

PROFESSIONAL PILOT

SAFETY TRENDS

Audible warning

Using marker beacons to fight runway incursions.

By Wes Stone
ATP. Cessna Citation series



Raytheon King Air 200 departs Rwy 19R at CCR (Concord CA) during recent testing of the Ground Marker situational awareness tool. This system, which works through an aircraft's ILS marker beacons, provides an audio cues regarding the aircraft's position on the airport.

On Oct 8, 2001, dense fog was swirling over the airport in Milan, Italy and ground operations were proving difficult. The crew of a taxiing Cessna CitationJet mistook their position and inadvertently crossed onto the active runway. They never saw the McDonnell Douglas MD87 airliner barreling toward them on its takeoff roll. The ensuing collision claimed 118 lives.

Statistics show that runway incursion incidents, most of them less severe than the Milan tragedy, have increased significantly over the past decade. In an effort to arrest this trend, FAA has placed runway incursions at the top of its "must fix" safety agenda.

FAA documents outlines this priority, saying it will place emphasis on "new and emerging technologies that are inexpensive and have a near-term impact on improving safety in the airport movement area."

A number of concepts designed to reduce or eliminate runway incursions are now under study and one of them, called Ground Marker, is in the test phase at CCR (Concord CA). This is a unique approach to airport safety, according to both FAA and Veracity Engineering, the company doing the program's systems integration. Ground Marker does not require any new cockpit equipment. Transmitters on the airport send a voice message to the aircraft via its standard marker beacon receiver.

Unlike signage or cockpit displays, Ground Marker tells the crew their position regardless of where they are looking, says FAA Ground Marker Program Manager Michael Hartzog. This characteristic could be critical during taxiing, when pilots are often performing tasks not directly related to maintaining situational awareness.

New job for an old friend

Ground Marker, as its name implies, uses an aircraft's 75-MHz marker beacon receiver—a piece of older technology that has long been a part of an IFR-capable aircraft's avionics suite.

In the Ground Marker application, the system relies on inductive loops installed under the taxiway surface. Four such loops are used to sense the weight of a passing aircraft and signal the Ground Marker control unit (GMCU) to send a "taxiway position message." This GMCU is the heart of the system and contains the transmitter and stored digital voice message. A dipole antenna, also embedded in the taxiway, transmits the message.

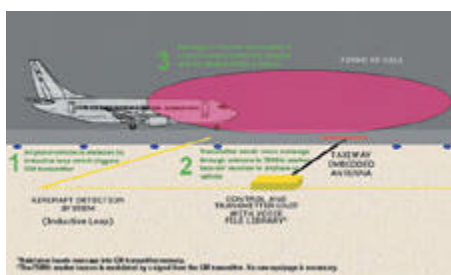
Each message contains the aircraft's current position and the name of an approaching intersection. An example would be "Taxiway X-Ray at Taxiway Yankee." This message tells the crew that they're currently taxiing on Taxiway X-Ray and the next crossing taxiway will be Yankee. The message is

heard as a voice speaking over the marker beacon receiver. To distinguish this message from background radio communications, an effort is being made to create a distinctive voice that pilots will notice and heed.

In the course of their research, FAA and Veracity came to the conclusion that not every intersection or an airport needs to be equipped with a transmitter, as only a few (3 to 5 is Hartzog's estimate) can be considered problematic. Such intersections are easy to identify, as they have a historically high rate of incursions or are located where any incursion could have grave consequences, such as where runways and taxiways meet.

CCR tests show promise

Based on its reputation as a hotbed for both general aviation activity and runway incursions, CCR was an apt choice as the site for the Ground Marker tests. CCR has been in the runway incursion "top 10" for the past 4 years, and features a relatively complex layout that some pilots have come to regard as a "runway incursion trap." Concord is at the top of the list in terms of both rate and number of runway incursions, Hartzog says, even though its rate of operations—around 130,000 annually—is relatively low.



Ground Marker relies upon the installation of inductive loops with dipole antennas built under the taxiway surface. The loops sense the weight of passing aircraft and the antennas broadcast taxiway position messages to pilots through their marker beacon equipment in real time.

