

DCA22LA126

OPERATIONAL FACTORS/HUMAN PERFORMANCE

Attachment 8: FedEx Express B-757 Aircraft System Manual [Excerpt]

Look-Ahead Alerting - Warnings

Aural Alert	Visual Alert	Description
TERRAIN TERRAIN PULL UP	PULL UP light (red). Master WARNING lights. Red TERRAIN message on the PFD. Solid red TERRAIN on the PFD and ND.	20 to 30 seconds from projected impact with terrain shown solid red on the PFD and ND (VOR, APP or MAP modes only). ⊖ Note: Pushing the TERR SYS OVRD switch to OVRD inhibits the alert.
OBSTACLE OBSTACLE PULL UP	PULL UP light (red). Master WARNING lights. Red TERRAIN message on PFD. Solid red TERRAIN on the PFD and ND.	20 to 30 seconds from projected impact with terrain shown solid red on the PFD and ND (VOR, APP or MAP modes only). ⊖ Note: Pushing the TERR SYS OVRD switch to OVRD inhibits the alert.
CAUTION TERRAIN	GND PROX light. Solid amber TERRAIN on the PFD and ND. Amber TERRAIN message on PFD.	40 to 60 seconds from projected impact with terrain shown solid amber on the PFD and ND (VOR, APP or MAP modes only). ⊖ Note: Pushing the TERR SYS OVRD switch to OVRD inhibits the alert.
CAUTION OBSTACLE	GND PROX light (amber). Amber OBSTACLE message on PFD. Solid amber OBSTACLE on the PFD and ND.	40 to 60 seconds from projected impact with obstacle shown solid amber on the ND and PFD HSI (VOR, APP or MAP modes only). ⊖ Note: Pushing the TERR SYS OVRD switch to OVRD inhibits the alert.
TOO LOW, TERRAIN	GND PROX light (amber).	Terrain Clearance Floor (TCF) alert indicating unsafe terrain clearance based on current airplane location, nearest runway center point and radio altitude. Similar to Mode 4 but available in all flight modes. ⊖ Note: Pushing the TERR SYS OVRD switch to OVRD inhibits the alert.

RUNWAY AWARENESS ADVISORY SYSTEM (RAAS)**Introduction**

RAAS is a software enhancement hosted within the EGPWS unit to provide aural advisories to assist flight crew awareness of airplane position during ground operations, approach to landing, and go-around. The airports in the RAAS airport database include details for every runway on the airport.

The RAAS OVRD switch is used to inhibit RAAS advisories if required.

The following RAAS characteristics must be considered:

- RAAS voice annunciations are based upon RAAS database runway details NOT the runway intended or planned.
- The voice annunciations do NOT take into account airplane performance factors such as airplane weight, wind, runway condition, slope, air temperature, or airport altitude.
- Voice annunciations do not ensure that a runway is inappropriate for takeoff or landing nor does the absence of voice annunciations ensure that a runway is appropriate for takeoff or landing.
 - Advisories do not ensure that the aircraft will land on the identified runway nor imply that the aircraft can or cannot be safely landed, stopped, or taken off, from a runway. They also do not ensure that the aircraft will, or can be, stopped before hold lines, the runway edges or the runway end.
 - The absence of advisories does not necessarily imply that the aircraft is approaching a surface other than a runway.
- Flight crew is responsible to use other means available to ensure correct runway selection and the performance calculations are accurate for the conditions.
- The design of RAAS does not include knowledge of ATC clearance or flight crew intent, and therefore factors such as clearance misunderstandings, incorrect or inappropriate clearances cannot necessarily be mitigated by use of RAAS.
- RAAS is not designed to enhance traffic awareness and therefore its use does not ensure protection from loss of separation with other traffic.
- Other EGPWS aural alerts and warnings may preempt RAAS advisories. RAAS advisories may be issued during ATC radio communications, flight crew/cockpit communications, or during other aural messages provided in the cockpit by other aircraft systems.
- RAAS may become unavailable at any time due to loss of accuracy of GPS signals. There is no cockpit annunciation to indicate the status of RAAS while airborne.
- Not all airports/runways in the EGPWS Terrain Database are RAAS enabled. RAAS advisories will not occur at an airport located in the EGPWS Terrain Database unless it is RAAS enabled.

