



Runway Status Lights (RWSL) DFW THLs and SAN RELs Human Factors Results

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Outline

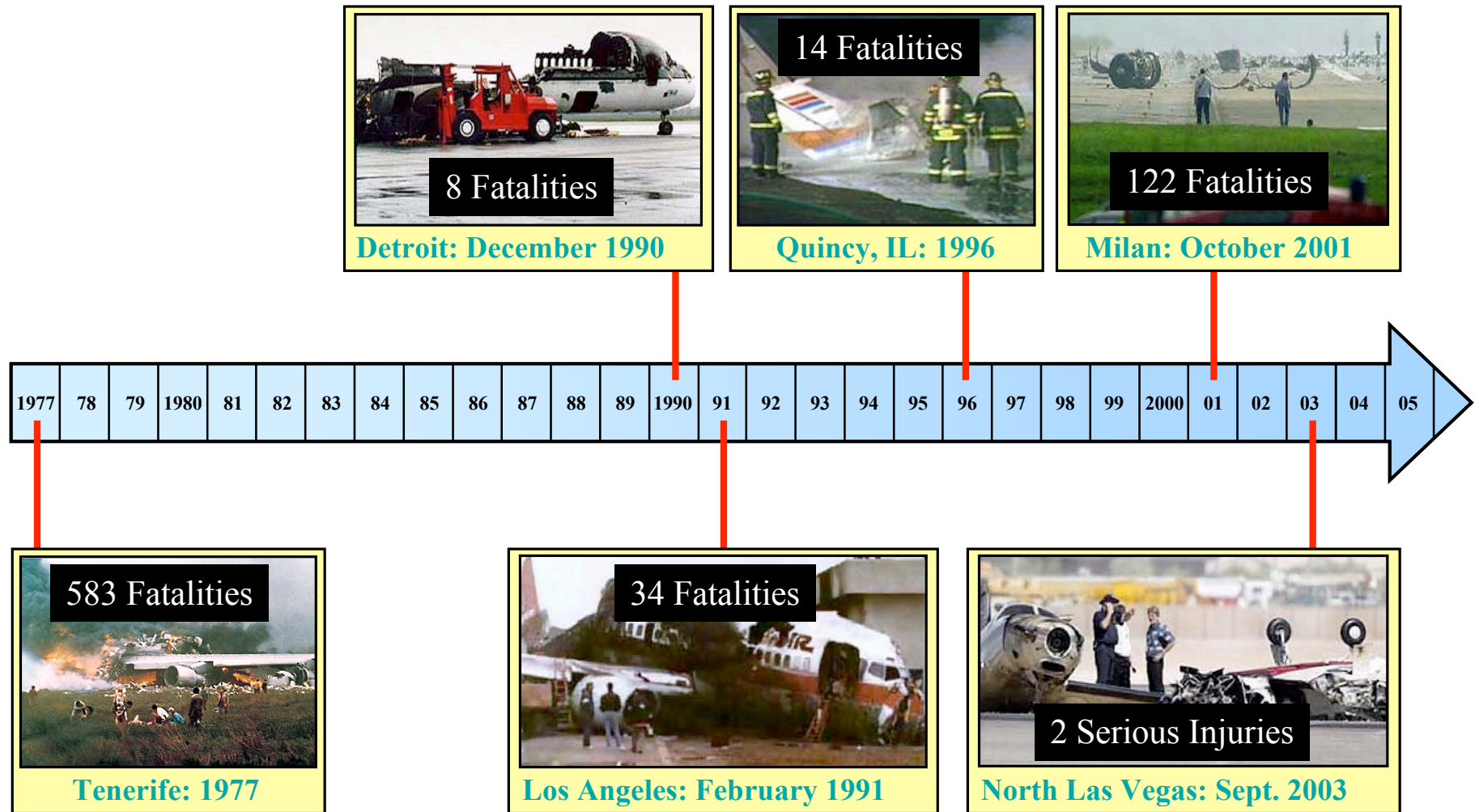
- RWSL Definition and Update
- Results of Operational Evaluation during 2006-2007
 - Runway Entrance Lights (RELs) at SAN
 - Comparison of Human Factors at DFW and SAN
 - Pilots' **concerns** and **actions** being taken to resolve them
- Real life examples of pilots' interaction with red lights
- Summary and Next Steps



