NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

June 4, 2014

Group Chairman's Factual Report

OPERATIONAL FACTORS

DCA14IA037

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A. INCIDENT

Operator: Southwest Airlines
Flight: 4013
Location: Branson, Missouri
Date: January 12, 2014 (1808 CST[1])
Type: Boeing 737-7H4
Aircraft: N272WN

B. OPERATIONAL FACTORS GROUP

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C. SUMMARY

On January 12, 2014, about 1808 CST (0008Z), Southwest Airlines flight 4013 (SWA4013), a Boeing 737-7H4, registration N272WN, mistakenly landed at M. Graham Clark Downtown Airport (KPLK), Branson, Missouri, which was 6 miles north of the intended destination, Branson Airport (KBBG), Branson, Missouri. The flight had been cleared to land on runway 14

[1] All times are central standard time (CST) unless otherwise noted.
[2] Captain David Tew was the NTSB Operations Group Chairman until his retirement from the NTSB on April 18, 2014.

at KBBG, which was 7,140 feet long, however, landed on runway 12 at KPLK, which was 3,738 feet long. There were no injuries to the 124 passengers and 7 crewmembers and the aircraft was not damaged. The aircraft was being operated under the provisions of 14 Code of Federal Regulations Part 121 as a regularly scheduled passenger flight from Chicago Midway International Airport (KMDW), Chicago, Illinois. Night visual meteorological conditions prevailed at the time.

D. DETAILS OF THE INVESTIGATION

The NTSB conducted interviews of both incident flight crew members, the jumpseater on the incident flight, Southwest training personnel, and the FAA. Manuals and training material from Southwest were requested and reviewed, and certification records from the FAA were obtained and reviewed.

E. FACTUAL INFORMATION

1.0 History of Flight

SWA4013 was a scheduled 14 CFR Part 121 flight from KMDW to KBBG. The incident airplane was preflighted in KMDW by the first officer (FO) prior to the departure. According to interviews, the FO also loaded the flight management computer (FMC) for the flight to KBBG. SWA4013's 1545 CDT departure from KMDW to KBBG was delayed to 1643 CDT due to the incident airplane arriving to KMDW late.

Departure from KMDW was normal, and the flight climbed to a filed cruising altitude of FL380 (38,000 feet). The FO was the pilot flying (PF) and the captain was the pilot monitoring (PM), and there was a Southwest dispatcher occupying the cockpit jumpseat. According to interviews, during cruise altitude the Captain noticed a fuel imbalance between the two wing tanks that required a crossfeed of fuel to rebalance. According to interviews with the flight crew, cruise and descent were otherwise uneventful.

Prior to arrival into the KBBG area, the FO briefed a visual approach to KBBG runway 14 backed up with the RNAV GPS[3] runway 14 to KBBG. According to interviews, after the FO loaded the RNAV 14 approach into the FMC, the captain tuned his navigational aid to the ILS DME for runway 32 at KBBG, and inserted 5 and 10 mile rings around runway 14 at KBBG. The FO conducted the approach briefing to KBBG, but did not brief the approach lights to the runway or the PAPI[4] lights to the runway.

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[3] RNAV: Area Navigation. GPS: Global Positioning System.

[4] Precision Approach Path Indicator (PAPI). The precision approach path indicator (PAPI) uses light units similar to the VASI but are installed in a single row of either two or four light units. These systems have an effective visual range of about 5 miles during the day and up to 20 miles at night. The row of light units is normally installed on the left side of the runway and the glide path indications are as depicted. Source: Aeronautical Information Manual (AIM).

At 1752, SWA4013 contacted the SGF (Springfield) approach controller at approximately 60 nautical miles northeast of KBBG while descending from 18,000 feet to 16,000 feet with Automatic Terminal Information Service (ATIS) information Delta. The SGF approach controller directed SWA4013 to descend at pilot's discretion to 4000 feet and advised the pilot to expect a visual approach to runway 14 at KBBG. SWA4013 was navigating direct to KBBG when the controller asked SWA4013 if he wanted to go to VUCUG[5] or WUTIB[6]. SWA4013 advised that either fix would work, and the controller directed SWA4013 to proceed direct VUCUG. According to interviews, the FO entered VUCUG into the FMC, and the autopilot turned the airplane slightly to the right to fly direct to the VUCUG.

At 1802:50, the SGF approach controller advised the pilot of SWA4013 that the airport was at his 11 o'clock position and 15 miles. According to interviews, both pilots indicated that they saw an airport beacon light ahead of the airplane, and both believed they identified KBBG. At 1802:58, SWA4013 reported "field in sight," and the SGF controller then cleared SWA4013 for the visual approach to runway 14 at KBBG, advised that radar services were terminated, and directed the pilot to contact Branson tower on frequency 128.15. At 1803:15, SWA4013 checked in with the tower controller, reporting out of 6,600 feet descending to 3000 feet and going direct to VUCUG for the visual approach to runway 14.

The FO indicated that he believed he was high on the approach, disconnected the autopilot, and began to manually maneuver the airplane for the approach. The pilots began configuring the airplane for a flaps 30 landing with autobrakes set to "3". According to interviews, the FO was visually flying to the airport he identified as KBBG, and the captain was using the HUD (Heads Up Display) in the VMC mode[7], and neither pilot was referencing the navigational information for the RNAV 14 approach to KBBG.

The KBBG tower controller issued SWA4013 a landing clearance for runway 14, and SWA4013 touched down at about 1808. According to recorded data, SWA4013's left main landing gear touched down 284 feet from the displaced threshold of the approach end of runway 12 at KPLK, and the right main gear touched down 315 feet from the displaced threshold. Both pilots stated they used maximum braking to stop the airplane on the runway prior to the end of the runway.

At 1809:45, SWA4013 called KBBG tower and stated, "I assume I'm not at your airport." The KBBG controller asked if SWA4013 had landed, and after the pilot confirmed he had. The crew then began referencing chart information and discovered that they landed at KPLK instead of KBBG.

2.0 Flight Crew Information

The incident flight crew consisted of a captain, first officer, and 3 flight attendants. A Southwest Airlines dispatcher conducting an observation ride occupied the cockpit jumpseat. There were

[5] VUCUG was the final approach fix for the RNAV runway 14 approach to KBBG, and located approximately 5.2 miles from the end of runway 14.
[6] WUTIB was the initial approach fix for the RNAV runway 14 approach to KBBG, and located approximately 13.3 miles from the end of runway 14.
[7] For additional information on the HUD VMC display, see Section 14.3 HUD "VMC" Mode of this Factual Report.

two jumpseat riders listed on the Southwest Loading Schedule; one was listed as an observer actually occupying the cockpit jumpseat and the other was listed as a cabin jumpseat rider.[8]

2.1 The Captain

The Captain was 58 years old and resided in Tampa, Florida. He had an Airline Transport Pilot (ATP) certificate with type ratings on the B737, BA3100, and the DC9. He also had a first class medical certificate dated August 12, 2013. His date of hire at Southwest was June 1999. At the time of the incident, he was based in Orlando, Florida.

Prior to Southwest, the captain was a first officer (FO) at Airtran Airlines from March 1998 to May 1999, and was an FO and captain at Corporate Express in Nashville, TN from May 1997 to March 1998, flying primarily out of Raleigh Durham, NC as a Midway Connection. He was in the United States Marine Corps (USMC) from July 1977 to May 1997.

A review of FAA records found no prior accident, incident or enforcement actions.

2.1.1 The Captain's Pilot Certification Record

FAA records of the captain indicated the following:

<u>Commercial Pilot – Rotocraft Helicopter Instrument Helicopter</u> certificate issued March 29, 1983.

<u>Commercial Pilot – Rotocraft Helicopter, Instrument Helicopter; Private Pilot Privileges Airplane Single Engine Land</u> certificate issued September 16, 1983.

<u>Commercial Pilot – Airplane Multiengine Land, Instrument Airplane; Rotocraft Helicopter, Instrument Helicopter; Private Pilot Privileges Airplane Single Engine Land</u> certificate issued May 20, 1992.

<u>Airline Transport Pilot – Airplane Multiengine Land; Commercial Privileges Rotocraft Helicopter, Instrument Helicopter; Private Pilot Privileges Airplane Single Engine Land</u> certificate issued February 14, 1993.

<u>Airline Transport Pilot – Airplane Multiengine Land, DC9; Commercial Privileges Rotocraft Helicopter, Instrument Helicopter; Private Pilot Privileges Airplane Single Engine Land</u> certificate issued August 22, 1996.

<u>Airline Transport Pilot – Airplane Multiengine Land, DC9 BA3100; Commercial Privileges Rotocraft Helicopter, Instrument Helicopter; Private Pilot Privileges Airplane Single Engine Land</u> certificate issued October 22, 1997.

[8] See Attachment 7 – Weight and Balance.

Airline Transport Pilot – Airplane Multiengine Land, DC9 BA3100 B737; Commercial Privileges Rotocraft Helicopter, Instrument Helicopter; Private Pilot Privileges Airplane Single Engine Land certificate issued March 20, 1998.

2.1.2 The Captain's Certificates and Ratings Held at Time of the Incident[9]

AIRLINE TRANSPORT PILOT (issued October 29, 2008)[10]
Airplane Multi-engine Land
DC9 BA3100 B737
Commercial Privileges Rotocraft Helicopter, Instrument Helicopter
Private Pilot Privileges Airplane Single Engine Land

MEDICAL CERTIFICATE FIRST CLASS (issued August 12, 2013)
Limitations: None

2.1.3 The Captain's Training and Proficiency Checks Completed[11]

Southwest Seniority Date	June 3, 1999
Date Upgraded to Captain on B737	July 7, 2005
Date of Initial Type Rating on B737	March 20, 1998
Date of Most Recent Proficiency Check	June 10, 2013
Date of Most Recent Proficiency Training	December 15, 2013
Date of Most Recent PIC Line Check	May 12, 2013

2.1.4 The Captain's Flight Times[12]

The incident captain's flight times provided to the NTSB:

Total pilot flying time	15,700
Total Pilot-In-Command (PIC) time	9,035
Total B737 time	10,400
Total B737 PIC time	6,720
Total flying time last 24 hours	7
Total flying time last 30 days	63
Total flying time last 90 days	188
Total flying time last year	753

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[9] Source: FAA
[10] The captain's ATP certificate was re-issued to remove his Social Security number.
[11] Source: Southwest Airlines.
[12] Flight times were provided to the NTSB by Southwest Airlines.

2.1.5 The Captain's 72-Hour History[13]

According to interviews and Southwest records, on January 10, 2014, the captain woke up about 0900 or 1000 and did routine activities at home, and ate a full breakfast. Around 1230 he drove from Tampa, FL to Orlando,FL, which took about 1.5 hours to drive the 88 miles. The report time was 1405 for flight 1786 from Orlando International Airport (KMCO) to Lambert-St Louis International Airport (KSTL). He began the trip with the incident FO from KMCO to KSTL. Flight 1786 was scheduled out at 1505, and departed KMCO at 1628. The FO was removed from the schedule due to legality reasons in KSTL. The captain picked up a second FO and flew flight 1786 to Denver International Airport (KDEN). He then picked up a third FO and flew flight 1786 from KDEN to San Francisco International Airport (KSFO), and arrived at 0059. They stayed at a Hilton, and he did not recall doing anything with FO. He was off duty for 13 hours and 6 minutes.

On Saturday, January 11, 2014, the captain said he probably woke up at about 1300 and got on the van by 1430 for a report time of 1435. At about 1430 he caught a shuttle to the employee café at airport and ate a meal. He then flew flight 2179 from KSFO to KMDW with a departure time of 1534. He then flew KMDW to Manchester Airport (KMHT) and arrived at 2236. He and the FO ate at the hotel bar in Manchester. He then went to a SWA room, sat on the sofa and chair, and had one more beer while watching sports from earlier that day, and went to bed about 0200. He was off duty for 12 hours and 14 minutes.

On January 12th, he woke up about 1000. That gave him about 1.5 hours to be ready for the van, which came at 1145. He went down to the restaurant, and had the buffet. He was probably in the restaurant by 1100. The showtime at KMHT was 1120 and they departed on flight 1035 at 1151, arriving at KMDW at 1417. The inbound airplane that they were to fly to Branson was at least an hour delayed getting to KMDW. The incident flight 4013 left KMDW at 1743 and arrived at KPLK at 1908.[14]

2.2 The First Officer

The first officer was 62 years old and resided in Valrico, Florida. He had an ATP certificate with type ratings on the B737, BA3100, and BA4100. He also had a first class medical certificate dated December 5, 2013. His date of hire with Southwest was June 2001. At the time of the incident, he was based in Orlando, FL.

Prior to Southwest, he flew for Atlantic Coast Airlines (ACA) for 11.5 years, where he was based at Dulles Airport (IAD) but lived in Knoxville, TN. He left ACA before they turned into Independence Air. Before ACA, he worked for Hewlett Packard as a hardware service engineer, and did general aviation (GA) flying, flight instructing, and flew Part 135 charters part time on the side. When asked about his high flight time (20,538), the FO told NTSB Staff "yeah, regional airlines will do that to you."

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[13] Times in the 72-hour history are Eastern Standard Time EST since the trip began in Orlando (EST). Activities were derived from the crew interviews.

[14] According to the dispatch release, the estimated flight time from KMDW to KBBG (6 miles from KPLK) was 1 hour and 18 minutes. The 3 hours flight time from KMDW to KPLK included ground time at KPLK waiting for ground services to assist the airplane.

A review of FAA records found no prior accident, incident or enforcement actions.

2.2.1 The First Officer's Certification Record[15]

FAA records of the first officer indicated the following:

Notice of Disapproval - Private Pilot issued March 14, 1980. Areas for reexamination: Airport operations.

Private Pilot – Airplane Single Engine Land certificate issued March 14, 1980.

Notice of Disapproval – Instrument Airplane issued April 12, 1983. Areas for reexamination: Timed turn, Primary panel.

Private Pilot – Airplane Single Engine Land; Instrument Airplane certificate issued April 20, 1983.

Commercial Pilot – Airplane Single Engine Land; Instrument Airplane certificate issued September 21, 1984.

Commercial Pilot – Airplane Single and Multi Engine Land; Instrument Airplane certificate issued January 1, 1985.

Ground Instructor – Advanced Ground Instructor certificate issued March 1, 1985.

Flight Instructor – Airplane Single Engine certificate issued April 17, 1985.

Ground Instructor – Advanced Instrument certificate issued June 22, 1987.
Renewed April 13, 1987

Flight Instructor – Airplane Single Engine; Instrument Airplane certificate issued April 7, 1988.
Renewed April 30, 1990; April 30, 1992; March 1, 1994; March 18, 1996; March 10, 1998; March 23, 2000.

Airline Transport Pilot – Airplane Multi-Engine Land, BA3100; Commercial Privileges Airplane Single Engine Land certificate issued December 6, 1992.

Airline Transport Pilot – Airplane Multi-Engine Land, BA3100, BA4100; Commercial Privileges Airplane Single Engine Land certificate issued March 16, 1996.

Airline Transport Pilot – Airplane Multi-Engine Land, BA3100, BA4100, B737; Commercial Privileges Airplane Single Engine Land certificate issued April 29, 2001.

[15] Source: FAA.

2.2.2 The First Officer's Certificates and Ratings Held at Time of the Incident

AIRLINE TRANSPORT PILOT (issued October 31, 2008)[16]
Airplane Multi-engine Land
BA3100, BA4100, B737
Commercial Privileges Airplane Single Engine Land

FLIGHT INSTRUCTOR (issued October 31, 2008)
Airplane Single Engine
Instrument Airplane

GROUND INSTRUCTOR (issued October 31, 2008)
Advanced Instrument

MEDICAL CERTIFICATE FIRST CLASS (issued December 5, 2013)
Limitations: Must have available glasses for near vision

2.2.3 The First Officer's Training and Proficiency Checks Completed[17]

Southwest Seniority Date	June 21, 2001
Date of Initial Type Rating on B737	April 29, 2001
Date of Most Recent Proficiency Check	January 13, 2012
Date of Most Recent Proficiency Training	January 29, 2013
Date of Most Recent Line Check	January 13, 2012[18]

On December 10, 2011, the FO began upgrade training to become a captain at Southwest Airlines, and completed flight training on December 18, 2011. On December 19, 2011, the FO was graded "unsatisfactory" on the LOFT[19] portion of the upgrade training, and received a proficiency check and returned to the line as an FO.[20] The FO's training record included the following note:

> *ACCOMPLISHED RIGHT SEAT SPECIFIC TRNG. PLEASE NOTE- UPGRADE LOFT WAS UNSAT. PILOT RETURNED TO FO LINE PER SWAPA CONTRACT*

The FO's training record also included the following note on December 21, 2011:

[16] The FO's ATP and Instructor certificates were re-issued to remove his Social Security number.
[17] Source: Soutwest Airlines.
[18] A note in the pilot's training record included the following: "IAW FAR 121.409 Credit for LC – Completed during PC."
[19] Line oriented flight training.
[20] The Southwest Airlines Flight Operations Training Manual (FOTM), Chapter 1, Section 4, "General Standards of Performance" stated the following, in part: "U -*Unsatisfactory:* The trainee did not demonstrate the skill or knowledge to accomplish the task correctly. This grade is only assessed once the trainee has had sufficient training and practice to be reasonably expected to be able to perform the task correctly. Prior to that time, an N - "Needs Work" should be assessed. The "U" grade is indicative of unsatisfactory progression in training or unacceptable regression from previously demonstrated proficiency."

CA UPGRADE LOFT - UNSAT- UNABLE TO MANAGE WORK LOAD EFFECTIVELY. UNABLE TO DEFINE THE PROBLEM, DIAGNOISIS, GENERATE OPTIONS, ASSIGN A RISK ASSEMENT, AND FINALLY MAKE A CHOICE. TUNNEL VISION LEADING TO A LOSS OF SITUATIONAL AWARNESS.

On January 4, 2012, the FO re-entered upgrade training, and his flight training record included the following note:

PREP FOR RE-TRAINING LOFT: SITUATIONAL AWARENESS TRAINING

On January 5, 2012, the FO received an "unsatisfactory" on his upgrade LOFT. His training record included the following note:

UNSAT LOFT- INW SWAPA CONTRACT, PILOT WILL RETURN TO FO LINE

2.2.4 The First Officer's Flight Times[21]

The incident first officer's flight times provided to the NTSB:

Total pilot flying time	20,538
Total PIC time	8,295
Total flying time B737	9,880
Total B737 PIC time	0
Total flying time last 24 hours	3
Total flying time last 30 days	55
Total flying time last 90 days	125
Total flying time last year	660

2.2.5 The First Officer's 72-Hour History[22]

According to interviews and Southwest records, the FO began his trip on January 10, 2014 with a report time of 1405 for flight 1786 from KMCO to KSTL. He began the trip with the incident captain from KMCO to KSTL. Flight 1786 was scheduled out at 1505, and departed KMCO at 1628, arriving KSTL at 1852. He was supposed to go with the incident captain to KSFO, but was rescheduled to fly to Minneapolis-St Paul International/Wold-Chamberlain Airport (KMSP), departing KSTL at 1915 and arriving KMSP at 2056. He went to the hotel, had dinner, and was asleep about 2230 or 2245. He was off duty for 11 hours and 54 minutes.

