National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

DCA23FA149

# OPERATIONAL FACTORS

Group Chair's Factual Report

August 1, 2023

# TABLE OF CONTENTS

## A. INCIDENT

Location: Austin , Texas
Date: February 4, 2023
Time: 06:40 CST[1]
12:40 Universal Times Coordinated, UTC
Airplane: B-737-79P, SWA 708 (A1); B-767-32LF, FEDEX1432 (A2)

## B. OPERATIONAL FACTORS GROUP

| | |
|---|---|
| Group Chair | Warren Abrams<br>NTSB<br>Washington, D.C. |
| Group Member | Dujuan Sevillian<br>NTSB<br>Washington, D.C. |
| Group Member | Mark Diaz<br>Boeing Safety Pilot<br>Seattle, Washington |
| Group Member | Matt Rigsby<br>Federal Aviation Administration (FAA)<br>Dallas, TX |
| Group Member | Roger "Andy" Anderson<br>Airline Pilots Association (ALPA)<br>Memphis, TN |
| Group Member | Corey Franklyn<br>FedEx Flight Operations<br>Memphis, TN |
| Group Member | Craig Jakubowski<br>Southwest Airline Pilots Association (SWAPA)<br>Dallas, TX |
| Group Member | Kevin Ferguson<br>Southwest Airlines Flight Operations<br>Dallas, TX |

[1] All time will be Central Standard Time, CST unless otherwise noted.

## C. SUMMARY

On February 4, 2023, about 0640 central standard time (CST), Federal Express (FedEx) flight 1432 (FDX1432), a Boeing 767-32LF, and Southwest Airlines flight 708 (SWA708) a Boeing 737-79P were involved in a runway incursion with overflight that resulted in a loss of separation at the Austin-Bergstrom International Airport (AUS), Austin, Texas. There were no injuries reported to the 128 passengers and crew onboard the SWA airplane or to the three [2] crewmembers onboard the FedEx airplane. SWA708 was a regularly scheduled international passenger flight operating under the provisions of 14 *Code of Federal Regulations (CFR)* Part 121 from AUS to the Cancún International Airport (MMUN), Cancún, Mexico. FedEx1432 was a domestic cargo flight operating under the provisions of 14 *CFR* Part 121 from Memphis International Airport (MEM), Memphis, Tennessee to AUS.

The Austin Airport Air Traffic Control Tower (AUS ATCT) Air Traffic Manager (ATM) stated at the time of the incident, "there was an extremely low traffic volume and complexity at AUS. The weather at the time of the incident was low instrument flight rules with the following conditions being reported: wind calm, visibility 1/4 mile in freezing fog, vertical visibility 200 ft above ground level, and a temperature minus 1 degree Celsius and a dew point of minus 1 degree Celsius."

## D. DETAILS OF THE INVESTIGATION

On the afternoon of February 4, 2023, the date of the incident, the Operational Factors (OPS) Group Chairman was informed by the Chief of AS-30, Operational Factors, that an incident had occurred in Austin, TX earlier in the morning and that the department was providing support the investigation. The initial notification indicated that OPS would be collecting pilot statements, ATC[3] would be assigned to the investigation as well as Meteorology. The preliminary report had the ATC group traveling to AUS along with support from Human Performance. Meteorology involvement stemmed from the fact that there was low visibility at of the time incident.

On Monday February 6, 2023, the OPS group chairman requested manuals, weight and balance information, training records and other material that was deemed necessary to the investigation. The request for documents and manuals was made to both FedEx and Southwest airlines.

On the afternoon of February 15, 2023, the FedEx flight crew was interviewed via Zoom. The interview was recorded by a court reporter. The recording was then sent off to be transcribed. (See attachment 1 for the FedEx pilots' interview and

[2] The third crew member was a jumpseat rider.
[3] Air Traffic Control

transcript.) The pilots were interviewed by the Ops Group members comprised of the FedEx group.[4]

On the morning of February 16, 2023, the Southwest Airlines flight crew was interviewed via Zoom. The interview was recorded by a court reporter. The recording was then transcribed. (See attachment 2 for the SWA pilots' interview and transcript.) The pilots were interviewed by the Ops group members comprised of the Southwest Airline group.[5]

On April 12, 2023, the FedEx ops group gathered at the FedEx training facility in Memphis, TN to conduct a Simulator Evaluation to simulate different scenarios relevant to the approach the crew was flying on February 4, 2023. A B-767 simulator was used, similar to the aircraft that was flying into AUS the morning of the incident. The Simulator Evaluation was flown by two FedEx pilots and observed by three FedEx ops group members (reference OPS attachment 5).[6]

On April 27, 2023, the SWA ops group gathered at the Southwest Airlines training facility in Dallas, TX to conduct a Simulator Evaluation to simulate different scenarios relevant to the takeoff the crew was flying on the morning of the incident. A 737-700 simulator was used, similar to the aircraft that was involved. The Simulator Evaluation was flown by two SWA pilots and observed by four of the SWA ops group members (reference OPS attachments 6).[7]

---

[4] The interview was conducted by Warren Abrams, NTSB Croup Chairman, Dujuan Sevillian, NTSB Operational Factors, Matt Rigsby, FAA group member, Andy Anderson, ALPA group member and Corey Franklin, FedEx 767 asst program manager.

[5] The interview was conducted by Warren Abrams, NTSB Croup Chairman, Dujuan Sevillian, NTSB Operational Factors, Matt Rigsby, FAA group member, Kevin Fergerson, Southwest Airline Check Airman, and Craig Jakubowski representing the Southwest Airlines Pilots Association, SWAPA.

[6] The Ops Group members for the FedEx Sim Eval were Andy Anderson, representing ALPA in the left seat, Corey Franklin, representing FedEx in the right seat, Mark Diaz, representing Boeing seated at the instructor IOS (Instructor Operators Screen), Dujuan Sevillian in the first observer jump seat and Warren Abrams in the second observer jump seat. Corey Franklin was operating the simulator with a remote IOS screen from the right seat.

[7] The Ops Group Members from FedEx and SWA were split into two groups. The SWA Ops Group members did not interview the FedEx pilots or participate in the FedEx Sim Eval. Conversely, the FedEx Ops Group members did not participate in the SWA interviews or the SWA Sim Eval.
The NTSB Ops Group members in the SWA simulator were captain Kevin Fergerson in the left seat, captain Craig Jakubowski in the right seat, Dujuan Sevillian NTSB observer, Mark Diaz Boeing Observer, NTSB Observer Warren Abrams, Matt Rigsby FAA, and Chuck Larson sim operator.

## E. FACTUAL INFORMATION

### 1.0 History of Flight

A review of FAA air traffic control (ATC) audio recordings indicated that about 0634, the pilots of FDX1432 established communication with the local controller and reported their flight was inbound and established on a CAT III instrument landing system (ILS) approach to runway 18L. The controller provided the pilots with the runway visual range (RVR) values and cleared them to land. The pilots acknowledged this information.

At 0638:49, the first officer (FO) of SWA 708 checked in with the local controller and indicated they were holding short of runway 18L and were ready for takeoff. The ATCT controller provided them with the current RVR values, advised them that a FedEx 767 was on a three-mile final (FDX1432), and issued them a takeoff clearance from runway 18L. The FO of SWA708 acknowledged the clearance with a readback. SWA 708 proceeded to taxi onto runway 18L, lined up with the runway centerline and came to a complete stop. The control of the aircraft was transferred from the captain to the FO. During a post incident interview, the FO stated that he advanced the power to 70% N1,[8] checked the engine parameters, and then released the brakes to begin their takeoff roll.

At 0639:32, the pilots of FDX1432 queried the local controller to confirm that they were cleared to land on runway 18L. According to the captain of FDX1432, he asked for confirmation because he "was concerned about the Southwest traffic on runway 18L". The controller confirmed FDX1432 was cleared to land and advised them of traffic (SWA708) departing runway 18L ahead of him.

At 0640:12, with FDX1432 on an approximate 0.7-mile final (according to radar data), the local controller queried SWA708 to confirm they were on the takeoff roll, to which the captain of SWA708 replied "rolling now." According to the captain of FDX1432, he noted that at an altitude of about 150 feet AGL[9] , the FO called go-around after visually seeing SWA708 on the runway approximately 1,000 ft to 1,500 ft from the approach end. At 0640:34 the FO of FDX 1432 transmitted "Southwest abort" and then at 0640:37 transmitted that "FedEx is on the go." According to the SWA 708 captain's narrative the captain noted that somewhere between the speeds of 80 KIAS[10] and V1[11], he and the first officer heard FedEx call for a go-around.

---

[8] N1 refers to the rotational speed of the low-speed spool which consists of the fan, the low-pressure compressor, and the low-pressure turbine. It's the primary indication of engine thrust. Source: SKYbrary.
[9] Above Ground Level.
[10] Knots indicated airspeed.
[11] Decision speed.

A review of preliminary Automatic Dependent Surveillance-Broadcast (ADS-B) data revealed that when FDX1432 was at the departure end of the runway climbing out of 1,900 ft MSL[12], the controller instructed FDX1432 to turn left heading 080 and maintain 3,000 ft. At the same time, SWA708 was about 1,000 ft lower than FDX1432 and began a right turn away from the runway heading.

The AUS ATCT Air Traffic Manager reported an overflight appeared to have occurred. SWA708 continued their flight plan route to Cancún, and FDX1432 after executing a go-around, returned for landing without incident on runway 18L.

## 2.0 FedEx Flight Crew Information

### 2.1 FedEx Captain

The captain was 56 years old and held an Airline Transport Pilot (ATP) certificate with ratings for multiengine land, and type ratings on the B-757, B767, BE-400, MD-11, MU-300, and LR-JET. Limitations; English Proficient; MD-11 B-757 B767 CIRC. APCH. – VMC ONLY; MD-11 Limited to 14 *CFR* 121.543(B)(3)(i) Operations at FDEA.[13] He also held a Flight Engineer, Turbojet Powered certificate. He held a FAA first-class medical certificate dated August 2022. There were no medical limitations reported for this captain. His date of hire with FedEx was July 29, 2002, and at the time of the incident he was based at MEM.

#### 2.1.1 Captain's Pilot Certification Records – FedEx

Flight Engineer – Turbojet Powered certificate was issued on September 24, 2002.

Airline Transport Pilot, Airplane Multiengine Land, LR-JET, BE-400, MU-300, MD-11; Limitations – MD-11 CIRC APCH VMC ONLY, MD-11LIMITED TO 14 *CFR* 121.543 (B) (3) (i) OPERATIONS AT FDEA, certificate was issued on December 31, 2008.

Airline Transport Pilot, Airplane Multiengine Land, B-757, B-767, LR-JET, BE-400, MU-300, MD-11; Limitations – English Proficient; MD-11, B-757, B-767 CIRC APCH VMC ONLY; MD-11LIMITED TO 14 *CFR* 121.543 (B) (3) (i) OPERATIONS AT FDEA, certificate was issued on December 23, 2019.

[12] Mean Sea Level.
[13] 14 *CFR* 121.543(B)(3)(I) allows the pilot to act as a relief pilot, on the DC-10 at FedEx, when other crew members take a rest break. Operations at FDEA indicates the limitation is FedEx specific.

### 2.1.2 Captains Training

Documents provided by FedEx indicated that during several training events, from the initial qualification syllabus, on the B-767, ground school computer- based training and simulator training, the captain was expected to show proficiency in Low Visibility approaches as well as Go-Arounds/missed approaches. His most recent training event occurred in October of 2022. Prior to that his most recent recurrent training was accomplished in January 2022.

FedEx and the captain provided the following information. Times are approximate and include the incident flight:

| | |
|---|---|
| Previous 24 hours | 3 |
| Previous 30 days in B-767 | 31 |
| Total Hours B767 | 1,324 |
| Total Hours B767 as Captain | 1,324 |
| Total Flight Experience | 23,500 |

## 2.2 FedEx First Officer

The first officer was 49 years old and held an ATP certificate with ratings for airplane multiengine land, commercial privileges airplane single-engine land, and type ratings on the B-757, B-767 and EMB-505. His certificate also included the limitations; B-757, B-767 CIR. APCH. – VMC ONLY. EMB-505 second in command required, English proficient. He was also a Flight Instructor with airplane single and multiengine. Commercial Glider and instrument airplane endorsements were also indicated. He held a FAA first-class medical certificate dated November 10, 2022, with the restriction that he must wear corrective lenses. His date of hire with FedEx was January 21, 2019. He was based at MEM.

### 2.2.1 First Officers Pilot Certification Records – FedEx

FAA records of the first officer indicated the following:

Commercial Pilot, Glider Aero Tow Only; certificate was issued on December 14, 1995.

