



Submission of the  
Air Line Pilots Association, International  
to the  
National Transportation Safety Board  
Regarding the Accident Involving

Northwest Airlines Flight 1432

A320-211

CHI08IA022

Fargo, ND

October 20, 2007



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## Acronyms/ Definitions

AD	Airworthiness Directive
ADIRS	Air Data Inertial Reference System
ADIRU	Air Data Inertial Reference Unit
ARFF	Aircraft Rescue and Fire Fighting
ATCT	Air Traffic Control Tower
BSCU	Brake and Steering Control Unit
CDT	Central Daylight Time
CFR	Code of Federal Regulations
CMM	Component Maintenance Manual
COM	Cockpit Operating Manual
CVR	Cockpit Voice Recorder
ECAM	Electronic Centralized Aircraft Monitoring System
FAA	Federal Aviation Administration
FAR	Hector International Airport, Fargo, ND
IC	Integrated Circuit
IFR	Instrument Flight Rules
MC	Maintenance Control
MSL	Mean Sea Level
MSP	Minneapolis- St. Paul International Airport
NLG	Nose Landing Gear
PF	Pilot Flying
VMC	Visual Meteorological Conditions



## Executive Summary

On October 20, 2007 at 2007 Central Daylight Time (CDT), Northwest Airlines flight 1432, an Airbus A320-211, landed on runway 18 at Hector International Airport, Fargo, ND (FAR), with the nose gear turned 90 degrees from the aircraft longitudinal axis. The aircraft sustained minor damage to the nose gear assembly. The flight was a Code of Federal Regulations (CFR) Part 121 scheduled, domestic passenger flight, operated by Northwest Airlines. Night visual meteorological conditions (VMC) prevailed and an instrument flight rules (IFR) flight plan was filed<sup>1</sup>.

This analysis identifies the chain of events leading to the incident and provides recommendations to prevent similar events from occurring in the future. It will show that there were failures directly causing the event and these failures exacerbated the difficulties for the flight crew attempting to resolve the presented problems.

Post incident tests determined the Brake and Steering Control Unit (BSCU) system 1 froze<sup>2</sup>, preventing the passive BSCU system 2 from becoming active<sup>3</sup>. Examination of the BSCU system 1 from the incident flight revealed several internal cracks and broken components. This included specific damage to the Integrated Circuit 57 (IC57). During post-incident analysis a serviceable IC57 was installed on the damaged BSCU system 1 monitor board and tested. This test produced similar anomalies to those that occurred during the original incident. The failed BSCU1 also caused the auto brake selector to remain illuminated, and presumably armed, at the maximum (MAX) setting.

The nose landing gear shock absorber did not fully extend. This caused the aircraft air/ground logic to be in the ground mode<sup>4</sup> and contributed to the Nose Landing Gear (NLG) turning to 90 degrees from the center position.

The Cockpit Operating Manual (COM) guidance was not sufficient for the flight crew to fully analyze and resolve the fault messages presented to them on the Electronic Centralized Aircraft Monitoring System (ECAM). These faults included the auto brake remaining in MAX after takeoff, a BSCU fault, and a landing gear shock absorber fault.<sup>5</sup> There was also a subsequent loss of the autopilot and auto throttle, and FMS flight plan and performance data.

After the ECAM messages were annunciated the flight crew called Maintenance Control (MC)<sup>6</sup>. MC was unable to provide sufficient guidance to solve the faults and the affected systems remained inoperative for the remainder of the flight.

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<sup>1</sup> NTSB Factual Report, Page 1

<sup>2</sup> Frozen in this scenario refers to a condition where the component is unable to perform. It is not frozen due to low temperatures.

<sup>3</sup> NTSB Factual Report, Page 1d

<sup>4</sup> Northwest Cockpit Operating Manual 2.32.15, (Dec 3, 2007)

<sup>5</sup> Post Flight Maintenance Report

<sup>6</sup> Crew Statements, Page 2



## 1.0 Factual Information

### 1.1 History of Flight

The incident flight originated from Minneapolis- St. Paul International Airport (MSP), Minneapolis, MN. The flight was given clearance to taxi to runway 12L. The First Officer was the Pilot Flying (PF). Shortly after take-off, while climbing through altitude of 1500' Mean Sea Level (MSL), at 1911 CDT<sup>7</sup>, the flight crew observed a BRAKES AUTO BRK FAULT and a BRAKES BSCU CH 2 FAULT (Brake and Steering Control Unit (BSCU) 2 Fault) message (1912 CDT)<sup>8</sup> on the upper Electronic Centralized Aircraft Monitoring System (ECAM).<sup>9</sup> The Captain then noted that the auto brakes were still set to MAX. When they leveled at 10,000' MSL, the flight crew attempted to reset the BSCU utilizing the COM procedure, but the fault message returned. The flight crew was also unable to change the brake setting to "Low" or "Medium", and the auto brakes selector remained illuminated, and presumably armed, in MAX.

