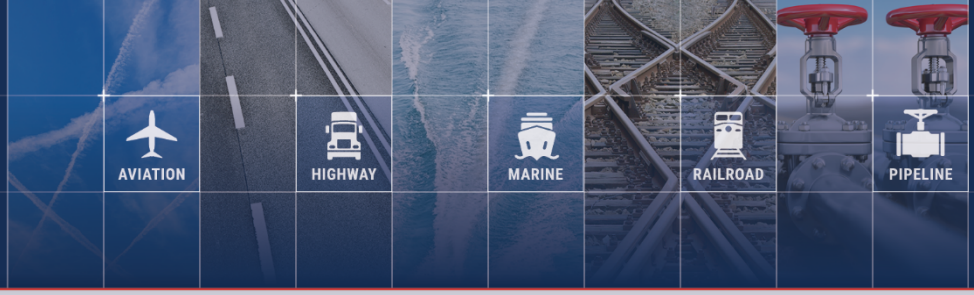

Aviation Investigation Factual Report

Location:	Fargo, North Dakota	**Incident Number:**	CHI08IA022
Date & Time:	October 20, 2007, 20:07 Local	**Registration:**	N331NW
Aircraft:	Airbus Industrie A320-211	**Aircraft Damage:**	Minor
Defining Event:		**Injuries:**	138 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Factual Information

HISTORY OF FLIGHT

On October 20, 2007, about 2007 central daylight time, an Airbus A320-211, N331NW, landed on Runway 18 at the Hector International Airport (FAR), Fargo, North Dakota, with the nose gear turned 90 degrees from the direction of travel. The airplane sustained minor damage to the nose gear assembly. The captain, first officer, 2 flight attendants, and 134 passengers were not injured. The 14 Code of Federal Regulations Part 121 scheduled domestic passenger flight was being operated by Northwest Airlines as flight 1432. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed. The flight originated from the Minneapolis-St. Paul International Airport (MSP), Minneapolis, Minnesota, at 1911.

Shortly after departing MSP the flight crew received a BRAKES BSCU CH2 FAULT caution display on the upper Electronic Centralized Aircraft Monitoring System (ECAM). The captain stated he noted that the autobrakes remained set to "maximum" after gear retraction. Upon reaching 10,000 feet, the flight crew reset the BSCU per the cockpit operational manual (COM); however, the BRAKES BSCU CH2 FAULT ECAM caution returned. The captain reported they could not turn off the autobrakes, nor could they change the brake setting to Low or Medium. The flight crew established they had yellow brake pressure (alternate brakes and parking brake), and given the indications they had in the cockpit, they believed they would be landing with alternate brakes. The crew then contacted the company maintenance control (MC) and advised them of the situation.

The captain reported that when they turned the antiskid and nose wheel steering to the off position, maximum braking would also turn off. Based on that information, the crew discussed the possibility of having to land with the antiskid and nose wheel steering turned off.

Although the first officer was the flying pilot for the flight, the captain took over the flying duties during the landing approach with the autopilot and autothrottles on. He reported that when the flaps were lowered to the number 3 position and the landing gear was extended, they received a landing gear (L/G) shock absorber fault indication and the autothrottles (A/THR) and autopilot turned off. The crew contacted the air traffic control tower (ATCT) and requested a climb so they could assess the situation. The captain stated the landing gear remained down and the flaps were raised to the number 2 position. The first officer continued to address the messages on the upper ECAM by performing the procedures in the COM. The first officer also contacted MC informing them of the L/G shock absorber fault. The first officer then informed the captain that he had finished the COM procedures and that the autopilot and A/THR were still inoperative.

The flight crew then requested and received vectors to final approach. The captain stated the

flaps were selected to full and they completed the landing checklist. He stated that they briefed keeping the brake pressure below 1,000 pounds per square inch (psi) during the landing and they would continue the landing roll with manual braking until they came to a stop. They would then turn the nose wheel steering on and taxi to the gate. The captain stated they anticipated an uneventful landing so they did not advise the ATCT of the situation.

