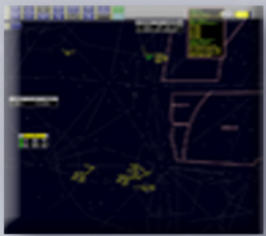
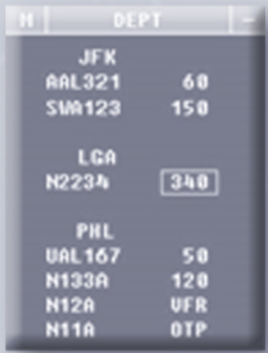
FAA Lesson Plan



En Route Stage 4
Radar Controller Training



Instructor

Radar Separation and Safety Alerts
Lesson 8

55055

V.1.06

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LESSON PLAN DATA SHEET

COURSE NAME:	RADAR CONTROLLER TRAINING
COURSE NUMBER:	55055
LESSON TITLE:	RADAR SEPARATION AND SAFETY ALERTS
DATE REVISED:	2014-04
VERSION:	V.1.06
REFERENCES:	JO 7110.65V, Air Traffic Control; JO 7210.3Y Facility Operation and Administration; JO 7110.311B, Procedural Guidance for FAA Order JO 7110.65 following En Route Automation Modernization (ERAM) Implementation; N JO 7110.647, Radar Identification Application; N JO 7110.626, Procedures for A380-800 and An225 Aircraft; TI 6110.100, En Route Automation Modernization (ERAM) Air Traffic Manual (ATM): R-Position User Manual; 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; ERAM EDSM SRS 210.04 V1B2, En Route Automation Modernization (ERAM) En Route Display Management (EDSM) Appendices for R-Position and General EDSM Requirements, Volume 1, Book 2
HANDOUTS:	55055-HO8, PRACTICE EXERCISE
EXERCISES:	YES (*REFER TO 55055-HO08.PDF)* *LAB SCENARIOS ARE REQUIRED FOR THE EXERCISE. THE EXERCISE IS ESTIMATED TO TAKE 1 HOUR LAB TIME PER STUDENT.*
END-OF-LESSON TEST:	YES *(REFER TO 55055-ELT08B.PDF [BLACK/WHITE] OR 55055-ELT08C.PDF [COLOR].)*
PERFORMANCE TEST:	NONE
MATERIALS:	NONE
OTHER PERTINENT INFORMATION:	SCENARIO REQUIREMENTS ARE LOCATED IN INSTRUCTOR HANDOUT. 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

Your primary task as an air traffic controller is to separate aircraft and provide safety alerts. In order to perform your main job while providing a safe and expeditious flow of traffic, you must know the separation requirements.

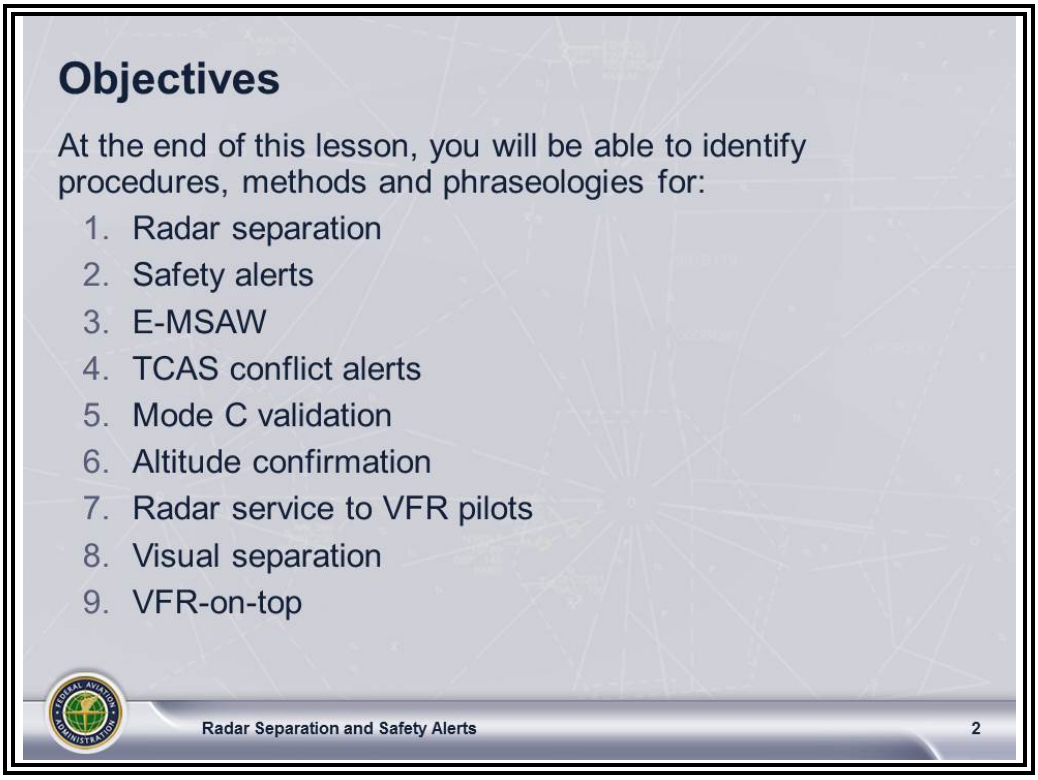
Purpose

This lesson covers the minimum radar separation required between aircraft, between aircraft and the boundary of adjacent radar or nonradar controlled airspace, and obstructions.

We will also cover the issuance of safety alerts, the conflict alert feature and procedures for altitude verification and visual separation, TCAS procedures, radar service to VFR aircraft, and VFR-on-top operations.

INTRODUCTION *(Continued)*

Objectives



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

RADAR SEPARATION

Terminology
JO 7110.65, Pilot/Controller Glossary

📖 **Altitude readout** is an aircraft's altitude, transmitted via the Mode C transponder feature, that is visually displayed in 100-foot increments on a radar scope having readout capability.

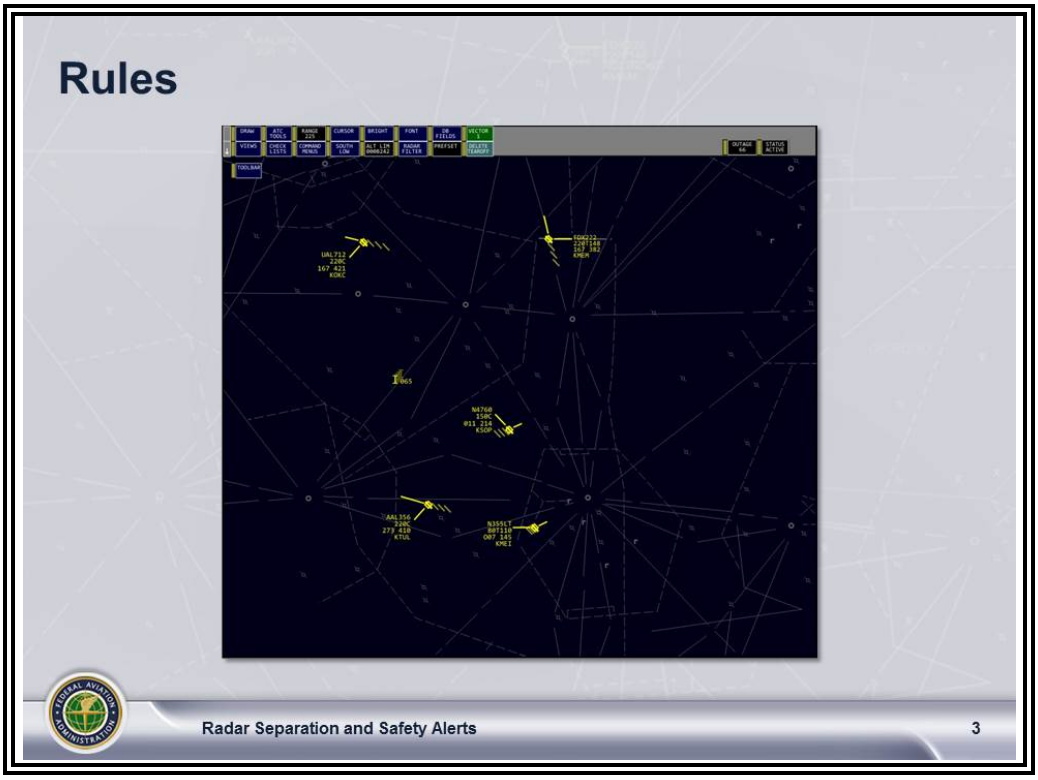
📖 **Conflict alert (CA)** is a function of certain air traffic control automated systems designed to alert radar controllers to existing or pending situations between tracked targets (known IFR or VFR aircraft) that require his/her immediate attention/action.

📖 **E-MSAW (En Route Minimum Safe Altitude Warning)** is a function of the En Route Automation System (EAS) that aids the controller by providing an alert when a tracked aircraft is below or predicted by the computer to go below a predetermined minimum IFR altitude (MIA).

📖 **Mode C Intruder Alert (MCI)** is a function of certain air traffic control automated systems designed to alert radar controllers to existing or pending situations between a paired target (known IFR or VFR aircraft) and an unpaired target (unknown IFR or VFR aircraft) that requires immediate attention/action.

RADAR SEPARATION *(Continued)*

Rules
JO 7110.65,
pars. 4-4-1, 5-5-1,
5-14-7;
N JO 7110.647,
par. 5-5-1



- ⊙ Radar separation must be applied to all area navigation (RNAV) aircraft on a random route at or below FL450, and to all published Q Routes in the conterminous United States.
  - The exception to this are GNSS equipped aircraft /G, /L, /S, and /V not on random impromptu routes:
    - When not being radar monitored, GNSS-equipped RNAV aircraft on random RNAV routes must be cleared via or reported to be established on a point-to-point route.
    - Protect 4 miles either side of the route centerline.
- ⊙ Radar separation may be applied between:
  - Radar-identified aircraft
  - A radar-identified aircraft and a departure that will be radar-identified within 1 mile of the takeoff runway end

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RADAR SEPARATION *(Continued)*

Rules (Cont'd)
JO 7110.65, pars. 5-5-1, 5-14-7;
N JO 7110.647, par. 5-5-1

☞ ***NOTE:*** *Stress the difference between 1 mile from airport and 1 mile from runway end. (Aircraft could be airborne a considerable time, making a 180 degree turn to proceed on course, and still be within 1 mile of the airport.) This rule is difficult to use in en route environment unless runways are displayed.*

- An identified aircraft and one not radar-identified when either aircraft is cleared to climb/descend through the altitude of the other, provided:
  - The performance of the radar system is adequate.
  - Primary radar targets or full digital radar primary symbol targets are being displayed within the airspace within which radar separation is being applied.
  - Flight data on the aircraft not radar-identified indicate it is a type that can be expected to give adequate primary returns in the area where separation is applied.
  - The airspace within which radar separation is applied is not less than 10 miles from the edge of the radar display.
  - Radar separation is maintained between the radar-identified aircraft and all observed primary and secondary radar targets until nonradar separation is established from the aircraft not radar identified.
  - When the aircraft involved are on the same relative heading, the radar-identified aircraft is vectored a sufficient distance from the route of the aircraft not radar identified to assure the targets are not superimposed prior to issuing the clearance to climb/descend.
- A radar-identified aircraft and one not radar-identified that is in transit from oceanic airspace or non-radar offshore airspace into an area of known radar coverage where radar separation is applied as specified in Paragraph 8-5-5, Radar Identification Application, until the transiting aircraft is radar identified or the controller establishes other approved separation in the event of a delay or inability to establish radar identification of the transiting aircraft.

NOTE: This is typically applied to broadband systems and not generally used in the en route environment.

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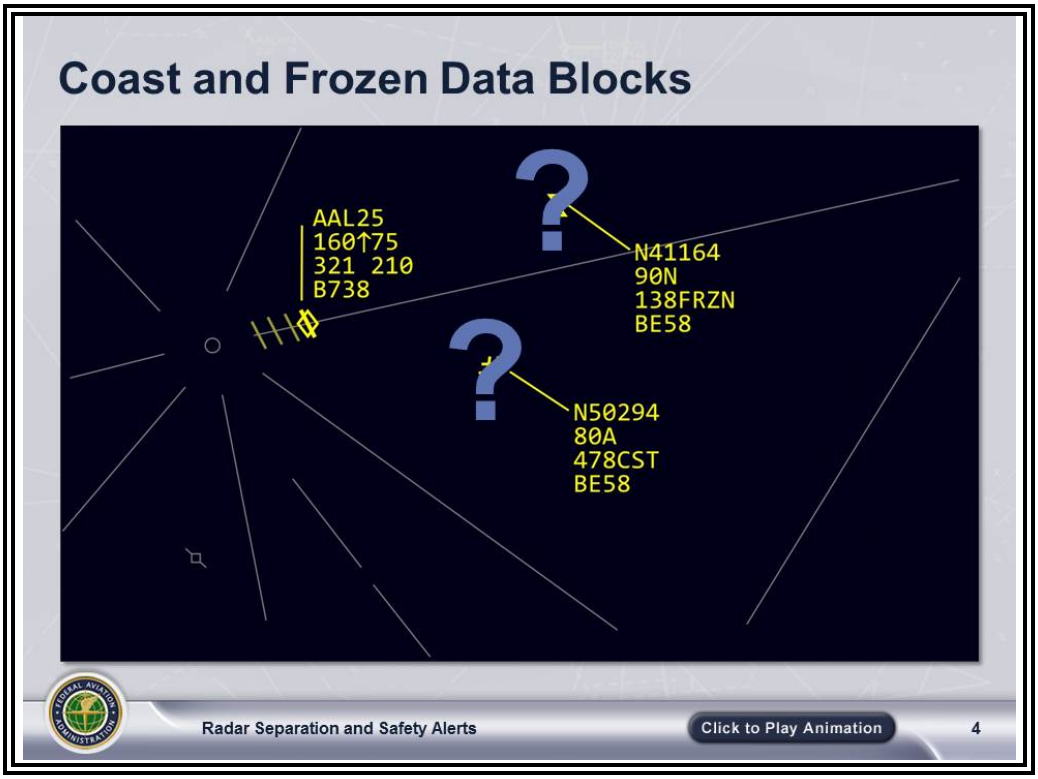
RADAR SEPARATION *(Continued)*

Rules (Cont'd)
JO 7110.65, pars. 5-5-1, 5-14-7;
JO 7110.311B, par. 5-14-7

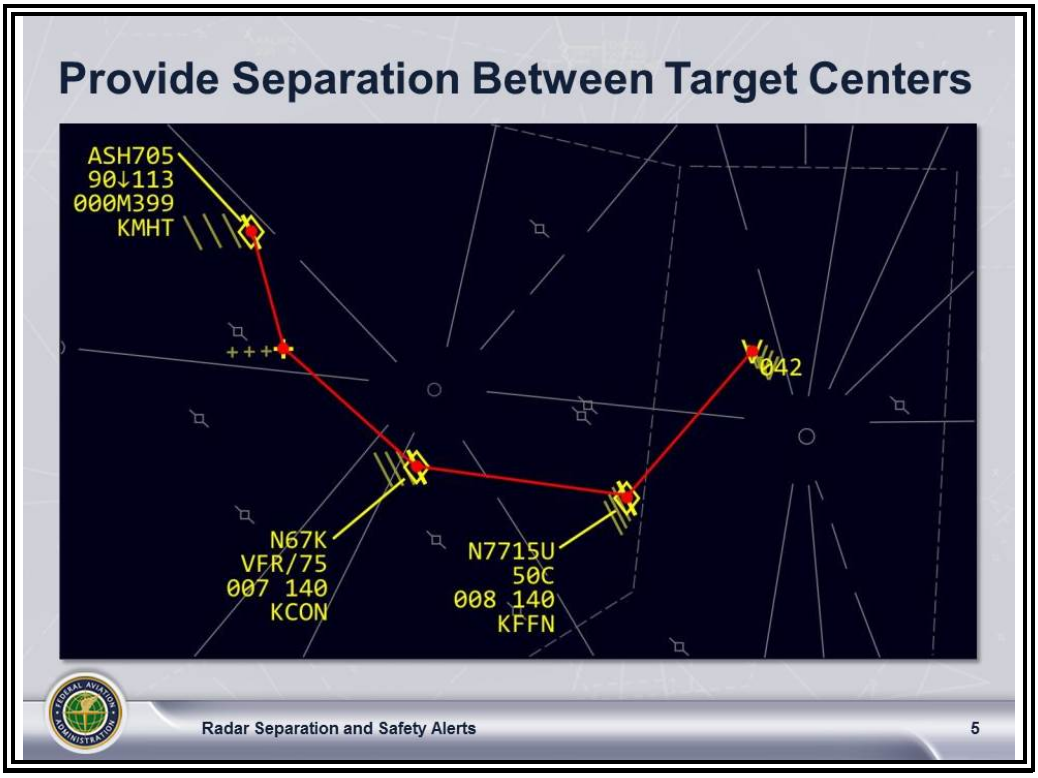


Click to animate.

- Do not use information in data blocks displaying CST or FRZN in the application of either radar or non-radar separation.

