NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

June 12, 2020

Attachment 9 – United Airlines Airbus 319/320 Flight Manual

[Excerpt]

OPERATIONAL FACTORS

DCA20CA058

Weather Radar Control Panels

Note: *48XX/49XX aircraft may either have one of two different weather radar control panels, as shown below.*

Location: Control Pedestal

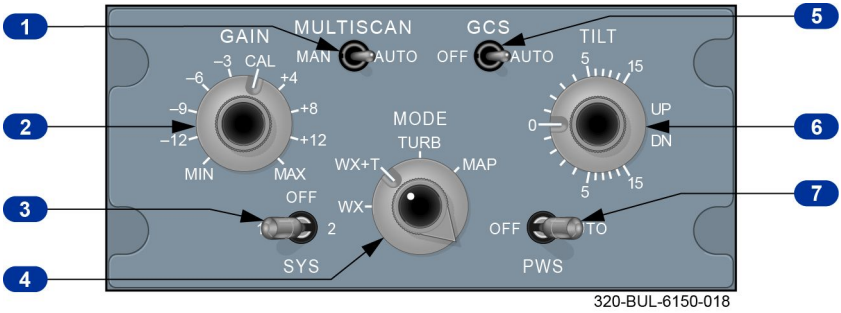
320-BUL-019

1 Radar Switch Position 1 activates the weather radar for display on the ND in any mode except PLAN.

Note: *Position 2 is deactivated. Inadvertently selecting this position will not turn on the radar.*

Note: *The OFF position is the middle position; therefore, exercise care to ensure the system is off after landing since the switch is positioned either full left or full right on UA-configured aircraft.*

Location: Control Pedestal



320-BUL-6150-018

The normal settings are:

- (1) MULTISCAN - AUTO
- (2) GAIN - CAL
- (3) SYS - 1
- (4) MODE - WX+T
- (5) GCS - AUTO

- (6) TILT - 0
- (7) PWS - AUTO

1 **MULTISCAN** In AUTO the radar alternatively scans at two antenna tilt settings. The weather radar image that is displayed is the result of the stored and combined information from each beam. It also removes the weather that is not on the aircraft flight path or is not a threat to the aircraft (post convective cell). In MAN the TILT setting becomes active and must be manually adjusted.

2 **GAIN** CAL provides automatic gain adjustment based on altitude, geographical area, season, and time of the day.

3 **SYS** Turns on/off weather radar system 1 or 2. The normal setting is 1 as SYS 2 may be deactived.

4 **MODE** WX+T is the normal mode. WX operates like UA 320s, the T feature displays turbulence areas within 40 NM in magenta.

5 **GCS** Is ground clutter suppression and removes ground returns from the ND. GCS is not available when using manual modes.

6 **TILT** Zero indicates the horizon reference, as provided by the ADIRS. If MULTISCAN is set to MAN, utilize the TILT knob per normal SOP as stated in the Flight Manual.

7 **PWS** Operates like UA 320s.

- Audio control panel (ACP) . . . . . As required

  Note: *On VHF 1, in the high frequency band (e.g., 135.97), there may be an increase in background noise due to electrical interference on the ground or in flight; use VHF 2 if necessary. A maintenance report is not required.*

- Thrust levers . . . . . Idle
- WX RADAR . . . . . Off

  Verify gain is in AUTO position and the image selector is in WX/TURB.

- PWS switch . . . . . Off
- Flight deck door open light . . . . . Verify on

  Confirms the flight deck door locking system is powered.

- ☐ Gravity gear extension handle . . . . . Stowed
- ☐ Passenger address system . . . . . Check

  Check clarity, volume, and operation of handset.

- ACARS/FMGC . . . . . Initialize/program

  The ACARS/FMGC may be initialized by either pilot at any time during the flight deck preparation; the other pilot independently verifies all entries are correct. See Supplementary Procedures>Communications/Navigation>Normal FMGC Procedures>FMGC Initialization.