On January 11, 2014, the FO woke up at about 0800 for a van time of 0900 and a report time of 0920. He flew flight 2168 from KMSP to KMCO, departing at 0955 and arriving at 1329. He then flew flight 3258 from KMCO to General Mitchell International Airport (KMKE), departing

[21] Flight times were provided to the NTSB by Southwest Airlines.
[22] Times in the 72-hour history are Eastern Standard Time since the trip began in Orlando (EST). Activities were derived from the crew interviews.

at 1419 and arriving at 1659. He had dinner and went to bed about 2300. He was off duty for 15 hours and 6 minutes.

On January 12, 2014, he woke at about 0615 EST and deadheaded from KMKE to New York La Guardia (KLGA) to KMDW, departing KMKE at 0903 and arriving KMDW at 1533. The inbound airplane that they were to fly to Branson was at least an hour delayed getting to KMDW. The incident flight 4013 left KMDW at 1743 and arrived at KPLK at 1908.[23]

2.3 Crew Experience to Branson, MO (KBBG)

The incident FO told NTSB Staff he had flown into Branson once before on a VFR[24] day. He was the pilot PF that time as well, but could not recall where they flew in from, but remembered that the arrival was from the south. According to records provided to the NTSB by Southwest Airlines, the incident first officer operated a flight from Dallas Love Field (KDAL) to KBBG, and KBBG to KMDW on June 24, 2013.

The incident captain had never flown into KBBG according to Southwest Airlines records prior to the incident flight.

3.0 Flight Crew Roles and Responsibilities

3.1 Captain

The SWA Flight Operations Manual (FOM), Section 3.1.2 “Captain” stated the following:

> *No Captain may allow a flight to continue toward any airport to which it has been dispatched or released if, in the opinion of the Captain or Dispatcher, the flight cannot be completed safely, unless, in the opinion of the Captain, there is no safer procedure. In that event, continuation toward that airport is an emergency situation.*
>
> *The Captain has full control and authority in the operation of the aircraft, without limitation, over other Crew Members and their duties during flight time, whether or not he holds valid certificates authorizing him to perform the duties of those Crew Members. The Captain is responsible for the safety of the Crew Members, Passengers, cargo, and aircraft during the flight. The Vice President Flight Operations designates the Captain's duties through certification and the Dispatch Release. The Captain’s responsibilities include the following:*
>
> > *• Promote an environment that solicits open communication.*
> > *• Provide instruction to the First Officer, as necessary, to ensure professional growth and proficiency.*

[23] According to the dispatch release, the estimated flight time from KMDW to KBBG (6 miles from KPLK) was 1 hour and 18 minutes. The 3 hours flight time from KMDW to KPLK included ground time at KPLK waiting for ground services to assist the airplane.
[24] Visual Flight Rules (VFR) are defined by 14 CFR 91.155, and generally consists of a ceiling above 1,000 feet and visibility greater than 3 miles.

• Advise the First Officer of deviations from established policies, procedures, and/or regulations.
• Exercise joint responsibility with the Dispatcher for the proper preflight planning, planned delays, and Dispatch Release of the flight.
• Verify that the Loading Schedule, weather information, NOTAMs, flight plan, Dispatch Release are onboard the aircraft prior to each departure.
• Ascertain that the fuel onboard the aircraft is correct for the specific flight conditions and that it complies with CFR fuel requirements for flight.
• Make the landing anytime an engine is shut down.
• Inform Dispatch of changing conditions that might adversely affect other flights.
• Occupy the left seat at all times. Designated Check Airmen may occupy the right seat.
• Monitor any fueling operation requiring the use of fuel dripsticks to ensure the accuracy of readings according to MEL procedures.
• Perform normal fuel system management (i.e., pump selection and fuel balancing).

3.2 First Officer

The SWA FOM, Section 3.1.3 "First Officer" stated the following:

The First Officer's duties and responsibilities include the following:

• Exercise Second-in-Command duties. Assume, secondarily, all responsibilities of the Captain. Should the Captain become incapacitated during flight, assume command of the aircraft. If another Southwest Airlines Captain or Lance Captain is onboard, they should subsequently take command of the aircraft, depending on the circumstances.
• Advise the Captain of deviations from established policies, procedures, and/or regulations.
• Assist the Captain in preflight planning.
• Perform other duties assigned by the Captain.
• Normally, the First Officer controls cabin and flight deck temperature and air flow for Passenger and Crew comfort.

3.3 Crew Coordination

According to the Southwest Airlines Flight Operations Manual (FOM), captains were responsible for decisions affecting the conduct of their flight. They were required to use all available resources to assist with operational decisions. According to the Southwest Airlines FOM, Southwest Airlines' First Officers were considered to have all been previously been Pilots-in-Command and therefore and to be treated as experienced pilots who were in training to be captains at Southwest Airlines. Both pilots were responsible for coordinating their efforts in every phase of the flight.

3.3.1 PF/PM Duties and Responsibilities

According to the Southwest Airlines FOM, preflight and postflight Flight Deck Crew duties were divided between the Captain and First Officer. Phase of flight duties were divided between the Pilot Flying (PF) and the Pilot Monitoring (PM).

3.3.1.1 Pilot Flying Duties

According to the Southwest Airlines FOM, the PF was required to control and monitor the aircraft regardless of automation level employed. During ground operations, the Captain was the PF. From takeoff to landing, the Captain may assign the PF role to the First Officer.

The Southwest FOM, Section 3.2.1 "PF/PM Duties and Monitoring Responsibilities" stated the following:

> *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)*
>
> *The PF will employ Southwest Airlines operating procedures and policies, which optimize safety, aircraft engineering design, and efficiency. Principles employed by the PF to provide quality Customer Service include the following:*
>
> - *Flying the aircraft as safely and professionally as possible, providing the highest quality Customer Service while optimizing efficiency. The PF will maneuver the aircraft using smooth and steady control inputs and thrust setting changes to instill Passenger confidence.*
> - *Developing, communicating, and executing the plan to achieve Southwest Airlines' goals. The PF works with the PM to keep the Passengers informed of normal conditions (e.g., ride, position) and exceptional occurrences (e.g., mechanicals, weather, reroutes).*

3.3.1.2 Pilot Monitoring Duties

The Southwest FOM, Section 3.2.1 "PF/PM Duties and Monitoring Responsibilities" stated the following:

> *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.

Communication responsibilities for the PM include:

• ATC communication
• Flight Attendant service interphone calls unless the PM is occupied with priority items, such as acquiring ATIS or making a Company call.

NOTE: The PF may answer provided it does not interfere with PF duties and ATC monitoring.

3.3.2 Shared Responsibilities—Both Pilots

The Southwest FOM, Section 3.2.1 "PF/PM Duties and Monitoring Responsibilities" stated the following:

When fulfilling either PF or PM responsibilities, both Pilots must comply with the following:
• Do not use any navigational system displaying an inoperative flag or failure indication.
• 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.

3.3.3 Verbalize—Verify—Monitor—Intervene

Southwest pilots were taught a "Verbalize-Verify-Monitor-Intervene" strategy when operating as a crew. The Southwest FOM, Section 3.2.1 "PF/PM Duties and Monitoring Responsibilities" stated the following:

> *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.

3.4 Automation Policy

The Southwest Airlines policy on the use of automation was defined in the the Southwest Airlines FOM, Section 4.1 "Automation Policy." That section of the FOM stated the following:

Autoflight systems perform flight and navigation tasks that would otherwise be accomplished by a Pilot. The proper use of automation allows Pilots to effectively manage and monitor the programmed or directed flight path. The PF will choose the appropriate level of automation, unless otherwise required by procedure, to meet these ordered priorities:

- *Enhance safety and situational awareness.*

- *Support Passenger service through increased operational capability.*
- *Maximize efficiency.*

Both the PF and the PM must remain aware of the automation in use. Ensure that automation tasks do not interfere with outside vigilance during VMC.

WARNING: *Use of automation must never interfere with maintaining aircraft control. Always fly the aircraft. If any autoflight system is not operating as expected, disengage it.*

While on the approach to KPLK, the incident FO indicated that he believed he was high on the approach, disconnected the autopilot, and began to manually maneuver the airplane for the approach. The FOM Section 4.1.3 "Levels of Automation" defined manual flight as the "direct control of the aircraft via the control wheel and thrust levers. The flight path is controlled with or without reference to the flight director." Further, the same section of the FOM stated the following:

> *When immediate and decisive control of the aircraft path is required (e.g. EGPWS terrain warning), this level of automation may be necessary. Manual flight may also be desired when maneuvering for visual approaches or to maintain hand-flying proficiency.*

4.0 Medical and Pathological Information

Both pilots were drug and alcohol tested on January 13, 2014 in Branson, MO, and the results were negative for both pilots.[25]

The captain told NTSB Staff he was in good health, and did not have any sleep disorders. He stated that he took 20mg/day of Lisinopril for hypertension, and it was documented on his flight physical. His first class medical certificate had no limitations.

The FO told NTSB Staff he did not take prescription medications, and considered his health very good. In the 72 hours before the incident, he had not taken any medications that could have affected his performance. He told NTSB Staff that he held a first class medical with a limitation to wear glasses for near vision. He said he was not wearing the glasses during the incident.

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[25] The drugs tested included Amphetamines (amphetamine, methamphetamine, Ecstasy), Cocaine, Marijuana, Phencyclidine, and Opiates (Codeine, Morphine, 6-MAM).

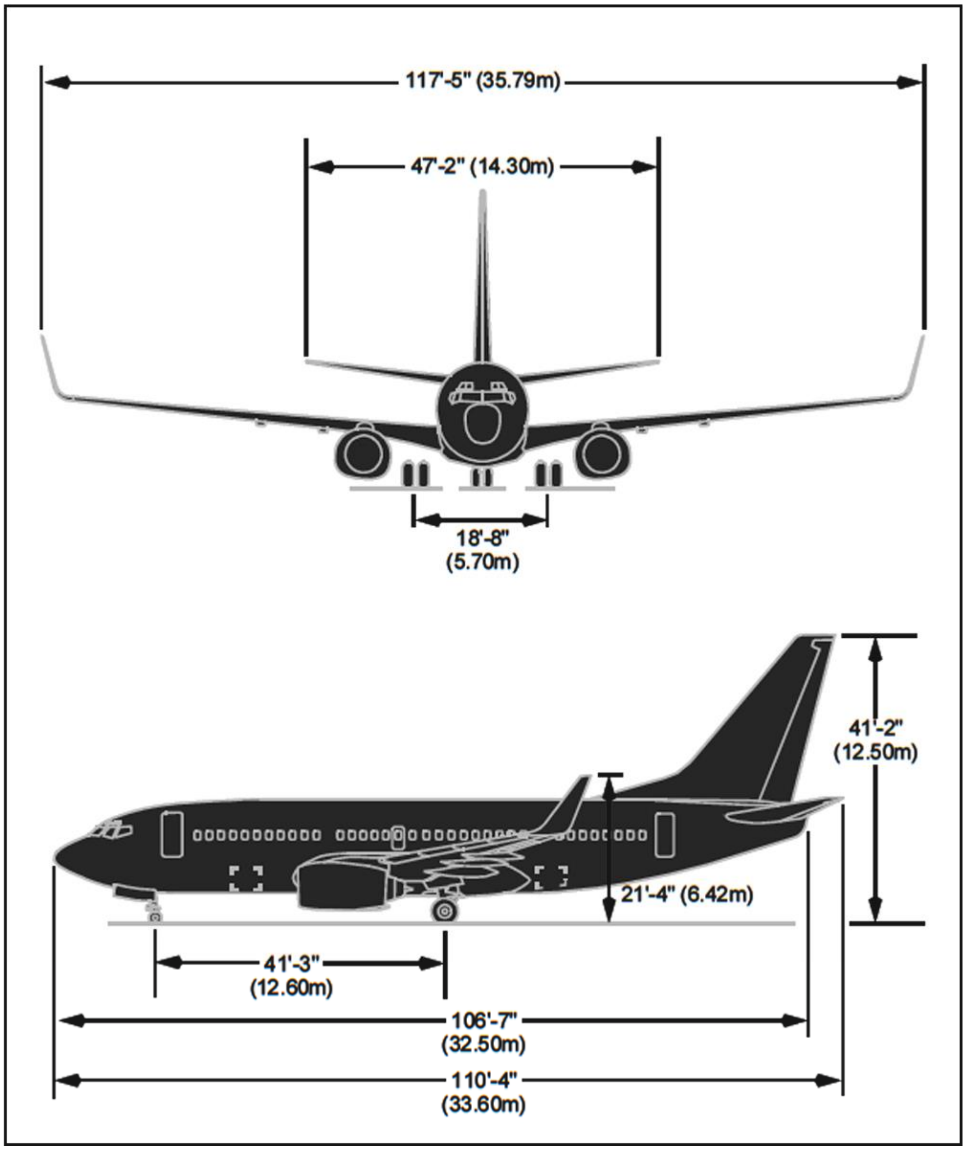
5.0 Aircraft Information

Photo 1: Incident Airplane (N272WN registration)

The incident airplane was a Boeing 737-7H4 (Registration N272WN), Serial number 32527, and was manufactured on March 29, 2007. The airplane had a max weight of 154,000 pounds and seated 151 passengers. At the time of the incident, it had a total of 24,561 airframe hours, and the last recorded inspection occurred on December 3, 2013. The registered owner of N272WN was Southwest Airlines. It held a transport category airworthiness certificate dated March 29, 2007. At the time of the incident, the airplane carried two MEL (minimum equipment list) deferrals. The #2 aft fuel boost pump and the right hand retractable landing light were both placarded inoperative.[26]

[26] See Attachment 6 - Aircraft Log Pages.

5.1 Airplane Dimensions[27]



6.0 Weight and Balance

The following weight and balance was derived from records provided by Southwest Airlines and from the Southwest Airlines electronic Loading Schedule for flight 4013.[28] The electronic Loading Schedule included the final Zero Fuel Weight (ZFW) and takeoff weight (TOW) of the aircraft prior to departure. It was generated and printed through Electronic Weight and Balance (EWB). The original electronic Loading Schedule was given to the pilots of SWA4013. Subsequent copies, including the second copy to file with the flight papers, were required to display a "COPY" watermark in the Remarks section. To view a copy of the incident flight's electronic Loading Schedule, see Attachment 7 - Weight and Balance.

[27] Source: Southwest Airlines Airplane Operating Manual (AOM).
[28] See Attachment 7 - Weight and Balance.

6.1 Incident Flight Weight and Balance

WEIGHT & BALANCE / PERFORMANCE		
	Operating Empty Weight (OEW)	85,762
	1st Observer (cockpit)	201
	2nd Observer (cabin)	199
	Operational Weight	86,162
	Passenger weight (124 passengers)	24,200
	Baggage (forward hold)	1,905
	Baggage (aft hold)	1,596
	Zero Fuel Weight (ZFW)	113,863
	Child weight adjustment (2 children)[29]	-200
	Revised ZFW	113,663
	Max ZFW	120,500
	Fuel (wing tanks) [30]	16,992
	Fuel (center tank)	1,001
	Takeoff Weight	131,656
	Max Takeoff Weight (structural)[31]	134,400
	Planned landing weight (KBBG)[32]	*124,700*
	Actual fuel burn (KPLK)[33]	6,893
	Actual landing weight (KPLK)	124,763
	Maximum Landing Weight	128,000
	V_{REF} (knots)	130
	V_{TARGET}[34] (knots)	147

7.0 Performance

7.1 Onboard Performance Computer[35]

The Onboard Performance Computer (OPC) was the primary source for takeoff, cruise, and landing data. It was a commercially available, pen-based tablet Fujitsu T2020 computer located on the flight deck. The OPC also contained the MEL/CDL and Flight Reference Manual (FRM) in the document viewer. The OPC's (color) liquid crystal display (LCD) screen used light-

[29] Child weights are addressed in the SWA B737 AOM, Chapter 17 Performance/Weight and Balance, page 17-33.
[30] Total fuel load (wings+center) includes -400 pounds for taxi fuel.
[31] For maximum structural takeoff weight for SWA4013, see Attachment 3 – Dispatch Release.
[32] See Section 6.1.2 "Incident OPC Landing Output Screen" of this Factual Report for planned arrival landing weight to KBBG, .
[33] Actual fuel burn based on ACARS arrival fuel message of 11,100 at KPLK. See Attachment 4 – ACARS Messages.
[34] V_{TARGET} speed is V_{REF} + wind additives. The headwind additive is 1/2 the headwind component plus the gust factor. The minimum additive is 5 kt; the maximum additive is 20 kt or flap placard speed minus 5 kt, whichever is lower. The tailwind additive is 5 kt. Note: The gust factor is added to V_{REF} speed when computing OPC landing distance.
[35] Source: SWA Flight Reference Manual, Section 8.1.1.

emitting diode (LED) internal backlighting for illumination in day or night conditions. A Harsh Environment Case (HEC) helped protect the computer against damage.

The OPC was stowed in a cradle located behind the captain's seat. The cradle was installed at an angle to allow access by either Pilot. The cradle had DC power, which kept the OPC battery charged when properly stowed. Power was supplied by the DC Bus #1 (or the ground service bus on modified B737-700s) and protected by the OPC/Laptop CB, P18-3.

The OPC used a large database of airport and runway information including field elevations for online, alternate and charter airports, including those airport's runway identifiers, lengths, slopes, and departure obstacles.[36] This database and the OPC software were maintained by Operations Engineering in Dallas and updated every 28 days. Maintenance loaded the updated software and database into each OPC.

Because the OPC was used by pilots to determine airport performance data, Dispatch used software identical to that used on the aircraft. If the OPC system was unavailable, pilots were guided to request required performance parameters directly from Dispatch.