Commercial Pilot, Airplane Single-Engine Land; Multiengine Land; Instrument Airplane; Glider Aero Tow; Multiengine Land Limited to Center Thrust; certificate was issued on February 23, 1998.

Commercial Pilot, Airplane Single- and Multiengine; Instrument Airplane; Glider; Limitation: English Proficient; certificate was issued on February 11, 2016.

Airline Transport Pilot, Airplane Multiengine Land; Commercial Pilot Privileges; Airplane Single-Engine land; Glider; Limitations, English Proficient; certificate was issued on December 11, 2016.

Airline Transport Pilot; Airplane Multiengine Land; EMB-505; Commercial Pilot Privileges, Airplane Single-Engine Land; Glider; Limitations: English Proficient; EMB -505 Second In Command Required, certificate was issued on August 28, 2018.

Airline Transport Pilot; Airplane Multiengine Land; B-757, B-767, EMB-505; Commercial Pilot Privileges, Airplane Single-Engine Land; Glider; Limitations: English Proficient; B-757, B-767 CIRC APCH – VMC ONLY; EMB -505 Second In Command Required, certificate was issued on April 10, 2019.

Flight Instructor; Glider; Airplane Single- and Multiengine; Instrument-Airplane; Limitations: Valid Only When Accompanied by Pilot Certificate No 3847420; Expires July 31, 2020; certificate was issued on July 24, 2018.

Flight Instructor; Glider; Airplane Single- and Multiengine; Instrument-Airplane; Limitations: Valid Only When Accompanied by Pilot Certificate No 3847420; Expires July 31, 2022; certificate was issued on July 15, 2020.

Flight Instructor; Glider; Airplane Single- and Multiengine; Instrument-Airplane; Limitations: Valid Only When Accompanied by Pilot Certificate No 3847420; Expires July 31, 2024; certificate was issued on July 31, 2022.

### 2.2.2 First Officer's Training

Documents provided by FedEx indicated that during several training events, from the initial qualification syllabus, on the B-767, ground school computer- based training and simulator training, the first officer was expected to show proficiency in Low Visibility approaches as well as Go-Arounds/missed approaches. The FO's most recent training dated 24, July 2022 indicated Satisfactory performance in all levels of training.

FedEx and the first officer provided the following information. Times were approximate and include the incident flight:

| | |
|---|---|
| Previous 24 hours | 3 |
| Previous 30 days in B-767 | 45 |
| Total Hours B767 | 3,500 |
| Total Flight Experience | 8,000 |

## 2.3 Third Crew Member

The required flight crew consisted of a captain and FO. Additionally, a company pilot was seated in the observer or jumpseat and was commuting home from work.

## 3.0 Southwest Flight Crew Information

## 3.1 Southwest Captain

The captain was 54 years old and held an ATP certificate with ratings for airplane single- and multiengine land and type ratings on the B-737, DC-9 and SA-227. Limitations: B-737, DC-9 CIRC. APCH. – VMC only. English Proficient. He held a FAA first-class medical certificate dated August 14, 2022. There was a restriction on his medical that indicated he must use corrective lens(es) to meet vision standards at all required distances. His date of hire with Southwest was April 2014 as the result of the merger with AirTran airways[14]. He was hired by AirTran in 2001. He was based in Houston, TX.

## 3.2 Captain's Pilot Certification Records - Southwest

FAA records of the captain indicated the following:

Private Pilot; Airplane Single-Engine Land; certificate was issued on June 25, 1991.

Private Pilot; Airplane Single-Engine Land; Instrument Airplane, certificate was issued on November 20, 1995.

Commercial Pilot; Airplane Single- and Multiengine Land; Instrument Airplane, certificate was issued on October 9, 1996.

Airline Transport Pilot; Airplane Multiengine Land SA-227; Commercial Privileges Airplane Single-Engine Land, certificate was issued on September 22, 1999.

[14] AirTran Airways was a low-cost airline that was based out of Orlando, Florida but ceased operations on December 28, 2014 after being integrated into Southwest Airlines. Source: The short-lived career of low-cost US airline AirTran Airways (aviationnepal.com)

Airline Transport Pilot; Airplane Multiengine Land, SA-227, DC-9; Commercial Privileges Airplane Single-Engine Land, Limitation: DC-9 CIRC. APP. – VMC Only, certificate was issued on November 10, 2003.

Airline Transport Pilot; Airplane Multiengine Land, SA-227, DC-9, B-737; Commercial Privileges Airplane Single-Engine Land, Limitation: DC-9, B-737 CIRC. APP. – VMC Only, certificate was issued on February 19, 2008.

Southwest and the captain provided the following information. Times are approximate and include the incident flight:

| | |
|---|---|
| Previous 24 hours | 6 |
| Previous 30 days in B-737 | 60 |
| Total Hours B737 | 6,000 |
| Total Hours B737 as Captain | 5,500 |
| Total Flight Experience | 20,600 |

His most recent training event occurred between August 6 and 7, 2022, which consisted of a Maneuvers Observation and a Line Oriented Evaluation and was conducted in a Boeing 737-700 simulator. He also received a random Line Check in September 2022 which was graded Satisfactory.[15] The captain satisfactorily completed a required Cold Weather Operations course on October 17, 2020.

## 3.3 Southwest First Officer

The first officer was 41 years old and held an ATP certificate with rating for multiengine land, commercial privileges airplane single-engine land, and a type rating on the B-737, BE-400, L-382 and MU-300. Limitations: English Proficient. He held a FAA first-class medical certificate dated August 01, 2022. There was no restriction on his medical. His date of hire with Southwest Airlines was July 2, 2016. He was based in Houston, TX.

FAA records of the first officer indicated the following:

Commercial Pilot; Airplane Multiengine Land; Instrument Airplane, certificate was issued on March 14, 1997.

[15] Line Checks are graded are either Satisfactory, Unsatisfactory, or Incomplete according to SWA Line Check Airman.

Commercial Pilot; Airplane Multiengine Land; L-382, BE-400, MU-300; Instrument Airplane, certificate issued February 23, 2001.

Airline Transport Pilot; Airplane Multiengine Land; B-737, BE-400, L-382, MU-300; Limitation, English Proficient, certificate was issued on September 29, 2014.

Southwest and the first officer provided the following information. Times are approximate and include the incident flight:

| | |
|---|---|
| Previous 24 hours | 5 |
| Previous 30 days in B-737 | 79 |
| Previous 90 days in B-737 | 230 |
| Total Hours B-737 | 4,893 |
| Total Flight Experience | 8,907 |

Documents provided by SWA indicated that during several training events, from the initial qualification syllabus, on the B-737, ground school computer- based training and simulator training, the FO was expected to show proficiency in De- ice procedures as well as Cold Weather Operations. His most recent training event occurred between January 20, and January 21, 2023, which was in a Boeing 737-700 simulator. The two simulator sessions consisted of a Maneuvers Observation and a Line Orientated Evaluation. The Maneuvers Observation consisted of Ground Operations, including cold weather operations, Low Visibility taxi, Instrument Approaches, Non-Precision approaches and emergency procedures. He was graded successful in all phases of the Maneuvers.

## 4.0 Airplane

### 4.1 FedEx Flight 1432 (A2)

Figure 1. Incident Airplane. (Source : Jetphotos.com)

The incident airplane was a Boeing B-767-32LF, N297FE, serial number 41068, and was manufactured in 2012. It was powered by two GE CF6-80C2B6F engines, each capable of producing 60,200 lbs. of thrust. It was registered to and operated by Federal Express Corp of Memphis, Tennessee. The airplane was equipped with 2 flight crew seats, 1 observer seat and 3 jumpseats. See Photo 2.

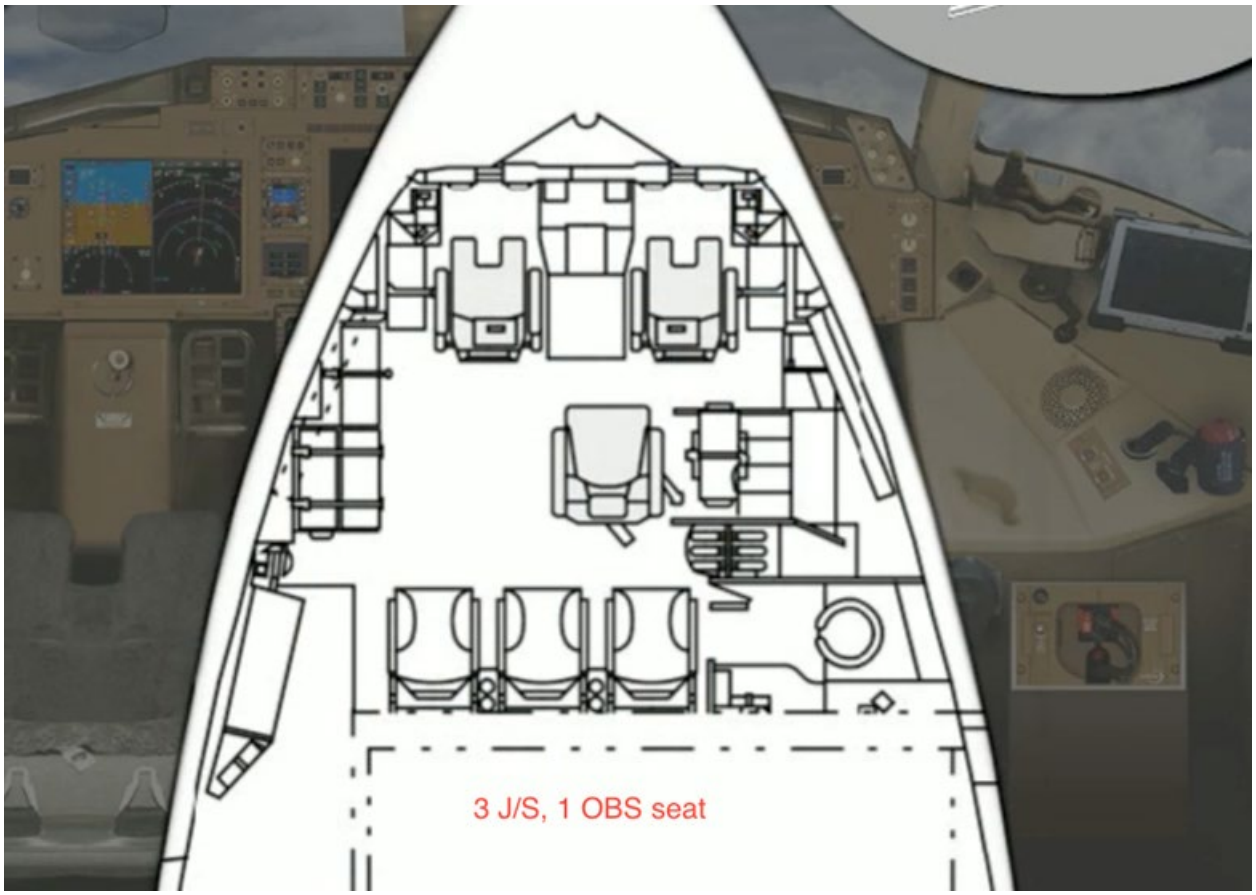



**Figure 2:** Diagram of FedEx 767 cockpit seating diagram. (Source: FedEx)

### 4.1.1 Weight and Balance, FedEx

A representative of FedEx Airlines provided the following information. Airplane limitations are indicated in **bold** type. FedEx utilized average standard weights as allowed in their approved FAA OpSpec[16] A099. All weights below are in pounds (lbs.).

| | |
|---|---|
| Basic Operating Weight | 184,785 |
| Payload | 86,000 |
| Zero Fuel Weight | 270,795 |
| **Maximum Zero Fuel Weight** | **309,000** |
| Ramp Fuel | 38,000 |
| Ramp Weight | 308,795 |
| Taxi Fuel | 710 |
| Takeoff Fuel | 37290 |
| **Maximum Ramp Weight** | **409,000** |
| Takeoff Weight | 308,085 |

[16] Operation Specifications

| | |
|---|---|
| **Maximum Takeoff Weight** | **408,000** |
| Planned Enroute Fuel Burn | 16,457 |
| Projected Landing Weight | 291,628 |
| **Maximum Landing Weight** | **326,000** |

## 5.0 Southwest Flight 708 (A1)


**Photo 3.** SWA Incident Airplane. (Source: Jetphotos.net)

The incident airplane was a Boeing B-737-79P, N7827A, serial number 28255, and was manufactured in 2003. It was powered by two CFM56-7B24 International engines, each capable of producing 24,000 lbs. of thrust. It was registered to and operated by Southwest Airlines Co. of Dallas, Texas at the time of the incident. The airplane, a -700 model, was equipped with 4 flight crew seats, 4 cabin crew seats, and 143 passenger seats.

