



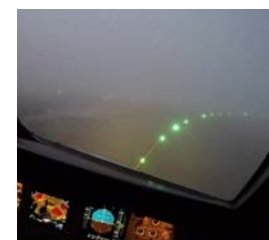
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AVIATION LIGHTING COMMITTEE



Runway Incursions and Airfield Lighting

NTSB Aviation Accident Investigation

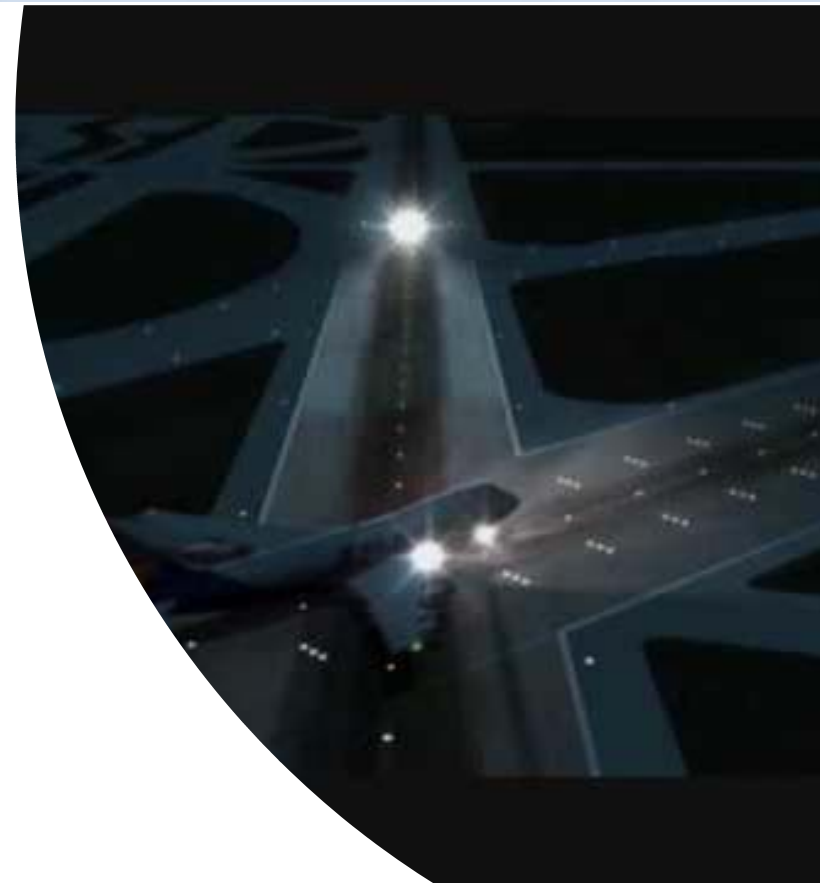
Anatomy of an Accident





Goals

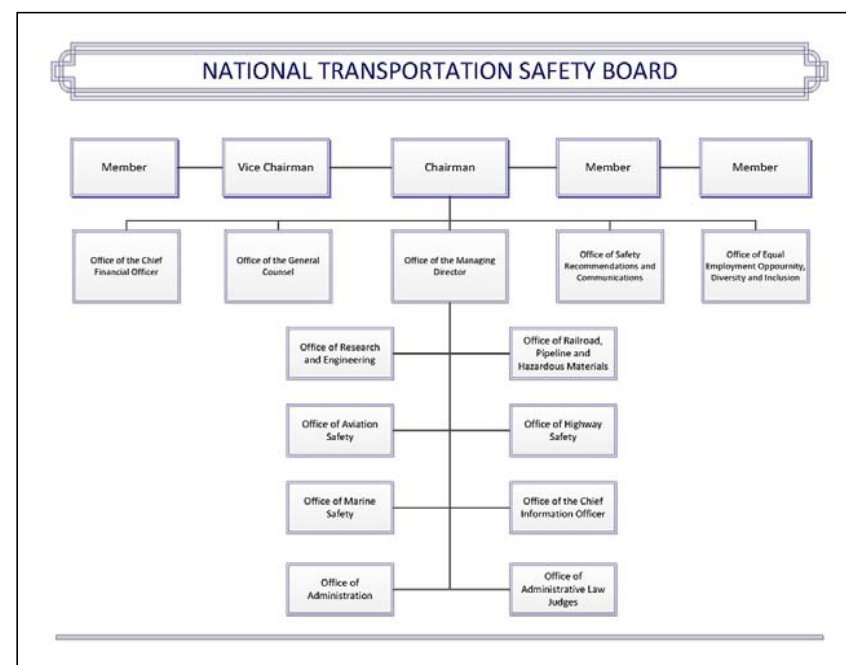
- Better understanding of the Anatomy of an Accidents
- Sequencing of Event prior to Accidents
- Our role as the Airfield Signage, Lighting and Marking's stakeholders





NATIONAL TRANSPORTATION SAFETY BOARD (NTSB)

- Investigative Body responsible for review Civil Transportation Accidents
 - Aviation**
 - Surface Transportation**
 - Highway**
 - Rail**
 - Marine with US Coast Guard**
 - Pipeline**
- Formed in FY1967 as part of the USDOT
- Became fully independent agency in FY1975 under Department of Commerce
- Five Person Investigative Board
 - Nominated by the President of the United States
 - Approved by the US Senate





NTSB AREAS OF REVIEW

OPERATIONS

HISTORY OF
FLIGHT AND
CREW REVIEW
IN DAYS PRIOR
TO ACCIDENT

STRUCTURES

REVIEW OF
AIRFRAME,
WRECKAGE AND
PRE-INCIDENT
COURSE AND
ATTITUDE

POWERPLANTS

EXAMINATION OF
ENGINES AND
ENGINE
ACCESSORIES

ATCT

REVIEW OF
ATCT
SERVICES
GIVEN TO THE
AIRCRAFT,
RADIO
COMM,
RADAR DATA

SYSTEMS

AIRCRAFT
SYSTEMS –
HYDRAULICS,
ELECTRICAL,
INSTRUMENT
AND
ELEMENTS OF
FLIGHT
CONTROLS

WEATHER

PERTINENT
WEATHER
DATA-
NATIONAL
WEATHER
SYSTEM AND
LOCAL TV

HUMAN PERFORMANCE

STUDY OF CREW
PERFORMANCE
AND PRE-ACCIDENT
FACTORS - HUMAN
ERROR, INCLUDING
FATIGUE, ALCOHOL,
DRUGS, MEDICAL
HISTORIES,
TRAINING,
WORKLOAD, AND
WORK
ENVIRONMENT

SURVIVAL FACTORS

DOCUMENT
IMPACT
FORCES/
INJURIES,
EVACUATION,
COMMUNITY
EMERGENCY
PLANNING
AND ALL
CRASH-FIRE-
RESCUE
EFFORTS



NTSB Go Teams

- Rapid response to accident investigation scenes
- Broad Spectrum of Technical Expertise
- Analyze Complex Transportation Accidents
- Team Size – 3 to 12 personnel





Accident Reports

- Public Hearing on Accident
- Catalog the Actual Sequential Events
- Evaluations
 - Personnel
 - Crew – Pilots, Flight Attendants
 - ATC – Ground and ATCT
 - ARFF Response to Accident
 - Aircraft
 - Airport
- Key Findings
- Cause
 - Probable
 - Contributing Factors
- Appendix – Voice Recorder Transcripts, flight charts...





