Overview of Automatic Dependent Surveillance-Broadcast (ADS-B) Out
Module Objectives

• Definition of ADS-B
• Overview of ADS-B OUT
• ADS-B Messages
• Aircraft Systems
• ADS-B Performance and Compliance
Automatic Dependent Surveillance - Broadcast (ADS-B)

- **Automatic**
  - Periodically transmits information with no pilot or operator involvement required

- **Dependent**
  - Position and velocity vectors are derived from the Global Positioning System (GPS) or other suitable Navigation System (i.e., FMS)

- **Surveillance** -
  - A method of determining 3 dimensional position and identification of aircraft, vehicles, or other assets

- **Broadcast**
  - Transmitted information available to anyone with the appropriate receiving equipment

- **Satellite-based Cooperative Surveillance Technology**
- **Allows pilots and controllers to have a common picture of airspace**
- **Allows for common situational awareness to all equipped users of the airspace**
ADS-B “OUT”

ADS-B transmissions

GNSS Satellite constellation

visible sat = 12

GPS position

ATC Center

(multi-sensor) Surveillance Data Processing

ADS-B Station
ADS-B "IN" Overview

ADS-B "out" → ADS-B "in"
Requires in the aircraft:
- ADS-B receiver
- ADS-B data processing
- Cockpit Display

ADS-B transmissions

GNSS Satellite constellation
visible sat = 12

ATCO remains responsible for separation
**ADS-B Components**

**ADS-B OUT - airborne**
- Mode S Transponder
- Extended Squitter enabled

**ADS-B OUT - receiver**
- Antenna + Receiver
- Adapted Surveillance Processor
FAA ADS-B Receiver Systems
ADS-B Technologies

- 1090 MHz Extended Squitter (1090ES)
  - Implemented widely on commercial traffic
  - Initial carriage facilitated by European Mode S mandate and the FAA ADS-B OUT Final Rule publications
  - 1090 MHz Extended Squitter is the preferred International link
- UAT
  - UAT = Universal Access Transceiver at 978 MHz
  - Used in USA (mainly for General Aviation aircraft)
  - Regional implementations
- VDL Mode 4
  - VDL = VHF Digital Link, Mode 4
  - Regional implementation

* It is important to note that 1090 MHz is the internationally approved frequency
The ADS-B Out equipment is designed to transmit two different message sets:

- “Short Squitter” (also known as the Mode S Acquisition Squitter)
- Extended Squitter

Acquisition squitters include minimal information and allow systems on other aircraft (e.g., ACAS) to acquire a target without the need to interrogate.

Extended squitters provide additional information based on the Minimum Operational Performance Standards (MOPS) that the avionics system is designed to:

- DO-260 (Version 0)
- DO-260A (Version 1)
- DO-260B (Version 2)
- DO-260C (Version 3), approved December 2020
Acquisition Squitter

- The Mode S transponder outputs an unsolicited transmission once per second to enable ACAS to acquire Mode S equipped aircraft
  - carries only the ICAO 24 bit a/c address, which is a unique aircraft identifier used in Mode S
ACAS X Overview

• ACAS X is a family of next generation aircraft collision avoidance systems.
  – Backward / forward compatible
  – ACAS Xa and Xo MOPS have been published (RTCA DO-385 MOPS)

• Provides the same general role as TCAS II:
  – Surveillance of nearby aircraft
  – Generation of Traffic Advisory/Resolution Advisory
  – Coordination with other aircraft collision avoidance systems

• Supports New Capabilities:
  – Leverages Additional Surveillance Sources (e.g., ADS-B)
  – Intended for multiple types of host aircraft (commercial, general aviation, rotorcraft, UAS)
Use of 1090ES for Surveillance

TCAS II or ACAS Xa

Active Surveillance

Intruder

No ADS-B Usage

TCAS / ACAS Xa

TCAS II w/ Current DO-300 HS*

Validated ADS-B

Active Surveillance

Intruder

ADS-B Usage

TCAS

ACAS Xa*

Non-Validated ADS-B

Validated ADS-B

Validated ADS-B fused with Active Surveillance

Intruder

ADS-B Usage

ACAS Xa

* Requires hardware that can receive and decode 1090ES DF17 messages
1090ES Message Format

1090ES includes a 56 bit data field used to carry ADS-B information.

