

Session 35-GNC-21: “Innovations and Support of the NAS at the FAA”

Paper AIAA-2007-6521: “Testing and Evaluation Methods of the Runway Status Lights System”

Presented to: AIAA GNC, Hilton Head, S.C.

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Federal Aviation
Administration



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Introduction

- The National Transportation Safety Board and the FAA administrator has listed runway incursions as an important aviation safety concern
- There is a need to provide a direct warning capability of runway status to the flight crew
- The Federal Aviation Administration is evaluating the RWSL concept that provides a direct warning capability to flight crews on runway status using in-pavement red lights on the airfield



RWSL Concept

- Is designed to operate in all-weather conditions
- Provide a direct indication of runway status to pilots and airfield vehicle operators using in-pavement red lights
- Must operate without changing air traffic controller and pilot procedures

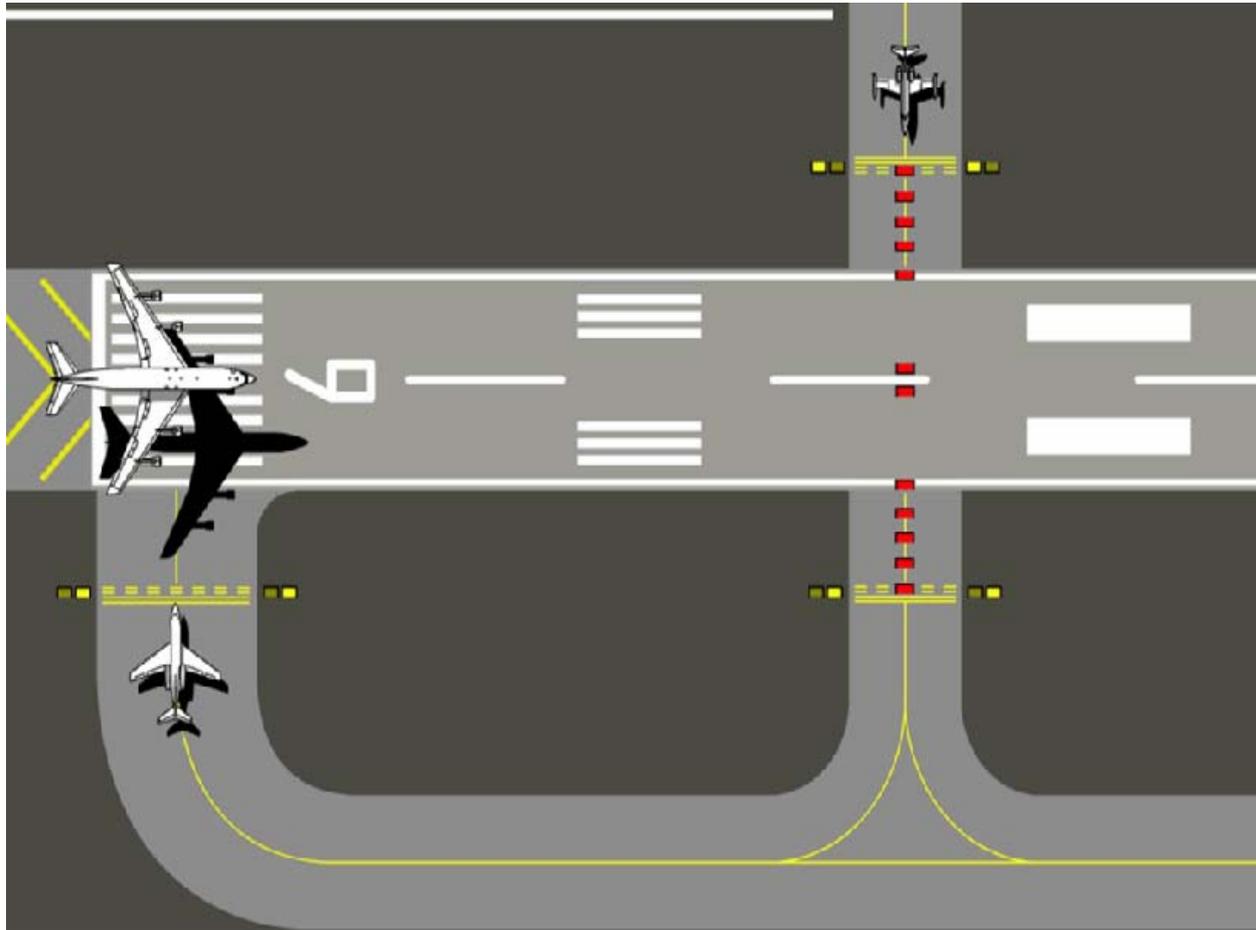


RWSL Components

- The RWSL concept consists of several elements
 - Runway Entrance Lights (RELs)
 - Takeoff Hold Lights (THLs)
 - Runway Intersection Lights (RILs)
- The RWSL processor takes surveillance and automatically sends commands to the Field Lighting System that illuminates and extinguishes the appropriate lights
- Testing of the **RELs** will be the focus of this presentation



REL Configuration



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How RELs Work

- The RELs illuminate red when the runway is unsafe to enter; they are off otherwise
- The RELs are extinguished just before the high-speed operation clears the intersection
 - not to interfere with fundamentally safe operations
 - allows controllers to use anticipated separation
- The RELs are extinguished when a departing aircraft is declared airborne (50 ft to 100 ft off the ground)
- **In all cases, runway status lights indicate runway status only; they do not indicate air traffic controller clearance**



Test Site Description

- San Diego-Lindberg Field Airport (SAN) in San Diego, CA
- Use an Airport Movement Area Safety System (AMASS) surveillance data (primary only radar data)
- AMASS surveillance data used as input to the RWSL system



RWSL Test Effort

- Test must be done without causing a decrease in safety
