

Automatic Dependent Surveillance-Broadcast regulations will be mandated on commercial aircraft and may eventually replace ageing radar technology. It is expected that 9,000 aircraft will need to become ADS-B compliant when the new regulations are put into effect next year.

# Time running out for ADS-B Out compliance

In fewer than 10 months, on 1st January 2020, a major aircraft avionics mandate will come into force in United States (US) airspace, followed by Europe on 7th of June 2020. What this means for operators and aircraft, in particular those in Europe, is examined.

Mandates to equip aircraft with Automatic Dependent Surveillance-Broadcast (ADS-B) equipment are being implemented worldwide, affecting almost all airline operators. Since 2010, the US and Europe have issued mandates for ADS-B Out. The ADS system currently supplements radar, and may eventually replace it for aircraft surveillance. The 'Out' version functions on 1090MHz via a suitable transponder.

## Deadlines

Since 2010, the Federal Aviation Administration (FAA) set a 1st January 2020 deadline for US operators, regardless of country of registration, to become ADS-B Out compliant. The FAA has mandated ADS-B Out for all classes of airspace, including A Class, which is fully controlled airspace used around commercial airports and airways.

In the US, ADS-B is an integral component of the NextGen national airspace strategy for upgrading and enhancing air traffic control (ATC) and air traffic management (ATM). The same applies to Europe's Single European Skies ATM Research (SESAR).

The mandate in the EU was preceded by a forward fit that required ADS-B Out equipment on all new-built aircraft with a maximum take-off weight (MTOW) greater than 5,700 kg and maximum cruise speed over 250 knots from 8th June 2016.

In the near future, most of the continental controlled airspace throughout the world will be using ADS-

B as the primary means of surveillance over land operations. Aircraft must be within direct, line-of-sight range of dedicated ground-based receivers. ADS-B Out is already mandated in some parts of the world, such as Canada, Australia and areas of the Asia Pacific.

For the new mandates, a more accurate version of the present ADS-B Out is mandated by the authorities, and aircraft will need to be appropriately equipped when operating in US and European airspace.

Other mandates have been issued by aviation authorities that include the Civil Aviation Authority of China (CAAC), with a deadline of 1st July 2019. With the deadlines fast approaching, there is a considerable retrofit market, since many aircraft are still non-compliant. The retrofit plans show that some airlines will still not be compliant by 2020.

SESAR's July 2018 workshop showed that only 20% of the region's in-service commercial aircraft fleet was equipped to comply with the mandate. Retrofits are the main issue, especially for many smaller operators or regionals operating legacy aircraft.

ADS-B has been undergoing deployment since 2000, however. The technology has proven attractive in remote areas where previously there was no form of surveillance. ADS-B supports radar-like separation modes, enabling an increase in airspace capacity. Many countries have assessed and implemented ADS-B independently for airport surface or airspace surveillance. ADS-B is capable of supporting the most stringent ATC separation standards.

ADS-B Out is an advanced surveillance radio frequency (RF) datalink technology to support Air Traffic Control (ATC) in radar airspace and to provide ATC-like surveillance in non-radar airspace. ADS-B provides ATC surveillance in non-radar areas where the

installation of radar could not be justified because of small traffic volumes.

ADS-B can be combined with satellite-based positioning with a datalink to continuously and automatically broadcast location updates and intents, instead of just responding to interrogations by ground stations. ADS-B improves safety by making aircraft visible in real time to ATC and to other ADS-B-equipped aircraft. This provides position and velocity data transmitted every second. ADS-B also provides the data infrastructure for inexpensive flight tracking.