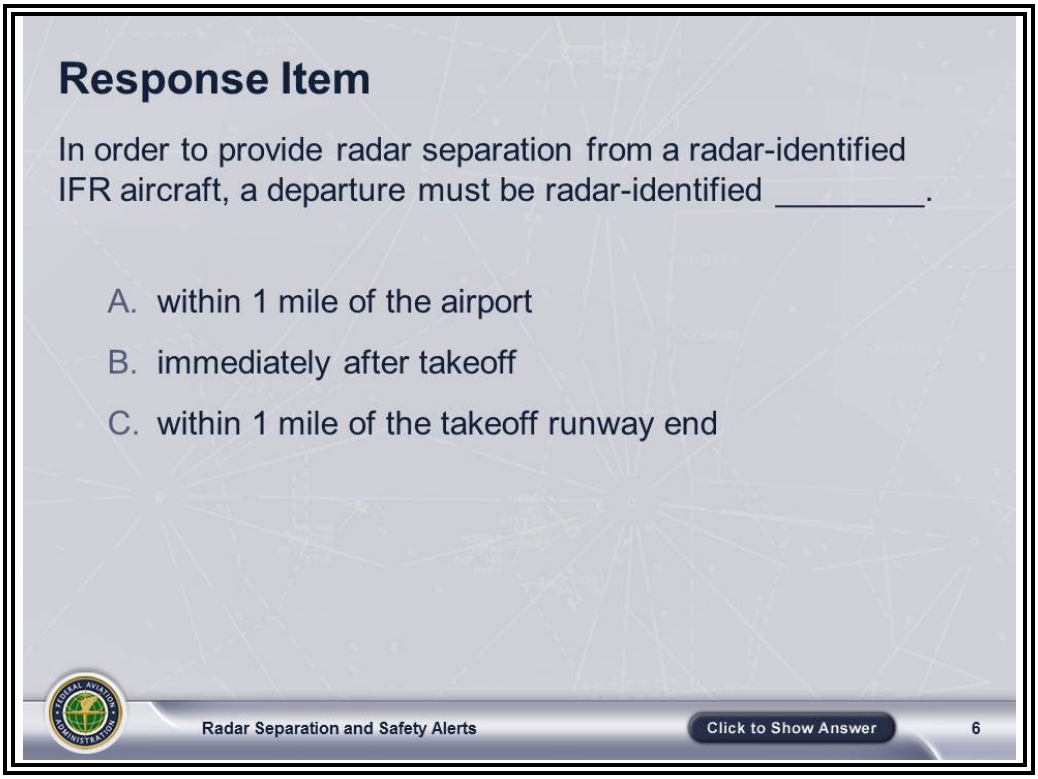
RADAR SEPARATION *(Continued)*

Target Separation
JO 7110.65, pars. 5-5-2, 5-5-3



- Apply radar separation on digital displays:
  - Between the centers of digitized targets
  - Do not allow digitized targets to touch

Review



SLIDE ANSWER: C

QUESTION: What part of a target must be used as a reference point of separation?

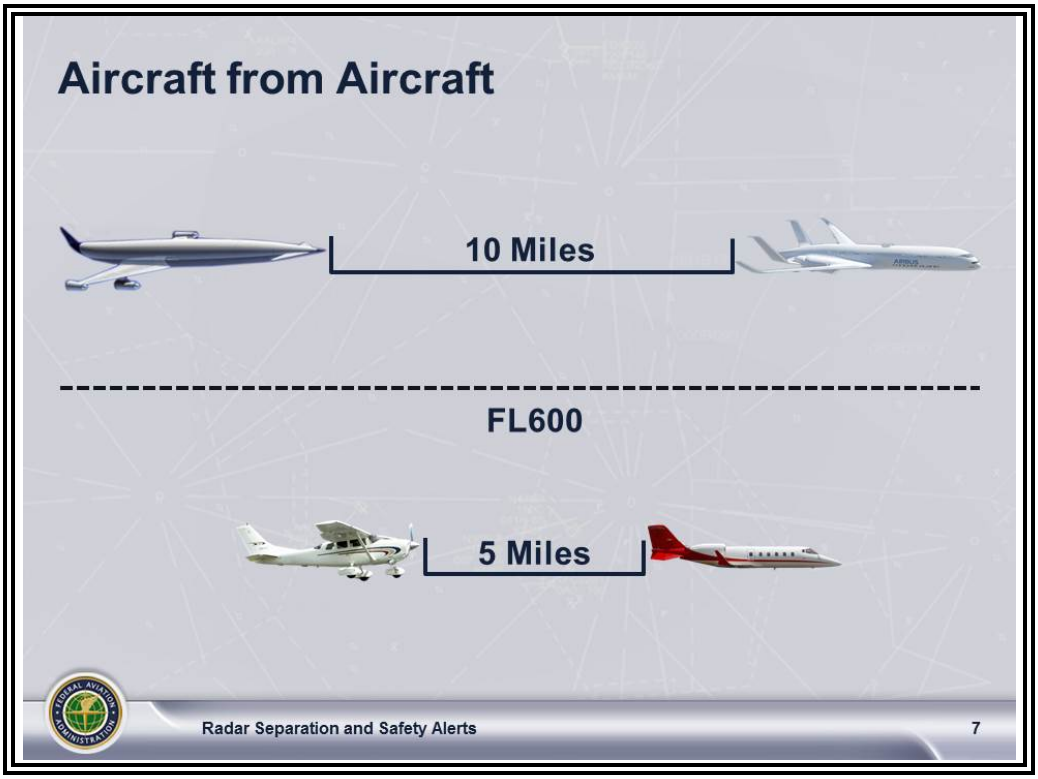
ANSWER: *The center*

QUESTION: True or false? Radar separation must be applied to all RNAV aircraft?

ANSWER: *False*

RADAR SEPARATION *(Continued)*

Minima Between Aircraft
JO 7110.65, par. 5-5-4;
JO 7210.3, par. 8-2-1;
JO 7110.311B



⊙ Separate one aircraft from another aircraft by the following minima:

- At or above FL600 - 10 miles
- Below FL600 - 5 miles
- Below FL 180 where all the following conditions are met – 3 miles:
  - Significant operational advantages can be obtained.
  - Within 40 miles of the preferred sensor, and within the 3 NM separation area.
  - The preferred sensor is providing reliable beacon targets.
  - Facility directives specifically define the 3 NM separation area.
  - The 3 NM separation area is displayable on the video map.
  - Involved aircraft are displayed using the 3 NM target symbol.

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RADAR SEPARATION *(Continued)*

Minima Between Aircraft (Cont'd)
JO 7110.65, par. 5-5-4;
JO 7210.3, par. 8-2-1;
JO 7110.311B

⊙ When transitioning from terminal to en route control, 3 miles increasing to 5 miles or greater, provided:

- The aircraft are on diverging routes/courses, and/or
- The leading aircraft is and will remain faster than the following aircraft; and
- Separation constantly increasing and the first center controller will establish 5 NM or other appropriate form of separation prior to the aircraft departing the first center sector; and
- The procedure is covered by a Letter of Agreement (LOA) between the facilities involved and limited to specified routes and/or sectors/positions.

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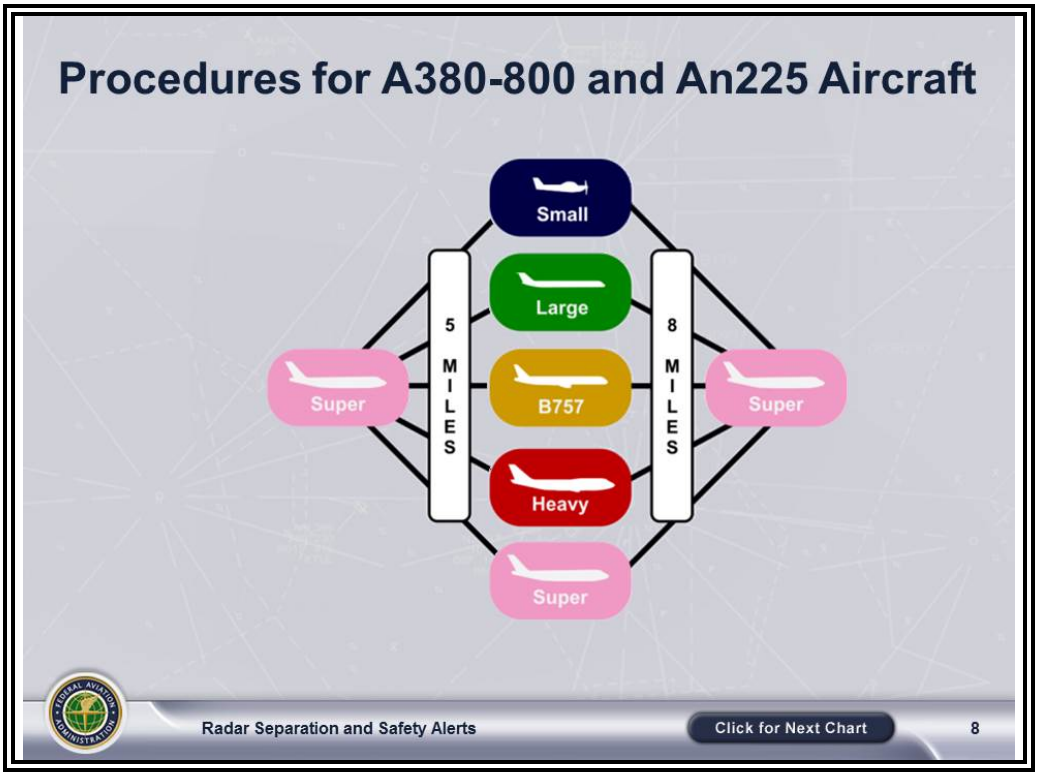
RADAR SEPARATION *(Continued)*

Minima Between Aircraft (Cont'd)
JO 7110.65, par. 5-5-4;
N JO 7110.677, par.5



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- ⊙ Separate aircraft operating directly behind the A388 or An225 by the following minima:
  - 5 miles
  - 8 miles – When an A388/An225 is operating at or below 250 KIAS and below FL240
- ⊙ Provide a minimum of 8 miles in-trail spacing behind an A388/An225 when transitioning from en route to terminal airspace.

NOTE: This interval must exist when the leading aircraft crosses the terminal/en route boundary or transfer of control point.

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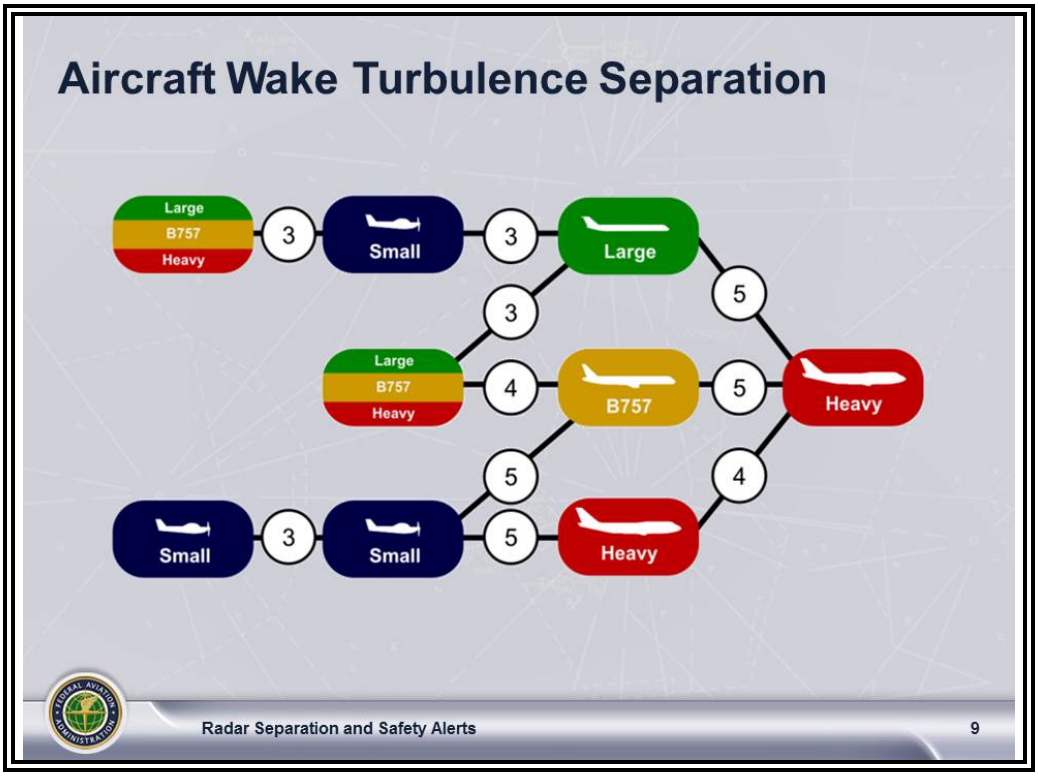
RADAR SEPARATION *(Continued)*

Minima Between Aircraft (Cont'd)
JO 7110.65, par. 5-5-4;
N JO 7110.667, par. 5

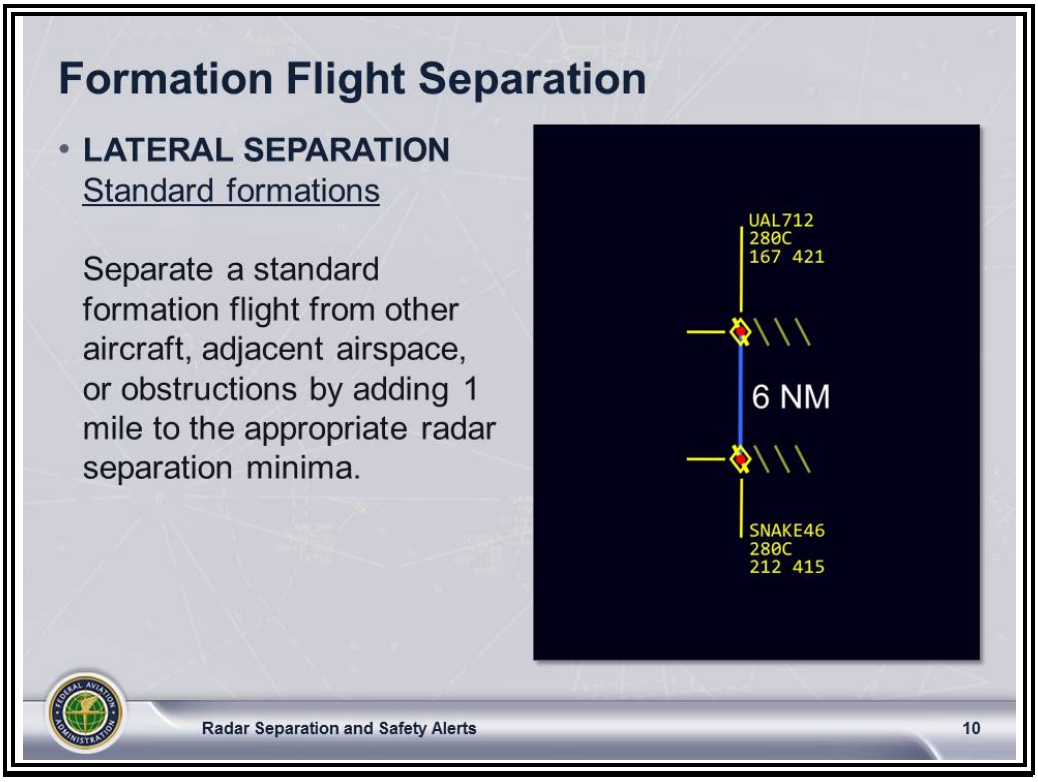


Wake Turbulence

- Separate aircraft operating directly behind, or directly behind and less than 1,000 feet below, or following an aircraft conducting an instrument approach by:
  - 4 miles – heavy or behind heavy
  - 4 miles – large/heavy behind B757
  - 5 miles – small behind B757
  - 5 miles – small/large behind heavy
- A388/An225, when applying wake turbulence separation criteria that are defined in minutes, add one additional minute.

RADAR SEPARATION *(Continued)*

Formation Flight Separation
JO 7110.65, pars. 2-1-13, 5-5-8



- ⊙ Control formation flights as a single aircraft
- ⊙ Provide supplemental separation from formation flights as follows:
  - Aircraft from standard formations:
    - – Add 1 mile to minimum.

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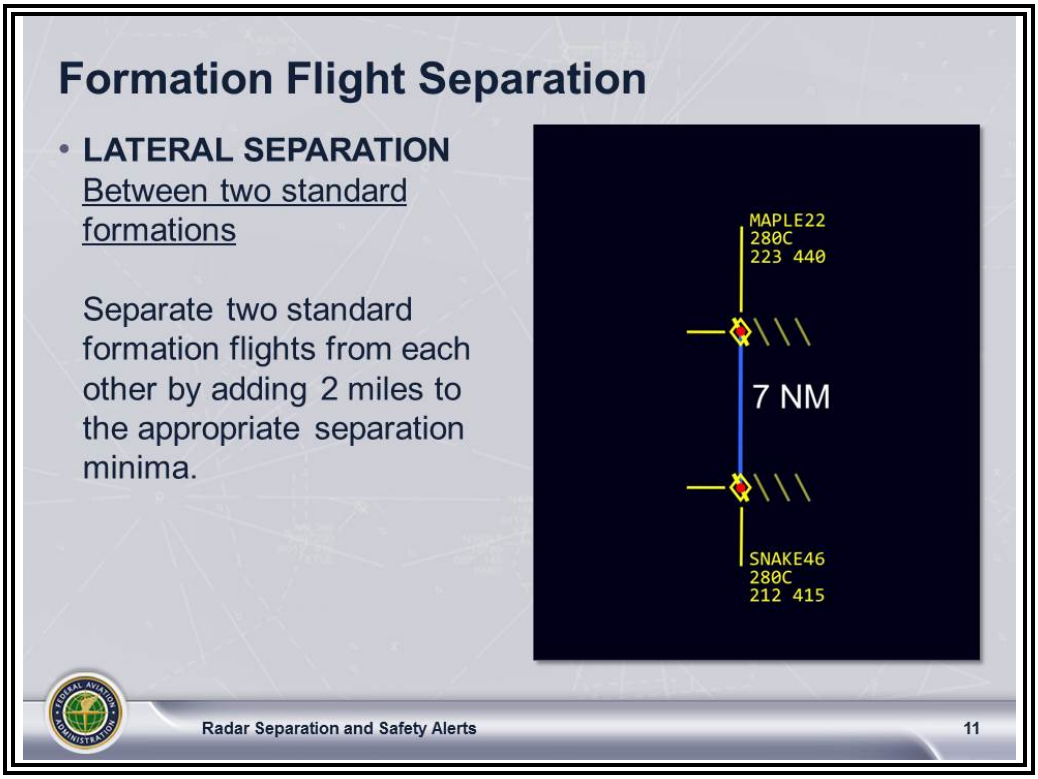
RADAR SEPARATION *(Continued)*

Formation Flight Separation (Cont'd)
JO 7110.65, pars. 2-1-13, 5-5-8



- Two standard formation flights from each other:
  - Add 2 miles to minimum.