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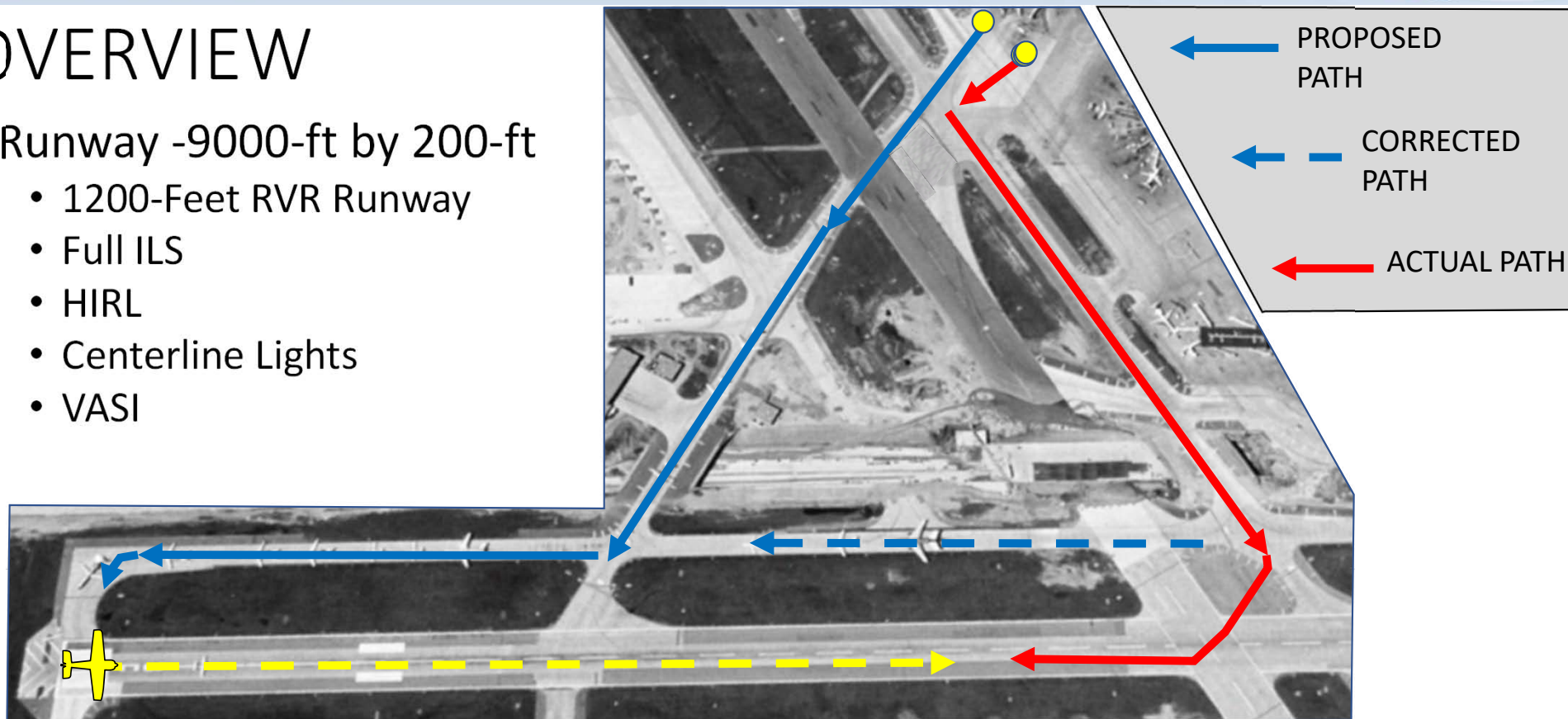
Case Study – Runway Incursion: Aircraft Mistakenly Taxies on to Active Runway





OVERVIEW

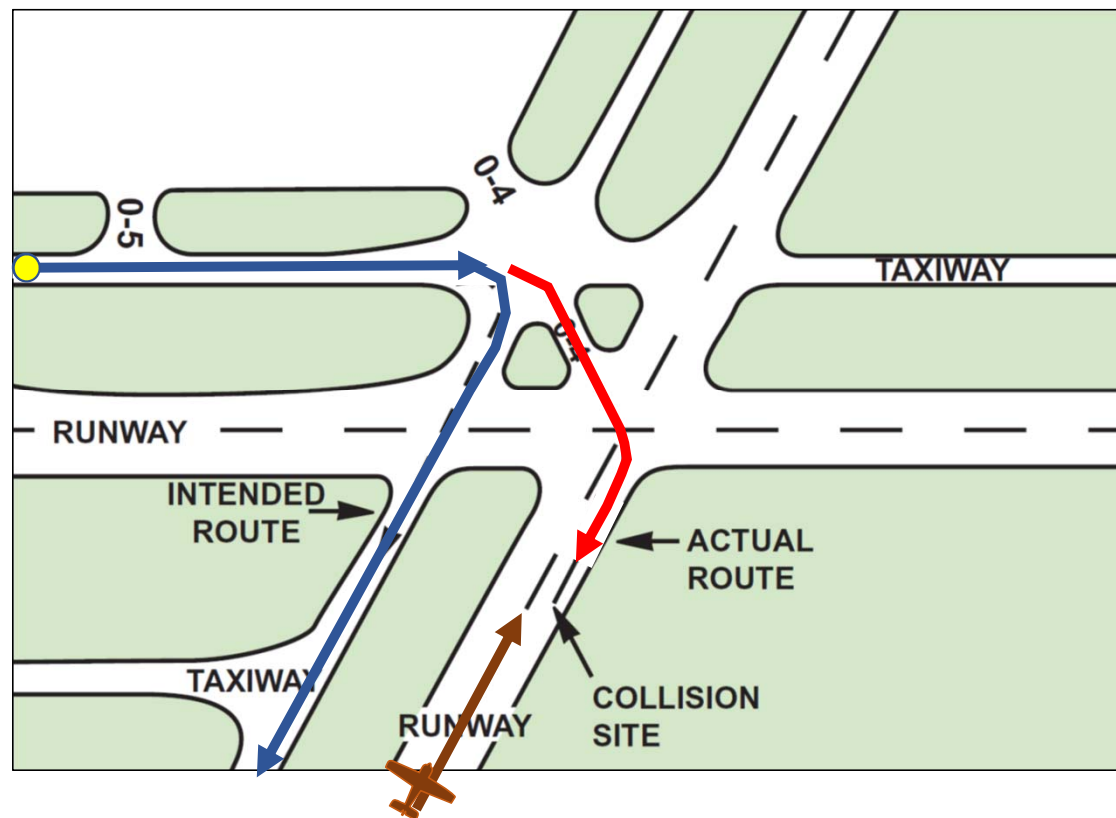
- Runway -9000-ft by 200-ft
 - 1200-Foot RVR Runway
 - Full ILS
 - HIRL
 - Centerline Lights
 - VASI





Summary of Events

- Aircraft No. 1
 - Made Wrong Turn No. 1
 - Received a Corrective Action
 - Made Wrong Turn No. 2
 - Taxied on to Active Runway
- Aircraft No. 2
 - Takeoff Rollout on Runway
- Aircraft Nos. 1 and 2 Engage





Key Findings

Low Visibility

- Automatic Terminal Information System (ATIS) - 1/4 –mile (1200-Feet RVR)
- Visibility near the Runway – Approximately 100-Feet and 200-Feet RVR