Ground Marker testing at CCR began on Oct 27, 2003, when installation of the equipment at this northern California airport was completed. The first of its kind, the CCR installation has

had its share of growing pains. Issues related to power supply are being resolved, program workers say, and the system is expected to be up and operating reliably by May 2004.

Pro Pilot had a chance to evaluate Ground Marker at CCR in Nov 2003. We discussed the system with Debra Derman, Ground Marker program manager at Veracity Engineering. Following an informal briefing of the system and armed with program literature, we had the opportunity to taxi around the airport and get a feel for using the Ground Marker system.

Since no additional equipment needs to be installed in the aircraft, our crew needed only to flip on the marker beacon switch and ensure that its volume control was set in the audible range. Although CCR is a complex airport, we heard few messages while taxiing. According to Derman, only 6 of the airport's more than 40 intersections warrant the installation of a Ground Marker transmitter.

When we did cross one of the 6 transmitter installations, it was reassuring to hear the message "Taxiway Bravo at Alpha." At CCR, that particular message could prevent an aircraft from a crossing no fewer than 3 active runways. Hearing the message served the same function as receiving a position update from a ground controller while taxiing at an unfamiliar airport.

It was almost as good as having a copilot familiar with the local airport environment, although it lacks the "You need to turn left here" kind of input a human would provide. Overall, though, the system impressed us with how much information it conveys to pilots without requiring them to spend a penny on additional avionics. Our experience, according to Veracity, was not unique. Other pilots who've sampled the system have liked it too, Derman says.

Since installing Ground Marker at CCR, only one runway incursion has been recorded. This bodes well for the future of the system, since the airport typically records 4 or 5 incursions during the same period. Many incursions go unreported, however, and it remains to be seen if a direct correlation can be drawn between Ground Marker use and increased safety. Aside from statistical anomalies, FAA has also undertaken an extensive runway incursion education program at CCR that could influence the data.

The next phase of the Ground Marker tests could see installation of the system at up to 5 other airports with their own runway incursion problems. On completion of these tests, a decision regarding the potential widespread application of the system will be made.

Ground Marker is just one of a number of potential solutions to the runway incursion problem that are now in the works at both government and industry research and development organizations.

Other approaches

On the commercial side, avionics giant Honeywell has done extensive research into the problem of runway incursions and has recently won an STC for its runway awareness and advisory system (RAAS). RAAS is unique in that it does not require new equipment, either on the ground or in the aircraft, as long as that aircraft is already equipped with Honeywell's enhanced ground proximity warning system (EGPWS).

EGPWS already keeps track of aircraft position through GPS, and it has a terrain database that includes runway position. Using the existing equipment, Honeywell developed a software upgrade that warns pilots when they're approaching a runway.

"EGPWS already keeps track of active runways to protect against landing short," says RAAS Engineer Ratan Khatwa. "Since we know where you are and where the runways are, this provided us with the opportunity to significantly reduce runway incursions."

RAAS's runway-related aural advisory functions are similar to Ground Marker's. As a crew taxis near a runway, RAAS will announce over the cockpit speaker, "Approaching Runway 27 Right." Testing by Honeywell has shown that not only does this announcement increase ground situation awareness—it also helps crews ensure they are setting up for take off on the correct runway.

RAAS includes additional functions. While descending through 750 ft, the system will announce the name of the runway ahead of the aircraft. If that runway is shorter than a user-selectable value, RAAS will announce the available runway length. During landing roll or during a rejected takeoff, the distance remaining to the end of the runway will be announced every 1000 ft. In all RAAS makes 10 different types of aural announcement, each of which Honeywell says it selected because of a specific runway incursion incident.

"Each of the RAAS modes exists today because of the data searched during our runway incursions analysis," says Khatwa. "Right now, RAAS does not include any information about taxiways because there wasn't enough detailed data on taxiway positions with the accuracy needed to include it at this time."