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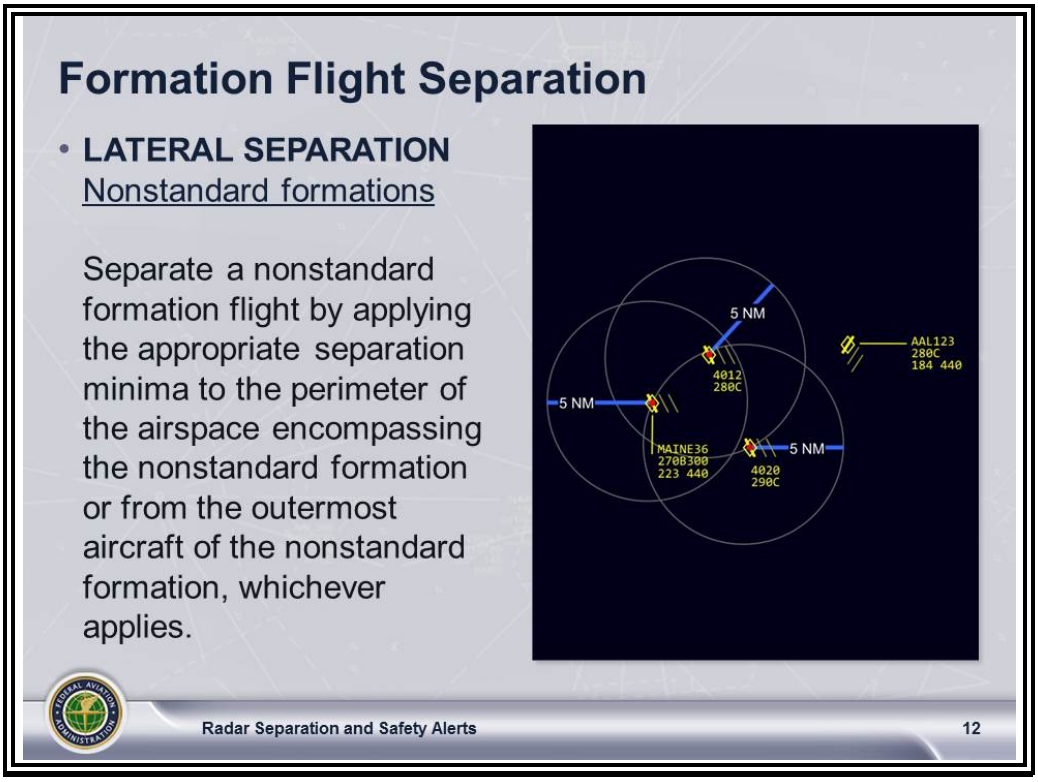
RADAR SEPARATION *(Continued)*

Formation Flight Separation (Cont'd)
JO 7110.65, pars. 2-1-13, 5-5-8



- Aircraft from nonstandard formations:
  - Apply appropriate minima to:
    - → Perimeter of encompassing airspace, or
    - → Outermost aircraft
- If necessary for separation, assign appropriate beacon code to:
  - Each aircraft in the formation, or
  - First and last aircraft in-trail
- Upon flight break-up:
  - Question each aircraft as to their RVSM status, and
  - Make the appropriate equipment suffix changes.

NOTE: Application of RVSM separation standards to formation flights is dependent upon the RVSM status of all aircraft involved. RVSM separation is only applied to formation flights consisting of all RVSM approved aircraft.

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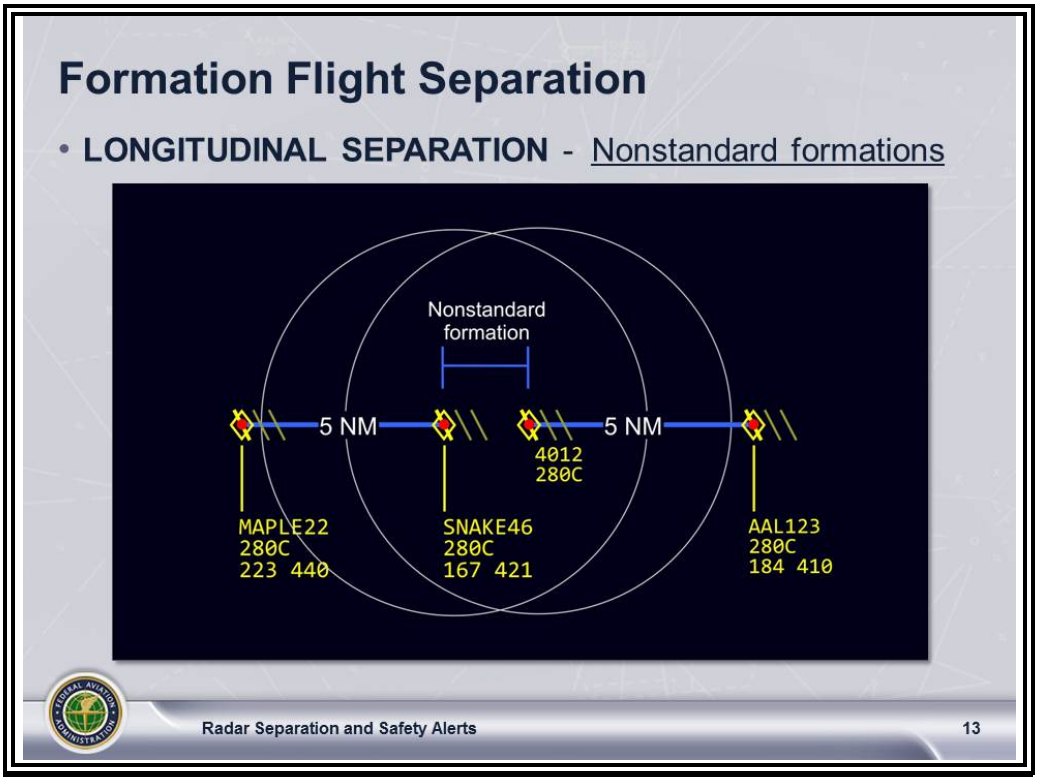
RADAR SEPARATION *(Continued)*

Formation Flight Separation (Cont'd)
JO 7110.65, pars. 2-1-13, 5-5-8



Vertical Separation
JO 7110.65, par, 5-5-5

⊙ Aircraft not laterally separated, may be vertically separated by one of the following methods:

- Assign altitudes to aircraft, provided:
  - Valid Mode C is monitored
  - Applicable minima is maintained at all times
- Assign an altitude to an aircraft, provided the aircraft previously at that altitude:
  - Has been issued a climb/descent clearance, and
  - Is observed (valid Mode C) or reports leaving the altitude

    → Consider aircraft characteristics and any other information which might indicate less-than-expected performance.

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RADAR SEPARATION *(Continued)*

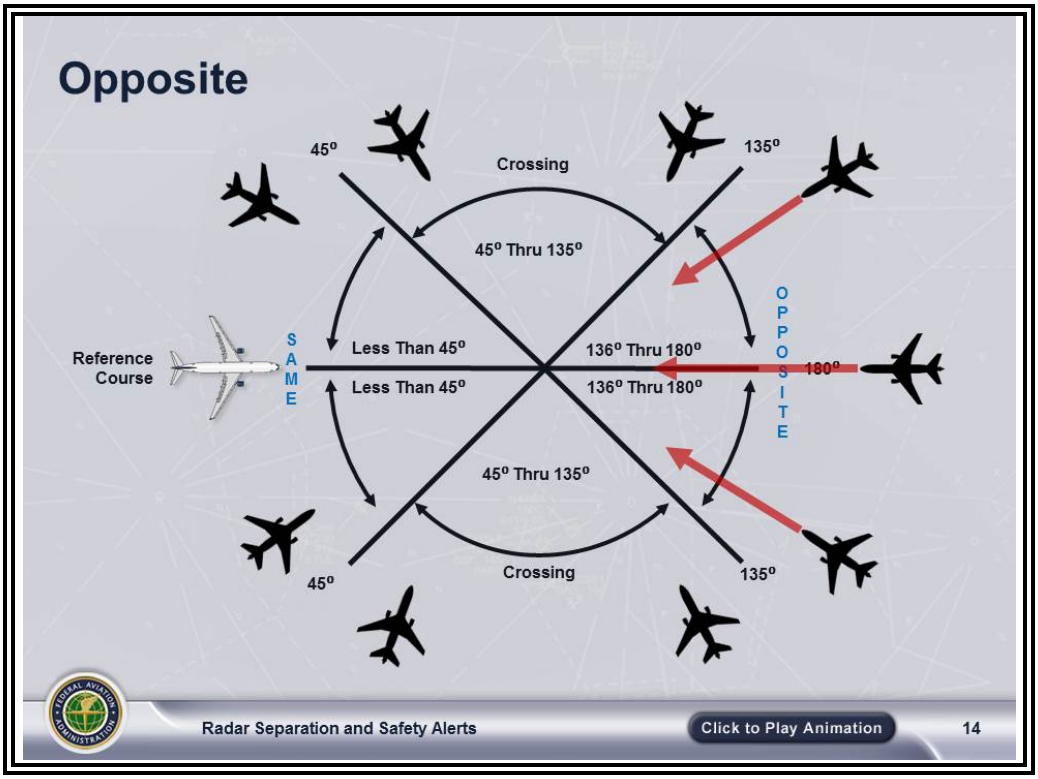
Vertical Separation (Cont'd)
JO 7110.65, par. 5-5-6

⊙ Exceptions:

- Do not use Mode C to effect vertical separation with an aircraft on a:
  - Cruise clearance
  - Contact approach
- Assign an altitude to an aircraft only after the aircraft previously at that altitude is observed at or passing through another altitude separated from the first by the appropriate minima when:
  - Severe turbulence is reported.
  - Aircraft are conducting military aerial refueling.
  - The aircraft previously at that altitude has been issued a climb/descent at pilot's discretion.

RADAR SEPARATION *(Continued)*

Passing or Diverging
JO 7110.65, par. 5-5-7;
N JO 7110.677



Click to animate.

⊙ Vertical separation may be discontinued between aircraft on opposite courses if **ALL** the following conditions are met:

- You are in communications with both aircraft.
- You tell the pilot of one aircraft about the other, including position, direction, and type.
- One pilot reports seeing and passing the other aircraft.
- You observe the radar targets have passed.
- You advise the pilots if either aircraft is a B757 or is classified as Heavy or Super.

✈ **Phraseology Example**

"TRAFFIC, TWELVE O'CLOCK, TWO MILES, OPPOSITE DIRECTION, BOEING SEVEN SIXTY-SEVEN, FLIGHT LEVEL THREE ONE ZERO. DO YOU HAVE IT IN SIGHT?" (if reply is affirmative) "REPORT PASSING THE TRAFFIC."

(Once you get the report passing **and** radar targets confirm this report, issue appropriate altitude clearance.)

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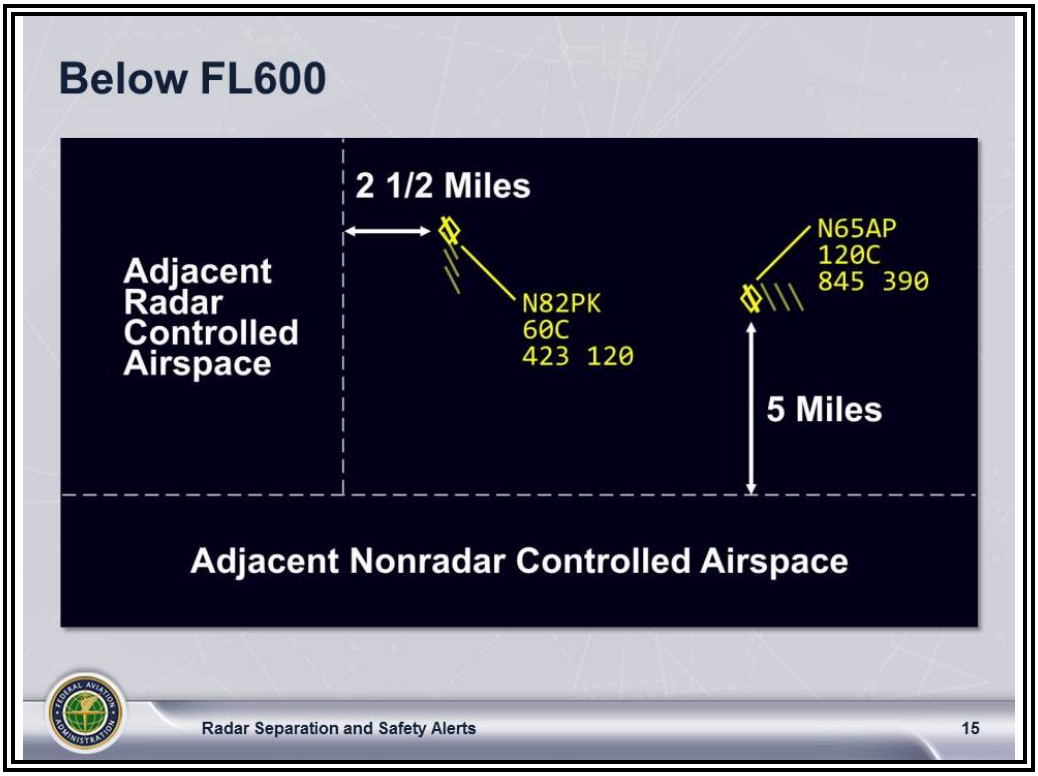
RADAR SEPARATION *(Continued)*

Minima From Obstructions and Adjacent Airspace (Cont'd)
JO 7110.65, pars. 5-5-9, 5-5-10



- Separate aircraft from obstructions by the following minima:
  - 5 miles
- Separate aircraft from adjacent airspace by the following minima:
  - Below FL600:
    - Adjacent radar controlled airspace - 2 ½ miles
    - Adjacent nonradar controlled airspace - 5 miles
- Separate radar-controlled aircraft from the boundary of airspace in which nonradar separation is being used by the following minima:
  - When less than 40 miles from the antenna − 3 miles
  - When 40 miles or more from the antenna − 5 miles

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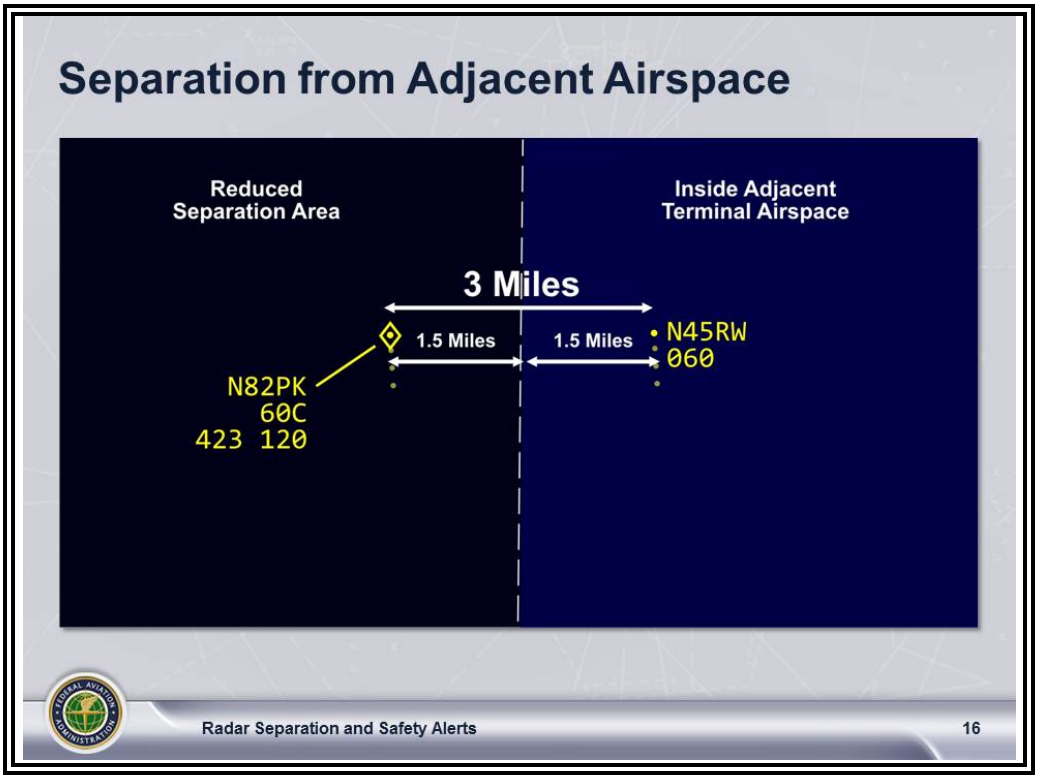
RADAR SEPARATION *(Continued)*

Minima From Obstructions and Adjacent Airspace (Cont'd)
JO 7110.65, pars. 5-5-9, 5-5-10



- If coordination between the controllers concerned has not been effected, separate radar-controlled aircraft from the boundary of adjacent airspace in which radar separation is also being used by the following minima:
  - When 40 miles or more from the antenna − 2 1/2 miles
  - When less than 40 miles from the antenna − 1 1/2 miles

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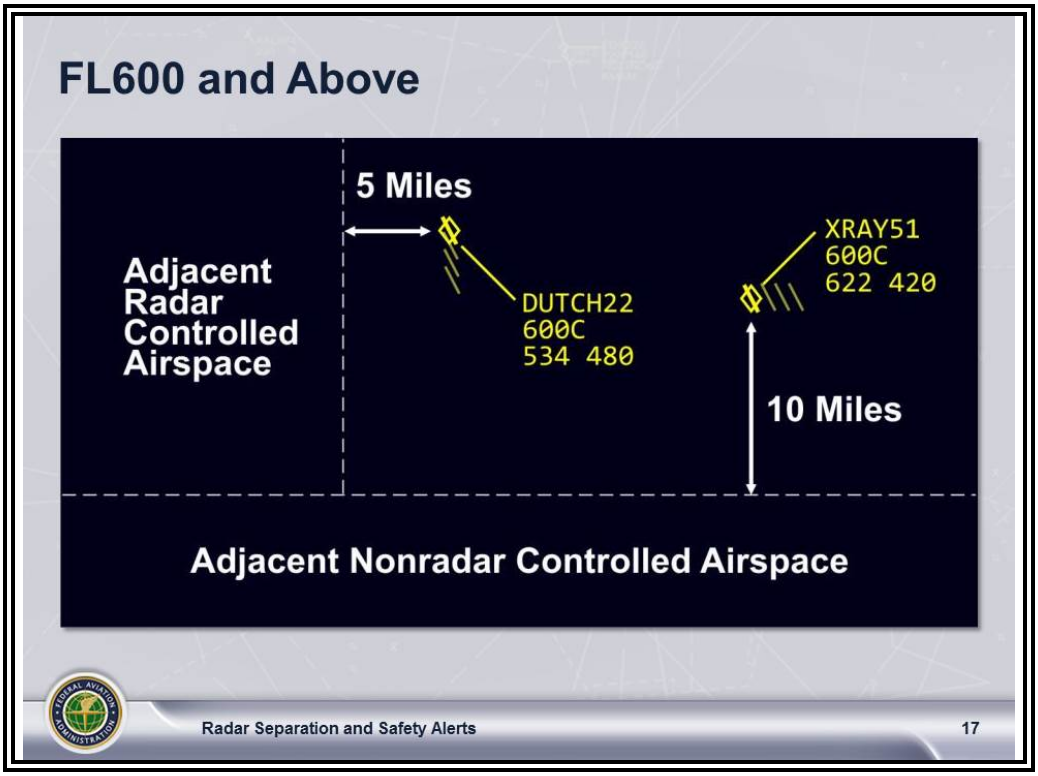
RADAR SEPARATION *(Continued)*

