CANADIAN FORCES
FLIGHT SAFETY INVESTIGATION REPORT (FSIR)

FINAL REPORT

FILE NUMBER: 1010-146434 (DFS 2-5)
DATE OF REPORT: 17 March 2006

AIRCRAFT TYPE: CH146 - Griffon
DATE/TIME: 281530Z August 2003
LOCATION: Valcartier Garrison, Québec
CATEGORY: "C" Category Accident

SYNOPSIS

The aircraft was conducting a parachute training mission for the CF "Skyhawks" Parachute Demonstration Team in anticipation of the Québec City Airshow planned for the following Labour Day weekend. This practice jump was taking place over the Valcartier Garrison. A total of eight jumpers exited the aircraft uneventfully. As the aircraft initiated its descent from 10 000 feet above sea level (ASL), following the last drop, the left hand (LH) cargo door departed the aircraft, went through the main rotor, and fell to the ground. The crew continued the descent while carrying out a controllability check. The aircraft landed at the Valcartier heliport without further incident. The aircraft received "C" category damage.
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1. FACTUAL INFORMATION

GENERAL

The Squadron (Sqn) was tasked the day before the occurrence to support the CF Skyhawks Parachute Demonstration Team because of a last minute unserviceability with their primary aircraft, a CC115. The flight was conducted as a Skyhawks practice jump just prior to their participation to the Québec City Airshow.

1.1 History of the Flight

The aircraft was on a training mission for the CF Skyhawks Parachute Demonstration Team. There were a total of 11 personnel on board prior to the jump: 6 x Skyhawks team members, 2 x CF personnel jumping in tandem chutes with 2 of the 6 Skyhawks team members and the 3 helicopter crewmembers. The northwest corner of the helicopter parking area of the Valcartier heliport was designated as the Drop Zone (DZ).

The aircraft departed from the Valcartier heliport at 1446Z and climbed to 2500 feet ASL with all doors closed. Two circuits were carried out to assess wind speed and direction using wind drift indicators (WDIs). The WDIs were dropped by the Skyhawk jumpmaster (JM) from the LH side of the aircraft. The LH cargo door was operated by the JM with proper authorization from the pilot. It was closed again following the WDIs drop.

The aircraft then climbed to 10,000 feet ASL with all doors closed while circling overhead the base. Approaching the planned altitude, the pilot established a circuit from the south using winds of 350 degrees at nine knots gusting to fourteen knots. Both cargo doors were opened for the jump sequence, which was comprised of two jumps of three members of the Skyhawks with one CF member in tandem each time.

The jumps were uneventful and the JM was the last parachutist to leave the CH146434. The flying pilot then initiated a left hand descending turn at about 80 knots indicated airspeed (KIAS) as the flight engineer (FE) closed the right hand (RH) cargo door. Almost immediately, two loud bangs and a jolt were felt. The FE observed the LH cargo door had departed the aircraft just as he was reaching over the left side of the aircraft to close it.

Aircraft control appeared normal to the crew as no further vibrations were felt. While continuing the descent, the pilot asked the FE to look for possible damage along the LH side of the fuselage and horizontal stabilizer. The FE reported that no damage could be seen. During the descent the flying pilot carried out a check of all flight controls: collective, cyclic, pedals and throttles and found no unusual response. The descent was completed and the aircraft was landed at the heliport with no further incident at 1543Z. Following shut down the crew noticed that all 4 main rotor blades were substantially damaged.

1.2 Injuries to Personnel

Table 1: Injuries to Personnel

	Crew	Passengers	Other
Fatalities	Nil	Nil	Nil
Major injury	Nil	Nil	Nil
Minor injury	Nil	Nil	Nil

1.3 Damage to Aircraft

The investigation revealed that after the LH cargo door assembly left the aircraft, it was struck multiple times by the main rotor blades and was cut to pieces and scattered over the administrative area of the Valcartier Garrison. In addition, various scratches and dents were observed along the LH side of the fuselage aft of the LH cargo door. The CH146434, received "C" category damage as a result of the damage sustained by the main rotor blades.

1.4 Collateral Damage

A very detailed ground search was performed through the Valcartier Garrison including the private military quarters (PMQ) area, the Garrison administrative area and the adjacent training range. No collateral damage was found. However, the ground search lead to the discovery of over 50 pieces of debris, which accounted for approximately 75% of the LH cargo door. While no personnel injury or property damage resulted from this occurrence, the potential for it to happen was high.

1.5 Personnel Information

Table 2: Personnel Information

	Pilot	Co-pilot	Flight Engineer
Rank	Capt	Capt	MCpl
Currency/Category valid until	Cat 1 31 Dec 04	Cat 1 31 Dec 03	Combat Ready 31 Dec 03
Medical Category valid until	(Apr 04)	(May 04)	(Mar 04)
Total flying time	1277	3600	1097
Flying hours on type	1056	600	1097
Flying hours last 30 days	32	12	14
Flying hours last 48 hours	5	1	3
Flying hours on day of Occurrence	1	1	1

1.6 Aircraft Information

The aircraft, and all associated parts, was quarantined by the Sqn Commanding Officer, along with maintenance logs.

