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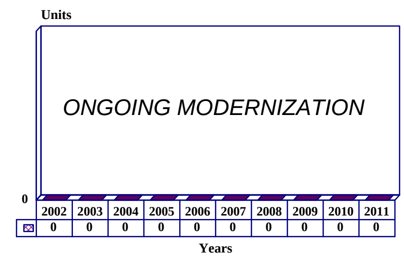
ASDE-3 - Archived 08/2003

Outlook

- Installations complete, test and evaluation nearing completion
- AMASS traffic management system add-on had development and budget problems
- First AMASS systems commissioned, with plans to have all operational by the end of 2002

10 Year Unit Production Forecast
2002 - 2011



Orientation

Description. Airport Surface Detection Equipment (ASDE-3). Airport Movement Area Safety System (AMASS) automation enhancement.

Sponsor
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Status. In production, installations under way, ongoing logistics support.

Total Produced. 40 ASDE-3 radars have been produced and installed at the 34 busiest airports and one at Andrews AFB, Maryland. AMASS units are being added to these sites.

Application. Airport surface-traffic detection and tracking, conflict/incursion warning. Planned for 34 airports, with two systems used for support and training at the Oklahoma City FAA facility.

Price Range. The price of a basic ASDE-3 installation was estimated in December 1993 to be US$4.5 million, up substantially from the previously documented US$2.9 million. Total F&E cost has been put at US$249.1 million.

Technical Data

	Metric	US
Dimensions		
Antenna		

Diameter	5.5 m	18 ft
Rotation	60 rpm	

Characteristics

Frequency	15/7 - 16.2 GHz (frequency hopping over 16 discrete selections)
MTBF	2,000 hr
MTTR	30 min
Output	Raw skin-paint video
Displays	8
Range scale selection	2,000-24,000 ft
Pre-set maps	100 stored

Design Features. The ASDE-3 was a significantly upgraded replacement for the ASDE-2 surface detection radar that had been installed at 12 airports. It was installed at several other US airports that had no surface radars. The system incorporated a variety of features that improved performance and made the radar compatible with the automated features planned for future surface traffic-control systems, such as AMASS (Airport Movement Area Safety System). AMASS was planned to combine ASDE-3 outputs with ASR and SSR inputs.

The system operates at very small pulse widths and high antenna rotation rates to discriminate small targets. For successful operation, the radar must be able to distinguish slow-moving or non-moving targets from background clutter. This major software challenge was at the heart of some of the design delays. Useful, reliable processing algorithms were very difficult to produce and system software eventually grew to 93,000 lines of code.

The antenna reflector is composed of layers of fiberglass and honeycombed aluminum. Designers developed a new design and bonding process to overcome delamination problems discovered during evaluation of the first system at Pittsburgh. Since the antenna is typically installed on the roof of the control tower, a belt drive system was used to ensure quiet operation.

The ASDE-3 uses dual transmitter/receiver systems; one is operating while the other is in a ready/standby mode. The transmitters are automatically switched in the event a fault is detected by the BITE system.

Bad weather penetration and reduced false-target reports are achieved by using a frequency-agile TWT transmitter and microprocessor-controlled receiver that can establish different signal threshold levels for runways, taxiways, and grassy areas. Automatic adjustment of receiver gain to match prevailing weather conditions uses reflectors at select locations around the airfield to provide known signal patterns and standardized returns for setting the gain baseline.

The display system has a provision for up to eight independent channels capable of driving three displays. Each channel is controlled separately. The operator can establish three windows on the display with zoom, offset, and rotation capabilities.

Airport Movement Area Safety System. AMASS is being added to all ASDE-3 installations to provide an automated runway incursion monitoring capability, including audible and visual alerts for over 500 potentially hazardous conditions in airport surface and approach operations.

The AMASS system also imports data from Airport Surveillance Radar (ASR) and ARTS III systems, using specialized processing algorithms to monitor aircraft on the ground, as well as those approaching/leaving the airport.

AMASS receives data from the ASDE-3 via direct cable connection and uses it to determine the position, direction, and speed of aircraft or vehicles in the airport movement area on the ground and up to 200 feet above it. A device called a terminal automation interface unit (TAIU) allows AMASS to interface with the ASR-9 and ARTS equipment.

