NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

July 23, 2014

Group Chairman's Factual Report

OPERATIONAL FACTORS

DCA13FA131

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A. ACCIDENT

Location:	La Guardia Airport, (KLGA), New York, New York, USA
Date:	July 22, 2013
Time:	approximately 1740 eastern daylight time[1] (UTC +4)
Airplane:	Boeing 737-700, Registration N753SW

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C. SUMMARY

On July 22, 2013 about 1740 EDT, N753SW, Boeing 737-700, operated by Southwest Airlines as flight 345, landed hard and sustained a collapsed nose gear on runway 04 at LaGuardia International Airport (KLGA), Flushing[3], New York. Visual meteorological conditions prevailed at the time and an instrument flight plan was filed. Of the 145 passengers and 5 crewmembers, there were 9 minor injuries. The airplane was substantially damaged and there was no fire. The flight was operating under the provisions of 14 Code of Federal Regulations Part 121 as a regularly scheduled passenger flight from Nashville International Airport (KBNA), Nashville, Tennessee.

[1] All times are eastern daylight time (EDT) based on a 24-hour clock, unless otherwise noted.
[2] Dr. Wilson was the NTSB Human Performance Group Chairman.
[3] Flushing, was a neighborhood in the north-central part of New York City borough.

D. DETAILS OF THE INVESTIGATION

The Operations Group was convened shortly after the accident, and interviews were scheduled and conducted with the accident flight crew, airline training and management personnel, and with other Southwest Airlines flight crewmembers. All interviews were conducted in conjunction with the Human Performance Group Chairman. Interviews were conducted during the initial Operations Group field phase in person and by phone conference between July 29, and August 2, 2013. Flight crew records, procedural and operating manuals, and other data relevant to the investigation were requested from both Southwest Airlines and the Federal Aviation Administration (FAA). The field phase was completed on August 2, 2013.

Additional phone interviews were conducted during the course of the investigation, and additional materials and documents were collected by the Operations and Human Performance Groups.

The Operations Group investigations explored the accident flight crew's personnel history, their performance, Southwest Airlines training and procedures, particularly those involving crew interaction, crew resource management, approach and landing, stabilized approach, transfer of aircraft control, and pilot flying and pilot monitoring duties.

E. FACTUAL INFORMATION

1.0 HISTORY OF FLIGHT

The captain and first officer were initially on different trip pairings before they met to fly together at Los Angeles International Airport (KLAX) in the morning of July 22, 2013. The captain had begun her sequence of trips on July 21, 2013, and the first officer began his sequence of trips on July 19, 2013. They met for the first time at the departure gate at KLAX for a planned 0615 PDT departure. They were both based in Oakland, California, but had not previously flown together and were not acquainted with one another.

The flight to Nashville International Airport (KBNA) was routine and the captain was the pilot flying (PF). They arrived at KBNA around 1200 noon CDT where they were scheduled to change airplanes. Their departure was delayed out of KBNA for KLGA, because of the late arrival of their airplane. The accident captain suggested that the accident first officer get lunch, which he did while she waited for the inbound flight. The accident captain took the airplane handoff from the inbound crew, and since he was getting lunch, the accident first officer did not take part in that conversation. The accident captain said the maintenance logbook had no write-ups, but the inbound crew mentioned that the nosewheel had a shimmy. She said that after the accident first officer rejoined her, she did not mention the nosewheel shimmy to him, because she had forgotten it due to the fact that she was caught up in dealing with ATC delays and with the passengers. The accident captain said she did not feel the shimmy during taxi out, but felt the nosewheel shimmy during the takeoff roll. She said she did not mention it to the first officer, because they were on the takeoff roll. She did not recall if the shimmy continued after the nosewheel left the ground or during gear retraction.

The accident first officer was the PF for the trip to KLGA. There was also an American Airlines pilot occupying the cockpit jumpseat for the trip to KLGA. The captain said that the majority of the flight from KBNA to KLGA was normal. However, because of some significant weather conditions in the arrival area, they were given radar vectors around some thunderstorm activity, and also a holding pattern at the beginning of the instrument arrival. During the descent they mostly had a tailwind and there was some rain on the approach. The captain stated that the significant weather activity was between them and the airport, but not at the airport itself. She said that the aircraft ahead of them reported no turbulence on approach.

The first officer as PF briefed for the approach, during which he said he referenced the weather, and planned a visual approach to Runway 4, backed up with the ILS to Runway 4. They used the "wet" runway condition when they entered their data into the Onboard Performance Computer (OPC), and saw that autobrakes 2 was bracketed, which indicated that the "2" setting could not be used in those circumstances. As a result, they selected autobrakes 3 for the landing at KLGA. The first officer said that the captain expressed her desire that they use a landing flap setting of 40º as opposed to the usual 30º flap setting. The KLGA Automated Terminal Information Service (ATIS) reported that it was clear at the airport and the surface winds were easterly at 10 or 11 knots. However the captain stated that the tailwinds on arrival reached as high as about 30 knots.

The first officer said that about 98% of the time, he had landed with a 30º flap setting, but he estimated that he had landed with 40º flaps about 30-50 times during the previous year-and-a-half. He stated that a pilot had to be "on his game" with a 40º flap landing, since the airplane had more drag, it required a higher power setting, and a pilot needed to keep a better check of airspeed, because it was quick to decrease. He characterized a 40º flap landing as a power on landing without the pilot reducing power until the airplane was established in the flare with the main gear about 3-4 feet above the runway.