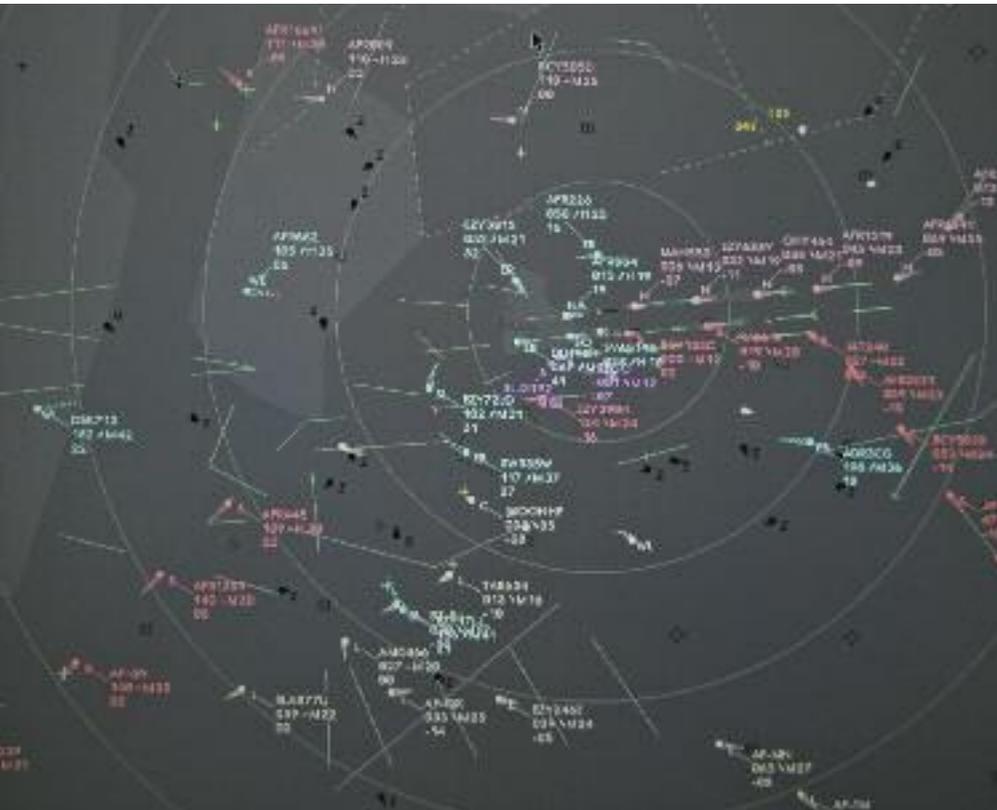
The system transmits automatically, and uses data from the aircraft's satellite navigation system. It broadcasts the information to any equipment that can receive the signal. The content of the signal is not encrypted. ADS-B Out transmits parameters, such as position, track and ground speed, via a datalink and at one-second intervals, without any request from ATC.

The 1090 extended squitter (ES) has been chosen as the global datalink technology to ensure global interoperability. The information is more accurate than current radar-based systems, allowing aircraft separation with improved precision and timing.

## Regulations in Europe

Europe had extended its ADS-B Out compliance deadline by three years to 2020, due to delays in certification and availability of required equipment, as well as industrial capacity constraints for equipping aircraft and synchronisation with the US, among other reasons.

All commercial aircraft in Europe flying an instrument flight rules (IFR) mission in European airspace will have to be compliant with the regulation either with forward fit for in-production aircraft from 8th June 2016, or retrofits



completed by 7th June 2020. This means a large fleet needs to be retrofitted.

Installation of ADS-B is considered to be a Supplemental Type Certificate (STC) or major change. All operators have to ensure that by 7th June 2020 all their aircraft with a certificate of airworthiness first issued before 8th June 2016 are equipped.

## Technology

Mode-S transponders automatically send self-generated, periodic burst transmissions called ‘squitters’. Squitter refers to random pulses. The information sent in these burst transmissions includes an aircraft’s identification, GPS position, projected trajectory and navigation system status to allow controllers to accurately track the aircraft.

There are three different datalink technologies for ADS-B Out: a 1090MHz extended squitter Mode S transponder, selected as the initial link for European airspace; a VDL Mode 4 (very high speed datalink) VHF Datalink Mode 4; and a Universal Access Transceiver (UAT), which is only mandated for general aviation in the USA: the first two transponders transmit on 1090MHz and the UAT operates on 978MHz.

By the late 1990s, Mode S Selective address transponders became available to communicate more versatile data. More recently, Mode S type transmissions have been augmented to 112-bit formats that are spontaneously transmitted by the aircraft once per second. The data portion of an ADS-B message consists of aircraft ID, surface position, airborne

position (with baro altitude), airborne velocities, and airborne position (with GNSS height).

ADS-B In, not mandated, is where the data can be received by other aircraft to provide situational awareness, and allow potential self-separation. This information is displayed on the flight deck via electronic flight bags, TCAS or a dedicated display.

## Aircraft equipment

The essential elements are a position source, typically Global Navigation Satellite Sensor (GNSS/GPS), and an ATC-capable transponder to meet the accuracy requirements. An STC also has to be issued. The most commonly used datalink operates at 1090MHz, which is essentially a modified Mode S transponder.

The original standard of 1090 ES was codified in DO-260, and was also known as ‘version 0’. This was later deemed inadequate, and was updated to DO-260A and the applicable edition DO-260B. The DO-260B version, known as ‘version 2’, is considered mature enough for areas like Europe and the US.

ADS-B capability is achieved by adding two GNSS receivers to the aircraft, and connecting them to the DO-260B transponders.

ADS-B Out compliance also requires the installation of line-replaceable units (LRUs).

A complex retrofit installation is required. The European mandate shows that the retrofit is more complex than a simple software update of the

ADS-B provides inexpensive aircraft surveillance. It has the capability to transmit position, track and velocity every second via a datalink without any request from ATC.

transponder. The additional equipment required includes dual GPS receivers.

