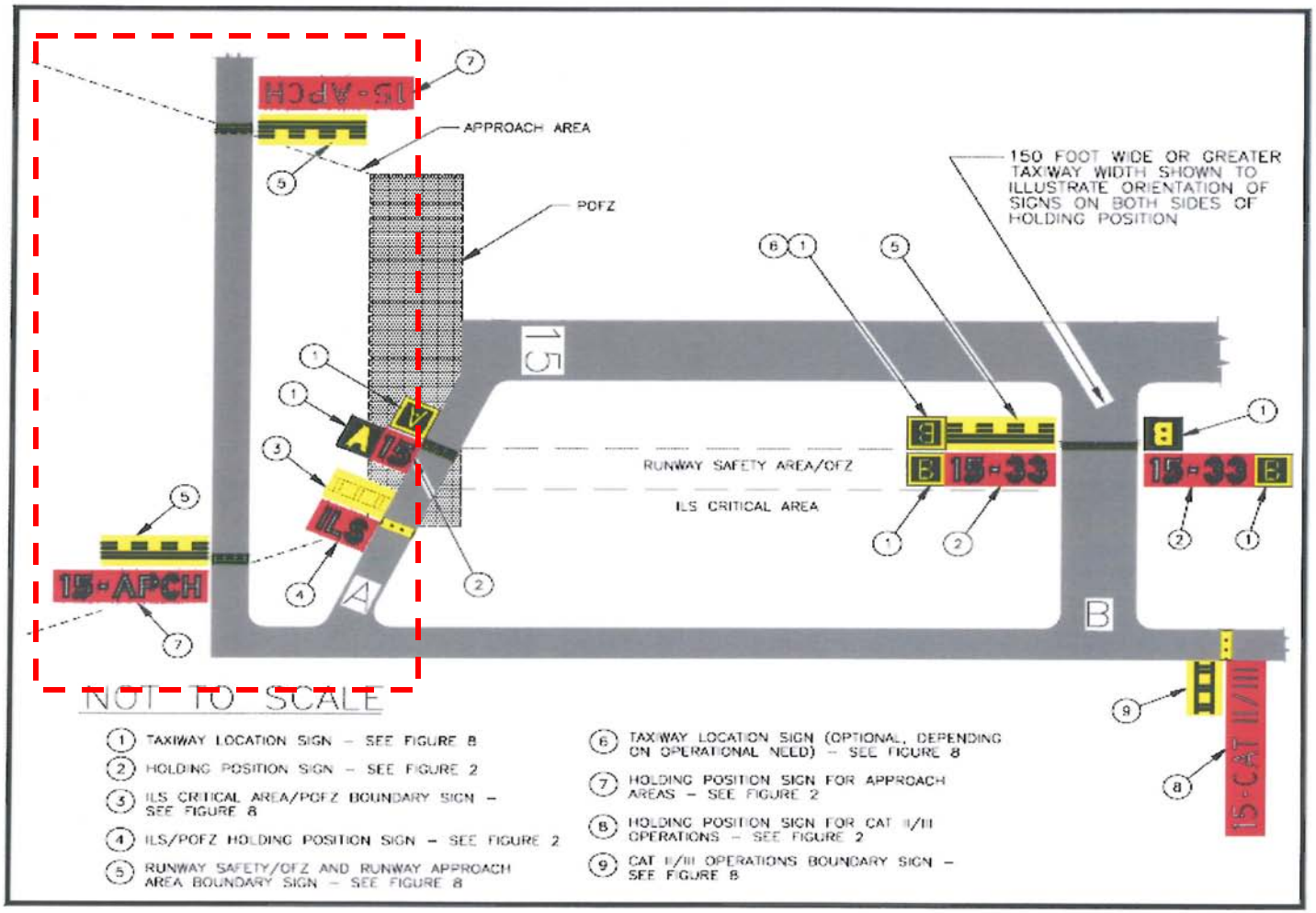

Figure 3. Application Examples for Holding Position Signs

09/12/08

AC 150/5340-18E

