



# Aviation Investigation Final Report

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<b>Location:</b>	Jackson, Wyoming	<b>Incident Number:</b>	DCA081A044
<b>Date &amp; Time:</b>	February 25, 2008, 21:16 Local	<b>Registration:</b>	N442UA
<b>Aircraft:</b>	Airbus Industrie A320	<b>Aircraft Damage:</b>	Minor
<b>Defining Event:</b>	Sys/Comp malf/fail (non-power)	<b>Injuries:</b>	1 Minor, 124 None
<b>Flight Conducted Under:</b>	Part 121: Air carrier - Scheduled		

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## Analysis

The flight crew reported that prior to the approach into KJAX, the captain performed an approach briefing which included that the Mu readings indicated "good" braking; it was determined that if the airplane did not touchdown in the first 2,000 feet of runway, they would perform a go around. The touchdown was "firm" and the captain believed it was within the first 2,000 feet of runway. The deceleration was normal until the airplane reached about 80 knots when it started to slide. The captain then applied maximum manual braking and the airplane started to slide toward the right side of the runway. The airplane exited the end of the runway and came to rest in the snow. The runway friction measurements taken before and after the incident were all above 0.45, which according to the Aeronautical Information Manual, is above the level when braking action would start to deteriorate. Therefore, the airplane braking performance was not deteriorated by the runway conditions.

There were no faults logged in the maintenance systems that were relevant to the antiskid or brake systems, however, the inboard (IB) and outboard (OB) tachometer wires on the left main landing gear (LMLG) were found to be cross connected. With the wires crossed connected, when the IB tire began to skid (stop rotating) the Brake Steering and Control Unit (BSCU) would have commanded a reduction in the hydraulic pressure to the OB brake, instead of the IB brake, causing a loss of braking on the OB wheel. At the same time, the BSCU would have continued to command an increase in hydraulic pressure to the IB brake, causing it to fully skid and fail. Therefore, when the captain applied full manual braking, the braking action on the LMLG was almost fully lost while the right MLG braking remained normal, resulting in the airplane veering to the right and exiting the runway.

A review of the maintenance documents and practices showed that there were no specific inspections required when the landing gear and wiring harnesses were received to ensure they were routed to the correct axle. Additionally, installation documents did not specify the exact wire number connector that needed to be installed on each tachometer for a given position. Finally, a proper functional check should have identified the cross connected tachometers, even though maintenance personnel indicated no

discrepancies when tested. After the incident, United Airlines took numerous actions to prevent similar incidents from reoccurring.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: the loss of braking action on the left main landing gear due to the cross connection of the wheel speed tachometer wires that was caused by inadequate maintenance performed on the airplane during the installation of the main landing gear.

### Findings

<b>Personnel issues</b>	Installation - Maintenance personnel
<b>Aircraft</b>	Landing gear brakes system - Related maintenance info
<b>Aircraft</b>	Landing gear brakes system - Incorrect service/maintenance

## Factual Information

### History of Flight

Landing-landing roll	Sys/Comp malf/fail (non-power) (Defining event)
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#### HISTORY OF FLIGHT

On February 25, 2008, at 2116 mountain standard time (MST), United Airlines flight 267, an Airbus A-320, N442UA, departed the right side of runway 19 during landing at Jackson Hole Airport (JAC), Jackson, Wyoming. The 119 passengers and 6 crew members evacuated the aircraft via the emergency slides. One passenger received minor injuries during the evacuation and the airplane was not substantially damaged. The flight was operating under the provisions of 14 CFR Part 121 and was en route from Denver International Airport (DEN), Denver, Colorado. Visual meteorological conditions prevailed during the nighttime landing.

The crew reported that the takeoff, climb, cruise and descent to JAC was normal. The captain was the flying pilot. After descending through a high overcast ceiling at about 12,000 feet, the airplane was in clear meteorological conditions.