The Captain briefed for abnormal landing procedures that included the nose wheel steering and the antiskid switch off<sup>10</sup>. He briefed that this would turn off the auto brakes selection of MAX. While established on final with the autopilot and the auto-throttles on, the Captain took over the flying duties. After the landing gear was extended and the flaps were selected to 3, a L/G SHOCK ABSORBER FAULT was annunciated (1954 CDT)<sup>11</sup>. The autopilot and auto-throttles then disengaged and remained inoperative for the remainder of the flight. Additionally, the FMS flight plan and aircraft performance data was dropped.

The flaps were selected to full and the landing checklist was completed. At 1955 CDT the Captain advised Air Traffic Control Tower (ATCT) the flight would execute a go around to have more time to address the shock absorber fault as well as the disengaged autopilot and auto throttles. The flight crew again consulted the COM to address these faults. After completing all appropriate checklists, though still unable to correct the faults, the flight was cleared for approach to runway 18, and 25 seconds later for landing.<sup>12</sup> After a visual approach<sup>13</sup> and main gear touchdown, the spoilers and reversers deployed. When the captain lowered the nose wheel onto the runway, the flight crew felt an airframe vibration. The ATCT then informed them of flames near the nose wheel. The landing roll was continued on the runway and vibrations increased as the aircraft slowed toward a stop. Aircraft Rescue and Fire Fighting (ARFF) were dispatched to the aircraft.

The aircraft came to rest on runway 18 with the nose gear strut turned to the 90 degree position, approximately a right angle to the direction of the landing. Half of the nose wheel and tire assembly were ground away by runway contact.

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<sup>7</sup> Maintenance Post Flight Report

<sup>8</sup> Maintenance Post Flight Report

<sup>9</sup> NTSB Factual Report, Page 1

<sup>10</sup> CVR Group Chairman's Report, Page 12-2

<sup>11</sup> CVR Group Chairman's Report, Page 12-2

<sup>12</sup> CVR Group Chairman's Report, Page 12-3

<sup>13</sup> NTSB Pilot/Operator Aircraft Accident/Incident report. Page5



## 2.0 Analysis

### 2.1 Systems

#### 2.1.1 BSCU Fault Messages

The flight crew received a BRAKES BSCU CH2 FAULT ECAM warning message, after takeoff, at 1912 CDT<sup>14</sup>. When the flight reached 10,000' MSL, the Captain reset the BSCU in accordance with the COM. COM 2.32.7<sup>15</sup>, a BRAKES BSCU CH 1 (2) FAULT without BRAKES AUTO BRK FAULT, which called for a reset per COM 3.6. To reset the BSCU in flight with landing gear retracted, the A/Skid & N/W STRG switch was to be cycled OFF, then ON. After the crew completed this procedure, the BSCU CH 2 fault message returned.

The BSCU contains two independent and redundant systems, one is active and one is passive during each flight. If the active system develops a critical fault during flight, the active system will declare itself faulty and the passive system will become the active system.

During the flight, SYSTEM failures were recorded internally on BSCU system 2. These failures were: BSCU and CHECK L/G HYDR PIPE as well as BSCU: ADIRU 1, 2, 3. Additional failures were noted during post incident testing on both system 1 and system 2.

Tests were conducted on certain aircraft components at the Messier-Bugatti facility in Velizy-Villacoubaly, France and at the Thales Avionics facility in Meudon-LaForet, France. Failure modes recorded during the incident flight were reproduced. These tests of the BSCU, and specifically IC57, produced a variety of additional intermittent failures as well. Several of these failures were read from IC57 of the BSCU System 1 monitor board. The IC57 was determined to be fractured.<sup>16</sup> The original IC57 on BSCU system 1 monitoring board was replaced with a serviceable IC57. A new IC57 was installed in BSCU 1 during post-incident testing. The new circuit card was subsequently found to be fractured as well, either prior to or during installation. Cracks were observed to transgress over the IC57 Chip select tracks<sup>17</sup>. Disturbing the chip select signal of a serviceable IC57 produced BSCU behavior similar to the incident flight. This signal would cause BSCU System 1 monitor board outputs to become frozen. Certain analog and discrete outputs were activated; this included AUTO BRK MAX ON light, activation current to the normal and alternate servo valves, current to the steering command and the braking and steering selector valve commands. These tests determined that if BSCU system 1 freezes, system 2 is able to detect the system 1 failure, but is unable to take control from system 1 and become active.