ADS-B information is derived from the onboard avionics navigation systems.

EXTENDED (112 BIT) SQUITTER

- 8 bit CONTROL
- 24 bit A/C ADDRESS
- 56 bit ADS MESSAGE
- 24 bit PARITY

TO ATC FACILITY

EXTENDED SQUITTER
GROUND STATION
BDS Registers

• **BDS Registers** are specified in ICAO Doc 9871, Edition 2, and the Mode S SARPs
  – BDS registers are also referred to as GICB registers because they can be downlinked via “Ground Initiated Comm B transactions”

• Each register **contains the data payload** of a particular Mode S reply or extended squitter

• Registers **not updated within a fixed period** are cleared by the transponder

• Registers are **identified by a two digit hex number**
  – for example BDS 05h or BDS 0,5 is the position squitter

• Certain BDS registers refer specifically to 1090ES
### Table 2-79: 1090 MHz Extended Squitter ADS-B Message Broadcast Rates

<table>
<thead>
<tr>
<th>Transponder Register</th>
<th>Event-Driven Message Priority</th>
<th>1090ES ADS-B Message</th>
<th>On-the-Ground, not moving</th>
<th>On-the-Ground and moving</th>
<th>Airborne</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDS 0.5</td>
<td>N/A</td>
<td>Airborne Position</td>
<td>N/A</td>
<td>N/A</td>
<td>2 / 1 second (0.4 – 0.6 sec)</td>
</tr>
<tr>
<td>BDS 0.6</td>
<td>N/A</td>
<td>Surface Position</td>
<td>LOW RATE 1 / 5 seconds (4.8 – 5.2 sec)</td>
<td>HIGH RATE 2 / 1 second (0.4 – 0.6 sec)</td>
<td>N/A</td>
</tr>
<tr>
<td>BDS 0.8</td>
<td>N/A</td>
<td>Aircraft Identification and Category</td>
<td>LOW RATE 1 / 10 seconds (9.8 – 10.2 sec)</td>
<td>HIGH RATE 1 / 5 seconds (4.8 – 5.2 sec)</td>
<td>HIGH RATE 1 / 5 seconds (4.8 – 5.2 sec)</td>
</tr>
<tr>
<td>BDS 0.9</td>
<td>N/A</td>
<td>Airborne Velocity</td>
<td>N/A</td>
<td>N/A</td>
<td>2 / 1 second (0.4 – 0.6 sec)</td>
</tr>
<tr>
<td>BDS 6.1</td>
<td>TCAS RA = 1 Emergency = 2</td>
<td>Aircraft Status</td>
<td>TCAS RA or Mode A Code Change 0.7 – 0.9 seconds</td>
<td>No TCAS RA, No Mode A Change 4.8 – 5.2 seconds</td>
<td>No TCAS RA, No Mode A Change, No Emergency, Mode A Code set to 10008, No Transmission</td>
</tr>
<tr>
<td>BDS 6.2</td>
<td>N/A</td>
<td>Target State and Status (TSS)</td>
<td>N/A</td>
<td>N/A</td>
<td>1.2 – 1.3 seconds</td>
</tr>
<tr>
<td>BDS 6.5</td>
<td>N/A</td>
<td>Aircraft Operational Status</td>
<td>4.8 – 5.2 seconds</td>
<td>No change NIC\textsubscript{SUPP}/NAC/SIL 2.4 – 2.6 seconds</td>
<td>TSS being broadcast or not change TCAS/NAC/SIL/NIC\textsubscript{SUPP} 2.4 – 2.6 seconds</td>
</tr>
</tbody>
</table>

N/A = Not Applicable
### Table 2-79: 1090 MHz Extended Squitter ADS-B Message Broadcast Rates

