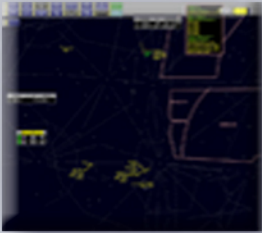




FAA Lesson Plan



En Route Stage 4 Radar Controller Training

H	DEPT	
JFK		
AAL321	60	
SWA123	150	
LGA		
N2234	340	
PHL		
UAL167	50	
N133A	120	
N12A	UFR	
N11A	0TP	

Instructor

Fundamentals of ATC Surveillance Systems Lesson 1



55055
V.1.06



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LESSON PLAN DATA SHEET

COURSE NAME: RADAR CONTROLLER TRAINING
COURSE NUMBER: 55055

LESSON TITLE: FUNDAMENTALS OF ATC SURVEILLANCE SYSTEMS

DATE REVISED: 2014-04
VERSION: 1.06

REFERENCES: JO 7110.65V, Air Traffic Control; JO 7110.10X, Flight Services; JO 7210.3Y, Facility Operation and Administration; JO 7610.4S, Special Operations; Aeronautical Information Manual (AIM); ETM 12-0-1, Fundamentals of Primary and Secondary Surveillance Radar; TI 6110.100, En Route Automation Modernization (ERAM) Air Traffic Manual (ATM): R-Position User Manual; AC 90-114, Automatic Dependent Surveillance Broadcast (ADS-B) Operations; 14 CFR 91.225, Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment and use; ERAM SURV SRS 210.24, En Route Automation Modernization (ERAM) Surveillance (SURV); ERAM DS DD 240.07, En Route Automation Modernization (ERAM) Display System (DS) Data Dictionary (DD); TI 6110.141, En Route Automation Modernization (ERAM) System Adaptation Manual (SAM): Local Data Panels; JO 7110.66D CHG 2, National Beacon Code Allocation Plan (NBCAP); ERAM EDSM SRS 210.04 V1B1, En Route Automation Modernization (ERAM) En Route Display Management (EDSM) R-Position and General EDSM Requirements Volume 1, Book 1

HANDOUTS: NONE

EXERCISES: NONE

END-OF-LESSON TEST: YES (*REFER TO 55055-ELT01.PDF*)

PERFORMANCE TEST: NONE

MATERIALS: NONE

OTHER PERTINENT INFORMATION: THIS LESSON IS BASED ON ERAM BUILD EAC1500. THE LESSON HAS BEEN REVIEWED AND REFLECTS CURRENT ORDERS AND MANUALS AS OF APRIL 2014.

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INTRODUCTION



Fundamentals of ATC Surveillance Systems



Fundamentals of ATC Surveillance Systems

1

In previous stages of instruction, you learned about manual air traffic control. This stage of training focuses on various ATC Surveillance Systems, which are some of the controller's most valuable aids.

Purpose

A basic knowledge of ATC Surveillance Systems and the components associated with a digitized radar system will benefit you in Radar On-the-Job Training (OJT). This knowledge will assist you in attaining Certified Professional Controller (CPC) status.

In this lesson you will learn the fundamentals of ATC Surveillance Systems.

INTRODUCTION *(Continued)*

Objectives



Objectives

At the end of this lesson, you will be able to identify:

1. Characteristics of primary and secondary radar systems
2. Factors that affect radar data display
3. Characteristics of Automatic Dependent Surveillance-Broadcast (ADS-B)
4. Characteristics of a digitized radar system



Fundamentals of ATC Surveillance Systems

2

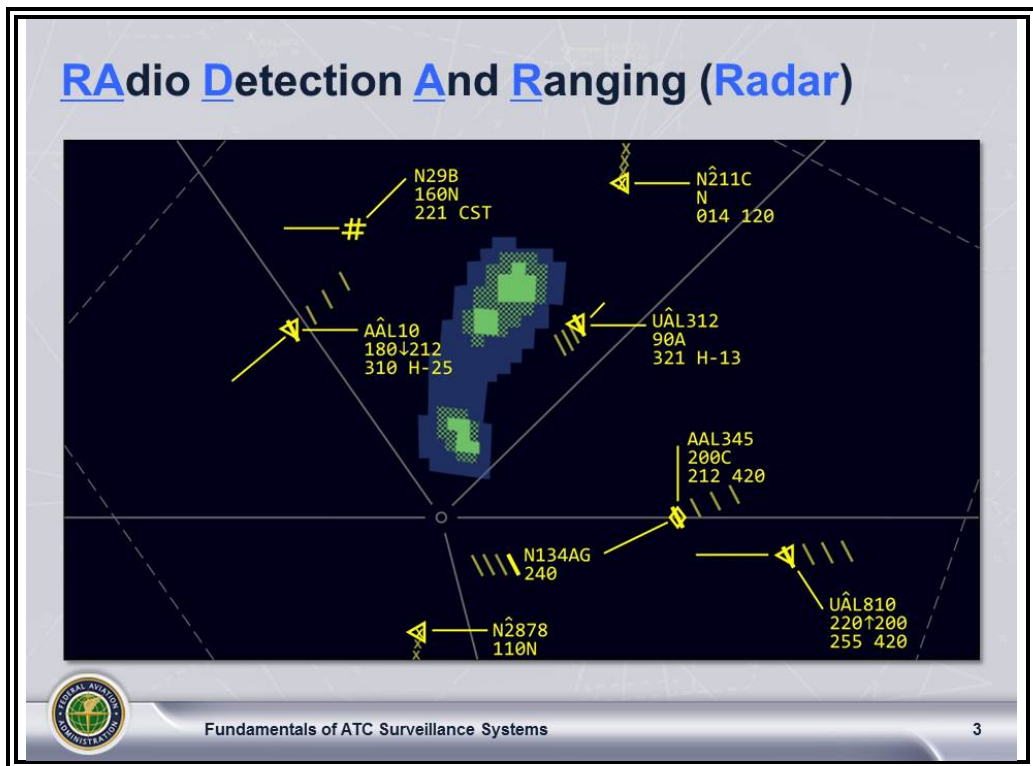
☞ **NOTE:** Review the lesson objectives.