The ASR-9 Surveillance Communications Interface Processor (SCIP) communicates data about position, direction, and speed of aircraft in the terminal area to the TAIU. The ARTS communicates flight plan data to the TAIU. From these inputs, the TAIU generates a target report that includes the position of each aircraft and the predicted runway assignment for each landing aircraft. This target report is sent to AMASS via a modem.

AMASS processes all of these data with software algorithms to predict any potential runway hazards. It also generates an overlay to the ASDE-3 display to provide controllers with a visual alert if a potentially hazardous condition exists. It highlights the aircraft involved and generates a text warning on the display, coupled with a audible voice alert.

Operational Characteristics. The ASDE-3 radar scans the surface of an airport to detect aircraft and ground vehicles. Traffic on the surface of many airports is too heavy to rely only on visual observation, even in good weather, to detect potential conflicts or runway incursions that could result in an accident. Initial program emphasis was to prevent unwanted or hazardous incursions onto runways. Future plans, however, include using ASDE-3-generated video for ground traffic management schemes. The radar has demonstrated its ability to provide better target data in poor weather conditions, especially in rain, than the ASDE-2. It was designed to be more user-friendly and reliable than the older equipment.

The system uses a television-like display for tower controllers. A zoom capability makes it possible to look at selected areas more closely. This capability was restricted in initial systems, as designers and the FAA continued to work on overcoming target splitting problems discovered when these systems were being set up to become operational.

The ASDE-3 has a built-in capability to provide radar data for other surface traffic control programs currently in development, such as AMASS.

AMASS identifies potential collisions between taxiing, departing, and landing aircraft on the same or intersecting runways, and reports improper location and travel direction on runways and taxiways. It also provides conflict alerts to tower controllers.

AMASS is configurable for each airport. Thousands of site-specific parameters are generated and applied to a set of generic operational situations to perform the safety checks. These generic operational situations are categorized into single- and multiple-track situations.

Single-track warning situations involve an aircraft or vehicle violating a safety rule. For example, each taxiway or runway is assigned a normal direction for a particular operational configuration. If a pilot steers incorrectly in the opposite direction, a caution indication is provided to the controller to call attention to a potentially dangerous situation or incursion.

Multiple-track warning situations involve two aircraft or vehicles that are on a possible collision course. Alerts are only issued if one of the two aircraft being analyzed is moving at a high rate of speed or, in the case of an aircraft, determined to be in a landing, arrival, or departure movement profile.

Variants/Upgrades

New slip rings were installed at 30 sites, and cartridge bearing specifications were updated. Four bearing cartridges have been repaired.

A service-life extension program to upgrade system microprocessors was begun in 2001, and planners will procure and install 40 new ASDE-3 displays in 2002.

Airport Surface Traffic Automation (ASTA). In a series of *Commerce Business Daily* announcements, the FAA announced that it was forming an ASTA FAA/Industry Technical Interchange Group (ATIG) whose purpose would be to enlist early industry involvement in the assessment and development of technical solutions to improve airport surface traffic operations and help prevent runway incursions.

The ASTA solution could be installed at airports that will eventually be equipped with ASDE-3/AMASS systems. ASTA would combine differential GPS and other surface sensors with a surveillance datalink, and display target location with alphanumeric data tags, process track data through safety logic, and generate aural and visual alerts to the controller. It will also drive the runway status lights that provide safety alerts for pilots.

The first ATIG meeting was held in June 1993, in Washington, DC, to discuss the draft specification. Follow-on meetings were also held.

Airport Surface Target Identification System (ATIDS). The FAA is working on the development of a system that will positively identify aircraft as unique targets. It is being tested at the Atlanta Hartsfield Airport in conjunction with the ASDE-3/AMASS system there.

The multilateration, processing, and display components of the ASDE-X system may be considered for upgrading ASDE-3/AMASS sites.

ASDE 3 Antenna

Source: FAA

Program Review

Background. There have been a significant number of fatal crashes that may have been prevented had controllers had a better picture of ground traffic.

Accidents at Tenerife (Canary Islands), Madrid, Atlanta, Detroit, and Los Angeles are obvious examples. There were over 322 runway incursions recorded in 1999, including aircraft-to-aircraft collisions, as well as collisions between aircraft and ground vehicles. In January and February 2001, there were 152 incursions.