<table>
<thead>
<tr>
<th>Transponder Register</th>
<th>1090ES ADS-B Message</th>
<th>Broadcast Rate</th>
<th>Surface, not moving</th>
<th>Surface and moving</th>
<th>Airborne</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDS 0,5</td>
<td>Airborne Position (see Note 5)</td>
<td>N/A</td>
<td>N/A</td>
<td>2 / 1 second (0.4 – 0.6 sec)</td>
<td></td>
</tr>
<tr>
<td>BDS 0,6</td>
<td>Surface Position</td>
<td>LOW RATE 1 / 5 seconds (4.8 – 5.2 sec)</td>
<td>HIGH RATE 2 / 1 second (0.4 – 0.6 sec)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>BDS 0,8</td>
<td>Aircraft Identification and Category</td>
<td>LOW RATE 1 / 10 seconds (9.8 – 10.2 sec)</td>
<td>HIGH RATE 1 / 5 seconds (4.8 – 5.2 sec)</td>
<td>HIGH RATE 1 / 5 seconds (4.8 – 5.2 sec)</td>
<td></td>
</tr>
<tr>
<td>BDS 0,9</td>
<td>Airborne Velocity (see Note 6)</td>
<td>N/A</td>
<td>N/A</td>
<td>2 / 1 second (0.4 – 0.6 sec)</td>
<td></td>
</tr>
<tr>
<td>BDS 3,0</td>
<td>Aircraft Status (Subtype=2 “TCAS RA Broadcast”) (see Note 1)</td>
<td>N/A</td>
<td>N/A</td>
<td>0.7 – 0.9 seconds</td>
<td></td>
</tr>
<tr>
<td>BDS 6,1</td>
<td>Aircraft Status (Subtype=1 “Emergency/Priority Status and Mode A Code”)</td>
<td>N/A</td>
<td>Mode A Code Change/Emergency Active 0.7 – 0.9 seconds</td>
<td>No Mode A Change and No Emergency Active 4.8 – 5.2 seconds</td>
<td></td>
</tr>
<tr>
<td>BDS 6,2</td>
<td>Target State and Status (TSS)</td>
<td>N/A</td>
<td>N/A</td>
<td>1.2 – 1.3 seconds</td>
<td></td>
</tr>
<tr>
<td>BDS 6,3</td>
<td>Aircraft Status (Subtype=4 “UAS/RPAS Contingency” Current/Next TCP) (see Notes 1, 2 and 7)</td>
<td>N/A</td>
<td>N/A</td>
<td>4.8 – 5.2 seconds</td>
<td></td>
</tr>
<tr>
<td>BDS 6,4</td>
<td>Aircraft Operational Status</td>
<td>4.8 – 5.2 seconds</td>
<td>No change NICₑᵤₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑᵉ</td>
<td>TSS being broadcast or not No change CAS/NAC/SIL/NICₑᵤₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑₑᵉ</td>
<td></td>
</tr>
</tbody>
</table>