RWSL Definition and Update



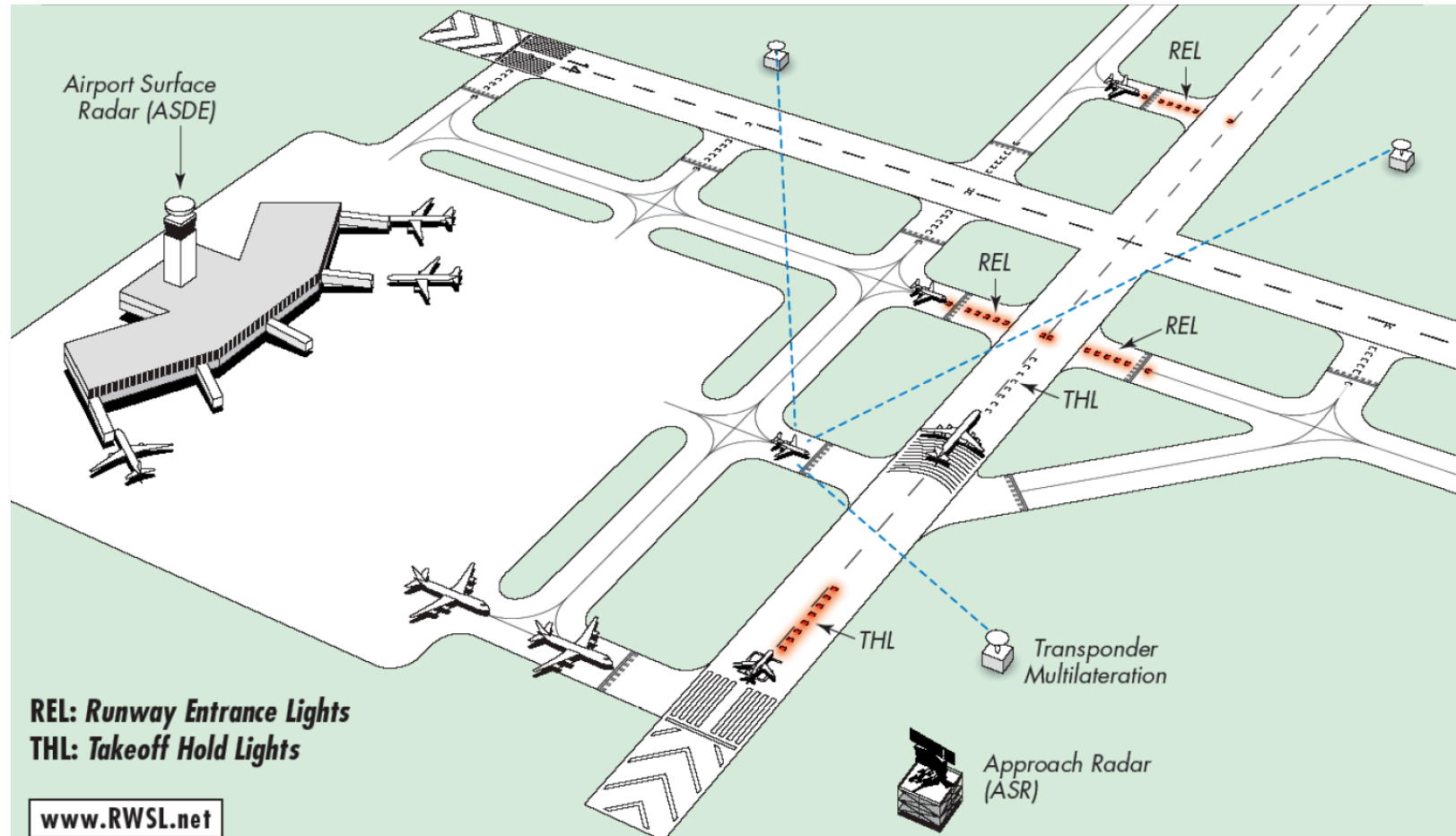
Motivation: Prevent Runway Accidents



Most runway incursions result from pilot deviations.



RWSL Operational Concept



- RELs and THLs turn on and off automatically, driven by fused multi-sensor surveillance
- RELs turn on when it is unsafe to enter runway; visible from taxi hold position
- THLs turn on when it is unsafe to takeoff; visible from takeoff hold position (and final)



RWSL Defined and Approved



Photo of SAN RELs



Photo of DFW THLs

- Purpose of RWSL
 - Prevent runway accidents
 - Reduce frequency and severity of runway incursions
- RWSL provides a **direct indication** to pilots when it is unsafe to
 - Cross or enter a runway or runway intersection, or takeoff or land
- RWSL currently undergoing extended operational evaluations
 - RELs and THLs on R/W 18L/36R at DFW, >180K operations to date
 - RELs on R/W 9/27 at SAN, >100K operations to date
- RWSL approved by Joint Resources Council in July, 2007
 - 19 airports have met cost/benefit criteria for installation
 - RWSL Engineering Brief and Advisory Circular drafts completed



Pilots' Protocol for RWSL

- When RELs or THLs illuminate, the runway is in active use
 - Crew should remain stopped or stop the airplane and notify Air Traffic (if appropriate) that they are stopped because of red lights
- If aborting a takeoff is impractical for safety reasons
 - Crews should proceed according to their best judgment of safety (understanding that the illuminated THLs indicate the runway is unsafe for departure) and contact ATC at the earliest opportunity
- If on short final and THLs are illuminated red
 - Crews should inform ATC they are going around because of red lights on the runway

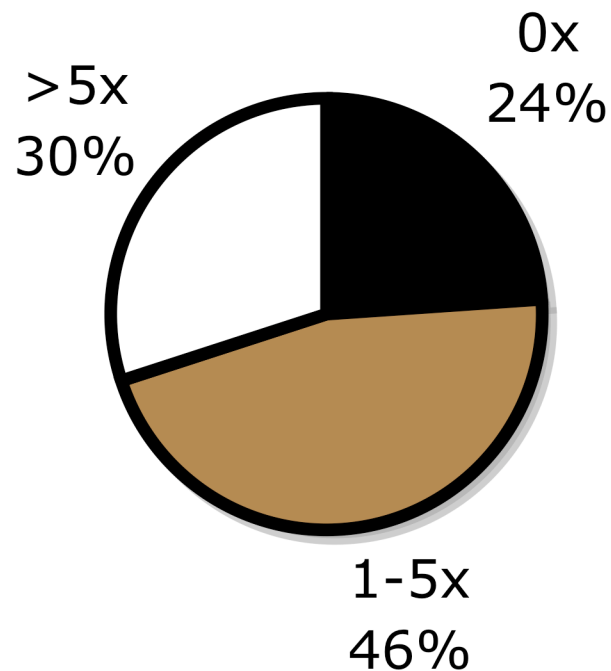


Results of Operational Evaluations during 2006-2007



SAN Pilot Survey Results

RELs Exposure Level



- Survey statements, method, and analysis validated
 - Adapted from evaluation of RELs at the first test site, DFW
 - Administered to pilots during Operational Evaluation of RELs at San Diego Airport, from December 2006 to present
- 83 SAN pilot survey responses received to date
 - 64 pilots used the web at www.RWSL.net
 - 19 pilots used paper
 - Over 50 percent added comments