The captain stated that prior to the night visual approach into JAC he performed an approach briefing. During the approach briefing it was noted that the Mu readings indicated "good" breaking and that if the airplane did not touchdown in the first 2,000 feet of runway, they would perform a go-around. The weather reported at the time of the approach was calm wind, 1 mile of visibility and no precipitation. Both the captain and first officer reported that they discussed the landing distance numbers. The captain reported that during the approach he could see the airport from about 15 miles away and configured the airplane early with full flaps and autobrakes set to "medium".

The captain stated that the touchdown was "firm" and the speedbrakes auto-deployed quickly; he believed that the airplane touched down in the first 2,000 feet of runway. The deceleration was normal until the airplane reached about 80 knots and 2,000 feet from the end of the runway when it started to slide. At that time, the captain stated that he applied maximum manual braking and the airplane started to slide toward the right side of the runway. The captain applied maximum left rudder, maximum braking, and reverse thrust as the airplane exited the right side of the end of the runway. The airplane came to rest against snow banks. The first officer said that the engines "flamed out" when they ingested snow. As the flight crew was shutting off the engine fuel levers and were getting out of their seats, they heard a passenger yell "fire" and the passengers began a self-initiated evacuation of the airplane.

#### PERSONNEL INFORMATION

The captain held an airline transport pilot certificate in airplane multi engine land and a commercial certificate in airplane single engine land, a flight engineer certificate, and an airframe and powerplant mechanic certificate. The captain also held a certified flight instructor certificate with single engine, multi engine, and instrument airplane ratings. He was type rated in the Airbus A-320, and the Boeing

737, 757, 767 airplanes. The captain had accumulated about 10,000 hours of total flight experience, which included 2,414 hours in the Airbus A-320. The captain's most recent Federal Aviation Administration (FAA) first class medical certificate was issued on September 24, 2007; and his most recent proficiency check occurred in January 2007.

The first officer held an airline transport pilot certificate in airplane multi engine land, and commercial privileges in airplane single engine land and rotorcraft. The first officer held type ratings in the Airbus A-320 and Boeing 757, 767 airplanes. The first officer reported that he had accumulated about 10,000 hours of total flight experience, which included 2,072 hours in the Airbus A-320. The first officer's most recent FAA first class medical certificate was issued on March 28, 2007. His most recent proficiency check was in August 2007.

At the time of the incident, the crew had been on duty for about 13 hours and 30 minutes; the first officer reported that their maximum allowed duty day was 14 hours.

## RUNWAY DOCUMENTATION

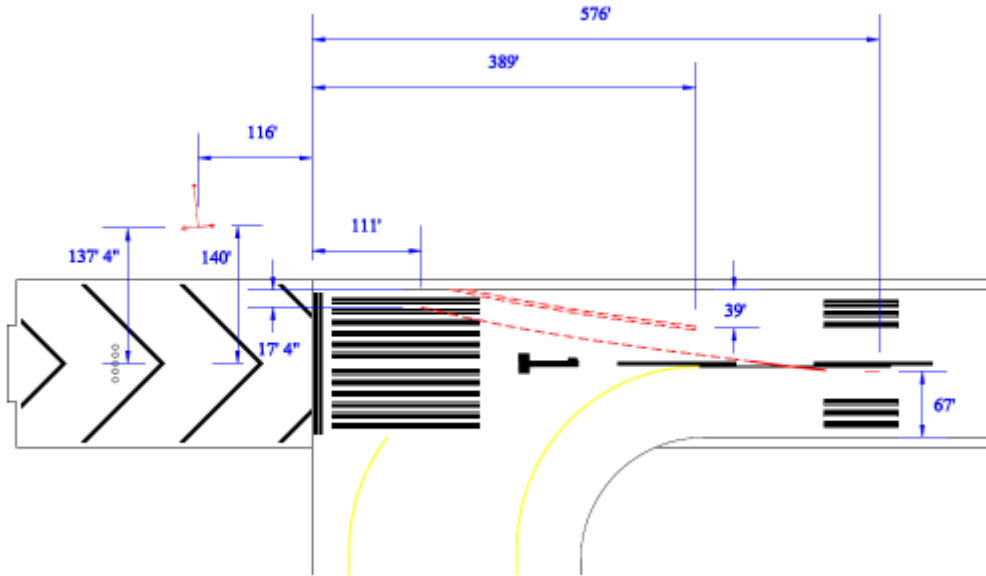
The Jackson Hole airport (JAC) has one asphalt runway (1/19) which is 6300 feet long by 150 feet wide.