## 5.1 Weight and Balance, SWA

A representative of Southwest Airlines provided the following information. Airplane limitations are indicated in **bold** type.

| | |
|---|---|
| Basic Operating Weight | 86,415 |
| Payload[17] | 28,518 |
| Zero Fuel Weight | 114,933 |
| **Maximum Zero Fuel Weight** | **136,500** |

[17] The payload weight included 4 flight attendants at 230 lbs. each, 171 total passengers (162 adults at 205 lbs. each and 9 children at 89 lbs. each), 70 regular bags at 32 lbs. each, 1 heavy bag at 61 lbs., and 25 lbs. of cargo. Source: Southwest Airlines Weight and Balance Manual, Table 04.03 "Average Weight Values."

| | |
|---|---|
| Ramp Fuel | 21,200 |
| Ramp Weight | 136,133 |
| Taxi Fuel | 400 |
| Takeoff Fuel | 20,800 |
| **Maximum Ramp Weight** | **155,000** |
| Takeoff Weight | 135,700 |
| **Maximum Takeoff Weight** | **154,500** |
| Planned Enroute Fuel Burn | 7,600 |
| Projected Landing Weight | 128,100 |
| **Maximum Landing Weight** | **129,200** |

## 6.0 Meteorological Information

Airport weather observations for AUS were obtained from the National Weather Service. Airport weather information found in the METAR[18] originated from the Automated Surface Observing System (ASOS) and was augmented by tower personal. The following METAR was issued for AUS for the time near the incident.

*KAUS special weather observation at 0618 CST (1218Z), wind calm, visibility 1/4 mile, runway 36R runway visual range 1800 variable 2400 ft, freezing fog, vertical visibility 200 ft agl, temperature -1° C, dew point temperature -1° C, and altimeter 30.43 inches of mercury (inHg). Remarks: automated station with a precipitation, temperature -0.6° C, dew point temperature -0.6° C.*

Just after the incident occurred, KAUS issued a special weather observation.

*KAUS special weather observation at 0647 CST (1247Z), wind calm, visibility 1/8 mile, runway 36R runway visual range 1800 variable 2400 ft, freezing fog, vertical visibility 200 ft agl, temperature -1° C, due point -1° C, and altimeter 30.43 inHg. Remarks: automated station with a precipitation discriminator.*

## 7.0 Airport Information

Austin-Bergstrom International Airport was located about 5 miles southwest of downtown Austin and covers 4,242 acres[19]. It had 2 paved landing surfaces and 3 helipads. The paved landing surfaces were designated as 18R/36L and 18L/36R. Runway 18R/36L was 12,250 feet long[20] and runway 18L/36R which was 9,000 feet

[18] Meteorological Aerodrome Reports
[19] Source: Austin-Bergstrom International Airport (AUS/KAUS) - Airport Technology (airport-technology.com)
[20] Source: Jeppesen.

long[21] The airspace surrounding the airport was designated as Class C[22] at the time of the incident. The airport had an air traffic control tower that operated 24-hours a day; it was staffed and in operation at the time of the incident.

## 7.1 Airport Diagram

The AUS airport diagram chart, 60-9 as designated by Jeppesen[23] showed an effective date of February 3, 2023. The changes to the airport diagram chart were "Notes Added."

[21] Source: Jeppesen.
[22] *"Class C airspace is generally airspace from the surface to 4,000 feet above the airport elevation (charted MSL) surrounding those airports that have an operational control tower, are serviced by radar approach control, and have a certain number of IFR operations or passenger enplanements."* Source: PHAK Chapter 15 (faa.gov)
[23] Both FedEx and Southwest used Jeppesen Charts.

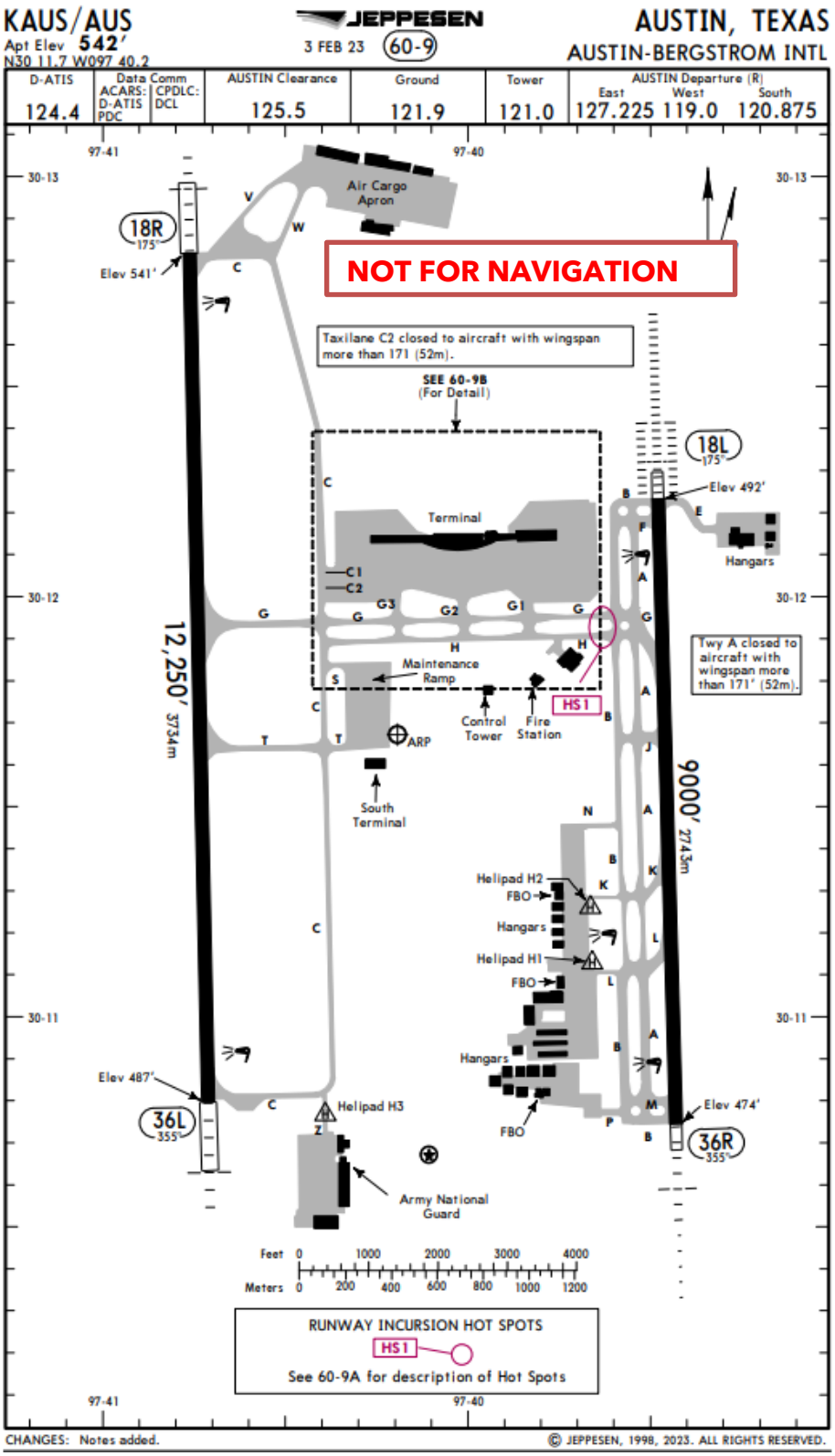



**Photo 4:** AUS, Airport Diagram; (Source: Jeppesen)

**Ph**

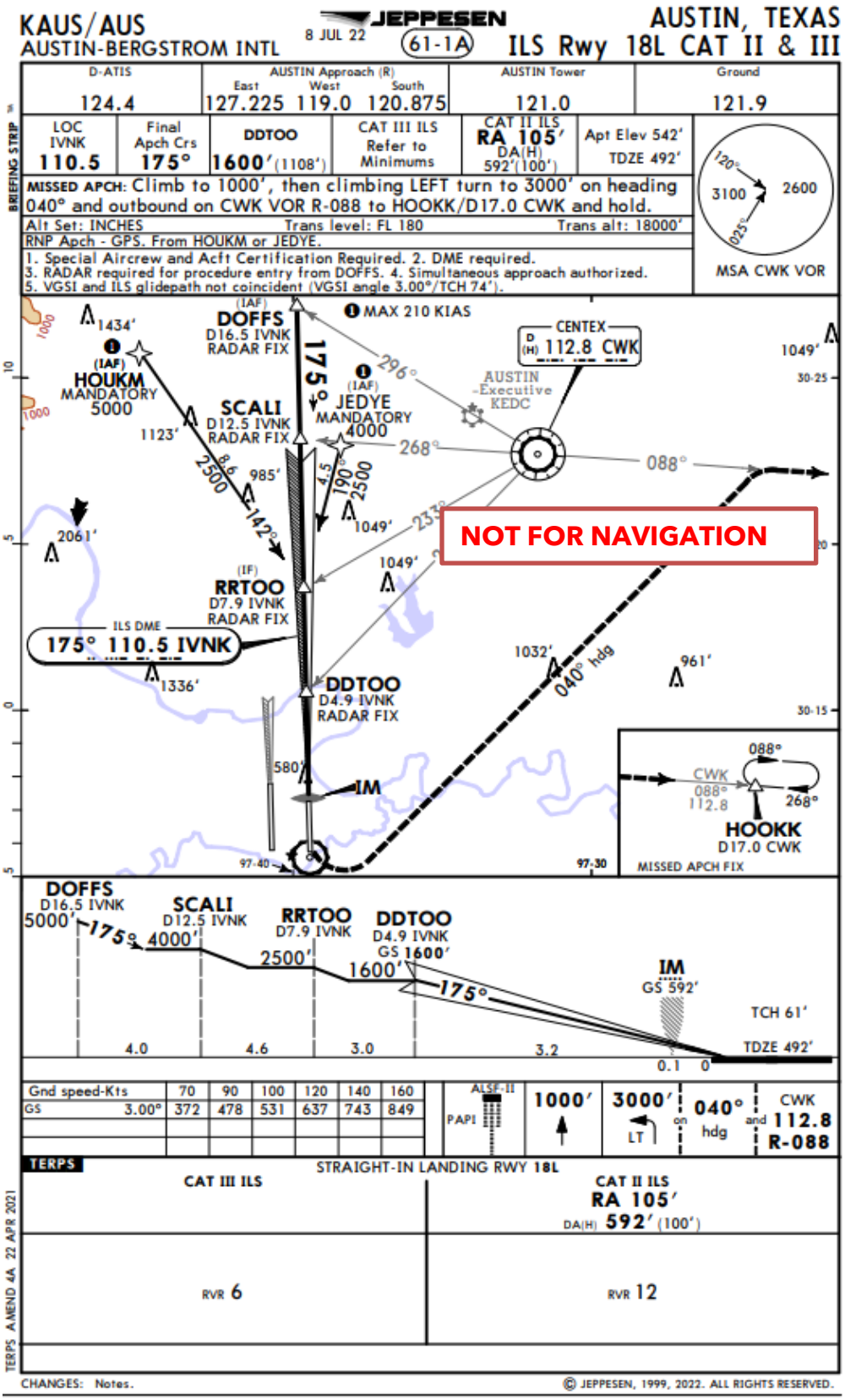



**Photo 5:** AUS ILS RWY 18L CAT II & III approach chart, (Source: Jeppesen)

**KAUS/AUS** JEPPESEN **AUSTIN, TEXAS**

3 FEB 23 (60-9A) AUSTIN-BERGSTROM INTL

GENERAL

Birds in vicinity of airport.
During the hours of 0000-0600 LT, arriving aircraft will be assigned Rwy 36L or Rwy 36R and departing aircraft will be assigned Rwy 18L or 18R to avoid noise sensitive areas.
Declared low visibility conditions require ATCT communication prior to push back.
Engine maintenance run ups require airport operations coordination.
People and equipment adjacent to taxiways.
Low-level wind shear alert system.
Prior permission required general aviation aircraft on the passenger terminal apron, call operations.
Prior permission required for non-State of Texas aircraft entering the State Ramp abeam Twy E. Call State Ops 131.375

ADDITIONAL RUNWAY INFORMATION

| RWY | | USABLE LENGTHS LANDING BEYOND Threshold | Glide Slope | TAKE-OFF | WIDTH |
|---|---|---|---|---|---|
| 18L | HIRL CL ALSF-II TDZ ❶ PAPI-L grooved RVR | | 7799'2377m | | 150' 46m |
| 36R | HIRL CL MALSR TDZ ❶ PAPI-L grooved RVR | | 8039'2450m | | |
| ❶ Angle 3.00° | | | | | |
| 18R | HIRL MALS ❷ PAPI-L grooved RVR | | 10,950'3338m | | 150' 46m |
| 36L | HIRL MALS ❷ PAPI-L grooved RVR | | 11,155'3400m | | |
| ❷ Angle 3.00° | | | | | |

RUNWAY INCURSION HOT SPOTS HS1

For information only, not to be construed as ATC instructions.