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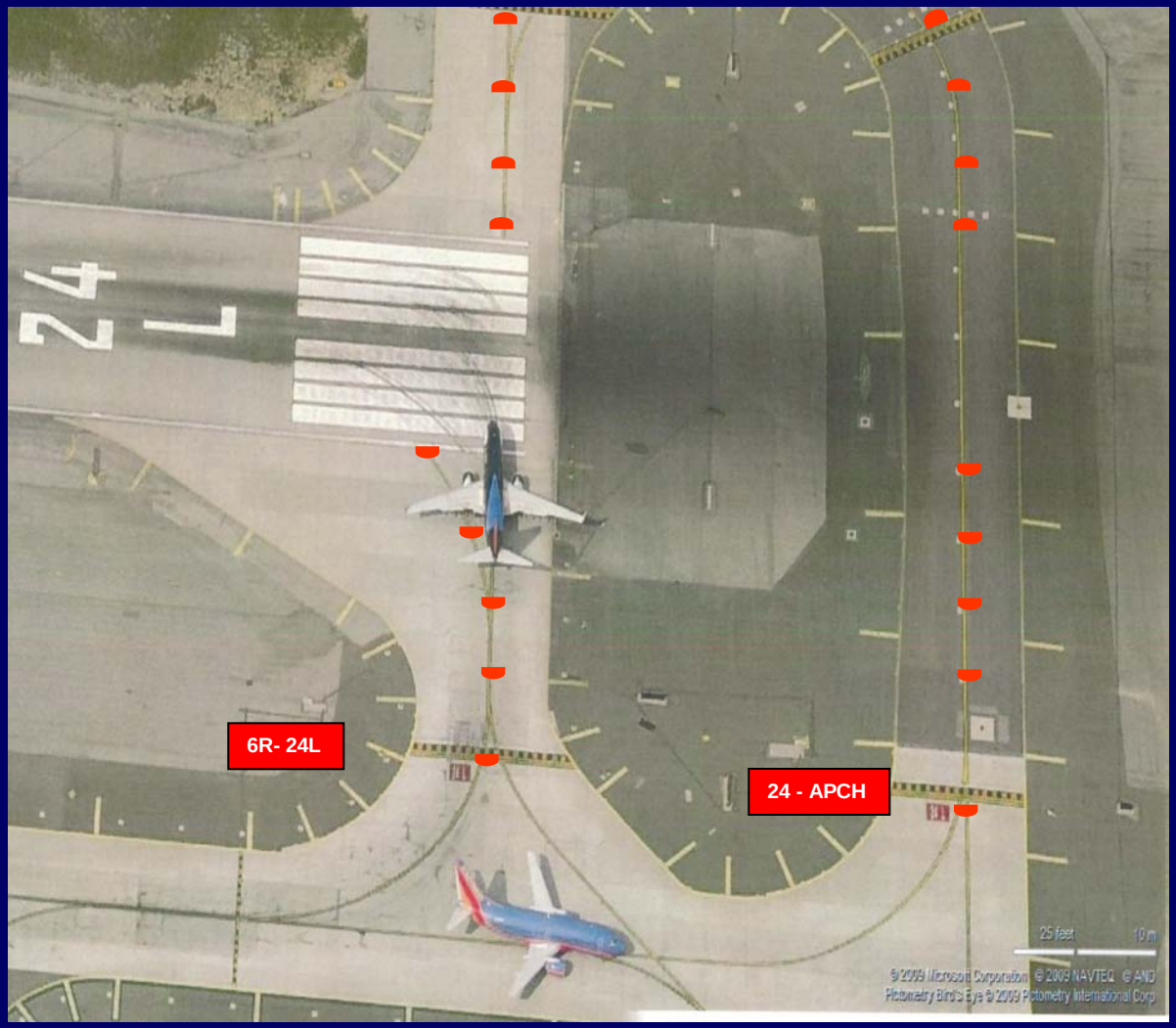
RELs at Runway Approach Areas



