Timing is EVERYTHING

The FAA's decision to deploy runway status lights over the next three years aims to further reduce the risk of collision.

BY WAYNE ROSENKRANS

When the U.S. Federal Aviation Administration (FAA) awards a contract in late 2008 to install runway status lights (RWSL) at 22 major U.S. airports[1] in 2009–2011, the worldwide aviation community will be anxious to hear about the new system's effectiveness in preventing runway incursions. From 2001 to February 2008, the FAA spent US$25.8 million to complete its research, development and operational evaluation of RWSL.

Available technology did not enable a nationwide deployment in the mid-1990s — the last time the FAA studied RWSL. Today, about two-thirds of the high-hazard runway conflicts can be addressed "without adversely impacting runway capacity or controller workload," the FAA said. The difference today is that airport surface detection equipment, model X (ASDE-X) — a surface surveillance system designed to identify and display traffic and, in enhanced versions, automatically alert air traffic control (ATC) to imminent ground collisions — has proved to be a key enabler.

"We have an approval and a commitment of capital to go out and invest hundreds of millions of dollars in getting RWSL to these airports," said Jaime Figueroa, field demonstration manager, surface technology assessment, FAA Air Traffic Organization (ATO) Operations Planning. "That's very significant because the decision says we have already persuaded ourselves — both technically and from a business-case standpoint — that this is a solution we need to deploy."

If the deployment repeats the success of systems already tested at Dallas-Fort Worth (DFW) and San Diego international airports, one result will be a compelling case for updating international standards to add RWSL to existing defenses against the human errors and other causes of runway incursions.

Saves So Far

The FAA cites two occurrences in 2008, both at DFW, as prime examples of RWSL providing safety-critical situational awareness quickly enough to prevent a runway collision with complete independence from air traffic control:

- A controller cleared the crew of a Saab 340 for takeoff on Runway 36R from the intersection at Taxiway Bravo. Moments later, the

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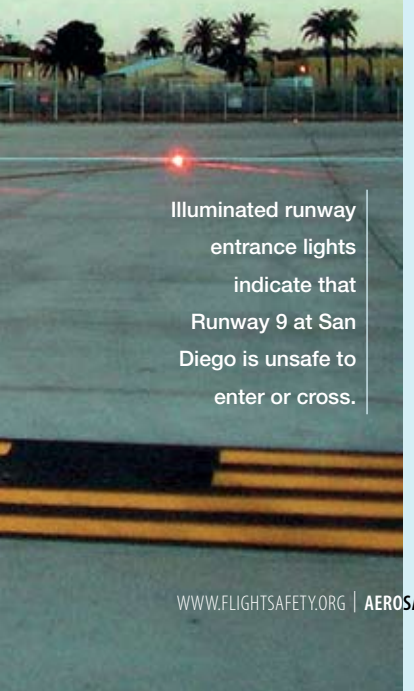
Takeoff hold lights at DFW warned two flight crews about aircraft crossing Runway 18L/36R after they received takeoff clearance.



Illuminated runway entrance lights indicate that Runway 9 at San Diego is unsafe to enter or cross.

controller — believing incorrectly that the 340 had been issued a position-and-hold clearance — cleared the flight crew of a McDonnell Douglas MD80 to cross Runway 36R at Taxiway Yankee. The 340 crew then radioed ATC that, although cleared for takeoff, they "saw the red lights" of RWSL and therefore did not begin the takeoff. The closest proximity of the two airplanes was 9,275 ft (2,827 m).

- ATC cleared the flight crew of a large commercial transport jet for takeoff, but the crew rejected the takeoff early in the takeoff roll. The FAA said that the captain later reported, "We began to roll, and I noticed the RWSL lights. … I aborted the takeoff at maximum speed below 80 kt. I looked down the runway and saw an aircraft crossing the runway left to right … [an unspecified Bombardier CRJ-series regional jet]. I noticed [the red lights] *before* I saw the intruding RJ. The RWSL worked — this is awesome. Put them everywhere."