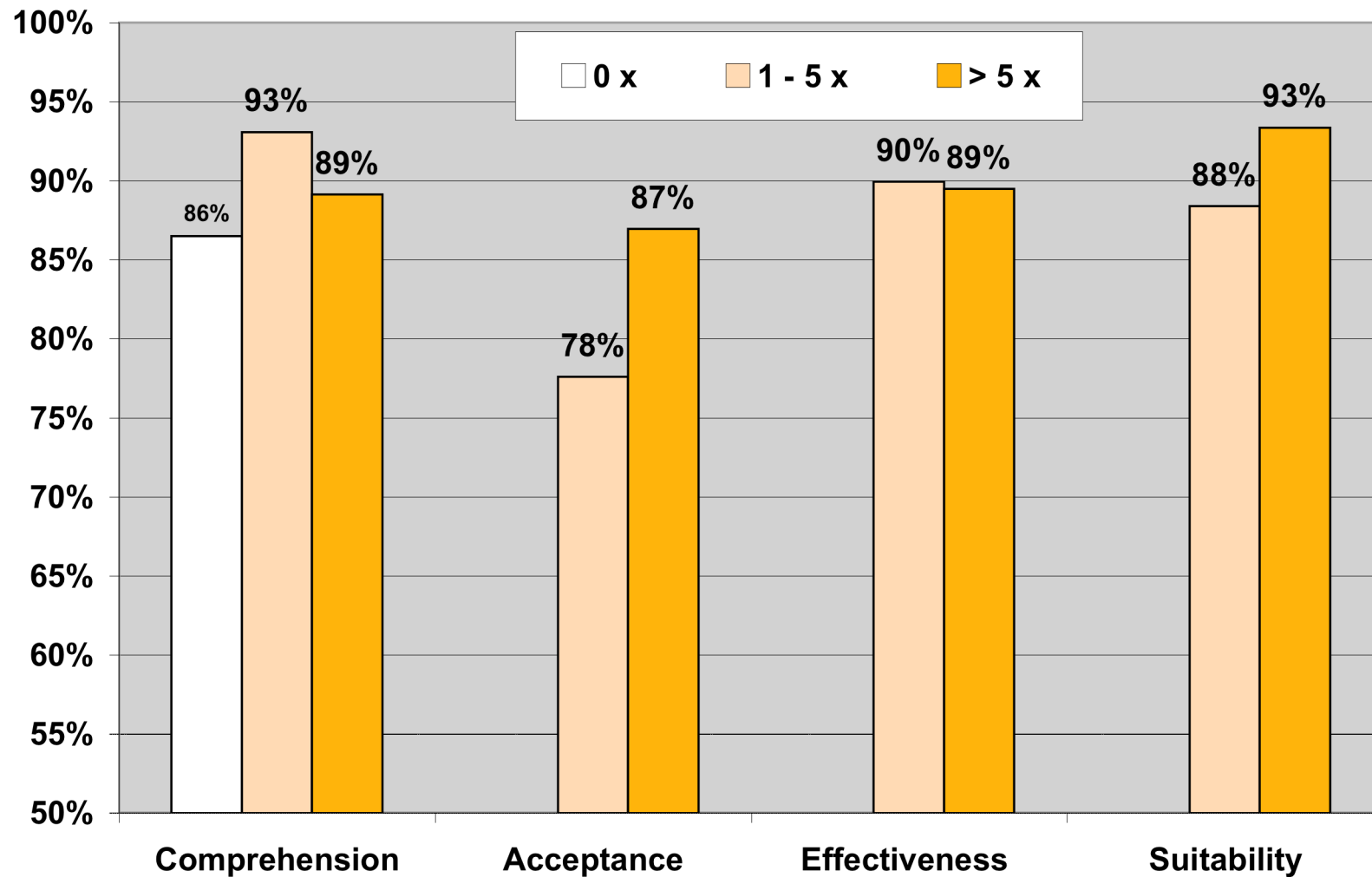
SAN Pilot Surveys Analysis

- Four key categories analyzed (as was done for DFW results)
 - **Comprehension**
 - Do not cross red RELs
 - REL off is not clearance
 - **Effectiveness**
 - RELs functioning, visible, consistent with clearances
 - **Acceptance**
 - Situational awareness enhanced, RELs valuable and valid
 - **Suitability**
 - Cockpit workload not increased, distinct from other lights