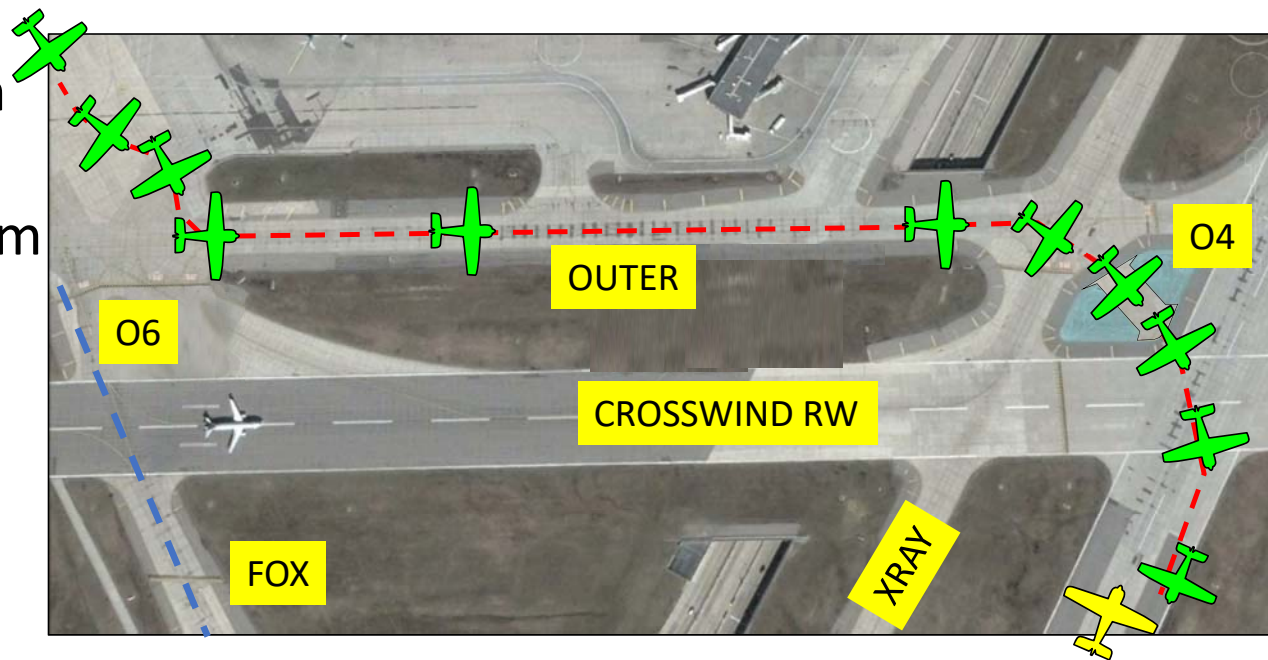




Key Findings

Dynamic between Captain and First Officer

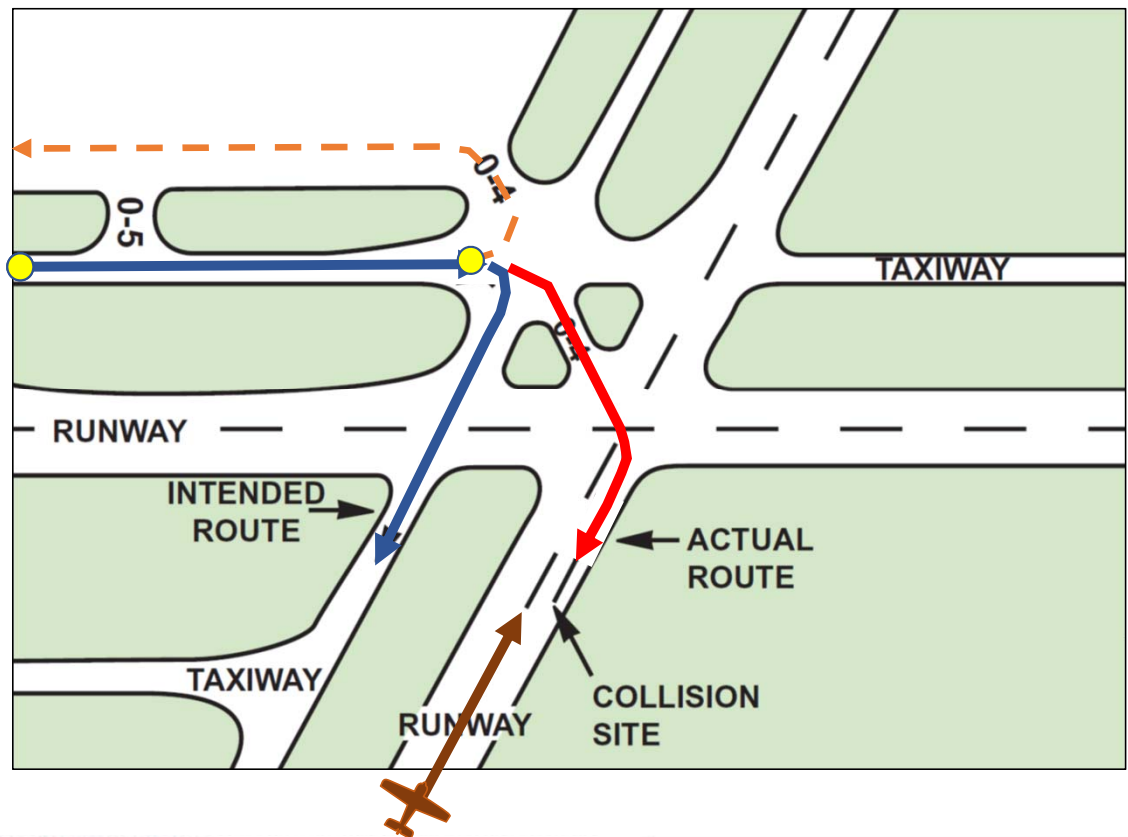
- Captain returning from 6-year medical leave
- FO Overstated Experienced
- Breakdown in Communication
- Role Reversal





Key Findings

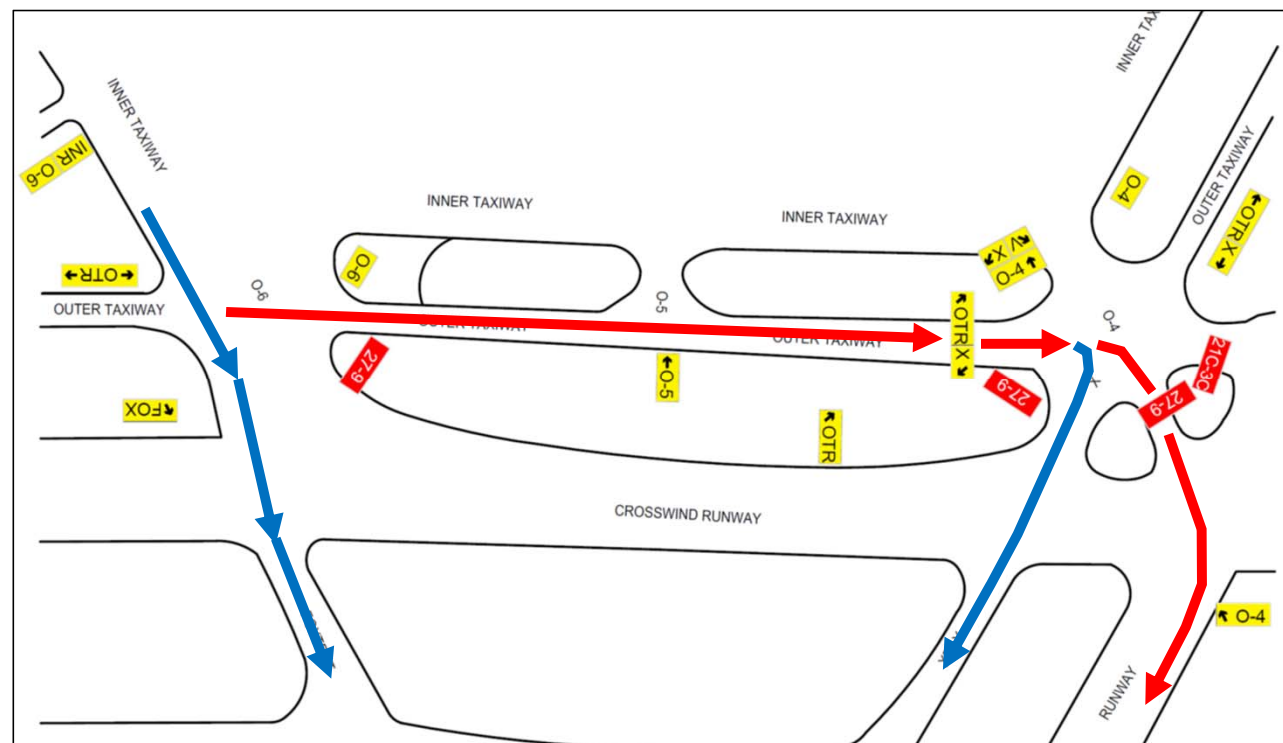
- Crews did not report RVR significantly below 1200-feet RVR
- Ground Controller did not take timely action
- Ground Controller did not properly notify
- Crew failure to notify Ground Controller of uncertain location
- Aircraft No. 1 did not follow assigned traffic route





Key Findings

- Complex Intersection / Airfield Geometry (1990)
 - HSE into Apron
 - Open Spans of Pavement
 - Small Islands
 - Undefined Area
 - Direct Access Taxiway





