

Trip Report Atlantic City Airport (ACY): 19-20 November 2002

Initial Viewing of Runway Entrance Lights (RELs)

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Executive Summary

On 19-20 November Maria Picardi Kuffner and Harald Wilhelmsen attended an in-situ demonstration of selected runway entrance light (REL) configurations at the Atlantic City Airport (ACY). We discussed the FAA's REL studies to date and their rationale for selecting certain candidate REL configurations. Four configurations were chosen during prior FAA-only preliminary exercises. We added one, which, by the next morning became the chosen configuration. We observed the various REL configurations on the airport ramp through day, sunset, night and light rainfall conditions.

While several candidate configurations had been considered, including the MIT/LL proposed row of in-pavement RELs across the taxiway at the runway edge, the group favored a longitudinal array of red RELs alternating with green lead-on lights along the taxiway centerline, extending from just before the hold line to the runway edge. This choice was based on the participants' concern that pilots would confuse transverse RELs with the low visibility SMCGS red stop bars and taxi to the runway edge if RELs were placed there. We reminded the group that the longitudinal configuration will decrease the effectiveness of RELs.

In one configuration, the longitudinal RELs were augmented by two elevated RELs at the hold line, bracketing the in-pavement Runway Guard Lights. Others had various combinations of longitudinal and transverse in-pavement and elevated RELs. Our advocacy of more lights at the runway edge led to two RELs being added there in addition to the two elevated RELs at the hold line. We believe this configuration that includes *conspicuous* lights at the runway edge, provides the best protection against runway conflicts by preserving the lights' effectiveness up to the *last* moment. However, critical issues remain. These include whether the proposed REL configuration could be confused with existing lights such as SMCGS, whether pilots will understand the lights' meaning, and incorporating RELs into a NAS standard.

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Discussion

The meeting took place in Building 296 at ACY. Attendees included Don Gallagher (host), Paul Jones, Holly Cyrus, and Jim Patterson from AAR-411, Vince Chu, Peter Hwoschinsky, and Son Tran (second day only) from AND-520, Dick Temple and Pam Whitley from AFS-400, Matthew Pollack, Jason Giovannelli, and Oscar Olmos from MITRE CAASD (first day only), as well as several FAA contractor personnel. As we see it, there are only two imperatives. First, the lights must be effective. Second, they must not cause a dangerous situation or otherwise impede operations by interfering with normal, safe operations or by confusion with existing SMCGS lights.

Field demonstration

The field demonstration was meant to be a preliminary show, not a formal evaluation, just to see how the lights appeared on the airport surface. Various light layouts were implemented and viewed on foot, from moving vehicles, and from stationary airstairs that put the observer roughly at the height of a 757 cockpit. Both in-pavement lights and spotlights on short stanchions were included. Level 5, 4, and 3 illumination was shown. The beam patterns appeared adequate both in elevation and azimuth. The in-pavement azimuth pattern was wide, probably 150° or so, but with some loss of intensity and color change from red to yellow at the extremes. The spotlights had a much narrower azimuthal beam but this may actually be an advantage.

Ambient light conditions ranged from bright daylight with filtered sunshine (sun at approximately 25° elevation), through dusk to darkness. Bright ramp lights, in spite of the fact that a work order had been submitted to have them turned off during the demonstration, illuminated the test area and prevented a complete assessment of the appearance of the lights in the dark. The lights were conspicuous with solar backlighting, but this test wasn't representative of simulating sunrise or sunset on a clear day with very dry and clean atmosphere.

Light configurations and conspicuity

The light configurations included alternating green and red in-pavement lights on the taxiway centerline between the hold line and the runway edge, with or without red in-pavement lights across the taxiway or red elevated spotlights on either side of the taxiway at the runway edge. The attached (not-to-scale) figures depict schematically the arrangements considered. The spotlights would be pointed in, but the best angle was not determined. No attempt was made to model oblique intersections.