On the approach, they configured the airplane for landing and switched communications to the KLGA tower, and the tower controller cleared them to land. The first officer said that when they reached the final approach fix they were configured with gear down, flaps 30º, and the speedbrakes were armed. Some distance past the final approach fix, the captain said that the pitch attitude did not look right to her, and she noticed that the flaps were set to 30º instead of 40º. They had briefed for 40º and the performance calculations were based on landing with 40º flaps so the captain said she told the first officer that the flaps were only at 30º, and that she was going to put them to 40º. She said that after she got confirmation from the first officer she selected 40º flaps. However, the first officer said that around 1000 feet above the ground, the captain called out "flaps forty" and set the flaps to 40º without any input or acknowledgement from him. He said that after she selected flaps 40º he responded, "oh thank you." The first officer said there were other instances where the accident captain positioned dials or controls before he called for them. He said he was certain that she was directing and coaching him on how to do the descent, and he had the feeling that she would rather have been flying the airplane.

The first officer stated that he was not certain if they were above 1,000 feet or below, when the flaps were reset, but it was close to 1,000 feet above ground level (agl). He said that SWA

procedures required the airplane to be fully configured by 1,000 feet; otherwise they were supposed to go-around.

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 feet per minute. At around 500 feet, he crosschecked the winds and recalled that there was a slight crosswind of around 11 knots. At about 500 feet, he disconnected the autopilot and autothrottles and took over manual control. Then he began to transition to a side-slip maneuver for the crosswind, by lowering the right wing and compensating with left rudder in order to align the airplane with the runway. The Precision Approach Path Indicator (PAPI) indicated 2 red and 2 white lights, and he was satisfied with the airspeed and crosswind corrections. He said he used the PAPI as his primary approach path reference, but also crosschecked with 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.

The first officer said that out of the corner of his eye he noticed that the captain appeared to be somewhat uncomfortable with the approach. As they crossed over the runway overrun, he noticed that the PAPI indicated 3 white lights and one red, which meant 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. He said that he then felt the captain's hand on top of his on the throttles, and she pulled his hand and the throttles back retarding the throttles to what felt like the idle position. He said that he did not recall her making any comments, before, or during her retarding the throttles. The first officer said that he had never had a captain put his/her hand over his on the throttles during an approach, although some captains would guard the throttles by placing their hand below his behind the throttle levers. He said he never had a captain pull the throttles back on him while he was flying an approach.

The captain stated that she was looking through the Heads Up Display (HUD) during the approach and she was able to see the wind display on the HUD. When over the threshold, she felt that the airplane was "groundspeed fast", and the pitch was too low. She felt that they were not getting the right sink rate to the ground. She said it felt as though they were being pushed over the ground. She said that over the threshold, she verbalized that they had to get the airplane down, and she put her hand over the first officer's hand on the throttle, but was not touching his hand. She said there was no standard procedure for that, but was certain that it was explained as a technique. She said she had verbalized that they had to get the airplane down on the ground, but she did not get the reaction she needed from the first officer, and did not believe she had time to try to articulate it again. She said she believed that if she did not act, the airplane would have continued to float past the touchdown zone. The captain said she told the first officer that she had the airplane, and he acknowledged, and she reduced power. In a post-accident interview, the captain said that she was looking for a nice flat, firm landing.

The first officer stated that when the captain pulled the power back, he knew he had to keep flying the airplane, and he was looking to see what he needed to do to accomplish the landing. But almost instantly after she pulled back the throttles, the captain said "I have the aircraft." The first officer said he acknowledged and immediately released control of the airplane. After giving up control he said his eyes scanned the altimeter and airspeed, but his eyes were drawn outside

the cockpit, because of the rapidly approaching runway. He said all he could think of was to brace for impact, but there was no time to say anything. The first officer stated that when he relinquished control of the airplane, he raised his hands in the air as he had been taught in the United States Air Force.

The captain said that she was not completely sure what the airplane pitch attitude was when she took control, but she said she knew it was not what it should have been for a 40º flaps landing. She thought the pitch attitude should have been around 5º, but it was less, and she said she increased back pressure on the controls to raise the nose and she was increasing power as the airplane dropped to the runway.

The first officer said the airplane hit hard, and it felt like they landed nose first. He did not recall if they bounced. The captain said that she saw the nose hit the runway, and felt the impact of the nose hitting, but did not feel the nose wheel hit, and had no recollection of which gear hit first. She said it was a hard impact, and the airplane started sliding. She said she tried to control the airplane with rudder and brakes. The airplane veered slightly to the right before stopping on the runway.

After the airplane came to a stop, the captain said she called the tower and asked for emergency equipment. She said she thought she shut the engines down, and then made a PA announcement telling the passengers to remain seated. The jumpseat rider opened the cockpit door and the captain said she could see smoke in the cabin. In addition, one of the forward flight attendants said there was smoke and asked if they should evacuate. The captain said that between the smoke and the urgency of the flight attendant, she gave the order to evacuate out the right hand side of the airplane, because the first responders were at that side of the airplane. The captain said she did a rough flow to secure the airplane, but did not use the evacuation checklist.

The captain said that prior to securing the airplane she told the first officer to go outside and help with the passengers, but after securing the airplane the first officer was still in the cockpit so she asked him again to leave, which he did. When the captain left the cockpit, she saw that the jumpseat rider was still on board. He said he wanted to help with the evacuation, but the captain told him to evacuate, which he did. The captain said she walked through the airplane with a Port Authority policeman to make certain no one was still on board, and then they exited through the forward right door.

After evacuating, the captain joined the rest of the crew outside the airplane, where she asked about the condition of the passengers. Port Authority personnel said they only knew of some minor injuries to passengers. The captain mentioned that her back hurt. EMT personnel checked her and recommended that she go to a hospital. The flight attendants were also complaining of injuries. The captain and first officer were transported to the hospital in one ambulance and the three flight attendants were transported to the hospital in another ambulance. At the hospital, the captain was admitted, checked, and subsequently discharged, as were the flight attendants. The first officer was not admitted. The captain and first officer were drug and alcohol tested at the hospital, and then they went to the hotel where they arrived sometime after midnight.