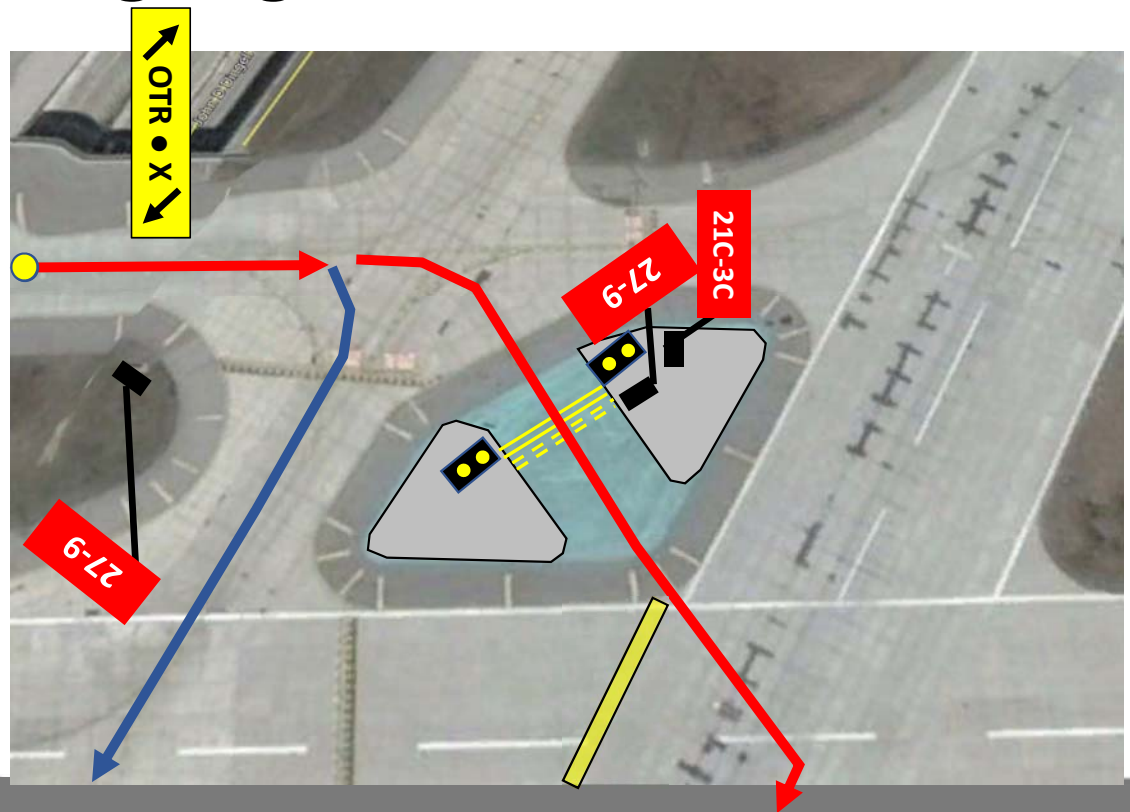
Airfield Lighting and Signage

Runway Centerline Lights

- Centerline Lights were not operable?
- Rotary Switch needed Replacement

Missing Runway Edge Lights

- No Inpavement lights Through Crosswind RW
- “Wig Wag”
 - No L-804 FAA specification
 - New Technology in 1990
 - Not required by FAA Criteria





Signage, Lighting and Marking

Paint Markings

- Reported Initially as poor in TW Oscar 6 area
- NTSB noted good paint markings in field investigation





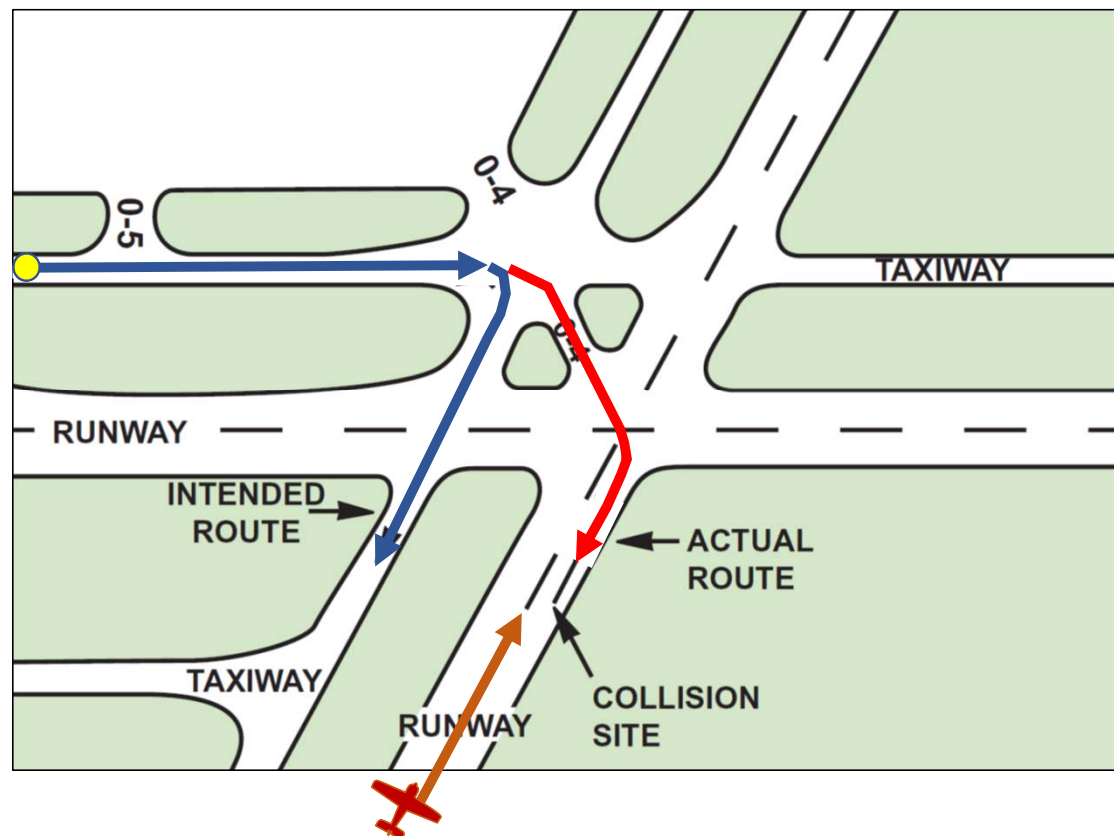
Cause

Probable Cause

- Lack of Crew Coordination
- Role Reversal

Contributing Cause

- Failure of Ground Controllers to act Quickly
- Need for improved Signage
- Inoperative runway centerline lights
- Failure of tailcone release mechanism

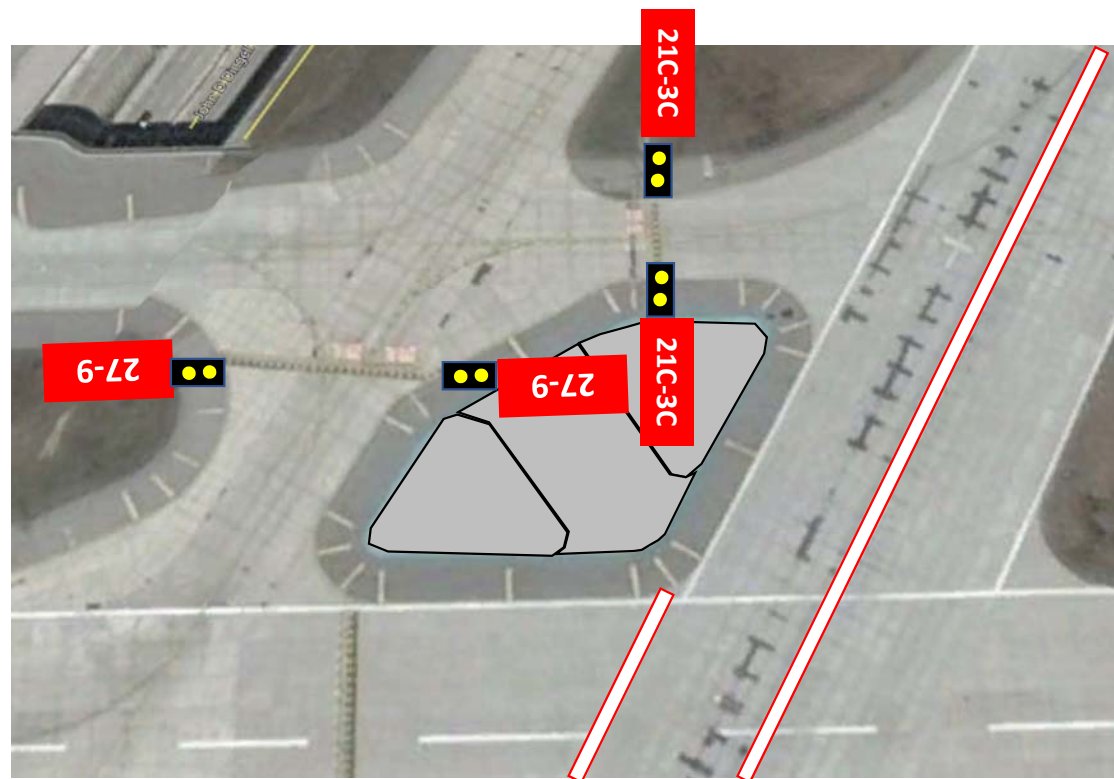




Corrective Action

Corrective Action

- Close Island
- Implement Signage Per FAA AC 150/5340-18A
 - Dedicated Sign Circuits
 - Rename Taxiways
- Install Wig Wags
- Install Inpavement Runway Edge Lights
- Revise Rotary Switch on Control Panel
- Complete New Lighting Vaults
 - New CCRs
 - New Generators
 - New Computer (CPU) based Controls System