SAN REL Operational Evaluation

Effect of Pilot Exposure to RELs





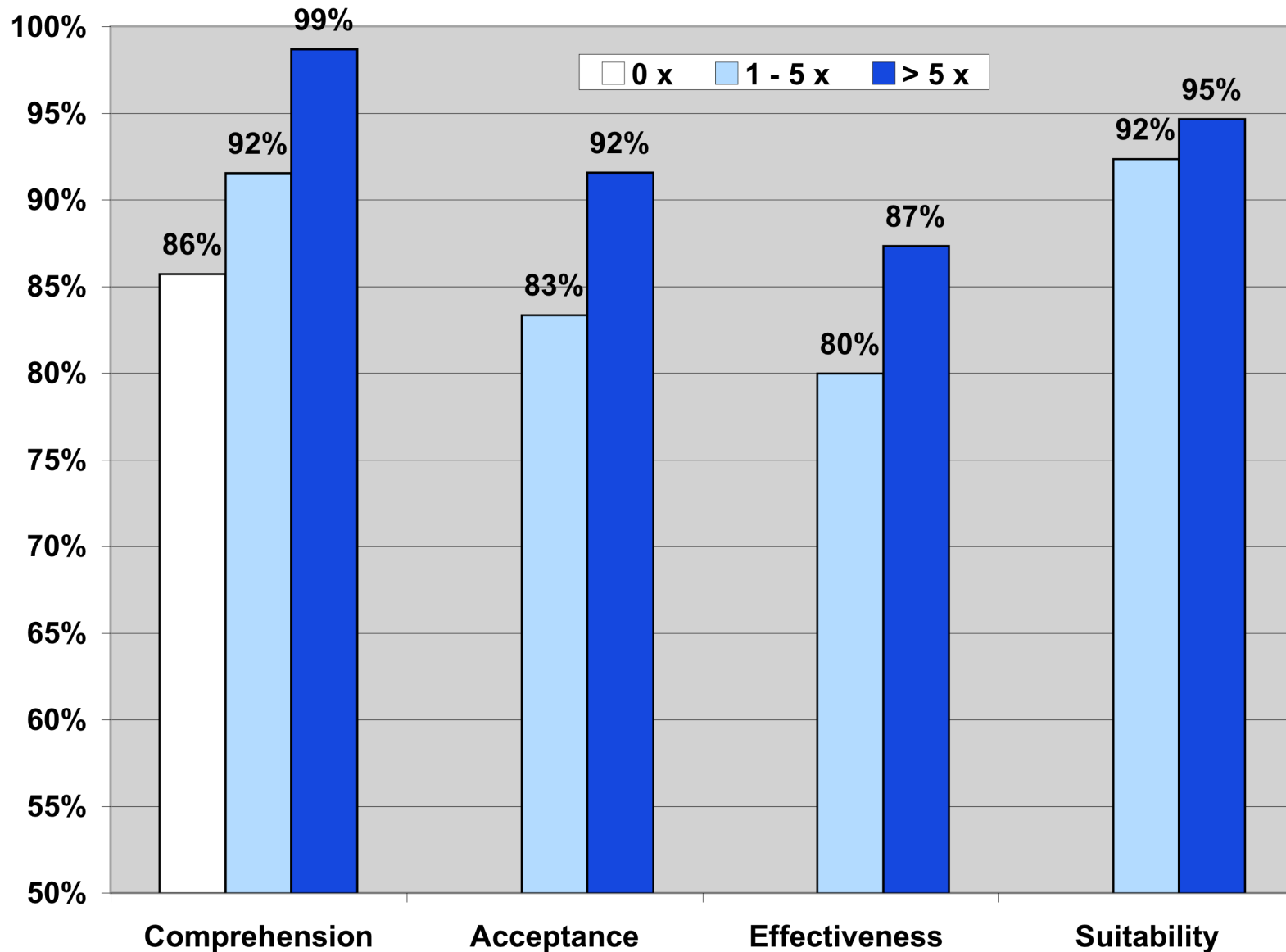
SAN REL Survey Results Summary

- Pilot feedback is favorable overall
- Pilot feedback indicated that REL timing is an issue
 - Issue to be resolved by modification to AMASS track input
- Recommend enhancements to pilot training
 - Encourage airlines to add RELs to their recurrent training
 - Explain “anticipated separation” in training materials
- Controller feedback is overall positive
 - Most comments about pilots reporting (to the control tower) that red runway centerline lights are being confused with RWSL lights