PRIMARY RADAR SYSTEM

Radar

Definition

ETM 12-0-1,
pp. 5, 6, Glossary;
JO 7110.65,
Pilot/Controller
Glossary



Radar (**RA**dio **D**etection **A**nd **R**anging) is a radio detection device that provides information on range, azimuth, and/or elevation of objects.

PRIMARY RADAR SYSTEM (Continued)

Primary Radar Definition

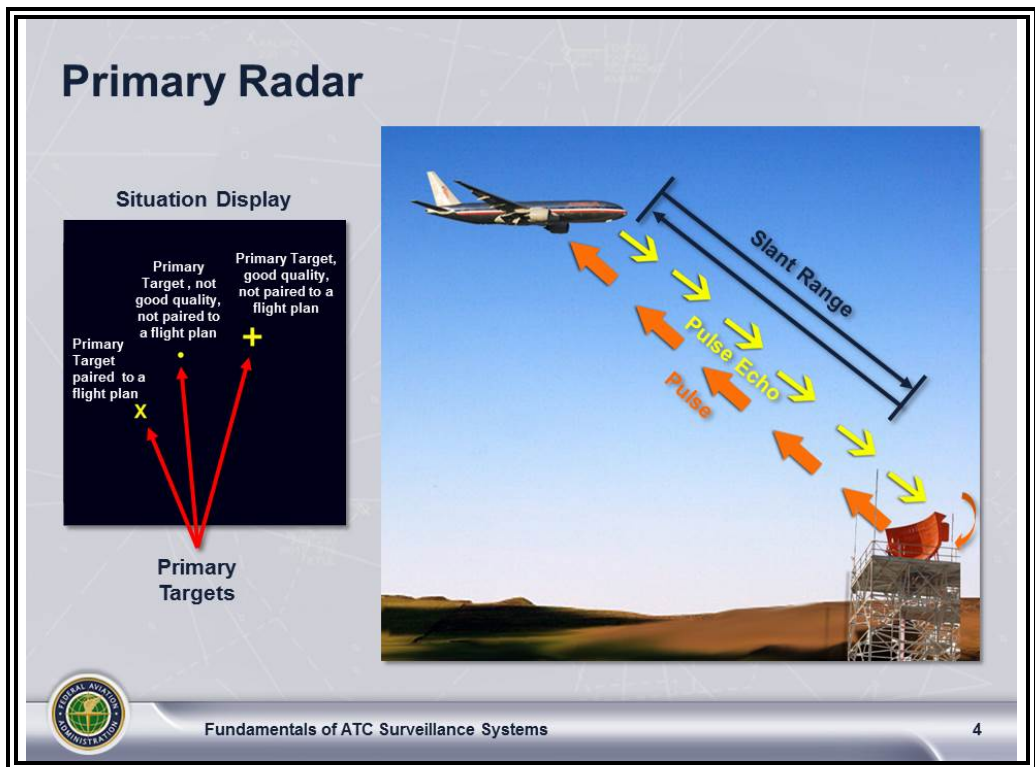
ETM 12-0-1,
Glossary;
JO 7110.65,
Pilot/Controller
Glossary



Primary Radar is a radar system which uses reflected radio signals.

Process

ETM 12-0-1,
pp. 5, 6, Glossary;
JO 7110.65,
Pilot/Controller
Glossary; ERAM
EDSM SRS 210.04
V1B1, par. 3.2.2.1



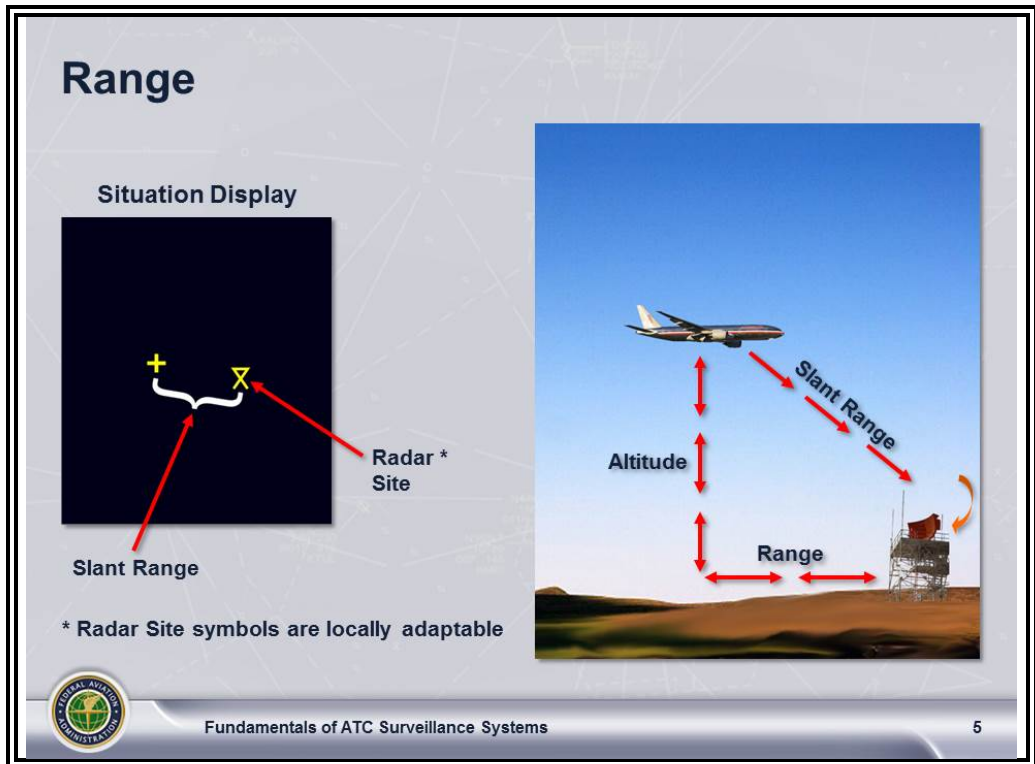
NOTE: Teach from the graphic.

