

Section 5. Radar Separation

5-5-1. APPLICATION

a. Radar separation must be applied to all RNAV aircraft operating at and below FL450 on Q routes or random RNAV routes, excluding oceanic airspace.

EXCEPTION. GNSS-equipped aircraft /G, /L, /S, and /V not on a random impromptu route.

REFERENCE-

FAAO JO 7110.5, Para 2-3-8, Aircraft Equipment Suffixes.
FAAO JO 7110.5, TBL 2-3-10, Aircraft Equipment Suffixes
FAAO JO 7110.65, Para 4-4-1, Route Use.
AIM, Para 5-1-8d., Area Navigation (RNAV).
AIM, Para 5-3-4a.3, Area Navigation (RNAV) Routes.
P/CG Term - Global Navigation Satellite System (GNSS)[ICAO].
P/CG Term - Global Positioning Satellite/ Wide Area Augmentation
Minimum En Route IFR Altitude (GPS/WAAS MEA).
P/CG Term - Parallel Offset Route.
AC 90-101A, U.S. Terminal and En Route Area Navigation (RNAV)
Operations, Para 8a, Navigation System Accuracy.

b. Radar separation may be applied between:

1. Radar identified aircraft.

2. An aircraft taking off and another radar identified aircraft when the aircraft taking off will be radar-identified within 1 mile of the runway end.

3. A radar-identified aircraft and one not radar-identified when either is cleared to climb/descend through the altitude of the other provided:

(a) The performance of the radar system is adequate and, as a minimum, primary radar targets or ASR-9/Full Digital Radar Primary Symbol targets are being displayed on the display being used within the airspace within which radar separation is being applied; and

(b) Flight data on the aircraft not radar-identified indicate it is a type which can be expected to give adequate primary/ASR-9/Full Digital Radar Primary Symbol return in the area where separation is applied; and

(c) The airspace within which radar separation is applied is not less than the following number of miles from the edge of the radar display:

(1) When less than 40 miles from the antenna- 6 miles;

(2) When 40 miles or more from the antenna- 10 miles;

(3) Narrowband radar operations- 10 miles; and

(d) Radar separation is maintained between the radar-identified aircraft and all observed primary, ASR-9/Full Digital Radar Primary Symbol, and secondary radar targets until nonradar separation is established from the aircraft not radar identified; and

(e) 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.

REFERENCE-

FAAO JO 7110.65, Para 4-1-2 Exceptions.
FAAO JO 7110.65, Para 4-4-1 Route Use.
FAAO JO 7110.65, Para 5-3-1 Application.
FAAO JO 7110.65, Para 5-5-8 Additional Separation for Formation Flights.
FAAO JO 7110.65, Para 5-9-5 Approach Separation Responsibility.

4. 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.

REFERENCE-

FAAO JO 7110.65, Para 2-2-6, IFR Flight Progress Data.
FAAO JO 7110.65, Para 5-1-1, Presentation and Equipment Performance.
FAAO JO 7110.65, Para 5-3-1, Application.
FAAO JO 7110.65, Para 8-1-8, Use of Control Estimates.
FAAO JO 7110.65, Para 8-5-5, Radar Separation.

5-5-2. TARGET SEPARATION

a. Apply radar separation:

1. Between the centers of primary radar targets; however, do not allow a primary target to touch another primary target or a beacon control slash.

2. Between the ends of beacon control slashes.

NOTE-

At TPX-42 sites, the bracket video feature must be activated to display the beacon control slash.

3. Between the end of a beacon control slash and the center of a primary target.

4. All-digital displays. Between the centers of digitized targets. Do not allow digitized targets to touch.

REFERENCE-

FAAO JO 7110.65, Para 5-9-7 Simultaneous Independent ILS/MLS Approaches- Dual & Triple.

5-5-3. TARGET RESOLUTION

a. A process to ensure that correlated radar targets or digitized targets do not touch.

b. Mandatory traffic advisories and safety alerts must be issued when this procedure is used.

