Voluntary use of ADS-B transmitters on U.S. airport ground vehicles will reduce risks.

Maximum **Visibility**

BY WAYNE ROSENKRANS

© DeRonn Smith/Wikimedia

Over time, planners of the Next Generation Air Transportation System (NextGen) for the United States expect situational awareness of all airport surface activity to be shared widely. The key safety objective is enabling controllers and pilots to reduce the risk of collisions in an airport's designated movement area by observing and reacting to the same display of aircraft/vehicle trajectories. New details from the Federal Aviation Administration (FAA) in early April show how the pieces will fit into place.

Guidance recently published in an FAA advisory circular (AC)[1] targeting airport operators and other stakeholder groups explains how they can provide a critical element. Voluntarily equipping airport ground vehicles with automatic dependent surveillance–broadcast (ADS-B) transmitters is the optimal technology — in the long run — to accurately observe and identify surface vehicles in the movement area, the AC says. The agency expects the first FAA-approved transmitter to be announced around the end of April and continues to assess eligibility for FAA funding assistance.

"Using this AC, airports will be able to acquire approved and authorized airport ground vehicle ADS-B squitter units[2] [which the FAA also calls *surface vehicle ADS-B transmitters*] that are compliant with [U.S. Federal Aviation] Regulations Part 91, *Automatic Dependent Surveillance-Broadcast (ADS–B) Out Performance Requirements to Support Air Traffic Control (ATC) Service,* as well as the initial set of ADS-B applications," the AC said. "The inclusion of airport vehicles into the surface surveillance picture gives air traffic controllers and operators one more way to identify traffic issues, understand the most efficient way to proceed on the airport surface, and avoid incursions." The FAA expects the entire network of ADS-B ground stations to be operational nationwide by the end of 2013.

Accurate and timely data for surveillance of every aircraft and ground vehicle operating in airport movement areas will be "crucial" to NextGen, says Robert Nichols, implementation lead for the FAA Surveillance and Broadcast Services (SBS) program office. "The surface environment has been very difficult to monitor due to multipath of radio frequency transmissions from the myriad of reflective surfaces on an airport, making it difficult to get the best picture," he said.

© Saab Sensis

All U.S. surface vehicles (facing page), unlike aircraft equipped with ADS-B Out, automatically silence their ADS-B datalink outside the movement area. Above, outside the United States, a Saab Sensis VeeLo NextGen vehicle locator transmits its position in the 1090 ES format.

The AC has been designed to ensure proper operation of surface vehicle ADS-B transmitters, which typically are small, self-contained devices attached to the exterior of a vehicle. Use of this AC is mandatory for several categories of airport operators. "While such units are not currently required, the FAA strongly encourages airport operators to voluntarily equip appropriate vehicles [to enhance safety and situational awareness]," the AC says. "The ADS-B system provides aircraft/vehicle position information using data provided by the unit's GPS [global positioning system] navigation system and transmitted via [one of two designated radio frequencies]. … The system converts that position into a unique digital code and transmits it, along with a unique identification code, to locate and identify the exact aircraft/vehicle."

Layering surveillance techniques has proven to be the best, though an imperfect, solution to overcome the inherent physical challenge of radio frequency reflections, Nichols said. Essentially, layering combines the respective strengths of airport-surveillance radar, airport surface movement radar, multilateration (triangulation of position from timing the arrival of conventional or ADS-B transponder signals at four or more antenna positions) and ADS-B.

"The primary locations for installation of ADS-B squitters on vehicles are 35 [airport surface detection equipment, model X (ASDE-X)] airports and the nine airports scheduled to

receive [airport surface surveillance capability (ASSC)] upgrades[3] to their ASDE-3 systems," the AC said. "ASDE-X and ASSC systems are needed to receive the ADS-B squitter signals for use on ATC displays. … In the future, the FAA may deploy ASSC or ADS-B surface surveillance volumes to additional airports that could then be appropriate sites for equipage of vehicles with ADS-B squitters."

The multilateration "layer" is being expanded at these airports to process 978-MHz universal access transceiver (978 UAT) signals from aircraft and, potentially, vehicles that otherwise could be invisible to controllers or to automated incursion-alerting systems. Multilateration also derives the position of vehicles from legacy transponders and Mode S 1090-MHz extended squitter (1090 ES), while the surveillance systems extract GPS data from ADS-B signal data.

Another major advantage of fusing the ADS-B data with ASDE-X is overcoming problems involving weather-related effects on radio and radar transmissions. "The radar component of the ASDE-X and ASSC systems can detect aircraft and vehicles in and around the airport operational area without the use of airport ground vehicle ADS-B squitter units," the AC said. "However, during periods of heavy and sustained precipitation, the precipitation may attenuate the radar, thus reducing the probability of vehicle detection. In these cases, vehicles equipped with … ADS-B squitter units can be tracked by … ADS-B [messages] and multilateration [using only the ADS-B radio signal itself] — thus increasing the accuracy and probability of detection. … Data fusion … systems also can alert controllers to potential conflicts so they can take appropriate action to prevent surface incidents."