2.0 FLIGHT CREW INFORMATION

2.1 The Captain

According to Southwest Airlines records, FAA records, and interview statements, the following information pertained to the accident captain:

Age at the time of the accident:	49
Date of Hire with Southwest:	October 12, 2000
Prior Employment (Aviation):	
AmeriFlight, Inc	January 1998 – October 2000
Line Captain	BE-99 and PA-31
Executive Flyers, Inc.	September 1994 – December 1997
Flight Instructor	Light General Aviation Airplanes
Independent Flight Instructor	January 1994 – September 1994
Flight Instructor	Light General Aviation Airplanes

At Southwest Airlines the captain flew as a Boeing 737 first officer until she completed upgrade training to B-737 Captain in August 2007. In interviews, the captain estimated that she had about 12,000 hours total flight time, of which 2,600 hours were pilot-in-command (PIC) and about 5,000 hours second-in-command (SIC) on the Boeing 737.

The accident flight was the captain's second trip as a flight crewmember into KLGA. She said that she had one previous trip to KLGA about 6 months prior to the accident flight, and on that occasion the first officer had made the approach and landing to runway 13.

2.1.1 The Captain's Currency and Certification

A synopsis of the captain's pertinent flight experience at Southwest Airlines follows:

Initial B737 First Officer Qualification:	November 19, 2000
Initial B737 Captain Operating Experience (OE) Qualification:	August 7, 2007
Most recent Proficiency Check prior to accident:	July 8, 2013

Flight Currency

Flight time, previous 24 hours	6:16
Flight time, previous 7 days:	12:04
Flight time, previous 30 days:	49:18
Flight time, previous 60 days:	107:59
Flight time, previous 90 days:	202:57
Flight time, last 12 months:	724:47

Certification

FAA Records indicate that the captain possessed the following airman certificates at the time of the accident:

- Private Pilot – Airplane Single Engine Land Oct. 25, 1989

- Instrument Airplane Jan. 2, 1993
- Commercial Pilot – Airplane Single Engine Land Jul. 6, 1993
- Commercial Pilot – Airplane Multi-Engine Land (VFR only) Oct. 14, 1993
- Instrument–Airplane Single Engine and Multiengine Land (exp. 12/31/01) Oct. 28, 1993
- Flight Instructor – Airplane Single Engine Dec. 2, 1993
- Flight Instructor – Instrument Airplane Dec. 16, 1993
- Ground Instructor – Advanced Instrument Jan. 12, 1994
- Airline Transport Pilot – Airplane Multiengine Land, B-737 Jul. 25, 2000

The captain had one Notice of Disapproval in her FAA flight records. This occurred on July 2, 1993. She was required to be retested for crosswind landings for her Commercial Pilot certificate. She was retested on July 6, 1993, and was issued a Commercial Pilot certificate.

The captain possessed a U.S. First Class Medical Certificate dated January 24, 2013. The only limitation listed was: Must wear corrective lenses. The captain stated in a post-accident interview that she was wearing glasses at the time of the accident.

2.2 The First Officer

According to Southwest Airlines records, FAA records, and interview statements, the following information pertained to the accident first officer:

- Age at the time of the accident: 44
- Date of Hire with Southwest: January 4, 2012
- Prior Employment (Aviation)
  - USAF 1991-2011
    - F-15C pilot 1995-1998
    - F-117A Eval. and Instructor pilot 1998-2001
    - F15C Pilot 2001-2004
    - T-38C instructor pilot 2006-2007
    - T38C evaluator pilot 2007-2010
    - T-38 chief evaluator pilot 2010-2011

The first officer completed ground and flight training at Southwest Airlines on February 15, 2012. He completed his initial proficiency check on February 16, 2012, and completed his Operating Experience (OE) on February 24, 2012.

The accident first officer had not flown with the accident captain before he met her in KLAX for their trip to KBNA. The first officer said that he had previously flown into KLGA, and had landed there about 3-4 times since the beginning of the year 2013.

2.2.1 The First Officer's Currency and Certification

A synopsis of the first officer's pertinent flight experience at Southwest Airlines follows:

- Initial first officer proficiency check Feb. 16, 2012

- Initial first officer OE Feb. 24, 2012
- Most recent Proficiency Check Dec. 16, 2012

Flight Currency

Flight time, previous 24 hours:	6:16
Flight time, previous 7 days:	16:06
Flight time, previous 30 days:	49:57
Flight time, previous 60 days:	124.01
Flight time, previous 90 days:	202:57
Flight time, last 12 months:	811:27

Certification

FAA records indicate that the first officer possessed the following airman certificates at the time of the accident:

- Commercial Pilot Airplane Multi-engine Land Limited to Center Thrust, Instrument Airplane Aug. 16, 1991
- Commercial Pilot Airplane Single and Multi-engine land – Limited to Center Thrust Oct. 10, 1991
- Airline Transport Pilot Airplane Multiengine land Jun. 27, 2010
- Flight Instructor Instrument Airplane (Exp. 1/31/11) Jan. 26, 2011
- Airline Transport Pilot – B-737 Aug. 13, 2011

The first officer possessed a U.S. First Class Medical Certificate dated June 21, 2013. There were no limitations or restrictions listed on the medical certificate.