Prior to moving to the ramp, the group had settled on the six candidate light configurations shown in the attached diagrams. Some were quite similar and it was agreed that only three (#s 6, 8, and 19) would be subjected to further study. On the second day it was decided to reduce this further to only one (#19).

The pros and cons of the three semifinalists can be summarized as follows; with the understanding that further studies should be performed to verify that these initial judgments are correct.

#6: In-pavement RELs at the runway edge maximize system effectiveness, but as shown they could be confused with a stop bar and might therefore tend to "draw" the pilot to the runway edge. The red centerline lights might indicate to the pilot that the entire stretch between hold line and runway edge is a danger zone, and that he should stop immediately (the correct response). The red in-pavement light (possibly dual-lens for increased conspicuity) just before the hold line is meant to induce the pilot to stop there if possible.

The interleaving of red and green in-pavement lights on the centerline might be problematic: when the RELs turn off, the pilot is left with green lights, which might cause him to move towards the runway without clearance. While this would be a violation of RWSL procedures, it is important to note that when SMCGS stop bars are in use, the green lead-on lights are extinguished when the red stop bar is illuminated manually by the tower controller, and then the green lights are turned on again when the controller verbally clears the traffic to proceed.

This human factors issue could be mitigated if these existing green lights were made a different color, say yellow, given that the blue taxiway edge lights are already one cue that pilot is on a taxiway. The green color could be reserved for use only during low visibility conditions as it is currently used in conjunction with red stop bars in SMCGS. It is advisable to test different color combinations at least in simulation to probe for detrimental effects.

#8: Same as #6, but no lights at the runway edge. This would seriously erode system effectiveness in precisely the most dangerous runway incursion scenarios.

#19: "Four Corners": Same as #8, but with added elevated lights just beyond the taxiway edge, both at the hold line and at the runway edge. The elevated lights at the hold line would presumably induce the pilot to stop there if he could. The elevated lights at the runway edge would ensure that system effectiveness is not compromised in the most time-critical incursion scenarios. (#20 differs from #19 only in that the elevated lights at the runway edge are replaced with in-pavement lights. This would be necessary at wide intersections).

Effectiveness

RELs must be visible from the cockpit of a large aircraft stopped at the hold line and during the short time that may be available for observing the lights from a moving aircraft. This is a drawback when the RELs are placed along the taxiway centerline from the hold line to the runway edge. DFW has the luxury of space: 200 feet between the hold line and the runway edge, as opposed to only 50-100 feet at many other airports, including SAN, the airport selected by the FAA for the AMASS-driven implementation of RWSL. But, even with the longer distance, not many red lights can be seen from the

cockpit of a large aircraft at the hold line – at most four if the separation is 50'. If this aircraft is taxiing at a fast but not unusual 30 kts, then the last light will disappear under the nose in about 3 seconds, leaving little time to notice any RELs turning red in the rapidly disappearing line of lights. This issue is mitigated somewhat by the two outboard RELs at the runway edge that will be closer to the pilots' line of sight as they scan the runway for traffic and look abeam of the cockpit window.

Simulation

Runway status lights would seem to be tailor-made for simulator-based studies. Some questions, such as conspicuity, are undoubtedly best settled on the airport surface, but many others could be explored thoroughly and relatively efficiently with the aid of a suitable cockpit ground simulator.

Such studies must be carefully planned and executed and should employ the most suitable simulation facility(ies) and a representative subject population. It would take time to do it right, but it appears that recent schedule slips has made this time available.

Intuitiveness

It was suggested to “test” pilots on the various light configurations without any introduction whatsoever to the concept of runway status lights. If even one of the pilots responds inappropriately to the lights by, e.g., pulling right up to the RELs before stopping, this would indicate that the lights were not sufficiently intuitive and that the REL concept may not be viable. In reality, pilots will be trained in the RWSL concept and reminded of the appropriate procedure via standard communication mechanisms already in use today such as the ATIS and NOTAMS. Testing with naïve subjects has limited value. Techniques from experimental psychology such as blind, double blind, or intentional deceit could be used toward the same purpose. We proposed that the Airports staff write up their test methodology and give us a chance to review it and make recommendations.