  Note: *Independent verification means that verification is accomplished without assistance or influence from the other pilot.*

FINAL PREFLIGHT PROCEDURE

CAUTION: ***The only confirmation the parking brake is set is an indication of brake pressure on the BRAKES and ACCU PRESS indicators.***

CAUTION: ***The parking brake should be set if the ramp is icy or if either wind speed or gusts of 40 knots or higher are anticipated.***

- [C] Parking brake . . . . . Set, pressure normal

  Parking brake must be set prior to beginning the Preflight Checklist.

  The brake accumulator is normally charged in the green range (approximately 3000 PSI). If the pressure drop is greater than 300 PSI, recharge the accumulator.

WARNING: ***If a departure procedure requires holding after takeoff (e.g., to climb to MEA/MCA), the holding must be manually loaded, even on line-selectable departures.***

- [C/F] ATC clearance . . . . . Obtain
  Obtain clearance and compare routing with Flight Plan routing. Make any necessary FMGC corrections.
- [C, F] FCU . . . . . Verify
  - Speed window. . . . . Managed
    Indicated by dashes.
  - Heading window . . . . . Nav or heading
    - Verify dashes are displayed for a NAV departure and verify the lateral column of FMA indicates NAV is armed.
    - Set heading in accordance with planned SID or planned runway heading to disarm NAV mode and verify the lateral column of FMA is blank.
  - Altitude window . . . . . Set
  - Vertical speed window . . . . . Dashed
- [C, F] PFD . . . . . Check
  After the FCU is set, verify autoflight modes for departure:
  - Climb mode . . . . . Armed
  - Lateral mode . . . . . As required
  - FCU altitude . . . . . Displayed
- [C, F] EGPWS, radar displays . . . . . As required
  If use of weather radar is not required, both pilots should select the TERR ON ND or TERR switches on. If weather radar is required, either or both pilots may deselect the TERR ON ND or TERR switch. If both pilots are in the weather radar display mode, the terrain display pop-up feature is still available.
- [C] Pilot and flight attendant briefings . . . . . Complete
  For review of applicable briefing items, see FOM>Operating Information> Crew Briefings and Departure Briefing.
- Preflight Checklist . . . . . Accomplish
- [C] APU . . . . . Start
  Start the APU as close to pushback as possible.

CAUTION: ***Select the EXT PWR switch off prior to disconnecting ground power to avoid power surges.***

- [C] External power . . . . . Off
  Ensure the CVR GND CTL switch ON light remains illuminated.

- Thrust reduction/acceleration altitudes
- Flap setting. Advise the Captain and change the flap handle setting, if required.
- FLEX TO temperature, if appropriate
- EO acceleration altitude and procedure

■ [F] FCU. . . . . Check

Ensure the FCU is set as follows:

■ SPD window . . . . . Displays dashes

Verify the speed window displays dashes and V2 is displayed on the PFD speed scale.

■ HDG/NAV . . . . . Verify

If departure is to be flown using heading, set assigned heading or runway heading. If NAV is to be used, the heading window displays dashes and NAV automatically engages at 30 feet on departure.

Verify the ND runway display is closely aligned to the actual runway heading.

Note: *If a heading is preset on the FCU, RWY TRK guidance automatically engages at 30 feet. If a heading is not preset prior to departure and an engine failure occurs, HDG must be engaged and wind adjusted, to track the extended centerline or to follow the engine failure procedure.*

■ ALT . . . . . Verify

Verify the correct altitude for the departure procedure is displayed in the FCU altitude window and on the PFD altitude scale.

■ [F] FMGC (F-PLN) . . . . . Verify departure programming

■ [F] PWS . . . . . AUTO

■ [C, F] Weather radar. . . . . As required

■ [C, F] Radar/terrain . . . . . As required

Select weather radar or terrain as appropriate. The terrain display pop-up feature is still available if both pilots have weather radar displayed.

■ [C] Before Takeoff Checklist. . . . . Announce

The Captain may call for the Before Takeoff Checklist in its entirety or to the line as appropriate.

When the Captain calls for the Before Takeoff Checklist:

■ [F] Final weights. . . . . ____ (GW), ____ (TOW CHG)

Respond with the Final Weight Manifest GW and TOW change.

Example: First Officer: “133.1, minus 501”

- If thrust variations become excessive, disengage the autothrust system and adjust thrust levers as necessary.