3.0 STABILIZED APPROACH

3.1 Southwest Airlines Stabilized approach criteria

The Southwest Airlines Flight Operations Manual (FOM) Chapter 11, section 11.1.1 defined Stabilized Approach Criteria, which is described in part as follows:

> ***Stabilized Approach Criteria – All Approaches***
> *By 1,000 feet above TDZE, 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.*

The guidance for stabilized approaches continues:

- *1,000 Ft Above TDZE*
  - *For all approaches, the aircraft must meet stabilized approach criteria.*

- *500 Ft Above TDZE*
    - *For approaches where maneuvering is required, the aircraft is on and maintaining final approach course or runway centerline with wings essentially level.*
- Warnings
    - *If a stabilized approach is not obtained, a go-around/missed approach is mandatory.*
    - *It is the duty and responsibility of the PM to direct a go-around when stabilized approach criteria are not met or anytime the approach appears unsafe. Unstabilized approaches are not acceptable.*

Significant speed and configuration changes during an approach complicate aircraft control, increase the difficulty of safely evaluating an approach as it progresses, and complicate the decision point (i.e., DA, DDA, MDA). Assess the probable success of an approach before reaching the decision point. This requires both Pilots to determine that the requirements for a stabilized approach have been met and are being maintained.

Comply with the following stabilized criteria for all approaches. Deviations within normal limit criteria are acceptable for operational conditions.
The intention is that the PF completes a stabilized final approach entry by 1,000 ft above touchdown zone elevation (TDZE). Above 1,000 ft, PMs should make necessary informative callouts to assist the PF to achieve stabilized conditions by 1,000 ft above TDZE. Momentary deviations of glidepath, course, airspeed, and sink rate do not require an immediate go-around. Make required deviation callouts.

By 1,000 ft above TDZE, 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

By1,000 ft above TDZE, the aircraft must be in the V_{TARGET} speed range.
V_{TARGET} speed range is V_{TARGET} +10 and -5 kt. The PF should clearly communicate adjustments for an updated wind report from tower.

By 1,000 ft. above TDZE, the aircraft must be on appropriate glidepath with a normal descent rate.
Maintain a stable approach path. Normal glidepath descent rate is 700-800 fpm. Final approach segments with glidepaths greater than 3° and/or high groundspeeds may require a sustained descent rate in excess of 1,000 fpm. This is acceptable as long as this condition is briefed and all other stabilized approach criteria are met. Use 1,000 fpm maximum for normal maneuvering during visual, circling, non-precision, and side-step approaches. This directive does not restrict Pilots from flying slightly above the glidepath for wake turbulence avoidance during visual approaches.

For approaches where maneuvering is required, the aircraft is on and maintaining final approach course or runway centerline with wings essentially level by 500 ft above TDZE.
The intention is for Pilots to comply with the configuration, speed, descent rate, and checklist requirements by 1,000 ft above TDZE, and then continue necessary maneuvering to be essentially wings level by 500 ft above TDZE. RNP AR approaches with RF legs may require a turn below 500 ft. This is acceptable as long as there is flight director guidance for a defined glidepath in the turn.

Once established, stabilized approach criteria must be maintained throughout the rest of the approach.

If stabilized approach criteria is 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 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.

4.0 CREW PERFORMANCE RELATIVE TO STABILZED APPROACH

The crewmembers stated that the approach and landing was planned for a 40º flap landing. The first officer stated in a post-accident interview that when they neared the 1,000 foot point on approach, they discovered that they had not yet positioned the flaps to 40º. The captain was the first to notice and called out "flaps 40" and reached over and set the flaps to the 40º flap position. The first officer added that he did not know if they had passed the 1,000 foot mark or not. He said it could have been prior to or after the 1,000 foot mark, but it was close. He added that "by the book" they should have been fully configured by 1,000 feet, or they were to go-around. He said that he could not recall if the flaps were set to 40º by 1,000 feet, because at the time "he was working pretty hard."

The captain said that when she realized that the flaps were not set to 40º, she was pretty certain that they were on the glideslope. She did not recall at what altitude the flaps were set to 40º but it was a "good time" prior to the 500 foot call out. She said she did not remember if they were below 1,000 feet when the flaps were set to 40º, but the flaps should have been down by then. Later in the interview, she stated that "the call for flaps 40 was made with plenty of time before the 500 foot callout. By the book, it would have been a go-around."

5.0 CREW DUTIES, RESPONSIBILITIES, AND AUTHORITIES

Statements by crewmembers and other witnesses indicated that crew coordination activities, such as the manipulation of controls and switches may not have been consistently accomplished in accordance with Southwest Airlines procedures or guidance. See section 8.0 of this Factual report.

The Southwest Airlines FOM (Chapter 3) provided guidance for company crewmembers duties, responsibilities, and authorities. Relevant sections in part are included as follows:

The Captain (3.1.2)

- *Promote an environment that solicits open communication.*
- *Provide instruction to the First Officer, as necessary, to ensure professional growth and proficiency.*
- *Advise the First Officer of deviations from established policies, procedures, and/or regulations.*

The First Officer (3.1.3)

- *Advise the Captain of deviations from established policies, procedures, and/or regulations.*
- *Assist the Captain in preflight planning.*

Crew Coordination (3.2)
Captains are responsible for decisions affecting the conduct of their flight. Use all available resources to assist with operational decisions. Southwest Airlines' First Officers have all previously been Pilots-in-Command and therefore should be treated as experienced Pilots who are in training to be Captains at Southwest Airlines. Both Pilots are responsible for coordinating their efforts in every phase of the flight. Pilots should support each other and adjust to the many varied personalities with whom they are required to fly. Pilots should encourage constructive feedback. The Captain and First Officer are jointly responsible for establishing and maintaining a positive work environment.