Examination of the runway revealed distinct rubber transfer marks leading to an area of disturbed snow on the right side of the runway (Figure 1). The longest of the rubber transfer marks began about 576 feet from the departure threshold of runway 19 (or the approach threshold of runway 1) and 67 feet from the left runway edge and arced to the right. The mark was very light for the first 55 feet then became very heavy for 76 feet followed by 332 feet of light markings (as measured along the mark). The mark stopped about 111 feet from the threshold and 17 feet, 4 inches from the right runway edge. The heavy mark crossed the centerline at an angle of about 31 degrees. A second set of two light rubber transfer marks began about 389 feet from the threshold and 39 feet from the right runway edge. The two marks were parallel and separated by about 40 inches. The marks ended at the disturbed snow at the right runway edge. At the edge of the runway there were three sets of parallel tracks through the snow consistent with the landing gear wheels on the airplane. The center of the right main landing gear (RMLG) tracks was 149 feet from the threshold, the center of the nose landing gear (NLG) tracks was 99 feet from the threshold, and the center of the LMLG tracks was 36 feet from the threshold. The perpendicular distance between the centers of the tracks was 13 feet, 9 inches between the LMLG and NLG and 10 feet, 3 inches between the RMLG and NLG.

The airplane came to rest in the snow on the right side of the overrun area. The two RMLG and two NLG tires each left distinct impressions with tread ribs in the soil and snow where they came to rest. The LMLG outboard tire left a distinct impression with tread ribs while the inboard tire left only a light impression. The center of the RMLG was 140 feet from the extended centerline, the center of the LMLG was 137 feet, 4 inches from the centerline, and the center of the NLG was 42 feet, 2 inches forward of a line connecting the center of both MLG. The distance between the RMLG and LMLG was 28 feet. A point midway between the MLG (airplane centerline) was 116 feet beyond the threshold.

Runway friction measurements were obtained from airport operations that were taken using a SARSYS Saab Friction Tester before and after the incident on runway 19. The first measurement was taken at 20:43 MST on 2/25 and showed readings of 0.45, 0.46, and 0.51. The second measurement was taken at 21:38 MST on 2/25 and showed readings of 0.62, 0.64, and 0.69.

According to the airport's director of operations, it was snowing earlier in the day; however, it had stopped before the incident occurred. The runway was swept of snow prior to the arrival of the incident airplane. Patchy, thin packed snow and ice (less than 1/8") was on the runway, but mostly along the edges and not covering more than 25%.



*Figure 1 – Diagram of Skid Marks*

#### AIRCRAFT DOCUMENTATION

The leading edge slats and trailing edge flaps were extended. Spoilers 3 and 4 on each wing were in the extended position. Both engine thrust reversers remained in the deployed position. There was snow packed in both engines from the fan area through the thrust reversers. There was snow in the aft end of the fan air ducts on both engines and a frozen pool of water in the left engine tail pipe.

Snow and ice was packed around all of the landing gear and up into the wheel well. The LMLG inboard tire exhibited a large flat spot with a rupture through the aft end from sidewall to sidewall (Figure 2). The LMLG outboard tire was intact with some minor abraded areas on the center tread rib. The RMLG tires were intact with some minor abraded areas on the center rib and some small cuts in the shoulder area. There was no other obvious damage to the landing gear.



*Figure 2– LMLG Inboard Tire*

### Anti-Skid System

Power was applied in order to check the status messages on the Multipurpose Control Display Unit (MCDU). The MCDU accesses the Centralized Fault Display System (CFDS) to read the status of every computer on the airplane. The maintenance post flight printout showed no failure messages around the time of the incident. The Brake Steering and Control Unit (BSCU) last leg report showed no faults were recorded during the incident flight that were relevant to the circumstances of the incident. Both BSCUs were tested with no failures noted.