Airbus says there is a four-month lead time on its ADS-B Out upgrade kits for the A320 fleet. There are suggestions that the waiting time for equipment to be brought up to standard is three to four months. It is not about maintenance and repair organisation (MRO) space being limited; instead there is a lack of manpower. The heavy maintenance sector is seeking labour, and ADS-B Out retrofit work can be expected to go into 2020.

While airlines have planned to cope with new aircraft entering service, the situation is different for retrofit plans. Major airlines foresee difficulties in retrofitting the large number of medium- and short-haul aircraft.

## Fleet status

It has been estimated that more than 9,000 aircraft globally need to be compliant by 2020.

Many older aircraft are not fulfilling the quality requirements defined in the EU Regulation. The European Commission confirmed in July 2018 it will keep the mandate in 2020, and individual extensions will be hard to come by.

Of 3,108 aircraft with 35 European airlines, only about 600 are equipped and certified with the appropriate DO-260B transponder. It is assumed that this percentage is a good representation of the overall European fleet. This capability largely comprises forward-fit installations. The retrofit plans reported by airlines show few are planning to install the DO-260B transponder to be compliant by 2020. It should be noted that many aircraft can transmit ADS-B, since they are equipped with DO-260 and -260A transponders, but they are not fulfilling the quality requirements defined in the regulation for congested terminal areas.

Airbus aircraft equipage rate statistics (about 6,000 aircraft) matched the SESAR survey in April 2018 at 20-21% of short-haul aircraft. About 31% of A330s/A340s are equipped with the correct DO-260B transponder.

For long-haul aircraft, 17% of the fleet is equipped, while for the short- and medium-haul aircraft, 21% are compliant with the regulation. Data shows that only

15% of regional carriers are compliant.

Most airlines are planning to retrofit their long-haul aircraft to comply with the regulation. Major airlines foresee difficulties retrofitting their short- and medium-haul fleets due to the large number of aircraft that need to be modified.

A significant number of aircraft in Europe may not meet the June 2020 deadline. According to Alexander Krause, product sales manager for avionics and flightdeck solutions at Lufthansa Technik, the latest Eurocontrol survey of the ADS-B implementation plan shows that more than 7,750 aircraft are affected by the mandate, and 15-25% will not be compliant in time. The upgrade rate should be 200 aircraft per month.

Terry Flaishans, president of Aviation Communication & Surveillance Systems (ACSS), in Phoenix reports that some 3,300 aircraft operated by US carriers have been retrofitted out of an estimated 5,000-6,000 aircraft.

### Expense and retrofit slots

ADS-B ground stations are cheaper to install and operate than radar systems used by ATC. Substantial investments are required for each aircraft for avionic equipment, downtime and MRO slots.

Commercial airline representations in

2018 predict their expense of removing aircraft from operation and upgrading them at a cost of \$60,000-530,000 per aircraft. For example, Fokker Services has estimated that western-built aircraft operating under Russian AOCs would cost \$50,000-100,000. ADS B Out is also a major change, so an STC is required.

Aircraft with all the hardware and software provisions can be upgraded to be ADS-B Out compliant during an overnight check. Aircraft with some or none of the provisions completed require a dedicated shop visit included in a significant maintenance event. This can take about 100 man-hours (MH) to complete.

For leased aircraft, lease documents usually require the operator to comply with mandated modifications. Lessors should review the terms of the lease, particularly if the aircraft will be returned before 1st January or 7th June 2020.

Aircraft without the upgrade will become more difficult to transfer after the deadline. Non-compliant aircraft will probably suffer a decrease in residual value.

### Regional activity

Operators will be affected if they fly in any of these regions: Australia, Canada, Europe, Hong Kong, Singapore,

USA, Taiwan and Vietnam.

Most European airlines only have firm plans to purchase ADS-B upgrades for their long-haul aircraft that fly to other regions where ADS-B equipage is already required, such as Australia, or where upcoming deadlines exist.

US aircraft equipped with (DO-260B) 1090 ES transponders are authorised to fly at all altitudes in the US.

Other nations, in general, follow the lead of the International Civil Aviation Organization's (ICAO's) Global Plan Initiatives and Aviation System Block Upgrade (ASBU). Initially, ADS-B is required on certain airway segments.

Australia mandated a phased requirement for all IFR aircraft above 30,000 feet to be equipped with ADS-B since 2nd February 2017.

Canada provides ADS-B air traffic services over the Hudson Bay, Greenland and specific airspace over the Atlantic Ocean. Canada has yet to publish a full coverage ADS-B mandate.