PF/PM Duties and Monitoring Responsibilities
Pilot Flying
The PF controls and monitors the aircraft regardless of automation level employed. During ground operations, the Captain is the PF. From takeoff to landing, the Captain may assign the PF role to the First Officer. PF phase of flight general responsibilities include:

- *Taxiing the aircraft*
- *Aircraft flight path control—flying assigned courses, speeds, and altitudes*
- *Aircraft configuration*
- *Navigation (including weather avoidance)*

Pilot Monitoring
The PM supports the PF by monitoring the aircraft and PF actions. During ground operations, the First Officer is the PM. The PM phase of flight general responsibilities consist of the following:

- *Assisting the PF in developing the plan*
- *Monitoring, taxiing, flight path, airspeed, aircraft configuration, and navigation*

- *Intervening if necessary*
- *Reading checklists*
- *Communications*
- *Tasks assigned or requested for by the PF*

The PM proactively assists the PF to ensure safety and professional completion of the flight in accordance with Southwest Airlines policy and procedures. The PM anticipates planning and information needs and improves Flight Deck Crew situational awareness by acquiring information, communicating options, and assisting the PF in building and executing the plan. The PM informs the PF anytime a trend away from standard operating procedures or stated intentions is detected. This is in addition to required deviation callouts.

Shared Responsibilities—Both Pilots
When fulfilling either PF or PM responsibilities, both Pilots must comply with the following:

- *Monitor flight/navigation instruments, and crosscheck for consistency and accuracy.*
- *Monitor Actual Navigation Performance (ANP) to ensure it meets Required Navigation Performance (RNP).*
- *Maintain altimeters at proper altimeter settings, and crosscheck against each other.*
- *Ensure callouts are correctly verbalized.*
- *Monitor flight, engine, system instruments, and avionics equipment closely for malfunctions, warning flags, lights, or out-of-tolerance conditions.*
- *Perform normal system functional tests as necessary.*

Verbalize—Verify—Monitor—Intervene
Flight Safety data analysis clearly indicates Pilots who communicate more commit fewer errors. As a result, communication is the cornerstone of the strategy to verbalize, verify, monitor, and intervene. Communication is also important as Flight Deck Crews work together to formulate, communicate, execute, monitor, and alter their plan, as conditions require. The Captain is responsible for fostering an environment of the team approach and ensuring a plan is developed.

Verbalize*—The FOM, IFOM, and B737 AOM procedures are used as the plan for normal operations. These publications contain procedures that are designed around the Flight Deck Crew utilizing the team approach. The PF must verbalize the plan and any changes to the plan, the sequence of the plan (e.g., extending the landing gear before flaps), or the time when tasks are accomplished, to maintain the team environment. The plan and all changes must conform to Southwest Airlines' operational priorities and may not be made to fulfill the personal needs of Crew Members. Changes to an aircraft system or the movement of a switch must be communicated (outside of primary flight control inputs), and verified/monitored by the other Pilot (e.g., 'Anti-ice is coming ON'). Communication of the change does not imply one Pilot is asking for permission to make the change, it simply fosters the team approach.*

Examples of items that are normally verbalized include the following:

- *Engaging the autopilot*
- *Engaging/disengaging the autothrottle*
- *Pilot-initiated systems changes (e.g., fuel balancing, anti-ice operations) Examples of items that are not normally verbalized include the following:*
- *Normal thrust changes and flight control inputs*
- *Personal adjustments of aircraft lighting*
- *Normal frequency changes*

If the Pilot who normally performs a given task is occupied by other duties, or if flight deck duties dictate, the other Pilot may accomplish the task. It is important that Pilots follow the convention of verbalizing the change.

***Verify**—The Flight Deck Crew must use effective communication to operate as a team. As a general rule, any flight task or action performed by one Pilot should be verified or verifiable by the other Pilot. Additionally, the plan must be understood and the intended operation of the aircraft agreed upon by both Pilots. Areas of confusion must be clarified to ensure the stated plan is executed correctly. The PF is responsible for executing the plan, and the PM is responsible for verifying the performance of the plan.*

Standardization is a key component of Southwest Airlines procedures and is achieved by precise terminology and callouts established in the manual system. These conventions are essential to providing the following:

- *Clear, efficient, and effective communication*
- *Predictable operations between Flight Deck Crew Members unfamiliar with each other*
- *Initiation of complex procedures during periods of task saturation (e.g., 'Go-Around')*

***Monitor**—The PF and PM are equally responsible for monitoring the execution of the stated plan. Deviations from the stated intention require an informative callout to alert the other Pilot of the deviation. Either Pilot may make the informative callout, however the PM is ultimately responsible for ensuring that the callout is made. The informative callout is a simple statement of fact or condition that identifies a deviation from the plan. The standard for speaking up is deviation, not personal comfort level. Research has shown that PMs are poor judges of the PF's level of task saturation. The PM must not wait until uncomfortable with a situation to speak up.*

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.

Intervene *—The PM is the last line of defense against an unsafe operation and, at times, accidents. Intervention normally begins with the PM making an informative callout. If the PF does not acknowledge the callout, fails to make an adequate correction, and/or failure is imminent due to decreased time for a safe correction, the PM must go beyond the informative callout and intervene further to break the error chain. The scope of a required intervention is dependent on the situation and ranges from the informative callout to taking control of the aircraft.*

6.0 40º FLAP LANDINGS

The Southwest Airlines Aircraft Operating Manual (AOM) stated in part in Chapter 17, page 17-10:

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

- *Negative [bracketed] OPC 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.*

In his post-accident interview, the first officer indicated that a 40º flaps landing was more challenging than a 30º flaps landing. He made the statements that, "you had to be on your game with a flaps 40º landing." He also said that in a 40º flaps approach the airplane had more lift, and flew slower, but also had more drag and required a higher power setting. He added that a pilot needed to keep better check of his airspeed, because it was "easier to bleed off airspeed." He characterized a 40º flap landing as a power on landing, and said that a pilot did not reduce power until established in the flare, with the main gear about 3-4 feet above the runway.

He also stated that he had made approximately 40-50 flaps 40º landings in the past, but about 98% of all landings were 30º flaps landings

There was no specific written guidance in Southwest Airlines manuals that indicated that a flaps 40º landing was more challenging or required special techniques. In discussions with Southwest Airlines management personnel, they indicated that flaps 40º landings are considered to be "normal", and although the sight picture may vary slightly from a flaps 30º landing, the difference is minimal. Both types of landings are covered during simulator flight training and also during Operational Experience (OE) line flying.