- RELs will also be installed at runway approach intersections

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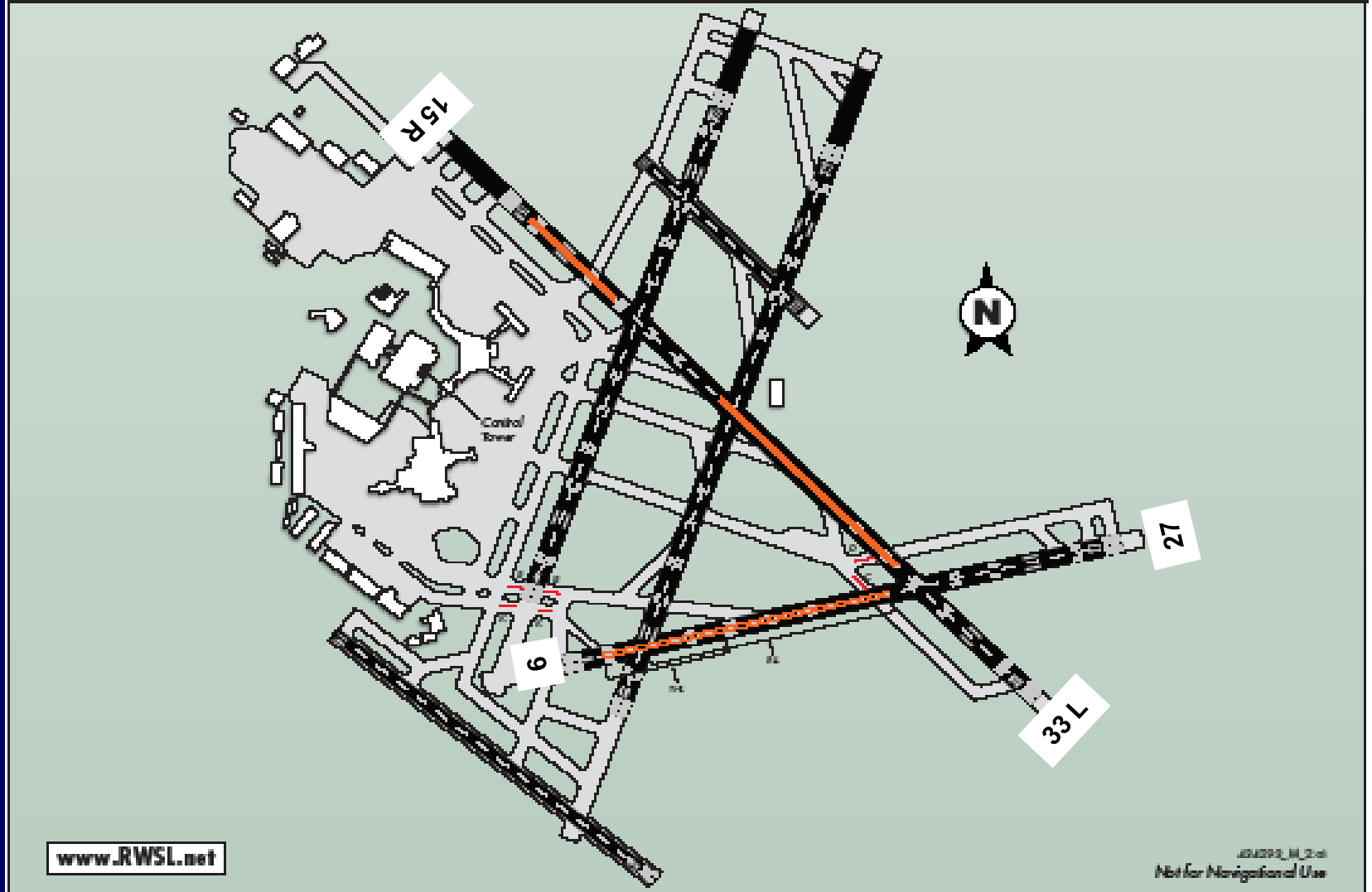
RWSL Test Site - BOS

- Runway Intersection Lights, Takeoff Hold Lights and Runway Entrance Lights have been installed.
- Shadow operations completed on 2/8/10
- OpEval demonstration is scheduled for 05/09/10
- Expect to go operational on/after 5/10/10

RUNWAY STATUS LIGHTS (RWSL) AT BOSTON (BOS)



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RWSL Engineering Brief 64B Updates

- THL Installation on a Runway With No Centerline Lights
- Taxiways with Multiple Entry Paths to a Runway
- Considerations for RELs and In-pavement Runway Guard/Stop Bar Lights
- Last REL and Runway Centerline Lights