Pre-Accident Events

Items not related to the Airfield

Poor Crew Coordination

- Captain Returning from 6-year Medical Leave
- First Officer in first year with airline
- Co-pilot overstated understanding of airport taxi routes
- Role reversal between Flight Crew

Low Visibility

- ¼-mile Visibility for airport
- Approximately 100-feet RVR at site

Complex Geometry

- Runway / Runway Intersection
- Small and Narrow Island

Miscellaneous

- Missed “straight” taxiway to the assigned Runway
- Ground Controller did not act quick enough
- Two failed radio attempts to contact ground control

Miscellaneous (Continued)

- Failure of Tail Cone
- Slow reporting to ARFF of accident Location
- Failure to Determine Minimums significantly lower than 1200-RVR

Lighting, Signage and Marking

- Slow Implementation of FAA Signage Standardization
- Runway Centerline Switch
- Inpavement Runway Edge Lights not Installed
- Wig Wags (first used of Elevated RW Guard Lights) were installed by not operable





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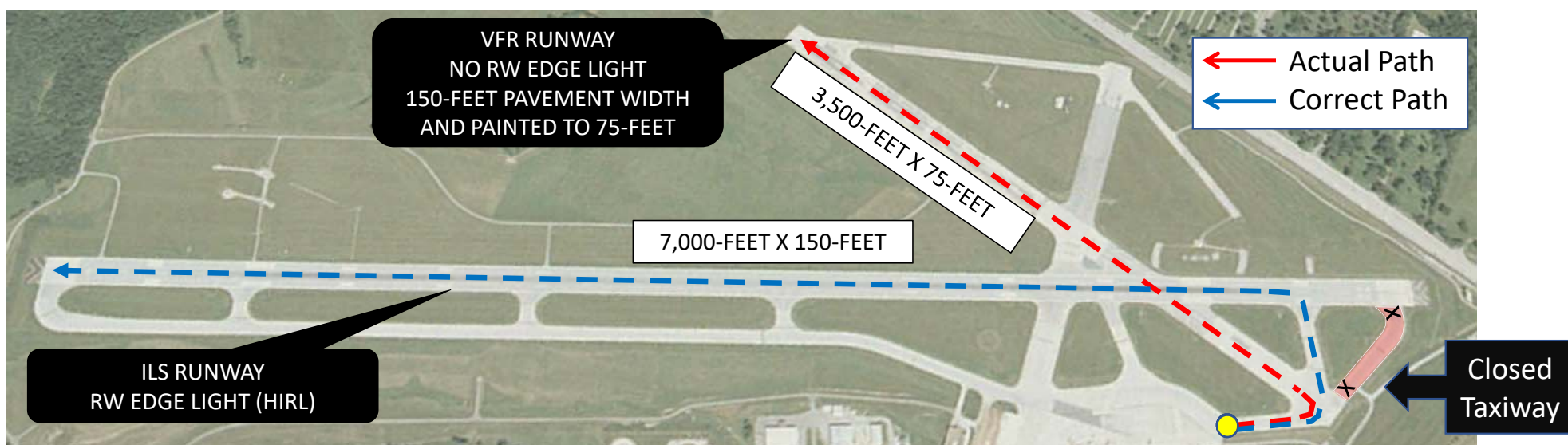


Case Study - Takeoff Roll-Out on Wrong Runway





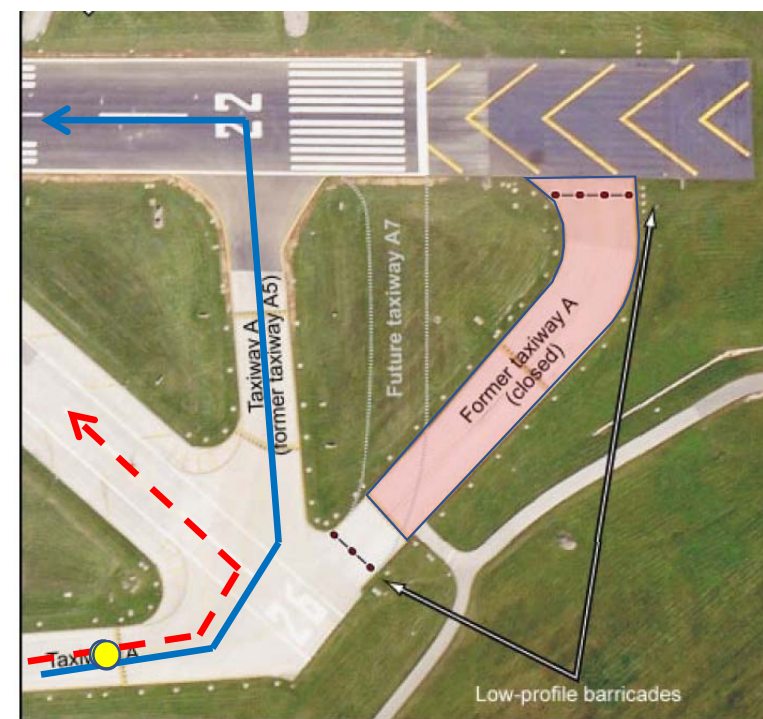
Overview





Key Events

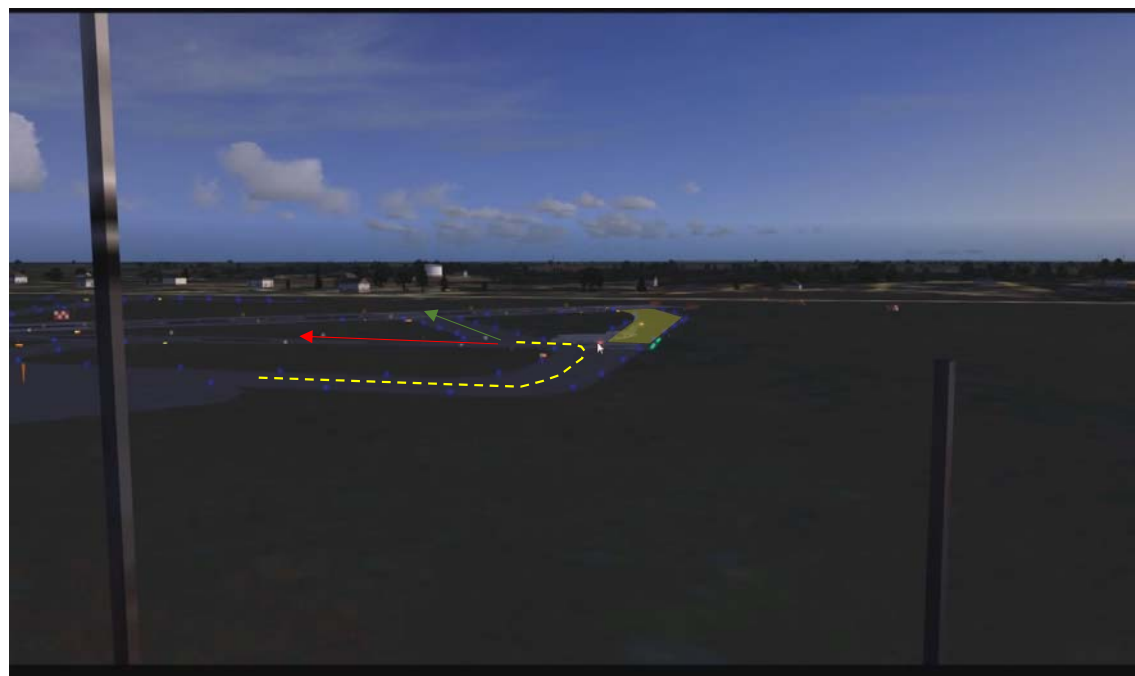
- Aircraft Cleared for push back
- Aircraft cleared to Runway 22 hold position
- Aircraft held past Runway 26 hold position and requested clearance on to Runway 22
- ATCT cleared aircraft to taxi on to the runway for takeoff
- Aircraft taxied onto the Runway 26 (in lieu of RW 22)
- Aircraft began takeoff rollout
- Crew realized problem during takeoff
- Crew did not sufficient stopping distance on shorter runway
- Aircraft crashed off Runway End
- ATCT heard crash, observed fire and notified ARFF
- Full search and rescue response from ARFF





ATCT View

- Aircraft Clearly Visible on TW A
- RW 26
 - Threshold - difficult to Discern which RW Aircraft was on
 - Initial Rollout – More Discernable Aircraft was on RW 26
 - Final Rollout – Difficult to Discern if aircraft was on RW 26 or parallel TW A
- Runway 22
 - RW 22 hold position (and taxi) – easily discernable aircraft on RW 22