The original ASDE-2 radar could do little more than provide a radar map of the airport and locate aircraft and ground vehicles on the runways and taxiways. Poor reliability and maintainability, weak video presentations, and a near-total inability to operate in moderate to heavy rain made these 30-year-old systems unsatisfactory. Twelve were in use at major US airports.

An increase in traffic moving about major airports has made it necessary to develop a more sophisticated system for monitoring surface movement and alerting traffic controllers to pending trouble while it could still be prevented. This generated the ASDE-3 requirement.

Norden Systems began developing the new airport sensor in 1985, but there was a succession of problems. Planners grossly underestimated the amount of time it would take to develop the advanced software, and at the same time, the FAA changed many of the requirements ASDE-3 had to meet.

In 1986, officials decided that the ASDE-3 would not be installed on the old ASDE-2 steel pedestals and that new pedestals had to be made from aluminum. This made it necessary to re-engineer the installation. The FAA also required a menu-driven display for controllers, further complicating the software development and increasing the cost by US$277,000.

During field testing of the first unit in Pittsburgh in 1990/91, problems developed. The antenna began to delaminate, due to the mechanical stress of 60-rpm operation and the heat caused by de-icing equipment. Designers developed a new antenna design and bonding process to eliminate the delamination. This caused a 19-month delay.

Other problems followed. The system display began to "split" targets when a controller used the zoom feature. Single targets, especially long-fuselage aircraft, broke into two or more targets in this presentation mode. The splitting was found to be caused by characteristics of the very high definition display.

Although the splitting problem was not unknown, engineers did not know whether it was a natural phenomenon or caused by the ASDE-3 software. Splits were not noticeable in the ASDE-2 because it did not have a zoom feature. Estimates to correct the problem varied from two to four years, with a cost of US$0.5 to US$1.5 million. The FAA agreed to install ASDE-3s with the split problem because the overall performance improvement outweighed the inconvenience of not always being able to use the zoom feature.

In May 1993, the FAA discovered that controllers at the Pittsburgh site could make inadvertent keyboard entries and shut down the radar display during routine operation. A software change cost US$200,000 and required several months to complete.

Also in 1993, Congress directed the FAA to procure 11 additional radars at the cost of US$49.5 million. But after delays in preparing a contract, the ASDE-3 production line was closed before the FAA could contract the additional systems. As a result, per-unit costs increased, and the FAA could only afford seven additional radars. A production award for the seven units was made in September 1993, in a contract valued at US$47 million.

The first ASDE-3 went into operation at the Seattle-Tacoma International Airport in November 1993, seven months later than planned. Technical problems at the Pittsburgh International Airport installation prevented that site from being the first to be commissioned.

Installation problems caused delays at eight or nine sites where new towers had to be built or the radar relocated. Technicians servicing the radar were coming into contact with cadmium dust from the antenna pedestal, and health concerns prompted the FAA to stop using the radar, replace components that were made with cadmium, and develop new maintenance procedures. This added four months and a cost of US$200,000 to the program.

During testing in Atlanta, controllers discovered that the radar created "ghost targets" when energy from the radar reflected off buildings or other objects. This created a false target on the runway. Sometimes the target would be stationary and predictable; at other times it would move about the display. The FAA stated that it would take two to three years to come up with a solution, and that the radar would be deployed even with the problem. The National Air Traffic Controllers Association (NATCA) stated that additional ASDE-3s should not be commissioned until the issue had been fully explored.

Despite these experiences, the FAA announced that the program would be completed eight months earlier than previously estimated because of the reduction from 11 to seven additional systems. It was expected to install two systems per month.

In March 1996, Northrop Grumman announced that it had been awarded a US$5 million contract to provide the ASDE-3 to Singapore's Changi Airport. The installation would be done by a subcontractor to Phillips Singapore Ptc, Ltd. The radar would be known as the Enhanced Airport Surface Detection Equipment (EASDE). Norden would supply the displays and incursion/display processing system, along with a Thomson-CSF ASTRE-2000 radar.

In July 1996, the FAA announced that it would proceed into AMASS full-scale development. It was planned for installation at 34 operational airports and two support sites. The existing contract was modified to procure three full-scale development systems. This followed the validation that runway-incursion warning could be automated. A contract for production of 36 AMASS systems was awarded in 1998. Full-scale development AMASS units were delivered to the airports at Detroit, Michigan, and at St. Louis, Missouri.