The captain stated the touchdown was normal, and the spoilers and reversers were deployed as the nose wheel was lowered to the runway. He stated they felt a vibration when the nose wheel touched down, and the ATCT informed them of flames near the nose gear. The ATCT called out the emergency equipment upon seeing the flames. The captain stated they continued the landing roll on the centerline with a brake pressure of 500 psi. He reported the vibration increased as they were slowing and that the air traffic controller informed them that they no longer could see flames.

The airplane came to rest on Runway 18 with the nose gear strut turned 90 degrees to the direction of landing. The lower half of both the nose gear tire and wheel assembly was ground away due to runway contact. The nose gear was the only part of the airplane that sustained damage.

PERSONNEL INFORMATION

The captain, age 57, held an airline transport pilot (ATP) certificate. He held ratings for airplane single-engine land, airplane multi-engine land, and airplane single-engine sea ratings. The captain held a first-class medical certificate issued on June 5, 2007. The certificate contained a limitation requiring corrective lenses for near and distant vision. The captain had a total flight time of 18,440 hours, of which 6,309 hours were in Airbus A320 airplanes.

The first officer, age 38, held ATP and flight instructor certificates. He held airplane single-engine land and airplane multi-engine land ratings. He also held a certified flight instructor certificate which contained airplane single-engine land, airplane multi-engine land, and instrument airplane ratings. The first officer held a first-class medical certificate issued on March 6, 2007. The medical certificate did not contain any limitations. The first officer had a total flight time at Northwest Airlines of 857 hours, of which 50 hours were in Airbus A320 airplanes.

AIRCRAFT INFORMATION

N331NW, manufacturer serial number 318, Northwest Airlines ship number 3231, was an Airbus A320-211 equipped with CFM56-5A1 engines. The maximum gross weight of the airplane was 166,400 pounds and the estimated gross weight at the time of the incident was 135,300 pounds.

The nose landing gear was last serviced on April 12, 2007. At that time, a pressure check was accomplished and the nose gear strut was serviced with nitrogen and hydraulic fluid.

The Northwest Airlines maintenance program called for the nose gear to be examined at each turnaround check and line check. On June 29, 2007, a pilot generated a maintenance log page stating that 1 – 1.5 inches of chrome was observed on the nose landing gear strut. There was no log entry that the nose landing gear strut was serviced at this time, only that the strut condition was within limits.

METEOROLOGICAL INFORMATION

The weather conditions reported at FAR at 1953 were: Wind 250 degrees at 4 knots; visibility 10 statute miles; few clouds at 10,000 feet; temperature 12 degrees Celsius; dew point 6 degrees Celsius; altimeter 29.55 inches of mercury.

RECORDERS

The airplane was equipped with a L-3 Communications Fairchild Model F100, 128 Word flight data recorder (FDR). The recorder was in good condition and the data were extracted normally. The FDR contained approximately 56 hours of data. According to the recorded data the Autobrake Decel Lo, Autobrake Decel Med, Autobrake Decel Max, Autobrake Fault, Autobrake Off, and the Brake Pedal and Brake Pressure parameters stopped registering valid data within 5 seconds after takeoff. Over the next 40 minutes, the flight climbed to 24,000 feet, cruised, and descended for the approach. At 19:54:24, the landing gear was selected down and the FDR recorded the gear down and locked at 19:54:37. Twenty seconds later, the landing gear Weight-on-Wheels (WOW) parameter for the nose transitioned from air to ground. At 19:55:28, the Autopilot 2, Autothrottle, and Flight Director parameters switched from engaged to disengaged, and a master Warning was recorded. The Gear WOW for Left and Right indicated ground at 20:06:46.

The airplane was equipped with a Honeywell 6022 SSCVR 120 cockpit voice recorder (CVR). The recorder was in good condition and the audio information was extracted normally. A summary of the audio information on the CVR was prepared.