DFW REL *Extended* Operational Evaluation

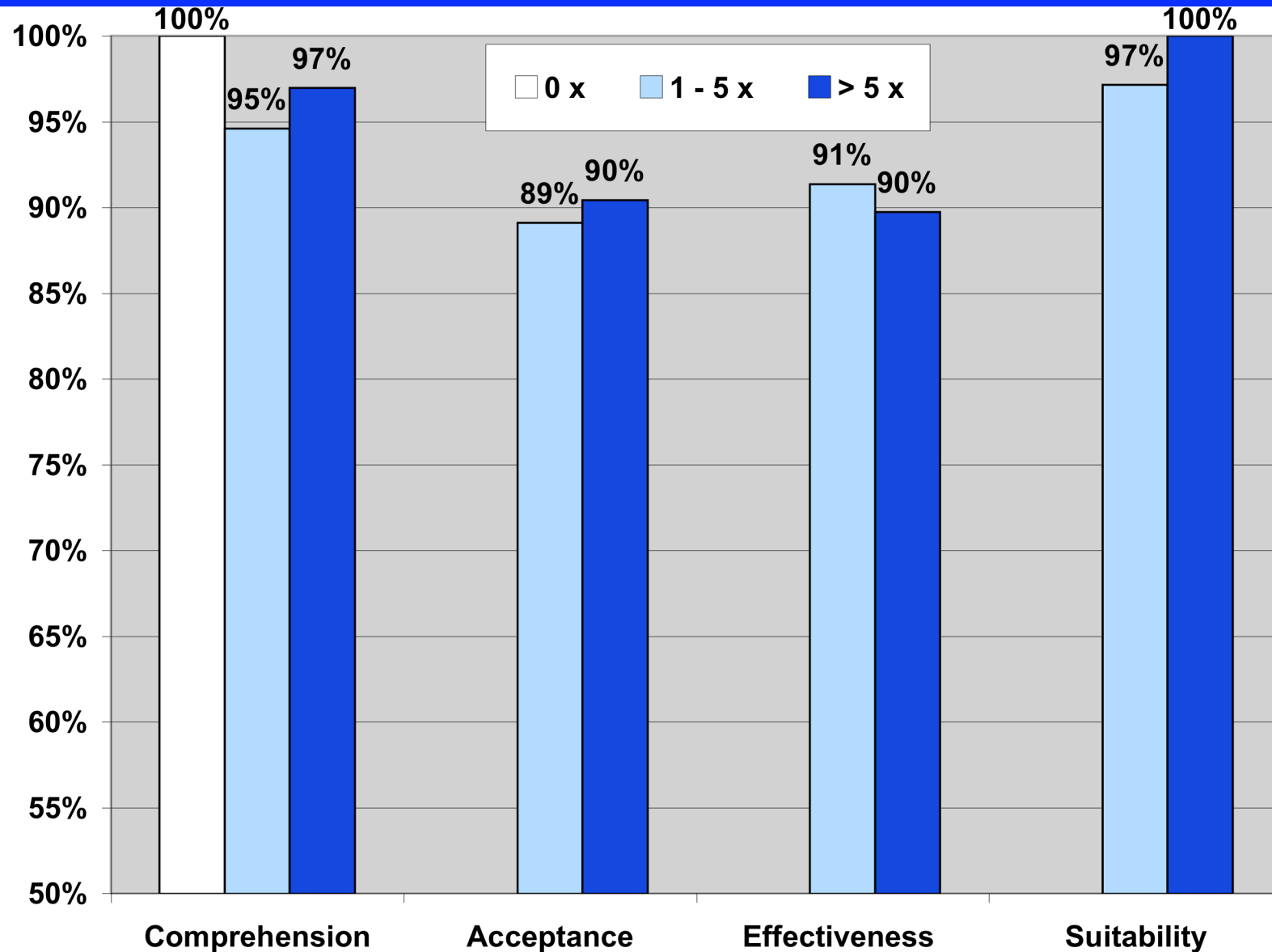
Effect of Pilot Exposure to RELs





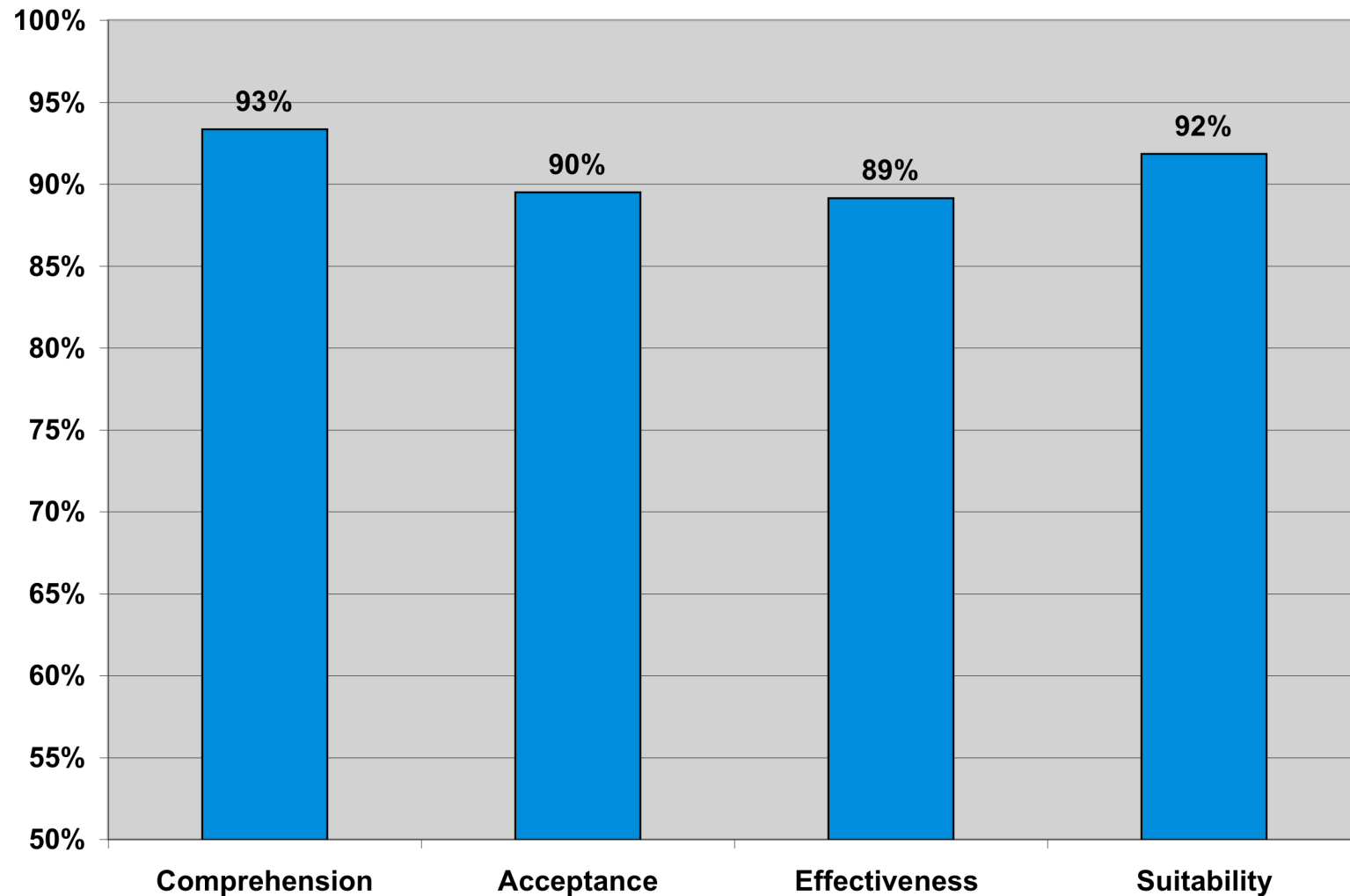
DFW THL *Extended* Operational Evaluation

