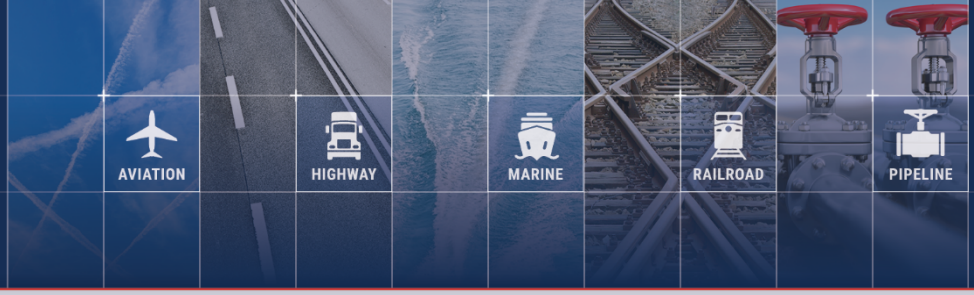


# Aviation Investigation Final Report

| | | | |
|---|---|---|---|
| **Location:** | Flushing, New York | **Accident Number:** | DCA13FA131 |
| **Date & Time:** | July 22, 2013, 17:00 Local | **Registration:** | N753SW |
| **Aircraft:** | Boeing 737 7H4 | **Aircraft Damage:** | Substantial |
| **Defining Event:** | Hard landing | **Injuries:** | 8 Minor, 141 None |
| **Flight Conducted Under:** | Part 121: Air carrier - Scheduled | | |

## Analysis

As the airplane was on final approach, the captain, who was the pilot monitoring (PM), realized that the flaps were not configured as had been briefed, with a setting of 40 degrees for the landing. Data from the flight data recorder (FDR) indicate that the captain set the flaps to 40 degrees as the airplane was descending through about 500 ft altitude, which was about 51 seconds from touchdown. When the airplane was between 100 to 200 ft altitude, it was above the glideslope. Concerned that the airplane was too high, the captain exclaimed repeatedly "get down" to the first officer about 9 seconds from touchdown. About 3 seconds from touchdown when the airplane was about 27 ft altitude, the captain announced "I got it," indicating that she was taking control of the airplane, and the first officer replied, "ok, you got it." According to FDR data, after the captain took control, the control column was relaxed to a neutral position and the throttles were not advanced until about 1 second before touchdown. The airplane touched down at a descent rate of 960 ft per minute and a nose-down pitch attitude of -3.1 degrees, resulting in the nose gear contacting the runway first and a hard landing. The airplane came to a stop on the right side of the runway centerline about 2,500 ft from its initial touchdown.

The operator's stabilized approach criteria require an immediate go-around if the airplane flaps or landing gear were not in the final landing configuration by 1,000 ft above the touchdown zone; in this case, the flaps were not correctly configured until the airplane was passing through 500 ft. Further, the airplane's deviation about the glideslope at 100 to 200 ft would have been another opportunity for the captain, as the PM at this point during the flight, to call for a go-around, as indicated in the Southwest Airlines Flight Operations Manual (FOM). Accident data suggest that pilots often fail to perform a go-around or missed approach when stabilized approach criteria are not met. A review of NTSB-investigated accidents by human factors researchers found that about 75% of accidents were the result of plan continuation errors in which the crew continued an approach despite cues that suggested it should not be continued. Additionally, line operations safety audit data presented at the International Air Safety Summit in 2011 suggested that 97% of unstabilized approaches were continued to landing even though doing so was in violation of companies' standard operating procedures (SOPs).

The Southwest FOM also states that the captain can take control of the airplane for safety reasons; however, the captain's decision to take control of the airplane at 27 ft above the ground did not allow her adequate time to correct the airplane's deteriorating energy state and prevent the nose landing gear from striking the runway. The late transfer of control resulted in neither pilot being able to effectively monitor the airplane's altitude and attitude. The first officer reported that, after the captain took control of the airplane, he scanned the altimeter and airspeed to gain situational awareness but that he became distracted by the runway "rushing" up to them and "there was no time to say anything." The captain should have called for a go-around when it was apparent that the approach was unstabilized well before the point that she attempted to salvage the landing by taking control of the airplane at a very low altitude.