RWSL Implementation
HQ Points of Contact

Claude Jones	**Program Manager**	**202-385-8407**
Barbara Kratz	**Program Lead**	**202-385-8645**
Mike Weiler	**Implementation Lead**	**202-385-8767**
Dan Hicok	**Engineering**	**703-786-6662**
Jo Ellen Kleindienst	**Logistics**	**202-479-0252**
Robert Valdes	**Contracting Officer**	**202-385-6157**

SMGCS/REL Simulation Plan

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Concurrent Use of RELs and SMGCS Stop Bars by Trained and Untrained Pilots

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Executive Summary

When pilots are cleared onto an active runway in low visibility, how do they respond?

	Response to conflict aircraft	*Stopping response time*	*% Cases where pilots stop beyond hold line*
Stop bars only	**0% Stop**		
RELs and stop bars – <u>No training</u>	**67.5% Stop**	**1.5 sec**	**25%**
RELs and stop bars – <u>Training</u>	**100% Stop**	**2.3 sec**	**7%**

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SMGCS Stop Bars

- Continued operational need to reduce the frequency of runway incursions to improve safety
- FAA points to need for improved surface markings

- SMGCS Stop Bars
  - Red unidirectional, in-pavement lights along holding position marking
  - Operate in conjunction with green centerline lead-on lights
  - When extinguished by ATC, lights confirm clearance; re-illuminate automatically to prevent entry by trailing traffic
  - Some controlled by ATC, others are uncontrolled and remain on when system is in use

SMGCS Stop Bars

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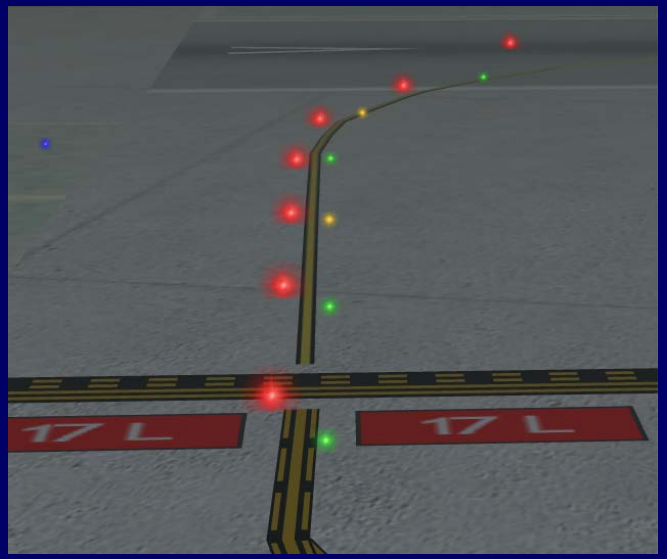
Runway Entrance Lights

- Runway Entrance Lights (RELs)
  - Red unidirectional, in-pavement lights from hold line to runway edge; one light at runway centerline
  - Automatic, surveillance-driven
    - Illuminate for arriving aircraft on short final, departing aircraft > 40 kts
    - *Progressively* extinguish for arriving aircraft < 40 kts, 2 sec before departing aircraft passes intersection
  - Extinguishing lights do *not* indicate clearance
  - If lights illuminate after clearance is given, pilot should stop aircraft unless (s)he cannot remain clear of the runway



Runway Entrance Lights (RELs)

Concurrent Lighting System Use

- Currently, no airport has both RELs and stop bars installed for concurrent use
- When used together, these systems can provide a complete picture of runway safety and clearance status
  - SMGCS stop bars, when extinguished, provide visual confirmation of verbal clearance given by ATCo
  - RELs, when illuminated, provide runway status information that the runway is being used by another aircraft
- If ATC issues an erroneous clearance, or if an unauthorized aircraft begins a roll on the runway, RELs may prevent runway incursions or reduce their severity.

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Research Questions

- Are pilots confused when both RELs and stop bars are used concurrently?
- Are pilots confused when the lighting systems provide different information?
  - When runway is clear but clearance has not been given
  - When the pilot has been cleared onto or across an active runway
- Do pilots respond appropriately when the lighting systems provide different information?
- Is confusion greater when pilots have not been trained on the systems?
- Can pilots learn to use the systems with minimal training?