Development and IOT&E testing was completed in 2001. The 40th system was delivered in 2001 with plans for all systems to be fully operational in 2003. On May 29, 2001, the FAA announced that it would begin using AMASS at all of the airports with operational ASDE-3 radars. All systems were planned to be in operation by the end of 2002; but a variety of testing and program problems delayed the program. Officials hope to have systems commissioned by November 2002.

<u>ASDE-3 Systems</u>. A total of 40 FAA systems were contracted to be installed: 34 at major commercial airports, two at FAA facilities and one at a USAF base.

Site Location	**Delivery date**	**Commissioning date**
FAA Academy [a]	NA	NA
FAA Technical Center [b]	NA	NA
Pittsburgh	December 1989	June 1996
San Francisco	November 1991	October 1995
Dallas/Fort Worth	February 1992	March 1995
Philadelphia	February 1992	March 1996
Los Angeles [c]	August 1992	April 1995
Detroit	August 1992	December 1994
Cleveland	August 1992	December 1994
Boston	August 1992	March 1995
Portland	August 1992	December 1994
Atlanta	September 1992	January 1995
Seattle	September 1992	December 1993
Los Angeles [c]	February 1993	February 1995
Denver (DIA) [c][d]	March 1993	May 1995
St. Louis	December 1993	January 1995

Site Location	Delivery date	Commissioning date
Denver (DIA)	December 1993	October 1995
New York-Kennedy	January 1994	February 1995
Minneapolis	July 1994	March 1995
Anchorage	August 1994	October 1995
New Orleans	October 1994	September 1995
Baltimore	November 1994	June 1995
Kansas City	December 1994	May 1995
Miami	February 1995	November 1996
Houston #1[c]	February 1995	August 1995
Memphis	June 1995	December 1997
Chicago	June 1995	April 1996
Houston [c]	August 1996	July 1997
Charlotte [e]	September 1999	December 1999
Raleigh-Durham (equipment redirected to Dallas-Ft. Worth)		
Reagan Washington National[f]	February 1996	November 1999
Cincinnati [e]	October 1995	September 1996
Dulles [e]	May 1997	February 1998
Louisville	August 1998	May 1999
Salt Lake City	1997	1999
San Diego [e]	November 1995	November 1996
Dallas-Ft. Worth (dual facility)	November 1996	February 1998
Orlando (equipment redirected to Dallas-Ft. Worth)		
Andrews AFB	January 1998	February 1999
Orange County (equipment redirected to Dallas-Ft. Worth)		
Tampa (equipment redirected to Dallas-Ft. Worth)		
New York-Laguardia	June 1999	December 1999
Newark	June 1998	May 1999

[a] FAA training/field support/depot support facility.
[b] R&D system for runway incursion.
[c] Dual sensor facilities.
[d] Second system was procured in FY93.
[e] FY93 congressionally mandated sites.
[f] The radar was removed in 2000 and moved to Charlotte, North Carolina.

The FY01 transportation included an increase of US$2.5 million, bringing the amount appropriated to US$4.0 million. Of the additional funding, US$500,000 is to be used only for the FAA to conduct a test and evaluation of roll-ring technology for the current ASDE system. The roll-ring technology would replace the current slip rings, reducing the need for periodic maintenance of the slip rings and attendant down time of the radar. The FAA directed a side-by-side comparison of slip rings and roll rings to verify operating life within a test period of five months.

The rest of the increase would be used to address delays in commissioning of the ASDE-3 and AMASS systems at Washington Reagan National Airport. The original plan was to commission the ASDE-3 in November 1999 and the AMASS in March 2000. The FAA was scheduled to report to the House and Senate Appropriations Committees by August 2001.

The FAA determined that the physical layout of the airport made it impossible to ever clear the line of sight of the radar while mounted on top of the control tower.

The two most likely new locations each had problems. One would be too close to existing ASR radars and the other would block the view of the Washington skyline from the terminal. Installation of one of the new ASDE-X radars was being considered as a solution.