Effect of Pilot Exposure to THLs



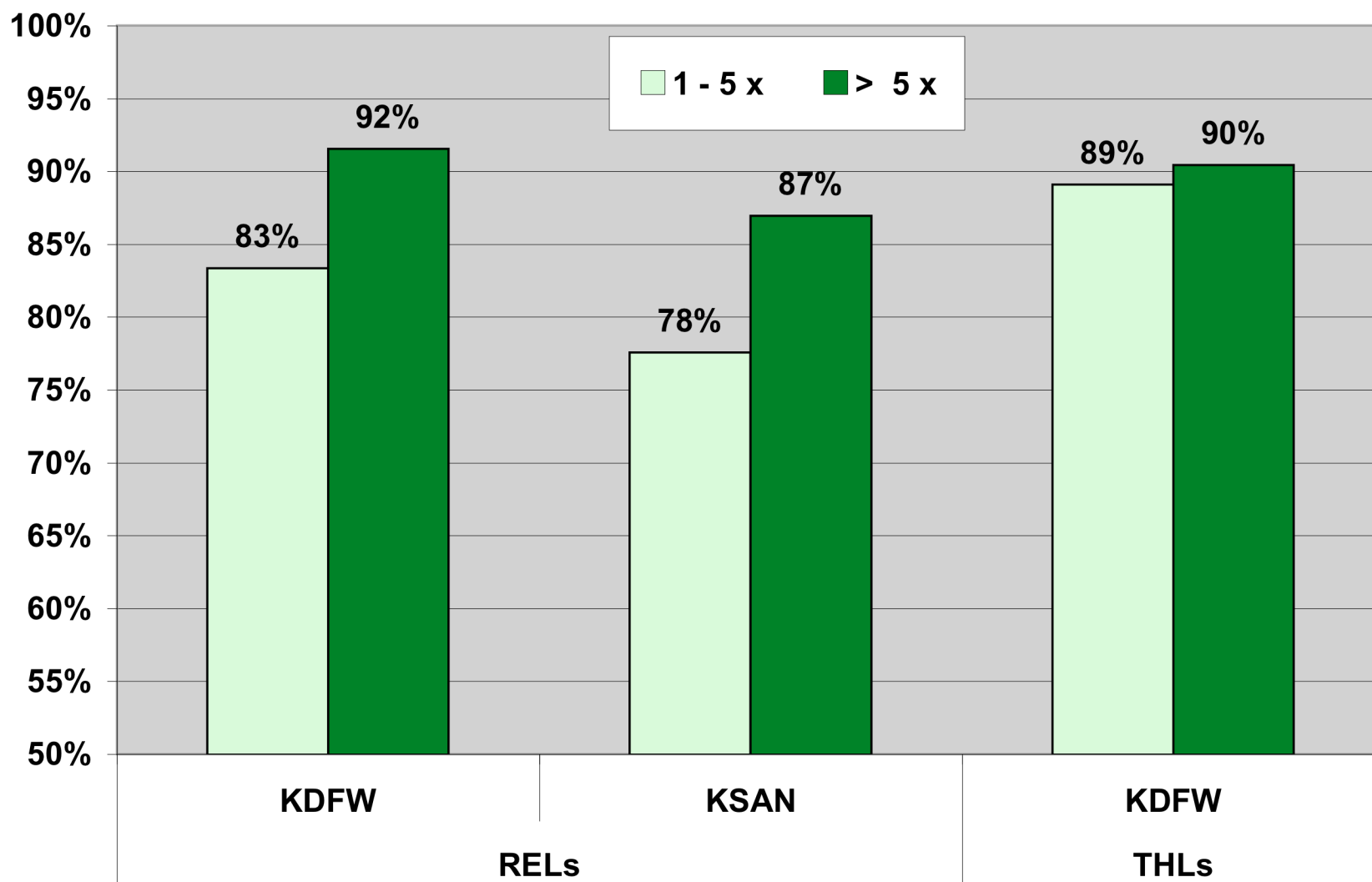


SAN and **DFW** Combined Results



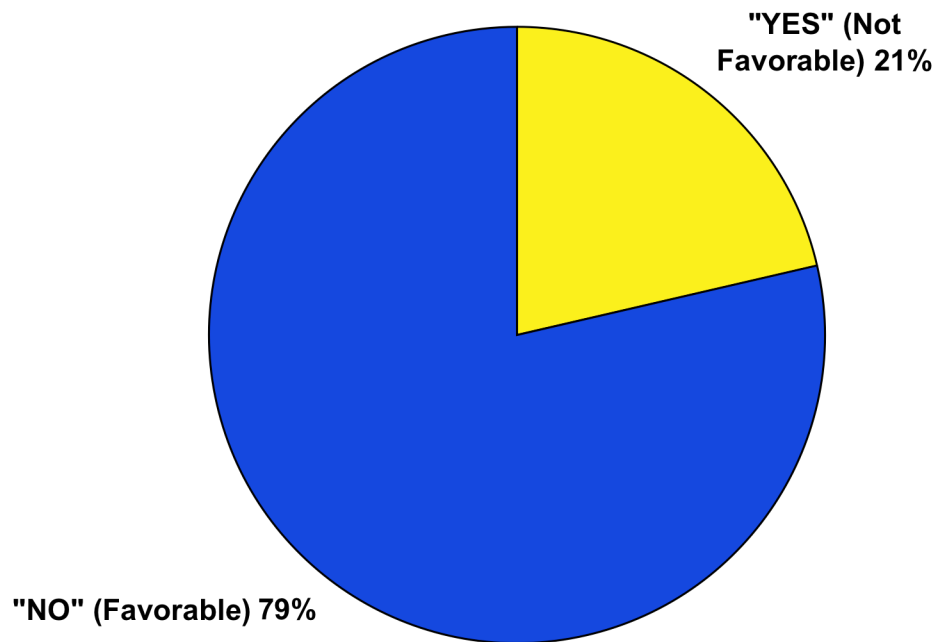


SAN and **DFW** Acceptance by Exposure and Lights





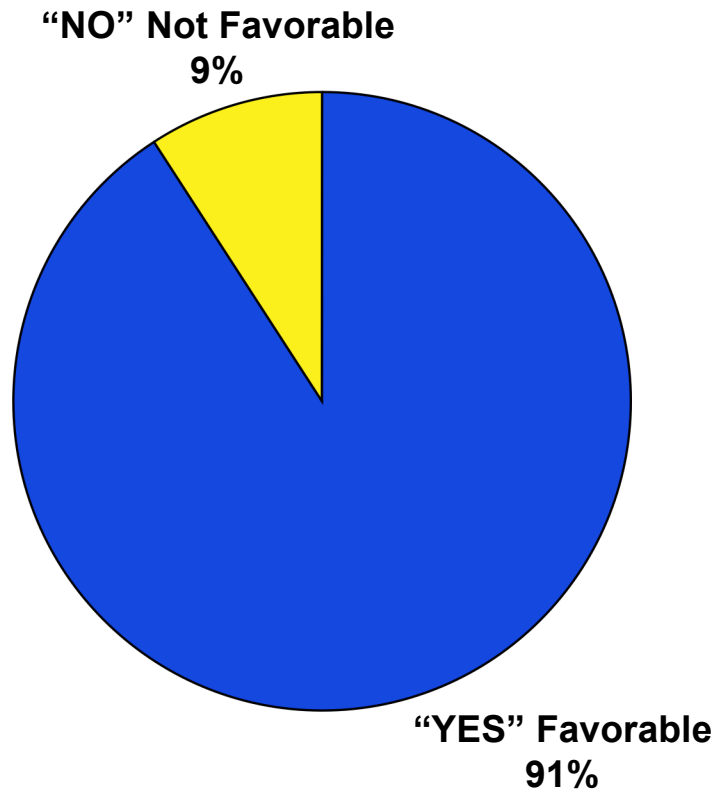
SAN Acceptance by Light Timing



- Question #12
 - The Runway Entrance Lights were **OFF** when they should have been **ON**.
- Pilot comment
 - “Ref. 12. Aircraft on final are too close to the runway before the REL lights are activated. If they were set to come on earlier this would be an excellent system to help prevent conflicts.”
 - (emphasis added by HF analyst)



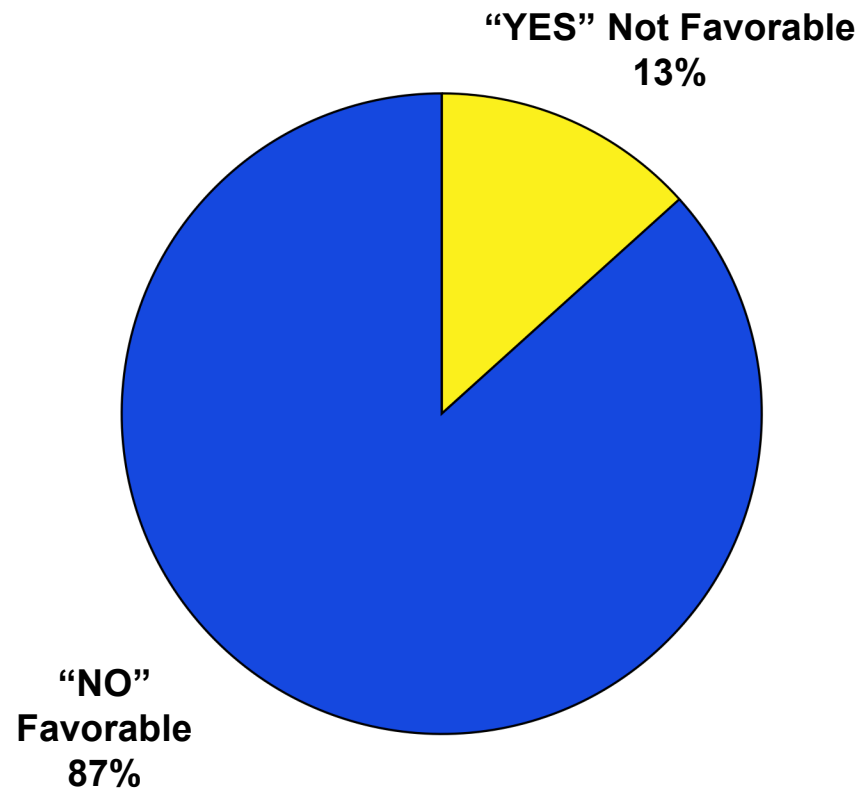
DFW Effectiveness by Light Configuration