Research Summary

- To answer these research questions, two studies were conducted

Trained

- Pilots were informed about and trained on the concurrent use of RELs and stop bars
- On half of trials containing both RELs and stop bars, pilots were cleared onto an active runway

Untrained

- Pilots were ***not*** informed about and ***not*** trained on the concurrent use of RELs and stop bars
- On half of trials, pilots were cleared onto an active runway

Conclusions

- Pilots who are trained on concurrent use of the lighting systems
  - Do not show evidence of crossing illuminated stop bars, even when RELs extinguish
  - Show evidence of appropriate response when RELs illuminate after receiving clearance onto/across runway
  - Show evidence of reduction in runway incursion severity with the use of RELs when used concurrently with stop bars

Conclusions

- Pilots who are not trained and are naïve to the concurrent use of lighting systems
  - Do not show evidence of crossing illuminated stop bars, even when RELs extinguish
  - Stop the aircraft when RELs re-illuminate in 67.5% of trials, preventing or reducing the severity of runway incursions
  - Can learn from operational errors, even without formal training, responding appropriately to RELs over time.

Conclusions

- Both trained and untrained participants:
  - Indicate that the systems have the potential to improve runway safety
  - Note that pilots may have confusion about how the systems operate together
    - When RELs extinguish, but stop bars remain on
    - Particularly when RELs re-illuminate to indicate the presence of a conflict aircraft
    - Indicate that confusion may be reduced, at least for some pilots, over time
- Overall, results suggest that training can improve the effectiveness of the concurrent use of RELs and stop bars.

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Delta Airlines Taxiway M Landing at ATL

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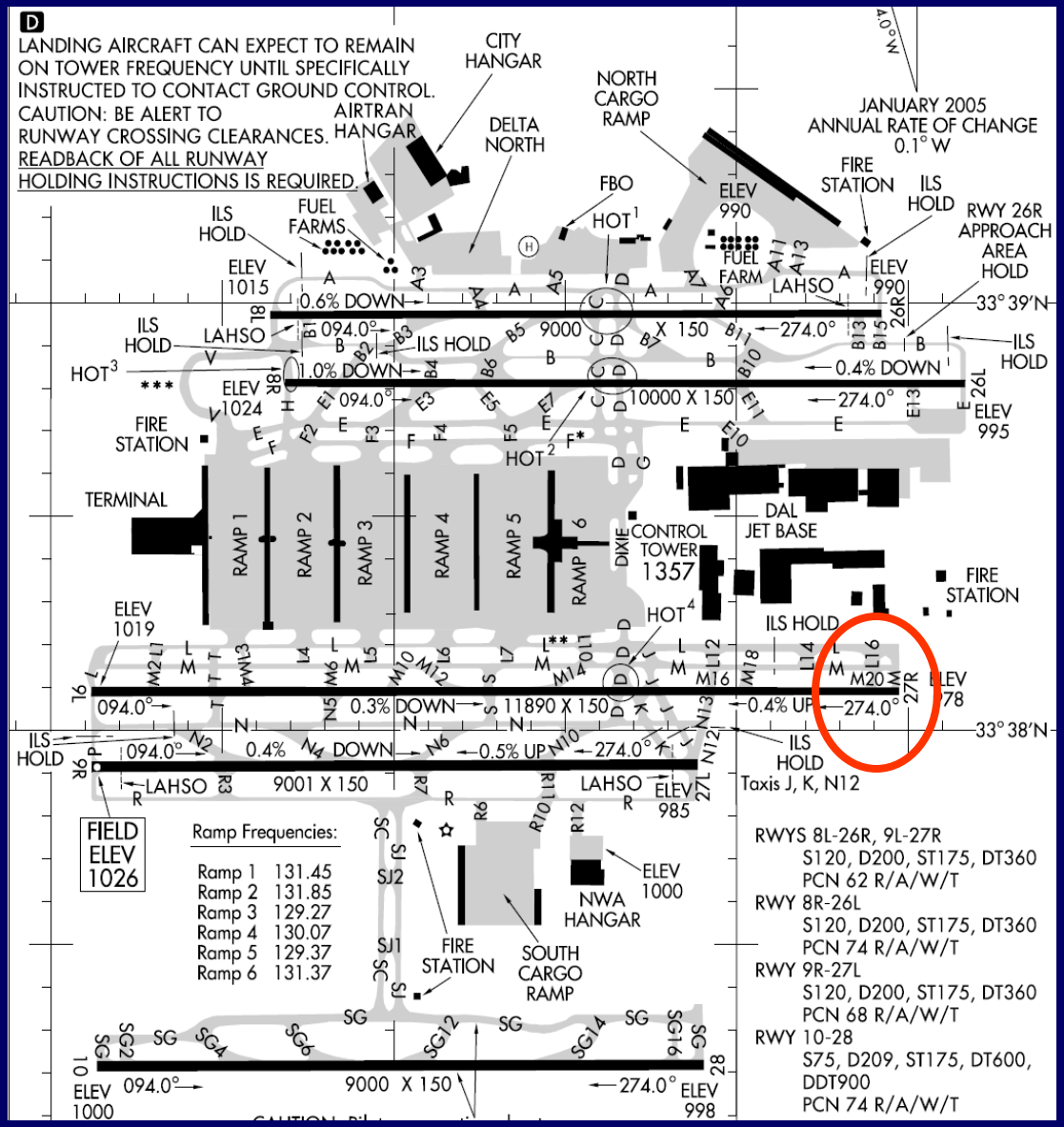
Delta Airlines Taxiway M Landing - ATL