1.7 Meteorological Information

TAF:

CYOY 281333Z 281414 30005KT P6SM BKN020 BECMG 1415 27010KT BKN030 BECMG 1921 SCT030

CYQB 281130Z 281212 28008KT P6SM BKN030 FM1700Z 28008KT P6SM SCT040 RMK NXT FCST BY 18Z=

METAR:

CYOY 281600Z 28011G18KT 15SM FEW040 FEW250 16/07 A3004 RMK CU1CI1 SLP174 SKY23=

CYQB 281600Z 28004KT 30SM BKN047 17/09 A3005 RMK SC6 SLP177 SKY77=

Upper Winds and Temperatures:

FCST BASED ON 280000 DATA VALID 281200 FOR USE 09-18

	3000	6000	9000	12000
YBQ	3324	2918+03	3026-01	3031-06

1.8 Environmental Conditions

The ground elevation at the Valcartier heliport is 550 feet ASL. The surface wind was assessed by the crew to be 350 degrees at 9 knots gusting to 14 knots during the wind drift assessment, which is acceptable for Skyhawks parachuting training. Ceiling and visibility allowed the crew to maintain visual flight rules (VFR) throughout the climb to 10,000 feet ASL, conduct the parachute drop, and return to the heliport.

1.9 Aids to Navigation

Aids to navigation were not a factor in this occurrence.

1.10 Communications

Effective and unimpeded radio communications were maintained among the crew, with the Valcartier Control Tower, the Québec Terminal Services and the DZ Coordinator throughout the flight. Communication was not a factor in this occurrence.

1.11 Aerodrome Information

The Valcartier heliport is located northeast of the Garrison administrative area, and south of the Jacques-Cartier River, which is the main boundary of the Valcartier Garrison Training Area. The Army Cadet Summer Camp and the

Militia Training Camp surround the heliport. All the debris from the door appears to have landed on the Garrison administrative area, the PMQ area or the heliport surrounding area, which is all Department of National Defence (DND) owned property.

1.12 Flight Recorders

CH146434 was equipped with a standard Griffon combined cockpit voice / flight data recorder (CV/FDR). It was removed and sent to the National Research Council (NRC) in Ottawa by the investigation team for analysis. The aircraft Health Usage Monitoring System (HUMS) data was downloaded and the information recorded on a tape. The tape was sent to 403 (Helicopter) Operational Training Squadron, Gagetown, New Brunswick, for analysis.

1.13 Wreckage and Impact Information

The aircraft was released from quarantine by the DFS investigator-in-charge (IIC) on 05 September 2003.

1.14 Medical Information

The two pilots and FE were taken to the Garrison civilian flight surgeon. Toxicology samples were taken in accordance with orders and sent for analysis. One aircrew member was tested positive for using over the counter allergy medication. This was not a factor in this occurrence.

1.15 Fire, Explosive Devices, and Munitions

There was no evidence of fire resulting from this occurrence. Explosive devices and munitions were not a factor in this occurrence.

1.16 Survival Aspects

Survival aspects were not considered in this investigation because the aircraft landed at the heliport and the crew was uninjured.

1.17 Tests and Research Activities

All available door components that were recovered on 28 and 29 August 2003 ground search were taken to Quality Engineering Test Establishment (QETE), Hull, for further analysis. This included all rollers, sliders and door latches.

1.18 Description of the parachuting mission

The CH146 helicopter is normally used as a training aircraft for military parachuting when fixed wing resources are not available. Both static line and freefall parachuting may be conducted by up to eight parachutists at any one time. The aircraft is normally configured in a “clean” configuration, i.e. without troop seats and without the installation of other mission kits. In this configuration the CH146 can carry four parachutists per side, seated on the floor. Maximum wind limitation for parachute training is normally 13 knots. Normally, the DZ

Controller uses a hand held wind speed indicator to assess the wind speed. Parachuting may be conducted with the cargo doors on or off the aircraft. When left on, the doors may be left closed until one minute prior to the drop at which time they are opened. Canadian Forces Technical Orders (CFTO) limits the airspeed of the CH146 helicopter to 80 KIAS, velocity-not-to-exceed (Vne), when a cargo door is open in flight.

Normally, the FE wears a crew safety harness that allows him to move freely inside the cabin area. He is responsible for the proper rigging of the helicopter with assistance from the JM and he normally occupies a position on the RH side of the cabin area. The JM is responsible to the pilot for the safe and efficient dispatch of all parachutists. He also checks the rigging of the helicopter, supervises and checks the rigging of the parachutists and supervises their loading. He wears a flight helmet or headset to ensure adequate communications with the flight crew.

An in-flight wind drift assessment is also normally conducted prior to the drop sequence. This consists of dropping WDIs from a lower altitude directly over the DZ. From this assessment an approximate release point will be identified by the JM, which is normally located up wind from the DZ.

CH146434 was properly rigged for the mission. It was reconfigured with the rotor turning (hot turn around) by the FE, assisted by the pilot and JM. This was a relatively simple and safe manoeuvre since the aircraft had just returned from a rappelling mission and was already in a “clean” configuration. The DZ used was the northwest corner of the helicopter parking area on the heliport. A DZ controller was used for the mission and he was equipped with a two-way radio to allow him to maintain communications with the aircraft.

