Front Line Managers (FLMs) and Airline Pilots Training for Operational Evaluation of enhanced Final Approach Runway Occupancy Signal (eFAROS) at DFW

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eFAROS ATC Training and Operational Evaluation

• **Goal of training**
  – Learn features of the eFAROS system and display, safety logic and adaptation

• **Purpose of training**
  – Become familiar with the eFAROS visual and aural advisories

• **Objective of eFAROS Operational Evaluation**
  – Identification and mitigation of status light anomalies
  – More thorough evaluation of eFAROS operational suitability
Overview of RWSL and eFAROS

- Runway Status Lights at DFW consists of existing Runway Entrance Lights (RELs) and Takeoff Hold Lights (THLs) and new enhanced Final Approach Runway Occupancy Signal (eFAROS)

- Runway Status Lights Purpose
  - Reduce frequency and severity of runway incursions
  - Prevent runway accidents

- How do Runway Status Lights do this? By increasing pilots’ and ground vehicle operators’ situational awareness
  - RELs give a direct warning to pilots and ground vehicle operators that it is unsafe to enter or cross a runway
  - THLs give a direct warning to pilots that it is unsafe to depart from a runway
  - eFAROS gives a direct warning to pilots that it is unsafe to land on a runway
    - By flashing existing Precision Approach Path Indicators (PAPIs)
Most runway incursions result from **pilot deviations**.

“Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take off of aircraft”
Objective of RWSL and eFAROS

• Per NTSB’s *MOST WANTED*:
  – “Give immediate warnings of probable collisions/incursions directly to flight crews in the cockpit.”

• RELs warn unsafe to enter/cross RWY

• THLs warn unsafe to depart from RWY

• RILs warn unsafe to cross RWY intersection

• eFAROS warns unsafe to land
Goal of eFAROS:
Prevent Runway Accidents and Incursions

- **Example: LAX 1991 “landover” accident**

  - “Forgetting is a human factor routinely found in operational errors by air traffic controllers that cause incidents virtually every day in our nation’s air traffic system. This type of human error has also been identified in past accidents. For example, on February 1, 1991, a USAir Boeing 737 collided with a Skywest Metroliner at the Los Angeles International Airport, killing 34 passengers and crew. This accident occurred, in part, because the air traffic controller cleared the USAir airplane to land about 3 minutes after she had cleared the Skywest airplane onto the same runway to hold for departure...”
    - Quote Reference: Testimony of Jim Hall, Chairman NTSB, April 16, 1997

- **Accidents with aircraft not exiting the runway after landing while a subsequent landing is in progress (aka “tail chase”)**

  - eFAROS would warn landers

- **Accidents with aircraft or vehicle crossing the runway while landing is in progress**

  - eFAROS would warn landers; RELs designed to prevent such events by warning crossers
eFAROS and RWSL
High Level Block Diagram

Surveillance
- Transponder Multilateration
  - ASDE-3
  - ASR-9

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Light Control Logic

Field Lighting System
- PAPIs
- eFAROS
- RELs
- THLs

RWSL Test Display with eFAROS, RELs and THLs on (red) due to traffic
Drawings of RWSL & eFAROS

Runway Entrance Lights (RELs)

Takeoff Hold Lights (THLs)

Runway Intersection Lights (RILs)

Flashing PAPIs indicate the runway is occupied!
Enhanced Final Approach Runway Occupancy Signal (eFAROS)

Note: Assessment of RWSL double-row THLs and RILs and eFAROS flashing PAPIs is TBD.
eFAROS: Pilots’ View

- Indicates runway unsafe for landing
- **Flashing** PAPIs if runway not safe for landing
- Otherwise steady (glide path indication only)
• **eFAROS** is a pilot notification system of runway status for pilots on final approach to landing

• When runway is occupied and approaching aircraft has reached the arming distance (default is 1.5 nmi)
  – PAPIs begin flashing to pilots
  – Red bar shown on RWSL display in tower

• When aircraft is within .5 nmi of landing threshold and runway is occupied
  – PAPIs begin or continue flashing to pilots
  – Red bar shown on RWSL display in tower flashes red and white
  – Audible advisory sounds in tower “eFAROS (RWY designator)”
eFAROS Operational Protocol for Pilots

- When eFAROS acquisition point is reached
  - Attempt to see traffic on runway
    - If seen, evaluate the situation then proceed with caution
    - If not seen, then prepare to contact ATC at contact point