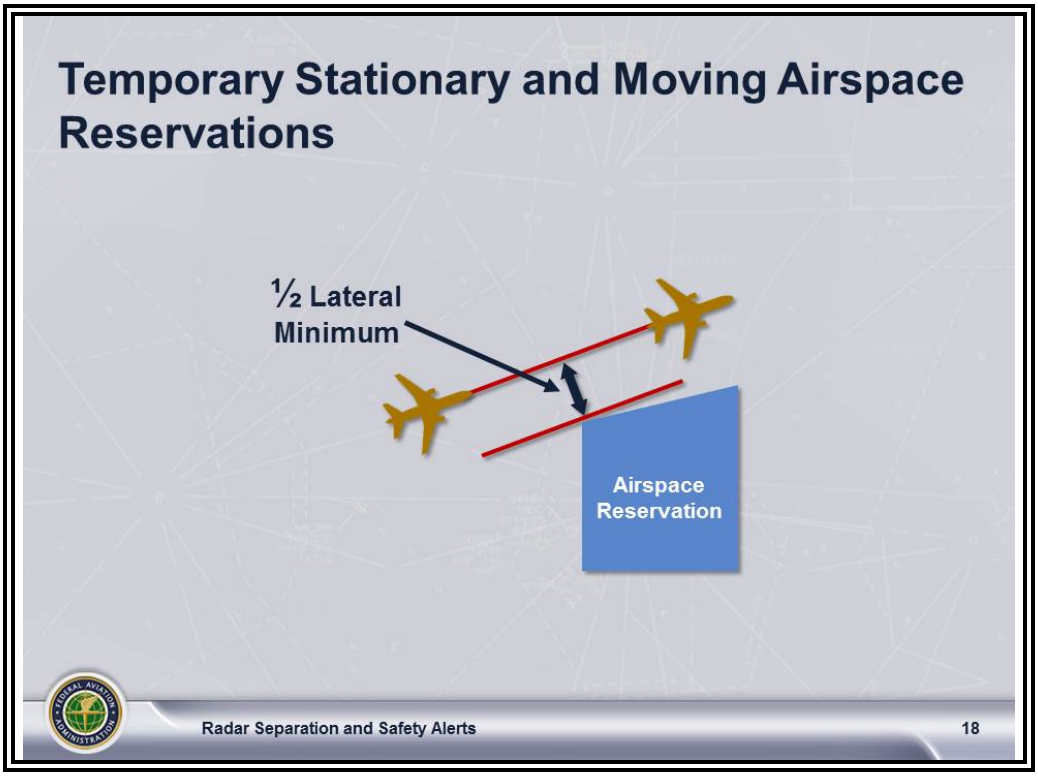
Minima From Obstructions and Adjacent Airspace (Cont'd)
JO 7110.65, pars. 5-5-9, 5-5-10



- Separate aircraft from adjacent airspace FL600 and above:
  - Adjacent radar controlled airspace − 5 miles
  - Adjacent nonradar controlled airspace − 10 miles

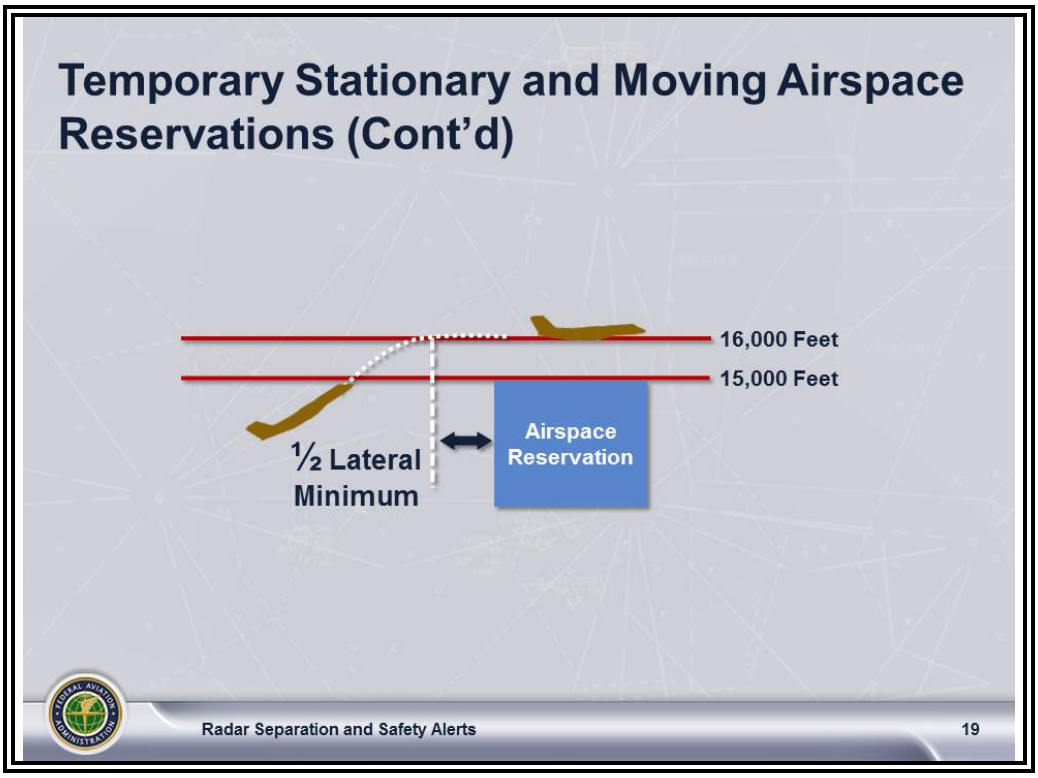
RADAR SEPARATION *(Continued)*

Temporary Stationary Airspace Reservations
JO 7110.65, par. 8-6-1



- Separate aircraft from a temporary stationary reservation by one of two methods:
  - Laterally
    - Clear aircraft so that the protected airspace along the route of flight does not overlap the geographical area of the stationary reservation.
  - Vertically
    - Clear aircraft so that vertical separation exists while the aircraft is within a geographical area defined as the stationary reservation.
    - Include a buffer around the perimeter equivalent to one-half the lateral separation minimum.

Temporary Moving Airspace Reservations
JO 7110.65, pars. 8-6-2, 8-6-3



- Separate aircraft from a temporary moving airspace reservation by one of the following methods:
  - Laterally
    - Clear aircraft so that the protected airspace along the route of flight does not overlap the (time-dependent) geographical area of the moving airspace reservation.
  - Longitudinally
    - Clear aircraft so that the appropriate longitudinal minimum exists ahead of the first or behind the last aircraft operating within the reservation.
  - Vertically
    - Clear aircraft so that vertical separation exists while the aircraft is within a (time-dependent) geographical area defined as the moving airspace reservation plus a buffer around the perimeter equivalent to one-half the lateral separation minimum.

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RADAR SEPARATION *(Continued)*

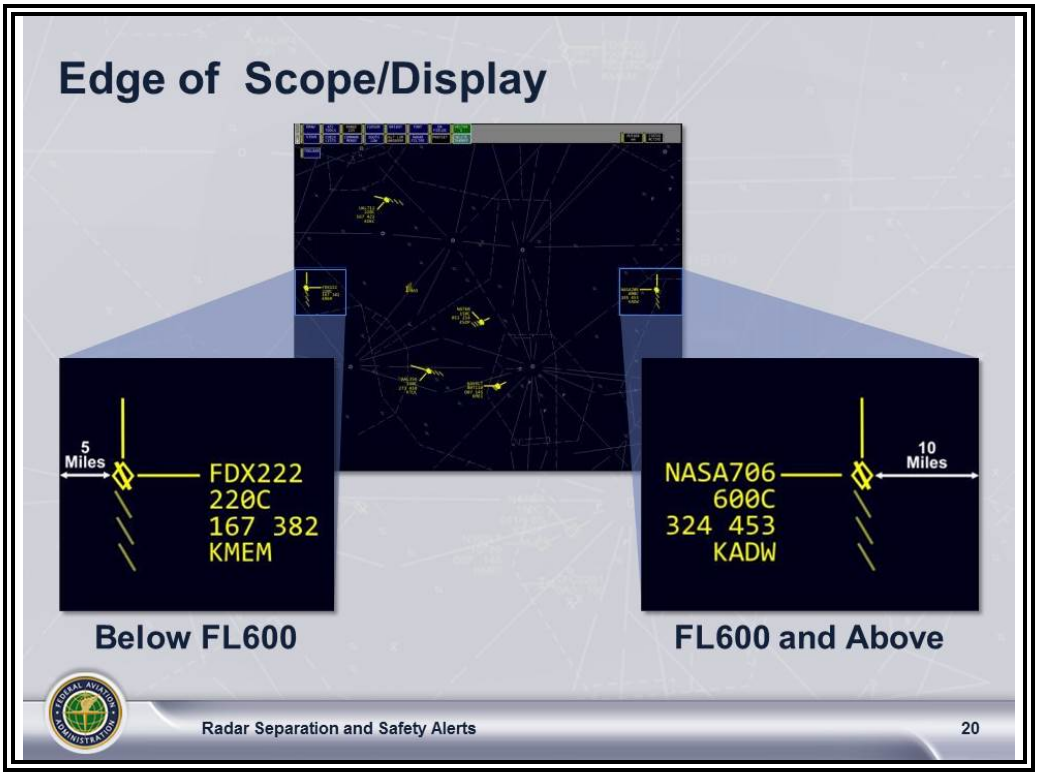
Temporary Moving Airspace Reservations (Cont'd)
JO 7110.65, pars. 8-6-2, 8-6-3

⊙ Refusal of Avoidance Clearance

- If a pilot refuses to accept a clearance to avoid a reservation:
  - Inform him/her of the potential hazard.
  - Advise him/her that services will not be provided while the flight is within the reservation.
  - Inform the appropriate using agency, if possible.

RADAR SEPARATION *(Continued)*

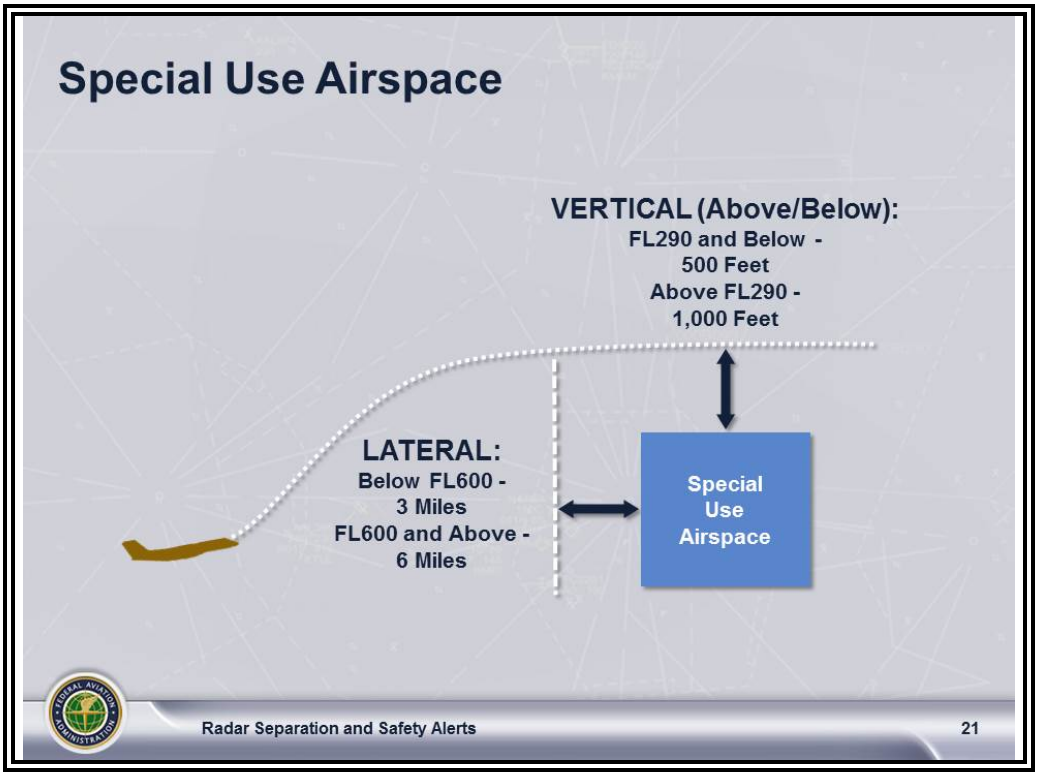
Minima From Edge of Scope
JO 7110.65, par. 5-5-11



- Aircraft from edge of scope:
  - Until nonradar separation has been established, separate radar-controlled aircraft climbing/descending through the altitude of aircraft that has been tracked to the edge of the scope by:
    - Below FL600 − 5 miles
    - FL600 and above − 10 miles

RADAR SEPARATION *(Continued)*

Minima from Special Use Airspace
JO 7110.65, par. 9-3-2



⊙ Separate aircraft from Special Use and Air Traffic Control Assigned Airspace (ATCAA):

NOTE: Special Use airspace includes Prohibited/Restricted/Warning and Military Operations Area (MOA).

- Involving aircraft operations
  - Lateral:
    - → Below FL600 - 3 miles
    - → FL600 and above - 6 miles
  - Vertical (above/below):
    - → FL290 and below - 500 feet
    - → Above FL290 - 1,000 feet
- Exception: Some prohibited/restricted/warning areas are established for security reasons or to contain hazardous activities not involving aircraft operations.
  - Where facility management has identified these areas as outlined in FAA Order JO 7210.3, Facility Operation and Administration, vector aircraft to remain clear of the peripheral boundary.

RADAR SEPARATION *(Continued)*

Review

QUESTION: What is the minimum lateral radar separation between two aircraft at FL260?

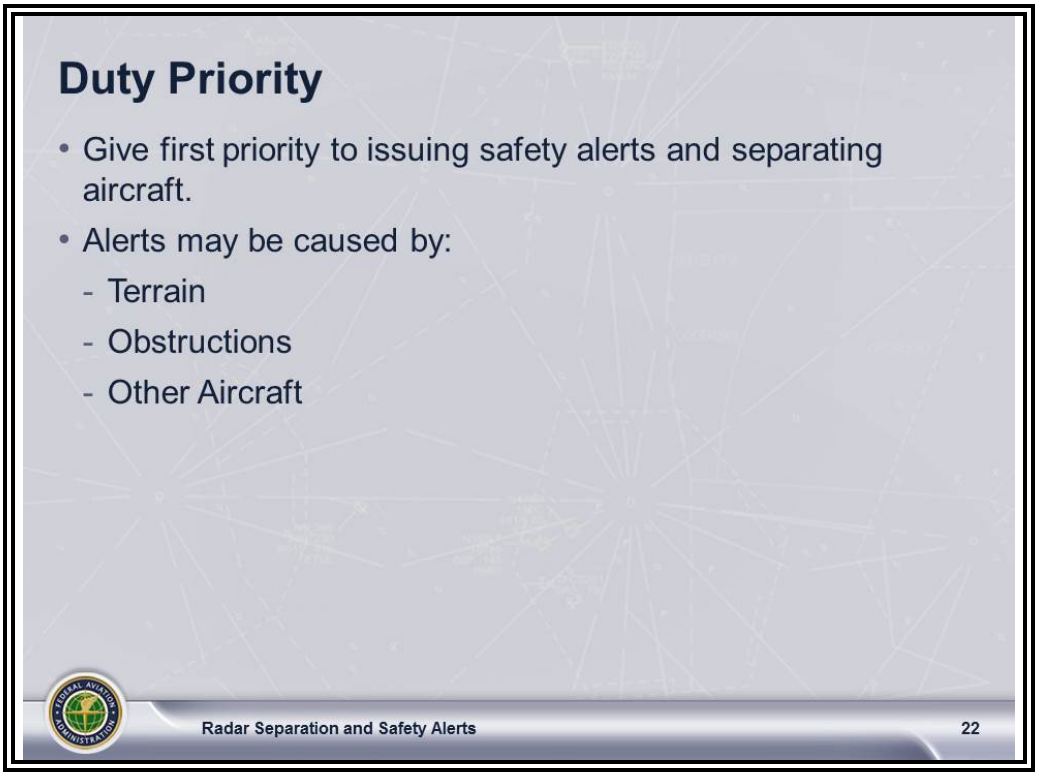
ANSWER: *5 miles*

QUESTION: What is the minimum lateral separation between an aircraft at 16,000 and a Military Operations Area (MOA)?

ANSWER: *3 miles*

SAFETY ALERTS

Duty Priority
JO 7110.65,
pars. 2-1-2, 2-1-6,
5-14-1



⊙ Give first priority to issuing safety alerts and separating aircraft.

- Perform action most critical from safety standpoint first.

⊙ Issue a safety alert to an aircraft if you are aware the aircraft is in a position/altitude that, in your judgment, places it in unsafe proximity to terrain, obstructions, or other aircraft.