- Question #13
 - I was able to distinguish between Takeoff Hold Lights and end of runway centerline lights.
- Pilot comment
 - “I feel a set or red lights perpendicular to my path would be more clear that I should stop. Red lights along my path would not be as clear. When I get to the end of a runway, the last 1000 feet, I taxi on them until I reach a turn off and then I leave the runway. This may be a mixed message, to a tired pilot.”
 - (emphasis added by HF analyst)



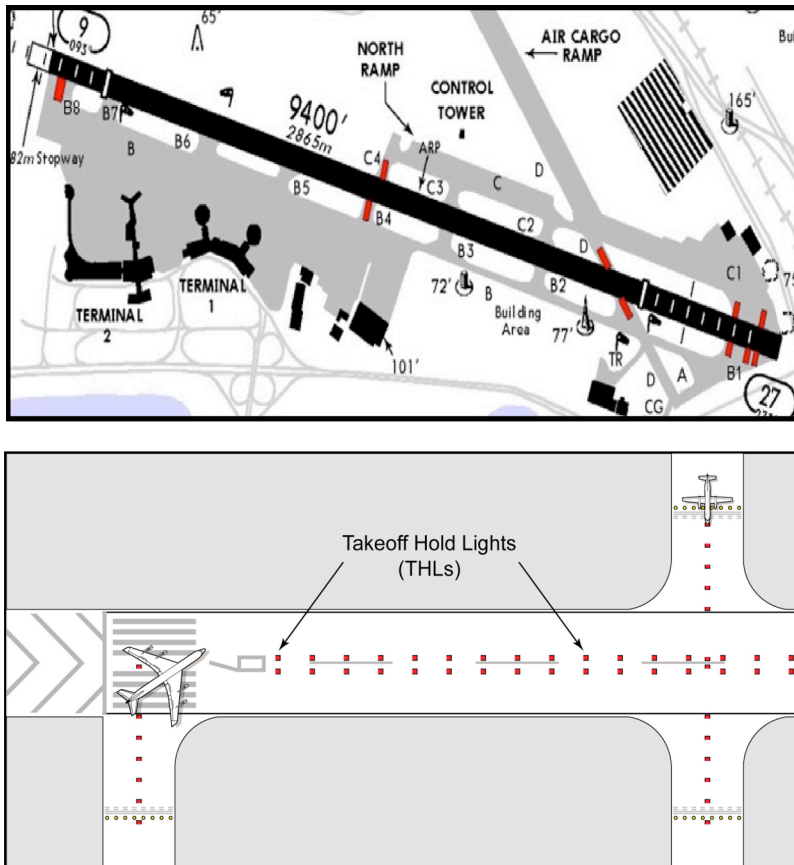
DFW Effectiveness by Light Conspicuity



- Question #5
 - I found the Takeoff Hold Lights were *not* conspicuous enough to serve their intended purpose.
- Pilot comment
 - “The position of the THL lights were further down the runway from my hold position than I think is optimum. I think they would be more noticeable if they were closer to the nose of the aircraft and possibly flash twice then go on steady. It would increase the optimization of the crew seeing the lights especially in lower visibility conditions.”
 - (emphasis added by HF analyst)



Resolutions to Pilots' Concerns



- Timing
 - SAN RELs at TWY B1/C1 will turn red sooner for arrivals to R/W 27 (at 2 nm instead of 1 nm from runway threshold)
- Conspicuity
 - Five lights will be added to beginning of each THL row (16 vs. 11)
 - THLs will be wired separately from RELs (different nighttime intensity)
- Distinctiveness
 - A second row of THLs will be added to bracket the R/W centerline
 - SAN Airport eliminated the red runway centerline lights that were placed prior to the displaced threshold on R/W27
- Training
 - Explanation of “anticipated separation” by ATC will be added



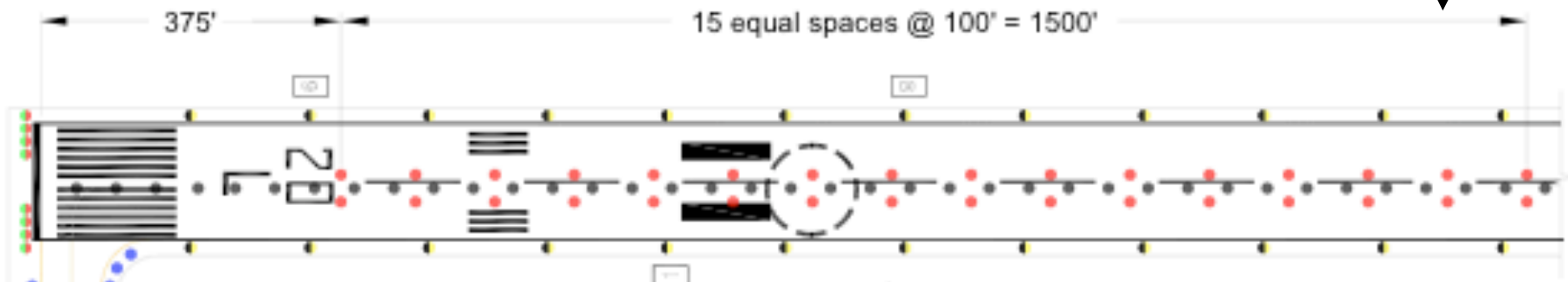
Resolution to Pilots' Concern: RWSL conspicuity and distinctiveness