1.19 Additional Information

Another Griffon helicopter, CH146414, from the same unit, was involved in a similar incident two days prior. While landing in a confined area during a night training flight, the FE opened the LH cargo door. After take-off, at approximately 70 knots, he could not close the door and found that it had came off the lower track. The airspeed was lowered to 20 knots and the aircraft was returned to the heliport with no further incident. The investigation revealed the door position to be out of adjustment and refers to the CH146434 investigation (FSIS no. 113286) for the causes and the preventative measures.

In addition, a search of the Flight Safety Information System (FSIS) database revealed that there were two other occurrences of cargo doors contacting the main rotor blades in flight. These incidents occurred with CH135 Twin Huey helicopter, which is very similar to the CH146 Griffon helicopter. The first incident took place in 1985 following a parachute drop mission when the RH cargo door departed the aircraft. In this case the door track had failed due to normal wear (ACAIRS Case #135136 26 MAR 1985). The second occurrence happened over DZ Buxton at Canadian Forces Base Edmonton, Alberta, in June 1993 when the aircraft was descending again following a parachute drop at

10,000 feet. In the descent, the pilot allowed the airspeed to exceed Vne by 10 knots. The investigation concluded that the 10 knot over speed caused the departure of the door due to aerodynamic overload (408 SQN FS-021A 051600Z JUL 93).

1.20 Useful or Effective Investigation Techniques

Nil.

2. ANALYSIS

2.1 General

Analysis of the maintenance log for aircraft, engine and transmission confirmed that the aircraft was serviceable prior to the door departing the aircraft. The investigation focused on the maintenance done on the door and the actions of the crew prior to the door departing the aircraft.

2.2 The Crew

The crew consisted of a pilot, a co-pilot and an FE. They were assisted by one of the Skyhawks team JM. The passengers were five other Skyhawks team members and two members of the CF who volunteered for a familiarisation jump in tandem chutes (each paired with one Skyhawks jumper). All aircrew members were medically fit to fly. The pilot and the co-pilot held a current flying category I. The FE held a valid combat ready category. They were properly authorized and briefed for the mission. The crew briefing prior to the flight was thorough and all crewmembers understood their tasks.

2.2.1 Medication

Although one aircrew member tested positive for using over the counter allergy medication, the effect and side effects of the over the counter allergy medication did not contribute to the accident.

2.3 The Accident

2.3.1 General

The accident occurred following the last drop and shortly after the aircraft had begun a left descending turn from 10 000 feet ASL. The JM was the last parachutist to leave the aircraft. The co-pilot, who was sitting in the right seat, was the flying pilot at the time of occurrence. The pilot was carrying out non-flying pilot duties from the left seat. The FE closed the RH cargo door and as he was reaching over to the left side of the aircraft two loud bangs and a jolt were felt. The FE then observed the left cargo door had departed the aircraft. It is suspected the jolt was caused by the cargo door hitting the main rotor.

Immediately after this jolt, the aircraft control appeared normal to the crew and no further vibrations were felt. During the descent the pilot asked the FE to look for possible damage along the left side of the fuselage and horizontal stabilizer. The FE reported no damage seen. The flying pilot also carried out a check of all flight controls: collective, cyclic, pedals and throttle; during the descent and found no unusual response. The aircraft was landed at the heliport without further incident. The crew did not realize the extent of the damage sustained by the main rotor blades until after engine shut down.

2.3.2 Cargo Door Operation

The aircraft initially departed the heliport with all doors closed. After the level-off at 2,500 feet ASL, the airspeed was reduced to below 80 KIAS. After receiving proper authorisation from the pilot, the JM opened the LH cargo door for the WDIs drop and wind drift assessment. Following that procedure, the door was closed again and the aircraft resumed its climb to the drop altitude of 10,000 feet ASL. Shortly before reaching the drop altitude the airspeed was reduced again to 70 – 80 KIAS and both LH and RH cargo doors were opened with pilot authorisation. The FE reported that the door restraining kit, normally referred as "door pinned'', was not used for either door so both cargo doors were free to slide fore and aft. There was no one on the left hand side of the aircraft to guard the cargo door from the time the jumpmaster exited the cabin until the time the door departed from the aircraft. This procedure was not in accordance with the CH146 Flight Standard Manoeuvre Manual, which states that cargo doors can be opened or closed asymmetrically, to a locked position, up to 80 KIAS.

2.3.3 CV/FDR Significant Events

CV/FDR analysis revealed that the aircraft was flying at 10 000 feet ASL at an indicated airspeed (IAS) ranging from 70 to 80 knots when the occurrence took place. The last jumper left the aircraft and then the descent was initiated by lowering the collective to 0%. The aircraft began to lose altitude. One of the pilots made a verbal observation on the high airspeed by saying: "Watch your speed", and approximately 2 seconds later the noise of the departing door was heard. The FDR data indicated an airspeed of 83 knots, 2 seconds before door departure and around 82 knots at door departure. The aircraft touched down 8 minutes and 47 seconds after the noise.