N/A = Not Applicable
# BDS Registers in ED-102B/DO-260C

## Table 2-79: 1090 MHz Extended Squitter ADS-B Message Broadcast Rates

<table>
<thead>
<tr>
<th>Transponder Register</th>
<th>1090ES ADS-B Message</th>
<th>Surface, not moving</th>
<th>Surface and moving</th>
<th>Airborne</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDS 6,8</td>
<td>ADS-Wx AIREP (Subtype=0 “Aircraft State”) (see Note 7)</td>
<td>LOW RATE 1/10 seconds (9.8 – 10.2 sec)</td>
<td>HIGH RATE 1/5 seconds (4.8 – 5.2 sec)</td>
<td>HIGH RATE 1/5 seconds (4.8 – 5.2 sec)</td>
</tr>
<tr>
<td>BDS 6,9</td>
<td>ADS-Wx AIREP (Subtype=1 “Weather State”) (see Notes 4 and 7)</td>
<td>N/A</td>
<td>N/A</td>
<td>1/2.2 seconds (2.1 – 2.3 seconds)</td>
</tr>
<tr>
<td>BDS 6,A</td>
<td>ADS-Wx AIREP (Subtype=2 “Alternate Weather State”) (see Notes 4 and 7)</td>
<td>N/A</td>
<td>N/A</td>
<td>3/10 seconds (3.1 – 3.5 seconds)</td>
</tr>
<tr>
<td>BDS 6,B</td>
<td>ADS-Wx PIREP (Subtype=0 “Flight Weather”) (see Notes 1, 3 and 7)</td>
<td>N/A</td>
<td>N/A</td>
<td>2/1 second (0.4 – 0.6 sec)</td>
</tr>
<tr>
<td>BDS 6,C</td>
<td>ADS-Wx PIREP (Subtype=1 “Temp, Wind &amp; Turbulence”) (see Notes 1, 3 and 7)</td>
<td>N/A</td>
<td>N/A</td>
<td>2/1 second (0.4 – 0.6 sec)</td>
</tr>
<tr>
<td>BDS 6,D</td>
<td>ADS-Wx PIREP (Subtype=2 “Hazardous Weather”) (see Notes 1, 3 and 7)</td>
<td>N/A</td>
<td>N/A</td>
<td>2/1 second (0.4 – 0.6 sec)</td>
</tr>
<tr>
<td>BDS 6,E</td>
<td>High Velocity and/or Altitude (Subtype=0 “HVA Position”) (see Notes 5 and 7)</td>
<td>N/A</td>
<td>N/A</td>
<td>2/1 second (0.4 – 0.6 sec)</td>
</tr>
<tr>
<td>BDS 6,F</td>
<td>High Velocity and/or Altitude (Subtype=1 “HVA Velocity”) (see Notes 6 and 7)</td>
<td>N/A</td>
<td>N/A</td>
<td>2/1 second (0.4 – 0.6 sec)</td>
</tr>
</tbody>
</table>

**Notes for Table 2-79:**

1. Aircraft Status – Subtype 2, Aircraft Status – Subtype 4, and the ADS-Wx PIREPs are On-Condition Messages that are only transmitted when certain conditions apply (see §2.2.3.2.7).
2. The UAS/RPAS Contingency Message alternates transmission of the Current and Next TCP until the last TCP has been sequenced.
3. If more than one PIREP subtype message is valid, the messages are interleaved as specified in §2.2.3.3.2.7.3.
4. The ADS-Wx AIREP Weather State and Alternate Weather State Messages are not transmitted concurrently (see §2.2.3.3.2.6.4.2).
5. The Airborne Position and HVA Position Messages are not transmitted concurrently.
6. The Airborne Velocity and HVA Velocity Messages are not transmitted concurrently.
7. The HVA Position & Velocity, UAS/RPAS Contingency, ADS-Wx AIREP and ADS-Wx PIREP Messages are optional.
In order to populate each of the messages, the ADS-B device relies on other aircraft systems.

The following is an example of some of the avionics systems providing information to the ADS-B avionics.
Aircraft Equipage

• Aircraft equipage is a key element that the Civil Aviation Authority (CAA) and Air Navigation Service Providers (ANSPs) must consider.

• The type of ADS-B implementation may drive additional considerations on the type of equipage required in order to ensure proper aircraft detection.

• For example:
  – ground system implementations may be satisfied with a bottom only antenna.
  – Space Based implementation would require aircraft to have an antenna visible to the satellites.
Quality Indicators are used by the ATC Processing System to determine
  - whether ADS-B Surveillance reports (and therefore the derived target position) can be used to support the various functions in the provision of Air Traffic Services, and in particular,
    - whether the defined ATC Surveillance Separation standard can be supported

These indicators are either calculated by the ADS-B device (e.g., NIC/NUCp) or configured at installation (e.g., SIL, SDA, Length/Width Code)
Navigation Integrity Category (NIC)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MSB</td>
<td>MSB</td>
<td>LSB</td>
<td>MSB</td>
<td>LSB</td>
<td>MSB</td>
<td>LSB</td>
<td>MSB</td>
</tr>
</tbody>
</table>