It was not determined if the cracks were present at the time of the incident, but a crack in the ceramic substrate of the IC57 board could also produce BSCU behavior similar to the incident.<sup>18</sup>

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<sup>14</sup> Maintenance Post Flight Report

<sup>15</sup> Cockpit Operating Manual 2.32.7 (February 10, 2003)

<sup>16</sup> NTSB Systems Group Chairman's Report, Page 17

<sup>17</sup> NTSB Factual Report, Page 1d

<sup>18</sup> NTSB Factual Report, Page 1d



Messier-Bugatti is the principal manufacture of the nose landing gear, main landing gear, brakes, steering and associated hydraulic and computer units for Airbus. As a result of this incident, and to continue reliability of the Components Maintenance Manual (CMM) BSCU's, Airbus and Messier-Bugatti established a program 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".<sup>19</sup> Airbus also issued a Service Bulletin A320-32-1336, Revision Number 1, in January, 2008, titled "Landing Gear – Normal Braking – Install BSCU STD 10 by SB only"<sup>20</sup>. The Federal Aviation Administration (FAA) issued a an Airworthiness Directive (AD) effective on August 25, 2009, mandating modification or replacement of BSCU standard 7, 9 or 9.1, with BSCU standard 10. The AD must be complied with within 18 months after the effective date of this AD.<sup>21</sup>

The BSCU software update to standard 10 corrects the failure of a passive BSCU system to "takeover" from a frozen active BSCU system<sup>22</sup>.

### 2.1.2 Shock Absorber Fault

After the Captain took control of the aircraft (1952 CDT) and became the PF, he called for gear down and for flaps 3 (1953 CDT). At 1954 CDT the flight crew received an L/G SHOCK ABSORBER FAULT on the ECAM. This message was followed by three more warning messages, AUTO FLT A/THR OFF, CAB PR LDG ELEV FAULT, and AUTO FLT AP OFF.<sup>23</sup>

This incident has similarities to the Jet Blue flight 292 that landed with the NGL turned 90 degrees from center. However, the Jet Blue crew also received an N/W STRG FAULT message. The Northwest crew did not receive this message. The gear was selected down at 1954 CDT at this time the N/W STRG and A/Skid was still on. The failed BSCU, which is responsible for the nose wheel steering, prevented the N/W STRG FAULT to be displayed on the ECAM. The crew later (at 2004 CDT) turned the nose wheel steering and anti skid switch off to eliminate the AUTO BRK MAX selection. The flight crew did not want to land the aircraft with maximum braking on.

## 2.2 Northwest Operations

### 2.2.1 AUTO BRK MAX Push Button

The crew of Northwest flight 1432 followed the procedures listed in the COM for this failure. The first fault message the crew had to resolve was BRAKES AUTO BRK FAULT. The AUTO BRK MAX push button had remained illuminated after takeoff. This selection (AUTO BRK MAX) is the normal selection for takeoff, but it should disengage once the aircraft has been in flight for 10 seconds or if the flight crew deselected the AUTO BRK MAX pushbutton switch. It will also disengage if one of the arming parameters is lost. These arming parameters include; green (left engine) hydraulic system pressure available, the

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<sup>19</sup> NTSB Systems Group Chairman's Report, Page 20

<sup>20</sup> NTSB Systems Group Chairman's Report, Page 20

<sup>21</sup> [www.regulations.gov](http://www.regulations.gov) (docket FAA-2008-1365)

<sup>22</sup> NTSB Factual Report, Page 1d

<sup>23</sup> Post Flight Maintenance Report



anti skid system has electrical power, there is no failure in the braking system and at least one of the Air Data Inertial Reference System (ADIRS) is functioning.

All airborne conditions were met, but the AUTO BRK MAX push button light remained on. The crew was also unable to select another brake setting (LO or MED).

There was not a COM procedure that would let the crew effectively handle this fault condition. The captain contacted Dispatch through the company radio and was patched through to Maintenance Control (MC). MC was advised about the crew's inability to deselect the MAX auto brakes. MC was not able to provide the crew with guidance to troubleshoot or disarm the maximum brake selection.

### 2.2.2 BRAKES BSCU CH2 FAULT

After takeoff, a BRAKES BSCU CH 2 FAULT was also annunciated. The flight crew proceeded to the COM and attempted a reset of the BCSU per COM 2.32.7 which, without a BRAKES AUTO BRK FAULT directed them to COM 3.6 which called for cycling the A/Skid & N/W STRG switch OFF then ON. The BSCU fault subsequently returned. MC was also informed about this fault and could not provide any further guidance.