- The system was broken down into smaller components and tested individually
- Each test effort was divided between different test groups with distinct expertise
- Testing was performed in series and in parallel where appropriate
- The common goal between the different test efforts was to prepare each part of the RWSL system for a safe operational evaluation



Parallel Testing of RWSL

- The FAA Program Office located in Washington DC along with a Research Program Management Team oversaw the entire test effort
- REL configuration (Flight Standards)
 - differentiable from other lighting configurations
 - intuitive to pilots
- FLS selection (Airports)
 - select a commercial off the shelf lighting system
 - verify that it would meet requirements for the operation of RWSL
- **RWSL processor and software algorithms (FAA William J. Hughes Technical Center)**



Series Testing of RWSL Processor

- Engineering Development Test
 - Performed in a laboratory environment using pre-recorded data
- Shadow Operations Test
 - Using off-duty air traffic controllers on site using live traffic and no operational RELs
- Operational Evaluation
 - RELs are operational and interaction with air traffic controllers, pilots and airfield vehicle operators



Measures of Performance

- Objective Measures of Performance
 - Missed detection - a failure of an REL to be activated when it should be
 - False activation - an REL being activated when it should not be
 - Instances of interference – REL illumination that causes an interruption to a safe operation
- Subjective Measures of Performance
 - Pilot and air traffic controller surveys



Performance Goals

Phase	Missed Detections	False Activations	Interference
Engineering Development Test	1/320 operations	1/800 operations	1/800 operations
Shadow Operations Test	1/360 operations	1/900 operations	1/900 operations
Operational Evaluation	1/400 operations	1/2000 operations	1/1000 operations



Engineering Development Goals

- Assess the core functionality of the RWSL system design under repeatable laboratory conditions
- A key element of the engineering development test was to test the capability of the RWSL system to identify all types of airport movement activity
- Verify that the RWSL processor could positively identify when an aircraft becomes airborne during its departure roll strictly from its surveillance track's movement behavior
- Meet objective measures of performance