Note: *If any overspeed occurs, a maintenance report is required.*

WEATHER RADAR OPERATION

GENERAL

While penetration of widespread areas of light stratiform rain is possible, caution should be used when flying through extended areas of moderate rain due to the possibility of embedded thunderstorms. Radar equipment is to be used as an aid ***to avoid severe weather, not as a penetration tool.***

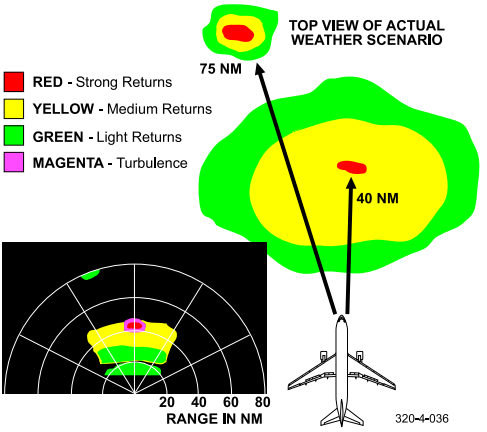
RADAR ATTENUATION CHARACTERISTICS

In widespread ***light*** rain, the radar displays ***green*** to a distance of 70 NM with the remainder of the light rain not displayed due to lower reflectivity. In widespread ***moderate*** rain, the radar displays ***yellow*** to a distance of 45 NM, then turns green for an additional 10 NM with the remainder of the moderate rain not displayed. Even though the reflectivity increases in ***moderate*** rain, the distance precipitation is displayed decreases due to radar attenuation.

A storm cell 3 NM wide and 3 NM tall with heavy rain surrounded by clear air displays on radar when within 230 NM of the aircraft. The same storm cell embedded in widespread light rain displays on radar when within 160 NM of the aircraft. Embedded in widespread moderate rain, the same storm cell displays when within 80 NM of the aircraft. These distances relate to a very intense storm; storms of less intensity are not detectable until closer to the aircraft. As the cell intrudes the colored area of the radar display, it casts some shadow. Whenever flying through widespread rain, using primary tilt position and searching for shadows are very important.

Note: *The weather radar may occasionally display red and black wedges or sharp sectors similar to a radar test pattern. This can be disregarded if these disappear in two to three radar sweeps. If the images persist, report the defect to Maintenance.*

Note: *All grids for spacial comparisons only, not on actual displays.*



SYSTEM TEST

WARNING: ***Do not operate the radar when personnel are within 15 feet of the radar antenna or while fueling or defueling.***

On power-up and during final approach, the aircraft runs a system self-test. The CFDS test emits a very brief radar pulse to verify transmitter operation.

To check the radar when clear of the ramp area:

- System switch . . . . . On
- Weather radar mode selector . . . . . Weather/turbulence
- Tilt knob . . . . . Adjust

  Tilt the antenna down until ground returns display on the NDs. Verify no fault messages. There is no test pattern display on the ND during this functional check.

To check the receiver, antenna, and displays, turn the radar on during taxi when clear of the ramp area. Tilt the antenna down until ground returns display on the NDs. Verify no fault messages.

SYSTEM OPERATION

- Weather radar mode selector . . . . . Weather/turbulence

  Provides normal weather radar operation plus Doppler detection of turbulence by measuring the velocity of rain droplets moving parallel to the aircraft flight path. Turbulence may be displayed in light rain or entirely outside the precipitation area. Although Doppler cannot detect clear air turbulence, it can detect turbulence in the presence of rain lighter than that displayed in the weather-only mode. Turbulence returns and Level 4 and higher storms are displayed in magenta. These areas can be ***very dangerous***. Avoid echoes in accordance with the FOM.

- ND brightness control knobs . . . . . Adjust

  Balance the radar returns and ND.

- ND range selector . . . . . As required

  As weather echoes move closer to the aircraft, selecting shorter ranges yields best results. Select progressively shorter ranges during a descent. The longer ranges should be monitored periodically to detect distant storm cells. When different ranges are selected, tilt adjustment is necessary.

- Tilt knob . . . . . As required

  See Weather Radar - Tilt Management, this section.

