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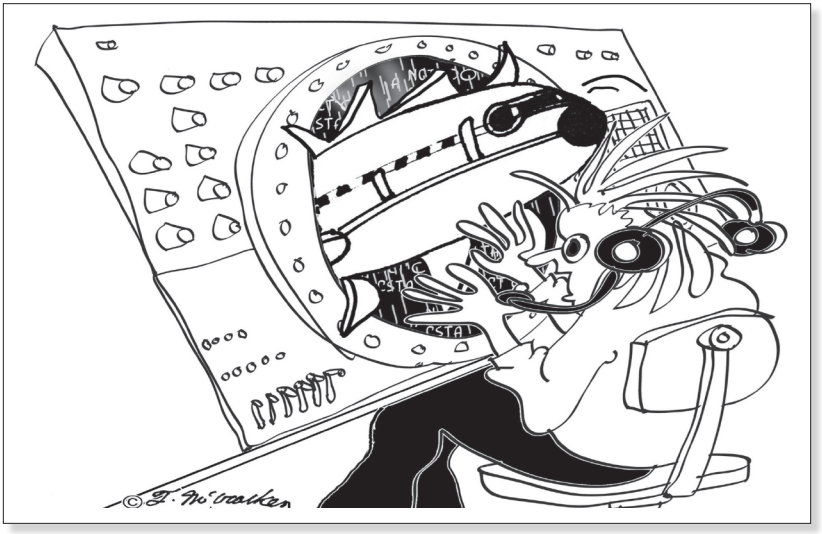
WHAT THE AIR TRAFFIC CONTROLLER SEES

FAA ATC use of ADS-B is a frequent Hangar Talk subject full of speculation and stories some true some not.

There are multiple ATC systems and multiple operational configurations and variations in the training received by controllers. A full discussion is beyond the scope of this book. Here we provide an overview.

SUMMARY

- **The Controller's Job**
  The controller's job is to separate traffic and the controller does not care where the data comes from. If the controller has a valid track it will be used with no regard to the source.
- **Special Treatment for ADS-B Aircraft**
  No special treatment or credit is given to ADS-B equipped aircraft except in areas with no radar or radar failure the aircraft may be able to get surveillance and routing not available to an aircraft not ADS-B equipped.
- **Controller's Knowledge of ADS-B**
  The controller is not trained or intended to check your ADS-B performance or inform you of your ADS-B performance
- **ATC Display Systems**
  There are multiple ATC Computer system implementations (STARS and ERAM) and there operation and displays are not the same.
- **Can the Controller See Your N#**
  The controller can, in many cases see, select to see, or determine the N# of a VFR ADS-B equipped aircraft displayed on their screen even if they are not tracking or talking to the aircraft. Sometimes the function is turned off and sometimes the controller is not trained to use all these features.
- **Enforcement**
  The controller's job is traffic separation not FAR enforcement. It is true that if an airspace violation is noticed it may be forwarded up the line for enforcement consideration. This is particularly true if the violation causes an automatic separation alert which requires controller's immediate attention. Currently, the controller is not spending his time searching for aircraft that might inadvertently encroach on the edge of his airspace.



The ADS-B data stream is full of information but for Air Traffic Control purposes the controller needs just a simple target symbol of known accuracy and reliability on which to base aircraft separation. Non-compliant ADS-B data which can be determined non-compliant by the ground (Sil and/or SDA=0 or ADS-B NIC below required level) is not used.

There are variations in ATC radar systems and variations on the display that can be provided to the controller. The FAA for example has both terminal and en route surveillance systems and the operational and display capabilities are not identical. Most approach and en route systems have been upgraded to STARS (Standard Terminal Automation Replacement System) and ERAM (En Route Automation Modernization).

For the control and separation of air traffic the controller needs an accurate picture of aircraft location and altitude. In the past the controller would have available data from a single radar and perhaps have a choice of radars to display on his screen. This has grown to the ability to display a target developed from fused multiple radars (including WAM and ADSE-X) and now ADS-B data is also available.

In some cases a single source of data (a single radar or ADS-B only) can be displayed alone or the "fused" target, that is a target generated from multiple radar and ADS-B sources, can be displayed.

For example, an ATC display can display a "FUSED" target where radars, ADS-B and WAM data are combined to provide a simple single target display on the controller's display or the ATC display may be configured to use just one sensor such as a single radar and not be operated in the "FUSED" mode.

In general, these choices are not the controllers but are decided by the facility management and the controller may not know exactly what is making up the display he sees. Some options may be controller selectable by the controller. However, the controller may not be familiar with display choices that are available at operational controller positions as they are not normally used.

The two primary systems we encounter are STARS (approach controls) and ERAM (enroute).