HS1 Drivers northbound on E service road may be unaware of aircraft from Rwy 36R exiting at Twys G and Twy H.

TAKE-OFF & OBSTACLE DEPARTURE PROCEDURE

**Rwy 18L/36R**

| 2 operating RVRs are required. All operating RVRs are controlling. | | Adequate Vis Ref | STD | |
|---|---|---|---|---|
| CL & HIRL | CL, or RCLM & HIRL | | 3 & 4 Eng | 1 & 2 Eng |
| TDZ RVR 5<br>Mid RVR 5<br>Rollout RVR 5 | TDZ RVR 10<br>Mid RVR 10<br>Rollout RVR 10 | RVR 16 or 1/4 | RVR 24 or 1/2 | RVR 50 or 1 |

**Rwy 18R/36L**

| Both RVRs are required and controlling. | Adequate Vis Ref | STD | |
|---|---|---|---|
| RCLM & HIRL | | 3 & 4 Eng | 1 & 2 Eng |
| TDZ RVR 10<br>Rollout RVR 10 | RVR 16 or 1/4 | RVR 24 or 1/2 | RVR 50 or 1 |

OBSTACLE DP: Rwy 36L, Climb heading 355° to 1700' before turning left.
Rwy 36R, Climb heading 355° to 1300' before turning left.

TAKE-OFF OBSTACLE NOTES:

Note: Rwy 18L: Lighting 10' from DER, 4' right of centerline, 1' AGL/475' MSL. Trees beginning 491' from DER, 560' left of centerline, up to 43' AGL/499' MSL. Tree 552' from DER, 641' right of centerline, 29' AGL/494' MSL. Tr ' AGL/501' MSL. Tree 617' from DER, 571' r m DER, 472' left of centerline, up to 517' 499' MSL. Trees beginning 721' from D eginning 756' from DER, 495' right of centerline, up to 64' AGL/508' MSL. Tree 1750' from DER, 523' right of centerline, 75' AGL/519' MSL. Tree 1899' from DER, 810' right of centerline, 75' AGL/526' MSL. Tree 2165' from DER, 458' right of centerline, 85' AGL/529' MSL.



Note: Rwy 18R: Lighting, SIGN beginning 10' from DER, 4' left of centerline, up to 2' AGL/489' MSL. Tree 1006' from DER, 730' right of centerline, 519' MSL. Trees beginning 1919' from DER, 541' left of centerline up to 93' AGL/545' MSL.

Note: Rwy 36L: Lighting beginning 5' from DER, 5' right of centerline, up to 1' AGL/543' MSL.

Note: Rwy 36R: Lighting 10' from DER, 5' LEFT of centerline, 1' AGL/493' MSL. Tree 816' from DER, 663' right of centerline, 528' MSL.

FOR FILING AS ALTERNATE

| | ILS Rwy 18L/R<br>ILS Rwy 36L/R | RNAV (GPS) Y Rwy 18L/R<br>RNAV (GPS) Y Rwy 36L/R | RNAV (RNP) Z Rwy 18L/R<br>RNAV (RNP) Z Rwy 36L/R | LOC Rwy 18L/R<br>LOC Rwy 36L/R |
|---|---|---|---|---|
| A<br>B<br>C<br>D | 600-2 | 800-2 | | |

AMEND 2A

**Photo 6**: Austin 60-9A chart depicting the takeoff minimums; Courtesy of Jeppesen.

## 8.0 Relevant Procedures – FedEx

The FedEx flight briefed and flew a CAT III[24] ILS instrument approach into AUS at the time of the incident. With the weather below minimums for a CAT I ILS approach the crew elected to conduct a CAT III autoland[25] approach. The following were relevant policies and procedures for FedEx to conduct a low visibility approach and missed approach.

## 8.1 General Approach Policies – FedEx

The FedEx B767 Flight Training Manual (FTM), Section 5, Page 139, provided, in part, the following general approach guidance:

### 8.1.1 ILS Autoland Performance

*Most ILS installations are subject to signal interference by either surface vehicles or aircraft. To prevent this interference, ILS critical areas are established near each localizer and glide slope antenna. In the United States, vehicle and aircraft operations in these critical areas are restricted any time the weather is reported less than 800-foot ceiling and/or visibility is less than 2 statute miles.*

*Flight inspections of ILS facilities do not necessarily include ILS beam performance inside the runway threshold or along the runway unless the ILS is used for Category II or III approaches. For this reason, the ILS beam quality may vary and autolands performed from a Category I approach at these facilities should be closely monitored.*

*Flight crews must remember that the ILS critical areas are usually not protected when the weather is above 800-foot ceiling and/or 2 statute miles visibility. As a result, ILS beam bends may occur because of vehicle or aircraft interference. Sudden and unexpected flight control movements may occur at a very low altitude or during the landing and rollout when the autopilot attempts to follow the beam bends. At ILS facilities where critical areas are not protected, be alert for this possibility and guard the flight controls (control wheel, rudder pedals and thrust levers) throughout automatic approaches and landings. Be prepared to disengage the autopilot and manually land or go-around.*

*The AFDS includes a monitor to detect significant ILS signal interference. If localizer or glide slope signal interference is detected by the monitor, the autopilot disregards erroneous ILS signals and remains engaged in an attitude stabilizing mode based on inertial data. Most ILS signal interferences last only a short time, in*

[24] Source: Smartcockpit.com, A category III approach is a precision instrument approach and landing with a decision height lower than 100ft and a runway visual range less than 700 ft.
[25] Source: Modernairliners.com Autoland is a system that takes control of the aircraft's approach and landing using autopilot.

*which case there is no annunciation to the flight crew other than erratic movement of the ILS raw data during the time the interference is present. No immediate crew action is required unless erratic or inappropriate autopilot activity is observed.*

*If the condition persists, it is annunciated on the attitude display. If the autopilot is engaged, annunciations alert the flight crew that the autopilot is operating in a degraded mode and the airplane may no longer be tracking the localizer or glide slope. When the condition is no longer detected, the annunciations clear and the autopilot resumes using the ILS for guidance.*

### 8.1.2 Low Visibility Approaches

*A working knowledge of approach lighting systems and regulations as they apply to the required visual references is essential to safe and successful approaches. Touchdown RVR is normally controlling for Category I, II, and III approaches. For Category I and II approaches, mid and rollout RVR are normally advisory. For Category III operations, mid and rollout RVR may be controlling. In some countries, visibility is used instead of RVR. Approval from the regulatory agency is required to use visibility rather than RVR.*

*During Category I approaches, visual reference requirements typically specify that either the approach lights or other aids be clearly visible to continue below DA(H). During Category I and II approaches, descent below 100 feet above touchdown zone elevation requires the red terminating bars, or red side row bars (ALSF or Calvert lighting systems, or ICAO equivalent as installed) to be distinctly visible. If actual touchdown RVR is at or above the RVR required for the approach, the runway environment (threshold, threshold lights and markings, touchdown zone, touchdown lights and markings) should become clearly visible resulting in a successful approach. After acquiring the red terminating bars or red side row bars, if the runway environment does not become distinctly visible,*
*execute an immediate missed approach.*

*Category III operations using fail passive autoland systems typically apply a DH of 50 feet when approaching the threshold. In this instance, criteria requires that the runway environment be clearly visible. If not, execute an immediate missed approach.*

*Category III operations using fail operational autoland systems normally do not require specific visual references below AH.*

*A review of the approach and runway lighting systems available during the approach briefing is recommended as the pilot has only a few seconds to identify the lights required to continue the approach. For all low visibility approaches, a review of the airport diagram (low visibility charts), expected runway exit, runway remaining lighting, and expected taxi route during the approach briefing is recommended.*

*Regulatory agencies may require an additional 15% be added to the dry landing distance. Agencies may also require wind speed limitations less than maximum autoland wind speeds found in the FM. Ensure appropriate entries are made in APS, i.e., autoland and TALPA information which takes these into account.*

## 8.2 Descent and Approach Briefing

The FedEx Flight Operations Manual, FOM, section 6.07 pages 6-5 through page 6-7 provided in part , the following general descent and approach briefing guidance:

*Planning*

*Crewmembers must review applicable destination NOTAMs, applicable Airport Info (10- 9x20-9x), FedEx Parking (10-10x/20-20x) and Airport Qualification (19-0x) pages to prepare for arrival. Obtain destination Arrival ATIS as early as possible with the goal of completing arrival planning and briefing prior to commencement of the initial descent.*

*When destination weather requires an Instrument Approach, the preferred order of approaches for any given runway is:*

- *PA (ILS)*
- *APV*
- *NPA*

*If the airport is conducting instrument approaches to more than one runway and it is not known which will be assigned, it is desirable to plan for and brief the most likely approach and at least one alternate.*

*When destination weather permits a Visual Approach, the PF should build, brief and select an instrument approach procedure as a backup (when available). Priority must be given to an instrument approach with vertical guidance to the runway in use. Reference the applicable Glideslope, VPATH or VGSI during the approach.*

*Refer to the QRH Approach Procedure Review to assess approach procedure requirements or limitations, and review approach procedure guidelines, techniques and callouts.*

*After the PF has selected an approach procedure, each crewmember must review the arrival and approach procedures prior to the briefing.*

*Notes*

*Both crewmembers must independently verify that the FMS is programmed properly and will provide lateral, vertical, and speed commands consistent with the arrival, approach, and missed approach profiles and restrictions. For the initial part of the brief, the PF should brief items from the published procedure (page number, notes, etc.) and then continue to brief the actual arrival and*

*approach procedure referencing the FMS while the PM confirms the arrival and approach procedure is correct using the appropriate chart.*
*The PM will determine landing performance data using either the Airplane Performance Software (when required or desired) or the QRH Quick Reference Landing Data table.*

*Briefing - General*
*The PF will give an Arrival Briefing to include expected descent and approach procedures. Arrival and approach briefings should be "brief and to the point" Long briefings are counterproductive to crewmember retention and understanding; however, the Captain may choose to increase the detail of the briefing with consideration of the weather and crew experience.*
*Brief only items that are unique to the planned arrival or approach or affect the safe/legal operation of the aircraft under the prevailing conditions.*
*The goals of the brief are to:*
- *Enhance communications, promote effective teamwork and ensure effective situational awareness of the crew.*
- *Identify and brief significant known threats to safety from top of descent through approach and landing, and crew strategies to reduce the potential for error.*
- *Brief any non-standard procedures to be used during descent and approach.*

Briefing - Arrival
*The PF briefs the arrival including the following, only as appropriate or applicable:*
- *Arrival chart title and page number.*
- *Arrival procedure routing with Altitude and Airspeed restrictions.*
- *Notes and Remarks.*
- *Transition level when other than FL180.*
- *Terrain/CFIT risks and EGPWS use.*
- *Airport Info, FedEx Parking and Airport Qualification pages.*
- *Any special procedures or crew duties (special altimetry procedures, customs, agriculture, etc.)*

*Briefing - Approach*
*The PF briefs the approach including the following, only as appropriate or applicable:*
- *Review applicable approach requirements, limitations, guidelines, techniques and callouts.*
- *IAP chart title, runway, and page number.*
- *Approach frequency/identifier and final approach course.*
- *Final approach fix crossing altitude.*
- *VOA Milestones (CDFA) or intermediate minimum crossing altitudes (step-down fix)*

*Any deviations from the briefed descent profile must be brought to the attention of the PF by the PM. The PF must acknowledge the deviation and where required, take corrective action.*

- *Approach minimums (visual, AH, DH, DA, ODA or MDA) and weather required.*
- *100 feet Baro-height above TDZE (Non-Precision or CAT I ILS)*
- *VDP (if depicted).*
- *Approach light configuration.*
- *VGSI aids (VASI, PAPI, etc.).*
- *Missed approach procedure(s) for the approach to be flown.*

*For a visual approach, unless specific missed approach procedures are supplied via chart and/or ATC, expect to initially fly runway heading and climb to an altitude at or above 1,500 feet AFE. Upon executing a missed approach from a visual, the PM should contact ATC as soon as practical to clarify ATC desires.*

- *Any published Climb Gradient requirement.*
- *Notes and Remarks.*
- *Noise abatement requirements.*
- *Wind and/or gust additives.*
- *Flap setting (for aircraft with multiple possible settings).*
- *MCP / FCP / FMS: intended use of Lateral, Vertical, and Speed modes.*
- *Intended use of autopilot and autothrottles.*
- *Intended use of autobrakes and autospoilers.*
- *Landing distance, runway length, and planned turnoff.*
- *Any special procedures, crew duties, or NOTAMs.*

*If weather is near CAT I minimums, the Captain should brief use of the EFVS, if available and qualified, to continue a domestic CAT I approach below minimums to 100 feet above TDZE. The Captain will also brief use of OpSpec C048 to start a domestic CAT I approach if the weather conditions may require its use.*

*Any airplane systems malfunctions or deferrals/restrictions that may affect the approach or landing.*

*Note*

*During last-minute runway/approach changes or during abnormal operations, the PM may build and brief the approach. If time does not allow for re-brief and verification of proper FMC/cockpit setup, the flight crew should ask for extended vectors or holding until briefing/setup can be accomplished.*

## 8.3 Precision Approach Requirements – FedEx

The FedEx Flight Operations Manual (FOM), dated March 2, 2022, Section 6.44 provided the following information for conducting low visibility precision approaches.