Engineering Development Test

- Recorded surveillance data was collected at two key site airports to test the capability of the RWSL system to identify movement activity
 - San Diego International Airport (SAN)
 - Dallas/Fort Worth International Airport (DFW)
- Specific scenarios were selected from the recorded surveillance data to test the RWSL system's ability to provide a light activation and deactivation for challenging traffic situations
- Time synched truth data was collected manually at each key site to determine if the RWSL processor could identify when an aircraft becomes airborne
 - aircraft type
 - position on the runway when it was approximately 50 ft off the runway with a positive rate of climb



Engineering Development Data Analysis

- RWSL test tool program was used to pre-screen data
- Times of interest along with selected scenarios were played back on the RWSL processor for in-depth analysis
- The time synched truth data was compared to the RWSL deactivation of RELs for departures and the time differences were calculated along with the mean and standard deviation
- Objective measures of performance were met



Shadow Operations Goals

- Verify that the RWSL concept can be optimized to perform in a live air traffic environment without requiring any changes to air traffic's operations



Shadow Operations Test

- Emphasized real-time but non-operational use of the RWSL system in a field environment
- No field lighting system was active
- No interaction with operational air traffic controllers, pilots, or airfield vehicle operators



Shadow Operations (Optimization)

- Off-duty air traffic controllers monitored the live airport traffic from the SAN tower for one week
- Identified when the RELs should be on and off for each traffic operation while the FAA test engineer watched the corresponding RWSL display
- The FAA test engineer logged any discrepancies found between the RWSL system and the air traffic controller's determination of when RELs should be activated and deactivated
- REL timing was optimized prior to the start of formal Shadow Operations testing



Shadow Operation (Formal Test)

- Same procedures used for optimization were used for 3 weeks
- Air traffic controller questionnaires were filled out at the end of each day of testing



Shadow Operations Data Analysis

- Any missed detections, false activations and instances of interference found during formal testing were used to determine if the system met the objective measures of performance
- Subjective measures included air traffic controller verbal feedback and questionnaires
- System met the objective and subjective measures of performance



Operational Evaluation Goals

- To verify the operational suitability of the RWSL concept for use in the National Airspace System



Operational Evaluation Test

- A full system operational demonstration was conducted
 - Test aircraft were used to view RELs and demonstrate REL functionality
- Trained all air traffic controllers, pilots and airfield vehicle operators
 - Training materials were made available months in advance
- First 2 weeks of testing, FAA test engineers were monitoring the system
- 3 months of data was collected for analysis using a dedicated data connection line to download
 - Log data directly from the RWSL system
 - Tower and Ground communications



Operational Evaluation Data Analysis

- Reviewed audio data to determine if there was an increase in communications involving RWSLs
- A RWSL Test Tool program was used to pre-screen the log data
- Times of interest were played back along with the audio communications for a more detailed analysis
- All surveys completed by pilots and vehicle operators were analyzed and used in the determination of the operational suitability of the RWSL system
- All comments sent by controllers were reviewed to determine if the RWSL system was invisible to controllers



Operational Evaluation Results

- 2,083 hours of data was collected during Operational Evaluation
- 49,985 operations were analyzed on RWY 09/27
 - 52 missed detections
 - 12 false activations
 - 0 instances of interference
- 9,974 aircraft/airfield vehicle operators observed lit RELs
- 5 air traffic controller comments
- 77 pilot surveys were collected with most being positive
 - Indicated that timing at the B1/C1 intersection needed to be adjusted



Summary

- Breaking down the system into smaller components is paramount in accomplishing successful testing
- Testing can be performed with different user groups using the three different test phases to ensure the basic metrics are met
- The RWSL system in SAN is still operating and data is still being collected and analyzed
- RWSL testing has also been successful at Dallas/Fort Worth International Airport and the system is still operating
- THL and RIL testing will follow the same testing and evaluation methods



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