China has a three-phase plan for implementing DO-260 ADS-B. The CAAC provided ADS-B Out service in some core airspace and routes since the end of 2017. ADS-B Out will be promoted and evaluated for safety aspects, from 2017 to 2020. A comprehensive nationwide ADS-B service is planned to be constructed from 2020



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to 2025.

ADS-B coverage is under way in other Asia Pacific nations, including Hong Kong, India, Indonesia, Japan, Malaysia, New Zealand, Philippines, Singapore, Taiwan, Thailand and Vietnam.

The Russian Federation is one of the few countries to widely use the VDL mode 4 option for ADS-B, particularly for ground stations. Both technologies including 1090 ES are being deployed in the Moscow and St. Petersburg areas and in the far north of Russia.

## Equipment manufacturers

The key manufacturers for 1090 ES are Honeywell, L-3, Esterline, Rockwell Collins, Thales and Garmin.

Rockwell Collins provides ADS-B transponders for all Airbus and Boeing types, as well as for ATR turboprops, the Bombardier C-Series and CRJ-family.

Rockwell Collins is expecting a surge in retrofit demand as the deadline approaches. “We have already seen the numbers trend up significantly in the past 12 months,” says Mike McDowell, marketing manager. “The large commercial carriers were already well-prepared. Now, we are starting to see the smaller operators with 20 or fewer aircraft, come forward. We have ramped up our transponder production rate to accommodate a surge.”

ACSS, a Thales/L3 Joint venture, is offering its NXT series -700 and -800 transponders, including NXT-600 forward-fitted to ATR-600 and Q400.

ACSS anticipated a last-minute rush

to equip aircraft, and so built up its transponder inventory. The more complex ACSS ‘SafeRoute’ application includes ADS-B In, which is displayed on electronic flight bags used by UPS and American Airlines A321s and A330s.

Honeywell manufactures ADS-B transponders for all current Airbus types, including the A350; and the 737 family, 757, 767 and 777 families.

All of this translates as original equipment manufacturer (OEM) certified DO-260B solutions for the A320 family and A330, through the latest ACSS XS-950 transponders or NXT-800, Rockwell Collins TPR-901 and Honeywell TRA-100B. On Boeing aircraft it is via ACSS NXT-800 or XS-950, Rockwell Collins TPR-901 and Honeywell TRA-100B. For regional aircraft, the OEM-certified solution is the NXT-600 for the ATR72-600 and Bombardier Q400.

## ADS-Contract

ADS-C is a specific version of Out. The surveillance only reports 4D position and aircraft identification in response to contracted requests issued by the Air Traffic/Navigation Service provider (ANSP). The contract identifies the type of airborne data, which can then be used by the ANSP for estimating and predicting aircraft position.

ADS-C is also a system for automatically sending position and other flight parameter reports at pre-defined or time-limited intervals, typically 30 or 15 minutes, on long-distance operations for trans-oceanic flights and operations over

*Typically a Global Navigation Satellite Sensor and an ATC-capable transponders are needed to meet the accuracy requirements. Most common datalinks operate at 1090MHz, which is essentially a modified Mode S transponder.*

polar and desert regions. ADS-C transmissions are on a one-to-one (not broadcast) transmission made via satcom or HF Digital Link.

ADS-C is essentially a communications technology that has been adapted for aircraft tracking. In its current form, it cannot be compared directly to ADS-B and cannot be officially used for ATS surveillance. SatCom provider Inmarsat offers this service and Iridium’s system also supports ADS-C services. The unexplained disappearance of MH370 over the Indian Ocean in 2014 provided an additional impetus for the introduction of ADS-B over vast oceanic areas, culminating in a global scale implementation of a satellite-based variant of ADS-B.

ADS-C is presently the only ATC surveillance system available in oceanic airspace and some remote regions. Unlike ADS-B Out, ADS-C position reports are not broadcast continuously, and so are not used to provide a live surveillance feed. The frequency of ADS-C transmissions is determined by one of three contract types between the relevant ANSP and the aircraft. These are current, periodic or event-based contracts. ADS-C transmissions are generated when an on-board position source interfaces with an aircraft’s flight management computer (FMS).

## Space-based infrastructure

A new technology is emerging in the form of space-based ADS-B Out. A big step forward is the reception by satellites of the ADS-B signal. Aireon is working on space-based ADS-B Out with the Iridium low orbit satellite network. ATC uses satellite surveillance-based separation standards over water and spare areas that radar cannot cover. ATC uses larger procedural separation standard on oceanic and remote areas. The system only receives ADS-B Out on aircraft broadcasting on the 1090MHz frequency. Eleven ANSPs with oceanic or remote area borders have signed up as launch customers for this service. Aireon is placing ADS-B receivers in the next Iridium NEXT satellites. The first operational trials are due to start in early 2019. [AC](#)

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