In addition, the captain did not follow SOPs at several points during the flight. As PM, she should have made the standard callout per the Southwest FOM when the airplane was above glideslope, stating "glideslope" and adding a descriptive word or words to the callout (for example, "one dot high"). Rather than make this callout, however, the captain repeatedly said "get down" to the first officer before stating "I got it." The way she handled the transfer of airplane control was also contrary to the FOM, which indicates that the PM should say "I have the aircraft." The flight crew's performance was indicative of poor crew resource management.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The captain's attempt to recover from an unstabilized approach by transferring airplane control at low altitude instead of performing a go-around. Contributing to the accident was the captain's failure to comply with standard operating procedures.

### Findings

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|---|---|
| **Aircraft** | Descent/approach/glide path - Not attained/maintained |
| **Personnel issues** | Lack of action - Pilot |
| **Personnel issues** | Use of policy/procedure - Pilot |

# Factual Information

## History of Flight

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|---|---|
| **Landing-flare/touchdown** | Hard landing (Defining event) |
| **Landing-flare/touchdown** | Landing gear collapse |

On July 22, 2013, about 1744 eastern daylight time (EDT), a Boeing 737-700, N753SW, operated as Southwest Airlines (SWA) flight 345, had a nose gear collapse during a hard landing on runway 4 at LaGuardia Airport (LGA), Flushing, Queens, New York. Of the 144 passengers and 5 crewmembers on board, 8 sustained minor injuries, and the airplane was substantially damaged. The flight was operated under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121 and had departed from Nashville International Airport (BNA), Nashville, Tennessee, about 1433 central daylight time. Visual meteorological conditions prevailed at the time of the accident flight, which operated on an instrument flight rules (IFR) flight plan.

The first officer was the pilot flying (PF) for the trip to LGA, and a pilot from another airline occupied the cockpit jumpseat. The captain stated during postaccident interviews that the majority of the flight from BNA to LGA was normal. However, because of some significant weather conditions in the arrival area, they were given radar vectors around thunderstorm activity and were also instructed to enter a holding pattern at the beginning of the arrival. During the descent, they mostly had a tailwind and there was some rain on the approach. As the PF, the first officer briefed the approach; data from the cockpit voice recorder (CVR) indicate that he agreed with the captain when she suggested a 40º flap setting for the approach. The first officer stated during postaccident interviews that he referenced the weather and planned a visual approach to runway 4, with a runway 4 instrument landing system (ILS) backup. The automated terminal information service (ATIS) at LGA reported clear visibility at the airport and 10- or 11-knot easterly surface wind. However, the captain later stated that, on approach, the tailwind reached as high as about 30 knots.

On the approach, the flight crew configured the airplane for landing and switched communications to the LGA tower, and the tower controller cleared the flight to land. The first officer said that when they reached the final approach fix, the airplane was configured with the gear down and the flaps set at 30º. The captain stated during postaccident interviews that, some distance past the final approach fix, the pitch attitude did not look right to her and she noticed that the flaps were set to 30º instead of 40º, which the performance calculations for landing were based on. CVR data indicate that at 1743:30, the captain said "oh we're forty," and the first officer responded, "oh there you go." Data from the flight data recorder (FDR) indicate that the captain set the flaps to 40º as the airplane was descending through about 500 ft radio altitude. CVR data show that she made the 500 ft callout about 13 seconds later.

The first officer stated that the autopilot was coupled to the ILS, the autothrottles were engaged during the approach, and the sink rate was about 700-800 ft per minute. Around 500 ft, he cross-checked the wind and recalled that there was a slight crosswind of around 11 knots. FDR data show that the autopilot was disconnected at 1743:50, when the airplane was somewhere between 385 and 361 ft radio altitude, and that the first officer was actively manipulating the flight controls after the autopilot was disengaged.

The first officer stated that he began to transition to a side-slip maneuver for the crosswind by lowering the right wing and compensating with left rudder to align the airplane with the runway.

