NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

GROUP CHAIRMAN'S FACTUAL REPORT – AIRCRAFT SYSTEMS

June 16, 2020

A. ACCIDENT DCA13FA094

Location:	Newark Liberty International Airport, New Jersey
Date:	May 18, 2013
Time:	0104 Eastern Daylight Time
Aircraft:	Piedmont Airlines, operated as U.S. Airways Express flight 4560, a Boeing (DeHavilland) DHC-8-102, N934HA

B. AIRCRAFT SYSTEMS GROUP

The following group members participated in the group's activities as follows:

On-scene activities, June 25-26, 2013:

Chairman:	Tom Jacky National Transportation Safety Board Washington, D.C.
Member:	Stan Peters Federal Aviation Administration Teterboro, New Jersey
Member:	Larry Bobak Piedmont Airlines Salisbury, Maryland
Member:	Captain Frank Young Air Lines Pilots Association Apex, North Carolina

Technical Advisors to the Transportation Safety Board – Canada:

Member:	Nora Vallée Transport Canada Ottawa, Ontario, Canada
Member:	David Fisher Bombardier Aerospace

Toronto, Canada

Member: Tom Fischer
Messier-Bugatti-Dowty
Ajax, Ontario, Canada

Examination at Messier-Bugatti Dowty, Ajax, Ontario, Canada, November 2013:

Chairman: Tom Jacky
National Transportation Safety Board
Washington, D.C.

Member: Larry Bobak
Piedmont Airlines
Salisbury, Maryland

Member: Captain Frank Young
Air Lines Pilots Association
Apex, North Carolina

Member: Peter Rowntree
Transportation Safety Board of Canada
Toronto, Ontario, Canada

Technical Advisors to the Transportation Safety Board of Canada:

Member: Paul Jones
Transport Canada
Ottawa, Ontario, Canada

Member: David de Vogel
Bombardier Commercial Aircraft
Toronto, Canada

Examination at Messier-Bugatti Dowty, Ajax, Ontario, Canada, May 2015:

Member: Larry Bobak
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Member: Peter Rowntree
Transportation Safety Board of Canada

Toronto, Ontario, Canada

Technical Advisors to the Transportation Safety Board of Canada:

Member: David Monteith
Bombardier Commercial Aircraft
Toronto, Canada

Member: Tom Fischer
Messier-Bugatti-Dowty
Ajax, Ontario, Canada

C. SUMMARY

On May 18, 2013, about 0104 eastern daylight time, N934HA, a Piedmont Airlines, Boeing (DeHavilland) DHC-8-102, operated as U.S. Airways Express flight 4560, a Title 14 CFR Part 121 scheduled domestic commuter passenger fight from Philadelphia, Pennsylvania, to Newark, New Jersey, experienced an event in which the left main landing gear did not release from the up and locked position prior to landing. The flight crew performed the applicable emergency procedures and tried to lower left main landing gear. All attempts were unsuccessful, and the crew elected to conduct gear up landing on runway 04L at Newark Liberty International Airport (KEWR), Newark, New Jersey. The airplane incurred substantial damage. There were no injuries to the 3 crewmembers or 31 passengers that were onboard.

The group met at the United Airlines Maintenance Hangar 55 at Newark Liberty International Airport in Newark, New Jersey on June 25-26, 2013 to document the accident airplane and witness a demonstration of the extension and retraction of the main landing gear of the accident airplane. The group focused its efforts on the left main gear and the inability of the gear to extend.

During the group activities, the main landing gear was extended 9 times by use of the alternate gear extension system and extended 2 times by use of the normal landing gear extension system.

Several airplane components were removed at the request of the group chairman. Prior to the arrival of the group for the June 2013 group activities, the removed components were re-installed onto the accident airplane. At the end of those activities, the following airplane components were retained by the National Transportation Safety Board for further examination:

1. Uplock Roller Assembly (Left Main Gear)
   Part Number: 10165-5
   Roller (sub assembly)
   Part Number: 10168-3
   Note: The rollers were not serialized.