The CV/FDR indicated that the aircraft was descending at an average rate of 3,120 feet per minute (fpm) prior to the cargo door departure, and 2,300 fpm after the cargo door departed. The initial plan was to recover the aircraft over the "tactical runway" for precautionary measures. Since aircraft control appeared normal to the crew with no further vibrations felt, the crew elected to taxi the aircraft to the ramp. This flight path circumstance explains the extra time it took for the aircraft to descent from approximately 10 000 feet at around 2,300 fpm, and land 8 minutes 47 seconds later.

2.4 CV/FDR analysis

2.4.1 Airspeed

Just prior to the cargo door departure, the aircraft was flying at an IAS ranging from 70 to 80 KIAS. At the time of the cargo door departure, the FDR recorded an IAS of 82 knots increasing to a maximum of 88 knots approximately 5 seconds later. Thereafter, the IAS was reduced to below 80 KIAS where it remained until the aircraft touched down.

FDR data shows that the IAS was kept within CFTO limitations for operations with an opened door with one exception. Vne was exceeded by 2 knots at the moment of the cargo door departure and was subsequently increased to 8 knots about 5 seconds after the door had departed. Although considered a small speed variation, the Vne exceeded by 2 knots is assessed as a contributing factor to this occurrence.

The accuracy of the airspeed indicator used by the flying pilot is also considered a contributing factor to this occurrence. Both pilots noted a difference of 5 to 6 knots between the LH and the RH airspeed indicators. The flying pilot was using the indicator with the lowest indication, which prompted the call from the non-flying pilot to: " watch your speed". Although the difference between the LH and the RH airspeed indicators contributed to the Vne being exceeded by 2 knots, the noted difference of 5 to 6 knots is within the acceptable limits for this aircraft. The acceptable limit is 6% at Vne, which represent $\pm$ 8.4 knots at Vne (140 knots).

The Vne being exceeded by 8 knots following the door departure was likely the result of a temporary distraction experienced by the crew following the noise and vibration of the door departure. It was corrected within seconds.

2.4.2 HUMS Data Analysis

The CH146 Griffon helicopter is equipped with a HUMS. The HUMS is a tool that monitors various aircraft components and systems. Its information is normally used by maintenance crews. The HUMS is not considered an FDR but can provide indications of limitations being exceeded on some aircraft components. CH146434's HUMS data cartridge was analyzed by 403 (Hel) OTS. The analysis showed an increase in vibration at the time the door departed the aircraft and also an increase in longitudinal vibrations when the helicopter went into a hover just prior to landing. The HUMS is not designed to show airspeed excesses. The vibrations recorded on the HUMS are consistent with the departure of the door and the damage sustained by the main rotor blades once the aircraft was in hovering flight.

2.5 Technical Analysis

2.5.1 General

QETE provided an investigator to assist DFS with the on-scene investigation at Valcartier Garrison. Images were taken of all damage to the aircraft. Parts were documented and all collected parts of the door were brought to QETE for a more detailed investigation. The onsite investigation included personnel interviews and a review of technical records by the investigation team.

It was determined that all the damage sustained by the aircraft was associated with the LH cargo door departing the aircraft and impacting the fuselage and main rotor blades. The investigation focused on the LH cargo door and all its attachment points. The aircraft tracks and their respective locations are indicated in photo 3 of Annex A.

2.5.2 Cargo door rigging

The upper support rollers, part number (P/N) 205-030-437-007, were examined. It was noted that one of the rollers showed significantly more wear of its internal diameter than the other rollers. This wear could be felt by moving the roller against the stem of the roller support. The rollers were removed from the door and numbered one through 6 starting from the most forward roller (see photo 2 of Annex A). The rollers were examined for wear and damage and measurements were taken of the inner and outer diameters. These measurements were compared to those described in the Canadian Government Catalog of Materiel (CGCM) for this item. The CGCM specifications reflect the "as new" manufactured condition of the components and are not "in service" wear limits, but is not an authorized technical reference or source of information for the CH146 parts. However since no other specifications were available, the investigation team believed that it was reasonable to use the CGCM's dimensions as a reference.

The inner bore diameter of the roller number two exceeded the maximum limit of 0.332 inch by 0.068 inch. The outer diameters of all rollers were within the tolerances of 1.020 inches – 1.040 inches described in the CGCM. The condition of rollers number 1 and 2, installed and removed with their respective measurements can be seen in photo 4 of Annex A.

The door slide was also examined. A typical door slide, P/N 120-127-4, is shown installed on the RH door of aircraft CH146434 (photo 5, Annex A). The slide appears to have more wear in the lower groove than in the upper groove, which is expected given the downward loading of the door. The recovered door slide from the left hand door of CH146434 had signs of damage that are consistent with the slide being torn from the aft lower fuselage track (photo 6, Annex A). Also, the LH door slide had more wear in its lower groove (photo 7, Annex A), similar to the RH slide.

The door support roller runs, P/N 205-030-437-005, in the aft upper track had no signs of damage. The aft upper track had damage that was consistent with the aft upper support roller being pulled from the track during the in-flight departure of the door (photo 8, Annex A).