← Old

- THLs will be changed to double row of 16 lights each instead of existing single row of 11 at DFW
- Precludes potential confusion with end of runway red centerline lights

New



- TBD at SAN on R/W 9/27 and DFW East on R/Ws 17R/35L and 17C/35C



Resolution to SAN Pilots' Concern: RWSL distinctiveness

Old



- SAN R/W 27 photograph dated 2007/01/08 showing red lights along centerline prior to displaced threshold
- SAN Airport removed the lights based on survey feedback [from both pilots and ATC] of potential confusion with RWSL
- Pilot comment:
 - “On takeoff the red centerline lights were on for my entire takeoff roll, no aircraft or vehicles were on or near the runway as far as I could tell. This presents a mental conflict as red lights are supposed to mean stop.”
 - (emphasis added by HF analyst)



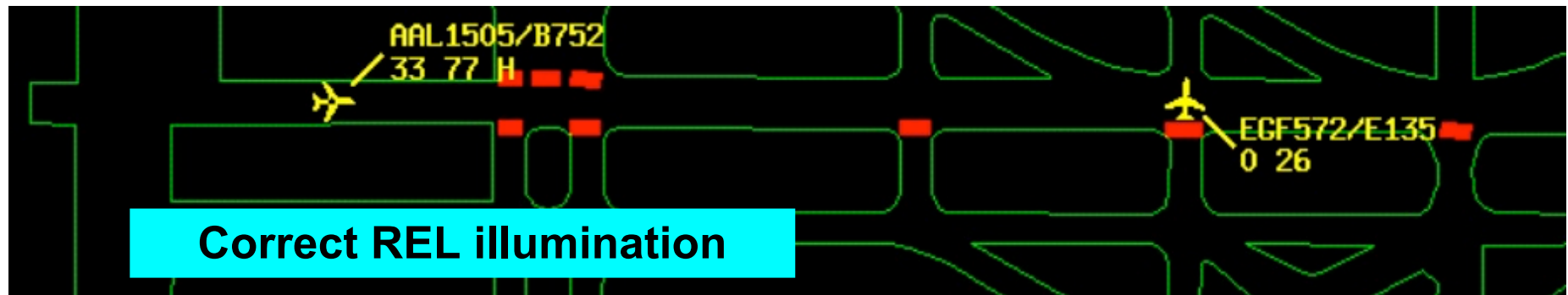
Pilots' interaction with **red** lights



Red Light Crossing at DFW: March 2005

One crew crossed over red Runway Entrance Lights (RELs)

- Crossed against ATC hold short clearance and pilot read back
- REL Activation caused by departure on RWY 18L
- Runway Incursion occurred at beginning of REL operational evaluation
- Pilots did not follow recommended protocol for RELs
 - Note that THLs were not yet installed at DFW





Red Light Crossings at DFW: June 2007

- Four crews took off over red Takeoff Hold Lights (THLs)
 - One contacted ATC with red lights but proceeded per 2nd clearance
 - THL FAs caused by false (rain) track,
 - *Resolution completed by narrowing of activation regions*
- Three crews crossed over red Runway Entrance Lights (RELs)
 - None contacted ATC, all crossed around the same time
 - REL False Activations caused by vehicle on R/W mistaken for departure
 - Equipping vehicles (on R/W) with transponders would resolve issue
- Pilots did not follow recommended protocol for THLs or RELs





RTO due to THLs at DFW: July 2007

- Crew saw red Takeoff Hold Lights (THLs) and rejected take off (RTO)
 - THL False Activation caused by false (rain) tracks,
 - *Resolution is pending improved surveillance and/or logic*
- Pilots did follow recommended protocol
- Crew departed approximately 7 minutes later after 2nd clearance





Partial Transcript of RTO at DFW: July 2007

Time and Source	ATC communications and systems information	THLs
00:12 TOWER	<i>Eagle Flight four-seventy-five, DFW tower, runway one-eight-left position and hold</i>	OFF
00:17 EGF475	Position and hold one-eight-left, Eagle Flight four-seventy-five	OFF
00:53 TOWER	<i>Eagle Flight four-seventy-five, wind zero-two-zero at five, runway one-eight-left clear for takeoff</i>	OFF
00:58 EGF475	Clear for takeoff one-eight-left, Eagle Flight four-seventy-five	OFF
01:02		ON
01:13	Eagle Flight 475 begins takeoff roll, THLs are ON, the lights flash as EGF accelerates over them	ON
01:30 EGF475	And tower, Eagle Flight 'uh' four-seventy-five 'uh' aborting on the runway, we had the red lights come on	OFF
01:36 TOWER	<i>Do you need any assistance?</i>	OFF
01:38 EGF475	No assistance, we just had the red stop lights come on, on the takeoff roll	OFF



Summary and Next Steps



Summary

- Pilot and ATC training and feedback both critical to success
 - Feedback used to identify and prioritize areas for improvement
- Pilot survey results favorable overall, consistent with the success of the RWSL operational evaluations to date
 - “I believe we should be moving to rapidly install RWSL's throughout our aviation system” (DFW REL Survey Response)
 - “Fantastic system that WILL save lives!!! Can't wait to see it installed in more locations.” (DFW THL Survey Response)
 - “These lights are a great help in moving toward the goal of 0 incursions.” (SAN REL Survey Response)
- All three operational evaluations have been completed successfully and are currently being extended by FAA



Next Steps

- MIT/LL will support the FAA in meeting upcoming milestones for 2007-2008 as follows
 - At **SAN**, B1-C1 RELs turn on earlier for arrivals Shadow Operation
 - At **SAN**, THLs Operational Evaluation (after installation)
 - At **DFW-E**, RELs and THLs Operational Evaluation (after installation)
 - At **DFW-W**, Advanced Final Approach Runway Occupancy Signal (AFAROS) Operational Evaluation
 - Currently in Operational Concept and Development phase
 - At **ORD**, Runway Intersection Lights (RILs) with RELs and THLs Shadow Operation
 - Currently in Engineering Development test phase

Please visit our website at www.RWSL.net for more on Runway Status Lights