*CAT I ILS Approach*

- *If visibility is less than 3/4 mile or RVR less than 4,000 ft [1200 m]; A coupled approach is recommended. Under these conditions a manually flown approach is permissible provided the entire flight crew has been briefed on the specific duties and responsibilities each is to perform during the approach.*
- *If RVR is less than 2,400 ft [750 m], use of FD, AP or HUD to DA[26] is required. Flight Directors must be used if available.*

*CAT II ILS Approach*

- *A coupled approach is required.*
- *A300/A310/757/767/MD-11/MD-10: Autoland is recommended.-*

  *If RVR is equal to or greater than 1,200 ft [350 m]: Autoland may be required if TDZ or CL lights are not installed or inoperative.*
  *If RVR is less than 1,200 ft. [350 m]: Autoland is required*
- *777: Autoland is required.*

*CAT III ILS Approach*

- *A coupled approach and autoland is required.*
- *If TDZ or MID RVR is less the 600FT [175 m] use of Rollout is required. (700 ft [200 m] in EU OPS countries).*

*NOTE*

*For all autolands, select CAT I or CAT II/III AUTOLAND option from the LANDING drop-down menu of the Landing Performance page of APS, and closely monitor autopilot performance for localizer and glideslope beam anomalies. Review approach charts for any restrictions that may prohibit an autoland.*

[26] FD, Flight Director; AP Autopilot; HUD, Head Up Display; DA, Decision Altitude.

### 8.3.1 Category III Operations - FedEx

*Category III operations are based on an approach to touchdown using the automatic landing system. Normal operations should not require pilot intervention. However, pilot intervention should be anticipated in the event inadequate airplane performance is suspected, or when an automatic landing cannot be safely accomplished in the touchdown zone. Guard the controls on approach through the landing roll and be prepared to take over manually, if required.*

*The airplane has been demonstrated to meet fail operational criteria with two engines operating. The airplane has also been demonstrated to meet fail passive criteria with two engines operating or with one engine inoperative if the engine failure occurs during the final approach.*

### 8.3.2 Mandatory Missed Approach - FedEx

*On all instrument approaches, where suitable visual reference has not been established and maintained, execute an immediate missed approach when:*

- *A navigation radio or flight instrument failure occurs which affects the ability to safely completely the approach.*
- *The navigation instruments show significant disagreement.*
- *On ILS final approach and either the localizer expanded scale shows full deflection or the glide slope indicators shows half or more deflection.*
- *On an RNP based approach an alert message indicates that ANP exceeds RNP.*
- *For airplanes with Navigation Performance Scales (NPS), during RNP approach operation, anytime the NPS deviation exceeds the limit or an amber deviation alert occurs unless the aircrew is able to change to a non-RNP procedure.*
- *For airplanes without NPS, during RNP approach operations, anytime the XTK exceeds 1.0 X RNP unless the aircrew is able to change to a non-RNP procedure.*
- *On a radar approach and radio communication is lost.*

## 8.4 Go-Around and Missed Approach Procedure - FedEx

The FedEx B767 Flight Manual (FM), Chapter 2, Page 138, provided in part, the following general Go-Around, and Missed Approach Procedure:

# Go-Around and Missed Approach Procedure

| Go-Around and Missed Approach Procedure - VNAV | |
|---|---|
| Pilot Flying (PF) | Pilot Monitoring (PM) |
| **Simultaneously:**<br>• Push either GA switch and confirm thrust lever advancement[1],<br>• Rotate to go-around attitude (if AP engaged monitor for proper rotation),<br>• Call "GO-AROUND, FLAPS 20." | **Simultaneously:**<br>• Position the flap lever to 20,<br>• Verify thrust lever advancement, pitch attitude, and FMAs.[2] |
| | Call "THRUST SET."[3] |
| (Footnote [4]) | |
| | Verify positive rate of climb on the altimeter and call, "POSITIVE RATE." |
| Verify a positive rate of climb on the altimeter and call "GEAR UP, CHECK MISSED APPROACH ALTITUDE." | Set the landing gear lever to UP.<br>Verify that the missed approach altitude is set.<br>Call "_____ SET". (e.g., "5,000 SET"). |
| Above 400 feet radio altitude, select or call for a roll mode. | Verify or select the roll mode as directed by the PF. |
| Verify that the missed approach route is tracked. | |
| At acceleration height (normally 1,000 feet AGL), select or call for VNAV. | Verify or select VNAV as directed by the PF. |
| Verify that climb thrust is set. | |
| Engage the autopilot, if not already engaged at go-around, after a roll and pitch mode are selected. | |
| Call "FLAPS _____" according to the flap retraction schedule.[5] | Set the flap lever as directed. |
| Call "AFTER TAKEOFF CHECKLIST". | Do the AFTER TAKEOFF checklist. |
| Verify that the missed approach altitude is captured. | |

Photo 6: FedEx Go-Around and Missed Approach Procedure: (Source FedEx Flight Manual)

| Go-Around and Missed Approach Procedure - VNAV | |
|---|---|
| Pilot Flying (PF) | Pilot Monitoring (PM) |
| [1] During a single engine go-around and/or when the autothrottle system is inoperative or A/T switch OFF, ensure that the thrust lever(s) are manually advanced to an appropriate thrust setting, up to and including max thrust. | |
| [2] Verify FMAs: GA / GA / GA (Blank / GA / GA if autothrottles inop). | |
| [3] The thrust reference limits displayed on the EICAS are maximum values for the GA mode but a go-around using the AFDS system will not normally achieve this amount of thrust (commanded N1 being less than the reference N1 'GA' limit). GA thrust should be sufficient to attain 2,000 fpm climb performance. | |
| [4] These procedures remain the same for a rejected landing. However, if the airplane is on the ground (and has been below five feet radio altitude for less than two seconds when the GA switch is pushed) the autopilot go-around pitch mode will engage but the autothrottle mode will remain in IDLE. Additionally, if the airplane is floating within five feet radio altitude for more than two seconds when the GA switch is pushed, the autothrottle go-around mode will engage but the autopilot pitch mode will remain in FLARE. | |
| [5] Retract flaps for the planned flaps setting. It is acceptable to remain at FLAPS 1 or FLAPS 5, as desired. | |

**Photo 7:** FedEx provided footnotes to explain Photo 6. (Source FedEx).

## 8.5 Stabilized Approach Criteria – FedEx

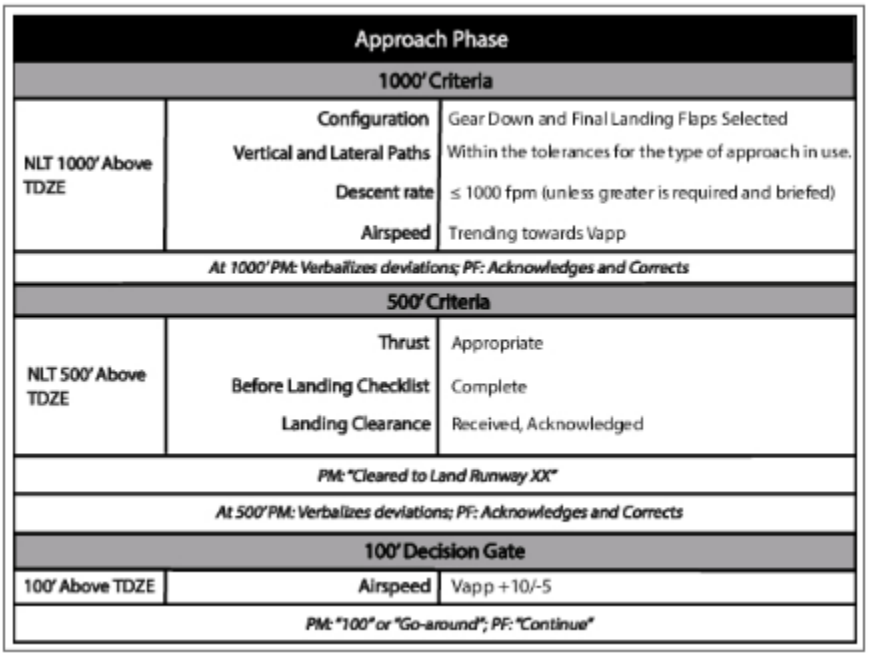
The FedEx Aircraft Operations Manual (AOM), dated January 15, 2022, Section 6.45 provided the following information about the FedEx Stable Approach, Landing, and Rollout Policy:

*A stable approach is essential for a safe landing and is mandatory for all FedEx operations. The standard procedure for all approaches is to be fully stable no later than 1,000 ft. above the TDZE, Regardless of weather conditions. An approach is considered fully stable at 1,000 ft. when the following are met.*

| Fully Stable no later than 1000' above TDZE | |
|---|---|
| **Configuration** | Gear down & Flaps at final setting |
| **Checklists** | Complete |
| **Thrust** | Appropriate for flight conditions |
| **Vertical and Lateral Displacement** | Within CFM-defined tolerances for Approach in use |
| **Sink Rate** | ≤ 1000 fpm (unless greater is required and briefed) |
| **Airspeed** | Vapp +10/-5 |

**Photo 8:** FedEx definition of Fully Stable for their Stabilized Approach Criteria.

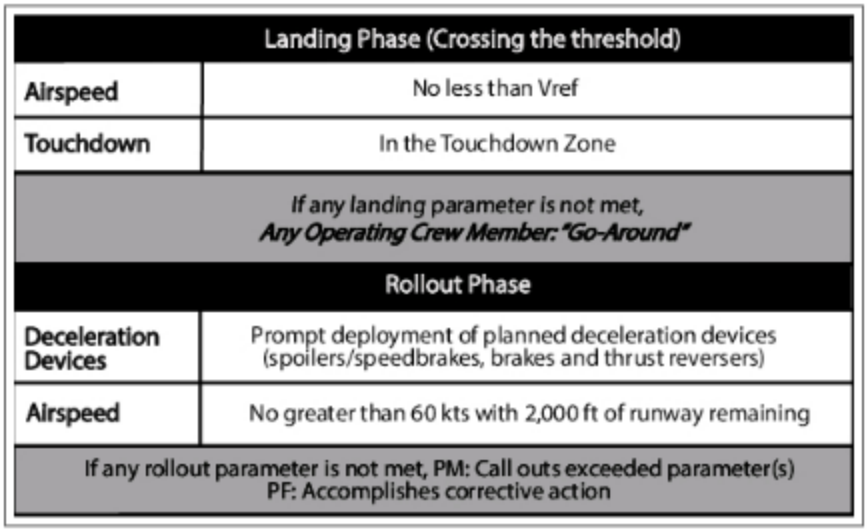
*Certain variables, including weather and ATC, may prevent the aircraft from being fully stable at 1,000 ft. above TDZE. If this occurs, the PM will verbalize the unstable condition and adhere to the parameters described in the following Approach Phase chart. The Approach Phase criteria and altitudes must be used to progressively reduce deviations and arrive at the threshold in a stable condition to land safely. In Addition, the Landing and Rollout Phase chart provides parameters to ensure the landing remains stable throughout the rollout.*



| Approach Phase | | |
|---|---|---|
| **1000' Criteria** | | |
| **NLT 1000' Above TDZE** | **Configuration** | Gear Down and Final Landing Flaps Selected |
| | **Vertical and Lateral Paths** | Within the tolerances for the type of approach in use. |
| | **Descent rate** | ≤ 1000 fpm (unless greater is required and briefed) |
| | **Airspeed** | Trending towards Vapp |
| ***At 1000' PM: Verbalizes deviations; PF: Acknowledges and Corrects*** | | |
| **500' Criteria** | | |
| **NLT 500' Above TDZE** | **Thrust** | Appropriate |
| | **Before Landing Checklist** | Complete |
| | **Landing Clearance** | Received, Acknowledged |
| ***PM: "Cleared to Land Runway XX"*** | | |
| ***At 500' PM: Verbalizes deviations; PF: Acknowledges and Corrects*** | | |
| **100' Decision Gate** | | |
| **100' Above TDZE** | **Airspeed** | Vapp +10/-5 |
| ***PM: "100" or "Go-around"; PF: "Continue"*** | | |