The FAA's strategy of applying evolving technology for runway incursion prevention also includes the enhanced final approach runway occupancy signal (FAROS), low-cost ground surveillance and cockpit moving-map solutions, all still under development. "Until a more comprehensive solution comes along, the FAA and [Los Angeles International Airport (LAX)] are continuing to look at stopgap measures such as runway status lights to improve safety," said Robert Sturgell, the FAA's acting administrator. "Runway status lights are one way to drive down incursions … one more layer of defense, but [not] the first line of defense." Reconfiguration of airport runways and taxiways is the highest priority solution for some airports, he said.[2]

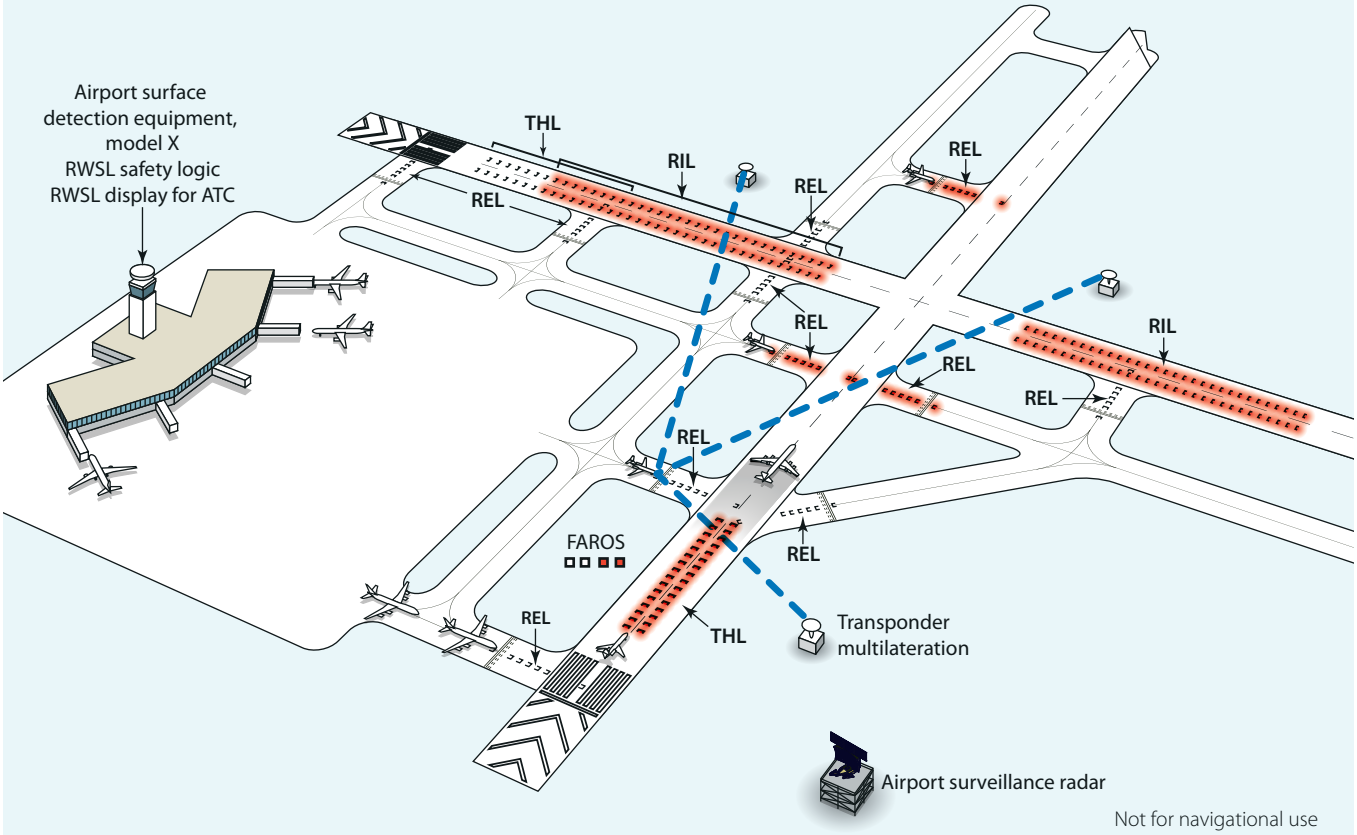
How It Works

An RWSL system (Figure 1, p. 48) comprises approach radar, surface radar and transponder multilateration; data processing safety logic; and red lights that communicate runway status. Unlike ASDE-X and the older airport movement area safety system (AMASS), RWSL is not designed for conflict detection, and the RWSL display in the airport tower is not a tool for the controller to resolve situations. "With every operation on a runway — whether there is a conflict or not — RWSL illuminates the red lights," Figueroa said.

For operational use, official details on RWSL systems at DFW and San Diego appear in the FAA *Notices to Airmen* (NOTAM). General background for pilots has been published by Lincoln Laboratory of the Massachusetts (U.S.) Institute of Technology — the FAA's principal RWSL contractor — on a Web site <www.rwsl.net>.