- When eFAROS contact point is reached after passing acquisition point
  - Attempt to see traffic on runway
    - If seen, evaluate the situation then proceed with caution
    - If not seen, then contact ATC to verify landing clearance and prepare for an immediate go-around
    - If ATC does not verify landing clearance promptly, go around
    - If ATC cancels the landing clearance, go around
• There is one **arming region** on each eFAROS-instrumented runway
  – Arming regions for 17R/35R and 17C/35C shown in light blue
  – Start of region is 3nmi from r/w threshold
  – Arming distance is the same for Enhanced and Active eFAROS
    - TBD based on user feedback
    - Default is 1.5 nmi from RWY threshold

• There are multiple **activation regions** that cover runway in both directions
  – Example activation regions for 17R/35R and 17C/35C shown in green (overruns not included)
  – When LAHSO is used, activation region ends at the LAHSO line

• Shape of activation region bumps out in all areas where high-speed taxiways meet the runway
  – To address issue of aircraft re-entering the runway after having started to exit at an angled taxiway
  – Also to allow for imprecision in aircraft or vehicle position data

*Illustration of eFAROS arming and activation regions on DFW-East (not to scale)*
High Level Operational Requirements

- eFAROS must have aircraft in position for landing (in arming region) and aircraft or vehicle “on” runway (in activation region) in order to turn on.

- eFAROS must turn off once either condition is no longer met.

- eFAROS must not interfere with normal safe operations.

- eFAROS must operate automatically for each operation:
  - No controller action required.

- eFAROS must accurately depict that it is unsafe to land.
DFW RWSL OPERATIONAL CONCEPT

- Runway Status Lights (RWLS) turn on and off automatically; RWLS driven by surface radar surveillance
- RELs turn ON when it is unsafe to enter or cross a runway; RELs are visible from taxi hold position
- THLs turn ON when it is unsafe to depart from the runway; THLs are visible from takeoff hold position (and final approach)
- FAROS turns ON when it is unsafe to land; FAROS is visible from final approach to runway

FAROS: Final Approach Runway Occupancy Signal
PAPI: Precision Approach Path Indicator
REL: Runway Entrance Lights
THL: Takeoff Hold Lights

www.RWSL.net
eFAROS Locations at DFW

- eFAROS deployment planned for 18R/36L, 17R/35L, and 17C/35C

- Need for eFAROS noted in FAA Runway Safety Blueprint 2004
  - “When pilots are on final approach for landing, in certain conditions such as periods of reduced visibility, it is difficult to distinguish an aircraft that is already on the runway and pointing directly away from an arriving aircraft. A visual method to warn pilots (operating in sufficient visibility) that the runway is occupied would reduce the opportunity for collision.”
New eFAROS advisory in ATC TWR

- **AMASS alert** is currently male voice
  - Mandatory go around issued by ATC
    - "Warning, runway 18L go around"

- New visual eFAROS **advisory** on RWSL displays
  - Red bar or flashing red/white bar adjacent to the runway

- New audible eFAROS **alarm and advisory** from small speaker
  - Brief tone for audible alarm, default is 1 second sine wave
  - Tone followed by *female* voice advisory
    - "**FAROS runway 18L**"  
    - Presented once
  - New visual indication of eFAROS not in service
  - "No FAROS" to be displayed on the RWSL display
  - Similar to current "No RWSL" display

- One small speaker was added to the RWSL hardware to sound eFAROS audible advisory
  - Other equipment is same as used for RWSL Operational Evaluation of RELs and THLs at DFW
• Adaptation parameters were adjusted to meet tempo of DFW operations while providing direct warning to pilots

• Default adaptation parameters have been tuned to
  – Arming distance is 1.5 nmi from runway threshold
  – Acquisition point is 500 ft AGL or about 1.5 nmi from landing threshold
  – Contact point is 300 ft AGL or about .75 nmi from landing threshold
eFAROS Anomalies

- Definition of runway status light anomalies:
  - False Activation (FA)
    - Light flashing when eFAROS advisory should not be in effect
  - Missed Detection (MD)
    - Light not flashing when eFAROS advisory should be in effect
  - Interference (I)
    - Communication interference occurs when eFAROS causes crew to contact ATC before descending to the contact point
    - Operational interference occurs when eFAROS causes crew to interrupt a normal, safe landing below the contact point
    - Increased controller and/or pilot workload
eFAROS Operational Evaluation Summary

• Goal
  – Expose eFAROS to real surveillance with live operations and expert observation by ATC and pilots

• Method
  – Evaluate accuracy of eFAROS advisories, given ATC clearances and aircraft or vehicle movement
  – Observe and record instances of anomalous light operation

• Results
  – Assess possible interference with normal, safe operations and degradation of airport capacity
  – Estimate effectiveness of eFAROS in preventing runway incursions
  – Determine operational suitability of eFAROS at DFW

❖ Please provide your feedback on eFAROS. Take the confidential survey at https://efaros.ll.mit.edu