



National Transportation Safety Board

Aviation Accident Final Report

Location:	Nashville, TN	Accident Number:	DCA16LA032
Date & Time:	12/15/2015, 1730 CST	Registration:	N649SW
Aircraft:	BOEING 737 3H4	Aircraft Damage:	Substantial
Defining Event:	Landing gear collapse	Injuries:	138 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

On December 15, 2015, at 5:23pm central standard time (CST), Southwest Airlines flight 31, a Boeing 737-300, N649SW, exited the taxiway while taxiing to the gate and came to rest in a ditch at the Nashville International Airport (BNA), Nashville, Tennessee. Nine of the 138 passengers and crew onboard received minor injuries during the evacuation and the airplane was substantially damaged. The airplane was operating under the provisions of 14 Code of Federal Regulations Part 121 as a regularly scheduled passenger flight from William P. Hobby Airport (HOU), Houston, Texas. Weather was not a factor, light conditions were dark just after sunset.

The airplane landed normally on runway 20R and exited at taxiway B2. The flight crew received and understood the taxi instructions to their assigned gate. As the crew proceeded along taxiway T3, the flight crew had difficulty locating taxiway T4 as the area was dark, and there was glare from the terminal lights ahead. The crew maneuvered the airplane along T3 and onto T4, and then turned back to the right on a general heading consistent with heading across the ramp toward the assigned gate. The flight crew could not see T4 or the grassy area because the taxiway lights were off and the glare from the terminal lights. As a result, the airplane left the pavement and came to rest in a drainage ditch resulting in substantial damage to airplane. The cabin crew initially attempted to keep the passengers seated, but after being unable to contact the flight crew due to the loud alarm on the flight deck, the cabin crew properly initiated and conducted an evacuation.

As a result of past complaints regarding the brightness of the green taxiway centerline lights on taxiways H, J, L and T-6, BNA tower controllers routinely turned off the taxiway centerline lighting. Although the facility had not received any requests on the day of the accident, about 30 minutes prior to the event the tower controller in charge (CIC) turned off the centerline lights as a matter of routine. In doing so, the CIC inadvertently turned off the "TWY J & Apron 2" selector, which included the taxiway lights in the vicinity of the excursion. The airfield lighting panel screensaver feature prevented the tower controllers from having an immediate visual reference to the status of the airfield lighting.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

the flight crew's early turn towards the assigned gate because taxiway lighting had been inadvertently turned off by the controller-in-charge which resulted in the airplane leaving the paved surface.

Contributing to the accident was the operation of the screen-saver function on the lighting control panel that prevented the tower controllers from having an immediate visual reference to the status of the airfield lighting.

Findings

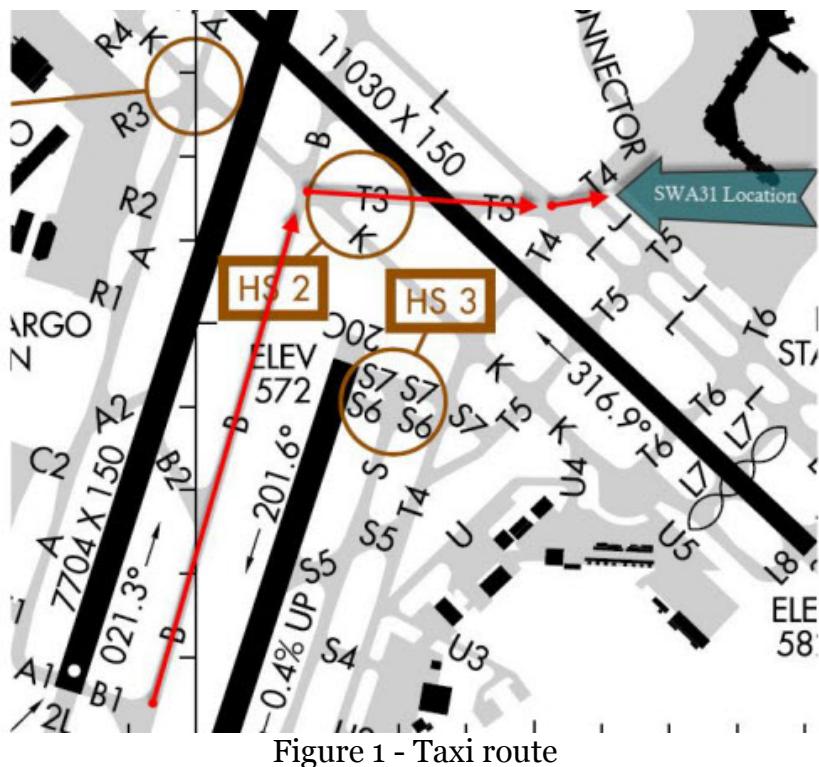
Aircraft	Taxiing - Not specified (Cause)
Personnel issues	Visual function - Pilot (Cause) Use of equip/system - ATC personnel (Cause)
Environmental issues	Taxiway lighting - Contributed to outcome (Cause)
Organizational issues	Equipment design - ATC (Factor)