2. Main Landing Gear Uplock Assembly (Left)
   Part Number: 11300-103
   Serial Number: DCL242/93
3. Uplock Roller Retention Shoulder Bolt
   Part Number 10166.3

The group then met at the Messier-Bugatti-Dowty facility in Ajax, Ontario, Canada on November 5-6, 2013 to further examine the retained components listed above.

The main landing gear uplock assembly was tested according to the Messier-Dowty Acceptance Test Procedure (ATP). The uplock roller assembly and retention shoulder bolt were visually and dimensionally checked. A groove worn on the uplock latch was also dimensionally checked.

Finally, the group met at the Messier-Bugatti-Dowty facility in Ajax, Ontario, Canada on May 5, 2015. The group met to conduct Acceptance Test Procedure (ATP) tests on a new Main Landing Gear Uplock Assembly, provided by Messier-Bugatti-Dowty, that did not have a groove worn on the uplock latch.

The investigation, in summary, found that the left main gear uplock roller was seized. In addition, the left main gear uplock latch was determined to have a wear groove larger than manufacturer's tolerance.

All documents and photographs developed during the group activities were provided electronically to the group members.

D. DETAILS OF INVESTIGATION

The airplane was landed without any of the airplane's three landing gears extended. The airplane landed (on its lower fuselage) on Runway 04L at Newark Liberty International Airport, New Jersey. See Figures 1 and 2.

Figure 1 -The airplane after landing without the nose or main landing gears extended. (Photograph courtesy of the FAA)

Figure 2 – Aft view of the airplane after landing without the nose or main landing gear extended. (Photograph courtesy of the FAA)

1.0 Description of Landing System and Alternate Gear Release Systems

The Bombardier (DeHavilland) DHC-8-102 was equipped with a normal landing gear extension and retraction system and an emergency extension system.

1.1 Normal Landing Gear System

The DHC-8-102 was equipped with a tricycle landing gear system, with one main landing gear on each wing completely enclosed in the engine nacelle when retracted. The nose landing gear was stowed in the forward fuselage. The main gears retract aft and the nose landing gear retracts forward. See Figure 3.

Figure 3 - The Left Main Landing Gear of the accident airplane, on jacks, after removal from the runway. The gear moves aft and up during the gear retraction sequence.

Each main landing gear consisted of a single stage nitrogen/oil shock strut with an outer cylinder and (inner) piston. The gear was attached to the wing/engine nacelle by a yoke assembly and supported by a drag strut and torque links.

The landing gear was controlled in the flight deck by use of the Landing Gear Selector Lever on the Landing Gear Selector Panel, located to the right of the Engine Instrument Panel. The lever is placed in either the UP or DN (down) position to operate the gear while holding down the gear selector lever lock release button. While the gear is in transit an amber light in the gear selector lever is illuminated. In addition, nine advisory lights on the top of the Landing Gear Selector Panel – for the LEFT, NOSE, and RIGHT gear – provided indication of the gear status. Three green lights indicated the respective gear are down and locked, 3 red lights indicated the gear are unlocked (or

unsafe), and 3 amber lights indicated that the respective gear doors are still open after completion of the extension or retraction sequence. See Figure 4.

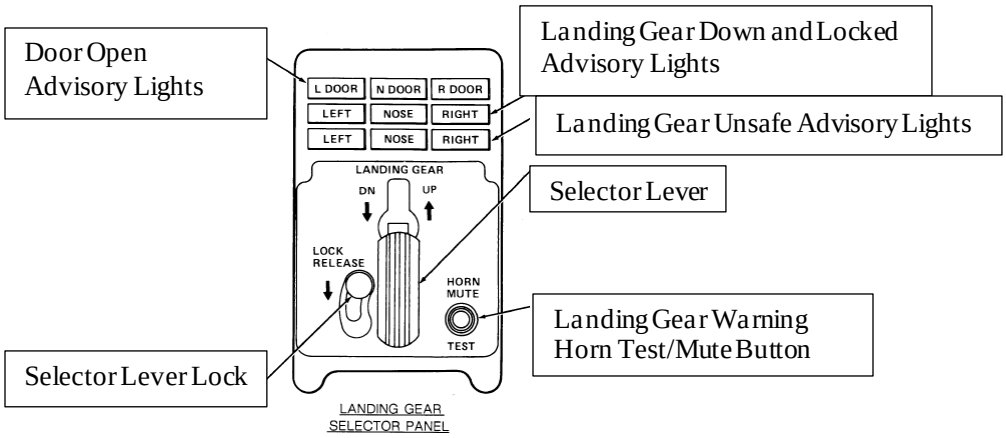

Figure 4 - Landing Gear Selector Panel (Courtesy of Bombardier)