The wheel tachometers were pulled from the axles without removing the wiring connections. Examination of the tachometer wires revealed that the wires were cross connected on the LMLG. Testing of the system per the AMM confirmed that the wires were cross connected. The wires were then installed correctly, and the test was re-run. The system operated normally with the wires installed correctly.

### MAINTENANCE RECORDS

N442UA was purchased new by United Air Lines, Inc. from Airbus Industries on February 26, 1998. The airplane had accumulated 34,587 flight hours, 13,631 cycles at the time of the incident. At the time of the accident, there were no open Minimum Equipment List (MEL) or deferred items in the airplane logbook.

### Main Landing Gear (MLG)

According to United Airlines, both MLG and the nose landing gear were replaced on the airplane on February 2, 2008 due to approaching overhaul time limits. The left-hand main landing gear was an "enhanced" landing gear and the right-hand landing gear was a standard or "pre-enhanced" landing gear. According to Airbus, the Service Bulletin to retrofit an airplane with the "enhanced" gear required they only be replaced as a set and that installation of a "mixed" configuration would only be approved on a case-by-case basis. United Airlines was unaware that two different types of landing gear were installed on the airplane and there were no records indicating that a request was made to install a "mixed" set of gear on the incident airplane.

### Overhaul of MLG

United Airlines contracted with Hawker Pacific Aerospace to overhaul its A320/A319 landing gears. Review of records and interviews of United and Hawker Pacific personnel revealed the following regarding the overhaul process.

All work was accomplished using United Airlines Joint Documents and Messier-Dowty Component Maintenance Manuals. The wiring harnesses of the landing gear are overhauled at this time and installed into the overhauled Hawker Pacific gear components. Once finished with the overhaul, Hawker Pacific shipped the landing gear to United Airlines.

During the landing gear installation, United Airlines personnel installed the tachometers to the overhauled landing gear prior to the gear being installed on the airplane. Interviews and review of the maintenance documents noted that the Maintenance Manual and task cards were not clear when specifying the correct position for the MLG wheel tachometers installation. In addition, the mechanic who installed all four tachometers had never installed one before, but indicated that a coworker, who had experience, guide him through the process if he had questions. He indicated he had no issues with the installation.

The removal and installation of the landing gears on the airplane required that a full check of the landing gear systems be accomplished. Records showed all required tasks had been accomplished and properly signed off and that that a functional test of the tachometers was accomplished with no discrepancies noted. During interviews, maintenance personnel noted that the functional spin up test for the tachometers was complex and could be confusing at times.

After the incident, United Airlines accomplished a functional check of the tachometers on three airplanes that had gone through gear changes between the October 2007 incident and February 2008 incident. There were no discrepancies found with any of the airplanes.

Subsequent to the incident, United Airlines made numerous modifications to their maintenance program regarding the MLG wheel speed transducers, including changes to their FOQA monitoring program, receiving inspection paperwork, installation procedures, inspection procedures, and functional test procedures.

### PREVIOUS EVENT

On October 9, 2007, about 2030 central daylight time, United Airlines flight 628, an Airbus A320-232, N431UA, received minor damage when it exited runway 22R and impacted runway lighting while landing at the O'Hare International Airport (KORD), Chicago, Illinois. Of the 125 passengers and crew

onboard, one flight attendant and one passenger reported minor injuries. The flight was operating un 14 CFR Part 121 as a scheduled domestic passenger flight from Seattle-Tacoma International Airport (KSEA), Seattle, Washington, to KORD. (CHI08IA026)

During the investigation, it was determined that the tachometer functional test was overlooked during the accomplishment of the sliding tube Airworthiness Directive (AD 2007-11-11) at a United Airlines contract maintenance facility.