One NOTAM for July 31, 2008 — which describes an initial configuration of takeoff hold lights (THLs) installed on DFW Runway 18L/36R — said in part, "RWSL is an automatic, advisory backup system expected to prevent or reduce the severity of runway incursions. RWSL conveys the runway occupancy status, indicating when a runway is unsafe to enter [or cross] through the use of in-pavement warning [runway entrance lights (RELs)] and when it is unsafe to take off through the use of in-pavement warning

Runway Status Lights Operational Concept



RWSL = Runway status lights; REL = Runway entrance lights; THL = Takeoff hold lights; RIL = Runway intersection lights (under development); FAROS = Final approach runway occupancy signal (under development); ATC = Air traffic control

Source: U.S. Federal Aviation Administration

Figure 1

THLs. The RELs are a series of five red, in-pavement lights spaced evenly along the taxiway centerline from the taxiway hold line to the runway edge. … THLs are directed toward the approach end of the runway and are visible to pilots in position for takeoff, just commencing departure or on final approach to land. There are four sets of THLs, each comprising a series of 11 red in-pavement lights at 100-ft [30-m] spacing along the runway centerline. The four sets of THLs are operational at the full-length and intersection departure positions.

"Status lights have two states: on (lights are illuminated red) and off (lights are off) and are switched automatically based on information from the airport surface surveillance systems. It is important that transponders be turned on and kept on while taxiing in the movement area so that beacon-based position and aircraft identification data are available to RWSL."

Situational awareness is critical to the concept. "Pilots should remain clear of a runway when an REL along their taxi route is illuminated," the NOTAM said. "Pilots should not take off when a THL on the runway ahead is illuminated. Lights that are off convey no meaning. The system is not, at any time, intended to convey approval or clearance to proceed onto a runway or to take off from a runway. Pilots remain obligated to comply with all ATC clearances, except when compliance would require crossing an illuminated red REL or THL. In such a case, the crews should *hold short* of the runway for RELs or *stop* the aircraft for THLs (if possible), *contact ATC,* and await further instructions."

The NOTAM also covers situations in which pilots have begun to enter a runway, conduct a takeoff or complete a landing at the moment the RWSL red lights illuminate. Instructions include taking action according to the

pilot's best judgment of safety when the usual response is not practical with full understanding that red lights indicate the runway is unsafe to cross or enter, and contacting ATC at the earliest opportunity.

Unique Airport Configurations

Now that RELs and THLs have passed engineering tests and met human factors performance criteria, the RWSL systems at DFW and San Diego are being completed, and all the other airports will install RELs on some or all taxiways and THLs on one or both ends of some or all runways under the FAA's schedule and budget for RWSL deployment.

"The FAA approved delivery of RELs and THLs in some mixture to [all] 22 airports," Figueroa said. "Some airports need RELs at every intersection of every runway. Some need RELs at just a few intersections because there may be other crossing points that are infrequently crossed or maybe never crossed. Other airport [officials said,] 'We only need full-length THLs or we only need them at one end of a runway because 90 percent of the time, we operate only north to south, so there is no point in investing in a south to north capability.'"

The system scheduled to be installed in February 2009 at LAX includes RELs and THLs, as well as the first operational evaluation of RELs for high-speed exit taxiways. Similarly, the system to be installed in November 2009 at Boston includes RELs and THLs, as well as the first operational evaluation of runway intersection lights (RILs). "RILs are a variation, a new component of runway status lights intended to provide protection at airports with crossing runway geometries," Figueroa said, and they require modified safety logic.

Some of the 22 airports will have to change from ASDE-3/AMASS to ASDE-X. "RWSL deployment is being scheduled such that ASDE-X will be installed and available well in advance of RWSL installation at most airports," Figueroa said.

International Interest

The U.S. National Transportation Safety Board (NTSB) since July 2000 has urged the development of technologies that directly increase the awareness of pilots and airfield drivers of collision threats on the ground. The NTSB supports RWSL as part of an overall response so far deemed unacceptable. NTSB member Steven Chealander said, "Direct warning is crucial because it gives both controllers and those operating the aircraft increased time to react. … [NTSB] investigations have found that AMASS/ASDE-X are not adequate to prevent serious runway collisions because too much time is lost routing valuable information through air traffic control. … All of the runway incursion prevention technology being developed and tested by the FAA that would give a direct warning to the cockpit, such as runway status lights and the final approach runway occupancy signal, and automatic dependent surveillance–broadcast are years from being installed, and they will not be installed at all airports with passenger service."[3]

Among organizations supporting the RWSL concept are the U.S. Commercial Aviation Safety Team; the Industry Safety Strategy Group, which recommends the technology to airports worldwide in *Implementing the Global Aviation Safety Roadmap;* and the Air Line Pilots Association, International.