The airplane's Proximity Switch Electronics Unit (PSEU) uses inductance-type proximity sensors to control the sequencing of the landing gear and gear door, landing gear and gear door advisory lights. In addition, a weight-on-wheels (WOW) signal from proximity sensors on the landing gear prevent the gear from retraction while on the ground.

1.2 Alternate Release/Emergency Extension of the Main Landing Gear System

The Alternate Landing Gear Extension System was meant for in-flight use when hydraulic power from the Number 2 hydraulic system is not available. The alternate release system is a mechanical system that uses cables and pulleys to open the main landing gear doors and release the main and nose gear uplocks. The main gears use free fall and, if necessary, a hydraulic hand pump, to extend the main landing gear to the fully extended and locked position. The nose landing gear extends by freefall and assisted by airflow.

The alternate release system is activated in the flight deck by use of the main gear alternate release handle. A door in the flightdeck ceiling, above the first officer, is opened for access to the handle. When the handle is pulled, the attached cable is routed through a series of pulleys, slide assemblies, cam mechanisms and turnbuckles to open the landing gear doors and eventually, the main gear uplock latch. See Figure 5.

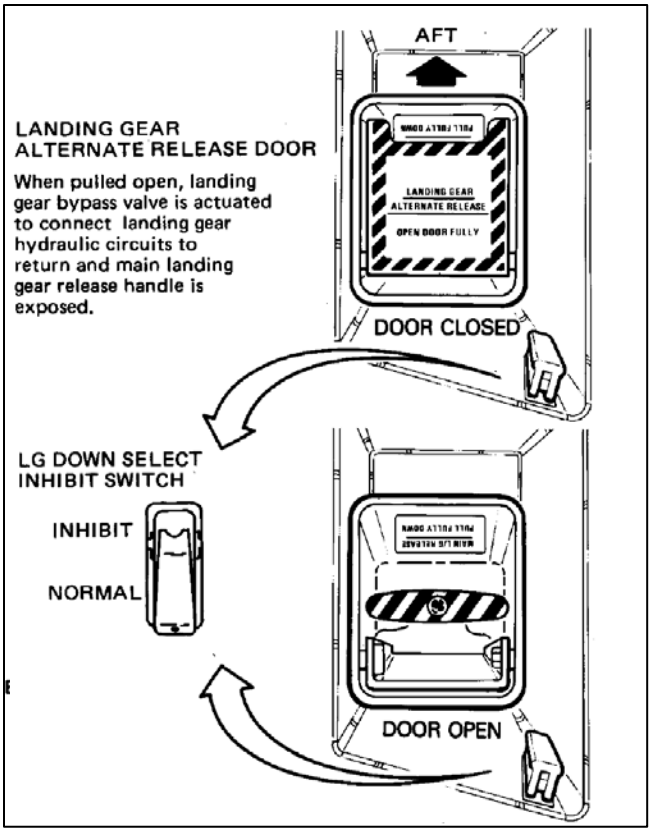

Figure 5 - Schematic of Landing Gear Alternate Release Door and Handle. (Picture Courtesy of Bombardier)

On the left and right gear strut, the main landing gear uplock roller sits on the uplock latch such that, when the alternate system is activated, the latch unhooks from the rotating roller and the gear "falls" away. See Figure 6.


Figure 6 - Main Gear with Uplock Roller Circled in Red. Note: Airplane in figure is not the accident airplane. (Photograph Courtesy of Piedmont)

The alternate system is designed so that the system will always release the gear; there is no back-up system to the alternate release/emergency release system.