⊙ When a CA or MCI alert is displayed, evaluate the reason for the alert without delay and take appropriate action. Alerts may be caused by:

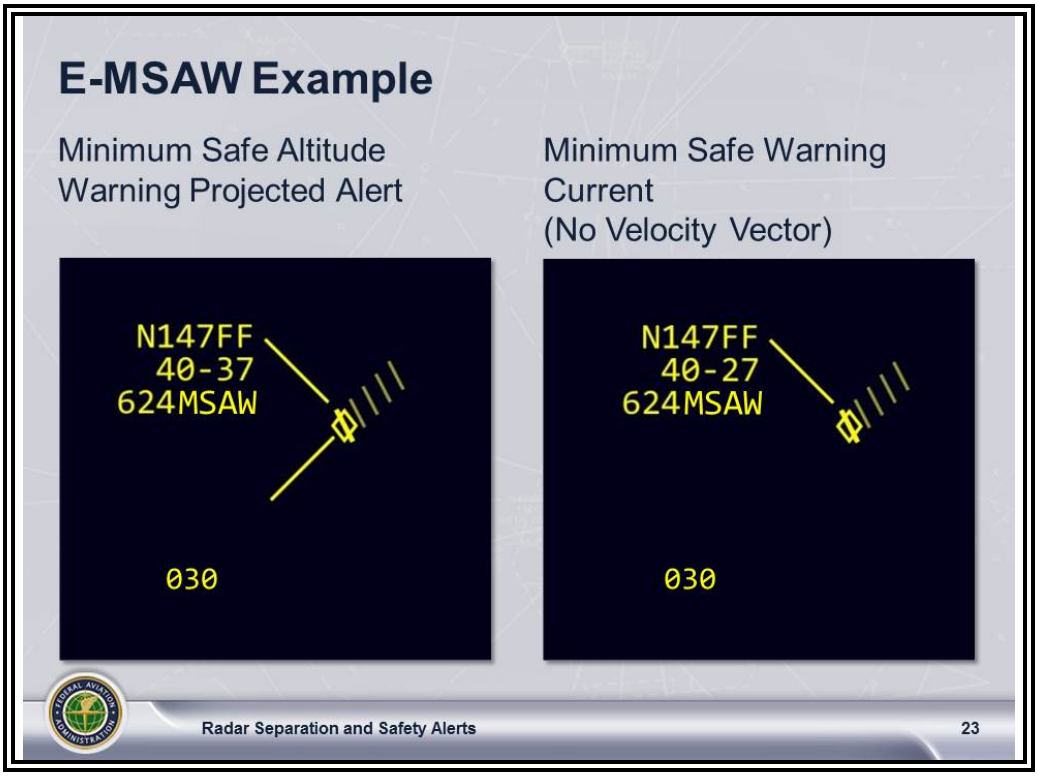
- Terrain
- Obstructions
- Other aircraft

⊙ Discontinue issuance of safety alerts when pilot informs you that action is being taken to resolve the unsafe situation.

NOTE: Don't assume because someone else in another sector has responsibility for the aircraft that the unsafe situation has been observed and the safety alert issued. Inform the appropriate controller. Prior coordination is not required when immediate action is dictated but must be accomplished.

SAFETY ALERTS *(Continued)*

E-MSAW Alert
JO 7110.65,
pars. 2-1-6, 5-14-2



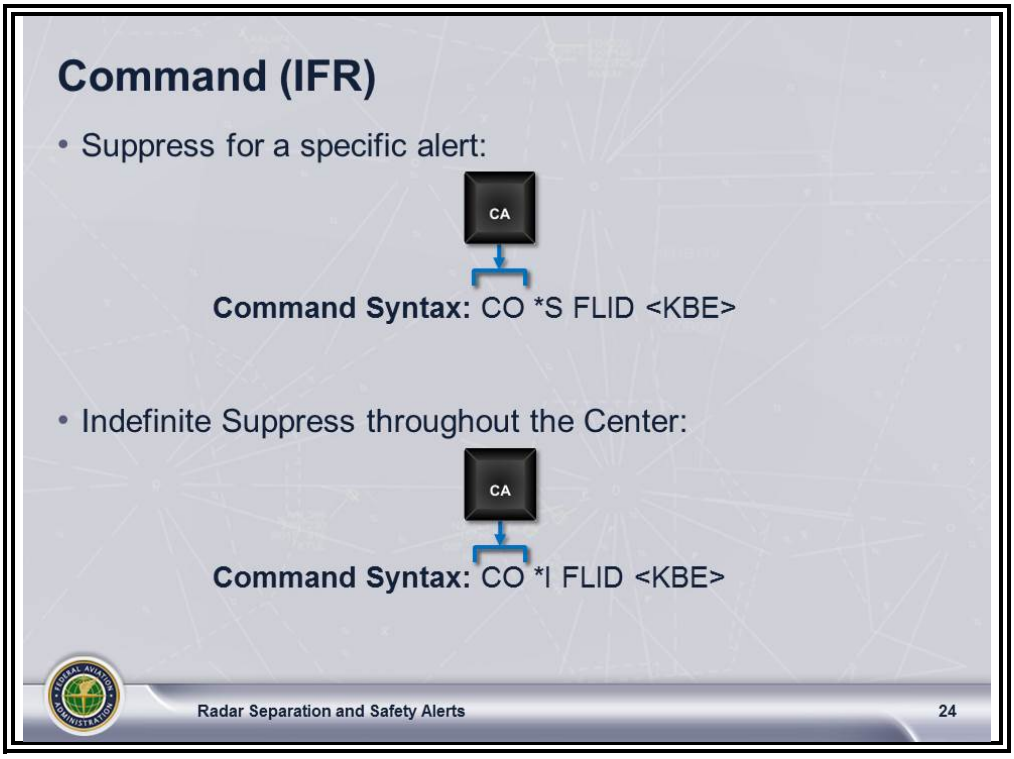
- When an E-MSAW alert is displayed:
  - Immediately analyze the situation and take appropriate action to resolve the alert.
- Issue E-MSAW terrain/obstruction alert if known altitude is unsafe.
  - Issue advisory for appropriate altitude, if necessary.

Phraseology

"LOW ALTITUDE ALERT (call sign), CHECK YOUR ALTITUDE IMMEDIATELY. THE (as appropriate) MEA/MVA/MOCA/MIA IN YOUR AREA IS (altitude)."

SAFETY ALERTS *(Continued)*

IFR Command Format
JO 7110.65, par. 5-14-2; EDSM SRS 210.04 V1B2, Appendix C.1



⊙ The controller may suppress the display of an E-MSAW alert if:

- Appropriate action has or will be taken to resolve the situation.

NOTE: Conflict Alert (CA) on keyboard displays as CO.

- The specific alert suppression command (*S) may be used to inhibit the E-MSAW alerting display on a single flight for a specific alert.
- The indefinite alert suppression command (*I) must be used exclusively to inhibit the display of E-MSAW alerts on aircraft known to be flying at an altitude that will activate the alert feature of one or more MIA areas within an ARTCC.

Review

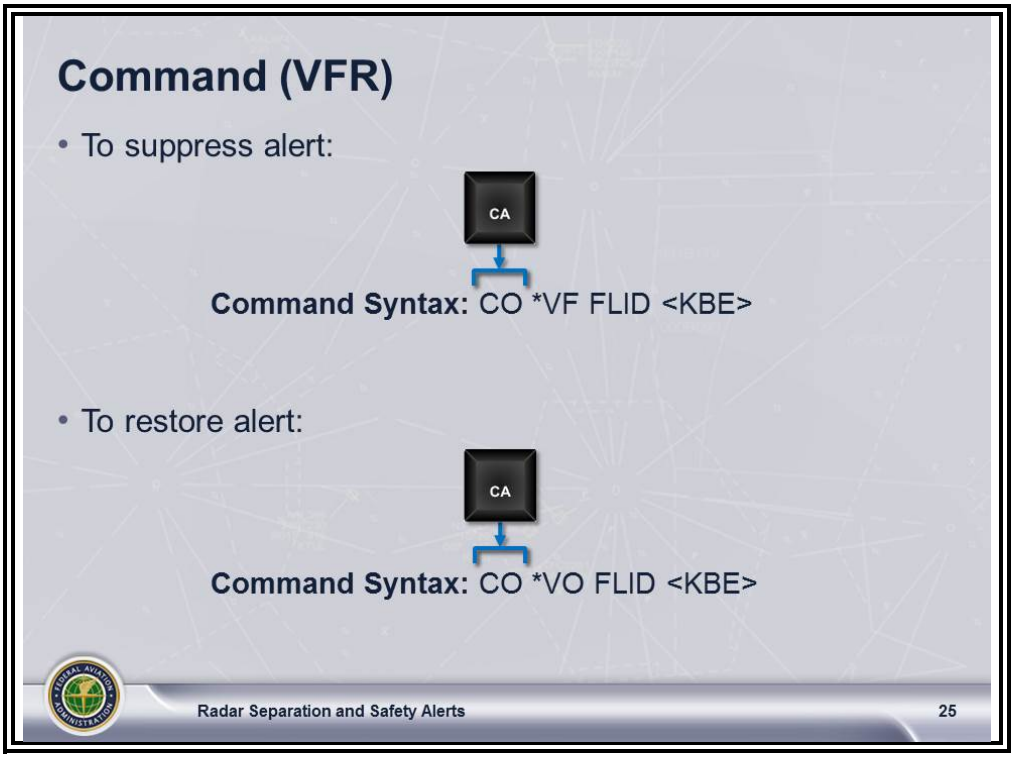
QUESTION: If a controller were simultaneously confronted with the need to issue a safety alert and the need to separate aircraft, which would have priority?

ANSWER: *The one most critical to safety*

Continued on next page

SAFETY ALERTS *(Continued)*

VFR Command Format
JO 7110.65, pars. 2-1-6, 5-14-2; EDSM SRS 210.04 V1B2, Appendix C.1

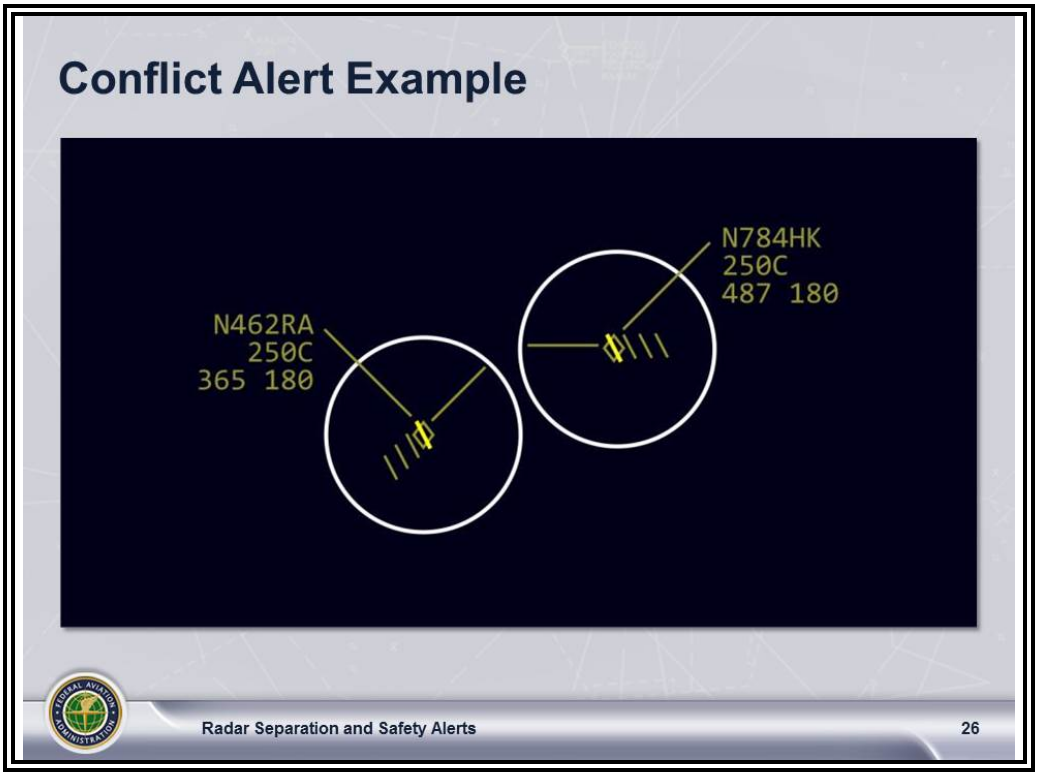


- E-MSAW alerts for VFR aircraft
  - To suppress: *VF command
  - To restore: *VO command
- Terrain/Obstruction Alert
  - Immediately issue/initiate an alert to an aircraft if you are aware the aircraft is at an altitude which places it in unsafe proximity to terrain/obstructions.
  - If feasible, offer the pilot an alternate course of action.

NOTE: Often E-MSAW alerts are locally suppressed by adaptation around the destination airport. It will be your responsibility to determine if the aircraft has deviated from a published procedure and is in unsafe proximity to terrain/obstructions.

SAFETY ALERTS *(Continued)*

Aircraft Conflict/Mode C Intruder Alerts
JO 7110.65, pars. 2-1-6, 5-14-1



⊙ Aircraft Conflict/Mode C Intruder Alert

- Immediately issue/initiate an alert to an aircraft if you are aware of another aircraft at an altitude which you believe places them in unsafe proximity.
  - If feasible, offer the pilot an alternate course of action.

✈ **Phraseology**

"TRAFFIC ALERT (call sign) (position of traffic), ADVISE YOU TURN LEFT/RIGHT (heading),"

and/or

"CLIMB/DESCEND (specific altitude, if appropriate) IMMEDIATELY."

Continued on next page

SAFETY ALERTS *(Continued)*

Aircraft Conflict/Mode C Intruder Alerts (Cont'd)
JO 7110.65, pars. 2-1-6, 5-14-1;
ERAM EDSM SRS 210.04 V1B1, par. 3.2.2.8.1.2

- FDBs will flash when targets are or are projected to be:
  - Within a predetermined parameter of each other, and
  - Less than minimum vertical separation exists.
- Alert is based on Mode C readout or controller-reported altitude, therefore timely altitude updates are imperative.

NOTE: The facility can determine flying time parameters for Conflict Alert activation.

⊙ Conflict Alert notifications come in two types: Predictive and Immediate.

- Predictive Alerts are triggered by the aircraft trajectory.
  - May be suppressed
- Immediate Alerts indicate that both horizontal and vertical alert separation criteria are violated.
  - May not be suppressed

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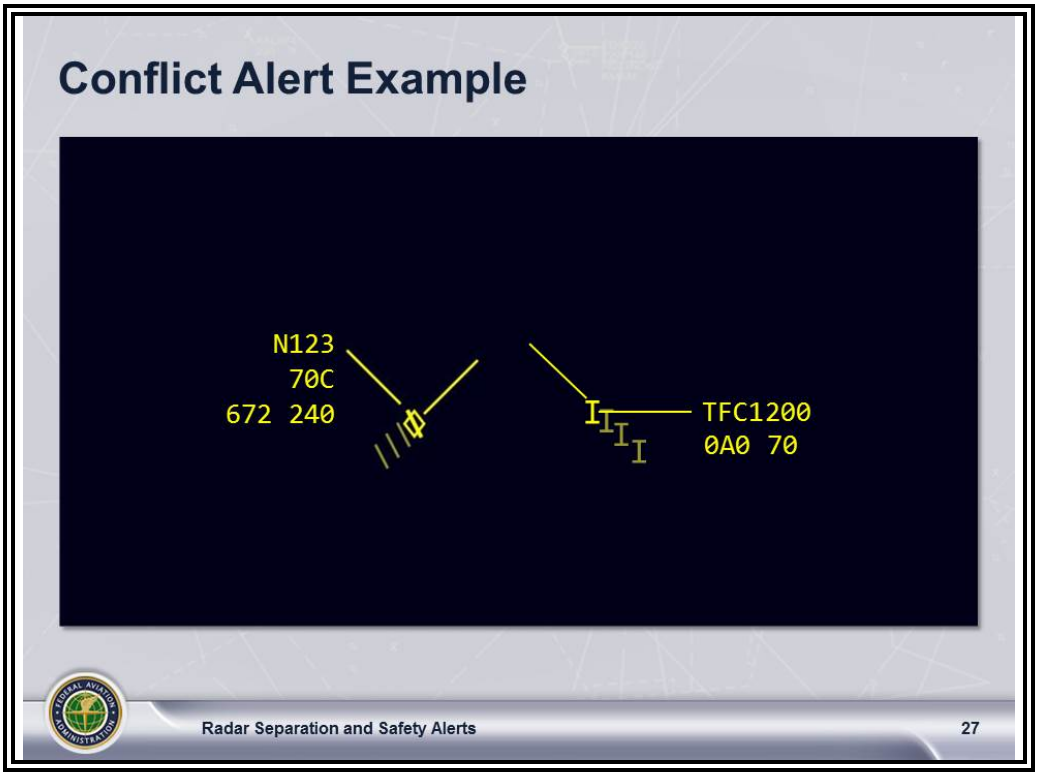
SAFETY ALERTS *(Continued)*

Aircraft Conflict/Mode C Intruder Alerts (Cont'd)
JO 7110.65, pars. 2-1-6, 5-14-1



- If the alert involves another controller:
  - Initiate appropriate coordination to ensure an effective course of action:
    - Not required if immediate action is dictated
- Conflict alert may be suppressed/restored by the controller:
  - Constitutes controller acknowledgement
  - Indicates appropriate action has been or will be taken

NOTE: Conflict Alert does not replace good control judgment. It may activate too late to maintain separation or won't activate unless the altitude is known.

SAFETY ALERTS *(Continued)*

Using Suppression Command
JO 7110.65, pars. 2-1-6, 5-14-1

⊙ Suppression command may be used under the following conditions:

- Conflict suppression (CO) function:
  - Between specific aircraft
  - For a specific alert
- Group suppression (SG) function:
  - Exclusively among military aircraft where Military Authority Assumes Responsibility for Separation of Aircraft (MARSA)
  - (SG) FLID/FLID
- The CA/MCI alert may not be suppressed or inhibited at or for another control position without being coordinated.

