Clean Sweep

New technologies are supplementing traditional methods of keeping foreign object debris off runways.

BY LINDA WERFELMAN

Airports traditionally have relied on regular visual inspections and sweeping to clear foreign object debris (FOD) from runways. In recent years, however, new systems have incorporated advanced technologies to help attack the problem, estimated to cost the industry $4 billion a year worldwide.[1]

The U.S. Federal Aviation Administration (FAA), while characterizing the people who work at and use airports as the "primary 'sensor' to detect FOD on airport surfaces," says that technological developments have "greatly expanded the capabilities of FOD detection through automation."[2]

In Advisory Circular (AC) 150/5220-24, *Airport Foreign Object Debris (FOD) Detection Equipment*, the FAA outlined minimum performance specifications for four types of detection systems:

- Stationary radar, which can detect a cylindrical metal object 1.2 in (3.0 cm) high and 1.5 in (3.8 cm) in diameter as far away as 0.6 mi (1.0 km). Two or three sensors typically are required per runway, with the sensors located at least 165 ft (50 m) from the runway centerline.
- Stationary electro-optical sensors, which can detect a 0.8-in (2.0-cm) object from distances up to 985 ft (300 m). Five to eight sensors are required per runway, with the sensors at least 490 ft (150 m) from the runway centerline.
- Stationary hybrid sensors, which combine radar and eletro-optical sensors and can detect a 0.8-in object. The sensors typically are located on every runway edge light, or on alternate lights.
- Mobile radar, which is mounted atop a vehicle and scans a surface area about 600 ft by 600 ft (183 m by 183 m) in front of the vehicle as it moves. The system can detect objects 1.2 in high and 1.5 in in diameter. The systems operate at speeds up to 30 mph (48 kph) and often are used to supplement visual inspections.

FAA performance requirements call for FOD detection systems to be able to detect an unpainted metal cylinder 1.2 in high and 1.5 in in diameter, as well as a white, gray or black sphere the size of a golf ball — 1.7 in (4.3 cm) in diameter. In addition, the systems must be able to detect at least nine of the objects in a specified group of 10, including a "chunk" of asphalt or concrete, a part of a runway light fixture, a piece of rubber from an aircraft tire, an adjustable crescent wrench as long as 8 in (20 cm), a metal strip as long as 8 in and a wheel lug nut.

The AC says FOD detection systems must provide location information for any detected object that is accurate "within 16 ft (5 m) of the actual FOD object location," operate continuously and operate when the pavement is wet or snow-covered, as well as when it is dry. Rapid detection is required, and "for continuously operating FOD detection systems that are designed to provide between-movement alerts, the system must provide inspection of runway surfaces between aircraft movements."

False alarms that cause an airport operator to act to remove a FOD object "should be minimized" and not exceed one a day for detection systems with visual detection capability and three a day for systems without visual detection, the AC says.

First Installation

The first system to be installed was a QinetiQ Tarsier radar system, deployed in 2006 at Vancouver (Canada) International Airport. The company says Tarsier uses high-resolution millimeter-wave radar to detect small objects on runways. Among the materials that can be detected are metal, plastic, glass, wood, fiberglass and animal remains, QinetiQ says.

At Vancouver, radar antennas, which measure about 35 cu ft (1 cu m) are housed in radomes atop hexagonal steel towers that are between 11 ft (3 m) and 24 ft (7 m) tall — in each case, the minimum height required to give the antenna a line of sight for the section of runway within its range. When the radar detects an object on a runway, a FOD alarm appears on an electronic airport map display at the airport operations center.[3] The map display is always monitored, and when an alarm is received, airport personnel respond to the scene.

"The system has proven to be so accurate that responding personnel in FOD retrieval vehicles have had to offset their vehicle position from the reported coordinates in order to avoid positioning themselves directly over the FOD during recovery," airport officials said in a presentation to Flight Safety Foundation's International Air Safety Seminar in 2006.

Tarsier has been installed at several other airports, including London Heathrow Airport, Dubai International Airport in the United Arab Emirates and Doha International Airport in Qatar. The system also was installed at the Providence (Rhode Island, U.S.) T.F. Green International Airport, where it was the subject of a performance study conducted for the FAA.[4]

The Tarsier system — like other FOD detection systems — was developed in the aftermath of the July 25, 2000, crash of an Air France Concorde after takeoff from Paris Charles de Gaulle International Airport. Investigators found that one of the Concorde's tires had run over a metal strip that had fallen onto the runway from another airplane; after pieces of the burst tire struck an engine and a fuel tank, the airplane burst into flames. All 109 people in the airplane were killed, along with four on the ground (see "FOD-Related Events").