2.0 On-scene Examination of Incident Airplane and Landing Gear Systems

The group met at the United Airlines Maintenance Hangar at Newark Liberty International Airport in Newark, New Jersey on June 25-26, 2013. The airplane had been moved into the hangar and placed onto hydraulic jacks to facilitate the group's activities. See Figure 7.

Figure 7 - The accident airplane in the hangar.

2.1 Installation of Removed Components

Prior to the arrival of the group the removed components were re-installed onto the accident airplane. The removed components were hand-carried by the NTSB to the United facility (except for the main landing gear retract actuator fitting, which was hand-carried by Piedmont Airlines personnel).

The following parts were reinstalled onto the airplane:

1) Uplock Assembly, Part Number: 11300-103, Serial Number DCL242/93
2) Retract Actuator, Part Number: 10500
3) Mechanical Sequence Valve (MSV), Part Number: 69210
4) Main Landing Gear Door Actuator, Part Number: 82970014
5) Main Landing Gear Retract Actuator Fitting

2.2 Examination of the Airplane's Exterior

The airplane exhibited substantial damage to underside of aircraft, including fuselage skin abraded in several areas, consistent with damage incurred during the accident sequence.

Inside the airplane, portions of the cabin floor, carpeting, and seats had been removed for access to the below-floor areas. Several avionics components below the cabin floor had been removed. In the flight deck, the AUX FUEL PUMPS and STBY HYD pumps were switched from ON to OFF.

2.3 Expanded Download of Proximity Sensor Electronics Unit

The proximity sensor electronics unit (PSEU) was downloaded in an expanded format using protocol provided by Bombardier. The following fault was noted:

Fault 52 – A1 Driver Card Fault

2.4 Examination of the Airplane's Main Landing Gear System

A visual examination of the left and right main landing gear was conducted. In general, neither landing gear displayed visible physical damage. However, the left main landing gear uplock roller was found seized and would not rotate by hand. See Figure 8.

Figure 8 - Left Main Gear Uplock Roller, as installed.

The right main landing gear uplock roller could be rotated by hand.

On the latch of both the left and right main gear uplocks a "worn" groove was noted on the lower surface of the latch. The groove in the left uplock latch appeared slightly larger than the groove in the right uplock latch. See Figure 9.

Figure 9 - Side View of Left Main Gear Uplock.

A measurement of the groove on the left and right uplock latch was conducted. Typically, this measurement would be accomplished using a pin gauge. However, because a pin gauge was unavailable, the measurements were taken using a calibrated scale.

The measurements were taken per the Messier-Dowty Data Sheet. Comparing the measurements of the grooves against the specifications detailed on the Messier-Dowty Data Sheet, the group consensus was that the groove on the left main landing gear uplock latch was at or beyond wear limits, and the groove on the right main landing gear uplock latch was at or slightly below wear limits.

2.5 Alternate Landing Gear Extension System Rigging Check

With landing gear extended, both main landing gear uplocks were placed in the "up and locked" position by hand. The alternate release extension T-handle (in the flight deck) was then pulled to verify that there was no undo slack or force required unlatch the uplocks. No undo slack or extra force was noted.

Two tests were accomplished. For the first test, the alternate extension handle was pulled slowly. Both uplock latches released; the right uplock latch released first, and the left uplock latch released second, with a delay due to the slow rate of handle pull.

For the second test, the alternate extension handle was pulled quickly. Both uplock latches released at approximately the same time.

The group considered the results of the test as normal.

2.6 Retraction of the Main Landing Gear

The airplane was lifted onto the jacks. Piedmont provided a hydraulic "mule" for hydraulic power. The landing gear was then retracted using the normal landing gear system.

During the retraction, the "L DOOR" amber advisory light remained illuminated substantially longer than the nose and right main gear door advisory lights.

2.7 Alternate Main Landing Gear Extension System Tests

A test of the alternate main landing gear extension system was then accomplished. With all the landing gear retracted, the alternate landing gear extension procedure, as documented in the Piedmont Dash 8 Non-Normal & Emergency Checklist, was followed.