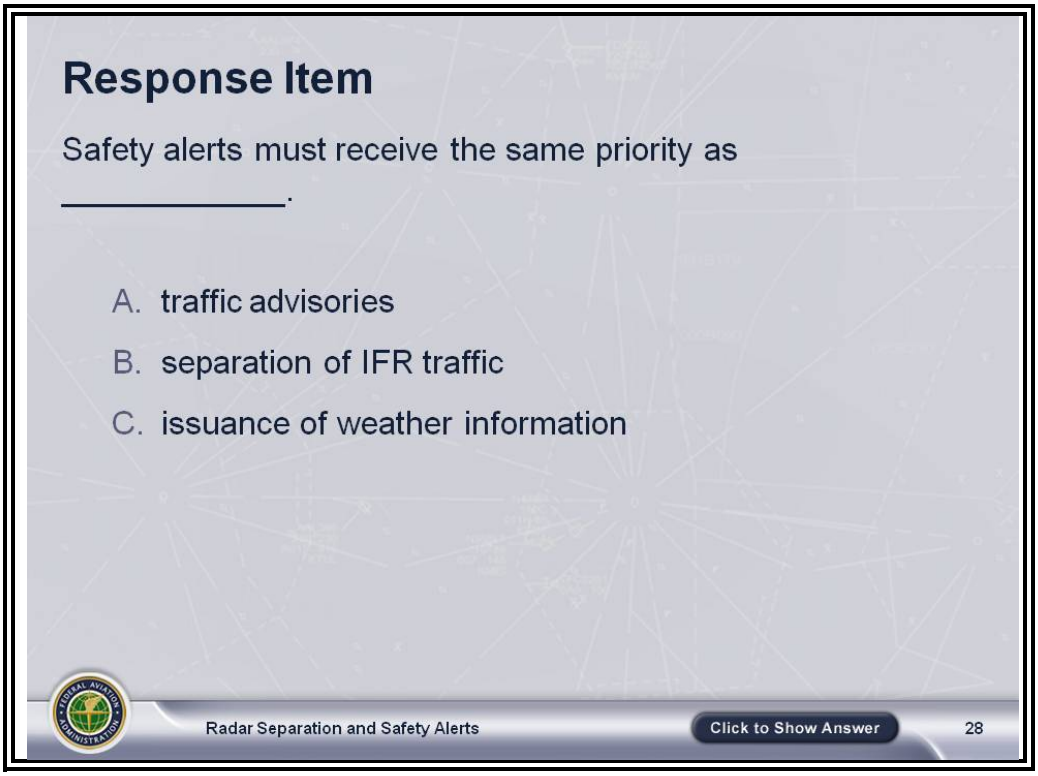
Continued on next page

SAFETY ALERTS *(Continued)*

Review

DISCUSSION ITEM: What are some conditions that might affect whether a controller will recognize a safety alert situation or not?

POSSIBLE ANSWER: *Workload, traffic volume, quality/limitations of radar, and available lead time to react. Controller must remain vigilant for these conditions.*



SLIDE ANSWER: B

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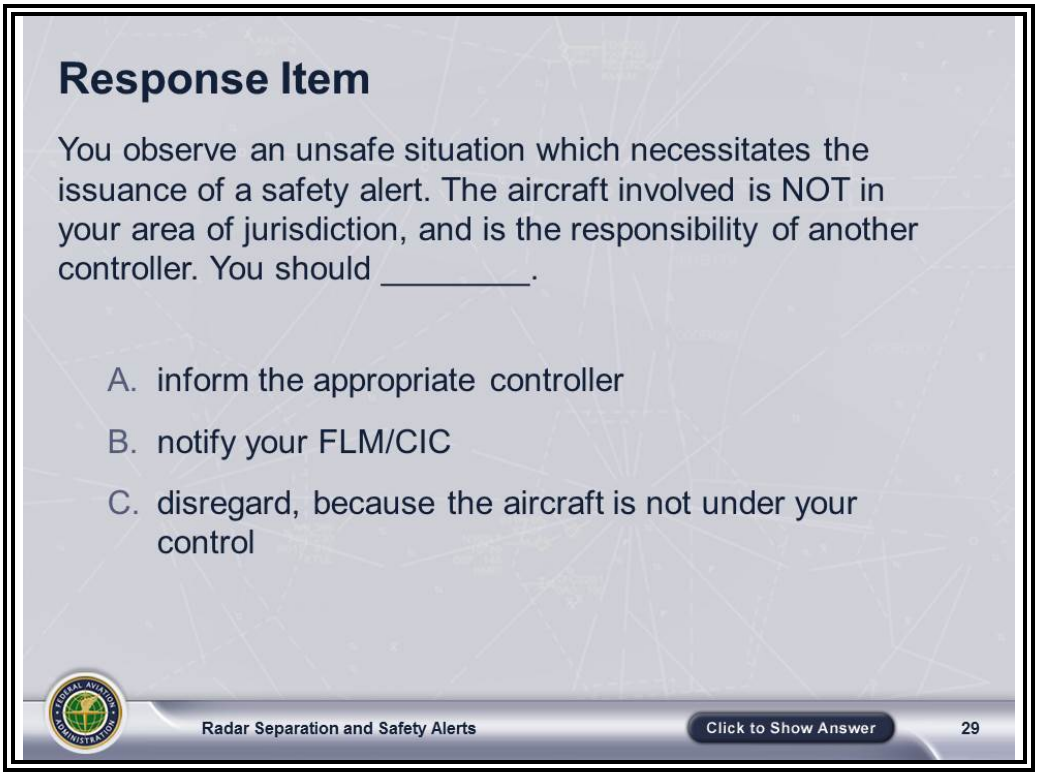
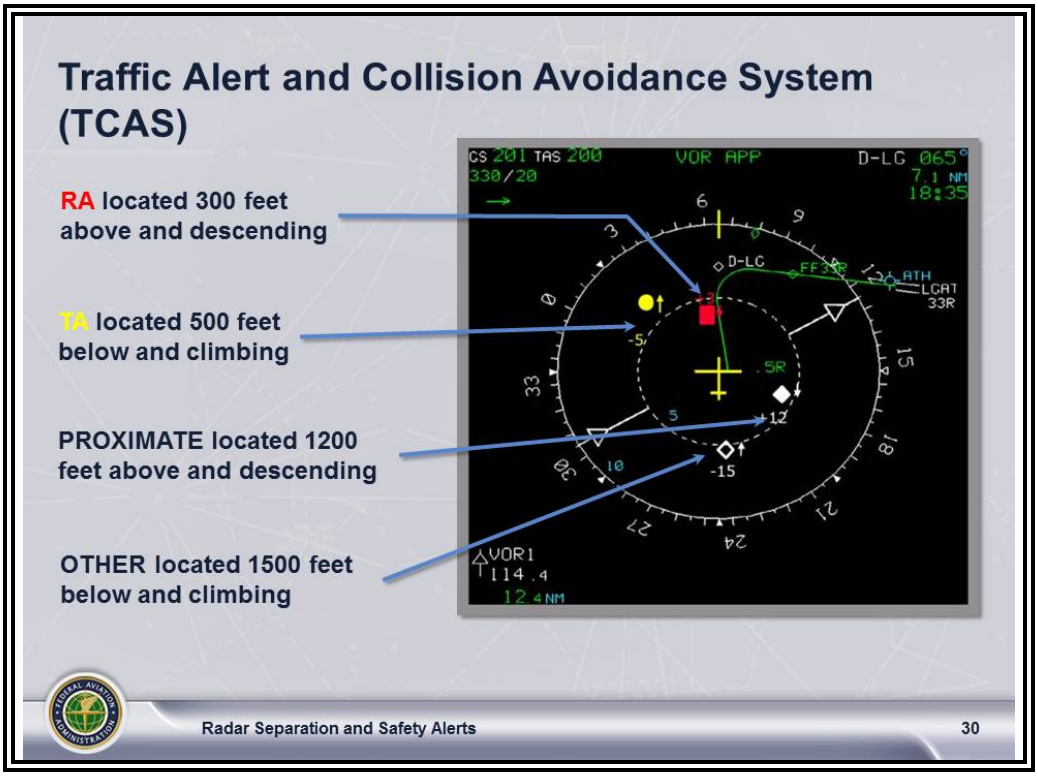
SAFETY ALERTS *(Continued)*

Review (Cont'd)



SLIDE ANSWER: A

TCAS RESOLUTION ADVISORIES



TCAS Definition
JO 7110.65, Pilot/Controller Glossary

Traffic Alert and Collision Avoidance System (TCAS) is an airborne collision avoidance system based on radar beacon signals, which operates independent of ground-based equipment. TCAS-I generates traffic advisories only. TCAS-II generates traffic advisories and resolution (collision avoidance) advisories in the vertical plane.

TCAS Resolution Advisories
JO 7110.65, par. 2-1-27

⊙ When informed by an aircraft that it is responding to a TCAS Resolution Advisory (RA):

- Do **not** issue control instructions contrary to the RA being executed.
- Do **not** assume that nearby aircraft are aware of or involved in the RA.
  - Continue to provide control instructions for these aircraft.
- Continue to provide safety alerts and traffic advisories for all concerned aircraft.

Continued on next page

TCAS RESOLUTION ADVISORIES *(Continued)*

TCAS Resolution Advisories (Cont'd)
JO 7110.65, par. 2-1-27

⊙ Once the aircraft has begun a maneuver in response to an RA:

- Controller is **not** responsible for providing the maneuvering aircraft with standard separation from:
  - Aircraft
  - Airspace
  - Terrain
  - Obstructions
- Controller resumes standard separation responsibility when one of the following occurs:
  - Responding aircraft returns to its assigned altitude
  - Crew member informs that TCAS maneuver is completed and controller observes standard separation is reestablished
  - Responding aircraft has executed an alternate clearance and controller observes standard separation is reestablished

⊙ When the RA has been resolved, the flight crew should advise ATC they are returning to their previously assigned clearance or subsequent amended clearance:

✈ Pilot Phraseology

"(Facility), (aircraft ID), TCAS (maneuver, e.g. "climb")."

⊙ When RA is resolved:

✈Pilot Phraseology

"(Facility), (aircraft ID), CLEAR OF CONFLICT, RETURNING TO (assigned or amended clearance)."

VFR-ON-TOP

VFR-on-top Definition
JO 7110.65, Pilot/Controller Glossary

VFR-on-top is ATC authorization for an IFR aircraft to operate in VFR conditions at any appropriate VFR altitude (as specified in FAR and as restricted by ATC). A pilot receiving this authorization must comply with the VFR visibility, distance from cloud criteria, and the minimum IFR altitudes specified in FAR Part 91. The use of this item does not relieve controllers of their responsibility to separate aircraft in Class B and Class C airspace or TRSAs as required by FAA Order JO 7110.65. The pilot is also responsible to comply with instrument flight rules applicable to the flight (e.g., adherence to ATC clearances).

VFR-ON-TOP *(Continued)*

VFR-on-top
JO 7110.65,
pars. 7-3-1; 9-3-3

⊙ You may clear an aircraft to maintain VFR-on-top if the pilot of an aircraft on an IFR flight plan requests the clearance.

✈
Phraseology

"MAINTAIN VFR-ON-TOP."

- When an aircraft has been cleared to maintain VFR-on-top, the pilot is responsible to:
  - Fly at an appropriate VFR altitude.
  - Comply with VFR visibility and distance from cloud criteria.
  - Be vigilant, in order to see and avoid other aircraft.
  - Comply with IFR rules applicable to the flight (e.g., adherence to ATC clearances).
- Although standard IFR separation is not applied, controllers must continue to provide:
  - Traffic advisories
  - Safety alerts

VFR-ON-TOP *(Continued)*

VFR-on-top Requirements
JO 7110.65, pars. 7-3-1; 9-3-3

- Apply merging target procedures to aircraft operating VFR-on-top.
- You may clear an aircraft to climb though smoke, clouds, haze, and other meteorological formations, and then to maintain VFR-on-top if the following conditions are met:
  - The pilot requests the clearance.
  - You inform the pilot of the reported height of the tops of the meteorological formation, or
  - You inform the pilot that no top reports are available.
  - When necessary, you ensure separation from all other traffic for which you have separation responsibility by issuing an alternative clearance.
    - Typically, this will be 1,000 below the other traffic.
  - When the aircraft is climbing to and reports reaching VFR-on-top:
    - Reclear the aircraft to maintain VFR-on-top.

✈ **Phraseology**

“CLIMB TO AND REPORT REACHING VFR-ON-TOP,”

and

“TOPS REPORTED (altitude),”

or

“NO TOPS REPORTS.”

“IF NOT ON TOP AT (altitude), MAINTAIN (altitude), AND ADVISE.”

“MAINTAIN VFR-ON-TOP.”

Continued on next page

VFR-ON-TOP *(Continued)*

VFR-on-top Requirements (Cont'd)
JO 7110.65, pars. 7-3-1; 9-3-3

⊙ Do not clear an aircraft to maintain VFR-on-top.

- Between sunset and sunrise:
  - To separate holding aircraft from each other, or
  - From en route aircraft, unless restrictions are applied to ensure the appropriate IFR vertical separation

✈ **Phraseology**

"MAINTAIN VFR-ON-TOP AT OR ABOVE/BELOW/BETWEEN (altitudes)."

✈ **Phraseology Examples**

"MAINTAIN VFR-ON-TOP AT OR ABOVE ONE THREE THOUSAND FIVE HUNDRED."

"MAINTAIN VFR-ON-TOP AT OR BELOW ONE TWO THOUSAND FIVE HUNDRED."

"MAINTAIN VFR-ON-TOP AT OR BETWEEN SIX THOUSAND AND ONE ZERO THOUSAND."

⊙ When, in your judgment, there is reason to believe that flight in VFR conditions may become impractical:

- Issue an alternative clearance which will ensure separation from all other aircraft for which you have responsibility.

✈ **Phraseology**

"IF UNABLE, (alternative procedure), AND ADVISE."

⊙ If aircraft's route, track, or altitude may cause it to enter an active Prohibited/Restricted/Warning Area, MOA, or ATCAA:

- Inform the pilot to conduct flight VFR-on-top at least 500 feet above the upper limit, or 500 feet below the lower limit, of the airspace.

✈ **Phraseology**

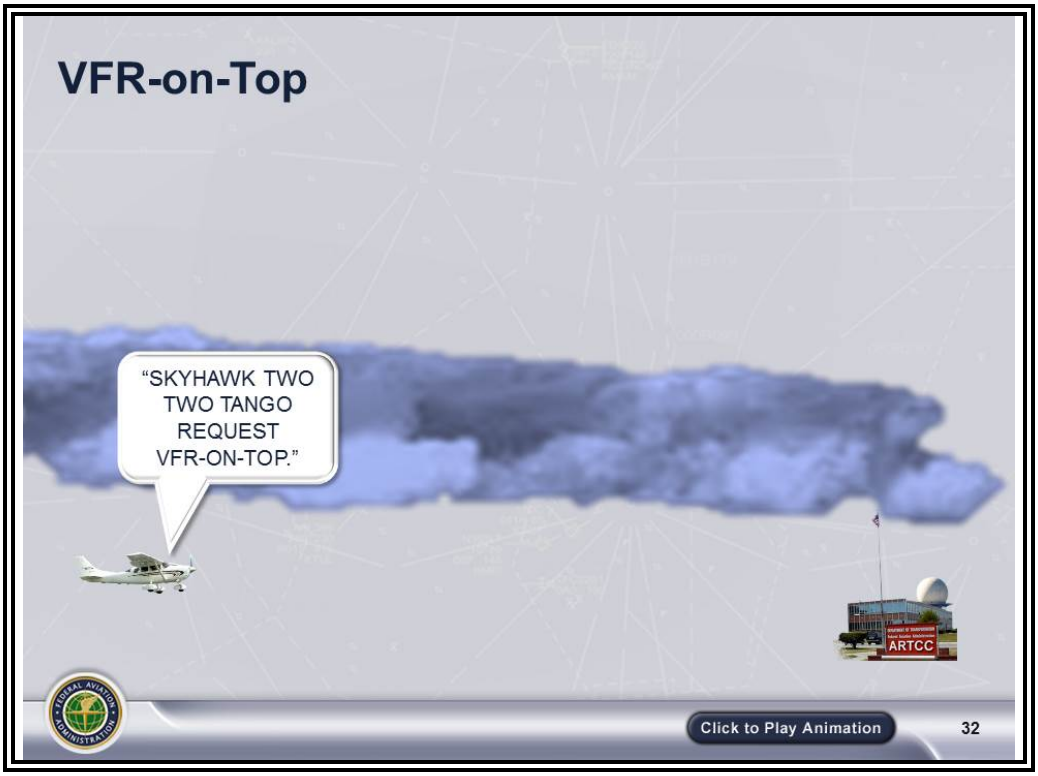
"MAINTAIN VFR-ON-TOP AT LEAST 500 FEET ABOVE/BELOW (upper/lower limit of airspace) ACROSS (name or number of airspace) BETWEEN (fix) AND (fix)."

Continued on next page

VFR-ON-TOP *(Continued)*

VFR-on-top Requirements (Cont'd)
JO 7110.65, par. 7-3-1; 9-3-3

Click to animate part 1.