Education – pilots

The potential for pilot confusion and mistakes during OpEval is inversely proportional to the quality and success of the program to educate pilots. Pilots passing through DFW need to know what the lights look like, how they operate, what they mean, and how to respond to them. A message on the ATIS is not enough. It was pointed out that a conventional, terse ATIS statement to the effect that (e.g.) "low-visibility procedures are in effect" is not sufficiently specific for many pilots. What are these procedures at the airport in question? What hardware – specifically, lights and signs – is being used and where? How is the pilot expected to respond?

A plan for pilot education and outreach needs to be prepared now to ensure that information about the RWSL reaches the majority of pilots and others who will be operating at DFW during OpEval. This effort must include domestic and foreign

commercial pilots, private pilots, military pilots, vehicle operators, etc. Formal briefings, informational brochures and videos, articles in professional and popular journals, etc. should be prepared and widely disseminated well in advance of the start of OpEval.

Education –general

During the discussions it became clear that some of those involved in the decisions of light placement and configuration were not sufficiently aware that the lights operate dynamically in response to traffic. Documentation and instructional videos on the RELs have been around for quite a while, but the information has obviously not gotten to all of those who are now involved in the decision-making process. We need to distribute and present our educational materials, including our 2002 movie of RELs and THLs turning on and off in accordance with high-speed traffic and the videotape we edited from the 1995 VNTSC video, more widely to all interested parties. This material should be viewed and understood by all those who are in a decision-making position.

Concerns

Several concerns were raised by the group during the discussions both in the meeting room and while viewing the light configurations at ACY. Some of these concerns are new while others have always been there but have taken on new meaning given the proposed configuration of RELs used in conjunction with SMCGS lights. Here is a list of the most prominent concerns with some of our own added.

- The idea that a pilot might be past the hold line *before* the light turned on – the most dangerous scenario – appeared to be new to some.
- Three widely separated single RELs at the runway edge may not be as effective as a row of more closely spaced RELs.
- As with any new lights, the “sea of lights” clutter phenomenon is possible.
- The RELs may not be intuitive enough, thereby interfering with traffic flow.
- The on-off nature of the RELs was a concern to several of those present, and the questions revealed that they had a hard time visualizing their operation.
- The dynamic nature of RELs was thought to be too similar to “flashing” red lights that are now used to indicate construction areas by ICAO and FAA.
- A single red light is now used to indicate obstructions and it was suggested that this could be confused with an elevated REL.
- Pilots will mistake RELs for stop bars and taxi up to them before stopping.
- Pilots will proceed once RELs extinguish without verbal clearance from the ATC tower, especially if the green lead-on lights are taken as a “go ahead.”
- Pilots will stop on the runway in response to an REL whereas they could have sped up and crossed without a collision.
- Pilots will misunderstand the RELs if not made standard throughout the NAS.