- ⦿ Antenna transmits
- ⦿ Aircraft/object reflects
- ⦿ Antenna receives
- ⦿ Computer processes
- ⦿ Center indicator displays position in terms of range and azimuth

PRIMARY RADAR SYSTEM *(Continued)*

Range and Azimuth Definitions

ETM 12-0-1,
pp. 7, 8, Glossary



Range is the distance from the antenna to a point on the ground directly below the aircraft.



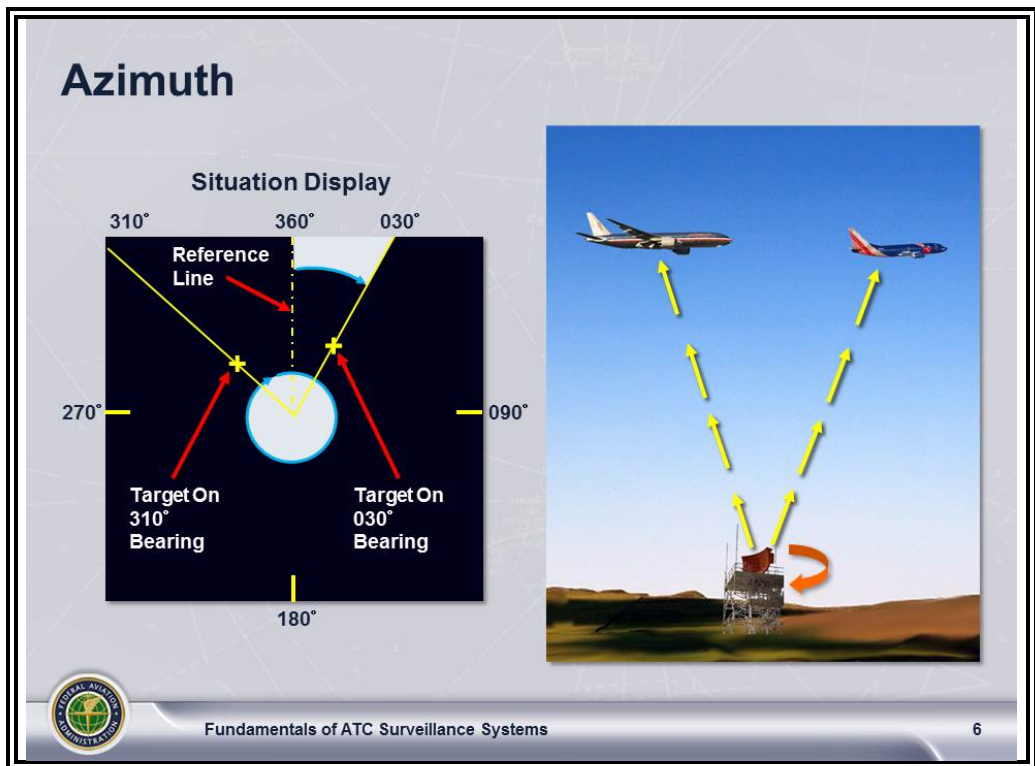
Slant range is the distance from antenna to aircraft.

Continued on next page

PRIMARY RADAR SYSTEM (Continued)

Range and Azimuth Definitions (Cont'd)

ETM 12-0-1,
pp. 7, 8, Glossary



Azimuth is the direction from the antenna based on a 360° circle measured clockwise from a reference line.

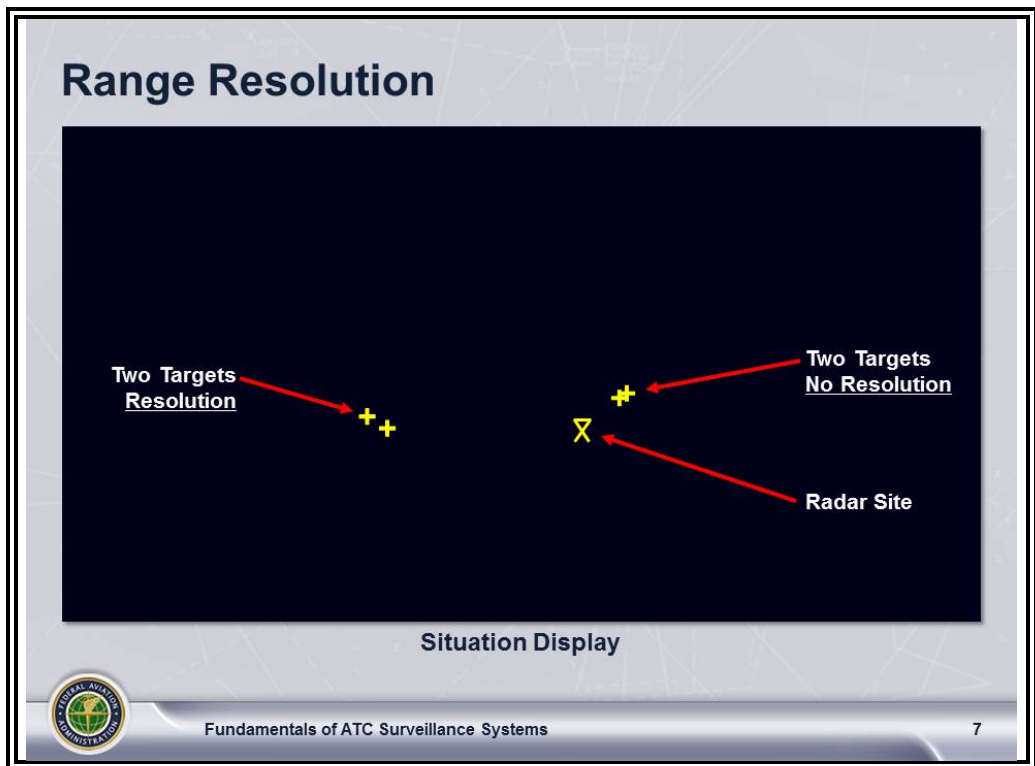


NOTE: Explain the difference between range and azimuth.