On Monday, October 19, 2009, at 6:05 a.m. EDT, a Boeing B767 operating as Delta Air Lines flight 60 (DL 60) from Rio de Janeiro, Brazil, to Atlanta, Georgia, landed on taxiway M at (ATL) after being cleared to land on runway 27R. No injuries to any of the 182 passengers or 11 crewmembers were reported.

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Delta Airlines Taxiway M Landing - ATL

- The runway lights for 27R were illuminated.
- Localizer and approach lights for the runway were not turned on.
- Taxiway M was active but was clear of aircraft and ground vehicles at the time the aircraft landed.
- The wind was calm with 10 miles visibility.
- Night VFR conditions prevailed.

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Flight Team Investigation

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Delta Airlines Taxiway M Landing - ATL

- Runway 27R lights were set on step 1 intensity
- PAPIs for runway 27L and runway 27R were easily discernable however runway 27R was not easily identified.
- Runway edge lights were very, very dim in comparison to its neighboring taxiway.
- Taxiway M lighting appeared markedly brighter than runway 27R
  - Lights are hardwired on step 3 intensity (100%)

Delta Airlines Taxiway M Landing - ATL

- Numerous signs that marked taxiway M connector taxiway stubs between runway 27R and taxiway L appeared as white edge lighting and mimicked the appearance of a runway.
- LED taxiway centerline lighting lead in lights were bright and could be seen on the taxiway
  - The remaining length of incandescent lights were not as easily identified as were the LED lights

Delta Airlines Taxiway M Landing - ATL

- The taxiway M lighting was dominant and appeared to be white.
- The illusion that the M taxiway was a runway was further supported with the PAPI position to its left.
  - The PAPI is positioned to the right of runway 27R.
- The wing threshold lights for runway 27R were not easily discernable
  - Perhaps due to the light pollution in the area
  - More dominant lighting on the taxiway

Delta Airlines Taxiway M Landing - ATL

- Runway lights were observed at settings step 1, 2 and step 3
- Step 1 was very dim in comparison to its parallel taxiway, taxiway M.
- Step 2 did not make much difference and was not effective in differentiating the runway from the taxiway.
- Step 3 was very effective and adding the approach lighting to the equation made identification likely.