The self-contained ERA Squid unit atop a German airport vehicle transmits GPS-derived position and identity using ADS-B 1090-MHz Mode S.

© ERA a.s.

Vehicle Policy Breakthrough

After the fundamental issue of aircraft surveillance in NextGen was settled — requiring equipage with ADS-B Out by 2020 as now specified by regulation — the FAA turned attention to alternatives in airport vehicle surveillance. "We took a hard look at how to address vehicles," Nichols said. "We already had vehicle transponder units out there that were fairly inexpensive." Historically, the legacy transponders were not expected to provide a high level of performance. Researchers and NextGen designers understood the value of equipping vehicles to maximize their visibility, however.

"As NextGen matured, the ADS-B specialists at the FAA started to work on rule making, recognizing that cockpit display of traffic information [CDTI, such as a GPS moving-map display or multifunction display] would enable pilots not only to see other ADS-B-equipped aircraft but, potentially, transponder-equipped ground vehicles," Nichols said. "However, the unresolved issue was confidence in the original transponder units. We wanted high confidence in the accuracy, and the navigation and surveillance integrity levels, to ensure that vehicles would be depicted where they actually are on the surface. That was not the case with the old transponder units, and the FAA's regulatory specialists said, 'We've got to get rid of these because aircraft pilots will see this information and potentially will react to bad information. We must limit or eliminate that risk to the greatest extent possible.'"

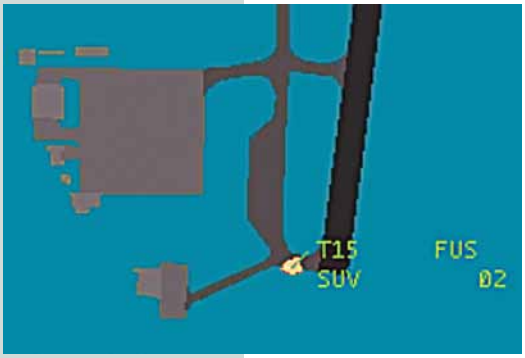
The FAA made the "difficult" policy decision that, going forward, airports that voluntarily equip vehicles for the movement area operation would have to procure technology that meets or exceeds the technical specifications of aircraft ADS-B units, he said. "To achieve rule-compliant accuracy and integrity values, we had to go up a level because the surface is a more stringent environment," Nichols

said. "Vehicle units need a GPS engine consistent with rule-compliant avionics, which is a cost driver for the units because this is a higher level than used in legacy units."

Currently, Boston Logan International Airport is the key site for the FAA. So far in 2012, the FAA technical center has conducted bench tests and on-site tests for 12 prototype, surface vehicle ADS-B transmitters. The first model slated to be approved uses 978 UAT.

"We are at a point where these units are compliant to our rules and our specification," Nichols said, noting that as of early April, agency engineers were finalizing their study of one nuance unrelated to compliance with specifications. "We needed to look at this nuance to understand it, but my goal is to have a unit identified as qualified and placed on the AC list by the end of April. Once that is announced, any airport in the country that wants to buy ground vehicle squitter units will have the option to buy this qualified product."

Each time a new unit qualifies, the FAA will update the AC list by an administrative change and announce the update on FAA websites for airports. Concerning any onboard capability for airfield drivers to share the display of surface traffic, the current U.S. technical specification for ADS-B-equipped airport ground vehicles "addresses the broadcast of ADS-B [data] only (the reception and display of ADS-B data in the vehicle is not addressed)," the AC said. Outside the United States, a number of surface vehicle ADS-B transmitters using 1090 ES have been approved and introduced at airports in several countries, but these are not compliant with U.S. specifications, Nichols said.



© Saab Sensis

An ASDE-X display shows the position, movement and identity of a surface vehicle equipped with an ADS-B transmitter (T15 SUV).

The FAA is considering the option of allowing its Airport Improvement Program (AIP) to provide funding assistance to airports. "I estimate a $5,000–$7,500 range per unit," Nichols said. Economies of scale also likely will reduce the cost to airports over time, he noted.

Beyond Incursions

As the cornerstone of NextGen technology, ADS-B also facilitates capturing aircraft activity in the movement and non-movement areas for purposes such as networked decision-support tools that enhance passenger service, airport operating efficiency and collaborative decision making.[4]

Apart from reducing collision risk, some airport and aircraft operators may develop a favorable business case for connecting to the FAA's networked ADS-B data to deliver and display "an integrated surface picture to airport operators through an additional display capability," the AC said. "While ATC surveillance benefits are only applicable to airports that currently have ASDE-X or ASSC, airport ground vehicle squitter units may be deployed at any airport. These [other] airports could still derive benefit … through ADS-B cockpit applications and through airport operator displays."

A slight constraint on potential efficiency gains from ADS-B transmitters on vehicles — the Federal Communications Commission's restriction on where 978 UAT and 1090 ES signals can be transmitted on any airport surface — is unlikely to affect the efficiency benefits sought by airport operators and other non-FAA users, Nichols said. The reason is that tracking aircraft is their primary interest in ramp and gate areas.