PRIMARY RADAR SYSTEM *(Continued)*

Range Resolution Definition

ETM 12-0-1,
pp. 7, 8, Glossary

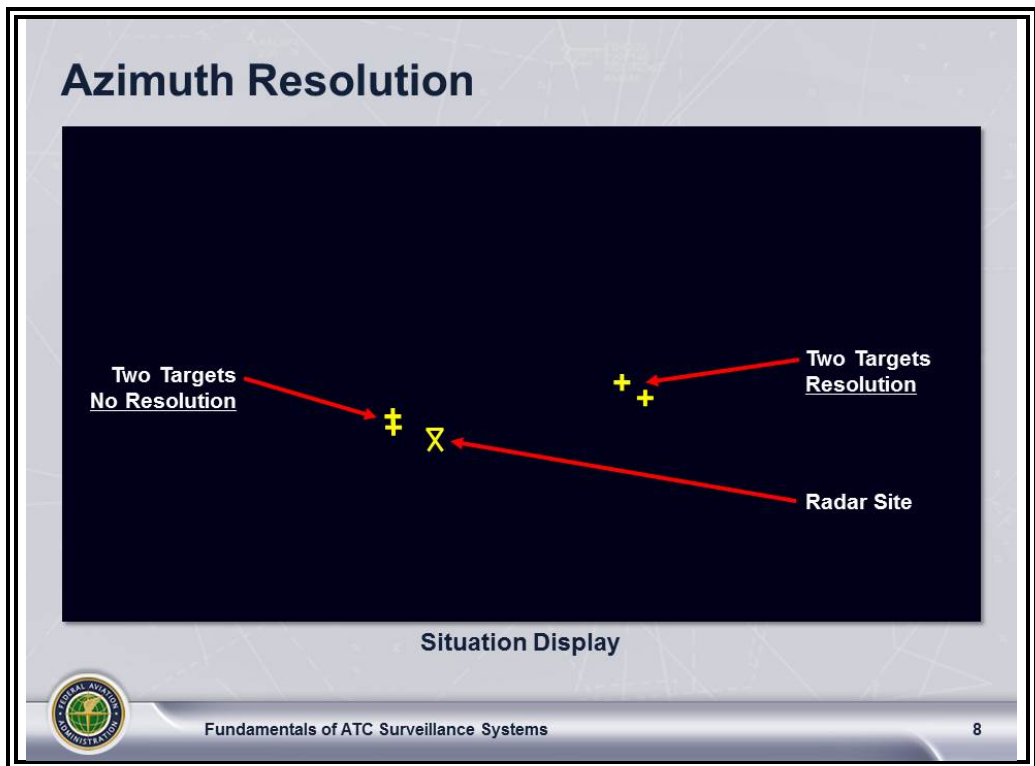


Range resolution is the minimum distance between two returns, measured along the same azimuth, at which returns still appear as separate, distinct targets.

PRIMARY RADAR SYSTEM *(Continued)*

Azimuth Resolution Definition

ETM 12-0-1, p. 8



Azimuth resolution is the minimum angular distance between two returns, measured at the same range, at which returns still appear as separate, distinct targets.

PRIMARY RADAR SYSTEM *(Continued)*

Review



Response Item

The radar term for distance is _____.

- A. mileage
- B. azimuth
- C. range



Fundamentals of ATC Surveillance Systems

[Click to Show Answer](#)

9



Response Item

The term used to describe the minimum distance that can exist between two targets and still make it possible to distinguish between them is _____.

- A. range
- B. resolution
- C. azimuth



Fundamentals of ATC Surveillance Systems

[Click to Show Answer](#)

10

SLIDE ANSWERS: Slide 9 = C; Slide 10 = B

Continued on next page

PRIMARY RADAR SYSTEM *(Continued)*

Review (Cont'd)



Response Item

The two items of information that primary radar furnishes the center controller are _____ and _____.

- A. altitude; distance
- B. azimuth; range
- C. azimuth; altitude



Fundamentals of ATC Surveillance Systems

[Click to Show Answer](#)

11



Response Item

The bearing of a target measured clockwise from a reference line is called the _____.

- A. range
- B. azimuth
- C. offset



Fundamentals of ATC Surveillance Systems

[Click to Show Answer](#)

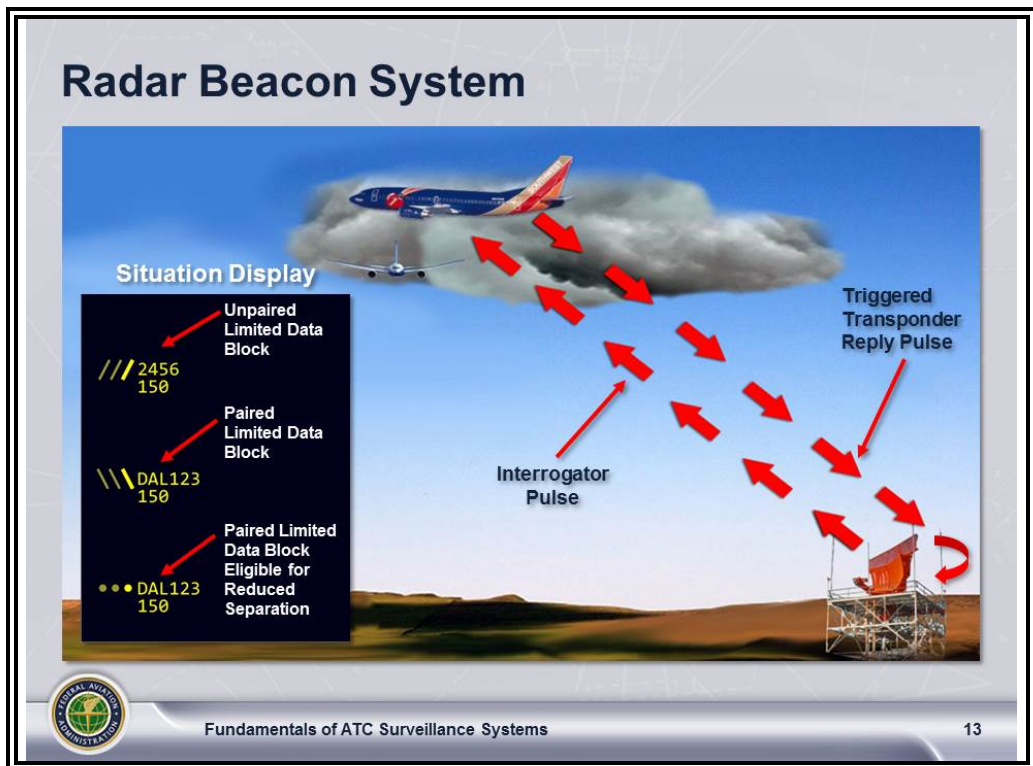
12

SLIDE ANSWERS: Slide 11 = B; Slide 12 = B

AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS) - SECONDARY RADAR

Overview

ETM 12-0-1,
p. 35, Glossary;
JO 7110.65,
Pilot/Controller
Glossary; AIM,
par. 4-5-2