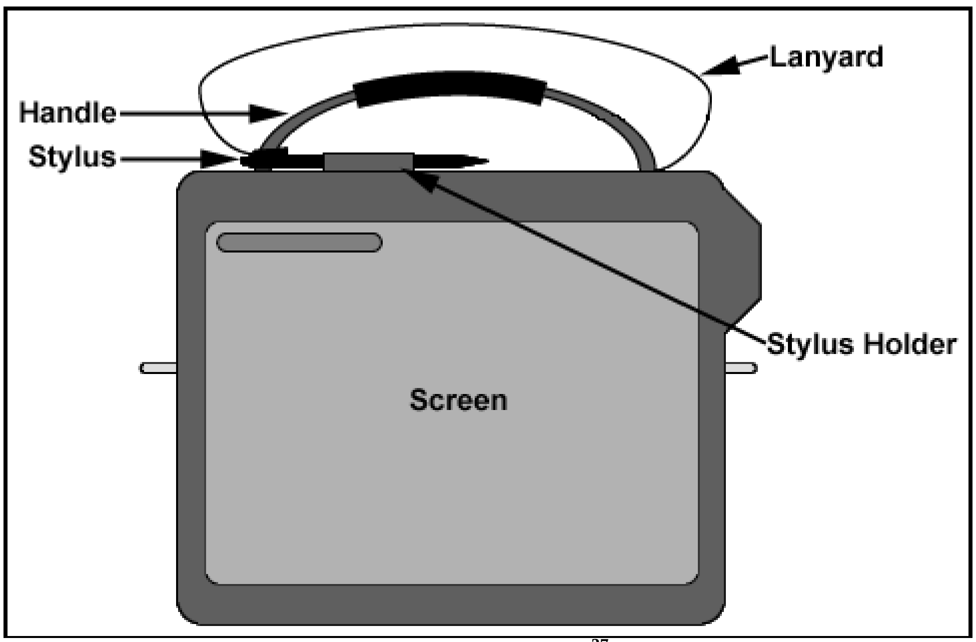


Figure 1: Onboard Performance Computer (OPC).[37]

7.1.1 OPC Landing Output Screen

The Landing Output screen displayed landing parameters for entered conditions. When viewing landing data for multiple runways, pilots would select the desired landing runway to display the

[36] According to the Southwest Airlines Flight Reference Manual, Section 8.4.12 "Offline Airport Data Option," "the program database stores airport and runway data including all online stations and many charter and alternate airports. If operations are required at an airport not in the current database, enter the data using the Offline Airport Data option."
[37] Source: Southwest Airlines Flight Reference Manual, Section 8.2.1 "Overview Fujitsu T2020."

Quick Turn weight, V_{TARGET} SPEED (V_{REF} + wind additives), and Brake Cooling (BRK COOL) button (if applicable). Pilots entered the most current destination weather from the most current ATIS at the destination, or the most current weather report in their weather briefing paperwork if a current ATIS was not available.

Actual steady wind speed components for headwinds and crosswinds, and peak cost component for tailwinds were depicted in the "winds" field. If a tailwind or crosswind component exceeded the corresponding limit, the actual component was highlighted and the OPC displayed dashes in lieu of a stopping margin. Limits displayed on the Information Line (IL) if the entered wind exceeded these limits. When viewing multiple runways, it displayed V_{REF} and go-around power. Pilots could also elect the desired landing runway to display the Quick Turn weight and V_{TARGET} speed (V_{REF} + wind additives). The headwind additive was 1/2 the headwind component plus the gust factor. The minimum additive was 5 knots; the maximum additive was 20 knots or flap placard speed minus 5 knots, whichever was lower. The tailwind additive was 5 kt. The gust factor was added to V_{REF} speed when computing OPC landing distance.

To obtain the calculated stopping distance for a given autobrake setting, the distance remaining specific to an autobrake setting would have to be subtracted from the available runway length. Based on the weather for KBBG (the closest official weather to KPLK) and the OPC landing performance data calculated for landing at KBBG at a weight of 124,700 pounds, with the thrust reversers engaged to the second detent, the stopping distance for autobrakes Medium (3) would have been 6610 feet. The stopping distance for an autobrake setting of Max (Manual) would have been 4,880 feet. The available runway length for landing at KPLK was 3,738 feet. For additional information on the B737 brake and autobrake system, see Section 14.6 Brake System of this Factual Report.

According to the Southwest Airlines FOM, the “Approx Stop Margin” calculated by the OPC was based on three different levels of deceleration as defined by the autobrake system, touching down 1,500 feet from the threshold, and adjusting the touchdown speed for wind. The OPC then included a 15 percent additional safety factor on the total calculated landing distance. The Min (2), Med (3), and Max (M) values were calculated using the deceleration rates for autobrake settings 2, 3, and MAX, respectively. The stopping margins for all aircraft models included the effects of reverse thrust as follows:

- At the detent 2 position for normal configuration landings.[38]
- At maximum reverse for non-normal landing configurations.
- No reverse thrust if “Flaps: 15 Single Engine” was selected.
- No reverse thrust if “Reversers: ONE OR BOTH INOPERATIVE” was selected.

When not using autobrakes, Min braking (AUTO BRAKE 2) could be approximated by accomplishing a normal landing using spoilers and reverse thrust with light manual braking initiated at approximately 80 kt.

Med braking (AUTO BRAKE 3) could be approximated by accomplishing a normal landing using spoilers and reverse thrust with moderate manual braking initiated at nose wheel touchdown.

Max braking (AUTO BRAKE MAX) could be approximated by accomplishing a normal landing using spoilers and reverse thrust with maximum manual braking initiated at nose wheel touchdown.

[38] According to the Southwest Airlines B737 AOM (Chapter 12 “Landing”), stopping margin computations were based on selecting reverse thrust within two seconds after touchdown and attaining the planned reverse thrust level within eight seconds after touchdown. Any delay would invalidate OPC stopping margin computations.

7.1.2 Incident OPC Landing Output Screen[39]

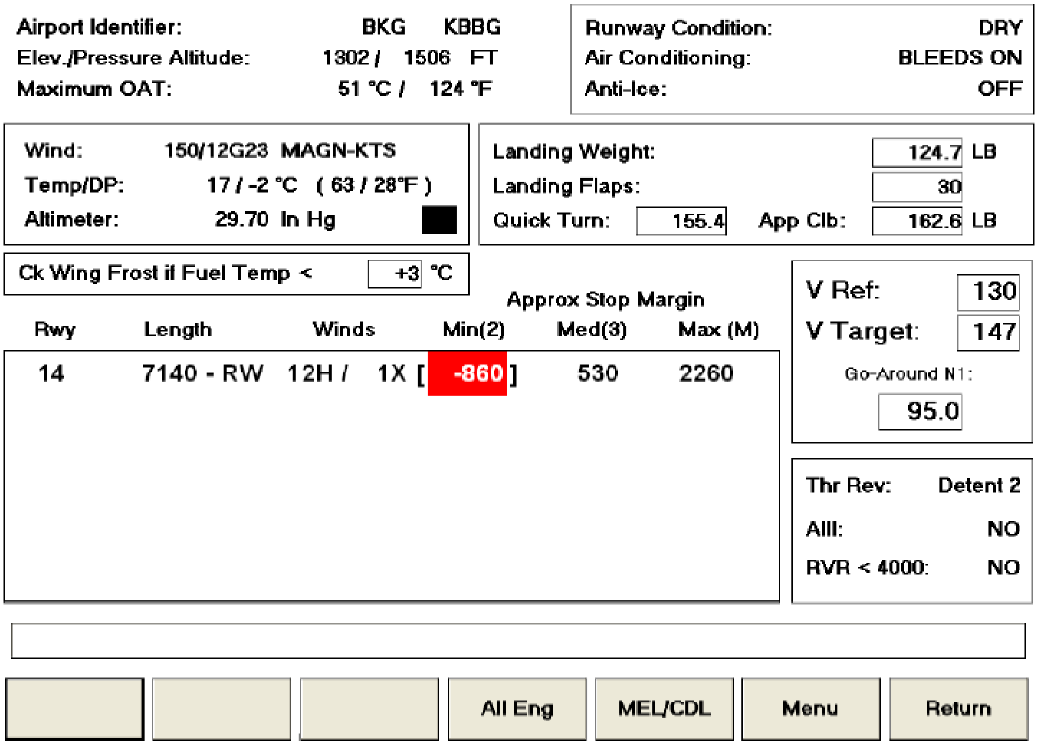


Figure 2: Incident OPC Landing Output Screen[40]

8.0 Meteorological Information

The following weather information was provided to SWA4013 via the weather briefing paperwork:

Surface Observations
KBBG 122045Z 19017G25KT 10SM SKC 18/M04 A2973
121948Z 18020G27KT 10SM SKC 18/M04 A2975

Terminal Forecasts
TAF KBBG 121720Z 1218/1318 18018G28KT P6SM SKC WS020/21050KT
FM130000 17014G24KT P6SM SKC WS020/21050KT
FM130600 23010KT P6SM FEW100 SCT250
FM131000 27007KT P6SM FEW100 SCT250
FM131600 29010G18KT P6SM SKC

[39] Source: Southwest Airlines.
[40] Approximate Stop Margin – based on minimum, medium, and maximum braking and corresponds to three different auto brake settings (2, 3, and MAX). Each stop margin calculation includes 1,500 ft air distance from threshold to touchdown and an extra 15 percent distance factor. Stop margin is the distance remaining after the aircraft comes to a complete stop, measured from the nose gear to the end of the available runway. If the estimated landing distance is longer than the available runway length, the approximate stop margin is negative, highlighted, and bracketed "[ ]". Source: SWA Flight Reference Manual, Section 8.4.4.2 Landing Output Screen.

There was no official weather observation for KPLK. The closest weather observation was from Branson Airport (KBBG), located about 6 miles south of KPLK.

At 1748 CST, the crew of SWA4013 received the following weather report for KBBG via the onboard ACARS[41] system:

METAR KBBG 122347Z 15012G23KT 10SM FEW250 17/M02 A2970

(Incident occurred at 0008Z)

The crew entered this weather information in the OPC to calculate the landing performance to runway 14 at KBBG. The end of civil twilight occurred at 1744 CST in the Branson area, and night conditions prevailed at the time of the incident.

9.0 Air Traffic Control (ATC)

See Air Traffic Control Group Chairman's Factual Report.

10.0 Communications

There were no known communication difficulties.

11.0 Airport Information

11.1 Branson Airport (KBBG)

Branson Airport was located 8 miles SSE of Branson, Missouri at a field elevation of 1,302 feet above mean sea level (msl) and at a latitude/longitude of N36º31.92´/W93º12.03´. The airport was owned by Branson Airport, LLC. It had a VFR federal contract tower staffed and managed by Midwest ATC. Approach radar services to SWA4013 were provided by Springfield-Branson National Airport (SGF). The KBBG did not have a radar monitor in the control tower. Airport ATC services were provided to SWA4013 by the KBBG ATCT.[42]

11.1.1 KBBG Runway Information

KBBG had a single runway 14/32 that was 7,140 feet long and 150 feet wide, with a concrete/grooved surface. Both runways had a 4-light PAPI on the left side of the runway (3.00 degrees glide path), and both runways had REIL[43] lights. According to interviews, ATC

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[41] Aircraft Communication Addressing and Reporting System (ACARS) is a digital datalink system for transmission of short, relatively simple messages between aircraft and ground stations via radio or satellite.

[42] For additional information, see ATC Group Chairman's Factual Report.

[43] Runway End Identifier Lights (REIL). According the Aeronautical Information Manual (AIM), Section 2-1-3, REILs are installed at many airfields to provide rapid and positive identification of the approach end of a particular runway. The system consists of a pair of synchronized flashing lights located laterally on each side of the runway threshold. REILs may be either omnidirectional or unidirectional facing the approach area. They are effective for: a. Identification of a runway surrounded by a preponderance of other lighting. b. Identification of a runway which

controlled the illumination of the runway lights. Both runways had an available landing distance of 7,140 feet.

lacks contrast with surrounding terrain. c. Identification of a runway during reduced visibility.

11.1.2 KBBG Charts[44]

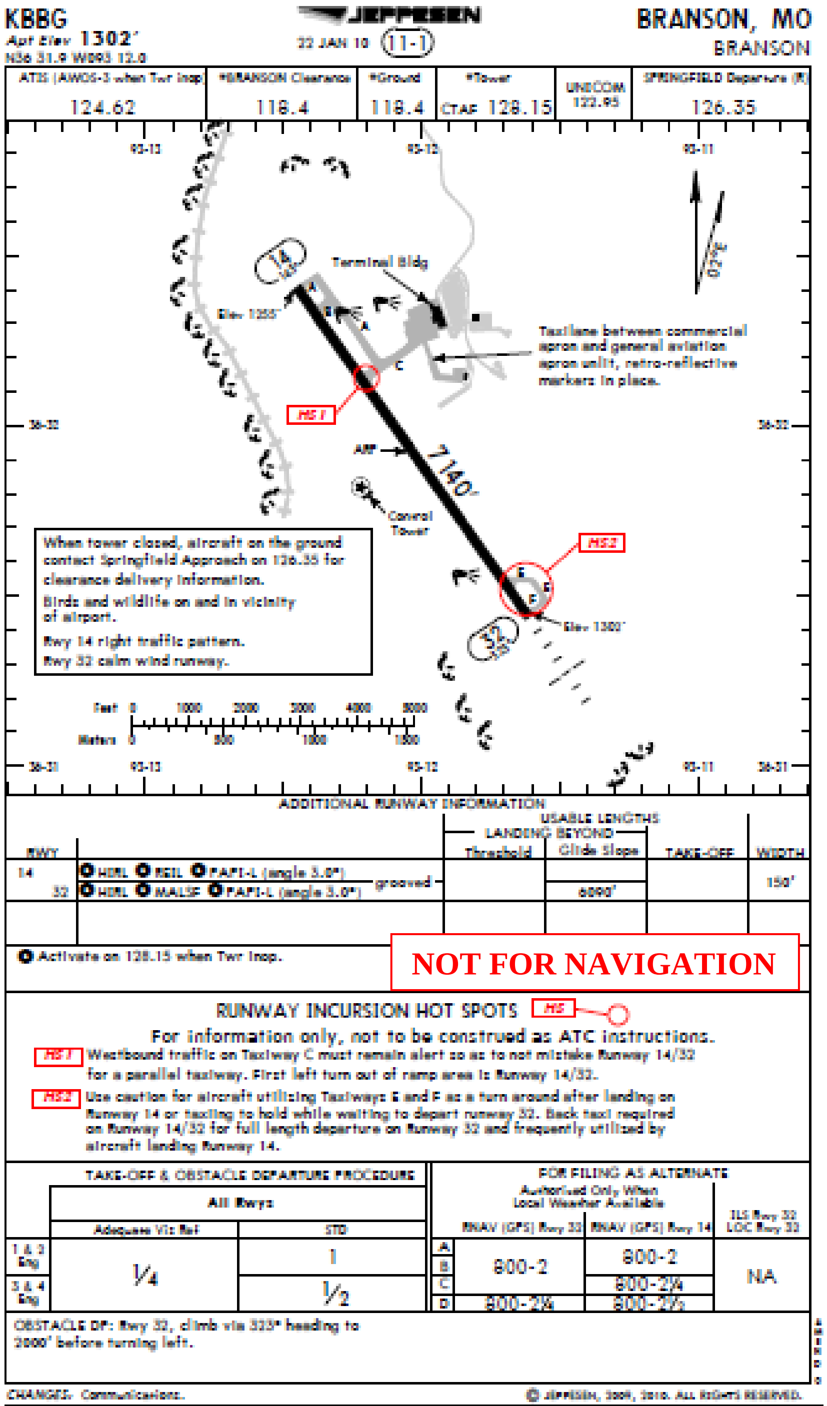

Figure 3: KBBG Airport Chart.

[44] See Attachment 9 – Charts.

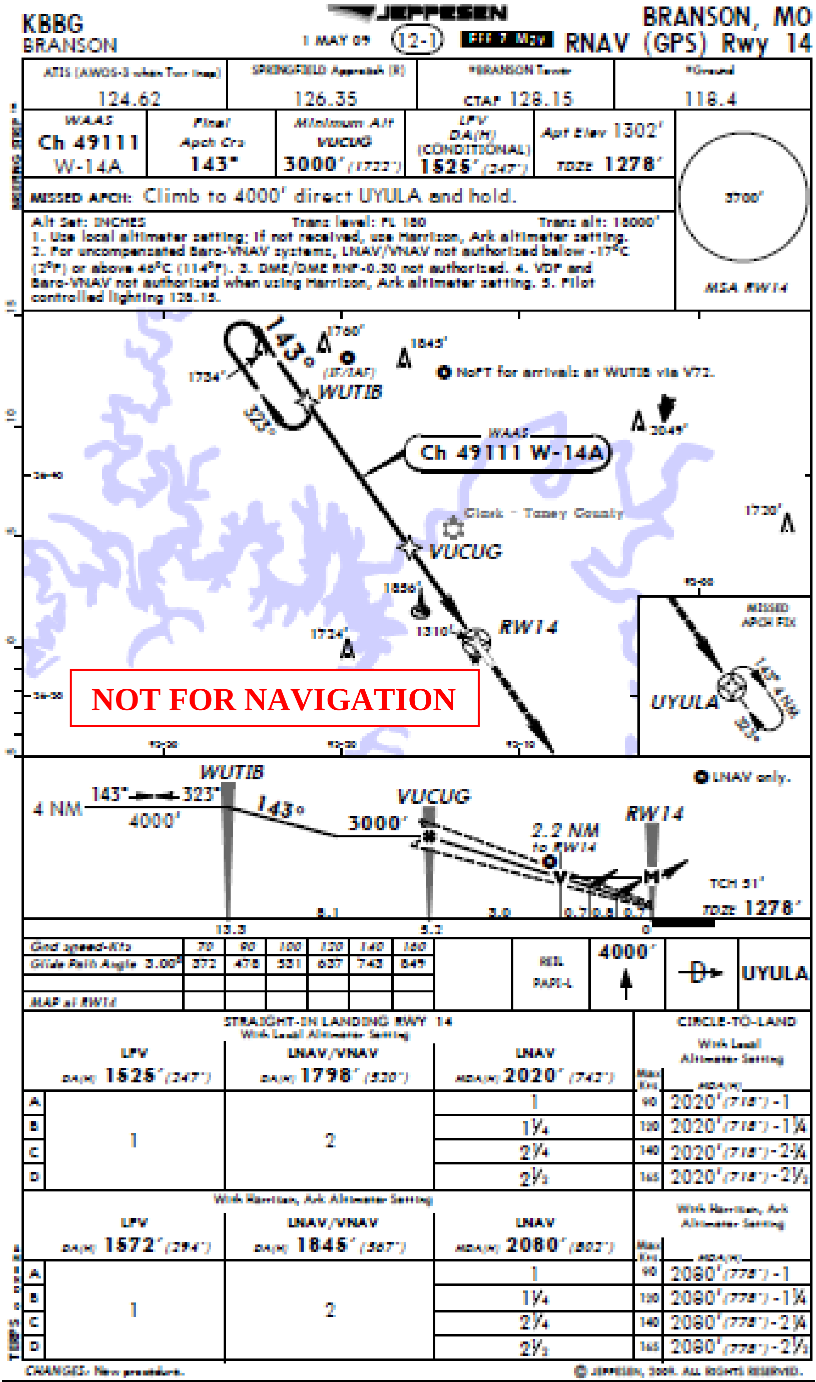

Figure 4: KBBG RNAV14 Approach Chart.