### Pilot Information

<b>Certificate:</b>	Airline transport; Commercial; Flight engineer; Flight instructor	<b>Age:</b>	42, Male
<b>Airplane Rating(s):</b>	Single-engine land; Multi-engine land	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	4-point
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	Airplane multi-engine; Airplane single-engine; Instrument airplane	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 1 With waivers/limitations	<b>Last FAA Medical Exam:</b>	September 24, 2007
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	
<b>Flight Time:</b>	10000 hours (Total, all aircraft), 2414 hours (Total, this make and model)		

### Co-pilot Information

<b>Certificate:</b>	Airline transport; Commercial	<b>Age:</b>	44, Male
<b>Airplane Rating(s):</b>	Single-engine land; Multi-engine land	<b>Seat Occupied:</b>	Right
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	4-point
<b>Instrument Rating(s):</b>	Helicopter	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 1 Without waivers/limitations	<b>Last FAA Medical Exam:</b>	March 28, 2007
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	
<b>Flight Time:</b>	10000 hours (Total, all aircraft), 2072 hours (Total, this make and model)		



## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Airbus Industrie	<b>Registration:</b>	N442UA
<b>Model/Series:</b>	A320	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>		<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Transport	<b>Serial Number:</b>	780
<b>Landing Gear Type:</b>	Retractable - Tricycle	<b>Seats:</b>	
<b>Date/Type of Last Inspection:</b>	February 19, 2008 Continuous airworthiness	<b>Certified Max Gross Wt.:</b>	
<b>Time Since Last Inspection:</b>		<b>Engines:</b>	Turbo fan
<b>Airframe Total Time:</b>	34587 Hrs at time of accident	<b>Engine Manufacturer:</b>	IAE
<b>ELT:</b>		<b>Engine Model/Series:</b>	2500 A5
<b>Registered Owner:</b>	United Air Lines	<b>Rated Power:</b>	26500 Lbs thrust
<b>Operator:</b>	United Air Lines	<b>Operating Certificate(s) Held:</b>	Flag carrier (121)
<b>Operator Does Business As:</b>		<b>Operator Designator Code:</b>	UALA

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Night
<b>Observation Facility, Elevation:</b>		<b>Distance from Accident Site:</b>	
<b>Observation Time:</b>		<b>Direction from Accident Site:</b>	
<b>Lowest Cloud Condition:</b>		<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	Overcast / 3200 ft AGL	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	7 knots /	<b>Turbulence Type Forecast/Actual:</b>	/
<b>Wind Direction:</b>	358°	<b>Turbulence Severity Forecast/Actual:</b>	/
<b>Altimeter Setting:</b>		<b>Temperature/Dew Point:</b>	
<b>Precipitation and Obscuration:</b>			
<b>Departure Point:</b>	DENVER, CO (DEN )	<b>Type of Flight Plan Filed:</b>	IFR
<b>Destination:</b>	JACKSON, WY (JAC )	<b>Type of Clearance:</b>	IFR
<b>Departure Time:</b>		<b>Type of Airspace:</b>	

## Airport Information

<b>Airport:</b>	Jackson Hole JAC	<b>Runway Surface Type:</b>	Asphalt
<b>Airport Elevation:</b>	6450 ft msl	<b>Runway Surface Condition:</b>	Unknown
<b>Runway Used:</b>	19	<b>IFR Approach:</b>	Visual
<b>Runway Length/Width:</b>	6300 ft / 150 ft	<b>VFR Approach/Landing:</b>	Straight-in

## Wreckage and Impact Information

<b>Crew Injuries:</b>	6 None	<b>Aircraft Damage:</b>	Minor
<b>Passenger Injuries:</b>	1 Minor, 118 None	<b>Aircraft Fire:</b>	None
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	1 Minor, 124 None	<b>Latitude, Longitude:</b>	43.606109,-110.738609(est)

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Sedor, Joseph
<b>Additional Participating Persons:</b>	Tony James
<b>Original Publish Date:</b>	March 30, 2020
<b>Last Revision Date:</b>	
<b>Investigation Class:</b>	<a href="#">Class</a>
<b>Note:</b>	The NTSB traveled to the scene of this incident.
<b>Investigation Docket:</b>	<a href="https://data.ntsb.gov/Docket?ProjectID=67588">https://data.ntsb.gov/Docket?ProjectID=67588</a>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).