Aircraft Entering Runway

Runway 26

- Hold Position Sign Visible
- RW “26” Paint Marking was visible from the Right of Aircraft

Runway 22

- RW 22 Hold Position Sign was Visible
- Taxiway CL markings were visible





Runway 26 Threshold

Runway 26

- RW Edge and CL Markings were Visible
- RW "26" Paint Marking were not visible
- RW 22 Hold Position Sign and White Edge Lights were Visible
- 2000-feet RDR Sign was not Visible
- RW 8 End not visible due to Dark Horizon
- TW Edge Lights were Visible





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Pilot's View – Runway 26





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Runway 26 Roll Out

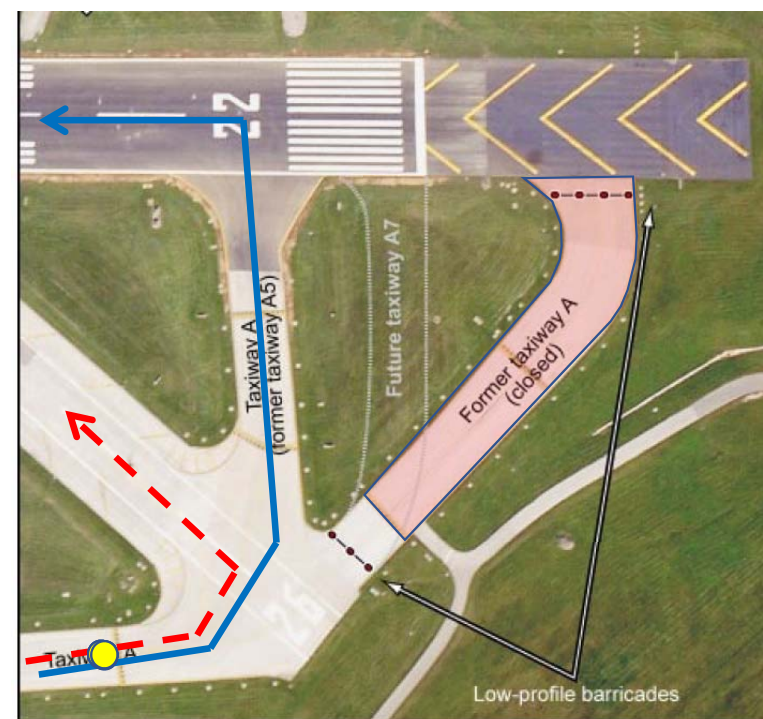


4-22



Summary of Findings

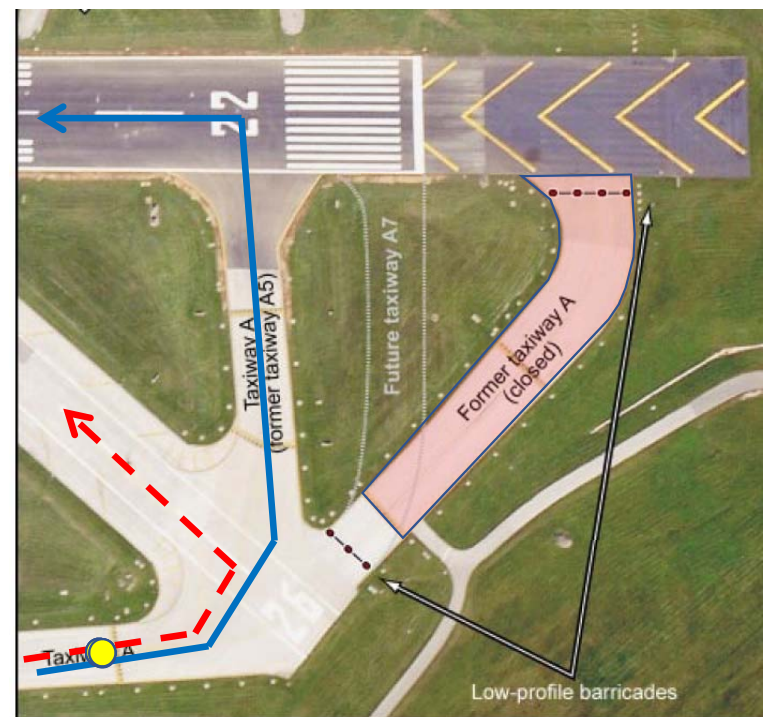
- Crew non-pertinent conversations during taxi
- Aircraft attempted Takeoff on Wrong Runway (RW 26)
- Crew realized problem too late and could not safely stop the aircraft
- Crew failed to identify wrong runway during final pre-flight check
- Crew abbreviated taxi briefing





Summary of Findings

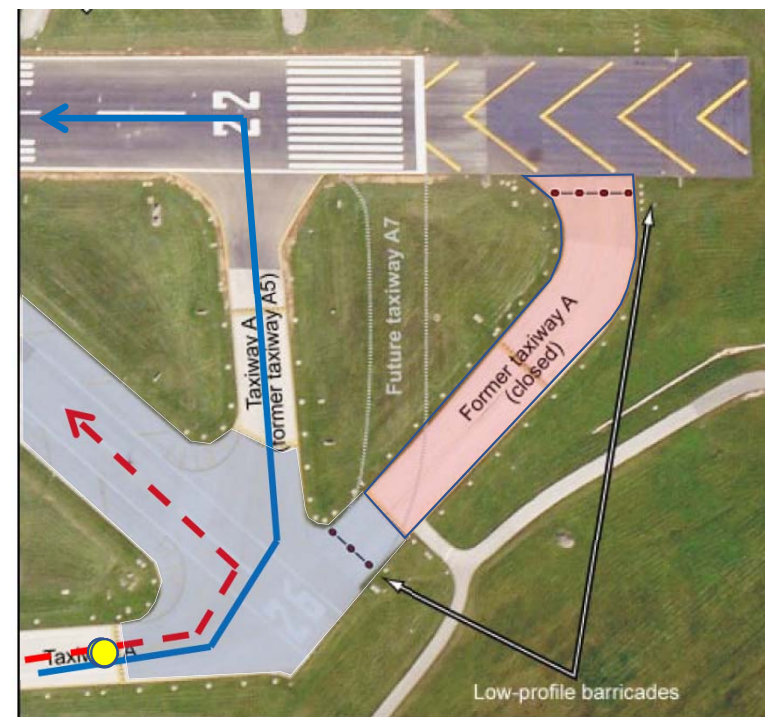
- Aircraft stopped just past Runway 26 hold position (not RW 22)
- ATCT did not notice aircraft stop at Runway 26 (not RW 22)
- ATCT was completing other administrative duties
- ATCT did not monitor aircraft takeoff
- ARFF response was timely and well-coordinated
- First Officer survival was directly attributed to ARFF response





Summary of Findings

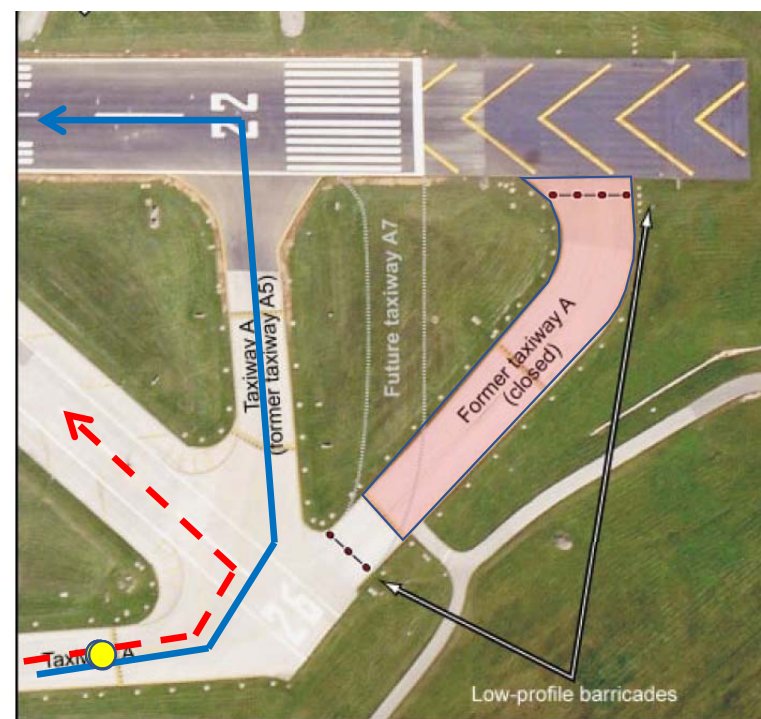
- Enhanced taxiway centerline markings and surface painted may have enhanced awareness (not a standard)
- Procedures need to be Revised
 - ATCT should confirm aircraft have crossed all runways prior to holding at departure runway
 - Reduce administrative task that may impair monitoring of aircraft