Airborne Position Message “ME” Field

<table>
<thead>
<tr>
<th>MSG Bit #</th>
<th>33-37</th>
<th>38-39</th>
<th>40</th>
<th>41-52</th>
<th>53</th>
<th>54</th>
<th>55-71</th>
<th>72-88</th>
</tr>
</thead>
<tbody>
<tr>
<td>“ME” Bit #</td>
<td>1-5</td>
<td>6-7</td>
<td>8</td>
<td>9-20</td>
<td>21</td>
<td>22</td>
<td>23-39</td>
<td>40-56</td>
</tr>
</tbody>
</table>

Aircraft Operational Status ADS-B Message “ME” Field Format

<table>
<thead>
<tr>
<th>MSG BIT #</th>
<th>33-37</th>
<th>38-40</th>
<th>41-52</th>
<th>53-56</th>
<th>57-72</th>
<th>73-75</th>
<th>76</th>
<th>77-80</th>
<th>81-82</th>
<th>83-84</th>
<th>85</th>
<th>86</th>
<th>87</th>
<th>88</th>
</tr>
</thead>
<tbody>
<tr>
<td>“ME” BIT #</td>
<td>1-5</td>
<td>6-8</td>
<td>9-20</td>
<td>21-24</td>
<td>25-40</td>
<td>41-45</td>
<td>44</td>
<td>45-48</td>
<td>49-50</td>
<td>51-52</td>
<td>53</td>
<td>54</td>
<td>55</td>
<td>56</td>
</tr>
</tbody>
</table>

- The Navigation Integrity Category (NIC) is calculated solely based on the containment radius.
- This value in combination with the NIC Supplement A & B determines the Type Code to be transmitted in the Airborne Position Message.
# NUCp to NIC Conversion