- Inflight radar check . . . . . Accomplish

  For enroute verification of radar operation, adjust tilt for maximum distance ground mapping. Consider radar accurate if able to display ground returns to the following distances:
  - Above 10,000 feet AGL to at least 100 NM ***or***
  - Above 20,000 feet AGL to at least 150 NM

SHUTDOWN

- Tilt knob . . . . . Up
- System switch . . . . . Off

WEATHER RADAR – TILT MANAGEMENT

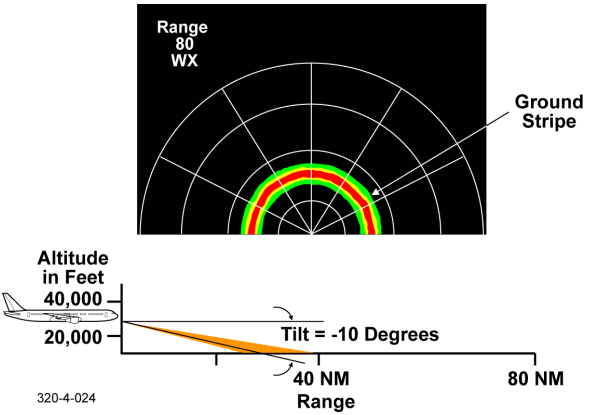
Range and azimuth depict the organization of the weather system, the relative position of echoes in a line, and an avoidance path. Measuring the height, gradient, reflectivity, Doppler return, and shape of cells depicts the degree of hazard. Note that shapes are often fleeting; they may appear only at certain tilt settings or disappear after a single sweep. Failure to spot a particular shape or feature does not necessarily mean the weather is nonhazardous. Also, size, intensity, and echo tops are not always clear-cut indicators of hazard. See FOM, Adverse Weather chapter for additional information.

TAKEOFF

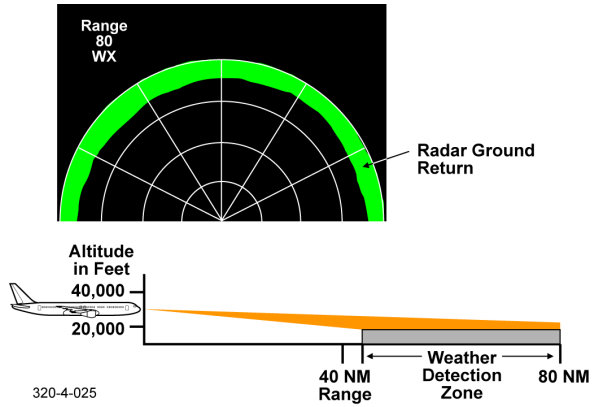
Scan for storms in the departure path at the 10 NM range and move the tilt slowly from +15° to +4°. If the 10 NM range is clear, repeat for the 20 NM and 40 NM ranges. Look for irregular shapes and crescent-shaped storms. Normal antenna tilt position during and after takeoff is +4°.

PRIMARY TILT POSITION

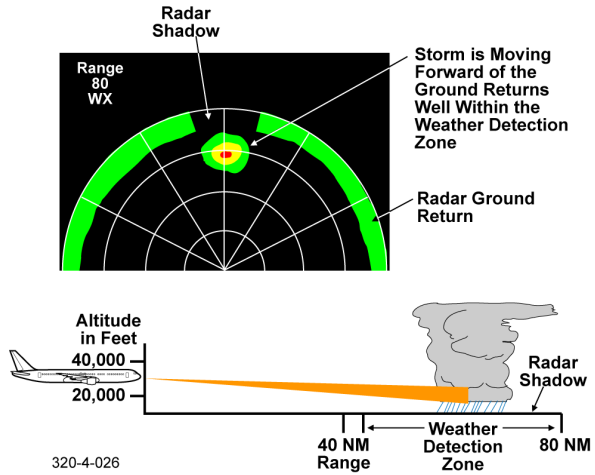
While in flight, move the tilt downward until ground return is displayed.



Raise the beam and observe the ground return moving farther out in range. A radar sweep takes about 4 seconds, so make the adjustments slowly. Stop adjusting the tilt when the ground return stripe moves to the outer edge of the indicator but can still be seen. At the higher ranges, the ground return appears as a sprinkle of ground return spots.