The LH track attached to the bottom of the door was not completely recovered. The most forward portion of the door was recovered (photo 9, Annex A) and two distinct horizontal parallel wear marks were visible and the lower forward 0.75 inch of the door channel had typical in use wear including loss of material (photo 10, Annex A). The upper wear mark was 0.175 inch measured from top to bottom and both marks together measured 0.320 inch. These measurements were noted due to the fact that the lower fuselage tracks are to be engaged by not less than 0.250 inch.

The holdback bracket on the LH cargo door was recovered and was not damaged or distorted (photo 11, Annex A). This bracket in combination with a mating bracket and pin on the fuselage enable the door to be pinned in the open

position (photo 12, Annex A). This physical evidence supports the FE statement that the left and right cargo doors were not pinned back.

In the full forward position or closed position the door is supported vertically by rollers numbers two and six running in the upper track and the aft lower slide in the aft lower track. In the full aft or open position, only roller number two and the aft lower slide support the cargo door vertically. Rollers numbers one, three, four and five and the aft upper roller and aft lower slide provide horizontal support to the door.

Wear of the upper rollers and the aft lower slide would result in the door hanging in a lower position when compared to a door with new rollers and slides and rigged in a similar manner. This lower position of the door results in the door channel overlap being less than the minimum 0.250 inch called for in C-12-146-000/MF-001

The two parallel horizontal rub marks on the door channel provide further indications of the door being in a lower position when the door is fully aft. The 0.320 inch wear mark is most likely the wear mark when the door is in the full forward position and being supported by upper rollers number two and six and by the lower aft slide. The 0.175 inch wear mark is most likely a result of the door being in the full aft or open position and riding only on the worn roller number two and the aft lower slide. The minimum overlap of 0.250 inch is met when the door is full forward or closed but is not met when the door is full aft or open.

Although this investigation revealed that there is no appropriate dimensional tolerance available to determine the serviceability of the cargo door rollers, the investigation team considers that the 0.250 inch door channel overlap, as specified in the C-12-146-000/MF-001, is the overriding criteria determining rigging of the cargo door. Worn rollers are still serviceable if the door can be adjusted to ensure at least 0.250 inch overlap between the door and fuselage channels through the full range of movement. The rollers and sliders are primarily for door guidance during motion while the door/airframe integrity is mainly achieved by proper track/channel overlap.

2.5.3 Airflow effect

The original equipment manufacturer (OEM) maximum airspeed (Vne) for the operation of cargo doors in flight was 60 knots. The Vne for the operation of the cargo doors was raised to 80 knots following the request from the CF and the acceptable review of a complete flight test program performed by the OEM.

The aircraft was in a rapidly descending LH turn, slightly exceeding the unpinned open door maximum airspeed of 80 knots Vne during the descent. The resultant force from the airflow on the LH door would have been up and aft. It is likely that at this point the lower door/fuselage mating channels separated and the lower edge of the door was lifted upward and outward by the airflow. Almost immediately thereafter the aft lower slide and the aft upper rollers were torn from their respective tracks enabling the door to come completely off and then come in contact with the main rotor blades.

3. CONCLUSIONS

3.1 Findings

3.1.1 The crew was qualified and current for the mission.

3.1.2 The mission was properly authorized, planned and briefed.

3.1.3 Wind and weather conditions at the time of the accident were acceptable.

3.1.4 The aircraft was configured for the mission.

3.1.5 The jumpmaster with the authorization of the pilot operated the LH cargo door.

3.1.6 Vne for the cargo doors opened in flight was exceeded by 2 KIAS just prior to the door departure.

3.1.7 The cargo doors were not restrained (not pinned) in the open position for the jump sequence of the mission.

3.1.8 The LH cargo door was left unguarded after the departure of the JM.

3.1.9 Based on the FDR data, Vne for doors open in flight was exceeded by 8 kts for a brief moment after the door departed the aircraft.

3.1.10 Examination of the LH cargo door lower door track indicates that the minimum overlap between the lower fuselage channel and the door track was outside of tolerance in the aft portion of the channel.

3.1.11 Toxicology results were positive for self-medication for one crewmember. This finding is not a factor in the occurrence.

3.2 Causes

3.2.1 The cause of this accident was the improper adjustment of the LH cargo door. Specifically, the overlap between the aft portion of the lower door fuselage channel and the door track itself indicates that the minimum overlap of 0.250 inch was exceeded.

3.3 Contributing Factors

3.3.1 Vne was exceeded by 2 knots at the moment of the cargo door departure.

3.3.2 The LH cargo door was left unpinned in the open position and not guarded contrary to AOI limitations.

4. SAFETY MEASURES

4.1 Safety Measures Taken

4.1.1 An Operational Airworthiness Authority Direction message was immediately published (1 CAD HQ Winnipeg Comd 173 291722Z Aug 03) promulgating interim risk mitigation measures consisting of a reduction in Vne from 80 to 60 KIAS for the movement of cargo doors in flight. Above this speed, the doors are to be closed or pinned. Also, cargo doors are to be pinned for parachute training. The operational restriction was later removed as detailed at paragraph 4.1.8 and 4.1.9.