7.0 TRANSFER OF CONTROLS

The first officer stated in his interview that when the airplane passed over the runway threshold on approach, the captain retarded the throttles, then almost immediately announced "I have the aircraft." 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. It stated:

(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."**

8.0 MANIPULATION OF SWITCHES, GEAR AND FLAP CONTROLS

The first officer stated in his interview that when he was the pilot flying (PF) with the autopilot engaged, the captain as pilot monitoring (PM), would reset flight mode controls (FMC) and indicators, and also select flap positions without being asked or commanded.

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

Section 3.2.3 in Chapter 3 of the Southwest Airlines FOM provided guidance on whom and when shall manipulate controls, in this case the gear and flap controls. It states:

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.

9.0 AIRPLANE INFORMATION

According to information supplied by Southwest Airlines, the airplane, owned by Southwest Airlines, was a Boeing 737-7H4, serial number 29848, and registration N753SW. The airplane was certificated in the Transport category, and had a retractable, tricycle gear configuration. The airplane was configured with seating for two pilots, two cockpit observer jumpseats, four retractable flight attendant seats, and 143 passenger seats. The airplane was powered by two CFM 56-78 turbofan engines, rated at 24,000 pounds of thrust. At the time of the accident, the souls on board were comprised of two flight crewmembers, three flight attendants, and 144 passengers that included one lap child. In addition, one of the cockpit jumpseats was occupied by an American Airlines pilot.

9.1 Weight and Balance Information

Operational Empty Weight (OEW)	85,762
Jumpseat Occupant Weight	201
Passenger Weight	27,200
Baggage/Cargo Weight	3,802
Zero Fuel Weight (ZFW)	116,965
Maximum ZFW	*120,500*
Adjustment for Child Weight (7 Children)	-600
Revised ZFW	116,635
Fuel Weight	18,193
Ramp Weight	134,828
Maximum Ramp Weight	*136,700*
Taxi Fuel Burn	-300
Actual Takeoff Weight	134,528
Maximum Takeoff Weight	*136,700*
Estimated Fuel Burn to KLGA	9,600
Estimated Landing Weight at KLGA	127,100
Maximum Landing Weight	*128,000*
Center of Gravity (CG) at Takeoff	22.6%
Landing Flaps at KLGA	40º
V_{REF} Speed	128

9.2 Airplane Maintenance Considerations

At the time of the accident, the dispatch paperwork referred to one open one Minimum Equipment List (MEL) item on the airplane;

<MEL> 33-2-03 [07/30/2013] CABIN INTERIOR ILLUM [WITH PHOTOLUMINESCENT FLOOR PATH MARKING] SAFTGLO EVOLVE 143 SEATS [--> FWD GALLEY CEILING WORK LIGHT INOP – ENTRY LGT OPS NORMAL <--]

10.0 METEOROLOGICAL INFORMATION

The accident occurred about 1740 EDT or 2140 UTC (Z). The closest reported weather observation to the time of the accident was approximately eleven minutes after the accident at 1751 EDT or 2151 UTC. That observation was as follows:

METAR KLGA 222151Z 04008KT 7SM FEW030 SCT050 BKN075 0VC130 25/22 A2985
**Decoded: Terminal report for LaGuardia Airport, July 22 at 2151Z, wind from 040 at 8 knots, visibility 7 statute miles, few clouds at 3,000 feet above the ground, scattered clouds at 5,000 feet, broken cloud layer at 7,500 feet, overcast layer at 13,000 feet, temperature 25ºC, dew point 22ºC, altimeter setting 29.85.*

The previous hour's weather report was at 1651 EDT or 2051 Z. It was as follows:

METAR KLGA 222051Z 05012KT 8SM FEW028 SCT050 BKN070 25/22 A2986
**Decoded: Terminal report for LaGuardia Airport, July 22 at 2051Z, wind from 050 at 12 knots, visibility 8 statute miles, few clouds at 2,800 feet above the ground, scattered clouds at 5,000 feet, broken cloud layer at 7,000 feet, temperature 25ºC, dew point 22ºC, altimeter setting 29.86*

11.0 AIRPORT INFORMATION

LaGuardia Airport was located on northwestern Long Island about 4 miles east of New York City. It's listed elevation was 21 feet above mean sea level (msl) and it's magnetic variation was 12W (1980).

KLGA had a control tower that was in operation 24 hours, had a lighted wind indicator, and had index D Aircraft Rescue and Fire Fighting (ARFF).

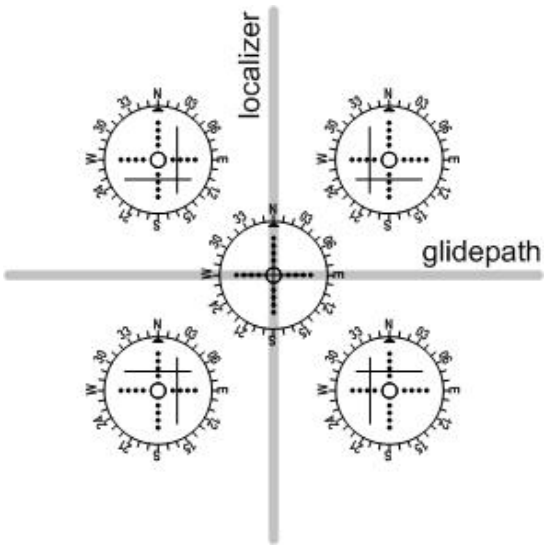
11.1 LGA Runway 4

Dimensions:	7,001 X 150 feet
Surface:	asphalt/concrete/grooved/good condition
Elevation:	20.6 feet
Gradient:	0.2%
Runway Heading:	044 magnetic/032 true
Markings:	Precision, in good condition
Visual Slope Indicator:	4-Light PAPI on right (3.10º glide path)
RVR Equipment:	Touchdown and Rollout
Approach Lights:	MALSR: 1,400 foot medium intensity approach lighting system with runway alignment indicator lights. Runway End Identifier Lights (REIL) Runway Centerline Lights Touchdown Point Lights