Secondary Radar Definition

JO 7110.65,
Pilot/Controller
Glossary; AIM,
par. 4-5-2



Secondary Radar is a radar system wherein a radio signal transmitted from a radar station initiates the transmission of a radio signal from another station.

- ⦿ Secondary radar relies on a specific radio transmission from an aircraft.
- ⦿ The detected object has cooperative equipment in form of radio/transmitter (transponder).
- ⦿ The secondary return reinforces or replaces the primary return.
- ⦿ Primary and secondary radar antennas are collocated.

AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS) - SECONDARY RADAR *(Continued)*

Process

AIM, par. 4-5-2;
ERAM EDSM SRS
210.04 V1B1,
par. 3.2.2.1

 **NOTE:** Teach from the graphic on slide 13.

- ⦿ Interrogator generates and transmits signal through antenna
 - ⦿ Transponder replies
 - ⦿ Interrogator receives transponder reply through antenna
 - ⦿ Computer processes information
 - ⦿ Situation Display displays beacon target
-

Radar Beacon Modes

ETM 12-0-1,
pp. 41, 52

- ⦿ Modes are different pulses on which the interrogator transmits and receives data.
 - Mode 1 (military use)
 - Mode 2 (military use)
 - Mode 3/A (military and civil use)
 - Mode C (military and civil use)
 - Mode S (military and civil use)
 - ⦿ ATC utilizes only:
 - Mode 3/A for target tracking and identification.
 - Mode C for altitude reporting.
 - Mode S
 - Altitude readout in digitized radar system
-

Radar Beacon Codes

JO 7110.66,
par. 11

- ⦿ The transponder transmits numerical signals from an octal number group from 0 to 7.
 - The numbers 8 and 9 cannot be used.

NOTE: Code 7777 is the largest numerical value.

AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS) - SECONDARY RADAR *(Continued)*

Review



Response Item

Radar that relies on a specific radio transmission from the aircraft (rather than a reflected signal) is _____ radar.

- A. secondary
- B. primary
- C. surveillance



Fundamentals of ATC Surveillance Systems

[Click to Show Answer](#)

14

SLIDE ANSWER: A

FACTORS THAT AFFECT RADAR DATA DISPLAY

Target Fades

ETM 12-0-1,
pp. 29 thru 34,
Glossary



Factors that Affect Radar Data Display

Target Fades	Electronic Attack (EA) or Jamming
• Intermittent or weak targets caused by: - Antenna Tilt - Terrain - Weather - Marginal Radar Coverage	• Interference with radar for military purposes • EA Types: - Electronic (strobing) - Corrective action is to locate the source, or request to discontinue EA - Chaff (metal strips released in air by aircraft) - Not correctable



Fundamentals of ATC Surveillance Systems

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- ⦿ Target fades are intermittent or weak targets caused by:
 - Antenna tilt
 - Terrain
 - Weather
 - Marginal radar coverage

Continued on next page

FACTORS THAT AFFECT RADAR DATA DISPLAY

(Continued)

Electronic Attack (EA) or Jamming (Cont'd)

JO 7110.65,
par. 5-1-5;
JO 7610.4,
par. 2.7

- ⊙ Electronic Attack (EA) or jamming is interference with radar for military purposes.
- ⊙ Refer all EA requests to the appropriate FLM/CIC.
- ⊙ Types
 - Electronic (Strobing)
 - Chaff - Thin metal strips released in air by aircraft
- ⊙ Corrective action
 - Strobing
 - Locate source
 - Request to discontinue EA (Inform when able to resume)
 - Chaff
 - Not correctable
 - Moves with wind until dissipated



Phraseology

“BIG PHOTO (identification, if known) (name)
CENTER/TOWER/APPROACH CONTROL.”

- To stop EA activity:



Phraseology

“STOP STREAM/BURST IN AREA (area name) (degree and distance from facility).”

or

“STOP BUZZER ON (frequency band or channel).”

- To resume EA activity:



Phraseology

“RESUME STREAM/BURST.”

or

“RESUME BUZZER ON (frequency band or channel).”

FACTORS THAT AFFECT RADAR DATA DISPLAY

(Continued)

Review



Response Item

The two types of radar jamming that interfere with ATC radar are _____ and _____.

- A. electronic; chaff
- B. anomalous propagation; strobing
- C. linear polarization; chaff



Fundamentals of ATC Surveillance Systems

[Click to Show Answer](#)

16

SLIDE ANSWER: A

ADS-B

Overview

14 CFR 91.225



Automatic Dependent Surveillance - Broadcast (ADS-B)

Automatic

- Periodically transmits information with no pilot or operator input required

Dependent

- Position and velocity vector are derived from the Global Positioning System (GPS)

Surveillance

- A method of determining position of aircraft, vehicles, or other assets

Broadcast

- Transmitted information available to anyone with the appropriate receiving equipment



Fundamentals of ATC Surveillance Systems

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ADS-B Definition

JO 7110.65,
Pilot/Controller
Glossary;
14 CFR 91.225



Automatic Dependent Surveillance-Broadcast (ADS-B) is a surveillance technology for tracking aircraft as part of the Next Generation Air Transportation System (NextGen). The United States will require the majority of aircraft operating within its airspace to be equipped with some form of ADS-B Out by January 1, 2020.