To check the force necessary to release the main landing gear, a Bombardier strain/force gauge (fish scale) [documented as Bombardier Tool #HF0093, Chatillon Force Gauge, calibrated Week 20, 2013, due date Week 20, 2015, calibrated range: 0-200 pounds], was secured to the alternate gear release T-handle using 2 zip ties (See Figure 10). The T-handle was pulled using the handles on the force gauge (2 handles, one on each side of the gauge, with one hand on each handle) and the maximum force noted to release the main landing gear.

Figure 10 - The "fish scale" force gauge, as installed, connected to the Alternate Gear Release T-Handle.

The test was accomplished several times, at different rates (e.g. slow, fast) and by use of rapid, jerking, extensions of the force gauge handle. In general, the right main landing gear released with "normal" force and in sequence, but the force required to release the left main landing gear was more than 240 lbs.

When the force gauge was pulled at a slow rate, the pull force results from the first alternate extension test were:

- Left/Right main landing gear doors: ~16 lbs.
- Right main landing gear release: ~70 lbs.
- Left main landing gear release: ~240 lbs.

In another test, a 186 lb. Piedmont Captain sitting in the First Officer's seat could not release the left main gear, even by "hanging" from the T-handle (i.e., pulling himself up from the seat).

After each test, the landing gear was retracted using the normal gear retraction system via the landing gear handle. The group noted that, for each retraction, the (left) L DOOR advisory light illuminated longer than what the group considered normal.

As per the alternate extension checklist, the nose landing gear alternate extension system operated normally.

2.8 Normal Main Landing Gear Extension System Test

With all the landing gears retracted, the normal landing gear extension was tested using the normal extension procedure. Once the landing gear handle was placed into the extended position, the following observations were made:

- Right main landing gear extended normally
- Nose landing gear extended normally
- Left main landing gear indicated "unsafe" on flight deck
- Left main landing gear did not extend; remained engaged in the uplock

2.9 Alternate Extension, Right Main and Nose Gear Down and Left Main Up

The conditions of this test were similar to the tests described in Section 2.7, with the exception that, at the beginning of the test, the test started with the right main and nose landing gear extended and the left main gear still retracted in the uplock.

In general, the forces experienced with earlier "all gear up" test were replicated here – i.e. high forces needed to extend left main gear.

During the test, smoke from an unknown origin was observed coming from the left nacelle. After troubleshooting it was determined the source of the smoke was not related to the landing gear.

2.10 Left Main Landing Gear Uplock Roller Inspection and Alternate Gear Extension with Uplock Rollers Switched

The left main gear uplock roller did not rotate by hand, but the right main gear uplock roller could be rotated by hand. The left main gear uplock roller was removed for inspection. Upon removal it was noticed that the internal roller bearings had rust-colored material on the internal surfaces (See Figure 11). The internal pin exhibited markings that appeared to be from the roller bearings. The bearing seal appeared compromised.

Figure 11 - The left gear uplock roller, after removal.

The roller was cleaned and lubricated and then installed on the right main landing gear. The right uplock roller was moved to the left main landing gear.

The tests of the normal and alternate main landing gear extension were then repeated.

Using the normal extension method, both landing gear extended in what appeared to be normal fashion. The flight deck L DOOR indication remained illuminated for a time closer to the nose and right main gear door advisory lights than with the left and right uplock rollers in their original positions.

The alternate main landing gear extension procedure was then repeated 4 times with the swapped uplock rollers. In each case, both the right and left main landing gear released and extended. The force used to pull the T-handle (using the force gauge) was measured on the first and second attempt; when the force gauge was pulled slowly, the force measured to release the left main gear was measured as approximately 150 pounds.

For the 3rd and 4th attempt using the alternate landing gear extension handle and the swapped uplock rollers, the test was conducted by group members to assess the amount force necessary to release and extend the main landing gears via the T-handle. In each case, the force necessary to release and extend the gears was noted as “normal force”.