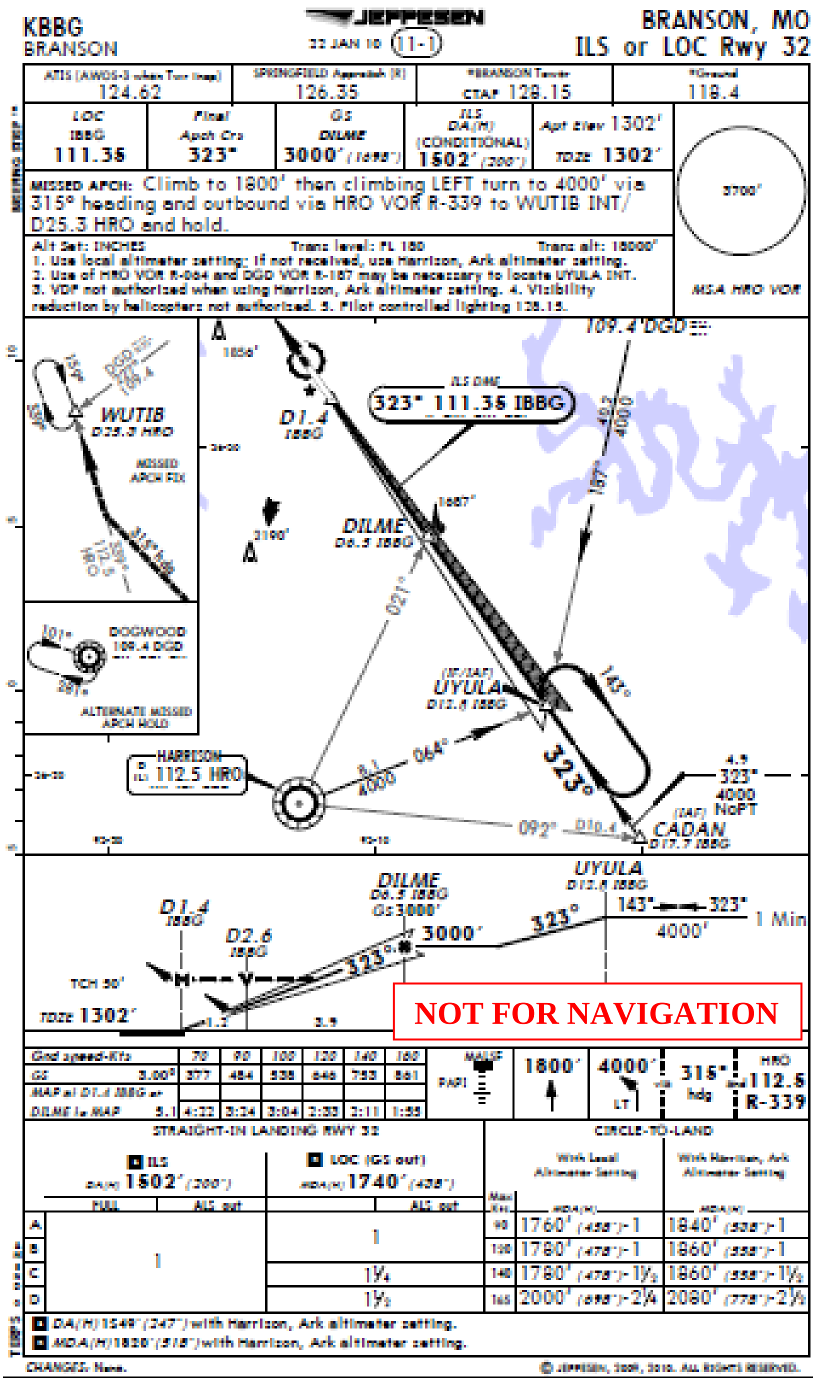

Figure 5: KBBG ILS32 Approach Chart.

11.2 M. Graham Clark Downtown Airport (KPLK)

M. Graham Clark Downtown Airport was located 1 mile south of Branson, Missouri at a field elevation of 940 feet msl (mean sea level), and at a latitude/longitude of N36º37.56´/W93º13.74´.

The airport did not have an ATC control tower. The airport was owned by Taney County, and had limited FBO[45] services at the airport.

11.2.1 KPLK Runway Information

KPLK had a single runway 12/30 that was 3,738 feet long and 100 feet wide, with an asphalt/grooved surface. The runway was dry at the time of the incident. Runway 30 had a 4-box VASI[46] on right side of the runway (3.00 degrees glide path). There was no VASI or visual guidance system for runway 12. Both runways had REIL lights and MIRL[47] runway lights that were pilot-controlled via the CTAF.[48] Runway 12 had a displaced threshold of 289 feet, and runway 30 had a displaced threshold of 310 feet. Runway 12 had an available landing distance of 3,449 feet. Neither runway had a safety/overrun area at the ends of the runways, and both runways had steep drop-offs and steep terrain gradients along the runway pavement edges.[49]

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[45] According to FAA AC 150/5190-7, Minimum Standards for Commercial Aeronautical Activities, a fixed-base operator (FBO) "is a commercial business granted the right by the airport sponsor to operate on an airport and provide aeronautical services such as fueling, hangaring, tie-down and parking, aircraft rental, aircraft maintenance, flight instruction, etc."

[46] According to the Aeronautical Information Manual (AIM), Section 2−1−2, "Visual Glideslope Indicators; Visual Approach Slope Indicator (VASI)," the VASI is a system of lights so arranged to provide visual descent guidance information during the approach to a runway. These lights are visible from 3−5 miles during the day and up to 20 miles or more at night. The visual glide path of the VASI provides safe obstruction clearance within plus or minus 10 degrees of the extended runway centerline and to 4 NM from the runway threshold. Descent, using the VASI, should not be initiated until the aircraft is visually aligned with the runway. Lateral course guidance is provided by the runway or runway lights.

[47] Medium Intensity Runway Lights (MIRL).

[48] According to the AIM, page 4-1-2, "A CTAF is a frequency designated for the purpose of carrying out airport advisory practices while operating to or from an airport without an operating control tower. The CTAF may be a UNICOM, MULTICOM, FSS, or tower frequency and is identified in appropriate aeronautical publications . . . Pilots of inbound traffic should monitor and communicate as appropriate on the designated CTAF from 10 miles to landing. Pilots of departing aircraft should monitor/communicate on the appropriate frequency from start-up, during taxi, and until 10 miles from the airport unless the CFRs or local procedures require otherwise."

[49] Source: http://www.airnav.com/airport/KPLK.

11.2.2 KPLK Charts[50]

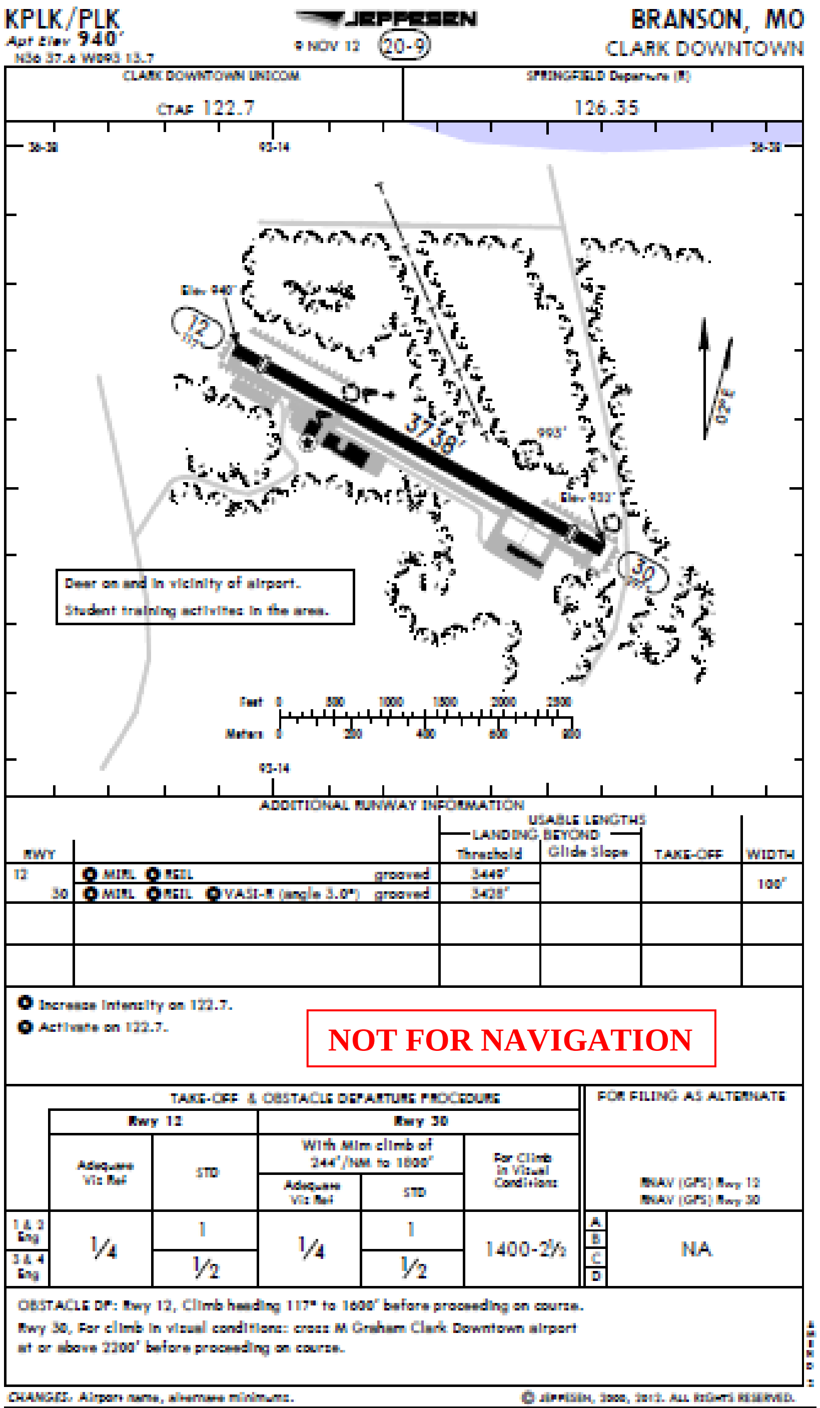

Figure 6: KPLK Airport Chart

[50] See Attachment 9 – Charts.

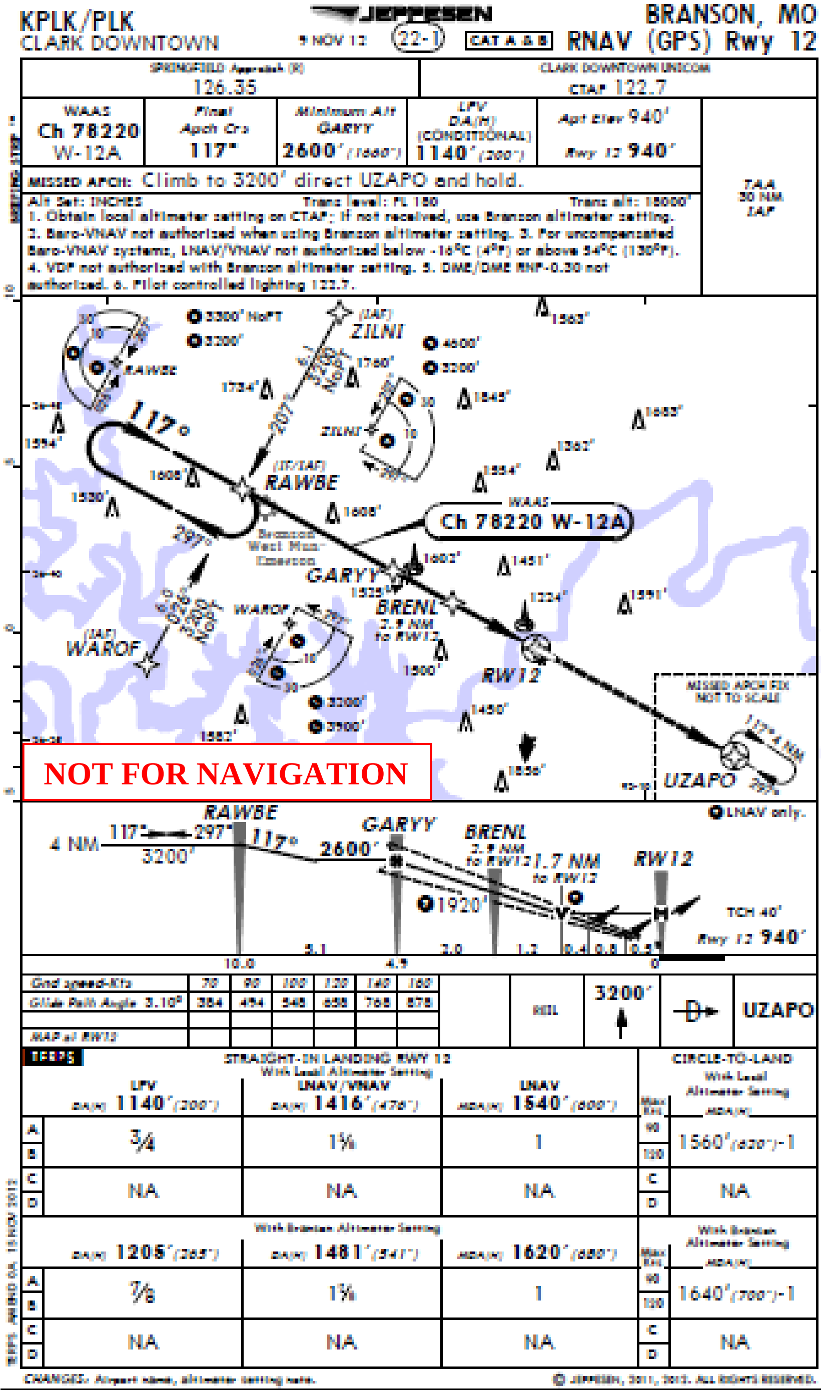

Figure 7: KPLK RNAV12 Approach Chart

11.3 Southwest Airlines Branson Airport Smartpack

Southwest Airlines began service into Branson Airport on March 9, 2013. The Southwest Airlines Safety department provided Southwest pilots with a Smart Pack that provided general information about the airport, departure and arrival information, and select ASRS[51] reports.

Information in the Branson Airport Smart Pack contained the following information in the "Need to Know" section:

> *Do not confuse Branson Airport (KBBG) with Springfield-Branson Natl Airport (KSGF), which is approximately 45 nm north of KBBG.*

The captain told NTSB Staff he did have a copy of the Branson Smart Pack, and had gotten a number of packs for new airports and had them in a stack in his bedroom on his valet stand. He did review the Branson Smartpack "some time ago," but he did not have it in his flight bag on the night of the incident. The FO remembered getting the Smartpack for Branson, and said there was nothing in it about the airport they landed at.

There was no guidance contained in the SmartPack regarding KPLK. The SmartPack was not a required briefing item as defined by the Southwest Airlines FOM or AOM.

12.0 Company Overview[52]

Southwest Airlines Co. (the "Company") operated Southwest Airlines ("Southwest") and AirTran Airways ("AirTran"), major passenger airlines that provided scheduled air transportation in the United States and "near-international markets."

According to the Southwest Airlines Operating Manual (SWOM) Section 2.1 "Authorized Operations," Southwest Airlines Co. was authorized to conduct operations in accordance with FAA-approved Operation Specification, certificate number SWAA304A. The following items document the operations Southwest Airlines is authorized to conduct:

- Southwest Airlines OpSpecs
- Southwest Airlines Operations Manual
- FAA-approved manuals and programs
- FAA-accepted manuals and programs
- Southwest Airlines and AirTran Airways Bridging Manual

Southwest was based in Dallas, Texas, and commenced service on June 18, 1971, with three Boeing 737 aircraft serving three Texas cities: Dallas, Houston, and San Antonio. Including the operations of both Southwest and AirTran, the Company ended 2013 serving 96 destinations in 41 states, the District of Columbia, the Commonwealth of Puerto Rico, and five near-international countries including Mexico (Cancun, Mexico City, and Cabo San Lucas), Jamaica

[51] Aviation Safety Reporting System. The ASRS collects, analyzes, and responds to voluntarily submitted aviation safety incident reports in order to lessen the likelihood of aviation accidents (see http://asrs.arc.nasa.gov/overview/summary.html).
[52] Source: SWA 2013 Annual Report. Also, see Attachment 10 – SWA Flight Ops Org Chart.

(Montego Bay), The Bahamas (Nassau), Aruba (Oranjestad), and Dominican Republic (Punta Cana). As of December 31, 2013, Southwest's and AirTran's combined active fleet consisted of 680 aircraft, including 614 Boeing 737s and 66 Boeing 717s. The Company competed the connection of the Southwest and AirTran networks in 2013.

In 2013, Southwest added service to two new states (Maine and Kansas) and ten new U.S. cities: Branson, Missouri; Charlotte, North Carolina; Flint, Michigan; Rochester, New York; Portland, Maine; Wichita, Kansas; Grand Rapids, Michigan; Memphis, Tennessee; Pensacola, Florida; and Richmond, Virginia. The addition of the new Southwest service established a Southwest presence in all domestic cities in Southwest's and AirTran's combined network. In 2013, Southwest also commenced service to San Juan, Puerto Rico, Southwest's first scheduled service outside of the continental United States. As part of its network optimization efforts, the Company has announced its plans to cease Southwest operations in Branson, Missouri; Key West, Florida; and Jackson, Mississippi beginning in June 2014. Based on the most recent data available from the U.S. Department of Transportation, as of September 30, 2013, Southwest was the largest domestic air carrier in the United States, as measured by the number of domestic originating passengers boarded.

While AirTran continues to service certain domestic cities and all of the Company's international markets, the Company announced plans to convert AirTran's remaining domestic and international service into Southwest service by the end of 2014.

13.0 Manuals and Guidance Material

In accordance with 14 CFR Part 121.141, Southwest Airlines was required to keep current an approved airplane flight manual for each type of airplane that it operates. The Aircraft Operating Manual (AOM) and Quick Reference Handbook contained the information required by the applicable Aircraft Flight Manual (AFM), and that information was identified as flight manual requirements.

The Director Central Publications, the Central Publications Flight Operations Manager, and the Dispatch Specialist subscribed to AFM changes from Boeing. The Dispatch Specialist would forward this information to the Chief Technical Pilot.

Manuals required to be onboard the aircraft were specified in the FOM and AOM. Additionally, the Onboard Performance Computer (OPC) contained an electronic copy of the Minimum Equipment List, Configuration Deviation List and Nonessential Equipment & Furnishings List. If the OPC was inoperative, that information was provided separately.

Manuals used by Southwest pilots included the following.[53]

- Flight Reference Manual (FRM)—The FRM contained aircraft system information. The three FRMs were the FRM General Information, the FRM B737-300/-500, and the FRM B737-700/-800. Unless otherwise specified, the term FRM referred to all three books.

[53] Source: Southwest Airlines Flight Operations Manual (FOM), Section 1.1 "Manual Overview."

• Flight Operations Manual (FOM)—The FOM contained Southwest Airlines philosophies, broad policy guidance, and procedures that applied across all aircraft in the Southwest Airlines fleet.

• B737 Aircraft Operating Manual (B737 AOM)—The B737 AOM contained policies and procedures that were specific to the operation of an aircraft type.

• Operations Binder—The Operations Binder contained Flight Operations bulletins, sensitive security information, common strategy information, communication, airport access information, Jeppesen interim revisions, and other information that may change frequently.