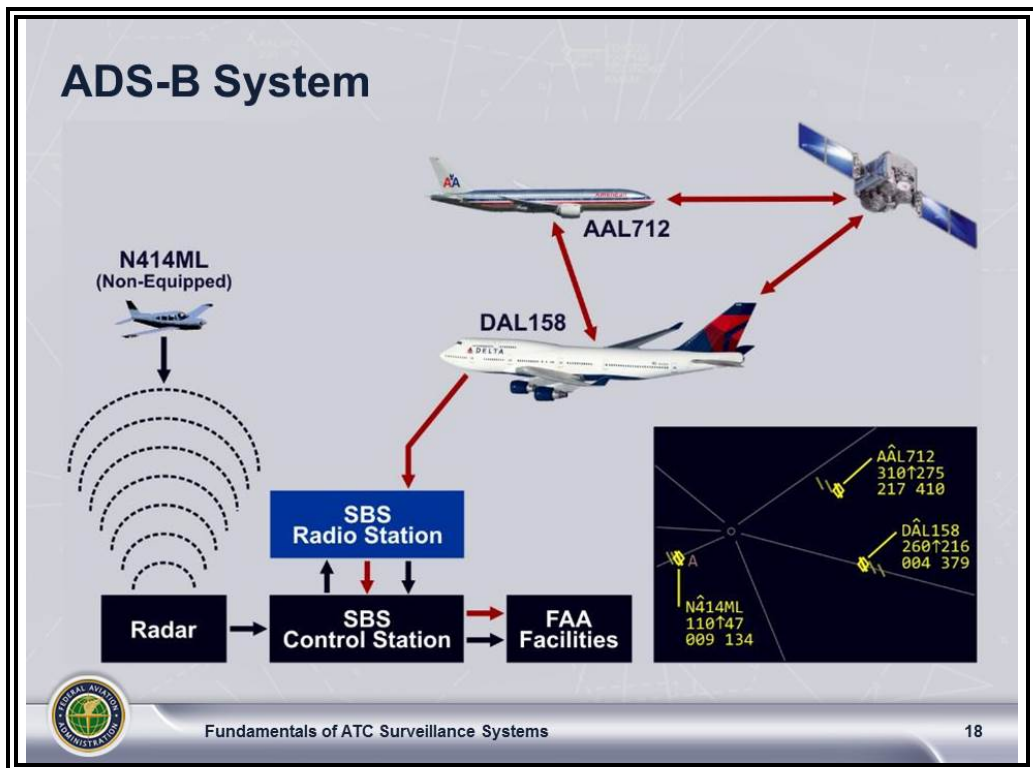


NOTE: Discuss what each term in ADS-B means.

- ⦿ The difference between ADS-B and traditional radar sources is the broadcast feature.
 - Position determination is made on the aircraft, not by radar.
 - Aircraft position is broadcast to other aircraft and back to ATC ground-based radio receivers.
- ⦿ ADS-B enhances safety by making aircraft visible, in real time, to ATC and to other ADS-B aircraft with position and velocity data.
- ⦿ ADS-B also provides the data infrastructure for inexpensive flight tracking, planning, and dispatch.

ADS-B (Continued)

Process
AC 90-114,
par. 2-2.a



- ⊙ The ADS-B system is composed of aircraft avionics and a ground infrastructure.
- ⊙ On-board avionics use GPS satellite signals to determine aircraft position.
- ⊙ ADS-B transceiver broadcasts a position (latitude/longitude) report, along with other information, such as:
 - Pressure altitude (like Mode C)
 - Beacon code
 - Call sign
 - ICAO aircraft address
- ⊙ Transmissions are received by:
 - Other ADS-B aircraft, giving them greater situational awareness
 - Network of ground radio stations contracted to FAA
 - Other aviation service providers

Continued on next page

ADS-B *(Continued)*

Process (Cont'd)

AC 90-114,
par. 2-2.a

-
- ⦿ The radio stations stream the reports over a wide area network to control stations that process the information and forward reports to ATC facilities.

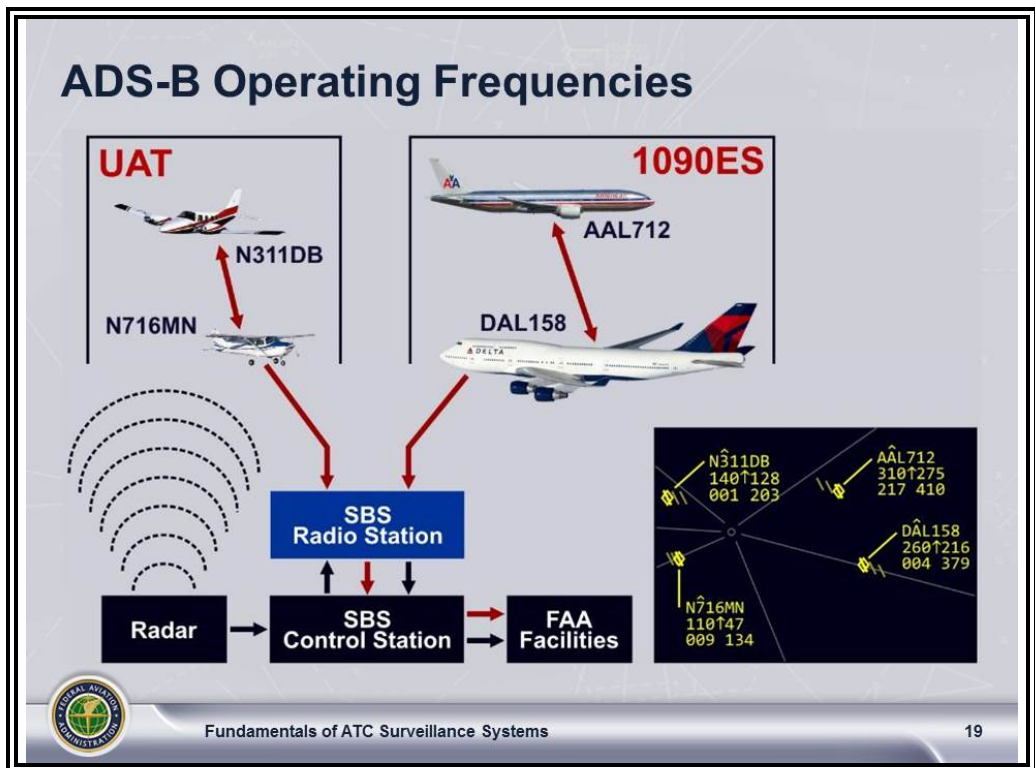
NOTE: The ground system of radio stations, data centers, and wide area network is known collectively as Surveillance and Broadcast Services (SBS).