Summary of Findings

- Due to airfield construction, taxiway identifiers did not match airport charts
- Not Likely Factors
 - ATCT failure to make Crew aware of altered TW A due to construction
 - Absence of NOTAM from flight release paperwork
 - Presence of a extended TW centerline from TW A





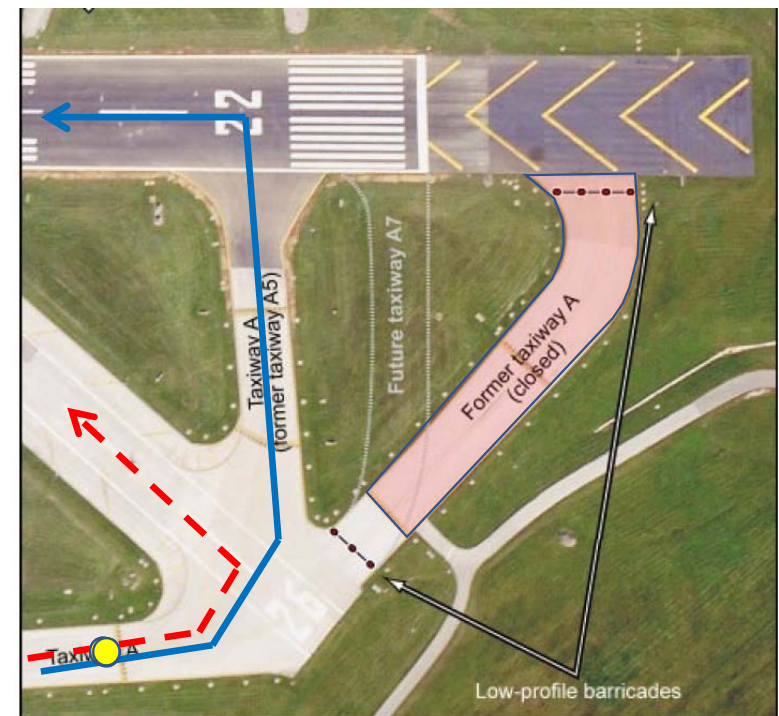
Causes

Probable Cause

- Flight Crews failure to use available cues and aids to identify the aircraft's location during taxiing
- Failure to cross check and verify the aircraft heading prior to takeoff roll out

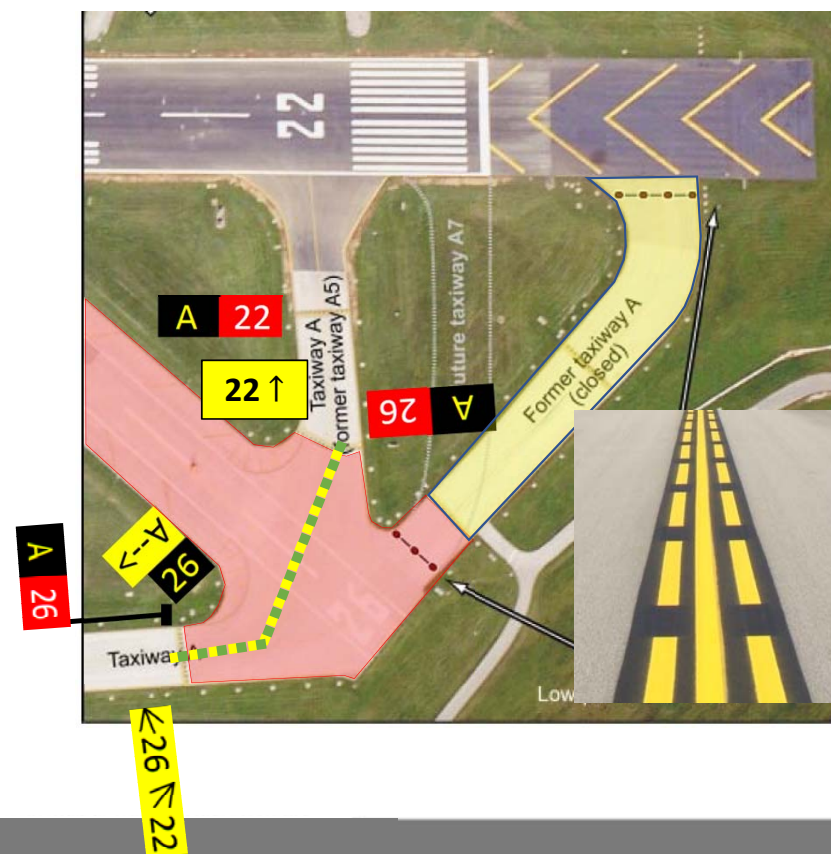
Contributing Crews

- Loss of Positional Awareness - Flight Crews non-pertinent conversation during taxiing
- Failure to stop at all runway crossings and receive clearance from air traffic control clearance



Lighting and Signage

- No Findings Pertaining to Lighting and Signage
- Generally meet FAA AC Criteria
- In Retrospect:
 - Signage Enhancements
 - Add RW Location Sign
 - Outbound Destination Signs
 - Taxiway Centerline Lights





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Pilot's View – Runway 26 Threshold





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CORRECTIVE ACTION





Comparison and Changes Since Events

Changes Since Events

- Aircraft must hold and be cleared at all Runway Hold Positions
- Crews must verbally call out Runway Entrance via Paint Marking or other visible queue
- FAA Runway Incursion Mitigation Team
- Marking Lighting Signage
 - Ground Radars (i.e. ASDE)
 - Runway Status Lights
 - Runway Guard Lights
 - Runway Stop Bars
 - Signage Criteria
 - TW Inpavement Light Criteria
 - Enhanced Taxiway Marking
 - SMGCS / Low Visibility Criteria

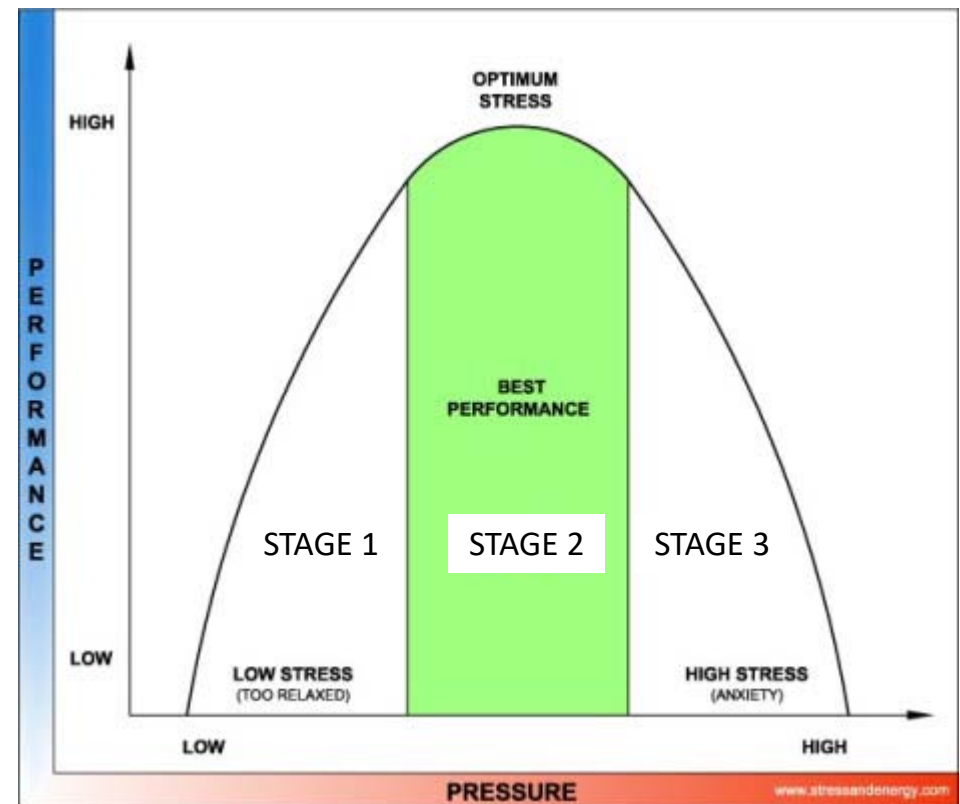
Factors	Event 1	Event 2
Lighting / Signage*		X
Weather	X	
Day	X	
Night		X
Pilot Communication	X	X
Controllers	X	X
Problematic Taxiway Geometry (PTG)	X	X
Training	X	X