• Quick Reference Handbook (QRH)—The QRH contained non-normal procedures and maneuvers for a specific type aircraft. The QRH also contained FMC messages, system schematics, and in-flight performance charts.

• Minimum Equipment List/Configuration Deviation List (MEL/CDL)—The MEL/CDL was a list of aircraft equipment that may be inoperative for a period of time and was intended to permit operation until repairs can be accomplished.

• Flight Deck Cards—Flight deck cards included Normal Checklists, Deice/Anti-Ice Procedures Cards, Winter Operations Reference Cards, Reference Cards, RNAV Approach Reference Cards, and Flight Deck Observer Briefing Cards.

The FOM, IFOM, B737 AOM, QRH, and MEL were approved by the FAA. As part of the Southwest Airlines Manual System (SWAMS), maintenance of those manuals was conducted in accordance with the applicable guidance outlined in the Southwest Airlines Operations Manual (SWOM) Chapter 4.

14.0 Relevant Systems

14.1 Electronic Flight Instrument System (EFIS)

The incident airplane was a B737-700 airplane, was equipped with an electronic flight instrumentation system (EFIS) with 6 flat panel liquid crystal displays including 2 Primary Flight Displays (PFD) and 2 Navigation Displays (ND), which provided flight and navigation information in a digital format.

Two EFIS control panels, located on the glare shield of the center main panel, control display options, mode, and range for the related Pilot's displays.

14.1.1 Primary Flight Display

According to the SWA Flight Reference Manual, Section 10.7 "Primary Flight Display (PFD)," the PFDs presented a dynamic color display of all the parameters necessary for flight path control. The displays provide the following information:

- Flight mode annunciation
- Airspeed
- Altitude
- Vertical speed
- Attitude
- Steering information
- Radio altitude
- Instrument landing system display
- Approach minimums
- Heading/track indications
- TCAS indications
- GPWS annunciations

Failure flags were displayed for aircraft system failures. Displayed information was blanked or replaced by dashes if no valid information was available to the display system (because of out-of-range or malfunctioning navigation aids). Failure flags were displayed when aircraft systems could not generate a reliable display.

14.1.2 Navigation Display

According to the Southwest Airlines Flight Reference Manual, Section 10.8 "PFD/ND Navigation Displays," the NDs provided a mode-selectable color flight progress display. The modes included the following:

- MAP
- VOR
- APP (approach)
- PLN (plan)

The MAP, VOR, and APP modes could be switched between an expanded mode with a partial compass rose and a center mode with a full compass rose.

14.1.2.1 MAP Mode

According to the Southwest Airlines Flight Reference Manual, Section 10.8.1 "Map Mode," the MAP mode was recommended for most phases of flight. This mode showed aircraft position relative to the route of flight against a moving map background. Displayed information could include:

- Current track
- Selected and current heading
- Position trend vector
- Range to selected altitude
- Map range scale
- Ground speed
- True airspeed
- Wind direction and speed

- Next waypoint distance
- Waypoint estimated time of arrival
- Selected navigation data points

According to the Southwest Airlines Flight Reference Manual, Section 10.8.1.1 "Navigation Data Points," additional navigation facility (STA), waypoint (WPT), airport (ARPT),[54] route progress (DATA), and position (POS) data were available for display on the ND in both the expanded and center MAP modes.

14.2 Heads-Up Guidance System (HGS)[55]

The captain of SWA4013 indicated he used the HGS system during the visual approach to the runway he believed was runway 14 at KBBG. A single Rockwell Collins Head-Up Guidance System (HGS) was installed on Southwest Airlines B737-700 aircraft on the captain's side. HGS Models 4000 and 2350 were installed on B737-700s. The HGS was an electronic and optical system with unique features for displaying information in the pilot's forward field of view. The display was focused at optical infinity with flight and navigational data displayed to overlay the outside world.

The system was FAA certified for all phases of flight and met the requirements for low visibility takeoffs and manual Category I, II, and III approaches and landings. Symbology was optimized for full flight regime use and included the application of inertial flight path and flight path acceleration. Guidance commands were provided by the HGS for low visibility takeoffs and CAT III approaches, landings, and rollouts (HGS 4000). During other operations, the Boeing 737 Digital Flight Control System (DFCS) commanded the display.

According to the Southwest Airlines Flight Reference Manual, the system's unique head-up view of symbology and integration with other aircraft systems allowed for manual aircraft control while enhancing situational awareness, energy management, and the potential to avoid diversions due to weather-related airport capacity controls.

14.2.1 Head-Up Display System Description

According to the Southwest Flight Reference Manual, Section 10.6 "Head-up Display System Descriptions," the Head-Up Display (HUD) system used electronics and optics to calculate and display flight information. The flight information is displayed as flight symbols which project on to a transparent glass screen in front of the Pilot. The flight symbols overlayed and combined with the outside view through window No. 1 (that incident airplane had a single HUD unit located on the captain's side). The HUD system could be used during manual flight operations, or with the AFDS[56] engaged during automatic flight operations. When used manually, internal

[54] EFIS Control Panel - ARPT (airport) – displayed all airports which were stored in the FMC database and which are within the viewable MAP area. (FRM page 10-63) Airports were displayed if the EFIS control panel ARPT map switch is selected on. Origin and destination airports were always displayed, regardless of map switch selection.
[55] Source: SWA Flight Reference Manual, Section 7.0 and 10.2. Note: HGS® is a registered trademark of Rockwell Collins.
[56] Autopilot Flight Director System.

HUD guidance was used to control flight symbology and was independent of any AFDS derived or displayed flight director guidance.

HUD system components, combined with other aircraft systems, produced flight symbology displayed in four distinct modes of operation. Each mode of operation has unique characteristics, and is intended to be used during a particular phase of flight based on system capability and meteorological conditions. TCAS[57] resolution advisories and system failure flags were also displayed when active. Detailed information on display symbology was found in in the Flight Reference Manual, Section 10.9 "Head-Up Display System, Symbology."

The HUD system consisted of the following components:

- HUD computer
- Overhead unit (OHU)
- Combiner
- Control panel
- Annunciator panel
- Drive electronics unit

14.2.1.1 HUD Components[58]

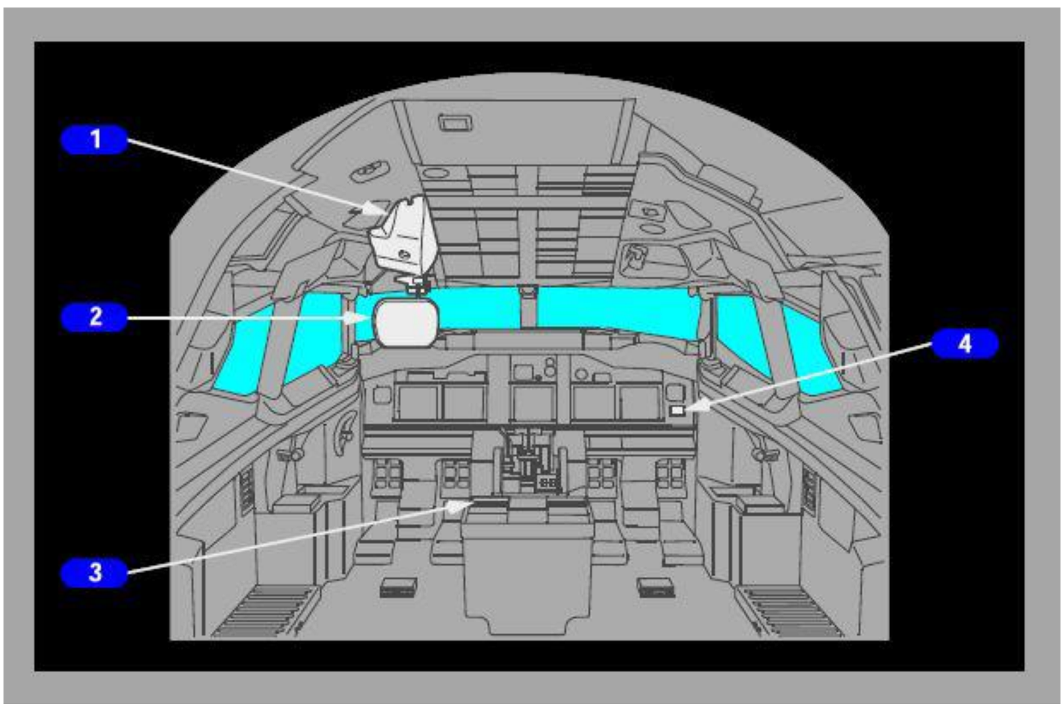

Figure 8: B737-700 Head-Up Display System.

1 Overhead Unit

Contains the CRT and projection optics to display the symbolic image on the combiner.

---

[57] Traffic Collision Avoidance System.

[58] Source: Southwest Airlines Flight Reference Manual, Section 10.2.1 "System Components."

2 **Combiner**
Combines displayed flight symbology with the Pilot's view through window No. 1.

3 **Control Panel**
Used for data entry and to select modes of operation.

4 **Annunciator**
Provides system status and warning annunciations during a CAT III approach.

14.2.1.2 Combiner

According the Southwest Airlines Flight Reference Manual, Section 10.6.1.4 "Combiner," the combiner optically combined flight symbology from the OHU with the pilot's view through window No.1. It acted as a wavelength selective mirror, reflecting only the flight symbology color (green) and lets other colors pass through.

The combiner alignment detector monitored the angular position of the combiner. The HUD computer used the detector to verify correct combiner position for normal viewing. If the combiner was not in the correct position, and the HUD was in the IMC or VMC modes, the ALIGN HUD message appeared on the combiner. The combiner glass element had a break away safety feature which allowed the element to rotate forward from the normal position, in case of abnormal deceleration.

14.2.1.3 Control Panel

According to the Southwest Airlines Flight Reference Manual, Section 10.6.1.5 "Control Panel," the HUD control panel was used to select and display modes of operation and enter data. Display intensity was controlled by panel switches or by an ambient light sensor located on the upper left corner of the panel.

The HUD control panel controlled modes of operation, display values, and system test and status information. The Southwest Airlines Flight Reference Manual, Section 10.4.1 "Head-Up Display Control Panel Controls – Flight Instrument Displays," stated the following:

> *Mode/Function Keys Push – selects mode or allows data entry:*
>
> - *MODE – selects desired mode from available modes on the standby display line.*
> - *STBY – selects standby mode.*
> - *RWY – used to enter runway length and elevation or to toggle between entered values. Select once to enter runway length, select again to enter runway elevation. Use the DIM "-" (minus) key to enter negative values.*
> - *G/S – used to enter the glideslope angle for the landing runway.*
>
> *Note: Values entered using the mode/function keys are stored in the HUD computer. If a power interruption should occur, the last mode and value will be displayed once power is restored.*

14.2.1.4 HUD Control Panel Components[59]

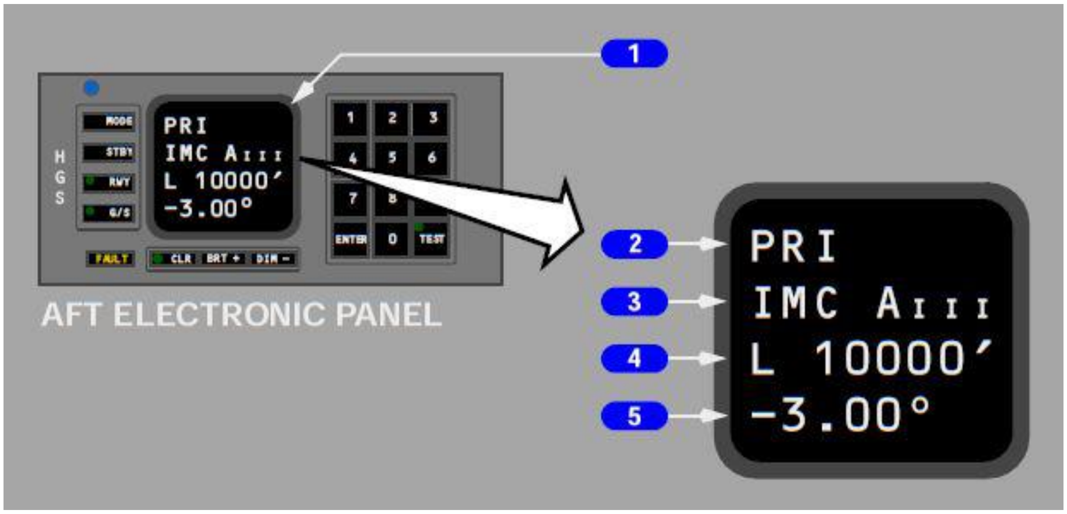

Figure 9: HUD Control Panel

1 Control Panel Display Window
Displays selected modes, entered values, system test, and system status.

2 Mode Display Line
Displays current mode:
- PRI – primary flight mode
- AIII – Cat III approach mode
- IMC – instrument meteorological conditions approach mode
- VMC – visual meteorological conditions approach mode
- NO AIII – AIII capability lost
- CLR – combiner display cleared

3 Standby Mode Display Line
Displays standby mode:
- PRI – primary flight mode
- AIII – Cat III approach mode
- IMC – instrument meteorological conditions approach
- VMC – visual meteorological conditions approach

4 Runway Length/Elevation Line
Displays runway length or elevation:
- L XXXXX – valid entry is 0 to 99,999 ft, however, entries between 7,500 and 13,500 ft are required to display ground
roll guidance for low visibility takeoff operations.
- E XXXXX – valid entry is -9,999 to 99,999 ft.

[59] Source: Southwest Airlines Flight Reference Manual, Section 10.6.1.5 "Control Panel."

5 **Reference Glideslope Line**
Displays runway glideslope:

- Valid entry is 0.00° to -9.99°.
- Entered values are required to be between -2.51° and -3.00° for AIII approach operations.

14.3 HUD "VMC" Mode

According to the Southwest Airlines Flight Reference Manual, 10.6.2.5 "VMC Mode," the VMC mode was intended for visual approach operations. No flight director or HUD guidance is displayed. The flight path vector was used to control the approach to the runway.

Approach symbology format for the VMC mode was similar to the AIII and IMC modes. However, according to the Flight Reference Manual, navigation data was not displayed in the HUD when in the VMC mode.[60] The proper mechanical alignment of the combiner was critical during visual operations. Combiner position was monitored by the combiner alignment detector, to determine if the combiner was within allowable position tolerances while in the IMC or VMC mode. If its position was out of tolerance, an ALIGN HUD message was displayed on the combiner. Elimination of the message was accomplished by gently pushing the combiner in the breakaway direction and releasing. This allowed the combiner to reposition itself. If the message could not be removed, the IMC or VMC mode was not to be used.

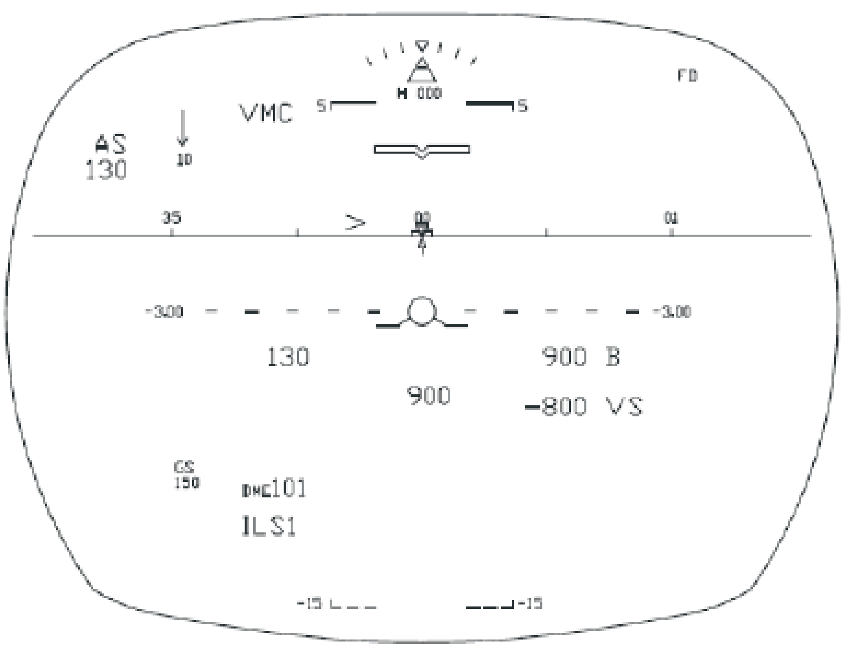

Figure 10: HUD "VMC" Mode.[61]

[60] Source: Southwest Airlines Flight Reference Manual, 10.6.2.5 "VMC Mode."
[61] Source: Southwest Airline Flight Reference Manual, Section 7.3.6 "VMC Approach Mode Symbology."

14.3.1 HGS Use During Visual or Circling Maneuvers

According to the Southwest Airlines B737 AOM, Section 11.1.3 “HGS Use During Visual or Circling Maneuvers Alignment,” alignment with the landing runway was normally accomplished by visually acquiring the runway and maneuvering the aircraft by primarily using outside references. The pilot would adjust the descent rate to place the 3° reference line over the point of intended touchdown. Then, the pilot would adjust aircraft pitch to place the flight path symbol over the intended touchdown point, resulting in an approximate 3° glidepath.

If the Pilot reverted to purely visual references, the HGS display could be blanked by pushing the CLR button on the HCP panel.

As previously mentioned, accoording to the Flight Reference Manual, navigation data was not displayed in the HUD when it was in the VMC mode.

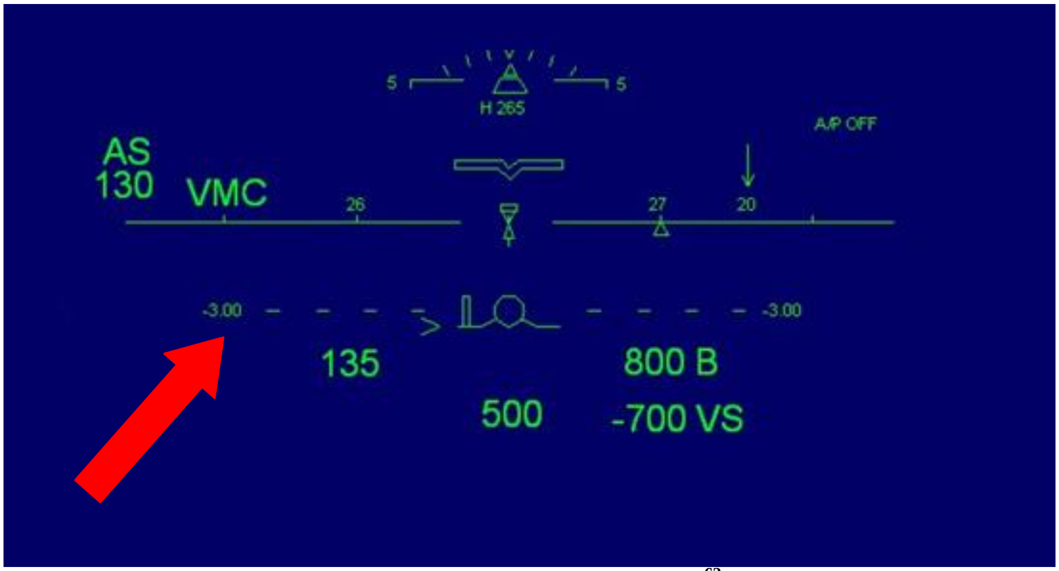

Figure 11: VMC Mode with 3.00 degree dashed reference line[62]

14.4 Flight Management System[63]

The flight management system (FMS) aided the pilots in managing automatic navigation, in-flight performance optimization, fuel monitoring, and flight deck displays. Automatic flight functions managed the aircraft lateral flight path (LNAV) and vertical flight path (VNAV). The displays included a map for aircraft orientation and command markers (bugs) on the airspeed and N1 indicators to assist in flying profiles. The Flight Deck Crew entered the desired route and flight data into the MCDUs. The FMS then used its navigation database, aircraft position, and supporting system data to calculate commands for manual or automatic flight path control. The FMS could automatically tune the navigation radios and determine LNAV courses. The FMS navigation database provided the necessary data to fly routes, SIDs, STARs, holding patterns,

[62] Source: Southwest Airlines.
[63] Source: Southwest Airlines Flight Reference Manual, Section 11.3.2 Flight Management Computer (FMC).

and procedure turns. Lateral offsets from the programmed route could also be calculated and commanded.