**Photo 9:** FedEx Approach Phase for Stabilized Approach Criteria.

- *If the 1,000' or 500' Criteria parameters are not met, the PM will verbalize deviations. The PF will acknowledge and correct the deviation.*
- *If all parameters are not met by the 100' Decision Gate, a go-around is required.*
- *In locations where the terrain is not a factor, the Aural Alert System callouts may be used instead of a PM callout for the 1,000' Criteria, 500' Criteria or 100' Decision Gate.*
- *Flight Manual instrument approach callouts are in addition to the stable approach callouts.*



| Landing Phase (Crossing the threshold) | |
|---|---|
| **Airspeed** | No less than Vref |
| **Touchdown** | In the Touchdown Zone |
| *If any landing parameter is not met,* ***Any Operating Crew Member: "Go-Around"*** | |
| **Rollout Phase** | |
| **Deceleration Devices** | Prompt deployment of planned deceleration devices (spoilers/speedbrakes, brakes and thrust reversers) |
| **Airspeed** | No greater than 60 kts with 2,000 ft of runway remaining |
| If any rollout parameter is not met, PM: Call outs exceeded parameter(s) PF: Accomplishes corrective action | |

**Photo 10:** FedEx Stabilized Approach Criteria for the Landing Phase of Flight

## 8.6 FedEx Stabilized Approach Decision Region

The FedEx Aircraft Operations Manual (AOM), dated January 15, 2020, Section 6.46 provided the following information about the FedEx Stable Approach, Decision Region:

*The Decision Region is that portion of the approach between 500 feet above TDZE and touchdown on all CAT I Autoland, CAT II and CAT III ILS approaches.*

*Refer to the respective Fleet QRH for Decision Region Criteria.*[27]

*When the tracking performance is outside these criteria, a go-around must be executed since the tracking performance is not sufficient to ensure the aircraft will safely complete a landing in the touchdown zone.*

*If the crew plane to brief a CAT I Autoland, CAT II, or CAT III ILS approach, the decision region applies. Since Decision Region tolerances are tighter and require a go-around when executed, the 100' Stable Approach decision gate and callouts is not utilized for these approaches.*

***NOTE***

*Decision region applies when conducting an autopilot coupled ILS approach. It does not apply to "practice" approaches, equipment checks, or when backing up a*

[27] See Photo 11 for the FedEx QRH Decision Region Criteria.

*visual approach. Deviations during these types of approaches might occur and there is no need to abandon the approach as long as the stable approach criteria are met.*

*When conducting a manual landing, glide slope deviation below the DH may occur. These deviations, in and of themselves, do not require a go-around, unless the Captain determines it unsafe to continue.*

| | | Decision Region[1] | |
|---|---|---|---|
| 500' Above TDZE | PM - "Cleared to Land RWY XX"<br>PF - Acknowledge | F - "Cleared to Land RWY XX"<br>C - Acknowledge | F - "Cleared to Land RWY XX"<br>C - Acknowledge |
| 200' Above Minimums | PM - "Approaching Minimums"<br>CA - "E-FESS Lights"[2]<br>PF - "Approach Lights"[2] | F - "Approaching Minimums"<br>C - "E-FESS Lights"[2]<br>C - "Approach Lights"[2] | F - "Approaching Minimums"<br>C - "Approach Lights"[2] |
| Minimums | PM - "Minimums"<br>PF - "Continue" or "Go Around" | F - "Minimums"<br>C - "Continue" or "Go Around" | F - "Minimums"<br>C - "Continue" or "Go Around" |
| 100' Above TDZE | PM - "100"[3]<br>PF - "Continue" or "Go Around" | F - "100"[3]<br>C - "Continue" or "Go Around" | |
| Touchdown | PM - "Spoilers Deployed" or "No Spoilers" | F - "Spoilers Deployed" or "No Spoilers" | F - "Spoilers Deployed" or "No Spoilers" |
| Rollout | PM - "60 knots"<br>PM - "Autobrakes off" | F - "60 knots"<br>F - "Autobrakes off" | F - "Steer ____(Left/Right)" (if req.)<br>F - "60 knots"<br>F - "Autobrakes off" |

**Photo 11:** FedEx definition of Decision Region requiring a go-around.

## 8.7 TCAS[28] Operation – FedEx

The FedEx B767 Flight Training Manual, FTM, Chapter 7, Page 304, provided in part, the following general TCAS guidance:

*The Traffic Alert and Collision Avoidance System (TCAS) is designed to enhance crew awareness of nearby traffic and issue advisories for timely visual acquisition or appropriate vertical flight path maneuvers to avoid potential collisions. It is intended as a backup to visual collision avoidance, application of right-of-way rules and ATC separation.*

[28] Traffic Alert and Collision Avoidance System.

### 8.7.1 Pilot Response to TCAS - FedEx

*Good use of TCAS requires good crew resource management. Standard procedures and crew coordination are mandatory.*

**Target 40 seconds to collision area becomes a TA:**

| | |
|---|---|
| Aural Warning | "TRAFFIC, TRAFFIC," "MAINTAIN VERTICAL SPEED" or other command |
| Visual Display | Amber TRAFFIC message and solid amber circle on ND. |
| PF Response | Look for traffic display as a guide. Call out any conflicting traffic. If traffic is sighted, maneuver as required. |
| PM Response | Look for traffic display as a guide. Call out any conflicting traffic. |

**Photo 8:** Target 40 seconds to collision area becomes a TA: (Source FedEx)

**TA may become a RA when 25 seconds from collision area:**

| | |
|---|---|
| Aural Warning | "CLIMB, CLIMB," "DESCEND, DESCEND" or other command |
| Visual Display | Red TRAFFIC message and solid red square on ND. |
| PF Response | If maneuvering is required, disengage the autopilot and disconnect the autothrottle. Smoothly adjust pitch and thrust to satisfy the RA command. Follow the planned lateral flight path unless visual contact with the conflicting traffic requires action. Attempt to establish visual contact. Call out any conflicting traffic. |

**Photo 9:** TA may become a RA when 25 seconds from collision area:

**When the conflict is resolved, the pilot is notified:**

| | |
|---|---|
| Aural Warning | "CLEAR OF CONFLICT" |
| Visual Display | PFD vertical guidance not displayed and traffic changes to a TA symbol. |
| PF Response | Engage autopilot. Comply with ATC clearance. |
| PM Response | Advise ATC of the TCAS event and intention. |

**Photo 10: When the conflict is resolved, the pilot is notified:**

### 8.7.2 Traffic Advisory - FedEx

*A Traffic Advisory (TA) occurs when nearby traffic meets system minimum separation criteria, and is indicated aurally and visually on the TCAS traffic display. A goal of the TA is to alert the pilot of the possibility of an RA. If a TA is received, immediately accomplish the Traffic Avoidance Maneuver located below or in the Non-Normal Maneuvers section of the QRH.*

*Maneuvers based solely on a TA may result in reduced separation and are not recommended.*

*The TA ONLY mode may be appropriate under the following circumstances:*

- *During takeoff toward known nearby traffic (in visual contact) which would cause an unwanted RA during initial climb.*
- *During closely spaced parallel runway approaches.*
- *When flying in known close proximity to other airplanes.*
- *In circumstances identified by the operator as having a verified and significant potential for unwanted or undesirable RAs.*
- *Engine out operation.*

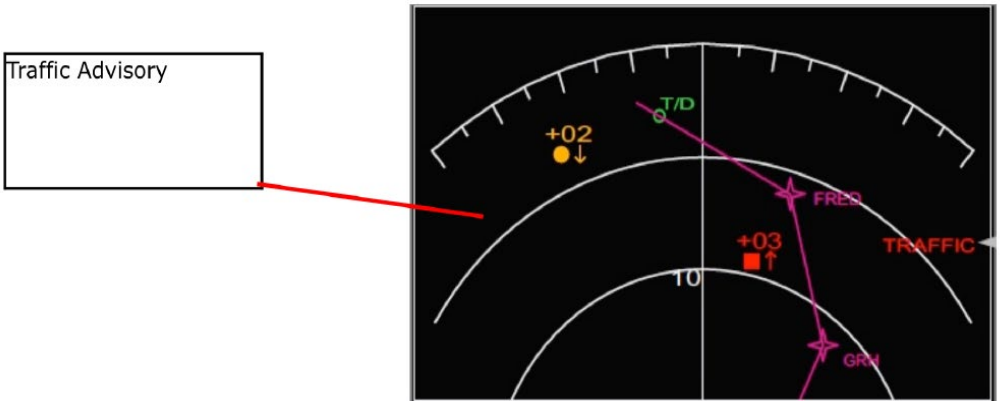


Photo 11: Example of a TA. (Source, FedEx)

### 8.7.3 Resolution Advisory – FedEx

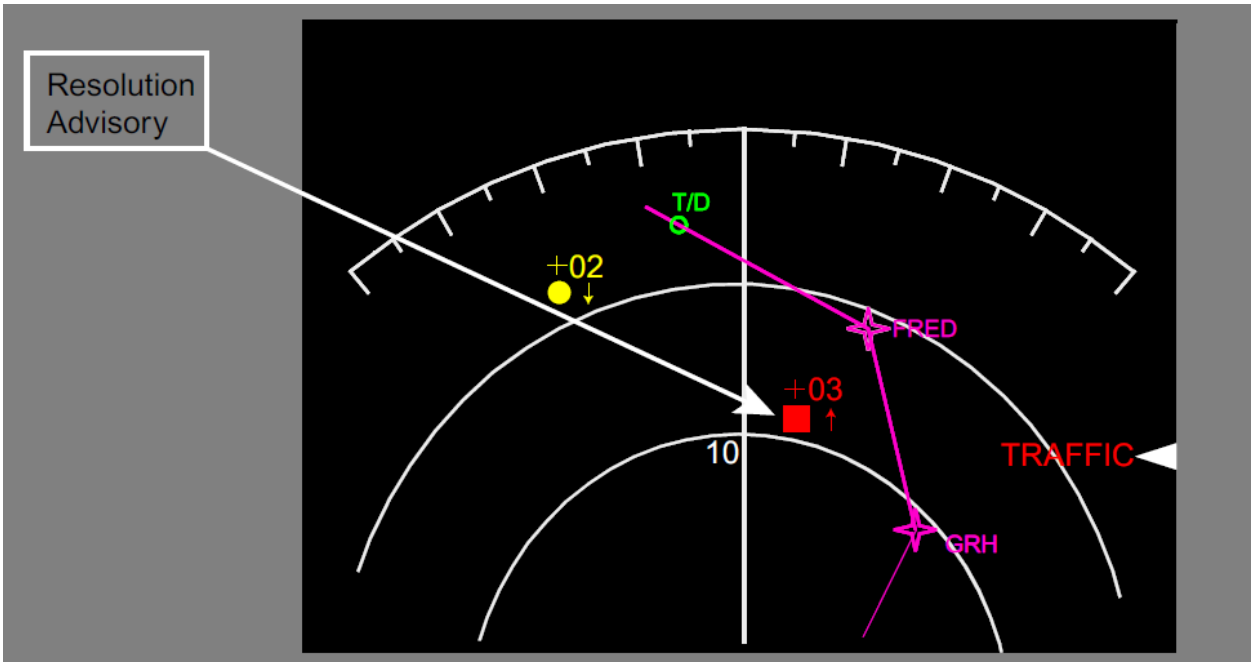



**Photo 12:** Example of Resolution Advisory, RA. (Source FedEx)

When TCAS determines that separation from approaching traffic may not be sufficient,

*TCAS issues a Resolution Advisory (RA) aural warning and a pitch command. Maneuvering is required if any portion of the airplane symbol is within the red region on the attitude indicator (as installed) or if the existing vertical speed is in the red band (RA VSI) (as installed). Flight crews should follow RA commands using established procedures unless doing so would jeopardize the safe operation of the airplane. If a RA is received, immediately accomplish the Traffic Avoidance Maneuver in the QRH.*

*RA maneuvers require only small pitch attitude changes which should be accomplished smoothly and without delay. Properly executed, the RA maneuver is mild and does not require large or abrupt control movements. Remember that the jumpseaters may not all be seated during this maneuver. The flight director will not provide TCAS guidance.*