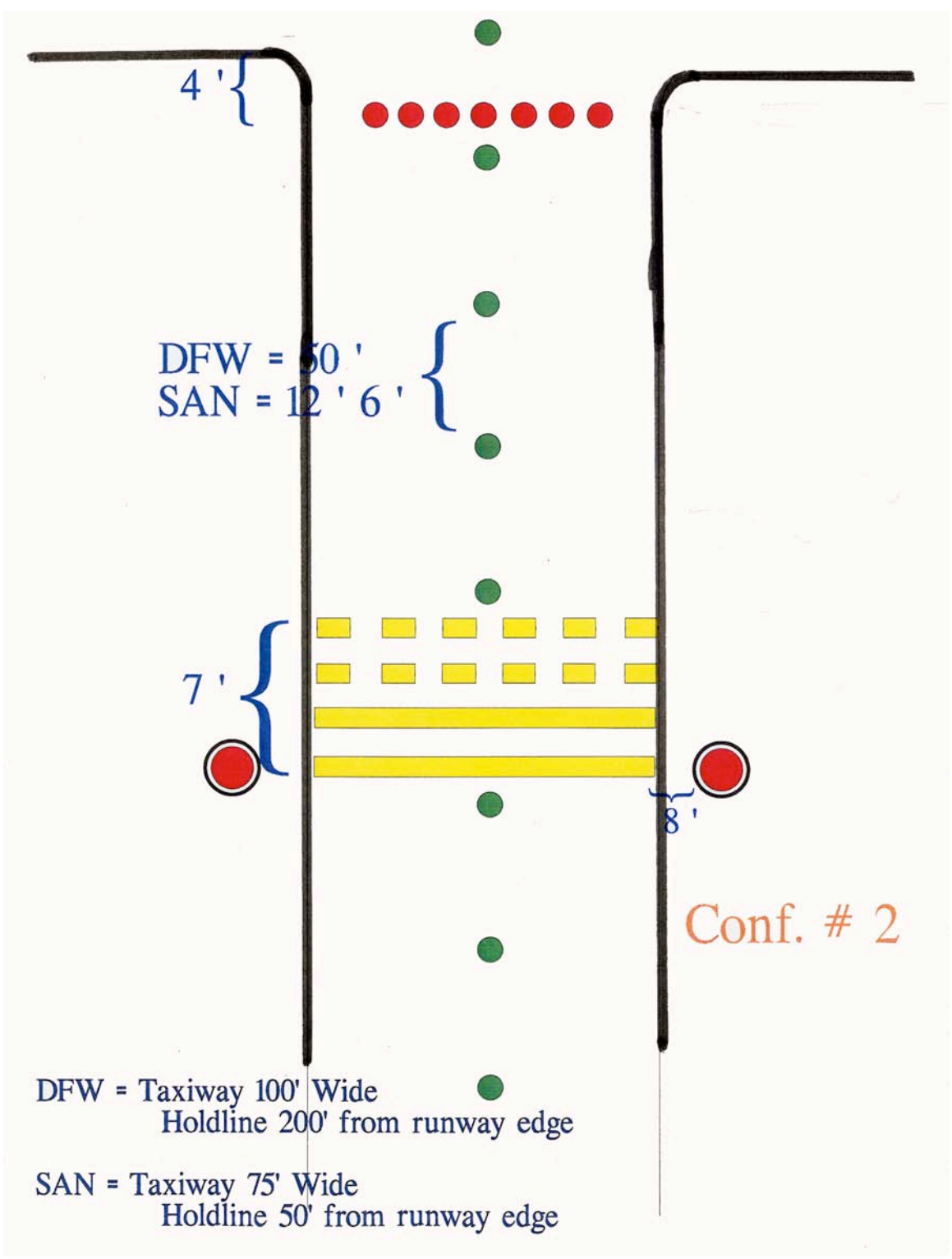
Conclusions

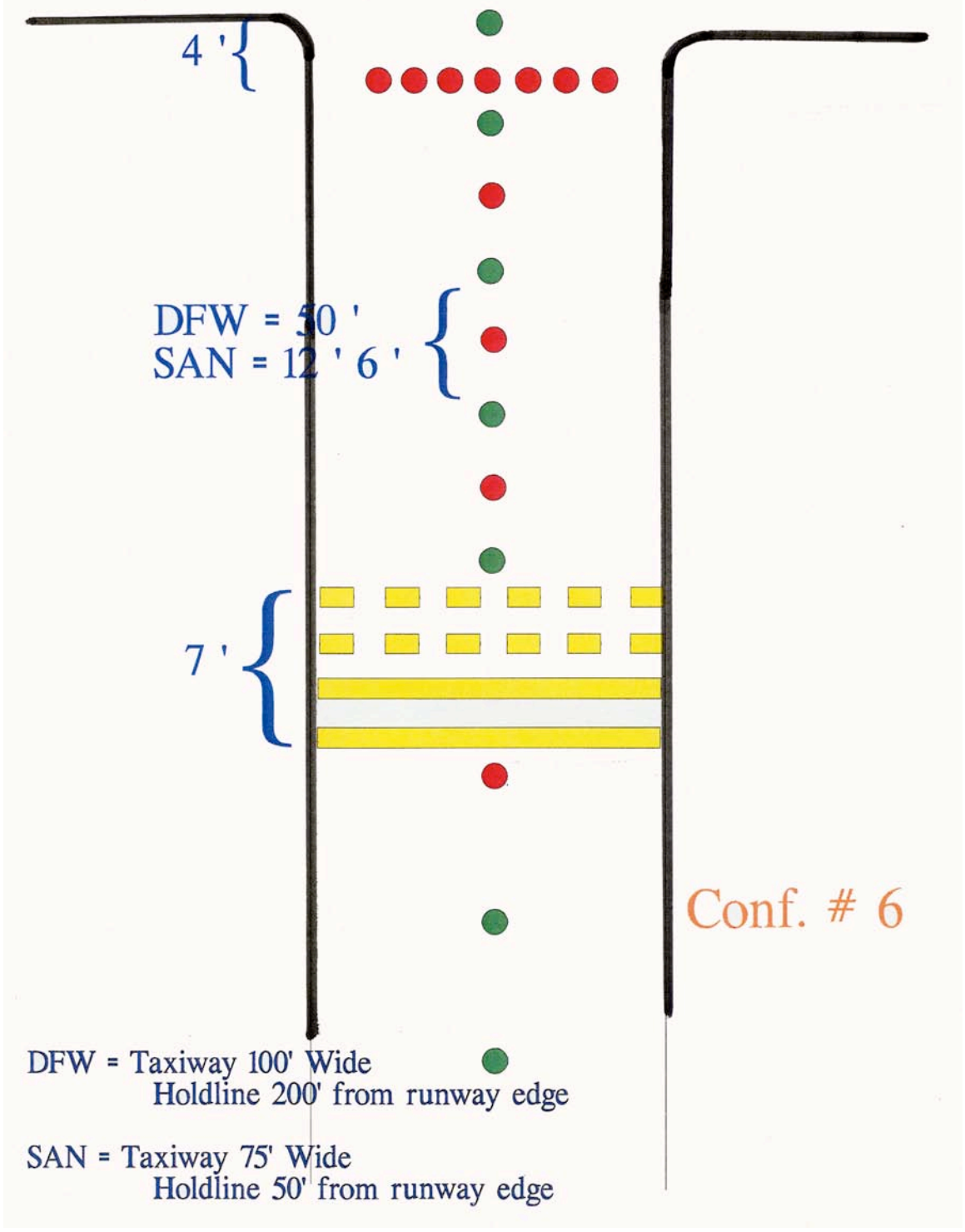
In deciding on placement and interoperability of RELs in the NAS, we recommend the following guiding principles:

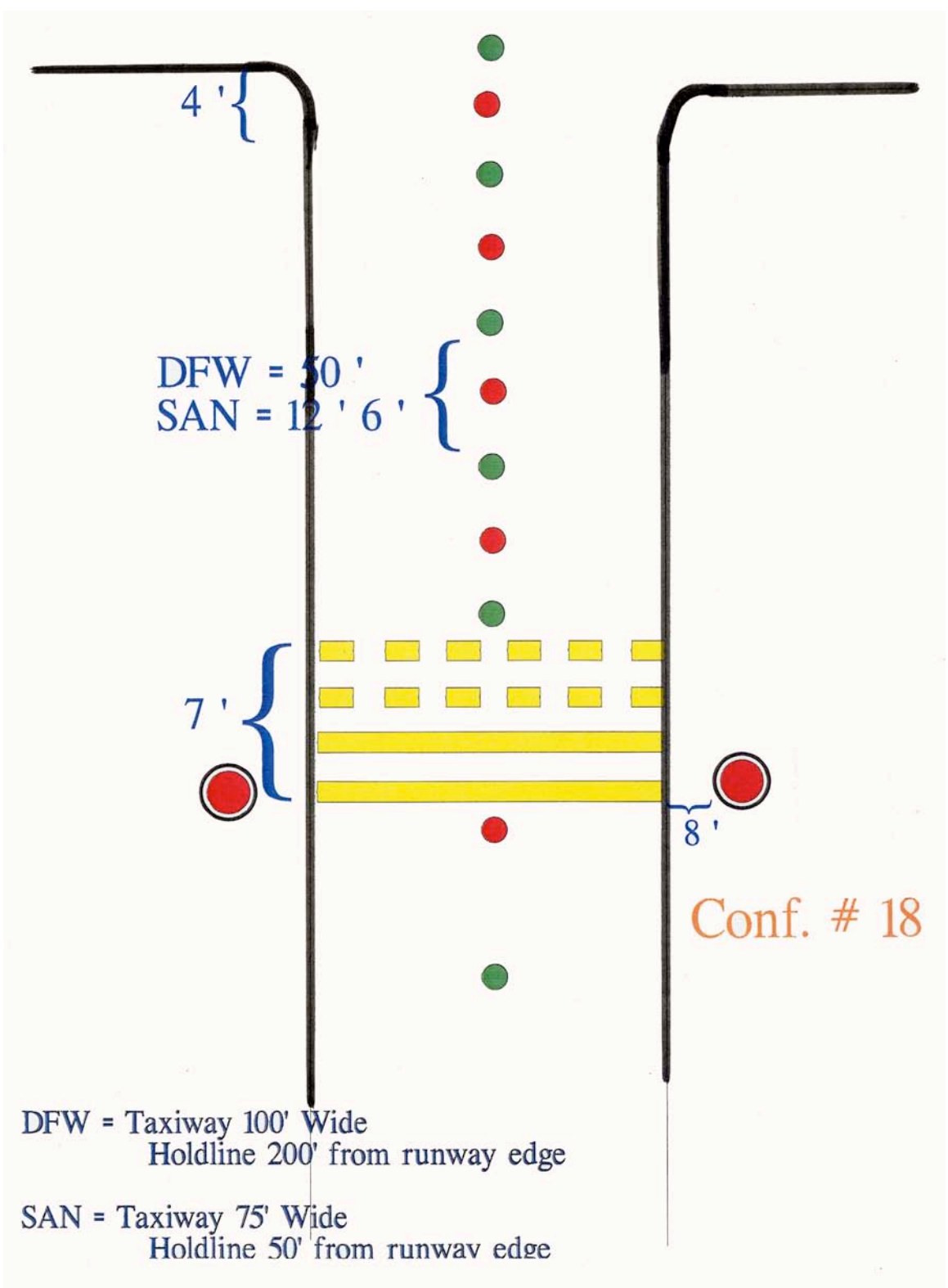
- All those in the decision-making loop must understand the REL concept.
- The users must be involved in the decision-making process.
- System effectiveness must be preserved.
- All other system requirements must be treated in balanced fashion.
- Human factors issues must be thoroughly investigated in a timely manner.
- Results from human factors studies must feed into the decision-making.
- Decisions should be data-driven wherever possible.
- The most appropriate simulation facilities should be identified and used.