2.11 Removal of Component for Further Investigation

After the tests, the following components were removed from the airplane and provided to the NTSB for further testing:

1. Uplock Roller Assembly, items not serialized

2. Main Landing Gear Uplock Assembly
   Part Number: 11300-103
   Serial Number: DCL242/93

3. Uplock roller retention shoulder bolt

3.0 Examination of Main Landing Gear Uplock Latch at Manufacturer's Facility

The group met at the Messier-Bugatti-Dowty facility in Ajax, Ontario, Canada on November 5-6, 2013 to examine the removed components (Section 2.11).

The removed components were shipped to the Messier-Dowty by the NTSB prior to the group's arrival. Messier-Dowty placed the components in secure storage. When the group met, the shipping container was removed from secure storage. The shipping box was opened and the components removed and visually inspected.

3.1.0 Examinations of the Main Landing Gear Uplock Assembly

3.1.1 General Visual Inspection

The main gear uplock assembly was visually inspected. The part number and serial numbers were confirmed. The hydraulic input junction was noted without a shipping cap. The input junction was removed from the unit and the exposed area wiped clean. In general, the uplock assembly was noted in good physical condition, with no visible damage; the component was dirty. The worn groove on the uplock latch was noted. See Figure 12.

Figure 12 - Left Main Gear Uplock Latch and Groove.

The alternate release bearing freely rotated when the lock lever (target arm) was lifted from the bearing.

3.1.2 Acceptance Test Procedure

The Messier – Dowty DHC-8 Uplock Assembly MLG Acceptance Test Procedure 11300-100, Revision E, was accomplished on the uplock assembly. For the test, the uplock assembly was attached to Messier-Dowty HTB 001 (Test Rig 18). Test conditions 5.4.1 and 5.4.2 were accomplished on the test rig.

The uplock assembly was then attached to Messier-Dowty HTB 002 (Test Rig 19). ATP Test conditions 5.4.3, 5.4.4, and 5.4.5 were accomplished on the uplock assembly while fitted to this test rig.

While fitted to the test fixture on HTB 002, the starting position of the test fixture uplock roller on each test condition was not in the accident airplane's uplock assembly's worn groove, but closer to the open end of the latch. Efforts to adjust the test fixture such that the uplock roller would start each test condition in the worn groove were unsuccessful.

The Alternate Release Test (5.4.3), in addition to the ATP criteria, was accomplished with the force applied to the latch in "horizontal" angle to simulate the arrangement of the alternate system release cable on the airplane. The values were recorded on the ATR (Acceptance Test Report) pages.

The pull force was applied in this manner 3 times. The following test values were recorded:

Paragraph 5.4.3 – Alternate Release Test:

Test 1 = 16 lbs.
Test 2 = 17 lbs.
Test 3 = 16 lbs.

The ATP was completed with no faults found; all measurements were within tolerances. Copies of the resultant ATR test sheets were provided to each of the group members and technical advisors.

3.1.3 ATP Test with Seized Roller Assembly

In addition to the ATP, pertinent sections of the ATP test were accomplished with the Test Rig's uplock roller assembly secured so that it could not rotate, simulating a seized roller. The seized roller was not in the worn groove, but more forward towards the open end of the latch. Then ATP sections 5.4.3 (Alternate Release) and the "Load" half of 5.4.4 (Unlocking Pressure at Load) were successfully accomplished 3 times. The following measurements were noted:

Paragraph 5.4.3. Alternate Release Results:

Test 1 = 15 lbs.
Test 2 = 15 lbs.
Test 3 = 15 lbs.

Paragraph 5.4.4. Unlocking Pressure at Load:

Test 1 = 980 psi
Test 2 = 1060 psi
Test 3 = 1060 psi

Note: Although the test elements and protocol were from the ATP, the seized roller was not part of the ATP and that the resultant recorded values may not be comparable to the values recorded with a functional uplock roller assembly.

3.1.4 Measurement of Wear on the Latch

Using the procedure detailed in Messier-Dowty Uplock Assembly 11300-100 Series, Component Maintenance Manual (CMM), Section 32-30-21, Revision Date March 25, 2013, (page 8009 for the procedure, page 8010 for Figure 802, and page 8011 for Figure 803, dated August 22, 2012), the groove worn on the uplock latch assembly was measured. See Figure 13.