ATL Runway 27L Runway Lights on Step 1


PAPI on right side of runway,
therefore on left side of parallel taxiway

Measured Chromaticity

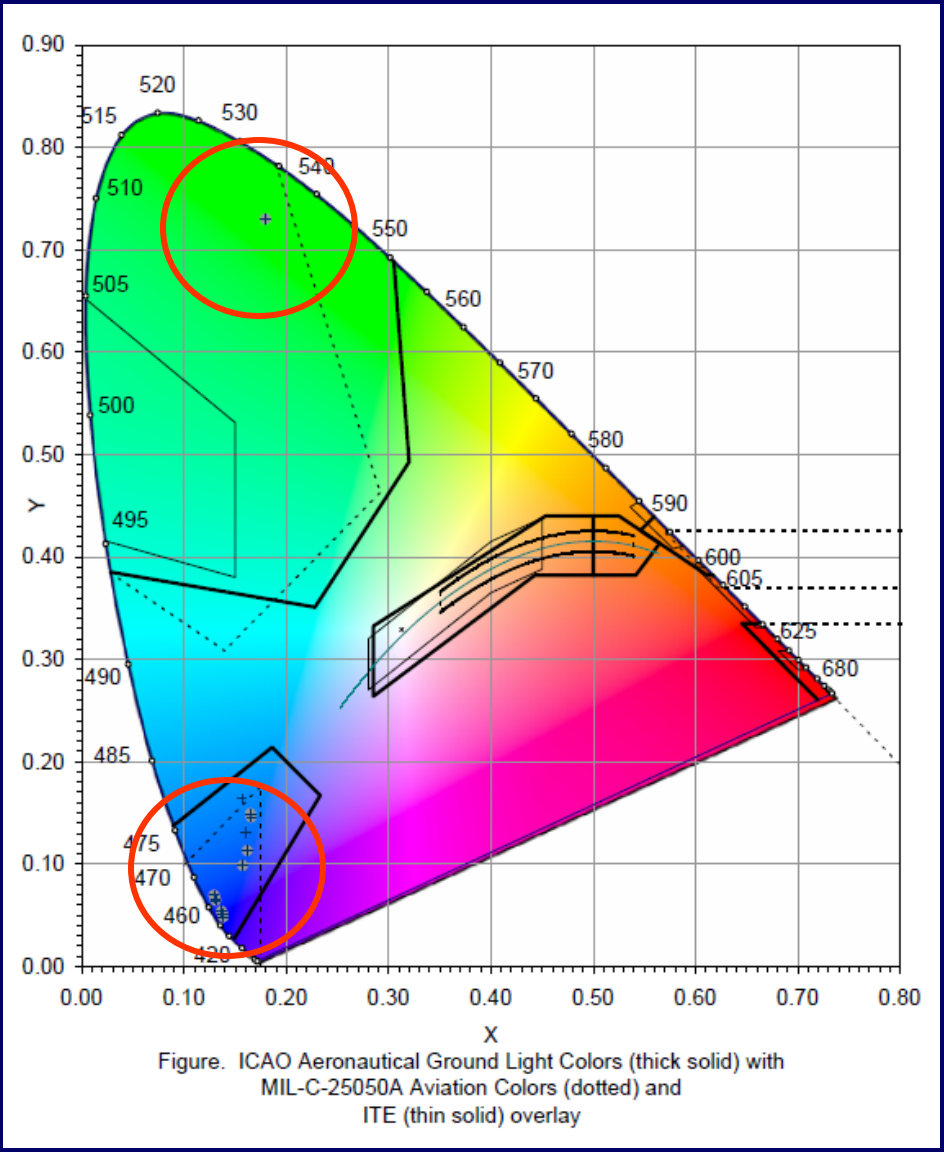

Figure. ICAO Aeronautical Ground Light Colors (thick solid) with MIL-C-25050A Aviation Colors (dotted) and ITE (thin solid) overlay

- Measured chromaticity for centerline and edge lighting on Taxiway M were within standard.

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Delta Airlines Taxiway M Landing - ATL

- On the date of the incident, the Delta crew misidentified Taxiway M as runway 27R
  - The approach lights and localizer were not activated.
- Consensus of the flight team was that when runway 27R is offered or used for arrival aircraft,
  - Runway edge lights should be set to no lower than step 3
  - Approach lights should be activated to provide adequate visual cues to the flight crews for identifying the runway surface.

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Assessment of Changing RCL from Alternating White/Red to White/Yellow

- ICAO Initiative – An accepted practice in aviation is to never cross red lights.
- Current RCL lighting cues does not support this position.
- Field test both incandescent and LED RCL technologies.

Questions?

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