4.1.2 Pending further accident investigation by DFS and Director General Aerospace Engineering Project Management (DGAEPM), a Record of Airworthiness Risk Management (RARM) was staffed to 1 Canadian Air Division (1 Cdn Air Div) and accepted by Commander 1 Cdn Air Div on 4 September 2003. The associated operational airworthiness risk of continued CH146 fleet utilization was assessed as being medium. Based on the limited technical and operational data available, a risk mitigation plan was put in place for the CH146 flying operations to continue with the following operational limitations:

a. Cargo door are to be moved in flight only at 60 KIAS or less vice the current limits of 80 KIAS. Manoeuvring is to be minimized while the cargo doors are in transit;

b. While in flight above 60 KIAS, the cargo doors are to be closed or pinned open; and

c. When conducting parachuting operations, cargo doors are to be pinned open prior to the drop.

4.1.3 Director Aerospace Equipment Program Management (Transport and Helicopters) (DAEPM (TH)) ordered a SI of the CH146 Griffon fleet to ensure proper adjustment of all cargo doors (SI C-12-146-000/NS-100, MSG 10 10003Z SEP 03, DAEPM(TH) 64127). The SI revealed that:

a. there were a total of 22 aircraft affected by this SI;

b. 27 doors were found with tracks worn;

c. 7 doors were found with tracks cracked;

d. 11 doors were found out of adjustment; and

e. 2 doors were found with rollers worn.

All these discrepancies were immediately corrected by the maintenance organizations involved.

4.1.4 The CH146 Flying Standard Manoeuvre Manual (B-GA-002-146/FP-001) was amended by the Tactical Aviation Standardization and Evaluation Team (TASET) to introduce a directive when the helicopter is used as a training aircraft

for military parachuting missions. The amendment provided procedures to be carried out by the pilot in control and the FE, immediately following the departure of the parachutist from the aircraft, and before any other manoeuvres can be executed.

4.1.5 The CH146 WSM staff conducted a review of the cargo door rigging procedures in the C-12-146-000/MF-001 to ensure that technicians evaluate all of the door attachment points including rollers, slides and channels. The review resulted in the following amendments:

a. The door overlap information was clarified by providing more details in the maintenance publication. More specifically, it specifies that a 0.250 inch overlap must exist between the door track and the fuselage channel through the full range of movement of the cargo door; and

b. The inspection criteria were also clarified as well as the addition of a caution to read; “The minimum 0.25 inch (6.35 millimetres) overlap between the lower track and the cabin door channel is critical both when the door is fully closed and fully open”.

4.1.6 A warning was added in the C-12-146-000/MB-002 to clarify the requirement that the cargo door is to be held or guarded by a crew member, during the opening and closing process, until properly opened to a pinned position or closed to a locked position, up to Vne.

4.1.7 The CH146 WSM had initiated an Aircraft Modification Approval Form to pursue the feasibility of acquiring door support metal rollers with ball bearings.

4.1.8 The CH146 WSM and the Director of Technical Authority reviewed the data supporting the flight clearance for airspeed limit of 80 KIAS for transitioning the cargo door in flight. This study was conducted to see if the operational reduction in Vne of 60 KIAS for the movement of cargo doors in flight could be safely increase back to the CFTO prescribed 80 KIAS. The CF Vne limit of 80 KIAS was reviewed, tested and deemed acceptable by Bell Helicopter. However, it was decided that the cargo door must be:

a. locked in the fully closed position; or

b. locked/pinned in the fully open position; or

c. under positive control of a crew member when in transit.

4.1.9 As a result of the study on flight clearance, the revised risk level of operating the cargo door up to 80 KIAS has been reduced to low. Consequently, the operational restriction mentioned at paragraph 4.1.1 was rescinded.

4.2 Further Safety Measures Recommended

It is requested that the CH146 WSM complete the Aircraft Modification Approval Form to pursue the feasibility of acquiring door support metal rollers with ball bearings.

4.3 Other Safety Concerns

Nil.

4.4 DFS Comments

It goes without saying that we were very fortunate that no one was injured in this accident. The damage to the main rotors of the aircraft was significant and it is fortuitous that the crew got the aircraft on the ground in a timely manner. In addition, the jumpers were still airborne when this accident happened and they, as well as the people on the ground were fortunate not to have been hit by the falling debris from the door. In summary, this occurrence had significant potential to be a much more serious accident.

This occurrence was the third reported in-flight departure of a cargo door since the CF acquired the Single Huey, Twin Huey and Griffon family of helicopters. Therefore, this is a very rare event. What is of concern is that a significant warning sign was missed. As described in paragraph 1.18 of this report, the same unit experienced a very similar occurrence approximately 36 hours prior to this accident. With the benefit of 20/20 hindsight, it can be seen that the initial incident should have raised a flag for not only this unit, but for the entire fleet. In all probability a check of Griffon cargo door rigging would have resulted in the same number of defects found following the SI ordered by DAEPM (TH) after this accident.