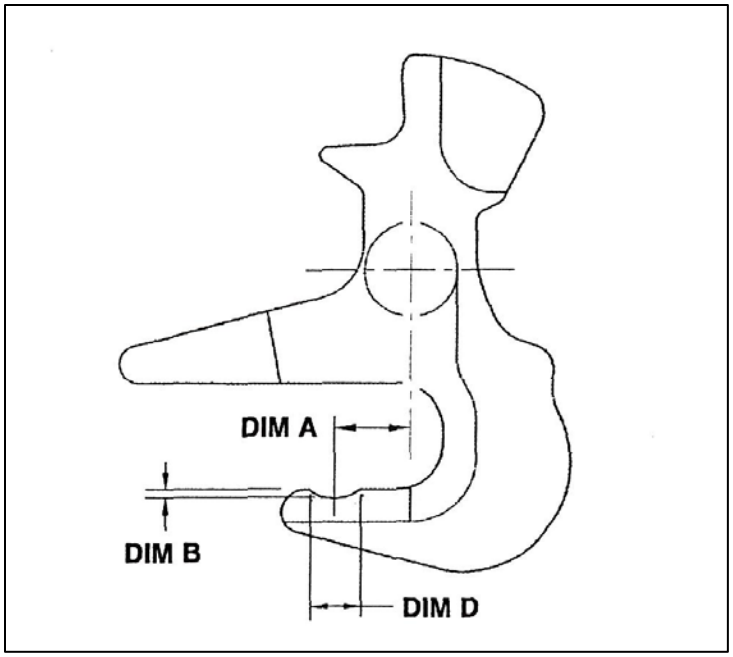

Figure 13 - Uplock Latch Wear Dimensions, From Messier-Dowty Uplock Assembly CMM, Figure 802. (Figure courtesy of Messier-Dowty)

- Using Figure 802, dimension "D", the width of the worn groove, was measured as 0.38".
- Using Figure 802, dimension "A" (the gear pin offset) was measured on the uplock latch as 0.6565".
- Using Figure 802 (Latch Working Surface - Wear Allowances) and Dimension "D", Dimension "B" was determined to be 0.044".
- Using Dimension "A" as the input to Figure 803 (Latch Working Surface-Wear Allowance Graph), the resultant permitted Maximum Indent Depth (Dimension C) was determined as 0.035".
- Using Paragraph C.1 (page 8009), Dimension "B" was greater than Dimension "C". Therefore, the uplock latch was determined to be beyond limits by 0.009".

3.1.5 Altered Test Fixture Tests Conducted with Uplock Roller in Worn Groove

Messier-Dowty altered the ATP Test Fixture so that the position of the uplock roller assembly was moved into the worn groove on the uplock latch assembly (the uplock roller was moved 0.262" back towards the closed end of the latch). Then ATP sections 5.4.3 (Alternate Release) and 5.4.4 (Unlocking pressure at load) were accomplished on the uplock latch assembly.

With the uplock roller in the uplock latch assembly worn groove and the uplock roller free to rotate, the following measurements were recorded:

Paragraph 5.4.3. Alternate Release Results:

Test 1 = 28 lbs.
Test 2 = 28 lbs.
Test 3 = 28 lbs.

Paragraph 5.4.4. Unlocking Pressure at Load:

Test 1 = 2,000 psi.
Test 2 = 2,100 psi.
Test 3 = 2,100 psi.

With the Test Rig's uplock roller assembly secured so that it could not rotate, thereby simulating a seized roller, and the uplock roller assembly in the worn groove of the uplock latch, ATP test sections 5.4.3 and 5.4.4 (Unlocking pressure at load) were attempted. However, for Test 5.4.3, the alternate system release could not be accomplished; the force gauge (fish scale) was at maximum value (50 lbs.) without alternate release. For ATP Test 5.4.4, the test was stopped at an unlocking load pressure at 3,000 psig without uplock latch release.

Finally, with the Test Rig's uplock roller assembly secured so that the roller could rotate but not "freely", and the uplock roller assembly in the worn groove of the uplock assembly, the ATP test section 5.4.4 (Unlocking pressure at load) was attempted. However, when the first test was attempted, the roller moved freely, and the test was aborted.