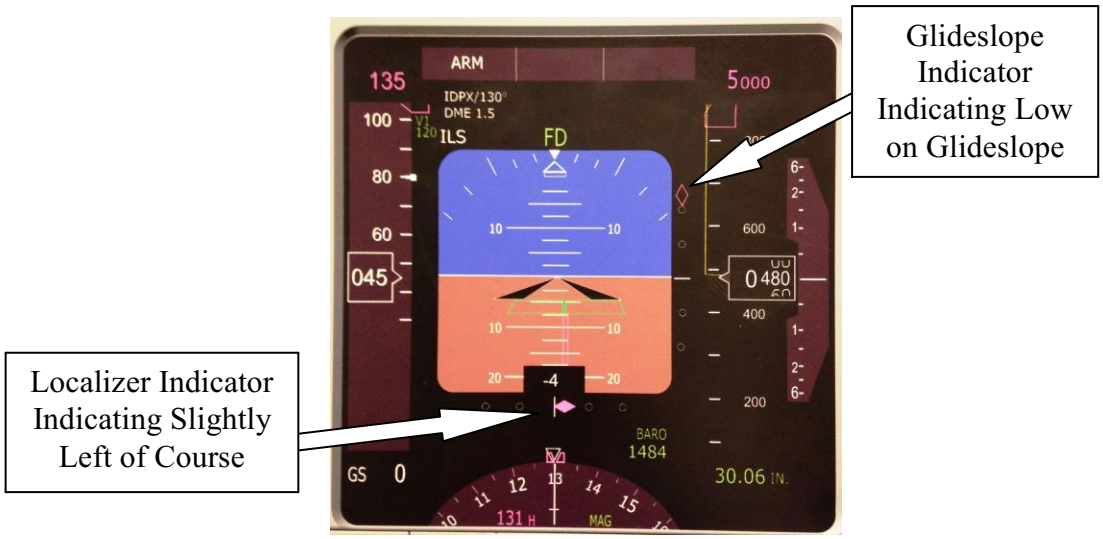
12.0 APPROACH IN USE

12.1 LGA Runway 4 ILS

The crew of Southwest flight 345 was cleared for the ILS Runway 4 approach to KLGA. The ILS incorporated a conventional straight in localizer and a 3º glideslope utilizing a localizer and glideslope transmitter. The localizer provided lateral guidance to the runway and the glideslope provided guidance for a vertical glidepath to the touchdown zone of the runway. In flying an ILS approach, the pilot would maneuver the airplane to keep both the localizer and glidepath indicators centered on the display. If one or both of the indicators were displaced, the pilot would maneuver the airplane toward the displaced indicator(s).



Graphic 1: Generic ILS Indicators Showing Centered and Displaced

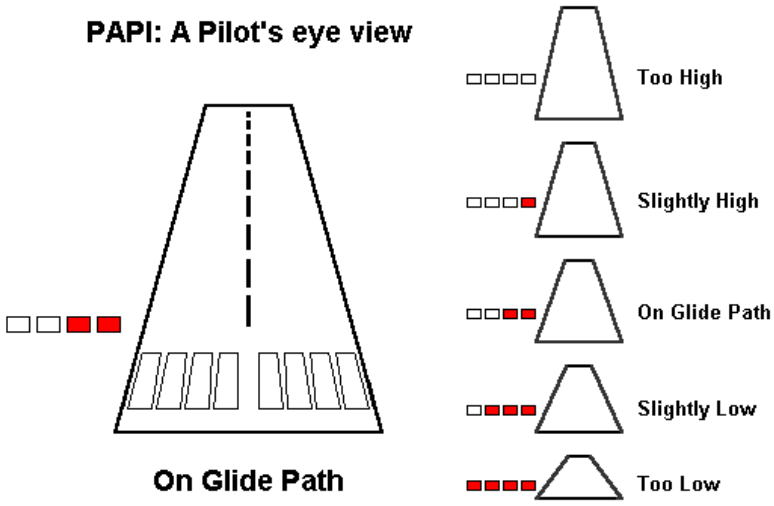


Graphic 2: SWA Boeing 737 Primary Flight Display (PFD) Showing ILS Indicators
Note: This is graphic is not meant to represent any phase of the accident approach

There was no integral distance measuring equipment (DME) associated with the ILS, but DME could be provided by the DME associated with the LGA very high frequency omnidirectional range (VOR) located about 1.1 nautical miles from the approach end of Runway 4. Runway 4 was 7,001 feet long and 150 feet wide. The runway length beyond the glideslope touchdown point was listed as 5,899 feet.