The recording began at 18:28:13. The engine start and takeoff were normal. Shortly after takeoff the captain commented “we’ll deal with it later.” Several minutes later the captain stated he would “work on this little problem.” The captain then referred to the Cockpit Operating Manual reset procedure.

At 19:19:35, the captain stated “we have a BSCU channel two fault without a brakes autobrake fault.” He then accomplished the BSCU computer reset procedure and checked the aircraft log books to see if there were previous problems with the system.

At 19:30:59, the captain radioed MC advising them of the BSCU channel two fault and that the autobrakes max had remained armed since takeoff.

When approaching Fargo, the captain performed the descent and approach checklists, and briefed the abnormal landing procedure with nose wheel steering and the anti-skid switch off. The captain also advised the first officer that he, the captain, would be making the landing.

Fargo approach control was contacted and the flight was issued vectors for a visual approach to Runway 18. The crew then began a descent.

At 19:47:27, the captain called MC again to see if there was any new information. There was none. The captain advised MC that they were going to land with anti-skid and nosewheel steering turned off.

The flight crew continued to prepare for the landing with the captain ultimately calling for flaps three. At 19:53:55, the first officer attempted to select several autobrake settings. The flight crew then observed and discussed the L/G Shock Absorber Fault.

At 19:54:41, the flight crew discussed a thrust lock message and the captain subsequently requested a go around from the tower. The flight crew contacted departure control and the captain requested additional time to work on the problem.

At 19:57:23, the flight crew consulted the Cockpit Operational Manual (COM) and performed the L/G Shock Absorber Fault procedure. The first officer then requested landing clearance to Runway 18.

At 20:01:30, the first officer advised MC of L/G Shock Absorber Fault.

Upon touchdown, the tower advised the flight crew that there were flames under the nosewheel tire. The captain directed the first officer to request emergency equipment. The airplane came to a stop shortly thereafter and the captain elected not to evacuate the airplane.

Recording stopped at 20:29:10

TESTS AND RESEARCH

The following components were removed from the airplane for examination:

1. Nose landing gear (NLG) leg assembly
2. Brake and Steering Control Unit (BSCU)
3. Nose Wheel Steering Hydraulic Control Unit (HCU)
4. Landing Gear Control and Interface Unit (LGCIU), 2 units
5. Electrical Towing Box

NLG LEG ASSEMBLY

The nose landing gear leg assembly, P/N D23175001-12, S/N B305 was manufactured by Messier-Dowty, France. The last overhaul of the assembly was on February 22, 2001.

A post incident examination of the NLG was conducted using the pertinent sections of Messier-Dowty Document Number 21098, A320 NLG - 90 [degree] Landing Shop Inspection Program. The correct amount of oil volume was present within the strut. The strut cylinder pressure at the time of the incident could not be determined as it was released during the initial on-scene examination. However, the cylinder was pressurized to 275 psi during the examination and no leaks were noted. This examination did not reveal any findings which would have resulted in the 90-degree rotation of the nose landing gear strut.

BSCU
The BSCU, P/N C202163382D32, S/N 1387, was manufactured by Messier-Bugatti. The BSCU performs the following functions:

1. Control of the manual or automatic braking for the four main wheels,
2. Regulation of the braking,
3. Nosewheel steering,
4. Brake temperature monitoring,
5. Associated tests and monitoring.

The Airbus A320 family of airplanes (including the A318/A319/A320/A321) is equipped with a BSCU. Some older A320 family airplanes (including the A318/A319/A320/A321) are equipped with an older, Conventional Manufacturing and Maintenance (CMM) BSCU whereas newer airplanes are equipped with a newer Enhanced Manufacturing and Maintenance (EMM) BSCU. The incident airplane was equipped with a CMM BSCU.

The BSCU contains 2 separate and redundant Systems, 1 and 2. The design of the BSCU is such that one system is active and the other system is passive for each flight. If the active system develops a critical fault during the flight, the active system will declare itself faulty and the passive system will become the active system.

Two failures were recorded on the System 2 during the incident flight. Those failures were:

BSCU
Check L/G HYDR. PIPE.