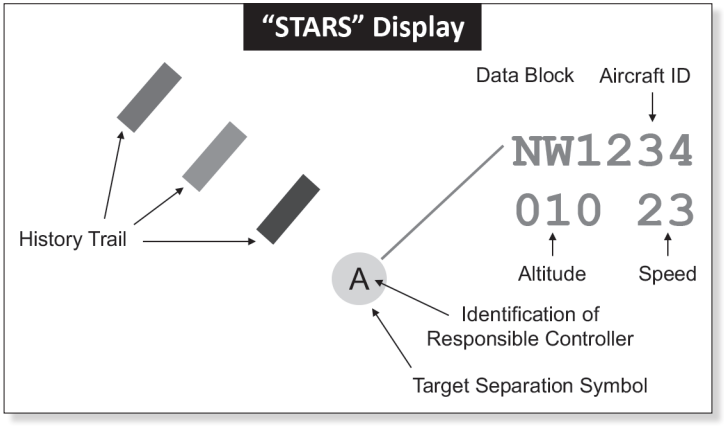
- Terminal Areas "TRACON"
  - Terminal Radar Approach Control
  - Often called Approach Control
  - Philadelphia Approach, Potomac Approach (Washington DC area), New York Approach, etc.
  - ADS-B implemented as part of "STARS" system
    - STARS "Standard Terminal Automation Replacement System"
- En route Areas
  - Center Control Areas
    - New York Center, Washington Center, etc.
  - ADS-B Implemented as part of "ERAM' system
    - ERAM "En route Automation Modernization"

Data Block on the ATC Display

The STARS and ERAM systems are not identical. The controllers display will have a symbol for the target aircraft as well as a data block with information about the aircraft. The data block is generally generated automatically by the ATC computer, although, in some cases, the controller can manually add some information.

Typically, the data block will show the aircraft "Call Sign" (N # or Flight Id) which comes from the filed aircraft flight plan which is matched to the aircraft by the squawk code transmitted by the aircraft.

In the case of VFR aircraft squawking 1200 typically "VFR" will be displayed in the data block. The controller can assign a squawk code to the aircraft and can enter the aircraft N # to assign it to the squawk code in which case the N # will be displayed on the data block. Although the N #/ Flight ID is transmitted in the ADS-B data the N # or Flight ID are not always automatically derived or displayed from the ADS-B data. There are ATC



This drawing shows a typical ATC display with data block on a STARS terminal ATC display.

display selection options in some systems which will display the N # although this is not the general case.

The controller will know the display is satisfactory for providing surveillance by a lack of any indication on the screen that the display is unsuitable. Some of the alerts a controller may see on his display are "ISR" increased separation required between aircraft (5 nm instead of 3 nm for example) or "TRK" which means the target display accuracy is not satisfactory for use for aircraft separation. These indications are referenced to the target symbol which may be derived from a single or fused source (radars, ADS-B, etc).

The controller's display uses data from the filed flight plan such as N# (or sometimes entered by the controller for VFR aircraft) as opposed to using the data such as N#/Flight ID from the ADS-B data stream. In the case of a transponder only target there is only squawk code and altitude in the transponder data.

In some cases the system will detect and alert the controller if there is a mismatch between the aircraft transmitted Call Sign and data and data derived from the filed flight plan.

A full description of all procedures is beyond the scope of this book.

Controller Display with ADS-B Status Indicator Active

STARS and ERAM are different but both have available a mode that can show the ADS-B status of the target aircraft, but this mode is often turned off and many controllers may not be familiar with how to activate this mode. See the figures for examples of the STARS and ERAM display indications for ADS-B functionality.

If ATC is operating in "FUSION" mode which is typical the controller would not know (or be able to tell) if your transponder is not working. If your ADS-B is working properly the ATC display will not change if your transponder failed. If the ATC display was in "single sensor mode" and using radar only then a transponder failure would result in the loss of data on the ATC screen, however, primary radar data (reflected RF signal only) would still be available to the controller.

Can the Controller Tell if You are ADS-B or Transponder Equipped?

As with many things the answer is sometimes. The controller may not have all display capabilities (shown above) activated and the target may not give any indication of the source.

In the case where you have a valid ADS-B OUT the controller, if ATC is in fusion mode using the combined ADS-B/Transponder fused target, cannot tell if your transponder is working. There is no display available that shows if the fused target has transponder return as part of the data source. If the ATC radar is in single sensor mode and a Radar only is selected, then the controller would not see a target unless you were transponder equipped. If you do not show on the screen when the radar is using radar data only the assumption is your transponder is not functional. Transponders and ADS-B are required to be on. If a transponder has failed, ATC using fused mode will not know. If the controller has the ADS-B status display option activated, they will be able to tell if your ADS-B is working. If ADS-B is working there is no other display that indicates the transponder status. The ADS-B status display may not be turned on by the controller as in general they do not need to know.