- ⦿ For controllers, the result is an accurate display of ADS-B flights showing precise locations.
 - ⦿ ADS-B data can be recorded and downloaded for post-flight analysis.
-

ADS-B (Continued)

Operating Frequencies and Modes

AC 90-114,
par. 2-2.b

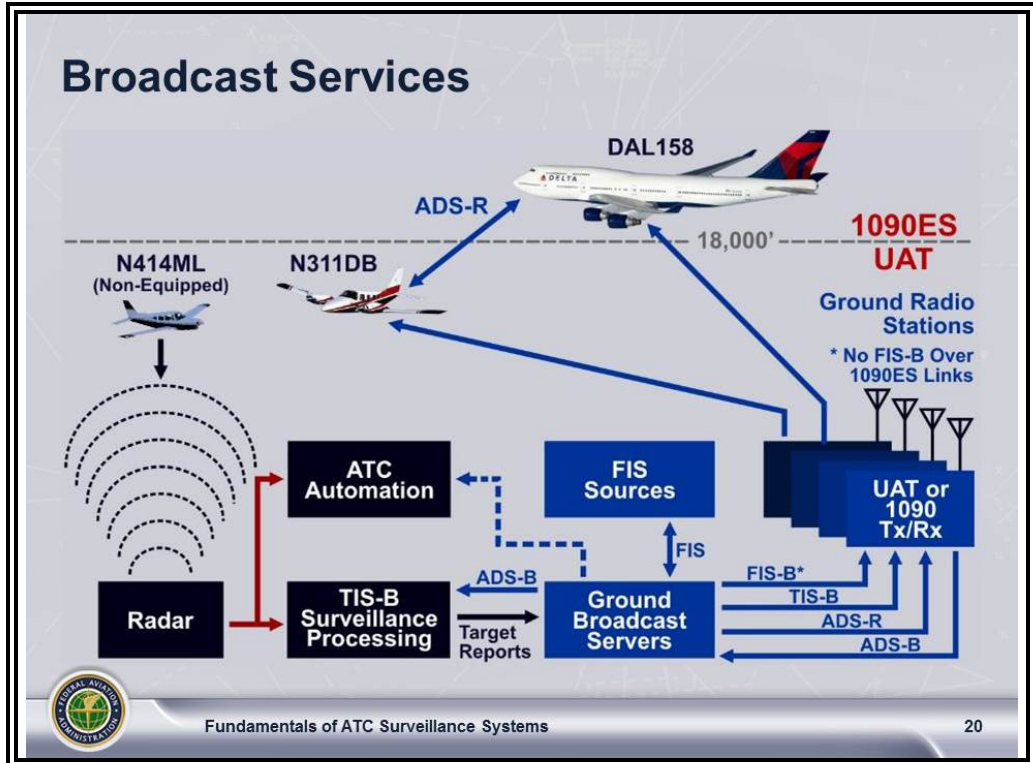


- ⊙ ADS-B operates on two frequencies:
 - Universal Access Transceivers (UAT)
 - 978 MHz
 - Used by general aviation
 - Used below 18,000
 - 1090ES (1090 MHz)
 - 1090 MHz
 - Used by most commercial aircraft and by military aircraft
 - Required at or above FL180 (Class A), but usable at all altitudes
- ⊙ ADS-B avionics can have the ability to transmit and receive information.
 - ADS-B Out - transmission of ADS-B information
 - ADS-B In - receipt of ADS-B information

ADS-B (Continued)

Broadcast Services

AC 90-114,
par. 2-3



NOTE: Use the graphic to explain ADS-R, TIS-B, and FIS-B.

- ⊙ SBS broadcasts information to aircraft as a service to aviation, which increases pilot situational awareness.

- Automatic Dependent Surveillance - Rebroadcast (ADS-R):
 - Because the ADS-B system operates on two separate frequencies, the information from each frequency must be reformatted and rebroadcast to enable aircraft operating on the alternate frequency to process and use the other's information.
 - This process occurs within the ADS-B control station.

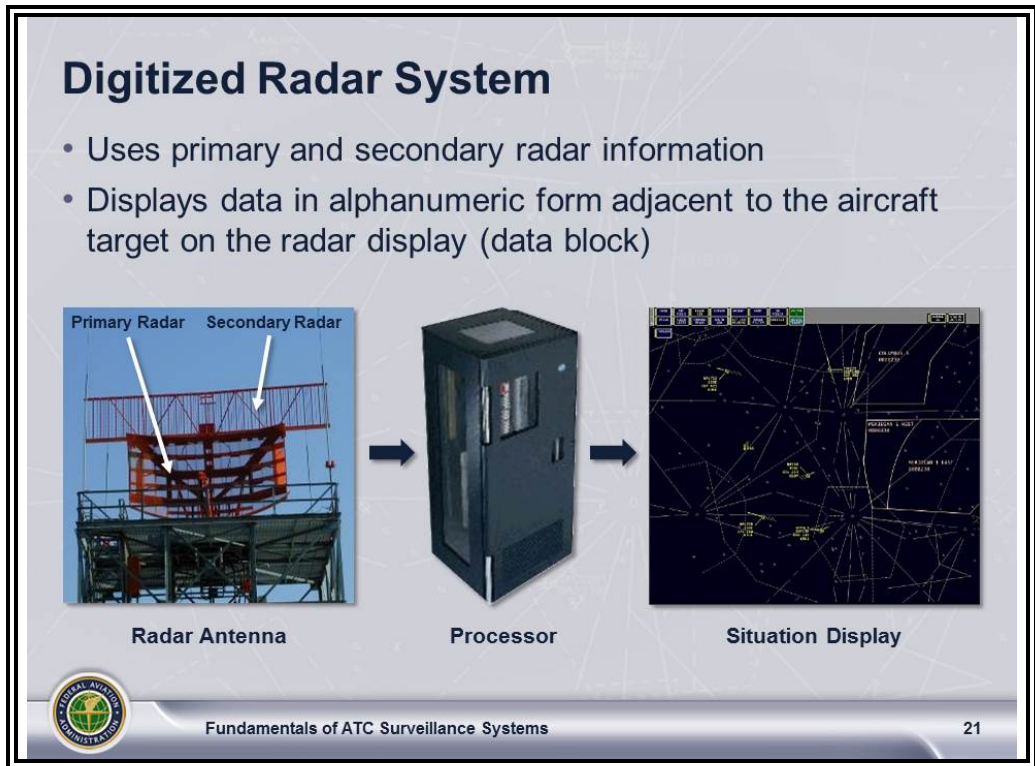
NOTE: Aircraft operating on the same ADS-B frequency exchange information directly (don't require translation). Aircraft with ADS-B IN capability on both UAT and 1090ES do not require ADS-R services