In flight RAAS voice annunciations are enabled or inhibited based on an algorithm that numerically subtracts the landing runway touchdown zone elevation in the GPWS database from the pressure altitude of the airplane. The term "above field elevation (AFE)" is used in the system description for these altitudes.

Voice Annunciations During Taxi and Takeoff on RAAS Airports

Voice Annunciation	Description
ON TAXIWAY, ON TAXIWAY	Sounds once each time the airplane: - Is on a surface other than a runway, and - Ground speed is greater than 40 knots.
APPROACHING (RUNWAY IDENTIFIER of runway end closest to airplane position)	Sounds once each time the airplane: - Ground speed is less than 40 knots, and - Approaches a runway.
APPROACHING RUNWAYS	Sounds once each time the airplane: - Ground speed is less than 40 knots, and - Approaches two runways within 20 degrees of each other.
ON RUNWAY (RUNWAY IDENTIFIER)	Sounds once when the airplane: - Enters a runway with an available runway length for takeoff greater than 5000 feet, and - Heading is within 20 degrees of the runway heading.
ON RUNWAY (RUNWAY IDENTIFIER) (LENGTH) REMAINING	Sounds once (with insufficient runway available for takeoff) when the airplane: - Enters a runway with the available distance for takeoff being less than 5000 feet, and - Heading is within 20 degrees of the runway heading.
ON RUNWAY (RUNWAY IDENTIFIER), ON RUNWAY (RUNWAY IDENTIFIER)	Sounds when the airplane: - Remains on the runway, and - Moves less than 100 ft. in 90 seconds, and - Heading is within 20 degrees of runway heading. ⓘ Note: This advisory is suppressed after a rejected takeoff. The advisory is reset when the aircraft leaves the runway area.

Voice Annunciations During Approach, Landing, Go-Around, and RTO on RAAS Airports

Voice Annunciation	Description
APPROACHING (RUNWAY IDENTIFIER)	Sounds once each time the airplane: - Approaches within approximately 3 nautical miles of a runway threshold, and - Is within 20 degrees of the runway heading, and - Is within approximately 200 feet plus one runway width of the runway extended centerline, and - Is between 750 feet and 300 feet AFE. ⓘ Note: The voice annunciation is delayed and sounds at 450 feet altitude if the voice annunciation would have sounded when the airplane was between 550 feet and 450 feet above field elevation. If the criteria above are not satisfied before the aircraft descends below 300 feet AFE, the advisory is canceled.
APPROACHING RUNWAYS	Sounds once each time the description is met while approaching two runways that meet the APPROACHING RUNWAY criteria.
APPROACHING (RUNWAY IDENTIFIER) (LENGTH) AVAILABLE	Sounds once (with insufficient runway available for landing) each time the airplane: - Approaches within approximately 3 nautical miles of a runway threshold with the available distance for landing being less than 5000 feet, and - Is within 20 degrees of the runway heading, and - Is within approximately 200 feet plus one runway width of the runway extended centerline, and - Is between 450 feet and 300 feet AFE. ⓘ Note: The voice annunciation is delayed and sounds at 450 feet altitude if the voice annunciation would have sounded when the airplane was between 550 feet and 450 feet above field elevation. If the criteria above are not satisfied before the aircraft descends below 300 feet AFE, the advisory is canceled.