Eurocontrol has begun to consider RWSL as an added functional capability to the advanced

Complex intersecting runways at Boston Logan will get the nation's first runway intersection lights in late 2009.

surface movement guidance and control system (A-SMGCS) specification and, during 2008, has hosted workshops aimed at developing a concept of operations for what they call "safety net" additions to the A-SMGCS Level 2 specification, Figueroa said. Representatives from Eurocontrol, individual European states and Japan have visited DFW and San Diego and expressed interest to the FAA in testing similar concepts.

"Eurocontrol has been very interested in this capability, so recently they began developing an operational concept that is not quite A-SMGCS level 3 but more an A-SMGCS Level 2–plus," he said. "Level 2, now being deployed in many countries throughout Europe, is the equivalent of ASDE-X with safety logic. Many major airports in Europe have the equivalent technology."

The U.S. representative to the ICAO Visual Aids Panel will continue to share data and work with international partners to begin the process of developing RWSL standards and recommended practices, ensure a uniform concept and minimize internationally any implementation differences, according to Figueroa.

Initial Deployment Readiness

Federal government reports in 2007 and 2008 raised concerns about whether an accelerated, interdependent deployment of ASDE-X and RWSL could be achieved. One, a U.S. Department of Transportation inspector general report, identified concern about the differences between the RWSL interface to the prototype ASDE-X equipment installed at DFW and the RWSL interface to the operational ASDE-X being deployed nationwide. "The FAA is confident that interfacing to an operational ASDE-X will not be a major problem," Figueroa said.

Another concern has been the need to install transponders in all airport vehicles that operate on airport movement areas. Not on the lists of safety concerns is interference by transponders with airborne traffic alert and collision avoidance systems; all existing ASDE-X multilateration sensors already depend on the ground operation of transponders, and they also identify and determine the position of aircraft flying within 5 mi (8 km) of the airport.[4]

"The RWSL system is stable and meeting its intended functional operational capability," Figueroa said. "We are trying to make the DFW system more robust and less prone to failures, such as a couple of power interruptions. We are going to be [adding some equipment redundancy] when we install RWSL and connect it within the next six months or so to the ASDE-X at LAX. We have done some early tests, and we do not foresee major problems." Plans call for these improvements to be replicated gradually at the other airports.

Some airports scheduled for RWSL systems also have runway guard lights at runway-taxiway intersections. Unlike Europe (*ASW,* 8/08, p. 27), however, relatively few of them have stop bars.[5] Guard lights have presented no problems. The simultaneous use of RWSL and stop bars appears feasible to the FAA but an operational evaluation still will be required, Figueroa said.

A comprehensive educational campaign augmented the FAA's official channels of information, such as notices to airmen and Jeppesen chart inserts, to target the multiple categories of RWSL users operating at San Diego and DFW airports. For the rest of the aviation community, the FAA's *Aeronautical Information Manual* probably will introduce RWSL during the upcoming deployment; educational outreach will continue as required with few changes to information until RILs or similar new functionality has been added, Figueroa said.

The new RWSL systems are not expected to yield much safety data for study because the thousands of daily activations of RELs, THLs and RILs at a single airport will be normal occurrences. "There would be tons of [useless] data if we tracked all the activations," Figueroa said. "More significant to us are the saves that get documented, showing that a conflict was developing and that an incursion would have happened but for the system. There is value in [reviewing] the traffic conditions and at what point the red lights activated. Those become a more compelling metric."

Notes

1. The list includes Atlanta Hartsfield, Baltimore-Washington, Boston Logan, Charlotte-Douglas, Chicago O'Hare, Dallas/Fort Worth, Denver, Detroit, Fort Lauderdale, Houston Bush, John F. Kennedy, La Guardia, Las Vegas, Los Angeles, Minneapolis, Newark Liberty, Orlando, Philadelphia, Phoenix, San Diego, Seattle-Tacoma and Washington Dulles international airports.
2. Sturgell, Robert A. "Red Means Stop." Remarks during news media event at Los Angeles International Airport, Feb. 26, 2008.
3. Chealander, Steven R. NTSB member remarks before the Commerce, Science and Transportation Committee; Aviation Operations, Safety and Security Subcommittee; U.S. Senate. April 10, 2008.
4. Office of Inspector General, U.S. Department of Transportation. "FAA's Implementation of Runway Status Lights." Report no. AV-2008-021, Jan. 14, 2008.
5. The FAA requires stop bars if airports will conduct low-visibility operations in conditions less than 600 ft [180 m] runway visual range (RVR), and the stop bars must be operated by ATC when conditions are less than 1,200 ft (350 m) RVR.