The first officer stated that the precision approach path indicator (PAPI) indicated two red and two white lights and that he was satisfied with the airspeed and crosswind corrections. He said he used the PAPI as his primary approach path reference but also cross-checked the ILS glideslope indicator. He said the airspeed fluctuated between $V_{ref}$ and $V_{target}$ but was generally closer to the $V_{target}$ speed. He recalled that there was about an 8-knot difference between the two speeds. FDR data indicate that the airplane was above glideslope about this time at 100 to 200 ft, reaching a maximum recorded deviation at 1744:23 just before touchdown.

The first officer stated that, as they crossed over the runway overrun area, he noticed that the PAPI indicated three white lights and one red, indicating that they were a little high on the glidepath. He knew that he would need to make a slight correction to land in the touchdown zone. The captain stated that she was looking through the heads up display (HUD) during the approach and was able to see the wind display on the HUD. When over the threshold, she thought the airplane was "groundspeed fast," the pitch was too low, and that they were not getting the right sink rate to the ground. She said she believed that if she did not act, the airplane would have continued to float past the touchdown zone. CVR data indicate that at 1744:14, she made the 100 ft callout then said "get down get down get down" about 3 seconds later. At 1744:23, the captain said "I got it," and the first officer responded "okay you got it." The airplane was about 27 ft radio altitude at this time. FDR data show that at 1744:36, the throttle resolver angles for both engines decreased to about 35º and that the recorded $N_1$ values for both engines also decreased.

The first officer stated that after giving the captain control of the airplane, he scanned the altimeter and airspeed, but his visual focus was drawn outside the cockpit because of the rapidly approaching runway. The captain said that she was not certain what the pitch attitude was when she took control of the airplane but knew that it was not what it should have been for a 40º flaps landing, which she thought should have been around 5º. FDR data show that, shortly before engine power was reduced, the aircraft's pitch began to enter a negative (nose down) trend that continued to decrease to a minimum airborne value of -3.87º.

The captain reported that she increased back pressure on the controls to raise the nose and was increasing power as the airplane dropped to the runway. FDR data show that, just before touchdown, control column position for the captain and first officer remained near zero and that the throttles were advanced about 1 second before touchdown. The captain said that she saw the nose hit the runway and felt the impact, which she said was hard. The first officer also said that the airplane hit hard and that it felt like they landed nose first. He did not recall if they bounced. The airplane started sliding and veered slightly to the right before stopping on the right side of the runway centerline about 2,500 ft from its initial touchdown.

## Pilot Information

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|---|---|---|---|
| **Certificate:** | Airline transport | **Age:** | 49 |
| **Airplane Rating(s):** | Single-engine land; Multi-engine land | **Seat Occupied:** | Left |
| **Other Aircraft Rating(s):** | None | **Restraint Used:** | |
| **Instrument Rating(s):** | Airplane | **Second Pilot Present:** | Yes |
| **Instructor Rating(s):** | Airplane multi-engine; Airplane single-engine; Instrument airplane | **Toxicology Performed:** | Yes |
| **Medical Certification:** | Class 1 With waivers/limitations | **Last FAA Medical Exam:** | January 24, 2013 |
| **Occupational Pilot:** | Yes | **Last Flight Review or Equivalent:** | July 8, 2013 |
| **Flight Time:** | 12522 hours (Total, all aircraft), 7909 hours (Total, this make and model), 7205 hours (Pilot In Command, all aircraft), 181 hours (Last 90 days, all aircraft), 64 hours (Last 30 days, all aircraft), 7 hours (Last 24 hours, all aircraft) | | |