'Intelligent Vision'

Another FOD detection system is Stratech System's iFerret, an electro-optical system that uses a line of self-calibrating cameras to inspect runways, taxiways and apron areas for FOD. The system's "intelligent vision" software

FOD-Related Events

Foreign object debris (FOD) has been blamed for numerous accidents in addition to the fatal 2000 crash of an Air France Concorde just outside Paris, including:

- A March 26, 2007, accident in which the crew of a Gates Learjet 36A heard a "loud pop" during the takeoff roll at Newport News/Williamsburg International Airport in Newport News, Virginia, U.S., and the airplane pulled to the left. The pilots rejected the takeoff but were unable to stop the airplane on the runway; it swerved off the runway to the right and struck a runway light. Neither of the pilots was injured, but the airplane was substantially damaged. The U.S. National Transportation Safety Board (NTSB) said the probable cause of the accident was the failure of tires because of FOD on the runway. Airport personnel said that, after the accident, they observed rocks and pieces of metal on the runway.[1]
- A Feb. 16, 2007, incident in which the crew of a Frontier Airlines Airbus A319 observed, shortly after takeoff from Denver International Airport, that the windshields were cracking. They returned to the airport for a normal landing, and no one in the airplane was injured. The NTSB investigation revealed that, during that same afternoon, 14 airplanes taking off from Denver experienced cracked windshields. One crew reported having taxied through "dirt and dust being blown around," and investigators determined that all of the windshields had cracked because of impacts with FOD.[2]
- A June 8, 2006, accident in which a piece of aluminum material that had been left on the taxiway during taxiway maintenance "became airborne and struck the tail" of an American Trans Air Boeing 737 taxiing for takeoff from LaGuardia Airport in New York. The aluminum plate measured about 25 in (64 cm) by 60 in (152 cm). None of the 143 people in the airplane was injured.[3]

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Notes

1. NTSB. Accident report no. NYC07LA087. March 26, 2007.
2. NTSB. Accident report no. DEN07IA069. Feb. 16, 2007.
3. NTSB. Accident report no. CHI06LA161. June 8, 2006.

helps identify, locate and record any object it discovers. It provides real-time alerts with text and image to allow the system operator to get a close-up look at the object before ground personnel are alerted to remove the FOD.

The company describes iFerret as the only system available that can enable airport personnel to monitor not only runways but also taxiways, aprons and other operations areas. A performance assessment at Chicago O'Hare International Airport marked the first deployment of a FOD detection system on taxiways; the first apron deployment was at Düsseldorf (Germany) International Airport.

iFerret also has completed a trial at Singapore's Changi Airport and been commissioned there.

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Stratech Systems' iFerret is an electro-optical system that can be used to monitor taxiways and aprons, as well as runways, for FOD.

Hybrid Sensors

Another FOD detection system is Xsight Systems' FODetect, a hybrid electro-optical and millimeter-wave radar sensing system that can be integrated into elevated runway- or taxiway-edge lights or in separate structures. The location of these surface detection units (SDUs) meets "the demanding requirements of detecting small FOD in challenging weather conditions while utilizing existing power and data infrastructure to minimize installation costs," the company says.

Each SDU scans a portion of the runway and analyzes the data it obtains to detect changes on the runway surface, including the presence of FOD; when an SDU detects debris, the FODetect operator receives an audio alert and a visual alert that includes information on the exact location and size of the detected FOD.

FODetect has been tested at Sde-Dov Airport in Tel Aviv, Israel, and Boston Logan International Airport; in May, the company announced plans for program implementation at Ben Gurion International Airport in Tel Aviv.

Radar on Wheels

The FOD Finder is a mobile system — a millimeter-band radar mounted on a vehicle — that is capable of detecting objects "smaller than gravel," according to the manufacturer, Trex Enterprises. The radar sensor, mounted atop a reciprocating platform, scans an area in front of the vehicle. The FOD Finder also includes a global positioning system, a photographic system, a personal computer and system software that provide the operator with images of the FOD it detects. The system automatically uploads data on the detected debris to an Internet-based data management system, the company says.

The FOD Finder operates as the vehicle moves forward, at speeds up to 30 mph, the company says. When FOD is detected and then retrieved, it is photographed by a camera on the vehicle's roof; the system produces a label for the item that includes information on where it was found and the date and time. The information is then entered into a data table in the on-board computer.

Notes

1. The estimate was developed by U.S. National Aerospace FOD Prevention, an association of people and organizations within the aerospace industry dedicated to preventing foreign object damage.
2. FAA. Advisory Circular 150/5220-24, *Airport Foreign Object Debris (FOD) Detection Equipment*. Sept. 30, 2009.
3. Richmond, Craig; Patterson, Brett. "A New Paragon of Airside Safety: Runway FOD Detection Radar." In *Enhancing Safety Worldwide: Proceedings of the 59th Annual International Air Safety Seminar*. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2006.
4. Herricks, Edwin E.; Woodworth, Elizabeth; Majumdar, Sid; Patterson, James Jr. *Performance Assessment of a Radar-Based Foreign Object Debris Detection System*. DOT/FAA/AR-10/33. February 2011.
5. FAA.