- Traffic Information Services - Broadcast (TIS-B): Provides ADS-B-IN equipped aircraft with a more complete picture of surrounding traffic, including non-ADS-B aircraft.
- Flight Information Services - Broadcast (FIS-B): Provides weather and aeronautical information. Available only to UATs.

DIGITIZED RADAR SYSTEM

Digitized Radar System Definition

ETM 12-0-1, p. 53



A **Digitized Radar System** uses basic primary and secondary radar information and displays it in alphanumeric form adjacent to the aircraft target on the radar display.

DIGITIZED RADAR SYSTEM *(Continued)*

Characteristics

ETM 12-0-1, p. 53;
TI 6110.100,
par. 1.2.7



Characteristics of a Digitized Radar System

1. Automatic target tracking
2. Uniform target and data size
3. Uniform display intensity
4. Conflict Alert feature
5. Mode C Intruder function
6. Minimum Safe Altitude Warnings (MSAW)
7. Ground speed display
8. Digitized weather display (NEXRAD)
9. Automatic flight plan updating (Flat Track)
10. Automatic pairing of target with an active flight plan
11. Flight plan modification (Trackball reroute)
12. Visual altitude information (Mode C)



Fundamentals of ATC Surveillance Systems

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- ⦿ Uses basic radar information in alphanumeric form
- ⦿ Data are grouped in a data block, which conforms to a specified tabular form.

DIGITIZED RADAR SYSTEM *(Continued)*

R-Position Console

TI 6110.100,
LOA-18



NOTE: Digitized radar equipment will be covered in later lessons.

- ⦿ System displays computer-processed alphanumeric data
 - Vertical face of the Flat Panel Monitor is known as a Situation Display

DIGITIZED RADAR SYSTEM *(Continued)*

Surveillance Sort Cells (SSCs)

TI 6110.141,
2-649 to 2-655



Surveillance Sort Cells (SSCs)

SURVEILLANCE SORT CELL:

- An area segment of the total ground region formed when a defined airspace is projected onto the earth's surface.
- Cells are locally adaptable to 16x16, 32x32, 48x48 or 64x64 nautical miles.



Fundamentals of ATC Surveillance Systems

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- ⦿ Grids divide the Situation Display.

NOTE: Grids are not displayed on the Situation Display.

- ⦿ Targets within a grid may be detected by one or more sensors.

Continued on next page

DIGITIZED RADAR SYSTEM *(Continued)*

Surveillance Sort Cells (SSCs) (Cont'd)

TI 6110.141,
p. 2-677 to 2-692;
ERAM SURV SRS
210.24, par.
3.2.1.4.2.5;
ERAM EDSM
SRS 210.04 V1B1,
par. 3.2.9.2.12



Surveillance Sort Cell Altitude Tier

- A volume of airspace with a defined floor and ceiling within a SSC in which sensors are prioritized for use for display and tracking.
- Each cell can contain up to five altitude tiers.
- Each altitude tier can be assigned up to nine different sensors:
 - Eight radar sites and ADS-B



Fundamentals of ATC Surveillance Systems

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- ⊙ Preferred and supplementary sensors are locally adaptable.
 - Determined by the best coverage within a sort box
- ⊙ SSCs may have up to 5 altitude tiers with up to 9 sensors for each tier:
 - Eight radar sites and ADS-B
- ⊙ SSC tiers may be locally adaptable for reduced separation.
- ⊙ Short range radars may be locally adapted to SSC's for use with long range radars used in ARTCCs.

ENHANCED RADAR COVERAGE

Enhanced Radar Coverage

TI 6110.100,
par. 1.2.6



Multiple Sensors (Preferred/Supplemental)

MULTIPLE SENSOR EXAMPLE:

- Long Range Radar updates approximately every 12 seconds.
- Short Range Radar updates approximately every 5 seconds.
- ADS-B updates approximately every second.

Grid not displayable on Situation Display

Fundamentals of ATC Surveillance Systems

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- ⦿ Automation provides the ability to adapt an increased number of radars in a center, which enhances radar coverage.
- ⦿ Automation also provides the capability to adapt several additional altitude tiers and an increased number of radars in each tier.
 - This flexibility reduces the likelihood that a radar target will be missed due to radar outages or incomplete radar coverage.
 - Improved flexibility in the definition of airspace volumes has improved the support for reduced separation areas.
- ⦿ Regardless of the individual sensor update rate, targets on the Situation Display will update approximately every 12 seconds.

CONCLUSION

Summary

 **NOTE:** Review and elaborate briefly on the following items:

- ⦿ Primary radar system
- ⦿ Air Traffic Control Radar Beacon System (ATCRBS) - Secondary radar
- ⦿ Factors that affect radar data display
- ⦿ Automatic Dependent Surveillance-Broadcast (ADS-B)
- ⦿ Characteristics of digitized radar systems
- ⦿ Enhanced radar coverage

 **NOTE:** Ask students if there are any questions.

End-of-Lesson Test

- ⦿ Your instructor will now administer the End-of-Lesson Test.

 **NOTE:** Distribute and administer the End-of-Lesson Test located in 55055-ELT01.