Additional failures were recorded on both System 1 and System 2 during post incident testing with the BSCU still installed on the airplane. The failures for System 1 included:

BSCU;
BSCU:ADIRU [Air Data Inertial reference Unit]1,2,3

The failures recorded for system 2 during the post incident testing were:

CHECK L/G HYDR. PIPE

BSCU:ADIRU 1,2,3

Several tests were conducted at different facilities in an attempt to induce the failure modes recorded by the BSCU during the incident flight. This testing produced a variety of additional intermittent failures. An examination of the test results revealed that several of the failures involved the System 1 monitor board (circuit card assembly), specifically the integrated circuit (IC)57.

Given this information, it was decided to replace the incident (original) IC57 on the System 1 Monitor Board with a new IC57 for further testing. The BSCU with the new IC57 installed passed all the tests. The incident (original) IC57 was then installed on a reference System 1 Monitor Board, during the installation the IC57 card was fractured. Examination of the fracture revealed that it transgressed over the IC57 Chip Select tracks. By disturbing the chip select signal of an undamaged IC57, it produced abnormal BSCU behavior similar to that which occurred during the incident. The failure would cause the BSCU System 1 outputs to become frozen, (analog and discrete outputs including the autobrake MAX ON light, current to the normal and alternate servovalves, current to the steering command, along with braking and steering selector valve commands). The examination also determined that, if the BSCU System 1 commands had frozen, the BSCU System 2 would have been able to detect the System 1 failure, but it would not have been able to take control from the frozen System 1.

Although it is not known if the crack was present at the time of the incident, it was determined that a crack of the IC57 ceramic substrate could also produce BSCU behavior similar to the incident. No other IC57 anomalies were identified during the investigation.

Nose Wheel Steering HCU
The Nose Wheel Steering HCU, P/N C24736000-0-1, S/N M042, controls the steering of the nose landing gear wheels via movements of the pilot's or copilot's flight deck controls. The HCU uses green system hydraulic power and is connected electrically to the BSCU to receive inputs from the hand wheels.

Some of the test results from the inspection of the HCU did not conform to test standards. However, the nonconformities alone would not have resulted in the incident.

Landing Gear Control and Interface Unit (LGCIU)
Two LGCIU's were removed from the airplane for testing. The LGCIU in the Number 1 position was P/N 664700500A4D, S/N 368 and the LGCIU in the Number 2 positions was P/ 664700500A4D, S/N 3431.

A download of the BITE data revealed that on October 21, at 00:55 GMT (19:55 cdt) both LGCIU positions recorded a fault code A152 "nose gear extended prox switch disagreement." This fault indicated that the "NLG Extended" proximity sensor was in a different state compared to the left and right MLG Extended proximity sensors for a period in excess of 30 seconds.

NLG ELECTRICAL TOWING BOX

The electrical box, P/ND23119750, S/N B691, was manufactured by Messier-Dowty. The box was subjected to the manufacturer's test protocol at room temperature and after being cold soaked. The box passed all functional tests under both conditions.

ADDITIONAL INFORMATION

As a result of this incident and the continuing reliability of the CMM BSCU's, Airbus and Messier-Bugatti established a program intended to increase the reliability of the units. In June, 2008, Messier-Bugatti issued Service Bulletin C20216-32-3289, Revision 1, titled "Landing gear – Braking and Steering Control Unit, Modification of the software to standard 10." In addition, on January 10, 2008, Airbus issued Service Bulletin A320-32-1336, Revision Number 01, titled "Landing Gear – Normal Braking – Install BSCU STD 10 by SB only." This Service Bulletin is mandated by European Aviation Safety Agency (EASA) AD 2008-0048 and FAA AD 209-15-07.

Airbus and Messier-Bugatti reported that the CMM BSCU software Standard 10 would correct the inability of a passive BSCU channel to "takeover" from a frozen initially active BSCU system.

As a result of this incident Northwest Airlines has revised the COM to include a Condition Statement, a Caution, and a Note.