NOTE-

This procedure must not be provided utilizing mosaic radar systems.

c. Target resolution must be applied as follows:

1. Between the edges of two primary targets or the edges of primary digitized targets.

2. Between the end of the beacon control slash and the edge of a primary target or primary digitized target.

3. Between the ends of two beacon control slashes.

5-5-4. MINIMA

Separate aircraft by the following minima:

a. **TERMINAL.** Single Sensor ASR or Digital Terminal Automation System (DTAS):

NOTE-

Includes single sensor long range radar mode.

1. When less than 40 miles from the antenna- 3 miles.

2. When 40 miles or more from the antenna- 5 miles.

3. For single sensor ASR-9 with Mode S, when less than 60 miles from the antenna- 3 miles.

4. For single sensor ASR-11 MSSR Beacon, when less than 60 miles from the antenna- 3 miles.

NOTE-

Wake turbulence procedures specify increased separation minima required for certain classes of aircraft because of the possible effects of wake turbulence.

b. **TERMINAL. FUSION:**

1. Fusion target symbol - 3 miles.

2. When displaying ISR in the data block- 5 miles.

3. If TRK appears in the data block, handle in accordance with Paragraph 5-3-7, Identification Status, subparagraph b, and take appropriate steps to establish non-radar separation.

c. Stage A/DARC, Terminal Mosaic/Multi-Sensor Mode:

NOTE-

Mosaic/Multi-Sensor Mode combines radar input from 2 to 16 sites into a single picture utilizing a mosaic grid composed of radar sort boxes.

1. Below FL 600- 5 miles.

2. At or above FL 600- 10 miles.

3. For areas meeting all of the following conditions:

(a) Radar site adaptation is set to single sensor.

(b) Significant operational advantages can be obtained.

(c) Within 40 miles of the antenna.

(d) Below FL 180.

(e) Facility directives specifically define the area where the separation can be applied. Facility directives may specify 3 miles.

REFERENCE-

FAAO JO 7210.3, Para 8-2-1, Single Site Coverage Stage A Operations.

FAAO JO 7210.3, Para 11-8-15, Single Site Coverage ATTS Operations.

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

(a) The aircraft are on diverging routes/courses, and/or

(b) The leading aircraft is and will remain faster than the following aircraft; and

(c) 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

(d) The procedure is covered by a letter of agreement between the facilities involved and limited to specified routes and/or sectors/positions.

d. MEARTS Mosaic Mode:

1. Below FL 600- 5 miles.
2. At or above FL 600- 10 miles.
3. For areas meeting all of the following conditions – 3 miles:

(a) Radar site adaptation is set to single sensor mode.

NOTE–

1. *Single Sensor Mode displays information from the radar input of a single site.*

2. *Procedures to convert MEARTS Mosaic Mode to MEARTS Single Sensor Mode at each PVD/MDM will be established by facility directive.*

(b) Significant operational advantages can be obtained.

(c) Within 40 miles of the antenna.

(d) Below FL 180.

(e) Facility directives specifically define the area where the separation can be applied and define the requirements for displaying the area on the controller’s PVD/MDM.

4. MEARTS Mosaic Mode Utilizing Single Source Polygon (San Juan CERAP and Honolulu Control Facility only) when meeting all of the following conditions– 3 miles:

(a) Less than 40 miles from the antenna, below FL180, and targets are from the adapted sensor.

(b) The single source polygon must be displayed on the controller’s PVD/MDM.

(c) Significant operational advantages can be obtained.

(d) Facility directives specifically define the single source polygon area where the separation can be applied and specify procedures to be used.

(e) Controller must commence a transition to achieve either vertical separation or 5 mile lateral separation in the event that either target is not from the adapted sensor.

e. STARS Multi–Sensor Mode:

NOTE–

1. *In Multi–Sensor Mode, STARS displays targets as filled and unfilled boxes, depending upon the target’s distance from the radar site providing the data. Since there is presently no way to identify which specific site is providing*

data for any given target, utilize separation standards for targets 40 or more miles from the antenna.