## Co-pilot Information

| | | | |
|---|---|---|---|
| **Certificate:** | Airline transport | **Age:** | 44 |
| **Airplane Rating(s):** | Single-engine land; Multi-engine land | **Seat Occupied:** | Right |
| **Other Aircraft Rating(s):** | None | **Restraint Used:** | |
| **Instrument Rating(s):** | Airplane | **Second Pilot Present:** | Yes |
| **Instructor Rating(s):** | Instrument airplane | **Toxicology Performed:** | Yes |
| **Medical Certification:** | Class 1 Without waivers/limitations | **Last FAA Medical Exam:** | December 6, 2012 |
| **Occupational Pilot:** | Yes | **Last Flight Review or Equivalent:** | December 1, 2012 |
| **Flight Time:** | 5200 hours (Total, all aircraft), 1100 hours (Total, this make and model), 4000 hours (Pilot In Command, all aircraft), 200 hours (Last 90 days, all aircraft), 70 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft) | | |

The Captain

The captain, age 49, was hired as a first officer by SWA in October 2000 and was upgraded to captain in August 2007. The captain held a multiengine airline transport certificate, with a type rating in the 737. The captain held a first-class Federal Aviation Administration (FAA) airman medical certificate dated January 24, 2013,with a limitation that she "must wear corrective lenses."

According to SWA, the captain had about 12,522 hours total flight time, including about 7,909 hours in 737s, of which about 2,659 hours were flown as captain. She had flown about 724 hours in the 12 months before the accident; 181, 108, 64, and 12 hours in the 90, 60, 30, and 7 days, respectively, before the accident; and 7 hours in the preceding 24 hours. Company records showed that the captain obtained her initial 737 type rating in July 2000. Her most recent 737 proficiency check and recurrent ground training occurred July 8, 2013. The captain was also provided refresher crew resource management (CRM) training in February 2010 as a result of complaints received by the chief pilot from first officers

who had flown with her. The chief pilot received no complaints regarding the captain after she received refresher training. A search of FAA records revealed no accident, incident, or enforcement actions for the captain.

The First Officer

The first officer, age 44, was hired as a first officer by SWA in January 2012. He held a multiengine airline transport certificate, with a type rating in the 737. The first officer held a first-class medical certificate dated June 21, 2013, with no limitations or restrictions.

According to SWA, the first officer had about 5,200 hours total flight time, including about 1,100 hours in 737s. He had flown about 811 hours in the 12 months before the accident; 203, 124, 50, and 16 hours in the 90, 60, 30, and 7 days, respectively, before the accident; and 5 hours in the preceding 24 hours. Company records showed that the first officer obtained his initial 737 type rating in August 2011. His most recent 737 proficiency check and recurrent ground training occurred in December 2012. A search of FAA records revealed no accident, incident, or enforcement actions for the captain.

## Aircraft and Owner/Operator Information

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|---|---|---|---|
| **Aircraft Make:** | Boeing | **Registration:** | N753SW |
| **Model/Series:** | 737 7H4 7H4 | **Aircraft Category:** | Airplane |
| **Year of Manufacture:** | 1999 | **Amateur Built:** | |
| **Airworthiness Certificate:** | Normal; Transport | **Serial Number:** | 29848 |
| **Landing Gear Type:** | Retractable - Tricycle | **Seats:** | |
| **Date/Type of Last Inspection:** | | **Certified Max Gross Wt.:** | 154500 lbs |
| **Time Since Last Inspection:** | | **Engines:** | 2 Turbo fan |
| **Airframe Total Time:** | | **Engine Manufacturer:** | CFM INTL. |
| **ELT:** | | **Engine Model/Series:** | CFM56 SERIES |
| **Registered Owner:** | SOUTHWEST AIRLINES CO | **Rated Power:** | |
| **Operator:** | SOUTHWEST AIRLINES CO | **Operating Certificate(s) Held:** | Flag carrier (121) |

The accident airplane, serial number (S/N) 29848, was manufactured by Boeing and received an FAA airworthiness certificate in October 1999. The airplane was equipped with two CFM International CFM56-7B24 turbofan engines that were each rated at 24,000 pounds of thrust and were new when the airplane was delivered to SWA. At the time of the accident, the airplane had accumulated about 49,536 total flight hours.