Voice Annunciation	Description
(LENGTH) REMAINING	Sounds once each time the airplane is on the ground: • With ground speed greater than 40 kts, and • Within the last half of the runway and 3,000 feet (or less) of runway remaining. • At 1,000-foot intervals, except the last possible advisory occurs at 500 feet. • During rejected takeoff, when ground speed during takeoff decreases by seven knots from the maximum ground speed achieved.
	Sounds once each time the airplane is in the air: • Less than 100 feet above the runway, and • Within the last half of the runway and 3,000 feet (or less) of runway remaining. • During a go-around the advisories are inhibited once the aircraft climbs higher than 100 feet above the runway or climb rate is greater than 450 fpm.

Routine Advisories

The following four routine advisories are intended to enhance aircraft position awareness and reduce the risk of a runway incursion:

- Approaching Runway (on ground)
- On Runway (on ground)
- Approaching Runway (in air)
- Distance Remaining (landing and rollout advisory)

Approaching Runway - On Ground Advisories

This advisory provides the crew with awareness of proximate runway edge being approached by the aircraft during taxi operations. RAAS determines the runway identifier for the end of the runway that is closest to the position of the aircraft. The aural message consists of the word "APPROACHING" followed by the runway identifier. This advisory is issued once each time the aircraft approaches a runway. If more than one runway meets the qualifying conditions as defined below, then the message "APPROACHING RUNWAYS" is generated. This advisory is enabled when:

- Aircraft ground speed is less than 40 kts, and
- Aircraft is within a specified distance from the runway. This distance is a function of aircraft ground speed and closure angle with the runway - a higher ground speed results in an earlier advisory.

On Runway Advisory

This advisory provides the crew with awareness of which runway the aircraft is lined up with during ground operations. The aural message consists of the words ON RUNWAY followed by the runway identifier. This advisory message is annunciated once each time the aircraft enters a runway. If more than one runway meets the qualifying conditions as defined below, then the message ON RUNWAYS is generated. The On Runway advisory is generated when the following conditions are met:

- Aircraft enters a runway and
- Aircraft heading is within ± 20 degrees of the runway heading.

Approaching Runway - In the Air Advisory

This advisory provides the crew with awareness of which runway the aircraft is lined-up with on approach. RAAS-equipped aircraft provide the flight crew with an aural advisory when the aircraft is airborne and approaching a runway. The aural message consists of the word "APPROACHING" followed by the runway identifier. If more than one runway meets the qualifying conditions defined below, then the message "APPROACHING RUNWAYS" is generated. This advisory is suppressed between 550 and 450 ft. above runway elevation to allow normal 500 ft. altitude callouts and/or crew procedures without conflict. If the advisory is triggered while the aircraft is between 550 and 450 feet Above Field Elevation (AFE), the advisory is suppressed until the aircraft descends below 450 feet AFE, where the message will be annunciated. The Approaching Runway advisory is enabled when:

- Aircraft is between 750 feet and 300 feet AFE and
- Aircraft is within approximately 3 nautical miles of the runway and
- Aircraft track is aligned with the runway within ± 20 degrees and
- Aircraft position is within approximately 200 feet, plus runway width, of the runway centerline.

If the criteria above are not satisfied before the aircraft descends below 300 feet AFE, the advisory is canceled.

Distance Remaining - Landing and Rollout Advisory

This advisory enhances crew awareness of the aircraft along track position relative to the runway end. These advisories are generated at whole thousand-foot intervals, except that the last possible advisory occurs at 500 feet. The Distance Remaining advisory is generated when the following conditions are met:

- Aircraft is on the ground (or within 100 feet of the ground,) over the last half of the runway and 3,000 feet (or less) of runway remaining.
- Aircraft ground speed is above 40 knots.

If the crew elects to go around after the Distance Remaining advisories are triggered, the advisories continue to be annunciated at the appropriate distance along the runway.

The Distance Remaining advisories are inhibited once the aircraft climbs above 100 feet radio altitude or aircraft climb rate is greater than 450 fpm.

Non-Routine Advisories

The five Non-Routine Advisories are provided to enhance safety in specific situations that are not necessarily encountered during routine aircraft operations.