ADS-B Infrastructure "STARS"

What the FAA Controller sees on Radar "STARS"

- When in the "FUSION MODE" and ADS-B activated
- If ADS-B Equipped and System using ADS-B information the Data Block will indicate nothing special
- Controller can choose not to display ADS-B status and display will still look the same

When ADS-B display activated

- Filled Circle to the left of the Aircraft ID in line 1 of the existing data block means:
  - ADS-B Surveillance information is being used but the Aircraft is NOT equipped to transmit this information.

There may be an occasion where you might want to ask the controller to check your transponder or ADS-B if you have a suspicion something is not right.

If the ATC controller has the ADS-B indicators turned on they are able to tell you if they are seeing your ADS-B target. If they do not have the indicators on they will not know.

Transponders and ADS-B are required to be on. If a transponder has failed, ATC using fused mode will not know.

ADS-B Call Sign Mismatch to Filed Flight Plan

As discussed in other chapters the FAA policy is that the ADS-B transmitted Call Sign must match the Call Sign used in filing the flight plan and match the identification used with voice communications with ATC. A mismatch between the ADS-B transmitted call sign and the data from the flight plan in the ATC computer produces a mismatch alert to the controller which increases the controller workload. These alerts are sometimes disabled.

What Controller Sees with Transponder or ADS-B Failure or Unit Off or Removed for Repair

1090 ADS-B Systems

With 1090 systems the Transponder and ADS-B are one unit with one set of controls. Putting the transponder in "STAND BY" will in general stop the transmission of both the transponder and ADS-B. Although technically possible to design a system so that the transponder or ADS-B can be disabled separately this is not the usual case. In most 1090/ADS-B systems there is generally no way to disable just the ADS-B or just the transponder. There are failure modes that may affect just the ADS-B or Transponder; for example, a failure of the GPS will in many cases stop the ADS-B from transmitting but have no effect on the Transponder function.

UAT Systems

The UAT is more complicated because the squawk code must be the same as the Transponder squawk code and is generally obtained from the transponder automatically. Many

ADS-B systems obtain the squawk code and ident from the transponder by serial data or by listening to the transponder transmissions. Also, the altitude source for ADS-B and the transponder must be from the same source and in some cases the altitude is obtained from the transponder as contrasted with the altitude being obtained from the encoder directly.

So turning off an ADS-B UAT or an UAT ADS-B failure should not have any affect on the Transponder output.

However, if the transponder is turned off (or in some systems in standby also) the UAT may not have any squawk code or altitude information to transmit. Some UAT ADS-B units will stop transmitting with the transponder failed or off.

At the time of this writing ADS-B data with a missing squawk code is not sent to ATC at all by the ADS-B ground system and therefore will not show to the controller.

This means that in most UAT systems, a transponder failure or turning of the transponder will remove the ADS-B data from the controller and the aircraft will not be seen. There may be future changes by the FAA in the requirement for the squawk code to for the data to be seen by ATC but, as of now, this is the way it works.

In UAT systems which have a control head, such as the FreeFlight system, if the transponder is off or failed, the squawk code can be entered using the control head and in this case ATC would see the ADS-B only target.

Same Squawk Code for ADS-B and Transponder

If the ADS-B and the Transponder have different squawk codes, the ATC system can see two different targets and present a conflict alert to the controller. This is unlikely with a 1090 ADS-B OUT system where the transponder and ADS-B unit are one system. For UAT systems which must determine the squawk from the transponder there are more failure possibilities that must be considered.

Low Altitude Filtering and On Ground ADS-B Coverage

Most airports do not have ADS-B coverage at ground level. There are 35 high traffic airports where ADS-B coverage (called ground surface volumes)is provided at ground level and ADS-B data is incorporated in the ground radar system (ASDE-X).

Many other airports have ADS-B coverage at ground level or to a very low altitude. Some airports not included in the 35 ground surface volume airports have an ADS-B station located on the airport which gives coverage at ground level over much of the airport surface. Some of ATC towers at these airports have a radar display repeater off of a surrounding ATC approach radar system.

The FAA has the ability to filter low level targets from the ATC display to eliminate ground traffic from cluttering the ATC display. ATC can filter VFR traffic (typically below 200 feet) but also has the ability to selectively based on squawk code see traffic below 200 feet. Except at the 35 airports with ground coverage any aircraft that is reporting ON GROUND in the ADS-B data is not sent to ATC and is therefore not seen by ATC once actually on the ground.

In general low altitude filtering is not always used and ADS-B targets can be seen at very low altitude as long as the aircraft is within range of an ADS-B ground station.