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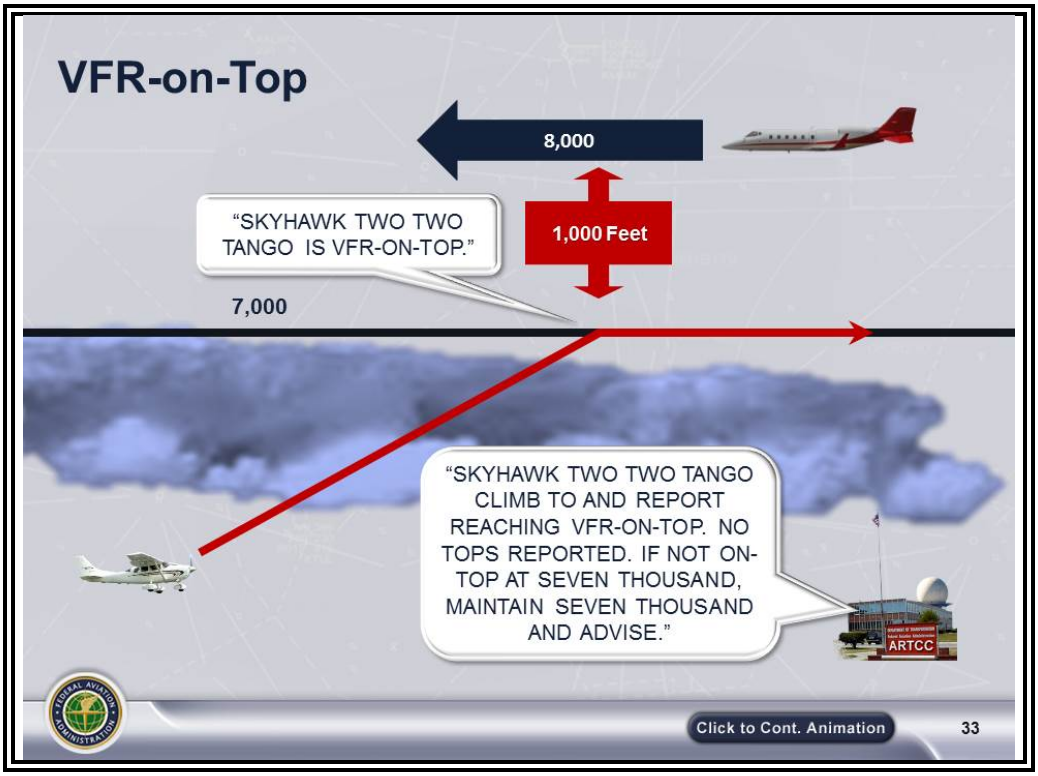

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VFR-ON-TOP *(Continued)*

VFR-on-top Requirements (Cont'd)
JO 7110.65, par. 7-3-1; 9-3-3

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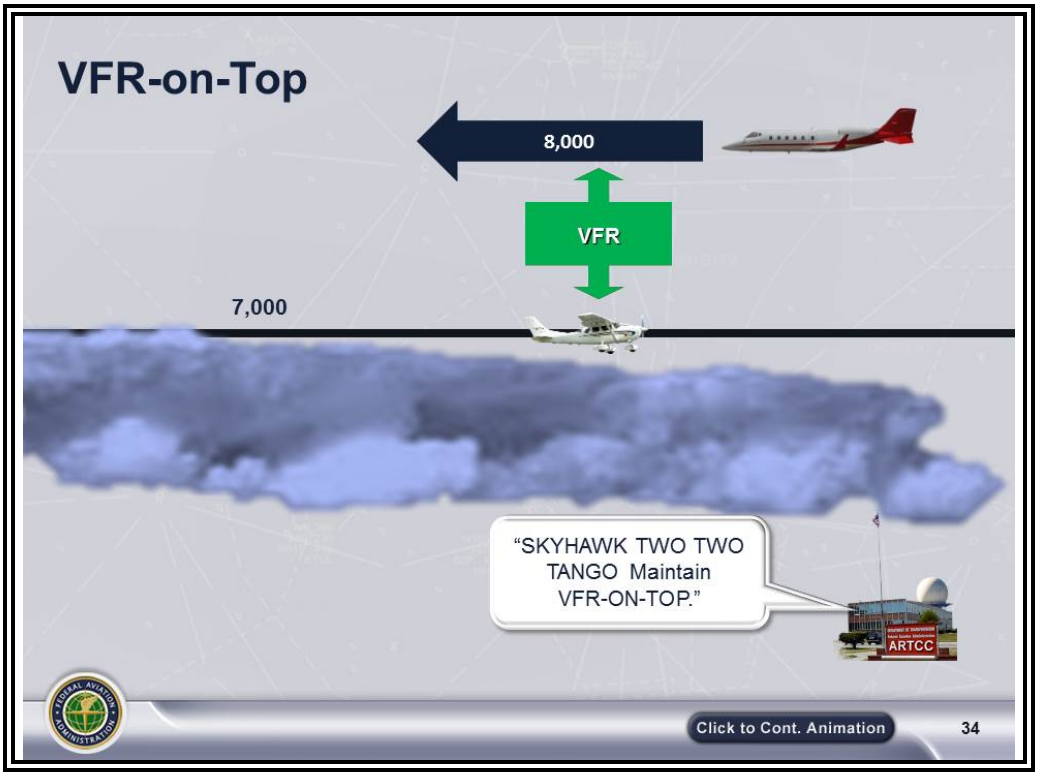


Altitude for Direction of Flight
JO 7110.65, par. 7-3-2

⊙ Inform an aircraft maintaining VFR-on-top when a report indicates the pilot is not complying with the following VFR cruising levels for direction of flight:

- VFR cruising levels on Magnetic courses 0-179 are odd cardinal altitudes plus 500 feet; e.g., 3,500, 5,500.
- VFR cruising levels on Magnetic courses 180-359 are even cardinal altitudes plus 500 feet: e.g., 4,500, 8,500.

✈ **Phraseology**

"VFR-ON-TOP CRUISING LEVELS FOR YOUR DIRECTION OF FLIGHT ARE :"

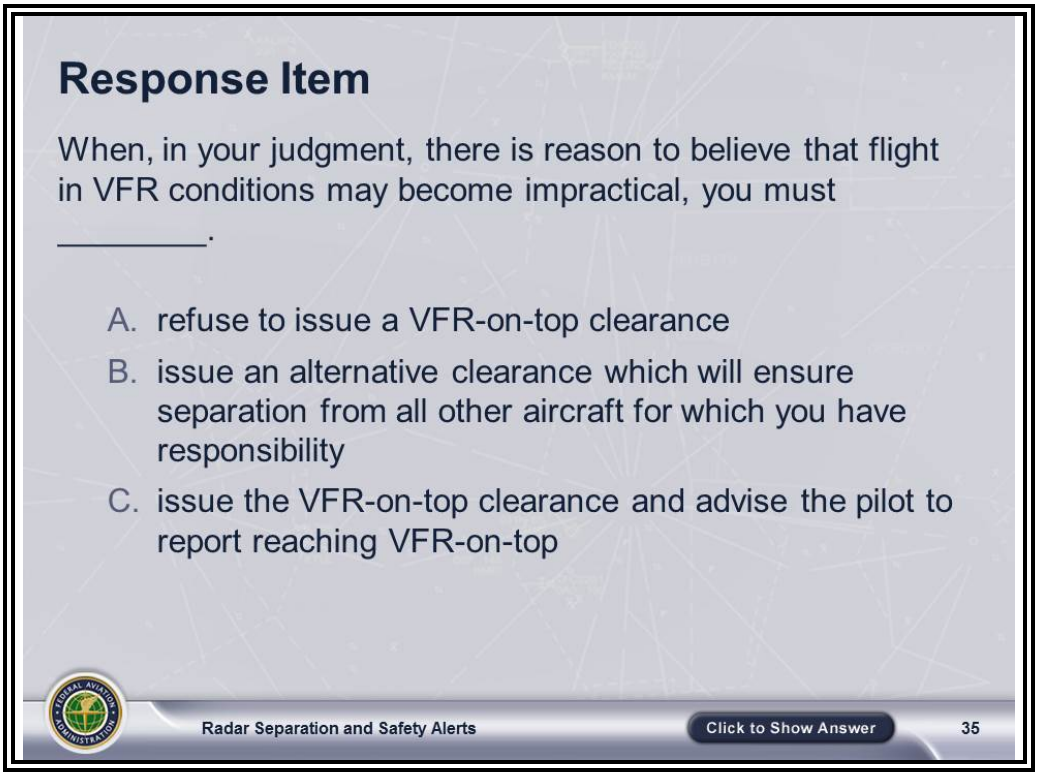
More than 3,000 feet above the surface to FL180:

"ODD/EVEN ALTITUDES/FLIGHT LEVELS PLUS FIVE HUNDRED FEET."

☞ ***NOTE:*** *Discuss options if aircraft does not report VFR-on-top at 7,000 per the graphic.*

VFR-ON-TOP *(Continued)*

Review



SLIDE ANSWER: B

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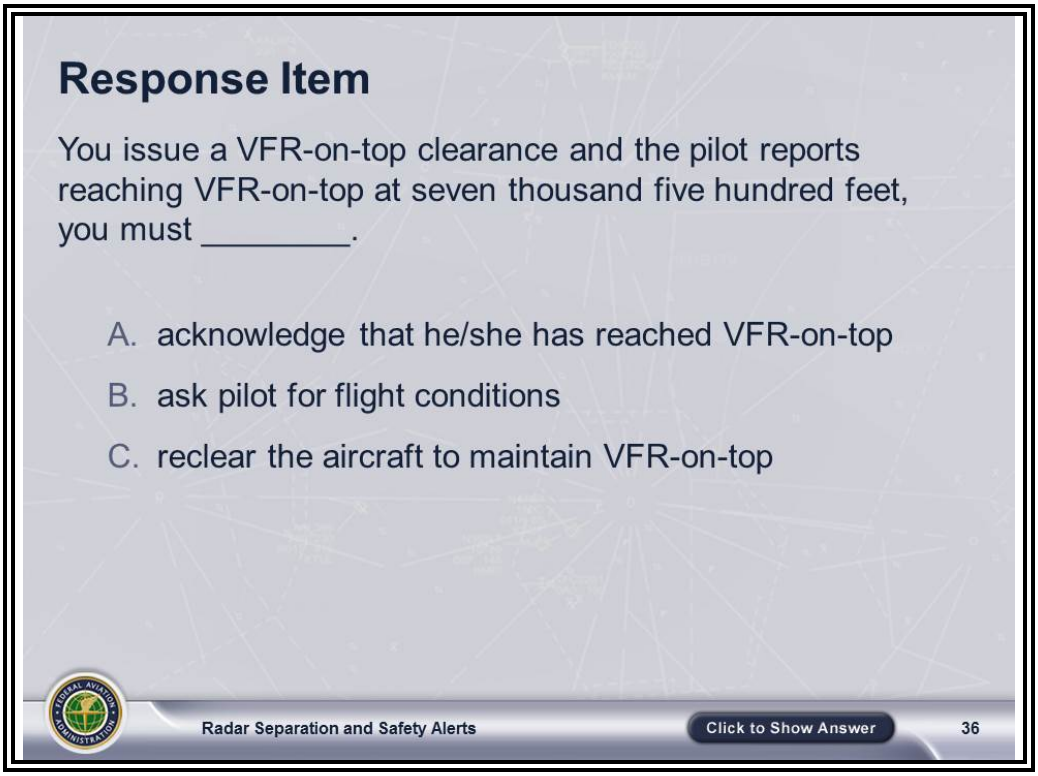
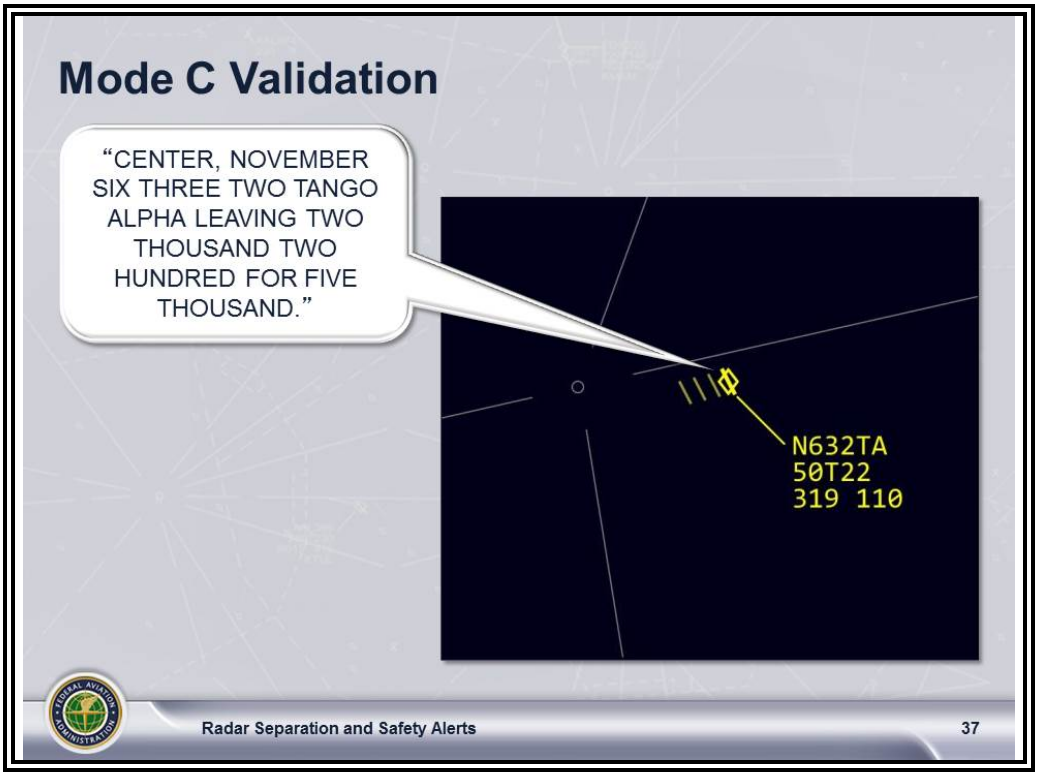
Review (Cont'd)



SLIDE ANSWER: C

VALIDATION OF MODE C READOUT

Validation of Mode C Readout
JO 7110.65, par. 5-2-17;
JO 7710.311B, par. 5-2-17



⊙ Ensure Mode C is valid for each aircraft after:

- Accepting an interfacility handoff
- Initial track start
- Track start from coast/suspend tabular list
- Missing, unreasonable or exceptional vertical rate Mode C readouts

✈ **Phraseology**

"SAY ALTITUDE/FLIGHT LEVEL."

⊙ Consider readout valid when:

- It varies less than 300 feet from pilot reported altitude, or
- You receive a continuous readout from aircraft on the airport, and the readout varies by less than 300 feet from field elevation, or
- Verbal coordination with another facility with validated altitude information shows exact correlation between your data block and theirs.

Continued on next page

VALIDATION OF MODE C READOUT *(Continued)*

Validation of Mode C Readout (Cont'd)
JO 7110.65, par. 5-2-17

⊙ If unable to validate the readout, do **NOT** use Mode C information for separation.

⊙ When you observe an invalid Mode C readout below FL180:

- Issue the correct altimeter setting and request the pilot confirm altitude.

✈ **Phraseology**

"(location) ALTIMETER (appropriate altimeter), VERIFY ALTITUDE."

- If Mode C readout is still invalid:
  - Instruct pilot to turn off altitude-reporting part of transponder and include reason.
  - Notify operations supervisor-in-charge of aircraft call sign.

✈ **Phraseology**

"STOP ALTITUDE SQUAWK. ALTITUDE DIFFERS BY (number of feet) FEET."

⊙ When you observe invalid Mode C readout above FL180 and the aircraft is **not** descending below Class A airspace:

- Confirm that the pilot is using 29.92 altimeter setting and has accurately reported the altitude.

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VALIDATION OF MODE C READOUT *(Continued)*

Validation of Mode C Readout (Cont'd)
JO 7110.65, par. 5-2-17

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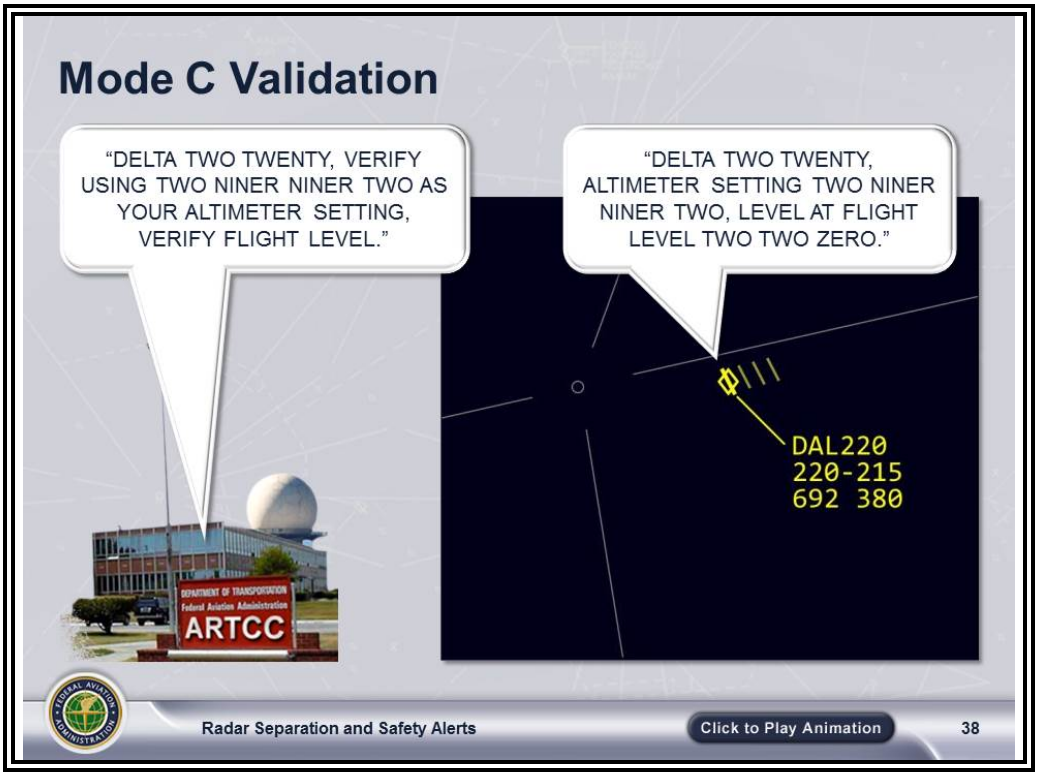


✈ **Phraseology**

"VERIFY USING TWO NINER NINER TWO AS YOUR ALTIMETER SETTING, VERIFY FLIGHT LEVEL."

- If readout continues to be invalid:
  - Instruct pilot to turn off altitude-reporting part of transponder and include the reason.
  - Notify the operational supervisor-in-charge of aircraft call sign.

✈ **Phraseology**

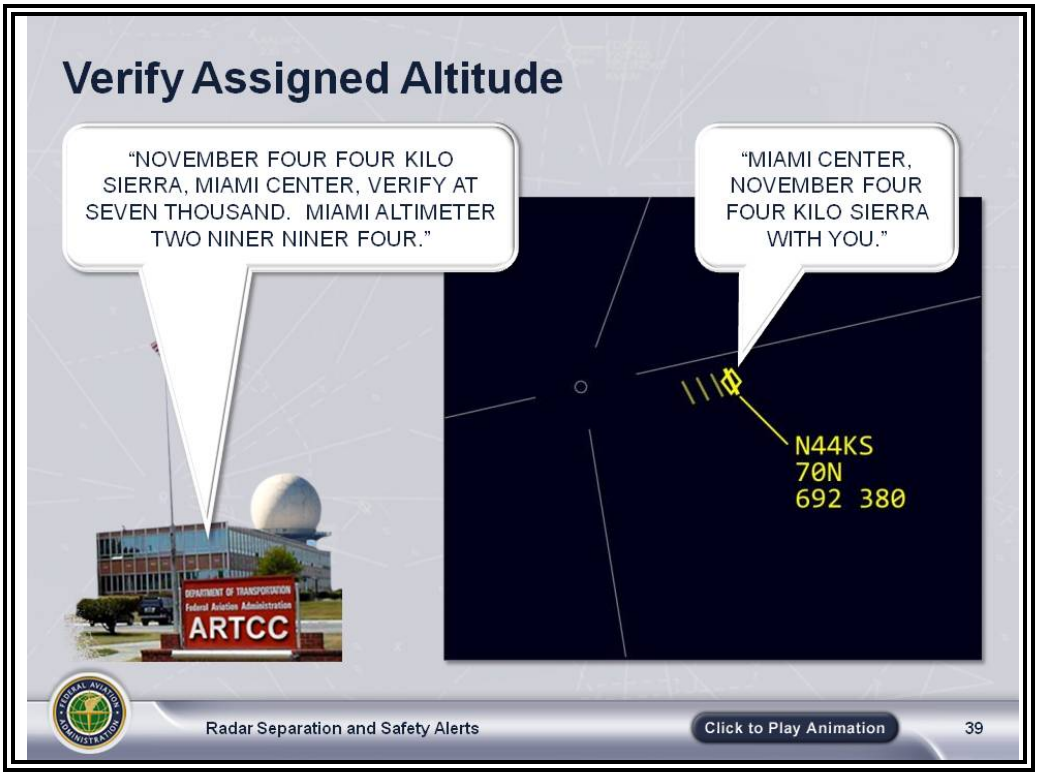
"STOP ALTITUDE SQUAWK. ALTITUDE DIFFERS BY (number of feet) FEET."