## Meteorological Information and Flight Plan

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| **Conditions at Accident Site:** | Visual (VMC) | **Condition of Light:** | Day |
| **Observation Facility, Elevation:** | KLGA,22 ft msl | **Distance from Accident Site:** | |
| **Observation Time:** | 17:51 Local | **Direction from Accident Site:** | |
| **Lowest Cloud Condition:** | Scattered / 3000 ft AGL | **Visibility** | 7 miles |
| **Lowest Ceiling:** | Broken / 7500 ft AGL | **Visibility (RVR):** | |
| **Wind Speed/Gusts:** | 8 knots / | **Turbulence Type Forecast/Actual:** | / |
| **Wind Direction:** | 40° | **Turbulence Severity Forecast/Actual:** | / |
| **Altimeter Setting:** | 29.85 inches Hg | **Temperature/Dew Point:** | 25°C / 22°C |
| **Precipitation and Obscuration:** | | | |
| **Departure Point:** | NASHVILLE, TN (BNA ) | **Type of Flight Plan Filed:** | IFR |
| **Destination:** | Flushing, NY (LGA ) | **Type of Clearance:** | IFR |
| **Departure Time:** | 14:33 Local | **Type of Airspace:** | Air traffic control;Class B |

The official weather observation recorded at LGA about 1751 indicated wind from 040° at 8 knots, visibility 7 miles, few clouds at 3,000 ft, scattered clouds at 5,000 ft, ceiling broken clouds at 7,500 ft and overcast at 13,000 ft, temperature 25° C, dew point 22° C, and altimeter setting 29.85 in of mercury.

## Airport Information

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| **Airport:** | LA GUARDIA LGA | **Runway Surface Type:** | Asphalt;Concrete |
| **Airport Elevation:** | 21 ft msl | **Runway Surface Condition:** | |
| **Runway Used:** | 04 | **IFR Approach:** | ILS |
| **Runway Length/Width:** | 7001 ft / 150 ft | **VFR Approach/Landing:** | None |

LGA is located in Flushing, New York, and has an airport elevation of 22 ft. The airport is served by runway 4/22, which is oriented north-northeast/south-southwest and runway 13/31, which is oriented northwest/southeast.

Runway 4 is 7,001 ft long and 150 ft wide, with a grooved paved surface constructed of asphalt and concrete. At the time of the accident, runway 4 was served by an ILS distance measuring equipment (DME) instrument approach made up of six components: glideslope, localizer, DME, approach lighting system, marker beacons, and compass locator. Runway 4 was equipped with high intensity runway lights, centerline lighting, runway end indicator lights, medium intensity approach light systems, runway alignment indicator lights, and PAPI on the right side (3.10º glidepath).

## Wreckage and Impact Information

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|---|---|---|---|
| **Crew Injuries:** | 5 Minor | **Aircraft Damage:** | Substantial |
| **Passenger Injuries:** | 3 Minor, 141 None | **Aircraft Fire:** | None |
| **Ground Injuries:** | | **Aircraft Explosion:** | None |
| **Total Injuries:** | 8 Minor, 141 None | **Latitude, Longitude:** | 40.777221,-73.872497 |

Examination of the runway revealed the airplane touched down about 1,850 ft from the runway threshold. The airplane came to a stop in a nose-down attitude about 3,600 ft from the threshold to the right of the runway centerline, adjacent to the turnoff for taxiway F. The nose tire assembly fractured from the nose gear strut and penetrated the electronic equipment bay. The fuselage was scraped and wrinkled, and the right engine nacelle was damaged.

## Damage to Aircraft

The airplane was substantially damaged during the landing rollout. The nose gear strut penetrated the electronic equipment bay, the fuselage was scraped and wrinkled, and the right engine was damaged.

## Other Damage

The asphalt and concrete runway was damaged due to impact forces.

## Communications

No technical communication problems were reported.

## Flight recorders

The airplane was equipped with a cockpit voice recorder (CVR) and a solid-state flight data recorder (FDR). The recorders showed no signs of damage and were sent to the NTSB laboratory in Washington, DC, for readout and evaluation. The readouts for both units were successful.

The CVR, a Honeywell 965-6022, S/N 2333, was played back normally without difficulty and contained good quality audio information. The recording started at 1539:47 EDT and continued until 1744:56 EDT, shortly after the aircraft departed the runway. A partial transcript was prepared and is included in the CVR Group Chairman's Factual Report.