COM 2.32.15 L/G SHOCK ABSORBER FAULT was revised to include the Condition Statement, "One landing gear shock absorber did not extend after liftoff or did not compress after landing, causing aircraft systems to be in wrong mode. Nosewheel may be deflected 90 degrees from center if triggered in conjunction with the N/W STRG FAULT." The revision of this procedure also included the addition of the Caution Statement, "If WHEEL N/W STRG FAULT is also displayed, then the nose wheel may be at maximum deflection. (turned 90 degrees from center). During landing, delay nose wheel touchdown for as long as possible."

COM 2.32.19 WHEEL N/W STRG FAULT was revised to include the Note, "If the L/G SHOCK ABSORBER FAULT is also displayed, then the nose wheels may be at maximum deflection. (turned 90 degrees from center). During landing, delay nose wheel touchdown as long as possible."

Pilot Information

Certificate:	Airline transport; Commercial	**Age:**	57,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	June 5, 2007
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	July 15, 2007
Flight Time:	18440 hours (Total, all aircraft), 6309 hours (Total, this make and model), 17216 hours (Pilot In Command, all aircraft), 231 hours (Last 90 days, all aircraft), 95 hours (Last 30 days, all aircraft), 8 hours (Last 24 hours, all aircraft)		

Co-pilot Information

Certificate:	Airline transport; Commercial; Flight instructor	**Age:**	38,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	March 6, 2007
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	October 1, 2007
Flight Time:	857 hours (Total, all aircraft), 50 hours (Total, this make and model), 47 hours (Last 90 days, all aircraft), 47 hours (Last 30 days, all aircraft), 8 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Airbus Industrie	**Registration:**	N331NW
Model/Series:	A320-211	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	318
Landing Gear Type:	Retractable - Tricycle	**Seats:**	157
Date/Type of Last Inspection:	October 15, 2007 Continuous airworthiness	**Certified Max Gross Wt.:**	166400 lbs
Time Since Last Inspection:	48 Hrs	**Engines:**	2 Turbo jet
Airframe Total Time:	47672 Hrs at time of accident	**Engine Manufacturer:**	CFM
ELT:	Installed, not activated	**Engine Model/Series:**	CFM56-5A1
Registered Owner:	Northwest Airlines	**Rated Power:**	25000 Lbs thrust
Operator:	Northwest Airlines	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:	Northwest Airlines	**Operator Designator Code:**	NWAA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night
Observation Facility, Elevation:	FAR,902 ft msl	**Distance from Accident Site:**	
Observation Time:	19:53 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Few / 10000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	4 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	250°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.54 inches Hg	**Temperature/Dew Point:**	12°C / 6°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	MINNEAPOLIS, MN (MSP)	**Type of Flight Plan Filed:**	IFR
Destination:	Fargo, ND (FAR)	**Type of Clearance:**	IFR
Departure Time:	19:11 Local	**Type of Airspace:**	Class D

Airport Information

Airport:	Hector International FAR	**Runway Surface Type:**	Concrete
Airport Elevation:		**Runway Surface Condition:**	Dry
Runway Used:	18	**IFR Approach:**	
Runway Length/Width:	9000 ft / 150 ft	**VFR Approach/Landing:**	Full stop;Traffic pattern

Wreckage and Impact Information

Crew Injuries:	4 None	**Aircraft Damage:**	Minor
Passenger Injuries:	134 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	138 None	**Latitude, Longitude:**	46.920555,-96.815834

Administrative Information

Investigator In Charge (IIC):	Sullivan, Pamela
Additional Participating Persons:	David Slaybough; FAA; Fargo, ND Victoria Anderson; FAA; Washington, DC Melissa Brockenbrough; NWA; Minneapolis, MN Richard Pauly; ALPA; Bloomington, MI Thomas Jacky; NTSB; Washington , DC Erin Gormley; NTSB; Washington, DC Frederic Aime; BEA; LeBourget, France Christopher Courteney; Airbus; Toulouse, France
Report Date:	December 10, 2010
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=66940