⊙ Whenever possible, inhibit altitude readouts on all consoles when a malfunction of the ground equipment causes repeated invalid readouts.

NOTE: Aircraft are required by FAR 91.215 to have an operating transponder with Mode C when operating in Class A airspace. Should the pilot lose altitude reporting capability, verbally obtain approval before allowing the aircraft to enter the receiving controller's airspace. See JO 7110.65, pars. 5-2-14 and 5-2-16 for supporting information.

ALTITUDE CONFIRMATION

Altitude Confirmation - Mode C
JO 7110.65, par. 5-2-18



Click to animate.

⊙ Request pilot to verify assigned altitude on initial contact with each sector/position, unless:

- Pilot states assigned altitude, or
- You assign a new altitude to a climbing/descending aircraft, or
- Mode C readout is valid and indicates that the aircraft is established at the assigned altitude.

⊙ In level flight situations:

✈ **Phraseology**

"VERIFY AT (altitude/flight level)."

⊙ In climbing/descending situations:

"VERIFY ASSIGNED ALTITUDE (altitude),"

or

"VERIFY ASSIGNED FLIGHT LEVEL (flight level)."

ALTITUDE CONFIRMATION *(Continued)*

Altitude Confirmation - Nonmode C
JO 7110.65, par. 5-2-19

⊙ Request pilot to verify assigned altitude on initial contact, unless:

- Pilot states the assigned altitude, or
- You assign a new altitude to a climbing/descending aircraft.

⊙ In level flight situations:

✈ **Phraseology**

"VERIFY AT (altitude/flight level)."

⊙ In climbing/descending situations:

✈ **Phraseology**

"VERIFY ASSIGNED ALTITUDE/FLIGHT LEVEL (altitude/flight level)."

Review

QUESTION: What is the phraseology to request an aircraft climbing to 16,000 to verify that altitude?

ANSWER*: "VERIFY ASSIGNED ALTITUDE ONE SIX THOUSAND."*

DISCUSSION ITEM: State the phraseology to verify N60JW's altitude.

POSSIBLE ANSWER: *"NOVEMBER SIX ZERO JULIETT WHISKEY, VERIFY AT FLIGHT LEVEL TWO SEVEN ZERO." "NOVEMBER SIX ZERO JULIETT WHISKEY, SAY ALTITUDE."*

AUTOMATIC ALTITUDE REPORTING

Automatic Altitude Reporting
JO 7110.65, par. 5-2-20

⊙ Inform aircraft when you want it to turn automatic altitude reporting feature on/off:

✈ **Phraseology**

“SQUAWK ALTITUDE,”

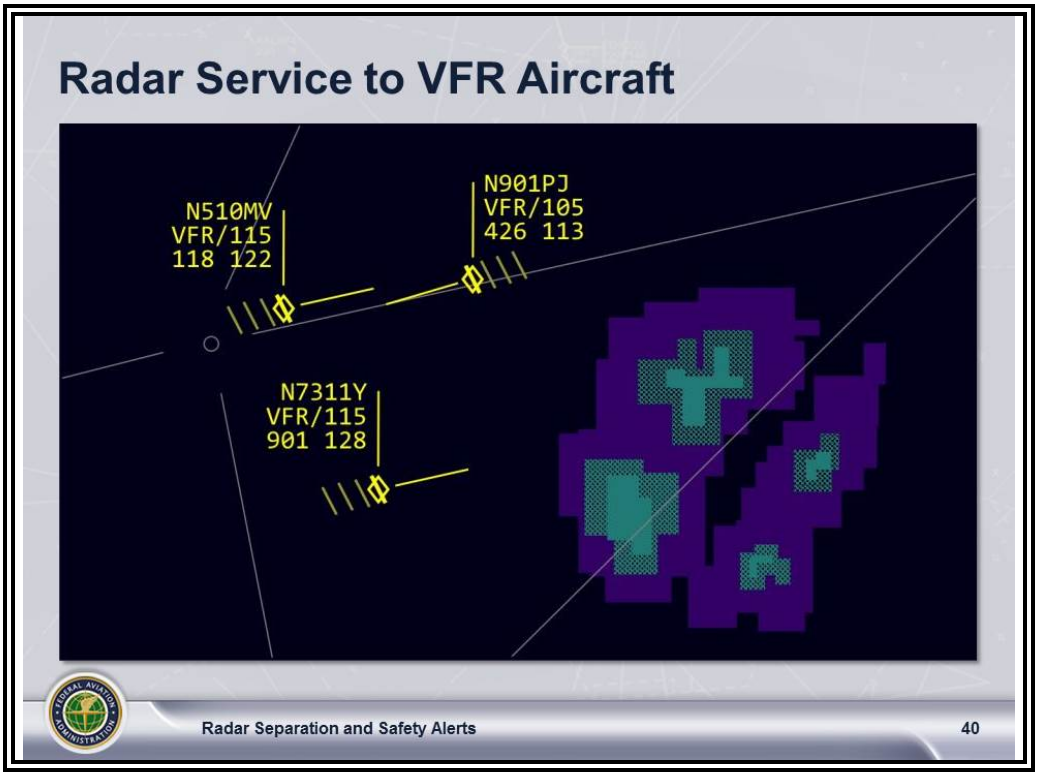
or

“STOP ALTITUDE SQUAWK.”

NOTE: Not all aircraft have the capability to disengage altitude squawk independently from beacon code squawk. On some aircraft, both functions are controlled by the same switch, so you may lose the beacon code on these aircraft.

RADAR SERVICE TO VFR AIRCRAFT

VFR Aircraft
JO 7110.65, pars. 2-1-6, 2-1-21, 5-1-8, 5-2-9



- Issue:
  - Safety alerts
  - Traffic advisories
- Apply merging target procedures.

NOTE: Traffic advisories and merging target procedures are taught in later lessons.

RADAR SERVICE TO VFR AIRCRAFT *(Continued)*

VFR Aircraft (Cont'd)
JO 7110.65, pars. 2-1-6, 2-1-21, 5-1-8, 5-2-9

⊙ Assign beacon codes.

- Assign appropriate function code or computer assigned code.
- Have terminated VFR aircraft squawk VFR or squawk 1200.

✈ **Phraseology**

"SQUAWK VFR,"

or

"SQUAWK ONE TWO ZERO ZERO."

⊙ Possible situations in which radar services and safety alerts would be provided to VFR aircraft:

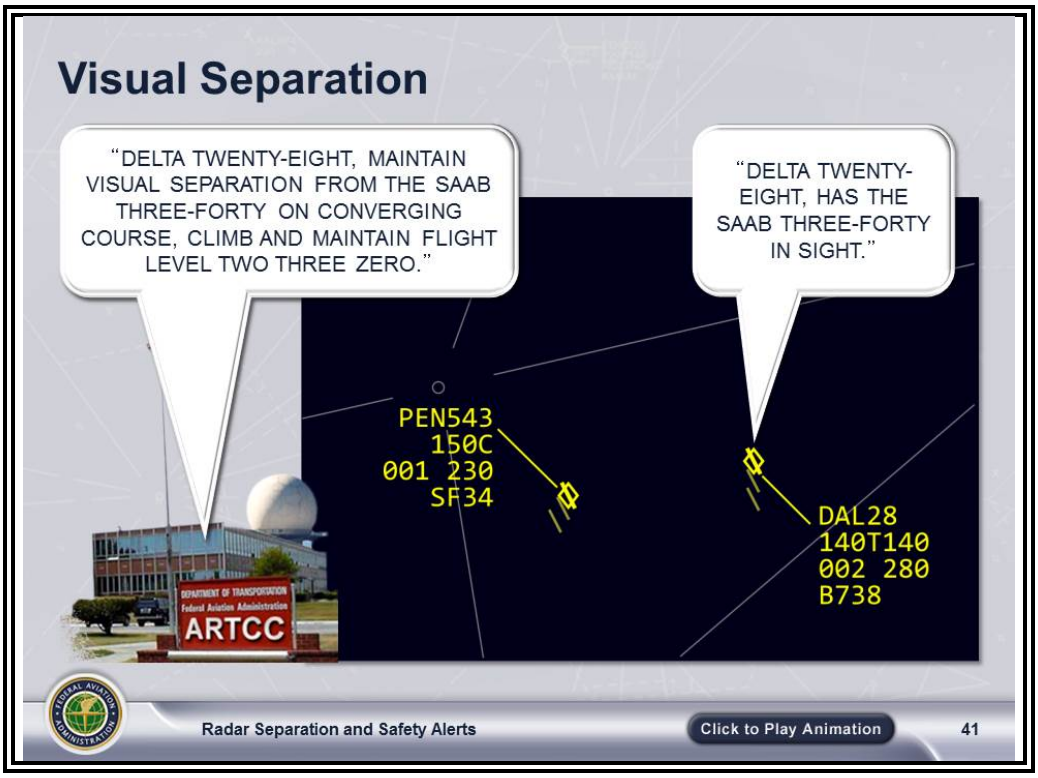
- Traffic advisories
- Routine flight-following:
  - IFR and VFR traffic calls
  - Radar-identified or not radar-identified
  - Obstacle/terrain avoidance
- Weather information
- Vectors to emergency airport
- Lost aircraft orientation

VISUAL SEPARATION

Visual Separation Definition
JO 7110.65, Pilot/Controller Glossary

Visual separation is a means employed by ATC to separate aircraft in terminal areas and en route airspace in the National Airspace System (NAS).

Visual Separation
JO 7110.65, par. 7-2-1



Click 2 times to animate.

⊙ There are two ways to apply visual separation:

- The tower controller sees the aircraft involved and issues instructions, as necessary, to ensure that the aircraft avoid each other.
- A pilot sees the other aircraft involved and, upon instructions from the controller, provides his/her own separation by maneuvering the aircraft as necessary to avoid it.
  - This may involve following another aircraft or keeping it in sight until it is no longer a factor.

Continued on next page

VISUAL SEPARATION *(Continued)*

Visual Separation (Cont'd)
JO 7110.65, par. 7-2-1; N JO 7110.677

⊙ Aircraft may be separated by visual means when other approved separation is assured before and after the application of visual separation.

- To ensure that other separation will exist, consider:
  - Aircraft performance
  - Wake turbulence
  - Closure rate
  - Routes of flight
  - Known weather conditions
- Reported weather conditions must allow the aircraft to remain within sight until other separation exists.
  - Do not apply visual separation between successive departures when departure routes and/or aircraft performance preclude maintaining separation.

⊙ Visual separation must not be applied when an A388 or An225 is the lead aircraft.

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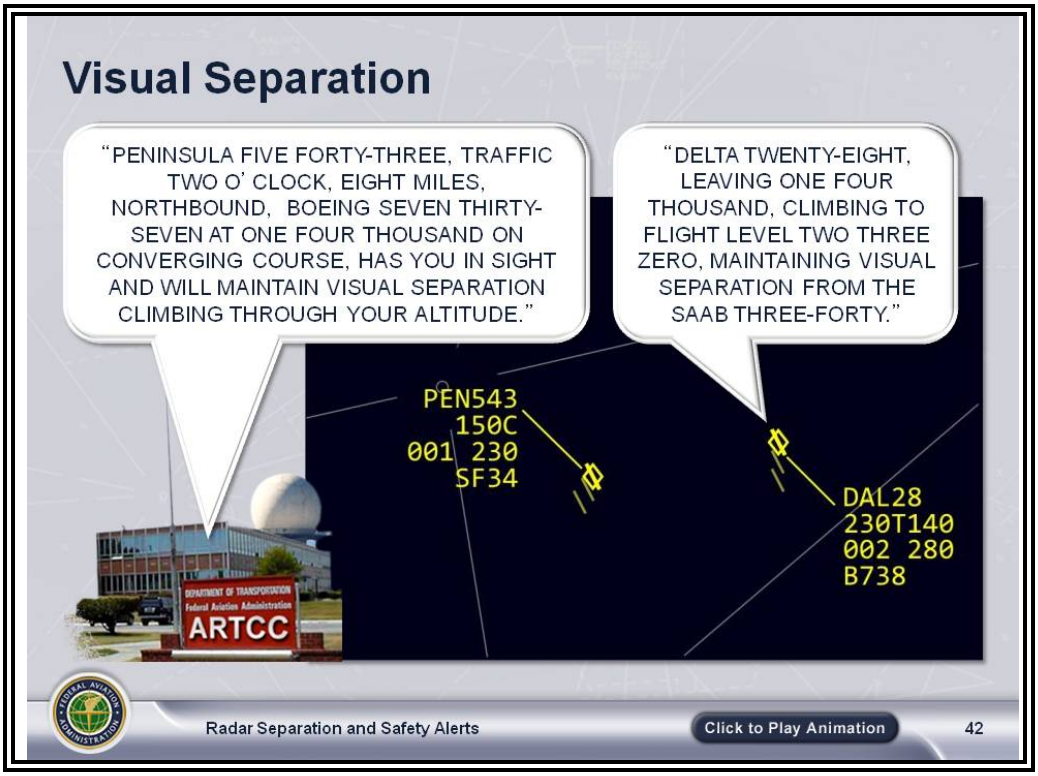
VISUAL SEPARATION *(Continued)*

Visual Separation (Cont'd)
JO 7110.65, par. 7-2-1



Click to animate.

⊙ En route: Visual separation may be used up to, but not including FL 180, when the following conditions are met:

- Direct communication is maintained with one of the aircraft involved and there is an ability to communicate with the other.
- A pilot sees another aircraft and is instructed to maintain visual separation from it as follows:
  - Tell the pilot about the other aircraft including position, direction and unless it is obvious, the other aircraft's intentions.
  - Advise the pilot if the radar targets appear likely to converge.
  - Advise pilots if either aircraft is a heavy/super.

NOTE: Traffic advisories and wake turbulence cautionary advisories must be issued in accordance with FAA Order JO 7110.65, par. 2−1−20, Wake Turbulence Cautionary Advisories, and par. 2−1−21, Traffic Advisories.

Continued on next page

VISUAL SEPARATION *(Continued)*

Visual Separation (Cont'd)
JO 7110.65, par. 7-2-1

"TRAFFIC (clock position and distance). (direction) - BOUND, (type of aircraft), (intentions and other relevant information). If applicable, ON CONVERGING COURSE."

- Obtain acknowledgment from the pilot that the other aircraft is in sight.

✈ **Phraseology**

"DO YOU HAVE IT IN SIGHT?"(If the answer is in the affirmative,)

- Instruct the pilot to maintain visual separation from that aircraft.

✈ **Phraseology**

"MAINTAIN VISUAL SEPARATION."

- If the aircraft are on converging courses, inform the other aircraft of the traffic and that visual separation is being applied.

✈ **Phraseology**

"TRAFFIC (clock position and distance), (direction) - BOUND, (type of aircraft). HAS YOU IN SIGHT AND WILL MAINTAIN VISUAL SEPARATION."

- If the pilot advises he/she has the traffic in sight and will maintain visual separation from it (the pilot must use that entire phrase),

- The controller need only approve the operation instead of restating the instructions.

✈ **Phraseology**

"(Call Sign) APPROVED."

Continued on next page

VISUAL SEPARATION *(Continued)*

Visual Separation (Cont'd)
JO 7110.65, par. 7-2-1

⊙ Ensure approved separation:

- Nonapproach control towers may be authorized to provide visual separation between aircraft within surface areas or designated areas provided other separation is assured before and after the application of visual separation.
  - This may be applied by the nonapproach control tower providing the separation or by a pilot visually observing another aircraft and being instructed to maintain visual separation with that aircraft.
- Before applying visual separation:
  - Following IFR separation standards
- After applying visual separation:
  - Vertical/lateral separation is being attained

⊙ When applying visual separation, consider:

- Aircraft performance
- Wake turbulence
- Closure rate
- Routes of flight
- Known weather conditions

Review

QUESTION: Other than in conjunction with a visual approach, at what altitudes may an en route controller apply visual separation?

ANSWER: *Up to but not including FL180*

QUESTION: Must the controller be in direct communication with both aircraft before applying visual separation? Explain your answer.

ANSWER: *No. The controller only has to be in direct communication with one of the aircraft, but must have the ability to communicate with the other one.*

CONCLUSION

Summary

⊙ Review procedures, methods, and phraseologies for:

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

- Radar separation
- Safety alerts
- E-MSAW
- TCAS Conflict Alerts
- Mode C validation
- Altitude confirmation
- Radar service to VFR pilots
- Visual separation
- VFR-on-top

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

Practice Exercise

⊙ The Practice Exercise is located in 55055-HO8. It encompasses content from Lesson 5 (Beacon Code Assignment), Lesson 6 (Radar Identification) and this lesson (Radar Separation and Safety Alerts).

⊙ You will complete this exercise in the lab.

☞***NOTE:***

- *Have students complete this practice exercise in the lab.*
- *The exercise is estimated to take 1 hour lab time per student.*
- *The recommended environment is in the TTL at a simulated position in the student's area of specialization with a scenario (labeled for Lesson 8) running. A ghost pilot is required.*
- *An instructor must be present in the lab to assist.*
- *The student may refer to notes, user manuals and course materials.*

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-ELT08.*