3.2 Examination of the Uplock Roller Assembly

The uplock roller assembly was visually inspected. There was visual evidence of wear noted on the outer diameter of the roller.

The following dimensional checks were made on the roller assembly:

Outer Diameter of Roller:

Check End = 0.8675
Check of Middle = 0.866
Check of Other End = 0.8697

According to Messier-Dowty, the specified outer diameter for the Roller Assembly is 0.875" +/- 0.010". The outer diameter measurements were within the specified limits.

The internal "needle" bearings were visually inspected. The following observation were made:

- One set of the bearings appeared out of alignment.
- Several needle bearings were noted to have flat spots and corrosion.
- The bearing assembly appeared to be devoid of lubricant.
- When placed onto the shoulder bolt and rotated, the bearing did not rotate smoothly.

The roller assembly was disassembled. The individual bearings were then placed on the shoulder bolt and play was noted between the bearings and the bolt.

3.3 Examination of the Uplock Roller Assembly Shoulder Bolt

The uplock roller assembly shoulder bolt was visually examined. Two areas of wear were noted, corresponding to the areas where the uplock roller assembly seals would contact the bolt.

The following dimensional measurements of the shoulder bolt diameter were measured twice and recorded as follows:

Check 1 = 0.4996”
Check 2 = 0.4997”

According to Messier-Dowty, the specified outer dimension of the shoulder bolt is 0.5000” +0.000” / - 0.0005”.

After all the tests, the removed components were quarantined in Messier-Dowty secured storage until further notice. The group declined to disassemble the uplock latch assembly in case of further tests on the unit.

4.0 May 2015 Examination of Main Landing Gear Uplock Latch at Manufacturer’s Facility

The group met at the Messier-Bugatti-Dowty facility in Ajax, Ontario, Canada on May 6, 2015 to conduct further tests, developed during the initial examinations.

4.1 ATP Test with new Uplock Assembly and a simulated seized Uplock Roller in the normal position

The ATP test was accomplished with the Test Rig' s uplock roller assembly was secured so that it could not rotate, simulating a seized roller. Torque seal was applied to the seized Uplock Roller as a visual means of identify whether or not the roller moved during testing. The seized roller was positioned in the normal position. Then ATP sections 5.4.3 (Alternate Release) and the "Load" half of 5.4.4 (Unlocking Pressure at Load) were accomplished.

The following measurements were recorded:

Paragraph 5.4.3. Alternate Release Results (650+/-20 psig):

Test 1 = 15 lbs.
Test 2 = 15 lbs.
Test 3 = 15.5 lbs.

Paragraph 5.4.4. Unlocking Pressure at Load (G2= 1520+/-20psig):

Test l = 937 psi
Test 2 = 925 psi
Test 3 = 919 psi

The torque seal was examined after the test. The group concluded that the roller had not rotated during the test.

4.2 ATP test with new Uplock Assembly and a Simulated, Seized Uplock Roller on Altered Test Fixture

Messier-Dowty altered the ATP Test Fixture so that the position of the Uplock Roller Assembly was moved to where the worn groove on the occurrence Uplock Latch Assembly was located. The Uplock Roller was moved 0.262" back towards the closed end of the latch.

ATP sections 5.4.3 (Alternate Release) and 5.4.4 (Unlocking pressure at load) were then accomplished on the new the Uplock Latch Assembly and a seized Uplock Roller. Torque seal was applied to the seized Uplock Roller as a visual means of identify whether or not the roller moved during testing.

The following measurements were recorded:

Paragraph 5.4.3. Alternate Release Results (650+/-20 psig):

Test 1 = 15 lbs.
Test 2 = 15 lbs.
Test 3 = 15 lbs.

Paragraph 5.4.4. Unlocking Pressure at Load (G2= l520+/-20psig):

Test 1 = 890 psi
Test 2 = 900 psi
Test 3 = 893 psi

The torque seal was examined after the test and the group concluded that the roller had not rotated/moved.

At the conclusion of the tests, the components were returned to secured storage and were later returned to the operator.

Tom Jacky
National Transportation Safety Board