*On airplanes equipped with TCAS 7.0 and earlier, there have been reports of some flight crews responding incorrectly to the RA "ADJUST VERTICAL SPEED ADJUST" (AVSA) by increasing rather than decreasing vertical speed. Flight crews*

*should be aware that an AVSA always requires a reduction in vertical speed. Follow TCAS procedures and comply with the RA commanded vertical speed.*

*On airplanes equipped with TCAS 7.1 and later, the "ADJUST VERTICAL SPEED ADJUST" RA has been changed to "LEVEL OFF".*

*During the RA maneuver, the aircrew attempts to establish visual contact with the target. However, visual perception of the encounter can be misleading, particularly at night. The traffic acquired visually may not be the same traffic causing the RA.*

*Pilots should maintain situational awareness since TCAS may issue RAs in conflict with terrain considerations, such as during approaches into rising terrain or during an obstacle-limited climb. Continue to follow the planned lateral flight path unless visual contact with the conflicting traffic requires other action. Windshear, GPWS[29], and stall warnings take precedence over TCAS advisories. Stick shaker must be respected at all times. Complying with RAs may result in brief exceedance of altitude and/or placard limits. However, even at the limits of the operating envelope, in most cases sufficient performance is available to safely maneuver the airplane. Smoothly and expeditiously return to appropriate altitudes and speeds when clear of conflict. Maneuvering opposite to an RA command is not recommended since TCAS may be coordinating maneuvers with other airplanes.*

## 9.0 Southwest Relevant Policies and Procedures

At the time Southwest taxied out for takeoff on the day of the incident, the weather was reported as calm wind, visibility 1/4-mile, runway 36R RVR 1800 variable 2400 ft with freezing fog, temperature -1° C, dew point temperature -1° C. According to SWA pilot interviews, in preparation for deicing, the plane was pushed off the gate approximately 10 ft and was deiced, prior to taxiing for departure. (See attachment 6 for excerpts for the SWA deicing procedures.)

## 9.1 Pushback and Engine Start

The Southwest B-737 AOM, Section 15.1.11 provided the following procedure for pushback and engine start.

[29] Ground Proximity Warning System.

*Note: The aircraft should not be pushed from the gate for the purpose of radiant heating deicing with Passengers onboard. Passengers may be onboard the aircraft while radiant heating deicing occurs at the gate.*

*Engine Start*

*Start engines using normal procedures.*

*Unless otherwise directed by an MEL procedure or limitation, set the ignition select switch to BOTH before starting the engines if all the following conditions exist:*

- *First engine start of the day*
- *Airport elevation at or above 2,000 ft MSL*
- *Temperature below 5°C/41°F*

*(NG)[30] The CFM56-7 engine may not light off on the first start of the day or after extended ground time at ambient temperatures below 0°C/32°F. Under this condition, a second start attempt is warranted. Perform the following steps:*

- *(NG) Comply with the Aborted Engine Start checklist on the Quick Reference Card.*
- *(NG) Attempt a second engine start, motoring the engine for five minutes before raising the start lever to IDLE.*
- *(NG) If the engine starts normally, make an Aircraft Logbook Info Only entry. Refer to FOM 19 Maintenance.*
- *(NG) If the second start attempt is unsuccessful, maintenance action is required. Record the fault in the Aircraft Logbook and contact Dispatch and Maintenance Control.*

*Note: If the engines have been cold soaked for more than one hour at ambient temperatures below -40°C, do not start or motor the engine until contacting Dispatch and Maintenance Control.*

*Note: If the ambient temperature is below -35°C, operate the engines at idle for two minutes before changing the thrust lever position.*

*If the START VALVE OPEN alert does not illuminate or an air duct pressure rise is not observed, the start valve solenoid may be frozen. Contact Maintenance Control.*

*After Engine Start*

*Engine Instruments …… Observe Normal Operation*

*Altimeters ……Within Tolerances*

*WARNING: Erroneous or unusual altitude and/or airspeed indications may indicate blocked static ports. Do not continue operations unless all altitude and airspeed indications are normal.*

*Engine Oil Pressure ……Check*

[30] Next Generation. The 737NG is commonly abbreviated as the NG.

*Initial oil pressure may rise slowly.*

- *The LOW OIL PRESSURE light may remain illuminated.*
- *The oil pressure may go above the normal range.*
- *The OIL FILTER BYPASS light may illuminate.*

Note:

*The engine should be operated at idle thrust until oil pressure returns to the normal range. The OIL FILTER BYPASS light should extinguish as the oil warms and the pressure returns to normal.*
*(NG) No minimum oil temperature is specified before setting takeoff thrust.*
*(AFML) (MAX) After starting, oil temperature rises to at least 31°C must be indicated before setting takeoff thrust.*

*As long as there is some indication of oil pressure, up to three and a half minutes may be allowed for oil pressure to reach the minimum operating pressure.*

- *Oil pressure may temporarily exceed maximum pressure limits.*
- *Oil pressure may not indicate any increase until the oil temperature rises.*
- *No oil pressure indication at idle RPM requires immediate engine shutdown. At low ambient temperatures, temporary high oil pressure may be tolerated.*
- *Slow oil pressure response is common.*

*Following a precautionary shutdown due to no oil pressure indication, contact Maintenance Control.*

*Anti-Ice ……..As Required*

*When starting both engines for taxi, do not select engine or wing anti-ice until rollback of the second engine.*

*Electrical Power ……..…… Transfer*

*In cold weather operations, generators may be slow to produce steady power due to cold oil in the IDG. IDG stabilization usually takes less than one minute but may require up to five minutes.*

*Flight Controls ……Check for Freedom of Movement*

*An increase in control forces can be expected at low temperatures because of increased resistance in the flight control gealed oil in the snubbers and bearings. Move the flight controls through full range of motion to sure proper movement.*

*Flaps ……Check for Normal Operation*
*<u>CAUTION:</u> When operating the wing flaps in low temperatures, the flap position indicators and leading-edge indicator should be closely monitored for positive movement. If the flaps stop moving, the flap handle should be immediately placed in the indicated position. The flaps must operate normally prior to takeoff.*

*Engine Anti-Ice Operation*

*Engine anti-ice must be on during all flight operations when icing conditions exist or are anticipated, except during climb and cruise when the temperature is below -40°C SAT*[31].

*If ice does form on the engine inlet, disturbance of the airflow can produce engine surging, engine vibration indications, high EGT*[32]*, or flameout. With even a small amount of ice present, turning the engine anti-ice on will cause melting ice to go through the engine, and may cause violent engine surging of intervals of one to two* minutes. Thrust *lever adjustments should be slow and deliberate to avoid engine flameout.*

*Engine Anti-Ice Operation (Ground or In Flight)*

*Engine Start Switches ……CONT*

*Note: Place the engine start switches to CONT prior to applying engine anti-ice to avoid possible flameout due ice ingestion.*

*Engine Anti-Ice Switches…… ON*

*(NG) Ensure that the COWL VALVE OPEN lights illuminate bright, then dim.*

*(MAX) Ensure that the COWL VALVE amber lights illuminate momentarily, then extinguish.*

*When Engine Anti-Ice is No Longer Required*

*Engine Anti-Ice Switches……OFF*

*(NG) Ensure that the COWL VALVE OPEN lights illuminate bright, then extinguish.*

*(MAX) Ensure that the COWL VALVE amber lights illuminate momentarily, then extinguish.*

*Start Switches……..… As Required*

[31] Static Air Temperature.
[32] Exhaust Gas Temperature.

### 9.1.1 Engine Run Up Procedures

The Southwest Airlines B-737 AOM, section 15.1.14.2 has the following engine run-up procedure when engine anti-ice is used for takeoff.

*(NG) When engine anti-ice is required and the OAT is 3°C or below, accomplish a static engine run-up to a minimum of 70 percent $N_1$ and confirm stable engine operation before the start of the takeoff roll. A 30-second run-up is highly recommended whenever possible if airport congestion and runway surface conditions do not allow for an engine run-up, continue the takeoff normally.*

## 9.2 Taxi Out

The Southwest B-737 AOM, Section 15.1.12 has the following procedure for Taxi Out.

*Refer to FOM 7.1 Single Engine Taxi for limitations regarding Single Engine Taxi after deicing/anti-icing operations.*

*CAUTION: Taxi at a reduced speed. Use smaller nose wheel steering wheel and rudder inputs and apply minimum thrust evenly and smoothly. Taxiing on slippery airport surfaces at an excessive speed or with high crosswinds may start a skid.*

*CAUTION: When operating the engines over a significant amount of standing deicing/anti-icing fluid, limit thrust to the minimum required. Excessive ingestion of de/anti-icing fluid can cause the fluid to build up on the engine compressor blades resulting in compressor stalls and engine surges.*

*(NG) Engine Run-ups During Taxi Operations*

*(NG) During periods of prolonged ground operations, when engine anti-icing is required and the OAT is 3°C or below, an engine run-up may be required to minimize ice buildup on the fan spinner and fan blades.*

*(NG) When conducting an engine run-up, use the following procedure:*

- *(NG) Ensure that the engine inlet and exhaust areas are clear.*
- *(NG) Run-up to a minimum of 70 percent $N_1$ for approximately a 30-second duration at intervals no greater than 30 minutes.*

*(NG) During moderate icing conditions (i.e., freezing rain, freezing drizzle, freezing fog, heavy snow), use the following procedure to minimize ice buildup on the fan blades and spinner, and to enhance ice shedding:*

- *(NG) Ensure that the engine inlet and exhaust areas are clear.*
- *(NG) Run-ups to a minimum of 70% N1 for approximately a one-second duration at intervals no greater than 10 minutes.*

*Note: (NG) Fan blade ice buildup is cumulative. If the fan spinner and fan blades were not deiced prior to taxi out, the engines are operated in icing conditions, including taxi in as applicable, must be included including in the 30-minute interval.*

*Note: (NG) If airport surface conditions and the concentration of aircraft do not allow the engine thrust level to be increased to 70 percent N1, set the thrust level as high as practical for the required duration.*

## 9.3 Low Visibility Taxi Procedures

Section 15.5 of the SWA FOM, Adverse Weather section described Low Visibility Taxi.

**SMGCS- General.**

*Surface Movement Guidance and Control System (SMGCS) refers to equipment installations and control procedures at U.S. airports conducting operations when visibility is less than 1200 RVR. It is designed to minimize confusion on the ground in low visibility conditions.*

*A surface movement surveillance system (SMSS) should be installed for operations below 600 RVR. Ground radar (ASDE II or III) is installed at some airports to augment visual observations. These systems are the primary means of monitoring airport ground movements. Procedures for establishing aircraft position are required when the SMSS is inoperative.*

*ATC may initiate or terminate SMGCS procedures when dictated by visibility.*

*Specific SMGCS procedures are developed for each participating airport. There may be different requirements for operations between 1200 RVR and 600 RVR and operations below 600 RVR.*

*More information may be found in the Jeppesen low visibility taxi route Additional information may be required concerning apron/ramp operations at some airports.*

*If the RVR value drops below charted SMGCS minima:*

- *Aircraft that have entered the movement area are permitted to continue to taxi by ATC (i.e., reported visibility of 500 RVR after entering the movement area, with a SMGCS charted minima of "Less than RVR 1200 to 600").*

- *Aircraft that have either passed the final approach fix or landed may be permitted to taxi by ATC.*

### 9.3.1 Flight Deck Procedures

*In the SMGCS environment, the Captain and First Officer must increase their focus on safe aircraft movement, and both must monitor radio communications. It may be necessary to delay checklists and flows until the aircraft is stopped. If the aircraft position is in doubt, immediately stop the aircraft and notify ATC. Detailed preflight review of taxi routes and procedures will enhance operational efficiency and safety.*

*In the SMGC environment, all ATC clearances must be read back in their entirety. Both Pilots should fully understand each clearance.*

### 9.3.2 SWA Definitions

According to the SWA Flight Operations Manual, Low visibility Taxi procedures, the following definitions were provided.

Low Visibility Operations

Refers to movement of aircraft on the airport when visibility is less than 1200 RVR.

Non-Movement Area

Includes taxiways and apron areas not under ATC control. A vehicle control line separates the non-movement area from the movement area. Ground vehicles should not cross the vehicle control line. The vehicle service road is located on the non-movement side of the vehicle control line.

Apron (Ramp)

Includes aircraft parking positions for loading/unloading Passenger/cargo, taxi lanes for taxiing to/from movement areas, and service and fire lanes for ground vehicles.

Taxi Route

A specific sequence of taxiways or segments between the runway and apron used by aircraft during low visibility operations.