Data from the FDR, an Allied Signal SSDR 256 WPS, S/N 2472, were extracted normally. The FDR recorded about 27 hours of data. The event occurred during the last flight of the recording and its duration was about 1 hour and 54 minutes. Details of the FDR evaluation are available in Attachment 1 to the FDR Specialist's Factual Report.

An analysis of the FDR data performed by Boeing and reviewed by the NTSB shows that the airplane was high and on a shallow glidepath during final approach. The airplane crossed the runway threshold at an altitude of 60 ft radio altitude (RA), and the throttles were positioned at forward idle at 46 ft RA. Based on CVR information, about 27 ft above the runway, a transfer of controls from the first officer to the captain occurred. After the transfer, the throttles were advanced, but the column deflection was relaxed to the neutral position.

The early reduction of thrust, lack of control column input, and nose-down pitch tendency in ground effect, resulted in the airplane pitching to a nose-down (negative) pitch attitude. The airplane touched down at a descent rate of 960 ft per minute, at a pitch rate of -2.8º/second and a nose-down pitch attitude of -3.1º, and the nose gear contacted the runway before the main gear, resulting in the nose gear collapse.

## Medical and Pathological Information

The accident flight crew was tested for drugs and alcohol following the accident. The results of the postaccident drug and alcohol screening for both flight crewmembers were negative.

## Survival Aspects

The R1 and R2 door slides were deployed for egress, and the right and left overwing window exits were opened. The crew and passengers evacuated the airplane using the R1 and R2 door slides and the right overwing exits.

According to a cabin crewmember, the main cabin door (L1) opened about 6 in during the impact sequence. The cabin crew reported the left side exits were not used due to the presence of smoke on the exterior left side of the airplane that subsequently entered the cabin. Details of the evacuation are included in the cabin crew interview summaries in the docket.

## Tests and Research

*Metallurgy*

The NTSB Materials Laboratory examined fractured pieces of the nose landing gear left axle and three fractured pieces of the nose landing gear lower drag brace bolt. The examination of the components revealed the fracture surfaces were consistent with an overstress fracture and no preexisting defects were observed. A hardness test of the axle and of the drag brace disclosed that all hardness values were within the limits of the material specification.

*Operational Trends for Go-Arounds and Missed Approaches*

Accident data suggest that pilots often fail to perform a go-around or missed approach when stabilized approach criteria are not met. A 1998 review of NTSB-investigated accidents by human factors researchers found that about 75% of accidents were the result of plan continuation errors in which the crew continued an approach despite cues that suggested it should not be continued. Additionally, line operations safety audit data presented at the International Air Safety Summit in 2011 suggested that 97% of unstabilized approaches were continued to landing even though doing so was in violation of companies' standard operating procedures.

## Organizational and Management Information

*Southwest Airlines Procedures*

Stabilized Approach

Stabilized approach criteria are defined in chapter 11, section 11.1.1 of the Southwest Airlines Flight Operations Manual (FOM) and are described, in part, as follows.

Stabilized Approach Criteria - All Approaches

By 1,000 feet above TDZE [touchdown zone elevation], the aircraft must be in the planned landing configuration (landing gear down and landing flaps).

For approaches flown in Vertical Speed, the aircraft must be in the planned landing configuration by the final approach segment.

By 1,000 feet above TDZE, the aircraft must be in the $V_{Target}$ speed range.

By 1,000 feet above TDZE, the aircraft must be on appropriate glidepath with a normal descent rate.

. . .Once established, stabilized approach criteria must be maintained throughout the rest of the approach. If stabilized approach criteria are not met, execute a go-around/missed approach. A go-around/missed approach is mandatory from any approach that fails to satisfy stabilized approach criteria.

It is the duty and responsibility of the PM [pilot monitoring] to direct a go-around/missed approach when the stabilized approach conditions are not met. Additionally, anytime the approach or landing appears unsafe, direct a go-around/missed approach.