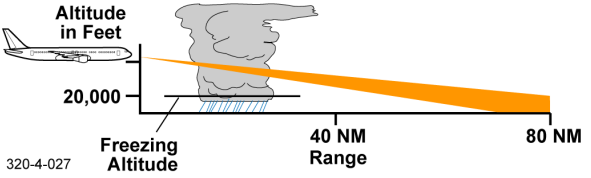
The primary tilt position creates a zone where no storm can go undetected as the radar beam is toward the most reflective section of a storm.

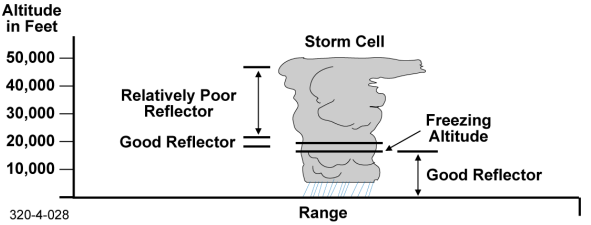


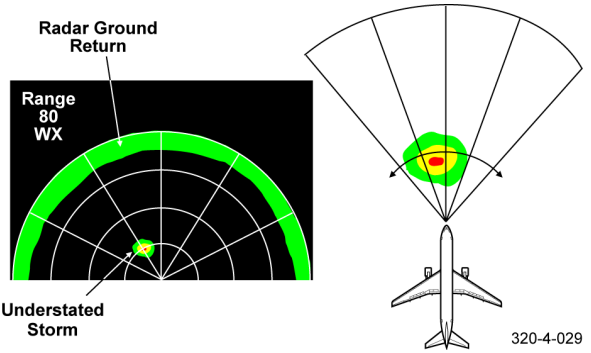
Any significant change of altitude requires a new primary tilt position; on descent, more upward tilt is needed; on climb, more downward tilt. Tilt control is independent of radar stabilization. The stabilization function maintains the antenna position parallel to the earth during aircraft maneuvering. However, tilt must be adjusted for significant altitude changes and when a different range is selected.

OVERSCANNING

Above 25,000 feet, as the aircraft approaches storms, the storms may become dangerously understated or disappear completely from the display. This is due to overscanning the most reflective part of the storm.







If an echo disappears from the scope or becomes understated, due to overscanning, reduce the range and repeat the primary tilt position procedure.

Special Convective Conditions

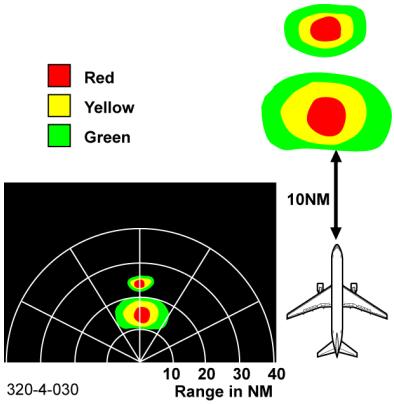
Storms in regions of unstable air (i.e., Tropics and Subtropics) may also be overscanned. To aid in detection of dry top cells:

- Position mode selector in WX/TURB.
- Position GAIN selector in AUTO.
- Keep flight deck lights low to optimize visual detection.
- Use 40 NM range; keep at least one pilot on this range.
- Use the primary tilt position for the 40 NM range.

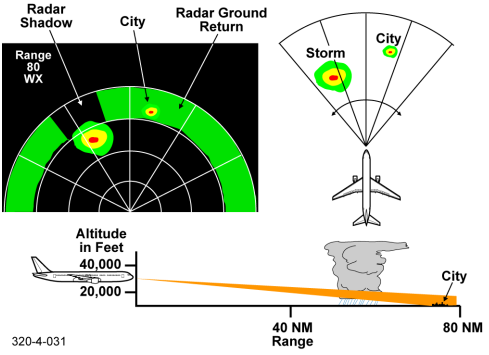
LOOKING FOR SHADOWS

Tilt the antenna down to a position that paints ground returns on the outer one-third to one-half of the display:

- ***If weather can be seen behind a cell, assume it is at least one level more hazardous than depicted, due to attenuation.***



- If no ground return or other echoes can be seen behind a cell, a radar shadow is indicated. This shadow is an important indicator of hazardous weather; ***avoid all shadowed areas.*** If it is an extreme storm, with only its leading edge depicted, it appears as a thin line or band of precipitation in the shape of a crescent, with the horns pointed away from the aircraft. A black area behind it (the radar shadow) is the most dangerous part of the storm. An isolated mountain echo appears as a crescent-shaped cell that casts a shadow, a city will not. Widespread areas of water (e.g., lakes, rivers) may also appear as shadows.