The flight management system (FMS) was comprised of the following components:

- Flight management computer system (FMCS)
- Autopilot/flight director system (AFDS)
- Autothrottle (A/T)
- Inertial reference systems (IRS)
- Global positioning system (GPS)

Each of these components was an independent system, and each could be used independently or in various combinations. The term FMS referred to the concept of joining these independent components together into one integrated system which provided continuous automatic navigation, guidance, and performance management.

The integrated FMS provided centralized flight deck control of the aircraft's flight path and performance parameters. The flight management computer, or FMC, performed navigational and performance computations and providing control and guidance commands.

The primary flight deck controls were the AFDS MCP, two multi-purpose control display units (MCDUs), two electronic flight instrument system (EFIS) control panels, and an FMC source selector switch. The primary displays were the MCDUs, outboard display units, inboard display units, and upper display unit.

The FMC used pilot entered flight plan information, aircraft systems data, and data from the FMC navigation database and performance database to calculate aircraft present position, and pitch, roll, and thrust commands required to fly an optimum flight profile. The FMC sent these commands to the autothrottle, autopilot, and flight director. Map and route information were sent to the respective pilot's navigation displays. The EFIS control panels were used to select the desired information for navigation display. The mode control panel was used to select the autothrottle, autopilot, and flight director operating modes.

14.4.1 Flight Management Computer (FMC)

The basis of the flight management system was the flight management computer. The FMC used pilot-entered flight plan information, aircraft systems data, and data from the FMC navigation database to calculate aircraft present position, and pitch, roll, and thrust commands required to fly an optimum flight profile. The FMC sent these commands to the autothrottle, autopilot, and flight director. Map and route information were sent to display units (DU). The EFIS control panels were used to select the desired information for the navigation displays. The mode control panel was used to select the autothrottle, autopilot, and flight director operating modes.

The FMC and MCDU were used for en route and terminal area navigation, RNAV approaches, and to supplement primary navigation means when conducting all types of instrument approaches.

The dual FMC installation was certified as a "sole source" navigation system. Airplanes equipped with two FMCs were certified to operate outside radio navaid coverage. The second FMC served as a backup, providing complete navigational functions if the other FMC failed.

14.4.2 Multi-Purpose Control Display Units (MCDUs)

According to the Southwest Airlines Flight Reference Manual, Section 11.3.3 "Multi-purpose Control Display Units," the B737 had two identical, independent MCDUs to provide the means for the pilots to communicate with the FMC. The crew may enter data into the FMC using either MCDU, although simultaneous entries should be avoided. The same FMC data and computations were available on both MCDUs; however, each pilot had control over what was displayed on an individual MCDU.

14.5 Thrust Reversers[64]

Each engine was equipped with a hydraulically-operated thrust reverser, consisting of left and right translating sleeves. Aft movement of the reverser sleeves caused blocker doors to deflect fan discharge air forward, through fixed cascade vanes, producing reverse thrust. The thrust reverser was for ground operations only and was used after touchdown to slow the aircraft, reducing stopping distance and brake wear.

When either reverser sleeve moved from the stowed position, the amber REV indication, located on the upper display unit, illuminated. As the thrust reverser reached the deployed position, the REV indication illuminates green and the reverse thrust lever could be raised to detent No. 2. This position provided adequate reverse thrust for normal operations.

When necessary, the reverse thrust lever could be pulled beyond detent No. 2, providing maximum reverse thrust. Downward motion of the reverse thrust lever past detent No. 1 (reverse idle thrust) initiated the command to stow the reverser.

14.5.1 Thrust Reverser Indications[65]

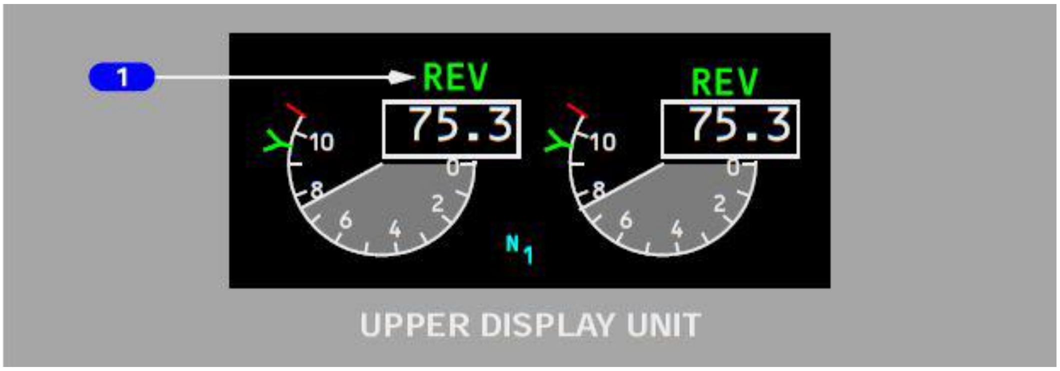

Figure 12: Thrust Reverser Indications

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[64] Source: Southwest Airlines Flight Reference Manual, Section 7.3.7 "Thrust Reversers".
[65] Source: Southwest Airlines Flight Reference manual, Section Figure 7.4 "Thrust Reverser Indications."

1 Thrust Reverser (REV) Indications
Displayed (amber) – thrust reverser is moved from stowed position.
Displayed (green) – thrust reverser is deployed.

14.6 Brake System[66]

Each main gear wheel had a multi-disc hydraulic powered brake. The brake pedals provided independent control of the left and right brakes. The nose wheels had no brakes. The brake system included the following:

- Normal brake system
- Alternate brake system
- Brake accumulator
- Antiskid protection
- Autobrake system
- Parking brake

According to the captain's interview with NTSB Staff, after landing at KPLK, he applied maximum braking as they approached the end of the runway. The Southwest Airlines B737 AOM contained the following note:

> *NOTE: Anytime the ability to stop on the remaining runway becomes a concern, maximum deceleration may be achieved by immediately applying maximum manual braking and maximum reverse thrust.*[67]

14.6.1 Antiskid Protection[68]

Antiskid protection was provided in the normal and alternate brake systems. The normal brake hydraulic system provided each main gear wheel with individual antiskid protection. When the system detected a skid, the associated antiskid valve reduced brake pressure until skidding stopped. The alternate brake hydraulic system worked similar to the normal system, however antiskid protection was applied to main gear wheel pairs instead of individual wheels. Both normal and alternate brake systems provided skid, locked wheel, touchdown and hydroplane protection. Antiskid protection was available even with loss of both hydraulic systems.

14.6.2 Autobrake System[69]

The crew of SWA4013 indicated that they selected autobrakes "3" for their landing. The autobrake system used hydraulic system B pressure to provide maximum deceleration for rejected takeoff and automatic braking at preselected deceleration rates immediately after

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[66] Source: Southwest Airlines Flight Reference Manual, Section 14.2.4 "Brake System."
[67] Southwest Airlines B737 AOM, page 12-6.
[68] Source: Southwest Airlines Flight Reference Manual, Section14.2.4.4 "Antiskid Protection."
[69] Source: Southwest Airlines Flight Reference Manual, Section 14.2.4.5 "Autobrake System."

touchdown. The system operated only when the normal brake system was functioning. Antiskid system protection was provided during autobrake operation.

14.6.2.1 Autobrake System Schematic[70]

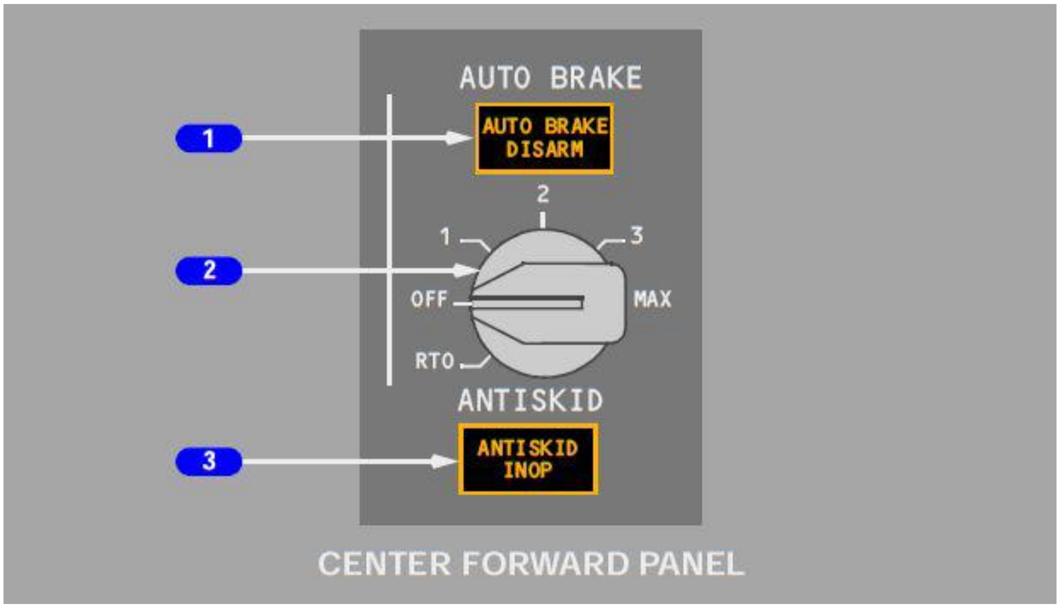

Figure 13: Autobrake System

1 AUTO BRAKE DISARM Light

Illuminated (amber) –

- SPEED BRAKE lever moved to down detent during RTO or landing.
- Manual brakes applied during RTO or landing.
- Thrust lever(s) advanced during RTO or landing.
  - Except during first 3 seconds after touchdown for landing
- Landing made with RTO selected.
- RTO mode selected on ground.
  - Illuminates for one to two seconds then extinguishes.
- A malfunction exists in automatic braking system. Extinguished –
- AUTO BRAKE select switch set to OFF.
- Autobrake armed.

2 AUTO BRAKE Select Switch

OFF – autobrake system deactivated.

- Selects desired deceleration rate for landing.
- Switch must be pulled out to select MAX deceleration.

1, 2, 3, or MAX –

RTO – automatically applies maximum brake pressure when thrust levers are retarded to idle at or above 90 kt.

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[70] Source: Southwest Airlines Flight Reference Manual, Section 14.1.4 "Autobrake and Antiskid Controls."

3 **Antiskid Inoperative (ANTISKID INOP) Light**
Illuminated (amber) – a system fault is detected by antiskid monitoring system. Extinguished – antiskid system operating normally.

15.0 Relevant Procedures

15.1 Approach Procedures

According to the Southwest Airlines B737 AOM, 11.1.1 "Approach Procedures and Restrictions—All Approaches," pilots were required to follow one of the following glidepath guidances when on final approach (if available):

- Electronic glideslope (ILS)
- Glidepath from an RNAV approach in the FMC navigation database
- Visual glideslope

15.2 Visual Approaches

The FO of SWA 4013, as PF, briefed a visual approach to runway 14 at KBBG, backed up by an RNAV approach. According to interviews with Southwest check airmen, pilots were taught to back up each visual approach with a charted instrument approach. The Southwest Airlines FOM (Section 11.2.1 "OpSpec Restrictions [OpSpec C077]) stated that visual approaches or charted visual approaches were authorized when all of the following conditions were met:

- The aircraft is in controlled airspace, or beneath the designated transition area.
- The aircraft is under the control of an ATC facility.
- VMC weather exists and the flight can remain in VMC.
- The aircraft is within 35 NM of the destination airport and has visual contact with the traffic to follow, the landmarks on the charted visual flight procedure, and/or the airport.

The Southwest Airlines AOM, Section 11.3.1 "Visual Approaches—Procedures and Considerations" stated the following, in part:

> *The visual approach is the most commonly flown approach. Plan to fly a visual approach whenever an instrument approach is not required.*

The Southwest Airlines B737 AOM, Section 11.3.2 "Visual Approach Profile" provided the following guidance for visual approaches:

> ***When ATC has issued a clearance for a visual approach.***
> *A visual approach is not an instrument approach procedure and has no missed approach segment. If available, reference an issued charted procedure contained in the NAV database to assist with lateral and vertical guidance to the correct runway. Maintain VMC throughout the approach. If a go around is necessary, remain clear of clouds and contact ATC for further clearance.*

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. When operating at an airport within Class D airspace, enter the traffic pattern at a minimum altitude of 1,500 ft above the elevation of the airport, unless otherwise required by distance to cloud criteria.

Configure as necessary to meet stabilized approach criteria.

(PF) Turn Base and descend, as necessary, to intercept a normal glidepath.
If a straight-in visual approach is planned, slow to flaps 15 maneuvering speed (150 kt) 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.

Continue to configure the aircraft for landing.

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:

At 1,000 ft Above TDZE:
(PF) ***"1,000 feet, airspeed ____, sink rate _____."***
If stabilized approach criteria are not met, initiate a go-around/missed approach.

(PM) Call, ***"1,000 feet."***
If stabilized approach criteria are not met, direct a go-around/missed approach.

On Final Approach:
(PF) Disengage the autopilot and autothrottle no lower than 50 ft AGL.

(PM) At 500 ft above 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 ft, call, ***"10."***

NOTE: *If the* ***"1,000 feet"*** *callout is missed, call the current altitude. For example, the call might be '900 feet.'*

15.2.1 Visual Approach Criteria

The Southwest Airlines FOM, Section 11.4.2 "Visibility At or Above 1000/3," stated:

The following criteria apply:

- *Either Pilot may fly the approach and land.*
- *Autopilot use is recommended but not required.*
- *Flight directors, if available, will be used.*
- *With weather at or above 1,000/3, brief and fly the portion of the published instrument approach that provides course guidance to visual approach conditions. For example, if an undercast cloud deck prevents flying a visual approach directly from the arrival, brief and fly the portions of the published instrument approach that will take the aircraft to visual approach conditions. Upon receiving ATC clearance for a visual approach, use visual approach procedures through landing or go around. Pilots may use any instrument approach to achieve visual conditions. The Captain may fly or monitor the approach on the HGS.*

15.2.2 Visual Approach Profile[71]

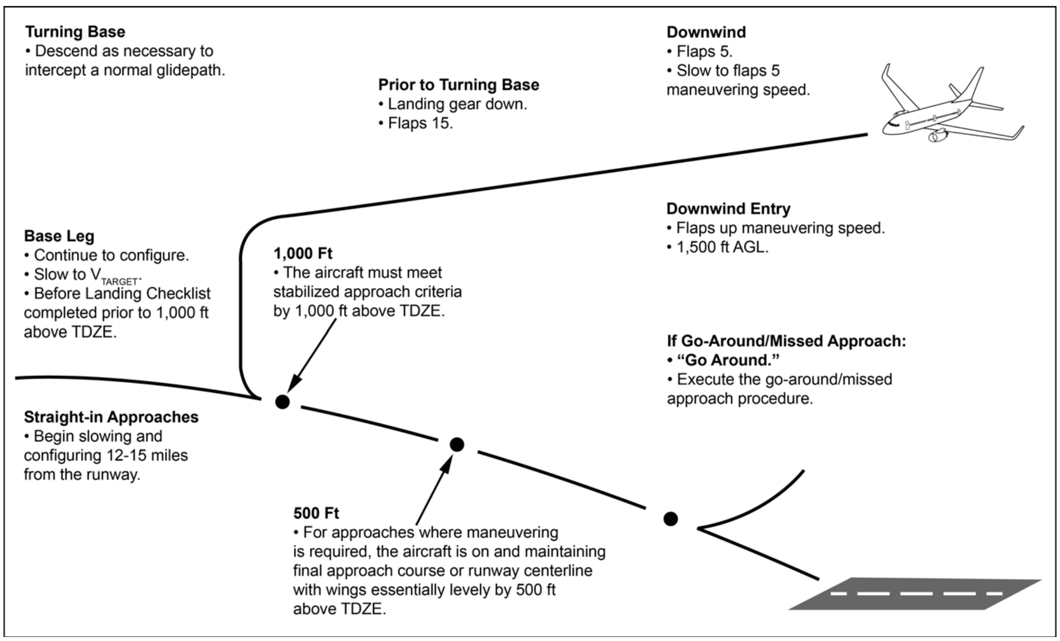

Figure 14: B737 Visual Approach Profile

15.3 RNAV approaches

Southwest Airlines was authorized to conduct RNAV approaches per Operations Specifications C052 "Straight-in Non-Precision, APV, and Category I Precision Approach and Landing Minima – All Airports."

According to the Southwest Airlines B737 AOM, Section 11.4.14 "Criteria Summary Table," use of the HUD was not required when conducting an RNAV approach.

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[71] B7378 AOM 11.3.2 Visual Approach Profile, page 11-10.

According the Southwest Airlines B737 AOM, Section 11.6.3 “RNAV (RNP) and RNAV (GPS) Approach Profile,” pilots were required to monitor the following pages, as appropriate, for situational awareness. One CDU was required to display the LEGS page, and the other CDU could display one of the following pages for situational awareness:

- DES page for flight path angle and vertical bearing to the next waypoint altitude constraint
- RNP PROGRESS page
- PROGRESS page
- FIX page

NOTE: Momentary display of other pages is acceptable.

The SWA B737 AOM, Section 19.5 “RNAV Approach Reference Cards” contained a briefing card for RNAV approaches available to pilots to ensure proper set-up and conduct of an RNAV approach. Use of the Approach Reference Card was not required.