In addition to the electronic glideslope portion of the ILS, vertical guidance could also be assisted by a Precision Approach Path Indicator (PAPI) that was located on the right side of the runway. However, the PAPI is a type of Visual Glide Slope Indicator (VGSI) that consisted of a light bar that showed a combination of four lights, either red or white. The LGA PAPI provided a 3º glidepath, but did not provide any lateral information relative to the runway. A pilot would maintain the appropriate glidepath by adjusting the airplane's altitude so that two white lights

and two red lights were visible during the approach to the runway. Three or four white lights would indicate the airplane was high on the glidepath, while three or four red lights would indicate the airplane was low. The graphic below illustrates the lighting for high, low and on visual approach path, but at KLGA, the PAPI lights were located to the right side of the runway while on approach. However, a note on the Jeppesen approach plate (11-1) for ILS Runway 4, stated, *VGSI* [PAPI] *and ILS glidepath not coincident.*



Graphic 3: PAPI: A Pilot's eye view
Note: The KLGA Rwy 4 PAPI was located on the right side of the runway during the approach

12.2 Approach Considerations

The following are relevant items of guidance taken in part from Chapter 11 of the Southwest Airlines B-737 Aircraft Operating Manual (AOM) that was current at the time of the accident:

> ***11.3.1 Visual Approaches – Procedures and Considerations.***
> *If available, use a charted procedure to back-up visual references. If using a visual glideslope indicator (VASI/PAPI/PLASI), maintain an altitude at or above the glidepath until a lower altitude is necessary for landing.*
>
> ***11.3.2 Visual Approach Profile.***
> *Configure as necessary to meet the stabilized approach criteria.*
> *If a straight-in visual approach is planned, slow to flaps 15 maneuvering speed (150 kts) when approximately 5 miles from the approach end of the runway.*
> *As a guide, use approximately 300 ft above the TDZE for each mile of travel to the runway.*
> *No later than 1,000 ft. above TDZE and after landing flaps are set, complete the Before Landing Checklist.*
> *Starting at 1,000 ft. above TDZE, make the following Flight Deck Crew coordination callouts:*

Position	*PF*	*PM*
At 1,000 ft. Above TDZE	*Call, "1,000 feet, airspeed__. Sink ___ If stabilized approach criteria are not met, initiate a go-around/missed approach.*	*Call, "1,000 feet." If stabilized approach criteria are not met, initiate a go-around/missed approach.*
On Final Approach	*Disengage the autopilot and autothrottle no lower than 50 ft. AGL*	*At 500 ft. above the TDZE, call, "500." Continue callouts on the radio altimeter if automated callouts are not available. At 100 ft, call, "100" At 50 ft, call, "50" At 30 ft, call, "30" At 10 feet, call, "10"*
Note: If the "1,000 feet" callout is missed, call the current altitude. For example, the call may be '900 feet.'		

11.4.2 Visibility At or Above 1000/3
Either Pilot may fly the approach and land.
Autopilot use is recommended but not required.
Flight directors, if available, will be used.

11.8.1 Go-Around/Missed Approach Requirements
- *Execute a go-around/missed approach if any of the following conditions occur:*
  - *The approach does not meet stabilized approach criteria.*
  - *The Pilot determines that a landing in the touchdown zone cannot be safely accomplished because of one or both of the following:*
    - *The required descent or maneuvering will exceed the stabilized approach criteria.*
    - *The aircraft touches down beyond 1,500 ft with an insufficient OPC computed stopping margin.*
  - *Either Pilot directs a go-around.*

13.0 FEDERAL AVIATION ADMINISTRATION OVERSIGHT

The Southwest Airlines Certificate Management Office (CMO) was located in Dallas, TX. The Principal Operations Inspector (POI) for Southwest Airlines had been in his position for about four years, but he did not observe training or get involved in oversight of Southwest Airlines to the extent that the Aircrew Program Managers (APM) did. The POI was mainly involved with office duties, while the APMs provided most of the direct oversight.

Southwest Airlines had four APMs and three of them were located in Dallas. The fourth was located in Atlanta and was primarily involved in oversight of the former AirTran pilots group.

Although all of the APMs provided oversight over the entire B-737 fleet, some of them specialized in specific models like the B737-700.

Southwest Airlines was an ATOS (Air Transportation Oversight System) carrier, or a managed risk carrier under ATOS. The APMs were involved in the approval or acceptance process of manuals such as the FOM or the AOM.

The APMs observed training classes and proficiency checks. The APM who was interviewed said that he observed about 70 proficiency checks a year, mostly because he had to observe company check-airmen.

Southwest Airlines was moving toward an Advance Qualification Program (AQP), but at the time of the accident, was still a year or two away from AQP.

The APM interviewed stated that he was not involved in the KLGA/nosewheel collapse investigation other than to recommend 709 check rides[4] for the accident crew. He stated that a 709 ride was recommended if a crew or crewmember's performance was being questioned.

The APM also stated in response to a question that if an airplane was on autopilot, the PF should be the one making changes to the mode control panel (MCP). If he saw the PM making changes, he would say something to the pilot afterward, unless it was a safety of flight issue. He also said he would be concerned if he saw a PM making changes to the MCP without being asked to do so by the PF.

14.0 COMPANY HISTORY

Southwest Airlines, headquartered in Dallas, Texas, started in 1967, but was incorporated in Texas and commenced Customer Service under its current name on June 18, 1971, with three Boeing 737 aircraft serving three Texas cities - Houston, Dallas, and San Antonio. The airline continued to grow and became a major airline in 1989 when it exceeded the billion-dollar revenue mark. Southwest topped the monthly domestic originating passenger rankings for the first time in May 2003.

As of June 5, 2011, it carried the most domestic passengers of any US Airline. Also, at the time of the accident, Southwest provided scheduled service to 89 destinations in 42 states and Puerto Rico.

The airline has exclusively operated Boeing 737 aircraft except for few years in the 1970s and 1980s when they also operated some Boeing 727 aircraft.

[4] The 709 ride refers to the FAA's authority to re-examine an airman holding a certificate (pilot, flight instructor, airframe and powerplant etc.) at any time pursuant to 49 U.S.C. 44709(a). The FAA issues a request for re-examination to an airman after it discovers evidence that leads it to question an airman's qualifications to exercise the privileges of the airman's certificate.

On May 2, 2011, Southwest acquired Orlando-based AirTran Airways and expected to complete the integration of the two airlines by 2015.

Southwest Airlines had approximately 45,000 employees, including 6,900 pilots. The Southwest Airlines fleet was comprised of 705 Boeing 737 and Boeing 717 airplanes.

Submitted by:

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