They are:

- Insufficient Runway Length (on ground)
- Approaching Short Runway (in air)
- Taxiway Takeoff
- Extended Holding on Runway
- Distance Remaining - Rejected Takeoff

Insufficient Runway Length - On Ground

The Insufficient Runway Length - This advisory provides the crew with awareness of which runway the aircraft is lined-up with, and that the runway length available for takeoff is less than the defined nominal takeoff runway length. The aural message consists of the words "ON RUNWAY" followed by the runway identifier, the distance remaining, and the word REMAINING. This advisory is generated when the following conditions are met:

- Aircraft enters a runway and
- Aircraft heading is within ± 20 degrees of the runway heading and
- Available distance for takeoff is less than 5,000 feet.

Approaching Short Runway Advisory - In Air

This advisory provides the crew with awareness of which runway the aircraft is lined-up with, and that the available runway length for landing is less than the defined nominal landing runway length. The aural message consists of the words "APPROACHING" followed by the runway identifier, the distance available, and the word AVAILABLE. This advisory occurs once for each runway alignment. This advisory is generated when the following conditions are met:

- Aircraft is between 750 feet and 300 feet AFE and
- Aircraft is within approximately 3 nautical miles of the runway and
- Aircraft track is aligned with the runway within ± 20 degrees and
- Aircraft position is within approximately 200 feet, plus runway width, of the runway centerline and
- Aligned runway is shorter than a nominal runway length of 5000 feet.

If the criteria above are not satisfied before the aircraft descends below 300 feet AFE, the advisory is canceled.

Taxiway Takeoff Advisory

The Taxiway Takeoff Advisory enhances crew awareness of excessive taxi speeds or an inadvertent takeoff on a taxiway. The aural message string "ON TAXIWAY! ON TAXIWAY!" is annunciated once each time the advisory is generated. RAAS generates the advisory when the following conditions are met:

- Ground speed of the aircraft exceeds 40 knots and
- Aircraft is on a surface other than a runway.

RAAS functions are based on a database of runway locations. The system does not have knowledge of location of taxiways. This message will occur when RAAS has determined that the aircraft groundspeed exceeds 40 knots on a surface other than a runway at a RAAS-validated airport.

Extended Holding on Runway Advisory

The *Extended Holding on Runway Advisory* provides crew awareness of an extended holding period on the runway. After 90 seconds, RAAS generates the advisory ON RUNWAY followed by the runway identifier. RAAS generates the advisory when the following conditions are met:

- Aircraft enters the runway and the aircraft heading is within 20 degrees of runway heading and
- Aircraft along-track distance does not change more than 100 ft. in the period of time configured to be an extended holding period.

⊞ **Note:** This advisory is suppressed after a rejected takeoff. The advisory is reset when the aircraft leaves the runway area.

Distance Remaining Rejected Take-Off Advisory

RAAS provides distance remaining advisories to provide the flight crew with position awareness during an RTO. These advisories are generated at whole thousand-foot intervals, with the last possible advisory occurring at 500 feet.

This Distance Remaining advisory is generated when the following conditions are met:

- Aircraft is on a runway and
- Ground speed is greater than 40 knots and
- Aircraft ground speed during the takeoff roll decreases by 7 knots from its maximum and
- Aircraft is on the last half of the runway, with 3,000 feet (or less) of runway remaining.

⊞ **Note:** These advisories terminate when the ground speed decreases below 40 knots.