Factual Information

HISTORY OF FLIGHT

On December 15, 2015, at 5:23pm central standard time (CST), Southwest Airlines flight 31, a Boeing 737-300, N649SW, exited the taxiway while taxiing to the gate and came to rest in a ditch at the Nashville International Airport (BNA), Nashville, Tennessee. Nine of the 138 passengers and crew onboard received minor injuries during the evacuation and the airplane was substantially damaged. The airplane was operating under the provisions of 14 Code of Federal Regulations Part 121 as a regularly scheduled passenger flight from William P. Hobby Airport (HOU), Houston, Texas.

The airplane landed normally on runway 20R and exited at taxiway B2. ATC instructed the flight to taxi to the ramp (gate C20) via taxiway B, T3, and T4. (Figure 1)



The captain reported he used landing lights to assist in the taxi along B and T3 and then extinguished the landing lights as the airplane crossed runway 13/31, but left the taxi lights on. Video surveillance footage was consistent with the captain's report. The flight crew reported that they had difficulty locating taxiway T4 as it appeared dark and there was glare from the terminal lights ahead. About 15 seconds prior to the excursion the airplane began a left turn briefly to a heading of about 065 degrees. Taxiway T4 was oriented about 045 degrees. Crew reports, and the cockpit voice recorder (CVR) recording, indicate the crew was searching for the turn to the ramp when flight data recorder (FDR) data and video surveillance footage indicated the airplane then turned back to the right to a heading of 090 degrees, consistent

with the heading toward gate C20. Three seconds later the airplane exited the taxiway into a grassy area with a large drainage ditch, east of the intersection of taxiways T4 and J. The nosegear collapsed, and the airplane came to rest angled to the right, on the left nacelle, right wing tip, and nose. (Figure 2)



Figure 2 - Aircraft resting position

Shortly after the airplane came to rest, the CVR recording indicated, an audible alarm began sounding in the cockpit which the flight crew indicated they could not silence (see Tests and Research section). The pilot advised ATC that "we've cut the corner here and are off in the grass" and asked for ARFF equipment.

According to the flight attendant (FA) statements, there was a large jolt and loud bang when the airplane stopped and all the cabin lights went out for some time before the emergency lights came on. The FAs stated that they did not know what was going on so began yelling, "heads down, stay down" as they tried to call the pilots but there was no power on the interphones. The FAs initiated the evacuation a short time later. About one minute after the airplane came to rest, the pilots noticed that the slides were deploying and passengers were evacuating and the captain announced on the public address system "okay don't evacuate flight attendants, do not evacuate" to which the first officer responded "oh they are already going."

Review of Air Traffic records and interviews with controllers revealed that about 30 minutes prior to the accident the taxiway lights for "TWY J & Apron 2" were selected "off." This resulted in shutting off the

lights for taxiways L and J; taxiways T4 and T5 to the northeast of L; the lights along the edge of the ramp parallel to J; and the connector and circular area between Concourses B and C.

INJURIES TO PERSONS

Nine of the 133 passengers received minor injuries during the evacuation. None of the five crew members were injured.

DAMAGE TO AIRCRAFT

The nose landing gear collapsed in a rearward direction resulting in substantial damage to frames, stringers, and the bulkhead aft of the nose gear well. Additional minor damage to engine nacelles, fairings, and skin was also found.