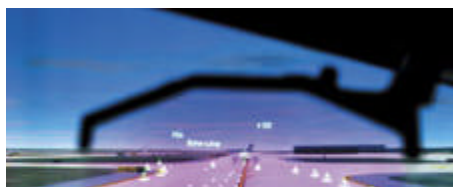
Future plans for RAAS include a detailed moving map of the taxiway environment when data becomes available and, with the aid of automatic dependent surveillance– broadcast (ADS-B), the display of other aircraft around the airport.

NASA's RIPS effort

For the past 4 years NASA has been testing a futuristic system to help prevent runway incursions. Called the runway incursions prevention system (RIPS), it has all the functions of Ground Marker and RAAS combined—and all in a tightly integrated set of systems.

RIPS is not a prototype, but an experiment being performed at NASA's Langley Research Center in Hampton VA. Using head-up displays (HUDs), digital datalinks and 3D moving maps, RIPS provides crew members with a complete view of the airport situation. This project shows what can be achieved using state-of-the-art technology.

Moving map displays, in both 2D and 3D formats, show "own ship" position on taxiways and the position of all other aircraft taxiing or flying near the airport. Digital datalinks allow aircraft controllers to send taxi route clearances directly to the aircraft's computers. The route is displayed to the crew as text, as highlights on the moving map and through the HUD.



NASA's runway incursion prevention system (RIPS) combines GPS, datalink and ADS-B with a HUD interface. Virtual cones delineate taxi routes while position and speed data are provided in text form.

The HUD depicts the route by projecting a synthetic view of the taxiway path the pilot needs to take. The image includes taxiway boundaries, turns at intersections and it's so compelling that normal taxiing can be performed even during periods of zero visibility.

RIPS worked extremely well during a recent series of tests (see Pro Pilot, Sep 2002), but this cutting-edge capability comes at a price. Researchers at both NASA and Honeywell believe that, with current technology, a system like RIPS is just too expensive for airlines and business jet owners to afford. RAAS is far less expensive, they say, and its capabilities are expected to grow over time.

"What we have now with RAAS is very similar to the early days of ground proximity warning," says Khatwa. "Ground proximity warning started out with just aural alerts and no display. Like enhanced ground proximity warning, RAAS will get a moving map display and, with ADS-B, it will be able to show your position and the position of other aircraft on the taxiways."

Measuring the impact

The big question with all of these systems is: "Do they reduce runway incursions?" The answer, according to FAA, is a strong "Maybe." Since Ground Marker installation at CCR, there has been only one recorded runway incursion. This should bode well for the system, since historically there would likely have been 4 to 5 incursions during the same period. But that doesn't tell the whole story.

The problem is that nationwide there are approximately 68 million tower operations per year. Even though a significant runway incursion happens nearly every day, it is hard to tease out this statistically small number from the millions of tower operations. The reduction of incursions at CCR may be an indication that Ground Marker is working successfully, or it might just be a statistical anomaly—only time and more data will tell.

Further complicating the issue is that FAA ran an extensive program to educate pilot groups at CCR on airport safety. That, along with the fact that Ground Marker has not been operating all of the time, further complicates the issue. More testing and a wider installed base of the system should give the answer, the participants believe.

FAA and commercial contractors involved with the Ground Marker program plan to produce a quarterly review after the conclusion of the CCR test. They will then look at the pilot questionnaire data and talk with controllers before moving onto the next phase.

That phase will probably involve the Ground Marker system being installed at up to 5 key sites. These airports, which will be chosen because they've had problems with runway incursions, will be tested and evaluated just like CCR. Following this test, a decision will be made as to whether to acquire the Ground Marker system and install it nationwide.

While confusion during ground operations for crews operating into and out of complex airports is nothing new, the current increase in runway incursions is a concern. It would be a benefit to have something cost-effective that increases ground situational awareness.

According to pilots who have used the system, Ground Marker fills that role. On that foggy day in Milan, it's hard to imagine that the CitationJet crew would have wandered on to the active runway if, as they approached the threshold, they'd heard "Taxiway Romeo Six at Runway Three Six Right."



Wes Stone has been flying and managing corporate aircraft for more than 10 years. He has performed flight testing and other research for NASA and private industry and now is chief pilot for a company based in Southern California.

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