Start/Ready Box

A pink rectangle with a white border and black outline. It is located just prior to reaching the vehicle control line when taxiing from the ramp. Southwest Airlines is

*responsible for the aircraft from the gate to the start/ready box. A yellow taxi line extends from the start box to the taxiway.*

*Termination/Stop Box*

*A pink rectangle with a white border and black outline. It is located just prior to reaching the vehicle control line when taxiing to the gate. Southwest Airlines is responsible for the termination box to the gate. A yellow taxi line extends from the taxiway to the termination box.*

*Hold Point/Pink Spots*

*A taxiway location where ATC may hold an aircraft for positive sequencing. Numbered pink spots are located along taxiways and at points were taxiways cross runways.*

*Clearance Line*

*A yellow dashed line perpendicular to the direction of taxi. The clearance line is co-located with a pink spot. Normally, the order of appearance is clearance bar, clearance line, and hold point/pink spot.*

*Taxiway Holding Position Lights*

*Yellow in-pavement lights installed across the taxiway at points where the taxiway intersects a SMGCS runway. Taxiway holding position lights are on and, in low visibility conditions, when RVR is 1200 or less.*

*Wig-Wag Lights*

*Elevated yellow lights installed outboard of the taxiway holding position lights. There is one blinking wig-wag light on each side of the taxiway. At most airports, wig-wags are installed whenever a taxiway crosses the SMGCS runway. Wig-wags remain illuminated when red stop bars are extinguished.*

*Stop Bar Lighting*

*Red in-pavement lights and elevated red lights on both sides of the taxiway at the point where the taxiway leads to the takeoff position on the runway. The stop bar is co-located with the ILS critical area hold short markings. Stop bar lights are controlled by ATC. Aircraft movement past the stop bar and onto the runway is detected by microwave sensors that automatically turn the red stop bar lights on after the aircraft has passed to prevent the next aircraft from crossing the stop bar. The stop bar lights are not normally used when the RVR is 1200 or greater but are in use below 1200 RVR. When the aircraft is holding number one for takeoff, the red stop bar is illuminated and the green lead-on lights are off, creating a black hole effect. When ATC clears an aircraft on to the runway, the red stop bars are turned off, while the green lead-in lights illuminate providing guidance into the runway takeoff position. This provides a visual confirmation of the clearance to taxi on to the runway.*

*Lead-On Lights*

*A segment of green centerline lights from the stop bar to the runway centerline. These lights are illuminated when the stop bar is off. When the lead-on lights illuminate, the stop bars go off, confirming. the ATC verbal clearance to taxi onto the runway.*

*Note: If after crossing a stop bar, the taxiway centerline lead-on lights inadvertently extinguish, Pilots should hold their position and contact ATC for further instructions.*

*Lead-Off Lights*

*A segment of green and yellow centerline lights from the runway centerline to the ILS critical area hold short markings as viewed from an aircraft taxiing off the runway. Once past the ILS critical area, the taxiway centerline lights revert to green. If taxiway centerline lights are not installed, a sign is required to indicate the location of the boundary of this area/zone.*

### 9.3.3 FOM Chart Symbology

*Pilots should review symbols by referring to the low visibility taxi route chart legend and Jeppesen Introduction.*

*Low visibility taxi routes are depicted by lines with directional arrows. Centerline lights are depicted as a series of small open circles. Movement/Non-movement Area Boundary is depicted by dashed lines. Stop bars are depicted as a line between two open circles. ILS hold line is depicted as two parallel lines crossing the taxiway (looks like a railroad track). Low Visibility Check Points or Spots are depicted as a number within a circle.*

*Low visibility taxi route charts should provide the following:*

- *Stop bar locations.*
- *Pink Spots*
- *Taxiway hold point markings.*
- *Clearance bar location*
- *Critical area boundaries*
- *Location of critical area signs*
- *Unique airport characteristics and/or procedures.*

### 9.3.4 Airport Operational Requirements

*When visibility is 1200 RVR or greater, taxi routing is at the discretion of the control tower.*

*Taxi guidance signs should be installed at taxiway intersections and supplemental taxiway designators should be painted on the pavement. Where signs are not feasible, for example, at a point where the taxiway centerline splits, geographic position markings that identify taxiway hold points should be painted on the pavement.*

*Most airports use one runway for takeoffs and landings during low visibility operations. Therefore, low visibility taxi routes to and from the runway are uni-directional. For example, at SEA, aircraft taxi northbound on taxiway A or B to or from runway 16. A few airports use more than one runway during low visibility operations, in which case taxi routes may be bi-directional.*

*Visibility from 1200 RVR Down to 600 RVR Requirements*

- *Taxiway centerline lights, raised edge reflectors on curves/turns.*
- *Taxiway edge lights*

*Visibility at 600 RVR or Less Requirements*

- *Specific airfield lighting, follow-me service, and defined low visibility taxi routes to facilitate ground operations.*
- *Taxiway centerline lights supplemented with edge lights on curves.*
- *Operative stop bar lights*

*Operations in the non-movement area may not have lighting installations but must then have provisions for taxiing assistance to Pilots (e.g., towing via a tug, follow-me vehicle, or ground marshal assistance from the taxiway to the gate lead-in line).*

## 10.0 SWA TCAS

The Southwest crew reported in their interview that soon after gear retraction was when a TCAS target appeared above and to the right showing 600 ft. The SWA Flight Reference Manual B-737-700/-800, section 15.2.11 indicated the following about TCAS.

## 10.1 Traffic Alert and Collision Avoidance System

*TCAS alerts the Crew to possible conflicting traffic. TCAS interrogates operating transponders in other airplanes, tracks the other airplanes by analyzing the transponder replies, and predicts the flight paths and positions. TCAS provides advisory and traffic displays of the other airplanes to the Flight Deck Crew. Neither advisory, guidance, nor traffic display is provided for other airplanes that do not have operating transponders. TCAS operation is independent of ground-based air traffic control.*

*To provide advisories, TCAS identifies a three-dimensional airspace around the aircraft where a high likelihood of traffic conflict exists. The dimensions of this airspace are based upon the closure rate with conflicting traffic.*

*TCAS equipment interrogates the transponders of other airplanes to determine their range, bearing, and altitude. A traffic advisory (TA) is generated when the other aircraft is approximately 40 seconds from the point of closest approach. If the other aircraft continues to close, a resolution advisory (RA) is generated when the other aircraft is approximately 25 seconds from the point of closest approach. The RA provides aural warning and guidance as well as maneuver guidance to maintain or increase separation from the traffic.*

*Non-transponder equipped airplanes are invisible to TCAS. RAs can be generated if the other aircraft has a mode C transponder. Coordinated RAs require both airplanes to have TCAS.*

### 10.1.1 Advisories and Displays

*TAs are indicated by the aural "TRAFFIC, TRAFFIC" which sounds once and is then reset until the next TA occurs. The TRAFFIC annunciation appears on the navigation display. The TA symbol appears at the proper range and relative bearing of the other aircraft. Altitude and vertical motion are included with the symbol if the other aircraft is using transponder mode S or C.*

*RAs are indicated by one or more aural listed in the RA aural table. The TRAFFIC annunciation and RA symbol which depicts the traffic's relative bearing, range, altitude, and vertical motion are on the navigation display similar to the TA symbol.*

*Additional symbols are proximate traffic and other traffic. Proximate traffic is within six miles and 1,200 ft vertically but is not expected to cause a TA or RA alert. Other traffic is beyond the six mile and 1,200 ft vertical criteria. Traffic symbols are revised as the TCAS system constantly re-evaluates the motion of other airplanes.*

*If the range of the navigation display does not permit the display of a TA or RA an OFFSCALE annunciation appears on the navigation display.*

TA or RA traffic detected by TCAS which do not provide a bearing generate a no-bearing text block beneath the TRAFFIC text on the navigation display. The text block contains distance, altitude, and vertical motion information.

Vertical motion information is indicated by an arrow depicting a climb or descent if a change of greater than 500 ft per minute is detected.

*TCAS display automatically shows when:*

- *The transponder mode selector is in TA ONLY or TA/RA, and*
- *A TCAS TA or RA occurs, and*
- *Neither Pilot has the TCAS (TFC) display selected, and*
- *In MAP, center MAP, VOR, or APP modes*

### 10.1.2 Inhibits

*INCREASE DESCENT RAs are inhibited below approximately 1,500 ft radio altitude.*

*DESCEND RAs are inhibited below approximately 1,100 ft radio altitude.*

*RAs are inhibited below approximately 1,000 ft radio altitude. Below 1,000 ft when the TA/RA mode is selected on the transponder panel, TA only mode is enabled automatically and the TCAS message TA ONLY displays on the ND.*

*All TCAS voice annunciations are inhibited below approximately 500 ft radio altitude.*

*All TCAS alerts are inhibited by GPWS and windshear warnings.*

### 10.1.3 Mode Control

*The TCAS operating mode is controlled from the TCAS/ATC transponder panel. TCAS is normally operated in the TA/RA mode. However, sometimes it is necessary to operate in the TA ONLY mode to prevent undesired RAs. For example, TA ONLY may be selected when intentionally operating near other airplanes such as might be found in VFR conditions at a busy airport, or on parallel approach.*

*ATC transponders on TCAS equipped airplanes communicate to provide appropriate coordinated avoidance maneuvers. When performance is limited, such as*

*with an inoperative engine, select TA ONLY to prevent receiving RAs beyond the aircraft's capabilities, and to prevent communicating to other airplanes an ability to perform a RA maneuver.*

## 11.0 ASRS Data Base Findings

A search of the ASRS[33] data base looking for runway incursions during a CAT I, CAT II , or CAT III approach did not turn up any findings. There were 1,331 reports of issues with ILS approaches but those did not include any reference to a runway incursion. There were 4,375 reports of runway incursions but not of those had any reference to CAT I, CAT II, or CAT III approaches.

## 12.0 FAA Guidance

### 12.1 Compliance with ATC Clearance and Instructions

Title 14 of the *Code of Federal Regulations,* chapter 1, subchapter f, part 91, subpart B, General, §91.123 indicates the following regarding compliance with ATC clearances.

*(a) When an ATC clearance has been obtained, no pilot in command may deviate from that clearance unless an amended clearance is obtained, an emergency exists, or the deviation is in response to a traffic alert and collision avoidance system resolution advisory. However, except in Class A airspace, a pilot may cancel an IFR flight plan if the operation is being conducted in VFR weather conditions. When a pilot is uncertain of an ATC clearance, that pilot shall immediately request clarification from ATC.*

*(b) Except in an emergency, no person may operate an aircraft contrary to an ATC instruction in an area in which air traffic control is exercised.*

*(c) Each pilot in command who, in an emergency, or in response to a traffic alert and collision avoidance system resolution advisory, deviates from an ATC clearance or instruction shall notify ATC of that deviation as soon as possible.*

*(d) Each pilot in command who (though not deviating from a rule of this subpart) is given priority by ATC in an emergency, shall submit a detailed report of that emergency within 48 hours to the manager of that ATC facility, if requested by ATC.*

[33] Aviation Safety Reporting System

*(e) Unless otherwise authorized by ATC, no person operating an aircraft may operate that aircraft according to any clearance or instruction that has been issued to the pilot of another aircraft for radar air traffic control purposes.*

### 12.2 ATC Clearances and Aircraft Separation

The Aeronautical Information Manual (AIM) contains the following information regarding ATC Clearances and Aircraft Separation. Chapter 4-4-1 states:

*"A clearance issued by ATC is predicated on known traffic and known physical airport conditions. An ATC clearance means an authorization by ATC, for the purpose of preventing collision between known aircraft, for an aircraft to proceed under specified conditions within controlled airspace. IT IS NOT AUTHORIZATION FOR A PILOT TO DEVIATE FROM A RULE, REGULATION OR MINIMUM ALTITUDE NOR CONDUCT UNSAFE OPERATION OF AIRCRAFT."*

The NTSB Air Traffic Control group interviewed the AUS ATC personnel including the control tower operator at the time of the incident. See investigation report number DCA23FA149, in the NTSB docket for the ATC Factual Report.

## F. LIST OF ATTACHMENTS

Attachment 1 - FedEx Pilot Interviews and Transcript
Attachment 2 – SWA Pilot Interviews and Transcripts
Attachment 3 – FedEx Crew Training
Attachment 4 – SWA Crew Training
Attachment 5 – FedEx Simulator Evaluation
Attachment 6 – SWA Simulator Evaluation
Attachment 7 - SWA Engine Run-up Procedure [Excerpts]
Attachment 8 – SWA Aircraft Deicing Procedure [Excerpts]

Submitted by:

Warren Abrams
Senior Aviation Accident Investigator

Intentionally Left Blank