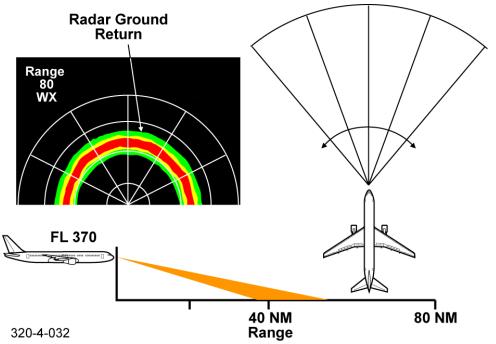


PARALLEL BEAM POSITION

This tilt position results in the bottom of the beam being parallel to the earth, and echoes depicted (weather and/or high terrain) are objects that intrude through the current altitude. It should be selected frequently, particularly when operating below 15,000 feet AGL, but for only a few sweeps. To find the parallel beam position:

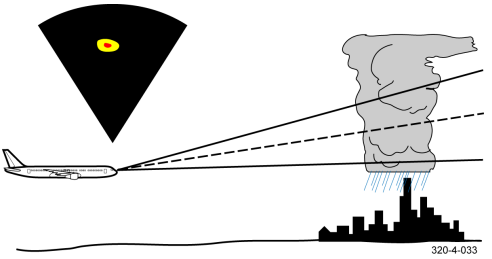
- Tilt. . . . . Adjust

  Adjust the tilt to paint the ground stripe at a range equal to current AGL altitude (e.g., flying at FL 370 over sea-level terrain, paint it at 37 NM; at FL 370 over Denver, paint it at approximately 32 NM):



- Tilt. . . . . Increase

  Increase the tilt 10° from the position in the previous step.

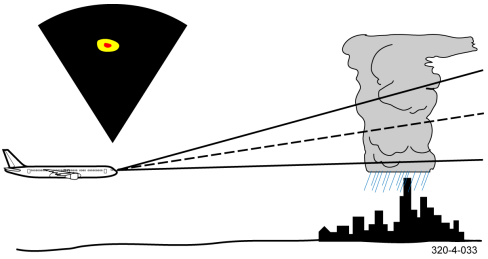


EVALUATING CELL HEIGHT

When used for a few sweeps, this formula gives a quick estimate of radar height of the echo and may be used at any range. This is useful ***only*** for determining the relative severity of the storm and should not be used to attempt overflight in IMC. Radar height is ***not*** the storm height, due to low reflectivity in the cell tops. Assume the actual storm top is at least 20% above the measured radar top. ***Severe turbulence can exist well above the actual top.***

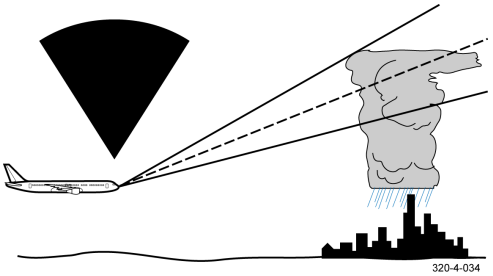
- Cell height . . . . . Evaluate

  Start from the parallel beam position.



- Tilt. . . . . Increase

  Increase until echo disappears.



- Cell height evaluation. . . . . Continue

  The radar top is distance to echo x 100 x degrees of tilt change from parallel beam (e.g., an echo at 40 NM disappears with a 4° tilt increase: 40 x 100 x 4° = ***radar top,*** which is at least 16,000 feet above current flight level; ***actual top*** is 120% of 16,000 feet or at least 19,200 feet above current flight level).