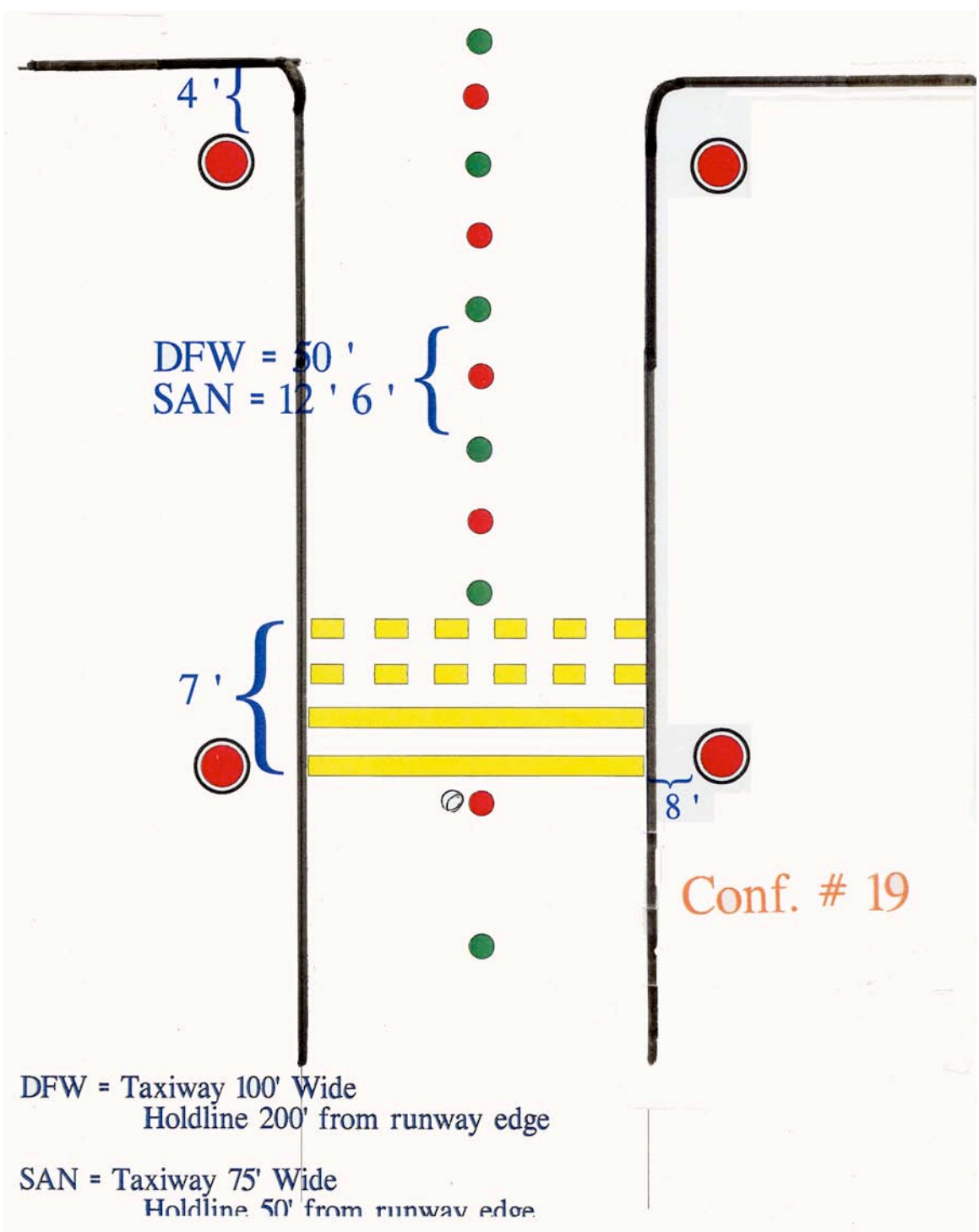
The FAA (AND-520) RWSL program office has drafted a human factors test plan, currently issued as Revision 4.2. MIT Lincoln Laboratory has reviewed the plan and should continue coordination with AND-520 and their suggested test conductors, including MITRE CAASD and the WJH Technical Center (with others possibly joining in due time), to oversee the planned activities and insure the key concerns are properly addressed in the human factors studies. Ultimately the human factors tests need to address the above-mentioned concerns and resolve them.