Chapter 3 of the FOM states, in part, the following concerning monitoring duties:

When the PM detects a developing trend away from standard procedures, the stated intention, or briefed plan, the PM uses the informative callout and a qualifier, if necessary, to voice the deviation (e.g., 'glideslope—one dot low'). The PF must verbally acknowledge all deviations and informative callouts and begin a timely correction. The PM must allow a reasonable time for correction. If the correction is not made or is ineffective, the PM must repeat the callout.

Flap Setting

The SWA Aircraft Operating Manual stated, in part, in chapter 17, page 17-10, the following information.

Flaps 30 is the normal setting for landing, but flaps 40 landings are recommended in the following situations:

• Negative [bracketed] OPC [onboard performance computer] stopping margin under Min (2) for flaps 30.

• Reported braking action is less than GOOD.

• Weather is at or near minimums for the approach to be flown.

No specific written guidance in SWA manuals indicated that a 40º -flaps landing was more challenging or required special techniques. Discussions with Southwest Airlines management personnel indicated that 40º -flaps landings are considered to be "normal" and that, although the sight picture may vary slightly from a 30º -flaps landing, the difference is minimal. Both types of landings are covered during

simulator flight training and also during operational experience line flying.

Transfer of Aircraft Control

The first officer stated in his interview that when the airplane passed over the runway threshold on approach, the captain retarded the throttles and then almost immediately announced "I got it." The captain, on the other hand, stated that she first announced that she "had the airplane," and, after the first officer acknowledged, she took control and retarded the throttles.

Section 3.2.2 in chapter 3 of the Southwest Airlines FOM provided guidance for transferring control of the airplane from one pilot to the other as follows.

(PF) Transfer aircraft control, when necessary.

Transfer of aircraft control must be concise and clear. There can be no doubt about who is controlling the aircraft. Therefore, when aircraft control is transferred, announce, **"You have the aircraft."** The Pilot assuming aircraft control acknowledges, **"I have the aircraft."**

(PM) Assume aircraft control, when necessary.

If there is a need to take control of the aircraft for safety reasons or required by specific procedures, announce, **"I have the aircraft."** The other Pilot acknowledges, **"You have the aircraft."**

Manipulation of Switches, Gear, and Flap Controls

Section 3.2.3 in chapter 3 of the Southwest Airlines FOM provided guidance on who, between the PF and PM, should manipulate controls and when they should do so, and states, in part, the following:

In flight, the PM normally moves the landing gear and flap controls upon the command of the PF. Prior to moving the landing gear or flap handle, the PM checks the airspeed to ensure that it is in the normal operating range for the requested aircraft configuration. After checking the airspeed, the PM accomplishes the following steps:

1. Repeat the command.

2. Select the landing gear or flaps to the commanded position.

3. .Ensure the landing gear or flaps move to the commanded position.

Interviews with SWA management and training personnel indicate that the correct protocol when the autopilot was engaged would be that the PF is responsible for manipulating the flight mode controls or commanding the PM to do so. The PF would also command a flap setting, which the PM would accomplish. It would not be a normal procedure for the PM to manipulate the flight mode controls, flaps, or gear without being asked or commanded.

*Crew Resource Management Training*

CRM was integrated throughout initial, upgrade, and recurrent flight crew training at SWA. Trained CRM principles included effective communication, threat identification, risk assessment, and error management. Recurrent training involved a one-on-one 4-hour classroom session taught by a CRM instructor.

## Administrative Information

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|---|---|
| **Investigator In Charge (IIC):** | Jones, Dennis |
| **Additional Participating Persons:** | David Keenan; FAA; Washinigton, DC<br>Dennis Post; Southwest Airlines; Dallas, TX<br>James Talay; Boeing; Long Beach, CA<br>Alan Roy; Southwest Airlines Pilot Organization; Dallas, TX |
| **Original Publish Date:** | July 22, 2015 |
| **Last Revision Date:** | |
| **Investigation Class:** | Class |
| **Note:** | |
| **Investigation Docket:** | https://data.ntsb.gov/Docket?ProjectID=87548 |