Funding

US FUNDING

	FY01		FY02		FY03(Req)		FY04(Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
Facilities & Equipment (FAA)								
Airport Surface Detection Equipment								
ASDE	-	5.6	-	10.0	-	4.0*	-	5.0
AMASS	-	9.8	-	18.2	-	20.6	-	12.6

*__NOTE:__ Congress added US$2.5 million to the original FAA request.

All $ are in millions.

Recent Contracts

Contract information is not currently available.

Timetable

Month	Year	Major Development
	1985	Initial ASDE-3 contract
	1988	Contract options exercised, added three systems
Mar	1988	Original implementation plan
Dec	1989	First ASDE-3 installed at Pittsburgh International Airport
Apr	1990	Original completion planned
Dec	1991	Design qualification and testing completed at Pittsburgh
Mar	1992	First production system delivered
Sep	1993	Add-on contract for seven systems
May	1995	First ASDE-3 commissioned at Pittsburgh International Airport
	1995	Conducted AMASS full-scale development, AMASS solicitation for SFO
1Q	1996	AMASS delivered to SFO
Apr	1996	Singapore contracts for EASDE
	1996	Complete AMASS FSD, CDR
1Q	1997	Award AMASS LRIP
3Q	1997	Deliver AMASS to T&E site
1Q	1998	Complete AMASS IOT&E
mid	1999	Select low-cost ASDE for full-scale development (planned)
Oct	1999	First AMASS implementation
2Q	FY99	AMASS IOC (planned)
Nov	1999	Last ASDE-3 delivered, last Operational Readiness Demonstration (ORD), first AMASS ORD planned
Mar	2000	Last AMASS delivered
	2000	Complete transmitter modification procurement
	2001	Complete delivery of 40 systems, microprocessor upgrade begun, last AMASS system delivered, first AMASS available
End	FY00	FAA required by Congress to have one contract for production of low-cost ASDE system for deployment to high-priority airports
May	2001	FAA announced it would begin AMASS operation
Jun	2001	San Francisco AMASS commissioned
Nov	2002	Last AMASS system to be commissioned

Month	**Year**	**Major Development**
	2003	40 new ADSE-3 displays to be installed

Worldwide Distribution

This is a **US** program, but the ASDE-3 is being marketed worldwide. The ASDE-3 system has been proposed to possible international customers, including **Singapore** and **Malaysia**. There is interest from Asia, and the new **Hong Kong** Chek Lap airport will acquire at least one ASDE-3 radar.

Forecast Rationale

The ASDE-3 design took advantage of what was then new (1980s) data-processing technology to overcome the deficiencies of the older ground-traffic detection equipment and provide the inputs needed for automated traffic/incursion monitoring. ASDE-2 displays were hard to interpret - jitter problems affected the quality of its presentation, and performance was poor in light/ moderate rain. In moderate/heavy rain, the ASDE-2 could be next to useless, and poor weather conditions are when such a system is most needed.

Developing software that could reliably pick out very small, slow-moving targets from clutter was a major challenge for engineers that, when combined with FAA redesign requirements, delayed fielding of the system by three years.

Siting can be a problem, since it is difficult to find a high location on an airport with an unobstructed view of all the areas controllers need to monitor. The is why the ASDE-3 was removed from Washington Reagan National Airport. Putting the radar on top of existing air traffic control towers calls for strengthening the buildings, and can cause excessive noise for operators in the tower cab.

Technical problems plagued the system and limited full performance, but were not considered serious enough to delay taking advantage of the ASDE-3 improvements over the old radar. It did cause delays of up to nine months in the development effort and the FAA prevailed over the objections voiced by the NATCA and continued the installation and commissionings.

AMASS suffered ongoing software development problems. This was blamed in part on FAA requirements changes along the way. The program was ambitious, and some of the implementation flawed. Planners hope they have put these troubles behind them. This is important, because the emphasis on security is going to leave little money for trying to fix programs that were scheduled to have been completed.

A National Runway Safety Summit was convened in Washington, DC, in June 2000. The FAA and NTSB reportedly addressed ways to improve safety at the nation's busiest airports and expand protection to most terminals. This was in response to a steady increase in incursions and other problems faced around the nation.

The summit supposedly focused on the recommendations, actions, and results of the FAA's nine regional workshops, a human factors symposium, and other industry-wide runway safety activities.

Ten-Year Outlook

No further production expected, upgrades continue.

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