15.3.1 RNAV Approach Profile

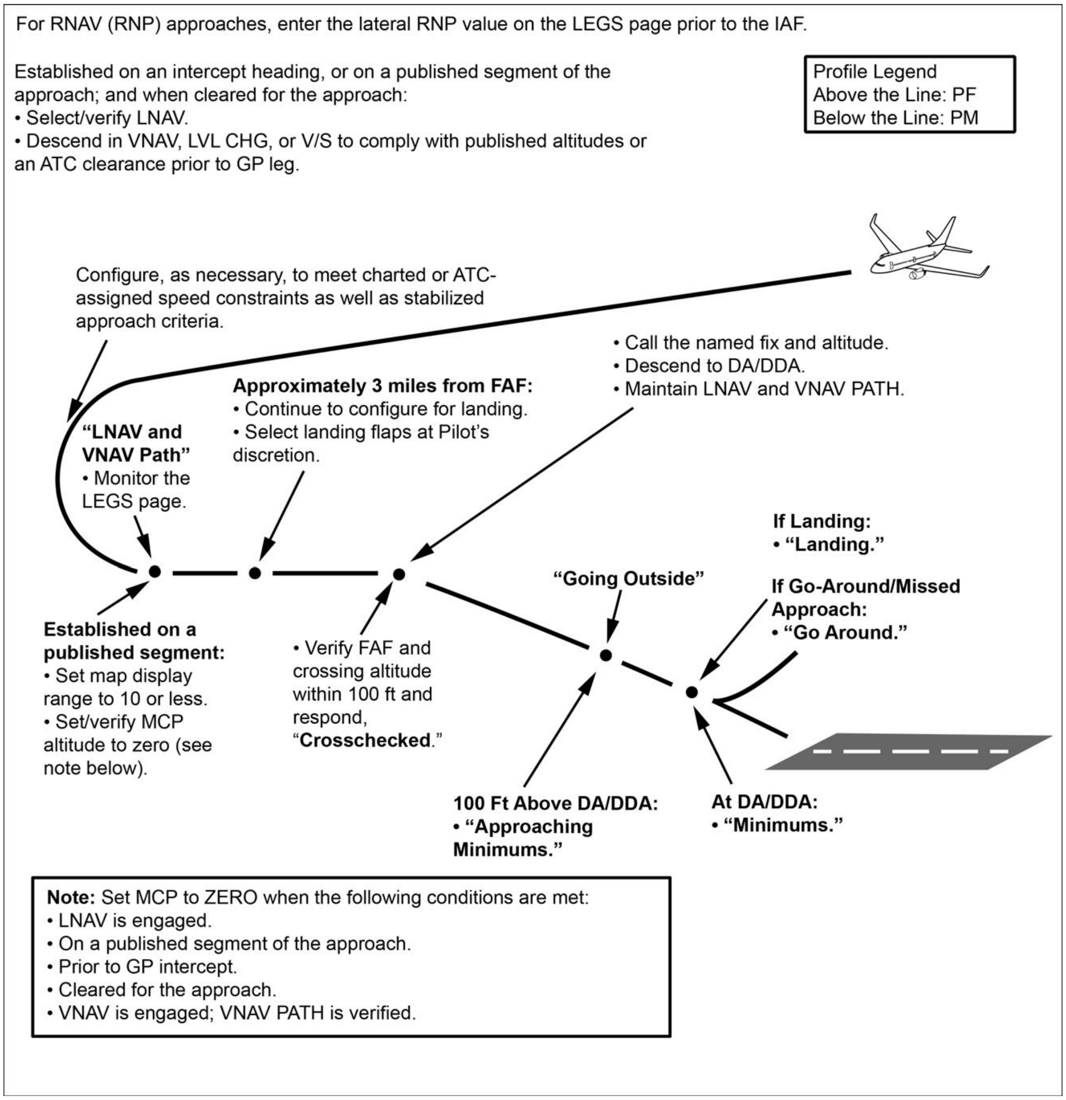


Figure 15: B737 RNAV Approach Profile

The Southwest Airlines B737 AOM, Section 4.6.1 "Monitoring Displays" included the following guidance:

> *Monitor the map display in the appropriate range. Set the minimum range sufficient to display the active waypoint and monitor path tracking. Monitor terrain/obstacles or weather radar.*
>
> *Monitor the LEGS page during RNAV operations. This does not restrict Pilots from momentarily selecting other CDU pages to maintain situational awareness. With a single operable CDU, monitor the appropriate page to maintain situational awareness.*

Monitor the Map and Navigation Performance Scales. Leave at least one CDU display on the LEGS page for situational awareness and to sufficiently monitor the RNAV departure or arrival route.

15.4 RNAV Visual Cues

11.3.2 Flight Management Computer (FMC): The FMC and MCDU are used for en route and terminal area navigation, RNAV approaches, and to supplement primary navigation means when conducting all types of instrument approaches.

15.4.1 Primary Flight Display/Navigation Displays

The Primary Flight Display and Navigation Display (PFD/ND) were electronic display formats for each pilot station. The PFD was normally displayed on the outboard Display Unit and consisted of primary flight information, such as a large ADI, airspeed tape, altitude tape, vertical speed, and heading arc. The ND was an electronic map format and is normally displayed on the inboard Display Unit. "ND" and "map" may be used interchangeably where the context is electronic flight deck displays.

15.4.1.1 PF and ND Displays: Cockpit Locations[72]

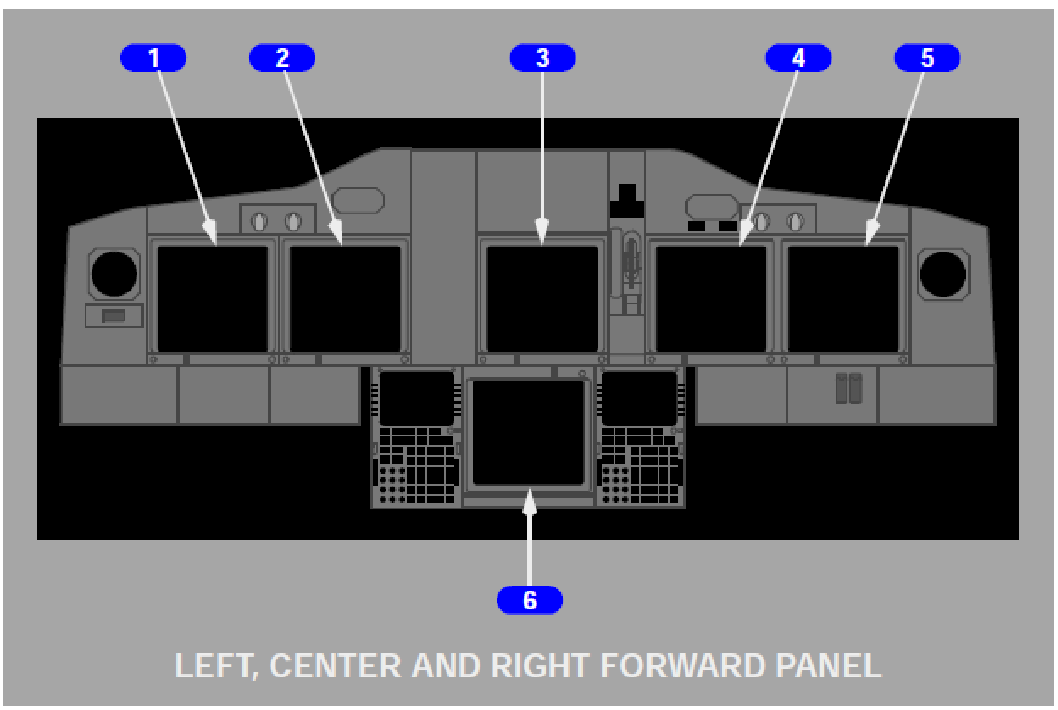


Figure 16: Cockpit Display Units.

1 Captain Outboard Display Unit
2 Captain Inboard Display Unit
3 Upper Display Unit

[72] Source: Southwest Airlines Flight Reference Manual Section 10.1.1 "PFD/ND Display System – Overview."

4 **First Officer Inboard Display Unit**
5 **First Officer Outboard Display**
6 **Unit Lower Display Unit**

15.4.2 PFD Visual Cues

There were multiple visual cues available to the crew of SWA4013 to determine their position relative to the briefed RNAV approach to KBBG by use of the PFD. Lateral and vertical deviation guidance was displayed on the PFD to determine the airplane's position relative to the extended centerline of runway 14 at Branson (via the LNAV course to the runway) and their relative position to the VNAV glideslope to runway 14 at Branson.

15.4.2.1 PFD Symbology[73]

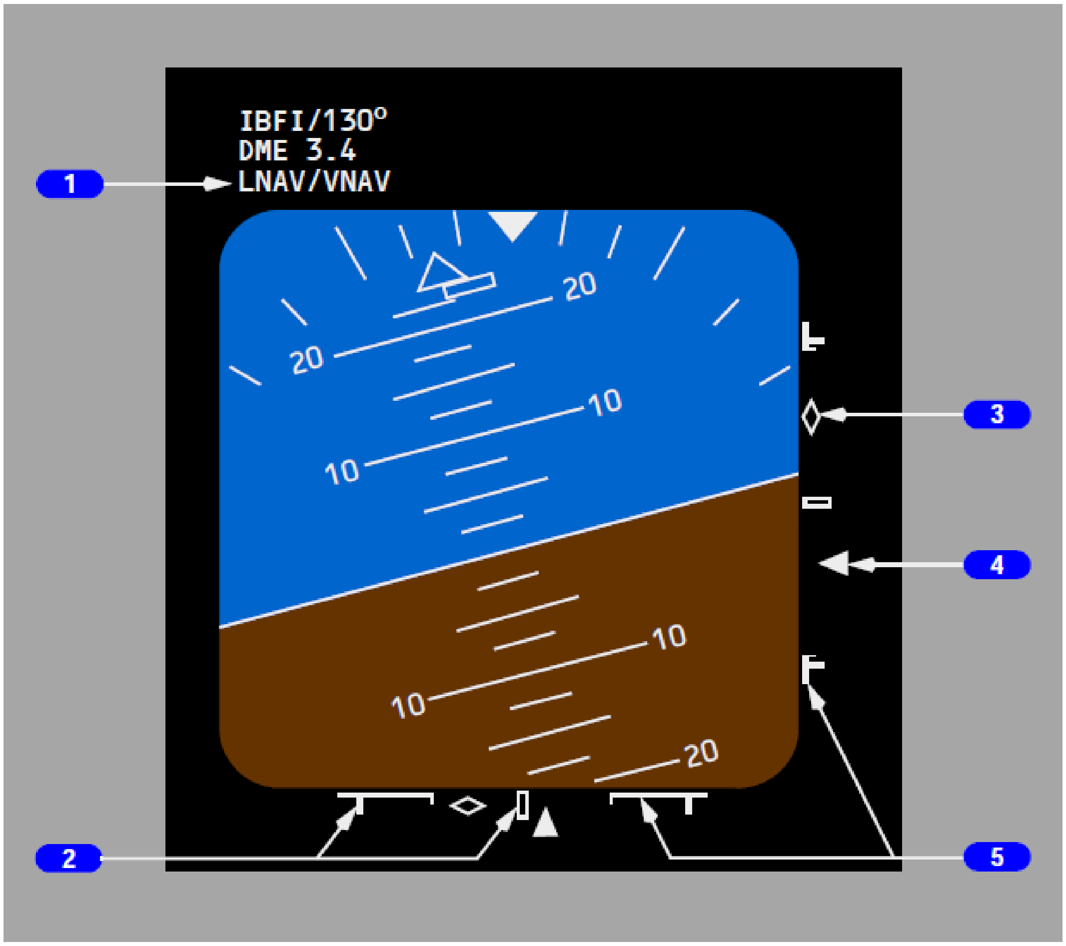


Figure 17: Primary Flight Display (PFD)

1 **Scale ID Annunciation (white)**

- Displayed above the left corner of ADI.
- Indicates the source of displayed deviation for each scale.

[73] Source: Southwest Airlines Flight Reference Manual, Section 10.1.3.2 "PFD Navigation Performance Scales (NPS) Indications"

● Displayed when LNAV, VNAV, HDG SEL, or TO/GA are engaged.
● Displayed when current aircraft position is laterally within 1NM or 2 x RNP of the flight plan route – will go out of
NPS if lateral limits exceeded.
● Possible annunciations include:
– LNAV/VNAV – (LNAV and VNAV deviations)
– LOC/VNAV – (ILS localizer course with VNAV deviation)
– LNAV/ G/S – (LNAV deviation with glideslope)
– LOC/ G/P – (ILS localizer course with FMC glidepath)
– ILS – (ILS approach)

2 NPS Deviation Scale
● Lateral NPS deviation scale represents current FMC lateral RNP.
● Vertical NPS deviation scale represents current FMC vertical RNP.
● Displayed if an approach mode is not engaged and either TO/GA, LNAV, or any VNAV mode is engaged.

3 Anticipation Cues
● Displayed if valid approach course deviation information is being received while corresponding NPS deviation scale and pointer are displayed.
● An unfilled white diamond symbol.
● If engaged, lateral mode subsequently transitions to LOC, lateral NPS deviation indications will be removed and normal ILS localizer indications will be displayed.
● If engaged, vertical mode subsequently transitions to G/S, vertical NPS deviation indications will be removed and normal ILS G/S indications will be displayed.

4 NPS Pointer
● A filled magenta symbol when it is not parked at deflection limit.
● An unfilled pointer outline when at deflection limit.
● Indicates lateral/vertical paths relative to the aircraft.
● Will flash for 10 seconds if deviation is within ANP bar limits for 10 continuous seconds.

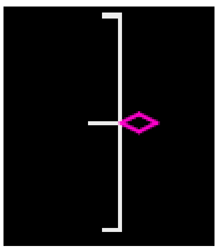
5 Actual Navigation Performance (ANP) Bars
● Lateral/vertical indication of available flight technical error remaining based on total system error.
● Lateral ANP bars can be displayed in all phases of flight.
● Vertical ANP bars can be displayed only after reaching top-of-descent.
● Originate from outer scale and expand inward as a function of increasing ANP relative to RNP.
● Will just touch at center of scale when ANP equals RNP.
● Turn from white to amber if current deviation is within the ANP bar limits for 10 continuous seconds.

15.4.3 ND Visual Cues

There were multiple visual cues on the ND to determine an airplane's position reference an RNAV course and destination airport. According to the Southwest Airlines Flight Reference Manual, Section 10.8.5 "ND Symbology" the following symbols could be displayed on each ND, depending on EFIS control panel switch selections. Colors indicate the following:

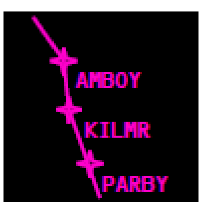
- W (white) – present status, range scales.
- G (green) – dynamic conditions.
- M (magenta) – command information, pointers, symbols, fly-to condition.
- C (cyan) – nonactive or background information.

15.4.3.1 ND Symbology[74]



A VNAV path pointer (M) and deviation scale (W) was visible in the MAP and MAP CTR modes for the ND. It displayed vertical deviation from a selected VNAV PATH during descent only. Scale indicated ±400 ft deviation. Digital display was provided when the pointer deviated more than ±30 feet from center.

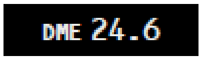
An active waypoint identifier (M) was visible in MAP, MAP CTR, PLN modes for the ND. It indicated the active flight plan waypoint, the next waypoint on the route of flight. It would also indicate a distance to the active waypoint.



The flight plan route: active (M), modified (W), inactive (C), offset (M) was available in the MAP, MAP CTR, and PLN modes for the ND. The active route was displayed with a continuous line (M) between waypoints. The active route modifications were displayed with short dashes (W) between waypoints. Inactive routes were displayed with long dashes between Waypoints. An offset route, selected through the FMC, was displayed with a dot-dash line (M) parallel to the active route.

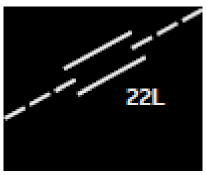
[74] Source: Southwest Airlines Flight Reference Manual Section 10.8.5.2 "MAP."

A waypoint: active (M), modified (W), inactive (C) was available in the MAP, MAP CTR, PLN modes for the ND. Active – represented the waypoint the aircraft was currently navigating to. Modified – represented the waypoints on the active route that were being modified. Inactive – represented the waypoints on the active route.



Reference VOR or ILS DME (W) was available in the VOR, VOR CTR, APP, APP CTR modes for the ND. It was located at the upper right corner of the ND. It indicated DME distance to the reference navaid. According to the incident captain, he had selected the DME for runway ILS32 at Branson for distance reference to Branson.

DME distance (G) was available in all modes of the ND except PLN. It was located at the lower left or right corner of the ND, and indicated DME distance to a navaid.



Airport and runway (W) was available in MAP, MAP CTR, PLN modes for the ND. It displayed when selected as the origin or destination and selected range was 5, 10, 20,or 40 NM. It had a dashed runway centerline that extended 14.2 NM.

In addition, according to the captain's interview with NTSB Staff, he entered a 5 and 10 mile ring around the Branson runway 14 fix via the fix page in the MCDU. The Southwest Airlines Flight Reference Manual Section 11.10.5.10 "Fix Information Page" stated the following:

> *Distances from the fix are displayed on the navigation display map mode as a dashed green circle around the fix.*

According to the Southwest Airlines Flight Reference Manual, Section 10.3.1.2 "EFIS Control Panel Controls – Navigation Displays," the desired display range on the ND (in nautical miles) for APP, VOR, MAP, or PLN mode was selectable to 5, 10, 20, 40, 80, 160, 320, and 640 nautical miles.

15.4.4 MCDU Visual Cues

As previously mentioned, according the Southwest Airlines B737 AOM, Section 11.6.3 "RNAV (RNP) and RNAV (GPS) Approach Profile," pilots were required to monitor the LEGS page on at least one of the CDU displays. The other CDU could display one of the following pages for additional situational awareness:

- DES page for flight path angle and vertical bearing to the next waypoint altitude constraint

• RNP PROGRESS page
• PROGRESS page
• FIX page

Each of those pages provided additional reference to the active waypoint and/or lateral and vertical deviation from the RNAV approach course.

The legs page provided reference to the active route. For an RNAV approach, bearing and distance to the active waypoint (typically the final approach fix) would be viewable.