PERSONNEL INFORMATION

The captain, age 58, had worked for Southwest Airlines since 1999. He held an Airline Transport Pilot certificate, multi-engine land, with a type rating in the B737. He held an FAA first class medical certificate with a limitation for glasses for near vision. Company records indicate that he had approximately 19,300 hours total time with approximately 14,100 hours in the B737. He had no previous accidents, incidents, or violations. He had flown to Nashville numerous times previously.

The first officer, age 61, had worked for Southwest Airlines since 2006. He held an Airline Transport Pilot certificate, multi-engine land, with type ratings in the B-727, B-737, B-757, B-767, CL-30, and DC-9. He held an FAA first class medical certificate with a limitation for glasses for near vision. Company records indicated a total time of approximately 15,500 hours, with approximately 5400 hours in the B737. He had no previous accidents, incidents, or violations. He had flown to Nashville numerous times previously.

The three flight attendants were all current and qualified on the B737.

AIRCRAFT INFORMATION

N649SW, manufacturer serial number 27719, was a Boeing 737-3H4 equipped with CFM-56-3B1 engines. The airplane had accumulated approximately 58,630 hours total time on the airframe. Recorded data and airline records indicated no relevant maintenance issues with the airplane.

METEOROLOGICAL INFORMATION

The Nashville Airport 5:05pm weather observation indicated clear conditions with 10 miles visibility, wind from 180 degrees at 3 knots, temperature 17° C. There was no precipitation. Night lighting conditions prevailed, local sunset was at 4:34pm.

COMMUNICATIONS

After the airplane came to rest, the pilot advised the tower that he had "cut the corner" and requested assistance. There were no further communications between the flight crew and the tower. The

flight crew reported that a loud audible alarm in the cockpit, which they could not silence, impeded communication.

AERODROME INFORMATION

The Nashville International Airport (BNA) is located approximately 5 miles southeast of the city of Nashville, Tennessee. The airport averages almost 500 operations per day, mostly air carrier and air taxi activity. Runway 20R is 7,704 feet long and 150 feet wide, aligned to 201 degrees magnetic.

The airfield lighting at BNA consisted of taxiway edge and taxiway centerline lights, runway edge and runway centerline lights, runway end identifier lights, approach lights, and a rotating beacon. The airfield lighting was controlled via two airfield lighting touchscreen control panels located near the local controller (LC) and ground controller (GC) positions in the control tower. The BNA air traffic control tower (ATCT) standard operating procedures (SOP), BNA Order 7111.1B, dated July 24, 2014, did not specify who had overall responsibility for the operation of the airfield lighting.

The airfield lighting panels (Figure 3) were owned by the Metropolitan Nashville Airport Authority (MNAA) and were operated using software installed in 2010. The airfield lighting was operated in accordance with requirements contained in FAAO 7110.65, Air Traffic Control, and a letter of agreement between the control tower and MNAA dated December 16, 2013.