2. *When operating in STARS Single Sensor Mode, if TRK appears in the data block, handle in accordance with para 5–3–7 Identification Status, subpara b, and take appropriate steps to establish nonradar separation.*

3. *TRK appears in the data block whenever the aircraft is being tracked by a radar site other than the radar currently selected. Current equipment limitations preclude a target from being displayed in the single sensor mode; however, a position symbol and data block, including altitude information, will still be displayed. Therefore, low altitude alerts must be provided in accordance with para 2–1–6, Safety Alert.*

WAKE TURBULENCE APPLICATION

f. Separate aircraft operating directly behind, or directly behind and less than 1,000 feet below, or following an aircraft conducting an instrument approach by:

NOTE–

1. *When applying wake turbulence separation criteria, directly behind means an aircraft is operating within 2,500 feet of the flight path of the leading aircraft over the surface of the earth.*

2. *Consider parallel runways less than 2,500 feet apart as a single runway because of the possible effects of wake turbulence.*

1. Heavy behind heavy– 4 miles.

2. Large/heavy behind B757– 4 miles.

3. Small behind B757– 5 miles.

4. Small/large behind heavy – 5 miles.

WAKE TURBULENCE APPLICATION

g. In addition to subpara f, separate an aircraft landing behind another aircraft on the same runway, or one making a touch-and-go, stop-and-go, or low approach by ensuring the following minima will exist at the time the preceding aircraft is over the landing threshold:

NOTE–

Consider parallel runways less than 2,500 feet apart as a single runway because of the possible effects of wake turbulence.

1. Small behind large– 4 miles.

2. Small behind B757– 5 miles.

3. Small behind heavy– 6 miles.

If the landing threshold cannot be determined, apply the above minima as constant or increasing at the closest point that can be determined prior to the landing threshold.

h. TERMINAL. 2.5 nautical miles (NM) separation is authorized between aircraft established on the final approach course within 10 NM of the landing runway when operating in single sensor slant range mode and aircraft remains within 40 miles of the antenna and:

1. The leading aircraft's weight class is the same or less than the trailing aircraft;
2. Heavy aircraft and the Boeing 757 are permitted to participate in the separation reduction as the trailing aircraft only;
3. An average runway occupancy time of 50 seconds or less is documented;
4. CTRDs are operational and used for quick glance references;

REFERENCE-

FAAO JO 7110.65, Para 3-1-9, Use of Tower Radar Displays.

5. Turnoff points are visible from the control tower.

REFERENCE-

FAAO JO 7110.65, Para 2-1-19, Wake Turbulence.
 FAAO JO 7110.65, Para 3-9-6, Same Runway Separation.
 FAAO JO 7110.65, Para 5-5-7, Passing or Diverging.
 FAAO JO 7110.65, Para 5-5-9, Separation from Obstructions.
 FAAO JO 7110.65, Para 5-8-3, Successive or Simultaneous Departures.
 FAAO JO 7110.65, Para 5-9-5, Approach Separation Responsibility.
 FAAO JO 7110.65, Para 7-6-7, Sequencing.
 FAAO JO 7110.65, Para 7-7-3, Separation.
 FAAO JO 7110.65, Para 7-8-3, Separation.
 FAAO JO 7210.3, Para 10-4-8, Reduced Separation on Final.

5-5-5. VERTICAL APPLICATION

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

- a. Assign altitudes to aircraft, provided valid Mode C altitude information is monitored and the applicable separation minima is maintained at all times.

REFERENCE-

FAAO JO 7110.65, Para 4-5-1, Vertical Separation Minima.
 FAAO JO 7110.65, Para 5-2-17, Validation of Mode C Readout.
 FAAO JO 7110.65, Para 7-7-3, Separation.
 FAAO JO 7110.65, Para 7-8-3, Separation.
 FAAO JO 7110.65, Para 7-9-4, Separation.

- b. Assign an altitude to an aircraft after the aircraft previously at that altitude has been issued a climb/descent clearance and is observed (valid Mode C), or reports leaving the altitude.

NOTE-

1. Consider known aircraft performance characteristics, pilot furnished and/or Mode C detected information which indicate that climb/descent will not be consistent with the rates recommended in the AIM.

2. It is possible that the separation minima described in para 4-5-1, Vertical Separation Minima, para 7-7-3, Separation, para 7-8-3, Separation, or para 7-9-4, Separation, might not always be maintained using subpara b. However, correct application of this procedure will ensure that aircraft are safely separated because the first aircraft must have already vacated the altitude prior to the assignment of that altitude to the second aircraft.