<table>
<thead>
<tr>
<th>Horizontal Protection Limit (DO-260)</th>
<th>Nuc_p (DO-260)</th>
<th>Type Code (DO-260)</th>
<th>Horizontal Containment Radius (Rc) (DO-260A)</th>
<th>NIC (DO-260A)</th>
<th>NIC Supplement (DO-260A)</th>
<th>Type Code (DO-260A)</th>
<th>Horizontal Containment Radius (Rc) (DO-260B)</th>
<th>NIC (DO-260B)</th>
<th>NIC Supplement A,B (DO-260B)</th>
<th>Type Code (DO-260B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPL &lt; 7.5 m</td>
<td>9</td>
<td>9</td>
<td>Rc &lt; 7.5 m and VPL &lt; 11 m</td>
<td>11</td>
<td>0</td>
<td>9</td>
<td>Rc &lt; 7.5 m</td>
<td>11</td>
<td>0,0</td>
<td>9</td>
</tr>
<tr>
<td>HPL &lt; 25 m</td>
<td>8</td>
<td>10</td>
<td>Rc &lt; 25 m and VPL &lt; 37.5 m</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>Rc &lt; 25 m</td>
<td>10</td>
<td>0,0</td>
<td>10</td>
</tr>
<tr>
<td>HPL &lt; 0.1 NM</td>
<td>7</td>
<td>11</td>
<td>Rc &lt; 75 m and VPL &lt; 112 m</td>
<td>9</td>
<td>1</td>
<td>11</td>
<td>Rc &lt; 75 m</td>
<td>9</td>
<td>1,1</td>
<td>11</td>
</tr>
<tr>
<td>HPL &lt; 0.2 NM</td>
<td>6</td>
<td>12</td>
<td>Rc &lt; 0.1 NM</td>
<td>8</td>
<td>0</td>
<td>12</td>
<td>Rc &lt; 0.1 NM</td>
<td>8</td>
<td>0,0</td>
<td>12</td>
</tr>
<tr>
<td>HPL &lt; 0.5 NM</td>
<td>5</td>
<td>13</td>
<td>Rc &lt; 0.2 NM</td>
<td>7</td>
<td>0</td>
<td>13</td>
<td>Rc &lt; 0.2 NM</td>
<td>7</td>
<td>0,0</td>
<td>13</td>
</tr>
<tr>
<td>HPL &lt; 1.0 NM</td>
<td>4</td>
<td>14</td>
<td>Rc &lt; 0.6 NM</td>
<td>6</td>
<td>1</td>
<td>14</td>
<td>Rc &lt; 0.3 NM</td>
<td>6</td>
<td>0,1</td>
<td>14</td>
</tr>
<tr>
<td>HPL &lt; 2.0 NM</td>
<td>3</td>
<td>15</td>
<td>Rc &lt; 0.5 NM</td>
<td>6</td>
<td>0</td>
<td>15</td>
<td>Rc &lt; 0.5 NM</td>
<td>6</td>
<td>0,0</td>
<td>15</td>
</tr>
<tr>
<td>HPL &lt; 10 NM</td>
<td>2</td>
<td>16</td>
<td>Rc &lt; 1.0 NM</td>
<td>5</td>
<td>0</td>
<td>16</td>
<td>Rc &lt; 0.6 NM</td>
<td>6</td>
<td>1,1</td>
<td>16</td>
</tr>
<tr>
<td>HPL &lt; 20 NM</td>
<td>1</td>
<td>17</td>
<td>Rc &lt; 2 NM</td>
<td>4</td>
<td>0</td>
<td>17</td>
<td>Rc &lt; 1.0 NM</td>
<td>5</td>
<td>0,0</td>
<td>17</td>
</tr>
<tr>
<td>HPL ≥ 20 NM</td>
<td>0</td>
<td>18</td>
<td>Rc &lt; 4 NM</td>
<td>3</td>
<td>1</td>
<td>18</td>
<td>Rc &lt; 2 NM</td>
<td>4</td>
<td>0,0</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rc &lt; 8 NM</td>
<td>2</td>
<td>0</td>
<td>19</td>
<td>Rc &lt; 4 NM</td>
<td>3</td>
<td>1,1</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rc &lt; 20 NM</td>
<td>1</td>
<td>0</td>
<td>20</td>
<td>Rc &lt; 8 NM</td>
<td>2</td>
<td>0,0</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rc ≥ 20 NM or unknown</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>Rc ≥ 20 NM or unknown</td>
<td>0</td>
<td>0,0</td>
<td>21</td>
</tr>
</tbody>
</table>

**Airborne Position**
## ADS-B Position Message

<table>
<thead>
<tr>
<th>Horizontal Protection Limit (DO-260)</th>
<th>$\text{Nuc}_p$ (DO-260)</th>
<th>Type Code (DO-260)</th>
<th>Horizontal Containment Radius (DO-260A)</th>
<th>NIC (DO-260A)</th>
<th>NIC Supplement (DO-260A)</th>
<th>Type Code (DO-260B)</th>
<th>Horizontal Containment Radius (DO-260B)</th>
<th>NIC Supplement A,C (DO-260B)</th>
<th>NIC (DO-260B)</th>
<th>Type Code (DO-260B)</th>
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</thead>
<tbody>
<tr>
<td>HPL &lt; 7.5 m</td>
<td>9</td>
<td>5</td>
<td>Rc &lt; 7.5 m</td>
<td>11</td>
<td>0</td>
<td>5</td>
<td>Rc &lt; 7.5 m</td>
<td>0,0</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>HPL &lt; 25 m</td>
<td>8</td>
<td>6</td>
<td>Rc &lt; 25 m</td>
<td>10</td>
<td>0</td>
<td>6</td>
<td>Rc &lt; 25 m</td>
<td>0,0</td>
<td>10</td>
<td>6</td>
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<tr>
<td>HPL &lt; 0.1 NM</td>
<td>7</td>
<td>7</td>
<td>Rc &lt; 75 m</td>
<td>9</td>
<td>1</td>
<td>7</td>
<td>Rc &lt; 75 m</td>
<td>1,0</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>HPL ≥ 0.1 NM</td>
<td>6</td>
<td>8</td>
<td>Rc &lt; 0.1 NM</td>
<td>8</td>
<td>0</td>
<td>7</td>
<td>Rc &lt; 0.1 NM</td>
<td>0,0</td>
<td>8</td>
<td>7</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Rc ≥ 0.1 NM or unknown</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>Rc &lt; 0.2 NM</td>
<td>1,1</td>
<td>7</td>
<td>8</td>
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</tr>
</tbody>
</table>