ASDE-X Emphasis

As the FAA's most advanced runway incursion detection system, ASDE-X as of September 2011 became operational at the last of 35 airports in the NextGen plan. To display to air traffic controllers highly accurate, near-real time position and identification information for aircraft and vehicles in the movement area — regardless of precipitation or reduced visibility — the latest updates to ASDE-X fuse data.

Pilots of aircraft that have ADS-B In with CDTI directly receive messages enabling the display of any ADS-B-equipped vehicles in the movement area whenever they are in range. By using the FAA's traffic information service–broadcast (TIS-B), however, even vehicles out of range or not equipped with ADS-B Out — but otherwise tracked by ASDE-X — appear as readily identifiable targets on cockpit displays and on authorized non-FAA displays at airports.

"Airports without FAA-deployed surface surveillance may choose to equip their vehicles with ADS-B squitters," the AC said. "Aircraft equipped with ADS-B In avionics and CDTI will enable pilots to see ADS-B-equipped vehicles' [locations]. [Airport operators] should consider current and near-term equipage of the aircraft using their airport when deciding on investments in ADS-B vehicle squitters. … The future use of vehicle units at airports other than ASDE-X-equipped airports is not yet defined."

However, Nichols said the safety benefits even to airports without ASDE-X or ASSC should be compelling. "It's important for pilots on approach, landing or on the takeoff roll in an aircraft with CDTI to see the equipped vehicles on the surface for enhanced situational awareness." Pilots of such aircraft on approach typically will be aware of equipped aircraft and vehicles on the surface from 5 to 7 nm (9 to 13 km) along the approach path. This distance provides sufficient time for pilots to determine, for example, that a vehicle displayed in the cockpit is not stationary on the assigned runway, and to safely comply with the ATC clearance, he said.

All surface vehicle ADS-B transmitters are designed for simplicity, transmitting data only when the vehicle position is within the GPS-defined *squitter transmit area* for the specific airport. "The ADS-B equipment will contain a [squitter] transmit map that will control the unit on/off function," the AC said. In the related document, the FAA explained that "the [surface vehicle ADS-B transmitter] units must be user-friendly to allow [airfield drivers] to utilize the transmitters without extensive training and allow technicians the ability to quickly install and/or remove the units without extensive ancillary equipment, supplies or training."[5]

Strong UAT Preference

Airport operators can select either or both of the ADS-B frequency options for surface vehicle ADS-B transmitters, but the FAA advocates just one. "Due to the 1090-MHz spectrum congestion and use by numerous other systems,[6] the FAA strongly prefers the use of the [978 UAT] link," the AC said. "The extensive use of the 1090-MHz frequency has the potential to cause numerous degradations to any system using 1090 MHz."

Each airport is limited to deploying 200 total surface vehicle ADS-B transmitters, with either or both ADS-B frequencies but with a given vehicle using only one frequency at a time.

Airport operators and other authorized ADS-B adopters that take the plunge must assume responsibility for proper equipment installation in each vehicle, including the current squitter transmit maps with correct on/off boundaries, correct programming of each vehicle's unique radio call sign used in ATC communications, proper entry of the unique International Civil Aviation Organization code that also identifies each vehicle, and monitoring to ensure that units function properly at the local airport.

To read an enhanced version of this story, go to <flightsafety.org/aerosafety-world-magazine/april-2012/surface-vehicle>.

Notes

1. FAA. "Airport Ground Vehicle Automatic Dependent Surveillance – Broadcast (ADS-B) Out Squitter Equipment." Advisory Circular 150/5220-26. Nov. 14, 2011.
2. A *squitter* is an output pulse generated by the internal triggering system of an ADS-B device, as opposed to an external interrogation pulse.
3. Saab Sensis, the FAA's ASSC contractor, said in January that each of these airports will have multilateration, safety logic conflict detection and alerting software, air traffic controller working positions and recording/playback functionality. The architecture also will allow future sharing of surface movement data with approved airport systems and users.
4. FAA. "ADS-B Ground Vehicle Transmitter Compliance Testing and Monitoring Master Plan." Version 2.0, Jan. 4, 2011.
5. Airport operators or other organizations approved by the FAA to use ground vehicle ADS-B Out squitter units must obtain a Federal Communications Commission (FCC) license prior to transmitting on either frequency. Unlike aircraft, such vehicles are restricted by FCC regulations to transmitting only from the movement area. An organization approved by the FAA can apply to operate up to the per-airport maximum 200 surface vehicle ADS-B transmitters under a single FCC authorization. The FCC has granted final authorization for the FAA's preferred 978 UAT frequency on airport vehicles. A 2010 FCC waiver temporarily governs the same use of the 1090 ES frequency, pending FCC rule making.
6. The existing terminal radar secondary surveillance system, many aircraft transponders, the traffic alert and collision avoidance system (TCAS II) and several other systems use 1090 MHz.