REFERENCE-

FAAO JO 7110.65, Para 2-1-3, Procedural Preference.
 FAAO JO 7110.65, Para 4-5-1, Vertical Separation Minima.
 FAAO JO 7110.65, Para 5-2-17, Validation of Mode C Readout.
 FAAO JO 7110.65, Para 6-6-1, Application.

5-5-6. EXCEPTIONS

- a. Do not use Mode C to effect vertical separation with an aircraft on a cruise clearance, contact approach, or as specified in para 5-15-4, System Requirements, subpara e3.

REFERENCE-

FAAO JO 7110.65, Para 6-6-2, Exceptions.
 FAAO JO 7110.65, Para 7-4-6, Contact Approach.
 P/CG Term- Cruise.

- b. 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:

1. Severe turbulence is reported.
2. Aircraft are conducting military aerial refueling.

REFERENCE-

FAAO JO 7110.65, Para 9-2-13, Military Aerial Refueling.

3. The aircraft previously at that altitude has been issued a climb/descent at pilot's discretion.

5-5-7. PASSING OR DIVERGING

a. **TERMINAL.** In accordance with the following criteria, all other approved separation may be discontinued and passing or diverging separation applied when:

1. Single Site ASR or FUSION Mode

(a) Aircraft are on opposite/reciprocal courses and you have observed that they have passed each other; or aircraft are on same or crossing courses/assigned radar vectors and one aircraft has crossed the projected course of the other, and the angular difference between their courses/assigned radar vectors is at least 15 degrees.

NOTE-

Two aircraft, both assigned radar vectors with an angular difference of at least 15 degrees, is considered a correct application of this paragraph.

(b) The tracks are monitored to ensure that the primary targets, beacon control slashes, FUSION target symbols, or full digital terminal system primary and/or beacon target symbols will not touch.

REFERENCE-

FAAO JO 7110.65, Para 1-2-2, Course Definitions.

2. Single Site ARSR or FUSION Mode when target refresh is only from an ARSR or when in FUSION Mode – ISR is displayed.

(a) Aircraft are on opposite/reciprocal courses and you have observed that they have passed each other; or aircraft are on same or crossing courses/assigned radar vectors and one aircraft has crossed the projected course of the other, and the angular difference between their courses/assigned radar vectors is at least 45 degrees.

NOTE-

Two aircraft, both assigned radar vectors with an angular difference of at least 45 degrees, is considered a correct application of this paragraph.

(b) The tracks are monitored to ensure that the primary targets, beacon control slashes, FUSION target symbols, or full digital terminal system primary and/or beacon target symbols will not touch.

3. Although approved separation may be discontinued, the requirements of Para 5-5-4, Minima, subparagraphs f and g apply when operating behind a heavy jet/B757.

REFERENCE-

FAAO JO 7110.65, Para 1-2-2, Course Definitions.

NOTE-

Apply en route separation rules when using multi-sensor mode.

b. EN ROUTE. Vertical separation between aircraft may be discontinued when they are on

opposite courses as defined in para 1-2-2, Course Definitions; and

1. You are in communications with both aircraft involved; and

2. You tell the pilot of one aircraft about the other aircraft, including position, direction, type; and

3. One pilot reports having seen the other aircraft and that the aircraft have passed each other; and

4. You have observed that the radar targets have passed each other; and

5. You have advised the pilots if either aircraft is classified as a heavy jet/B757 aircraft.

6. Although vertical separation may be discontinued, the requirements of para 5-5-4, Minima, subparas f and g must be applied when operating behind a heavy jet/B757.

EXAMPLE-

“Traffic, twelve o’clock, Boeing Seven Twenty Seven, opposite direction. Do you have it in sight?”

(If the answer is in the affirmative):

“Report passing the traffic.”

(When pilot reports passing the traffic and the radar targets confirm that the traffic has passed, issue appropriate control instructions.)

5-5-8. ADDITIONAL SEPARATION FOR FORMATION FLIGHTS

Because of the distance allowed between formation aircraft and lead aircraft, additional separation is necessary to ensure the periphery of the formation is adequately separated from other aircraft, adjacent airspace, or obstructions. Provide supplemental separation for formation flights as follows:

a. Separate a standard formation flight by adding 1 mile to the appropriate radar separation minima.