### Surface Position
Monitoring of Regulatory Compliance

- FAA* uses a tool called the ADS-B Performance Monitor (APM) to detect:
  - Non-Equipped operations in ADS-B Out required airspace
    - Including improperly equipped aircraft (e.g., Version 0 or Version 1)
- Improper ADS-B Operation
  - Equipment must be on at all times
    - Subject to revised 91.225 (f)
    - Proper procedures for pilot entered data (e.g., Flight ID)
      - Call Sign Mis-Match (CSMM)
- Non-performing equipment (NPE)
  - Airworthiness issues, monitored by FAA Flight Standards

*Inspectors from aircraft Maintenance and Flight Technologies and Procedures Divisions in the Office of Safety Standards
Monitoring of Regulatory Compliance

- In order to identify NPE’s, the APM leverages the ADS-B Out information to identify aircraft operating in U.S. airspace that are not meeting the performance standards specified in 14 CFR 91.227.
  - Checks integrity and accuracy of position information
    - Compliant NIC, NACp, NACv, SIL, SDA
  - Checks for required message elements
    - Lat/Long, Velocity, Baro & Geo Altitude, Mode 3/A, Flight ID, proper ICAO 24-bit address, Emitter Category, Length/Width code, etc.
  - Performs validity checks (Kinematics) on position, velocity, altitude
ADS-B Performance Monitor
ADS-B Performance Monitor

2300 ft.
Monitoring of Regulatory Compliance

- When the FAA learns of a suspected violation, via the APM or any other means, the following is initiated:
  - Relevant information is sent to an investigating office (e.g., Flight Standards District Office (FSDO), Certificate Management Office (CMO), or International Field Office (IFO))
    - If detected by APM, information will be sent from the Aircraft Maintenance Division or Flight Procedures and Technologies Division
  - Responsible FAA office conducts investigation following procedures established in FAA Orders 8900.1 and 2150.3C

- After the investigation occurs, the responsible FAA office takes appropriate actions to address the apparent violations
  - Compliance, administrative, or legal enforcement actions, in accordance with established policy
FAA Surveillance Functional Architecture

- **Vehicle Function**: ADS-B Transmission

- **Processing Function**:
  - ADS-B Reception
  - ADS-B Report Processing
  - WAM / ASSC Interrogation
  - WAM / ASSC Reply Reception
  - WAM / ASSC MLAT Processing

- **Aircraft Function**:
  - ADS-B Reception
  - ADS-B Transmission
  - ATCRBS / Mode S Interrogation / Reply
  - VHF Comm Transmission / Reception

- **GOMEX VHF Comm Function**

- **SBS Monitoring & Control Function**:
  - Compliance Monitoring
  - Service Monitoring and Control
  - Service Availability Prediction Tool

- **ATC Automation Data Processing and Display Function**:
  - Terminal and En Route Automation
  - Traffic Flow Management (TFM) Automation
  - Surface Automation

- **Legacy NAS Secondary Radar Sources**
  - Legacy NAS Secondary Radar Sources

- **Pilot / Controller Voice Comm**

- **Airworthiness Enforcement**

- **Technicians / Engineers**

- **Aircraft Operators**

- **Radar Reports**

- **1090 SSR Messages**

- **ADS-B Messages**

- **Mode A/C/S Interrogations & Replies**

- **WAM Reports**

- **Service Status Reports**

- **GPS Status and Health**

- **GNSS (GPS) Constellation Status**