### 2.2.3 L/G SHOCK ABSORBER FAULT

On descent into Fargo, the captain elected to take over as the PF. He called for flaps 3 and gear down. Shortly thereafter, a chime sound, normally associated with gear extension, was recorded on the Cockpit Voice Recorder (CVR).<sup>24</sup> The crew observed a L/G SHOCK ABSORBER FAULT on the ECAM. This fault was followed by the sound of a triple chirp<sup>25</sup>, indicating an approach capability downgrade. The autopilot and auto-throttle self-disengaged, the FMC flight plan deleted and a CAB PR LDG ELEV FAULT was annunciated. According to the COM, the procedure for the shock absorber fault was to "Place the landing gear lever DOWN when below 250 knots or leave landing gear lever down if retraction was not attempted". It was also noted not to exceed 280 knots and if necessary to deselect auto brakes MAX.

This procedure did not provide any additional assistance to the crew since they were on their descent and had already lowered the gear and had been unable to deselect auto brakes MAX.

In the revised Northwest Airlines COM dated December 3, 2007, a L/G SHOCK ABSORBER FAULT condition is described as: "One landing gear shock absorber did not extend after liftoff or did not compress after landing causing the aircraft to be in the ground mode. It also states "Nose wheel may be deflected 90 degrees from the center if triggered in conjunction with N/W STRG FAULT".

In the case of the incident flight there was no N/W STRG FAULT message displayed. However, the nose wheel did deflect 90 degrees from center. The BSCU and the N/W STRG are directly connected; the BSCU also controls the Steering Servo Valve. This same error in the aircraft flight mode existed but because the BSCU was frozen, the N/W STRG FAULT message was not displayed. Even with the updated

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<sup>24</sup> Group Chairman's Summary Report, Page12-2

<sup>25</sup> ibid





COM from December 3, 2007, the crew could not have anticipated the nose wheel position at 90 degrees from center.

The December 3, 2007 COM wording for the procedure was included in the AD effective October 10, 2007<sup>26</sup> but the AD does not include a procedure for the case the nose wheel steering is selected off by the flight crew in order to avoid landing with AUTO BRK MAX, as in this case.

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<sup>26</sup> Docket FAA-2007-27776



### 3.0 Conclusions

1. After receiving multiple fault messages, the pilots and Maintenance Control utilized the Aircraft Cockpit Operating Manual guidance. The information within the COM or in other documents available to MC was insufficient for the flight crew and or Maintenance Control to resolve the following specific failures:
  - a. AUTO BRK MAX: The system remained armed in excess of 10 seconds after the aircraft became airborne as well as after the flight crew attempted to select different brake settings.
  - b. BSCU failure: BSCU CH1 froze and inhibited BSCU CH2 from assuming control. Neither BSCU was able to control the nose wheel steering.
  - c. L/G SHOCK ABSORBER FAULT: A partially extended shock absorber caused the aircraft to remain in the ground mode after takeoff. This may have caused the landing gear to be turned 90 degrees from center.
2. Resources available to Maintenance Control were insufficient to provide flight crew with additional resolution strategies.
3. The AD FAA-2008-1365 does not provide guidance for the situation where the anti skid and the nose wheel steering is turned off; therefore the flight crew may not suspect the nose landing gear to be turned 90 degrees.
4. No aircraft modification, procedure or COM change actually prevents the possibility of the nose landing gear being turned 90 degrees.



## 4.0 Findings

1. ECAM warning messages were displayed while climbing through 1500' MSL. These messages were a BRAKES AUTO BRK FAULT and a BSCU CH2 fault.
2. The auto brake selection did not clear after 10 seconds after takeoff as it was designed to.
3. Crew was unable to deselect the current auto brake setting.
4. The Cockpit Operating Manual does not include procedures for the auto brake locked on.
5. The Brake and Steering Control Unit system 1 froze and was unable to transfer control to system 2.
6. Reset procedures for the BSCU did not succeed and the fault message returned.
7. After the flaps 3 were selected and the gear was down, a shock absorber fault message displayed.
8. A less-than fully extended shock absorber caused the aircraft to be in the ground mode.
9. The failed BSCU and the aircraft in the wrong mode caused nose landing gear to be turned 90 degrees from the center.
10. Cracks were found on the monitoring board of the faulty BSCU
11. IC57 was fractured.



## 5.0 Recommendations

To the Federal Aviation Administration...

1. Add language in the Cockpit Operating Manual for L/G SHOCK ABSORBER FAULT that includes the situation where the nose wheel steering is turned off to ensure the flight crew can anticipate the nose gear might be turned 90 degrees.
2. If the shock absorber does not extend fully after takeoff, and the aircraft is in an incorrect mode, an alert should display to the flight crew.
3. Consideration should be given to enabling the FMS to retain the active flight plan and performance data until receiving a weight-on-wheels message from all three landing gear or until both engaging master switches are selected off.