REFERENCE-

FAAO JO 7110.65, Para 2-1-13, Formation Flights.

FAAO JO 7110.65, Para 5-5-1, Application.

FAAO JO 7110.65, Para 7-7-3, Separation.

P/CG Term- Formation Flight.

b. Separate two standard formation flights from each other by adding 2 miles to the appropriate separation minima.

c. Separate a nonstandard formation flight by applying the appropriate separation minima to the perimeter of the airspace encompassing the nonstandard formation or from the outermost aircraft of the nonstandard formation whichever applies.

d. If necessary for separation between a nonstandard formation and other aircraft, assign an appropriate beacon code to each aircraft in the formation or to the first and last aircraft in-trail.

NOTE—

The additional separation provided in Paragraph 5-5-8 Additional Separation for Formation Flights, is not normally added to wake turbulence separation when a formation is following a heavier aircraft since none of the formation aircraft are likely to be closer to the heavier aircraft than the lead aircraft (to which the prescribed wake turbulence separation has been applied).

REFERENCE—

FAAO JO 7110.65, Para 9-2-13, Military Aerial Refueling.

5-5-9. SEPARATION FROM OBSTRUCTIONS

a. Except in En Route Stage A/DARC or Stage A/EDARC, separate aircraft from obstructions depicted on the radar display by the following minima:

1. When less than 40 miles from the antenna—3 miles.

2. When 40 miles or more from the antenna—5 miles.

b. Except in En Route Stage A/DARC or Stage A/EDARC, vertical separation of aircraft above an obstruction depicted on the radar display may be discontinued after the aircraft has passed it.

c. En Route Stage A/DARC or Stage A/EDARC, apply the radar separation minima specified in Paragraph 5-5-4, Minima, subparagraph c1.

5-5-10. ADJACENT AIRSPACE

a. 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:

REFERENCE—

FAAO JO 7110.65, Para 2-1-14, Coordinate Use of Airspace.

1. When less than 40 miles from the antenna—1 1/2 miles.

2. When 40 miles or more from the antenna—2 1/2 miles.

3. En route Stage A/DARC or Stage A/EDARC:

(a) Below Flight Level 600—2 1/2 miles.

(b) Flight Level 600 and above—5 miles.

b. Separate radar-controlled aircraft from the boundary of airspace in which nonradar separation is being used by the following minima:

1. When less than 40 miles from the antenna—3 miles.

2. When 40 miles or more from the antenna—5 miles.

3. En route Stage A/DARC or Stage A/EDARC:

(a) Below Flight Level 600—5 miles.

(b) Flight Level 600 and above—10 miles.

c. The provisions of subparas a and b do not apply to VFR aircraft being provided Class B, Class C, or TRSA services. Ensure that the targets of these aircraft do not touch the boundary of adjacent airspace.

d. VFR aircraft approaching Class B, Class C, Class D, or TRSA airspace which is under the control jurisdiction of another air traffic control facility should either be provided with a radar handoff or be advised that radar service is terminated, given their position in relation to the Class B, Class C, Class D, or TRSA airspace, and the ATC frequency, if known, for the airspace to be entered. These actions should be accomplished in sufficient time for the pilot to obtain the required ATC approval prior to entering the airspace involved, or to avoid the airspace.

5-5-11. EDGE OF SCOPE

Separate a radar-controlled aircraft climbing or descending through the altitude of an aircraft that has been tracked to the edge of the scope/display by the following minima until nonradar separation has been established:

a. When less than 40 miles from the antenna—3 miles from edge of scope.

b. When 40 miles or more from the antenna—5 miles from edge of scope.

c. En route Stage A/DARC or Stage A/EDARC:

1. Below Flight Level 600– *5 miles*.
2. Flight Level 600 and above– *10 miles*.

5-5-12. BEACON TARGET DISPLACEMENT

When using a radar target display with a previously specified beacon target displacement to separate a

beacon target from a primary target, adjacent airspace, obstructions, or terrain, add a 1 mile correction factor to the applicable minima. The maximum allowable beacon target displacement which may be specified by the facility air traffic manager is $\frac{1}{2}$ mile.

REFERENCE–

FAAO JO 7210.3, Para 3-7-4, Monitoring of Mode 3/A Radar Beacon Codes.