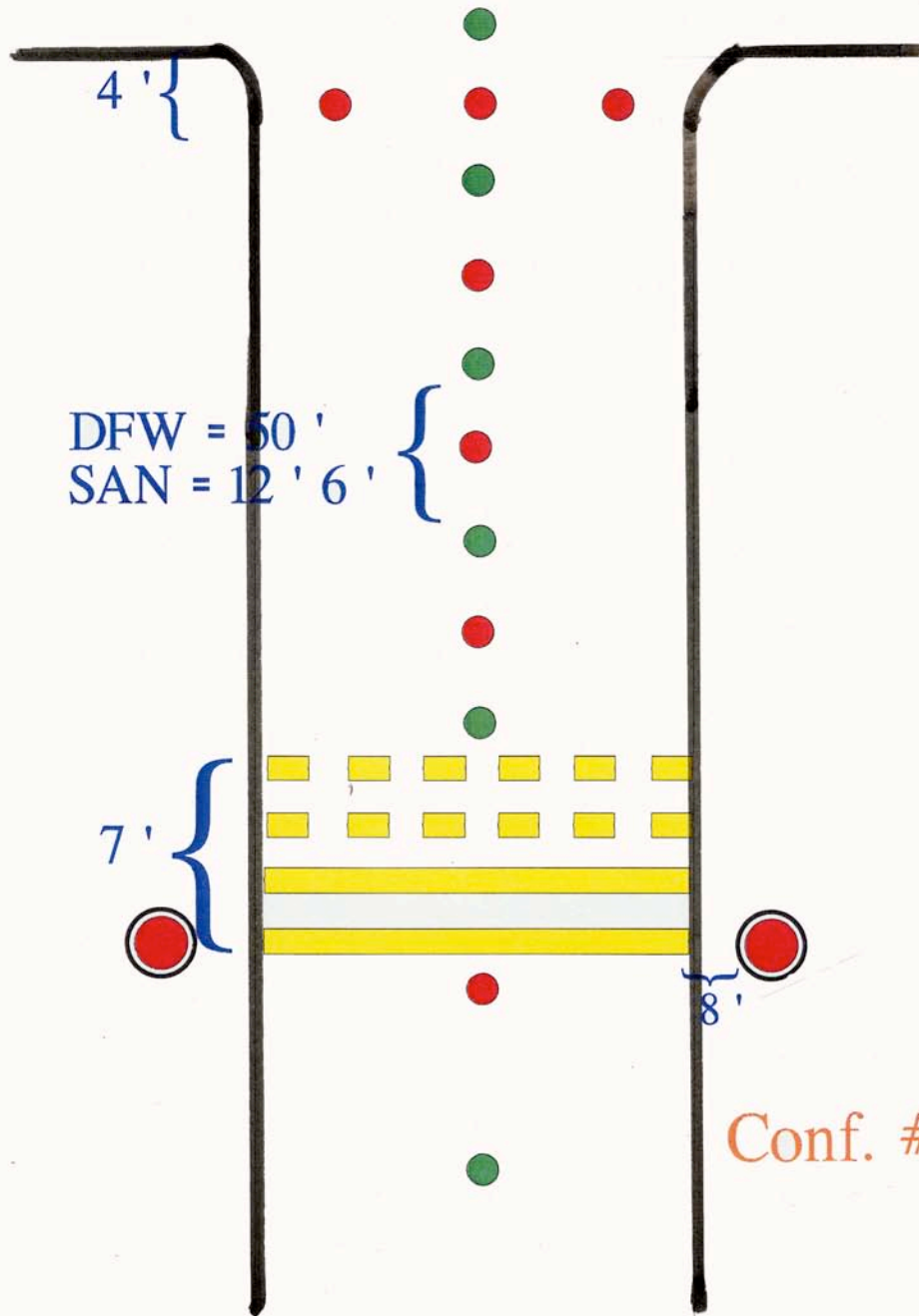
Attachments











Conf. # 20

DFW = Taxiway 100' Wide
 Holdline 200' from runway edge

SAN = Taxiway 75' Wide