Human Factors

Performance as a function of Stress

- Stage 1 – Low Stress (Low Stress)
- Stage 2 – Best Performance
- Stage 3 – High Stress (Anxiety)





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Runway Incursion Mitigation

- Established in July 2015 by FAA Airports Division
- Program Designed to Enhance Safety on Runways
- Risk-based Approach to Analyzing Data for Recurrent Runway Incursions
- Identify Strategic Solutions





FAA Runway Incursion Mitigation Team

- Runway Incursions
 - Catalog
 - Quantify
 - Classify
- Analyze and Evaluate Solutions
 - Taxiway Reconfiguration
 - Improvement to Lighting, Signage and Marking
 - Education / Outreach
- Implement Changes

Risk - Based RIM Criteria	Event 1	Event 2
Y-SHAPED TW CROSSING A RUNWAY		x
HSE COSSING A RUNWAY		
ALIGGNED TW ENTERING RUNWAY ENDS	x	x
TW INTERSECTS RUNWAY AT OTHER THAN 90-DEGREE ANGLE	x	x
USE OF RUNWAY AS A TAXIWAY		
WRONG RUNWAY EVENT	x	x
TWO TUNWAY THRESHOLDS IN CLOSE PROXSIMITY		x
NON-STANDARD SIGNAGE/MARKINGS		
SHORT TAXI DISTANCE ON TO RUNWAY		
WIDE EXPANSES OF TW PAVEMENT	x	
SHORT TW STUBS BETWEEN RW	x	x
GREAT THAN THREE-NODE TW INTERSECTIONS	x	
HSE WITH DIRECT LEAD ON TO ANOTHER RW		
CONVERGENCE OF NUMEROUS TW TYPES ENTERING A RW	x	
DIRECT TW ACCESS TO RW FROM APRON		
TW CONNECTION TO V-SHAPED RW		
TW COINSIDES WITH INTERSETING RUNWAYS		
UNEXPECTED HOLDING POSTIONS		
MISCELLANEOUS	x	



RIM Example No. 1

- Runway Ends to Close Together
- Non-Standard Geometry





RIM Example No. 1

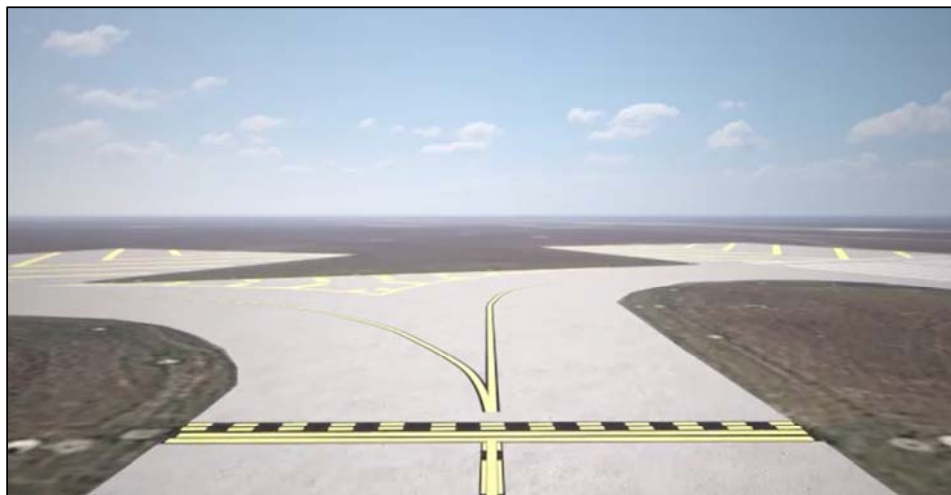




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Pilots View



BEFORE



AFTER





RIM Example No. 2

- Nine Runway Incursions in 6 Years
- Challenges
 - Wide Expanse of Taxiway near a Runway
 - Short Taxiway Stubs between Runways
 - Non-Standard Marking and Signage





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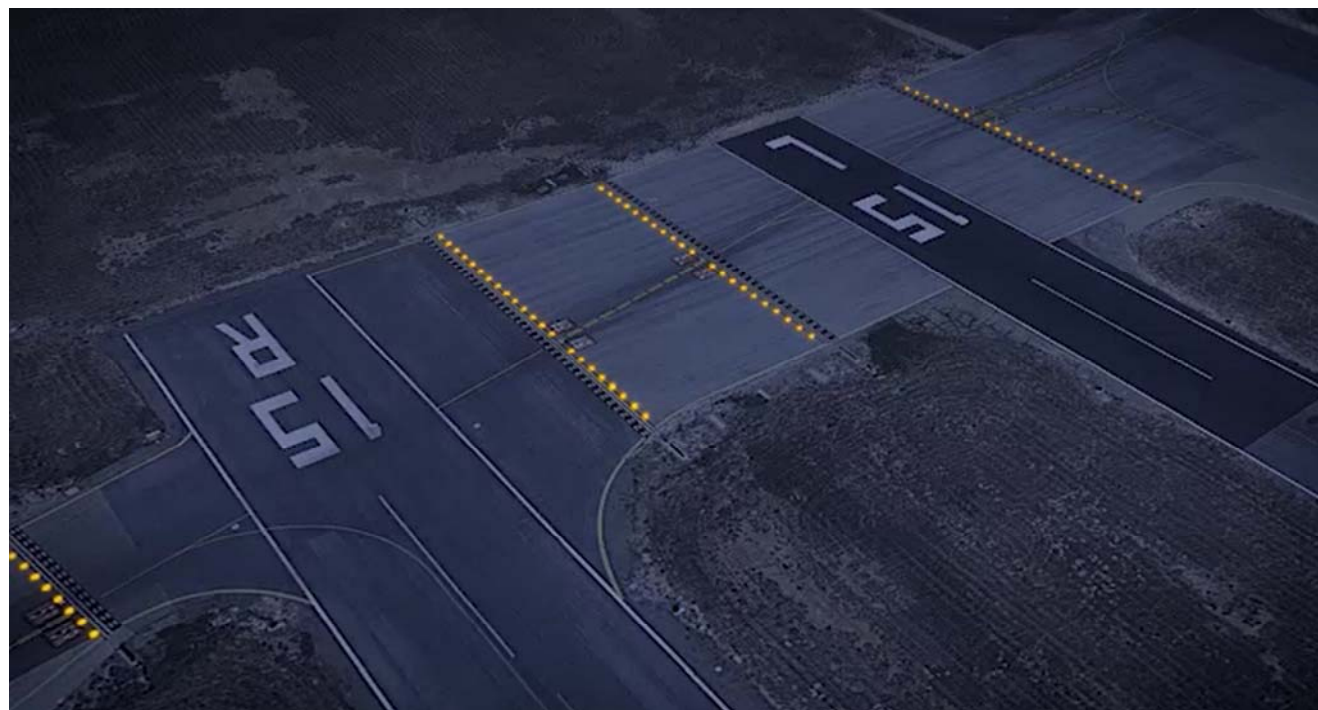
Pilot View





RIM No. 2 – Corrective Action

- Install Runway Guard Lights





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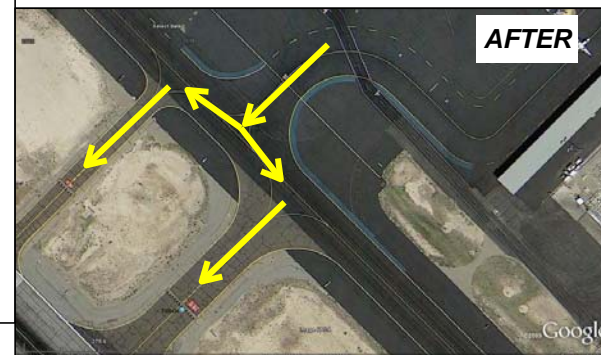


Pilot View – Corrective Action





RIM Examples





Conclusions

- Accident
 - Long Series of Sequential Events
 - Most Events are not Lighting Signage
- Problematic Taxiway Geometry (PTG) – Lighting and Signage cannot Compensate for PTG
- Airfield Lighting and Signage
 - Last Line of Defense
 - Passive System





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*2019 IES Aviation Lighting Committee
Technology Meeting
Monterey, CA*



TITLE | Runway Incursions and Airfield Lighting

SPEAKER | Richard Walls, P.E. WE, pllc

DATE | October 23, 2019

Thank you | Corey Adams, Capt. JetBlue Airlines



OCTOBER 21-24, 2019 | www.iesalc.org



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