The concerns raised above must be balanced by the reaction of various staffs to this occurrence. The operational staff at 1 Cdn Air Div HQ, the CH146 Weapon System Manager and various staff from DGAEPM all quickly realized the seriousness of this occurrence. They were very proactive in researching the issues associated with the accident and in putting in place effective countermeasures to reduce the risk of a re-occurrence. As a result, most of the recommended safety measures have already been implemented. This is a clear example of an effective Flight Safety culture.

//ORIGINAL SIGNED BY//

A.D Hunter
Colonel
Director of Flight Safety

ANNEX A: PHOTOGRAPHS

QUALITY ENGINEERING TEST ESTABLISHMENT (QETE)

PHOTO 1
Recovered pieces of the LH cargo door of Griffon CH146434.

PHOTO 2
Standard CH146 Griffon LH cargo door indicating the roller numbering sequence used.

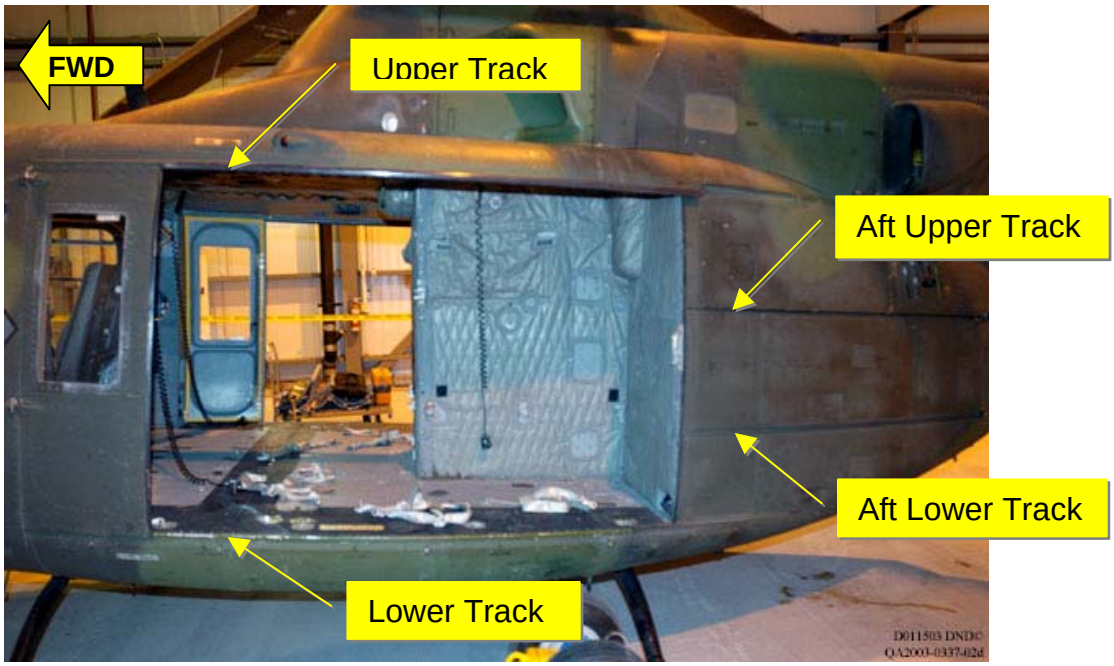

PHOTO 3
View of LH side of aircraft CH146434 indicating cargo door track locations.

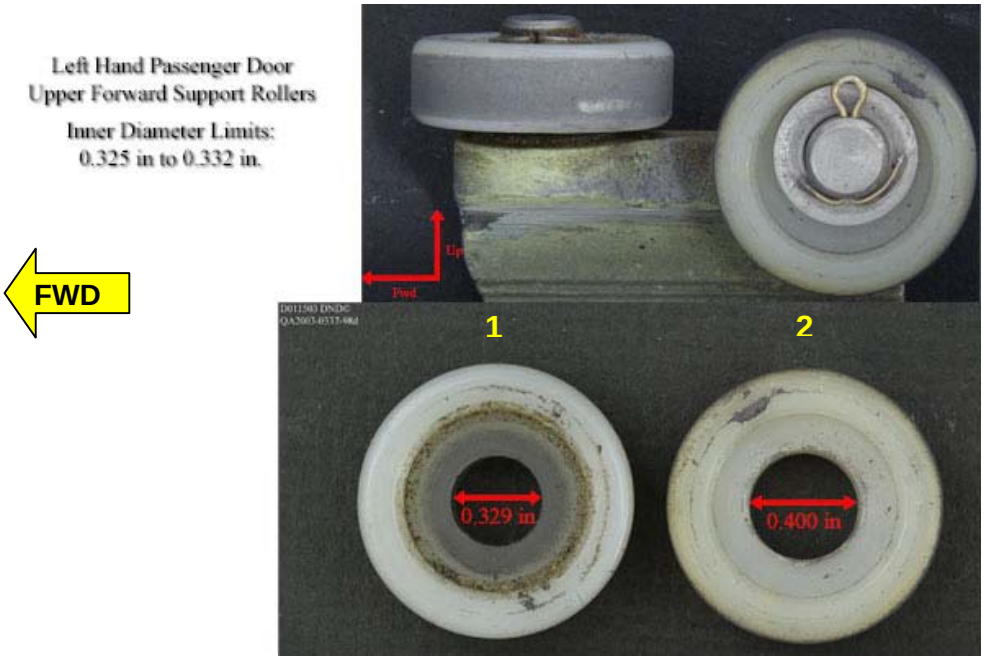

PHOTO 4
LH cargo door rollers 1 and 2 installed and removed with inner bore diameters indicated.