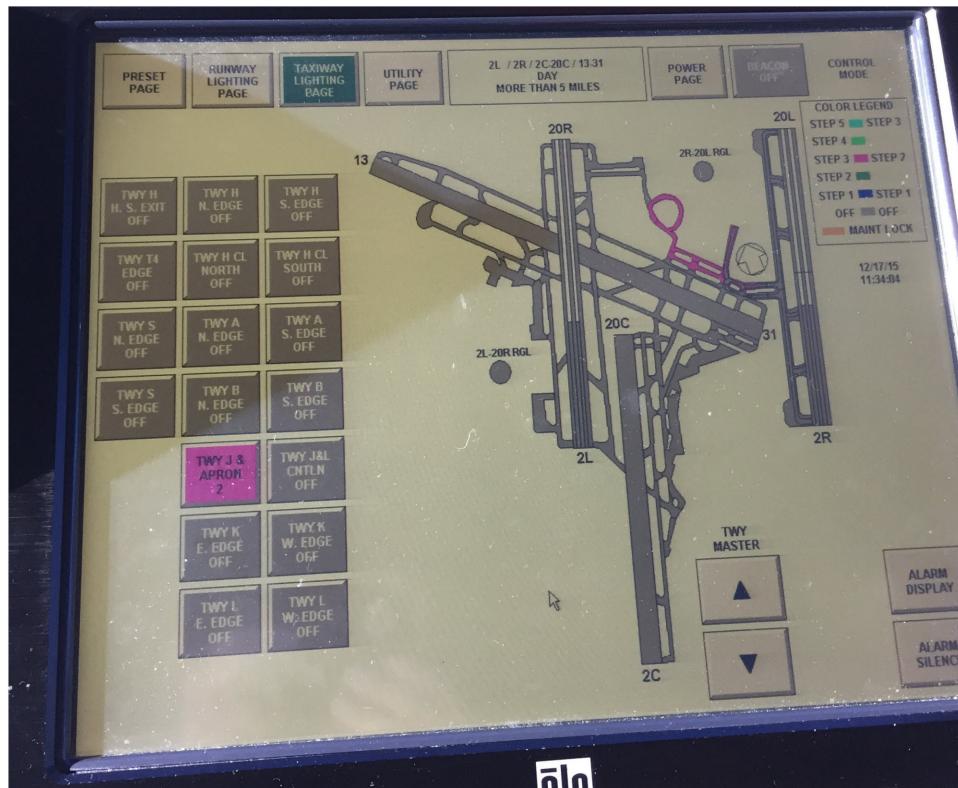


Figure 3 - Lighting panel

The lighting panel had preset intensity selections used according to current weather/day/night conditions and was operated by the tower controllers via a touch screen that selected lighting intensities as required by the current conditions. Specific airfield lighting configurations could be selected to operate independently of the pre-set conditions, such as turning off a specific taxiway lighting circuit. The touch screen control circuit that activated or deactivated the taxiway centerline lights was located next to the touch screen control circuit that activated or deactivated the lighting for the ramp/apron and a portion of taxiway T4.

The lighting panels had a screensaver mode that caused the screen to go black after approximately five minutes if the panel was not accessed by a controller.

ATCT staff informed investigators that as a result of past complaints regarding the brightness of the green taxiway centerline lights on taxiways H, J, L, and T6, BNA tower controllers routinely turn off the centerline lighting. On the date of the accident the facility had not received any specific request to turn off the centerline lights; however, prior to the event, the controller in charge (CIC) attempted to turn off the centerline lights as a matter of routine. In doing so, the CIC inadvertently turned off the "TWY J & Apron 2" selector.

The CIC was later notified by Airport Operations that the lights were off, and he turned them back on approximately 25 minutes after the incident.

Subsequent to the accident, Nashville ATCT modified their standard operating procedure regarding responsibility for taxiway lighting and eliminated the lighting panel screensaver function.

FLIGHT RECORDERS

The solid-state flight data recorder (FDR), a Honeywell SSFDR, model 980-4700, records a minimum of 25 hours of airplane flight information in a digital format. The FDR was in good condition, and the data were extracted normally from the FDR.

The solid-state cockpit voice recorder (CVR) was a Honeywell 6022 SSCVR 120 that recorded 2 hours of digital cockpit audio. The audio information was extracted from the CVR normally, without difficulty. The quality of the audio was characterized as good to excellent. No CVR group was convened, and a summary was prepared by the NTSB recorders lab.

SURVIVAL ASPECTS

The cabin crew consisted of three flight attendants (FA). The lead A-FA was seated at the outboard position of a dual jumpseat located in the forward entry area next to door L1. The B-FA was seated at the outboard position of a dual jumpseat located in the aft galley next to door L2. The C-FA was seated at the inboard position of a dual jumpseat located in the forward entry area next to door L1. All three flight attendants stated the aircraft landed normally and was taxiing to the gate when it came to an unexpected abrupt stop. The loud sounds and unusual attitude of the airplane alerted the FAs that there was a problem. All three flight attendants stated they waited for the pilots to contact them with further instructions. Passengers had started getting out of their seats and were moving around the cabin, so both the A-FA and C-FA started using their emergency commands "heads down, stay down" to control passenger movement. The A-FA attempted to use the interphone to call the cockpit, but was not successful because it was not powered. The A-FA and C-FA discussed the aircraft attitude, loud sounds

and lack of communication from the cockpit and initiated an evacuation using only door R1 (the A-FA had assessed door L1 and observed the left engine on the ground and decided to block the exit). The C-FA operated door R1 while the A-FA tried contacting the pilots for the second time with no success. The B-FA heard evacuation commands coming from the forward cabin and started yelling evacuation commands in the aft cabin. She turned on the emergency light switch located on the aft jumpseat panel and opened her primary (L2) exit door first, followed by her secondary (R2) exit door. After all the passengers had evacuated the aircraft, the FA's checked the cabin, gathered emergency equipment and exited the aircraft. They staged outside on the tarmac to keep passengers a safe distance from the aircraft.