System Self-Test (RAAS W/OVRD Switch)

The configuration and proper operation of RAAS can be verified on the ground via two methods, either initiating a self-test of the EGPWS or by changing the display range on terrain display. At the end of the self test, one of the following messages will be annunciated:

- **RUNWAY AWARENESS OK FEET** is annunciated if RAAS is enabled, functioning, has good position information, and is at a validated airport. Distances are annunciated in feet.
- **RUNWAY AWARENESS NOT AVAILABLE** is annunciated if RAAS is enabled, but the system either has no position information, the accuracy of the position information is insufficient to allow RAAS to function, or the aircraft is at an airport that has not been validated in the EGPWS Terrain Database.
- **RUNWAY AWARENESS INOP** is annunciated if RAAS is enabled but the function is inoperative.
- **RUNWAY AWARENESS R-T-O** is annunciated if RAAS is enabled and functioning, but RAAS advisories (other than distance remaining) are temporarily inhibited because RAAS has detected a Rejected Takeoff condition. To clear this message and enable RAAS advisories, the aircraft must be taxied off the runway area.
- **RUNWAY AWARENESS INHIBITED** is annunciated if RAAS is inhibited and functioning but the RAAS Override Switch is in the "OVRD" position. No RAAS audio advisories will be annunciated in this state.

RAAS status will be displayed on the terrain display as well. This is active only when the aircraft is on the ground. The procedure requires the flight crew to select the terrain display followed by a change in the displayed range (to a higher or lower range). RAAS status is annunciated for two sweeps of the terrain display. The displayed status messages are:

- **RAAS - OK - FT** (green): RAAS enabled, functioning, has good position information, and is at a validated airport. Distances annunciated in feet.
- **RAAS-N/AVBL** (amber): RAAS enabled, but the system either has no position information, the accuracy of the position information is insufficient to allow RAAS to function, or the aircraft is at an airport that has not been validated for RAAS in the EGPWS Terrain Database.
- **RAAS-INOP** (amber): RAAS enabled but function is inoperative.
- **RAAS-RTO** (green): RAAS enabled and functioning, but RAAS advisories are temporarily inhibited because RAAS has detected a rejected takeoff condition. To clear this message and enable RAAS advisories, the aircraft must be taxied off the runway area.

- **RAAS INH** (amber): RAAS is functioning but the audio advisories are inhibited due to the input from the RAAS Override Switch being in the OVRD position.

Alert Priorities

The RAAS aural advisories have the lowest priority of all Enhanced or Basic Ground Proximity alerts.

System Constraints

 **Caution:** Runway location data may have errors inherent in the source data. Such errors can delay an advisory, or may cause unwanted advisories.

- The RAAS aural advisories have the lowest priority of all Enhanced or Basic Ground Proximity alerts. Other EGPWS aural alerts and warnings may preempt RAAS advisories.
- RAAS may become unavailable at any time due to loss of accuracy of GPS signals. There is no cockpit annunciation to indicate the status of RAAS while airborne.
- The design of RAAS does not include knowledge of ATC clearance or flight crew intent, and therefore factors such as clearance misunderstandings, incorrect or inappropriate clearances cannot necessarily be mitigated by use of RAAS.
- RAAS In-Air Approaching Runway advisories do not ensure that the aircraft will land on the identified runway.
- The absence of an Approaching Runway In-Air advisory does not necessarily imply that the aircraft is approaching a surface other than a runway.
- RAAS is not designed to enhance traffic awareness and therefore its use does not ensure protection from loss of separation with other traffic.
- Other EGPWS aural alerts and warnings may preempt RAAS advisories. RAAS advisories may be issued during ATC radio communications, flight crew/cockpit communications, or during other aural messages provided in the cockpit by other aircraft systems.
- RAAS advisories do not ensure that the aircraft will, or can be, stopped before hold lines, the runway edges or the runway end.
- RAAS distance advisories do not imply that the aircraft can or cannot be safely landed, stopped, or taken off, from a runway.
- Not all airports/runways in the EGPWS Terrain Database are RAAS enabled. RAAS advisories will not occur at an airport located in the EGPWS Terrain Database unless it is RAAS enabled.
- RAAS Short Runway In-Air advisory is based on runway lengths defined in the RCD. Weather conditions and aircraft loading information are not used in the calculation of these advisories.