15.4.4.1 MCDU Symbology[75]

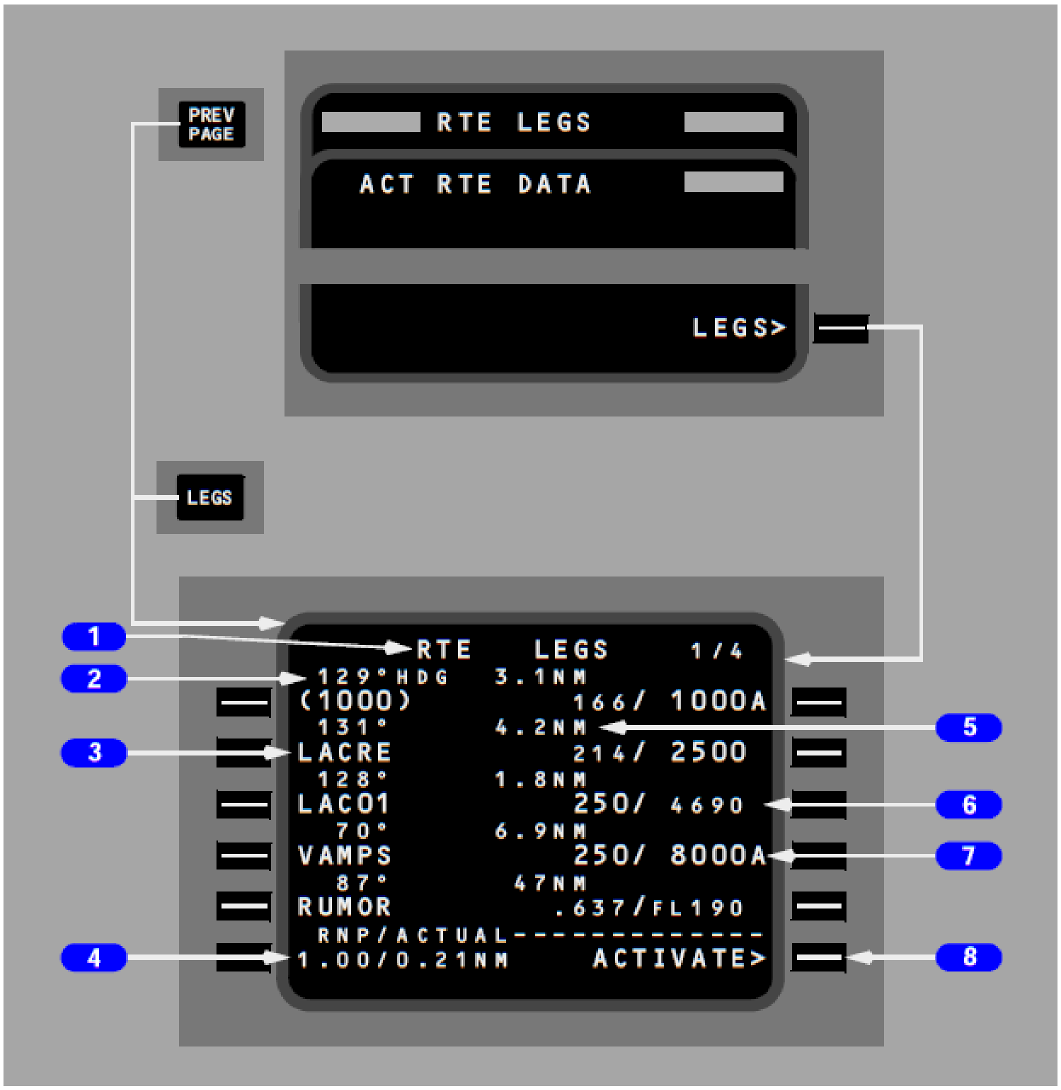


Figure 18: RTE LEGS Page

(1) Page Title

[75] Source: Southwest Airlines Flight Reference Manual, Section 11.9.3.3 "RTE LEGS Page."

An active route legs page title is displayed with ACT as part of the title. A modified page title displays a reverse video MOD.

2 Leg Direction

The leg segment direction is displayed as the title of the waypoint line. Courses are displayed in magnetic (xxx°) or true (xxx° T). Directions to maintain an arc display the arc distance, the word ARC followed by the direction, and left or right (24 ARC L). The computed great circle route leg directions may be different than chart values. Heading leg segments to conditional waypoints are displayed as (xxx° HDG) and track leg segments are displayed as (xxx° TRK). Directions may be displayed as special procedural instructions, such as HOLD AT or PROC TURN.

3 Waypoint Identifier

The current active leg is always displayed at the top of the first active RTE LEGS page. All route waypoints are displayed. Waypoints on an airway are included on the route legs page. Waypoints appear in flight sequence.
Waypoints can be entered and moved. This includes:

- Adding new waypoints
- Removing existing waypoints
- Resequencing existing waypoints
- Linking route discontinuities

Displays the waypoint by name or condition.
Box prompts are displayed for route discontinuities.
Dashes are displayed for the next line beyond the end of the route.

4 Required Navigational Position/Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigation accuracy. Manual entry is allowed.

5 Distance to Waypoint

Displays the distance from the aircraft or the waypoint to the next waypoint.

6 Calculated Waypoint Speed/Altitude

Displays the calculated speed or altitude at the waypoint in small font.

7 Specified Waypoint Speed/Altitude

Displays any waypoint speed or altitude constraint in large font. Manual entry is allowed.

8 ACTIVATE, RTE DATA

The activate prompt is displayed on the legs page when the route is not active. Push –

- ACTIVATE arms the execute function. Pushing the EXEC key activates the route and changes the ACTIVATE prompt to RTE DATA.
- RTE DATA displays the route data page. The RTE DATA prompt is used to review or modify additional information about the route.

15.5 Arrival Briefings

According to interviews with NTSB Staff, the FO indicated that he briefed a visual approach to runway 14 at KBBG, backed up by the RNAV runway 14 instrument approach. The Southwest Airlines B737 AOM, Section 10.7.4 "Arrival Briefing Requirements," stated the following:

> ***(PF) Complete an arrival briefing.***
> *The purpose of this briefing is to review and plan the descent, approach, landing, and taxi-in phases while the Flight Deck Crew's workload is low. The PF performs the briefing while the PM verifies the route and restrictions in the FMC. The depth and detail of this briefing varies, depending on operational conditions. The following sections outline the main briefing considerations.*
>
> ***Review conditions at the destination airport.***
> *Review the following resources, as needed, which affect the flight:*
>
> - *Destination -7 page (10-7 or equivalent)*
> - *Jeppesen Special Airport qualification charts*
> - *Arrival ATIS, forecast weather, SIGMETs, and adverse weather advisories*
> - *Terminal NOTAMs, FDC NOTAMs, runway conditions, field conditions,* and *terminal CHART NOTAMs*

15.5.1 Visual Approach Briefings

Southwest Airlines required pilots to conduct an approach briefing prior to every approach. The briefing was to be conducted by the PF. For visual approaches, the Southwest Airlines B737 AOM, Section 10.7.5 "Approach Briefing Requirements," stated in part:

> *There are two general rules to follow. First, brief for the published approach category that satisfies expected conditions. Second, brief the portions of the instrument approach expected to be used to achieve visual landing conditions.*
>
> *Southwest Airlines evaluates existing and forecast weather conditions to choose the best approach to achieve visual landing criteria. The three following cases outline specific briefing and planning needs:*
>
> ***Visual Approaches with Unrestricted Visibility***
> *Under VMC conditions, or anytime ATIS indicates "Visual Approaches" as a minimum, brief the final approach course and navaid frequency on the charted instrument approach for the expected runway. For RNAV approaches, brief the chart while the PM verifies the FMC programming. The intent is to reference a charted procedure to back up the visual approach. This helps prevent "wrong runway" and "wrong airport" errors.*
>
> *For unrestricted visual approaches, the briefing is as simple as, 'Visual approach, backed up with the ILS 7L, frequency 111.5, and 078° final approach course'*

According to interviews with Southwest check airmen, there was no requirement for pilots at Southwest Airlines to brief runway and approach lighting for a visual approach, although some pilots did. The presence of a VASI or PAPI could be part of a visual approach briefing, but it was not a requirement to be briefed.

15.5.2 Full Instrument Approach Briefing

According to the Southwest Airlines B737 AOM, Section 10.7.5 "Approach Briefing Requirements," pilots at Southwest Airlines were required to conduct a full instrument approach briefing for the following types of approaches:

- The runway is not expected to be in sight by the FAF/GSIA.
- Rain is reported or visible in the airport vicinity.
- Significant weather is reported or apparent in the airport vicinity (e.g., TRWs, fog, blowing dust, snow).
- Restricted visibility is reported or apparent in the airport vicinity (e.g., haze, mist, low sun angles).

For full instrument approaches, the Southwest Airlines B737 AOM, Section 10.7.5 "Approach Briefing Requirements," stated in part:

> *The Pilot who will fly the procedure must perform the briefing. (PF) Review the items in the instrument approach briefing:*
>
> - *Approach chart (page number, chart name, runway, and effective date).*
> - *Terrain and obstacle considerations. Review minimum safe altitudes, terrain, and obstacles.*
> - *Navigation radio set up. Set the navaid frequency, final approach course, and marker beacon.*
> - *EFIS Control Panel MINS Selector—BARO or RADIO (Special Authorization CAT I, CAT II, or CAT III).*
> - *Applicable NOTAMs, FDC NOTAMs, field conditions, RNP Availability Forecast (RAF), and special notes.*
> - *The approach sequence, which includes the following:*
> - *Stepdown altitudes*
> - *FAF or GSIA (altitude check)*
> - *DA, DDA, or MDA*
> - *Setting the Mode Control Panel (MCP) altitude to zero*
> - *Runway and approach lighting—Brief what the lighting will look like on final, not just the names of the lighting. Emphasize the type of lead-in lighting (steady or flashing), centerline lighting (none, centerline lights, full touchdown zone lights), and VASI/PAPI (location and type). For non-precision approaches, brief where the runway is expected to be when breaking out of the weather.*
> - *Missed approach point and procedure—Brief the missed approach point and procedure. If the missed approach has a non-standard missed approach climb gradient, full go-around thrust must be used. LNAV may be used for the missed*

approach. The FMC-coded routing must be verified with the missed approach routing on the approach chart. Briefed items must include waypoint sequence, waypoint names, and altitudes and speeds.

15.6 Stabilized Approach Criteria

SWA Stabilized Approach Criteria was defined in the Southwest Airlines FOM, Section 11.1.1 "Stabilized Approach Criteria—All Approaches," and included the following guidance:

• ***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.

• ***By 1,000 ft above TDZE, the aircraft must be in the VTARGET speed range****.*
VTARGET speed range is VTARGET + 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 sidestep 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 center line 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 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 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.

15.7 Checklists

According to the Southwest Airlines B737 AOM, Section 10.10 "Descent Checklist," the PM read and verified, and the PF verified and responded the following checklist as the airplane descended below FL180 (18,000 feet msl):

Descent Checklist
Altimeters and Bugs..Set and Crosschecked
VREF and VTARGET......................................____, ____ Set, Noted
Autobrake...As Required
Packs...Auto
Start Switches..As Required
Recall...Clear

According to Southwest Airlines B737 AOM, Section 11.2.1 "Configuration Callouts and Sequence," once the landing flap setting was selected, the PF would call for, and the PM would read the following checklist:

Before Landing Checklist
Speedbrake...Armed, Green Light
Landing Gear...Down, 3 Green
Flaps...____, Green Light

16.0 Training

16.1 Fleet Differences and Training

At the time of the incident, the fleet included 737-300, 737-500, 737-700 and 737-800 airplanes with a mix of automation systems and flight deck instrumentation. The -300 and -500 were equipped with electric and pneumatic analog flight instrument systems while the -700 and -800 airplanes were equipped with an electronic flight instrumentation system (EFIS) with 6 flat panel liquid crystal displays including 2 PFD's and 2 ND's which provided flight and navigation information in a digital format.

Flight crew training, checking, and currency requirements applicable to flight crews operating different model 737 airplanes were directed by the Flight Standardization Board Report (FSB)[76] and additional guidance for operators was provided in Advisory Circular 120-53A43.

Southwest Airlines designated the B737-700 as the Base Aircraft and the FOTM included an Operator Differences Requirements (ODR) table which specified the method of compliance and the level of training, checking, and currency applicable to fleet differences.[77]

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[76] Boeing B737-100, -200, -300, -400, -500, -600, -700, -800, -900, -900ER, revision 12 of Flight Standardization Board Report (Washington, DC: U.S. Department of Transportation, Federal Aviation Administration, December 11, 2009).

[77] As defined by AC 120-53A, a Base Aircraft is one designated by an applicant and used as a reference to compare

16.2 Visual Approach Training

A review of the Southwest Airlines Flight Operations Training Manual (FOTM) showed that visual approaches were taught in the B737 initial, upgrade training, transition, requalification and recurrent training curriculums. According to interviews with Southwest B737 check airmen, visual approaches were typically not conducted during annual proficiency checks.

The Southwest check airmen also stated that during simulator training and line training, pilots were trained to back up every visual approach with an instrument approach, and monitor the instrument approach. Use of the HUD on visual approaches was not a requirement. Pilots could put the HUD in VMC mode, and pilots were taught how to put the reference line on the runway for glide path information. According to one check airman, the HUD in VMC mode would not tell the pilot they were approaching the correct runway, and that was why pilots were taught to back up the visual approach with an approach like an ILS.

The Southwest Airlines AOM, Section 11.1.3, "HGS Use During Visual or Circling Manuevers" stated the following:

> *Alignment with the landing runway is normally accomplished by visually acquiring the runway and maneuvering the aircraft by primarily using outside references. Adjust the descent rate to place the 3° reference line over the point of intended touchdown. Then, adjust aircraft pitch to place the flight path symbol over the intended touchdown point, resulting in an approximate 3° glidepath.*
> *If the Pilot reverts to purely visual references, the HGS display may be blanked by pushing the CLR button on the HCP panel.*

17.0 FAA Oversight

Southwest Airlines held an Air Carrier Certificate, Number SWAA304A, and was authorized to conduct domestic, supplemental and flag operations. The FAA Certificate Management Office (CMO) ASW-SWA-CMO-29 had oversight of the Southwest Airlines certificate. The office was staffed with a Principle Operations Inspector (POI), with two Aircrew Program Managers (APMs) and one assistant APM. One APM had responsibility for the B737-300, -500, -800, and the other had oversight responsibility on the -700. There were a total of 10 Aircrew Program Designees (APDs), with a new class of 16, for a total of 26. The reason for the increase was in preparation to their transition to Advanced Qualification Program (AQP) training and the need for APDs to do the initial checks, which was set to phase in on January 1, 2015 with the introduction of Continuing Qualification Training (CQT).

According to the B737-700 APM, oversight was conducted through ATOS,[78] and the FAA conducted risk assessments, identified the risks, performed EPI's and SAI's and ConDOR.[79]

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differences with another.

[78] Air Transportation Oversight System.

[79] Element Performance Inspection (EPI), Safety Attribute Inspection (SAI), Constructed Dynamic Observation Report (ConDOR). See FAA Order 8900.1 (CHG 210) Volume 10 "Air Transportation Oversight System." Line

The APM conducted oversight under the ATOS format, did a risk management, figured out the risk, and attacked those problems. The SAI's were done on a timeframe, and EPIs were done as needed. They conducted ConDORs for special problem areas if they saw a need to conduct them. When asked if the FAA had conducted any ConDORs on the B737-700 program at Southwest Airlines, the APM said no.

According to an interview with NTSB Staff, the APM said there was no real need for additional oversight following the incident since Southwest was working on additional human factors training. Southwest was "upping their emphasis" on human factors. The APM said the company was coming up with a new Division Manager position for human factors, and was emphasizing their looks at pilot monitoring on PCs (proficiency checks), increasing training for pilot monitoring (PM), and encouraging the PM to "speak up."

The APM said he was not concerned about how visual approaches were briefed by Southwest pilots, and had no suggested improvements to Southwest procedures or training. He said Southwest had conducted a LOSA[80] audit, and he thought that occurred last year or the year before. There were no significant findings from the LOSA audit other than issues related to pilot monitoring. An increased emphasis on pilot monitoring and human factors began following the audit and prior to the Branson incident, and according to the APM, Southwest had further emphasized both factors since the incident.

18.0 Operations Specifications

Operations Specifications C070 "Airports Authorized for Scheduled Operations" stated the following:

> *The certificate holder is authorized to conduct scheduled passenger and cargo operations between the regular, refueling, and provisional specified in the following table. Except for alternate airports, the certificate holder shall not use any other airport in the conduct of scheduled passenger and cargo operations. The certificate holder shall maintain a list of alternate airports which can be used and shall not use any alternate airport unless it is suitable for the type of aircraft being used and the kind of operation being conducted.*

According to the "Airports Authorized for Scheduled Operations" listed under C070, Branson Airport was an approved Regular Airport.[81] M. Graham Clark Downtown Airport (KPLK) in Branson, Missouri was not on the list of approved airports for Southwest Airlines.

19.0 Recent Wrong Airport Landings

On November 21, 2013, about 2120 local time, a Boeing 747-400LCF (Dreamlifter) landed at the wrong airport in Wichita, Kansas, in night VMC conditions.[82] The airplane was being

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Operations Safety Audit.

[80] Line Operations Safety Audit.

[81] Regular Airport: an airport approved under scheduled service to a community as the regular stop to that community.

[82] NTSB incident case number DCA14IA016.

operated as a cargo flight from John F. Kennedy International Airport, Jamaica, New York, to McConnell Air Force Base, Wichita, Kansas. Instead, the flight crew mistakenly landed the airplane at Colonel James Jabara Airport, Wichita, Kansas. The flight crew indicated that during their approach to the airport, they saw runway lights that they misidentified as McConnell Air Force Base. The flight was cleared for the RNAV GPS 19L approach, and the flight crew saw Jabara but misidentified it as McConnell. The flight crew then completed the flight by visual reference to the Jabara runway. Once on the ground at Jabara, the flight crew was uncertain of their location until confirmed by the McConnell Air Force Base tower controller. The Jabara runway was 6,101 ft long, whereas McConnell runways were 12,000 ft long.[83]

20.0 Previous Recommendations and Guidance

In April, 2014, the NTSB issued a Safety Alert for landings at the wrong airport. In the Safety Alert, pilots were guided to use the following tools to prevent landings at the wrong airport:

- Adhere to standard operating procedures (SOPs), verify the airplane's position relative to the destination airport, and use available cockpit instrumentation to verify that you are landing at the correct airport.
- Maintain extra vigilance when identifying the destination airport at night and when landing at an airport with others in close proximity.
- Be familiar with and include in your approach briefing the destination airport's layout and relationship to other ground features; available lighting such as visual glideslope indicators, approach light systems, and runway lighting; and instrument approaches.
- Use the most precise navigational aids available in conjunction with a visual approach when verifying the destination airport.
- Confirm that you have correctly identified the destination airport before reporting the airport or runway is in sight.

21.0 Southwest Actions Subsequent to the Incident

According to correspondence between the NTSB and the Southwest Airlines Safety Department, a Project Management tracking program at Southwest had been initiated to review visual approach briefings at the airline, and Southwest Airlines intended to revise visual approach briefing guides to include runway and approach lighting to the intended runway of landing as required pilot briefing items.

F. LIST OF ATTACHMENTS

Attachment 1 - Interview Summaries

[83] Reference NTSB Case DCA13IA016.

Attachment 2 – Crew Information
Attachment 3 – Dispatch Release
Attachment 4 – ACARS Messages
Attachment 5 – Weather
Attachment 6 – Aircraft Log Pages
Attachment 7 – Weight and Balance
Attachment 8 – BBG Smart Pack
Attachment 9 - Charts

Submitted by:

Captain David Lawrence, NTSB
Operations Group Chairman