TESTS AND RESEARCH

The flight crew reported that a loud alarm in the cockpit, that they were unable to silence, distracted them from communicating with the cabin crew. A review of the sound by a Boeing test pilot confirmed that the alarm was consistent with the gear unsafe alarm, and could not be silenced without disabling a circuit breaker or running a checklist procedure for an unrelated scenario.

History of Flight

After landing	Collision with terr/obj (non-CFIT) Landing gear collapse (Defining event)
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Pilot Information

Certificate:	Airline Transport; Flight Instructor; Commercial	Age:	58
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	4-point
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	Toxicology Performed:	
Medical Certification:	Class 1 With Waivers/Limitations	Last Medical Exam:	07/10/2015
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	07/09/2015
Flight Time:	19186 hours (Total, all aircraft), 14186 hours (Total, this make and model), 12428 hours (Pilot In Command, all aircraft), 210 hours (Last 90 days, all aircraft), 66 hours (Last 30 days, all aircraft)		

Co-Pilot Information

Certificate:		Age:	61
Airplane Rating(s):	Multi-engine Land	Seat Occupied:	Right
Other Aircraft Rating(s):	None	Restraint Used:	4-point
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	None	Toxicology Performed:	
Medical Certification:	Class 1 With Waivers/Limitations	Last Medical Exam:	07/14/2015
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	08/20/2015
Flight Time:	15500 hours (Total, all aircraft), 5473 hours (Total, this make and model), 4530 hours (Pilot In Command, all aircraft), 198 hours (Last 90 days, all aircraft), 68 hours (Last 30 days, all aircraft), 3 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	BOEING	Registration:	N649SW
Model/Series:	737 3H4 3H4	Aircraft Category:	Airplane
Year of Manufacture:	1997	Amateur Built:	No
Airworthiness Certificate:	Transport	Serial Number:	27719
Landing Gear Type:	Retractable - Tricycle	Seats:	
Date/Type of Last Inspection:		Certified Max Gross Wt.:	138499 lbs
Time Since Last Inspection:		Engines:	2 Turbo Fan
Airframe Total Time:		Engine Manufacturer:	CFM INTL.
ELT:	Not installed	Engine Model/Series:	CFM56 SERIES
Registered Owner:	SOUTHWEST AIRLINES CO	Rated Power:	
Operator:	Southwest Airlines	Air Carrier Operating Certificate:	Flag carrier (121)

Meteorological Information and Flight Plan

Observation Facility, Elevation:	KBNA	Observation Time:	1705 CST
Distance from Accident Site:		Condition of Light:	Night
Direction from Accident Site:		Conditions at Accident Site:	Visual Conditions
Lowest Cloud Condition:	Clear	Temperature/Dew Point:	17°C / 7°C
Lowest Ceiling:		Visibility	10 Miles
Wind Speed/Gusts, Direction:	3 knots, 180°	Visibility (RVR):	
Altimeter Setting:	29.92 inches Hg	Visibility (RVV):	
Precipitation and Obscuration:			
Departure Point:	Houston, TX (KHOU)	Type of Flight Plan Filed:	IFR
Destination:	Nashville, TN (KBNA)	Type of Clearance:	IFR
Departure Time:	1558 CST	Type of Airspace:	

Airport Information

Airport:	Nashville International Airport (KBNA)	Runway Surface Type:	Unknown
Airport Elevation:	599 ft	Runway Surface Condition:	Dry
Runway Used:	20L	IFR Approach:	None
Runway Length/Width:	7700 ft / 150 ft	VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	5 None	Aircraft Damage:	Substantial
Passenger Injuries:	133 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	138 None		

Administrative Information

Investigator In Charge (IIC):	William R English	Adopted Date:	01/23/2017
Additional Participating Persons:			
Publish Date:	01/23/2017		
Note:	The NTSB did not travel to the scene of this accident.		
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=92458		

The National Transportation Safety Board (NTSB), established in 1967, is an independent federal agency mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report.