PHOTO 5
Yellow object is the lower aft track slide of the RH door of aircraft CH416434. Note the upper groove of the slide is barely in contact with the fuselage track.

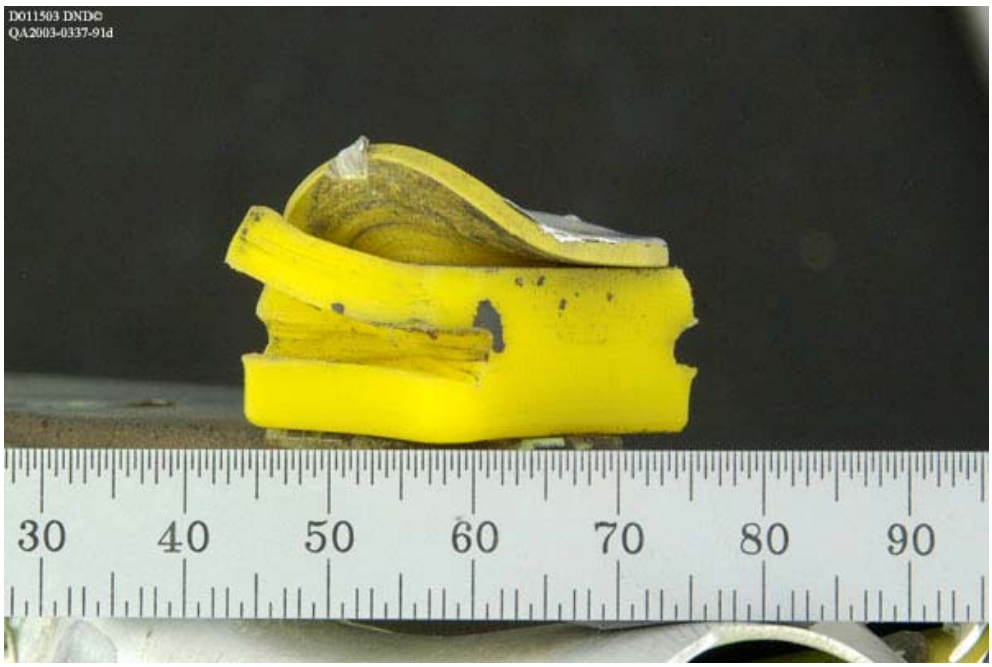

PHOTO 6
LH lower aft cargo door slide from aircraft CH146434. Damage to slide is consistent with being pulled from the aft lower fuselage track

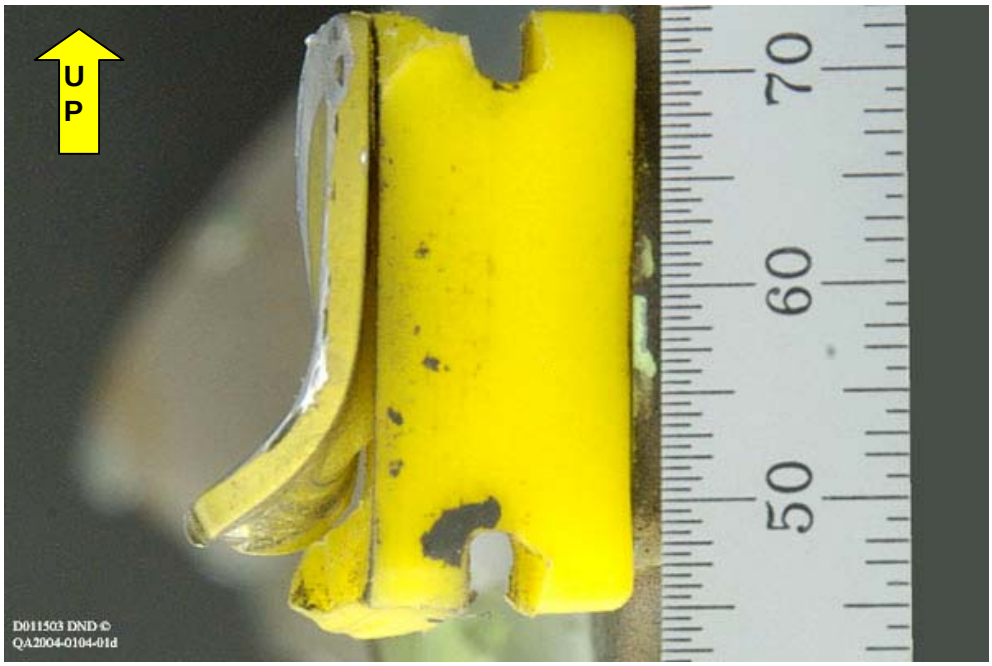

PHOTO 7
LH lower aft channel door slide with lower groove showing more wear than the upper groove.

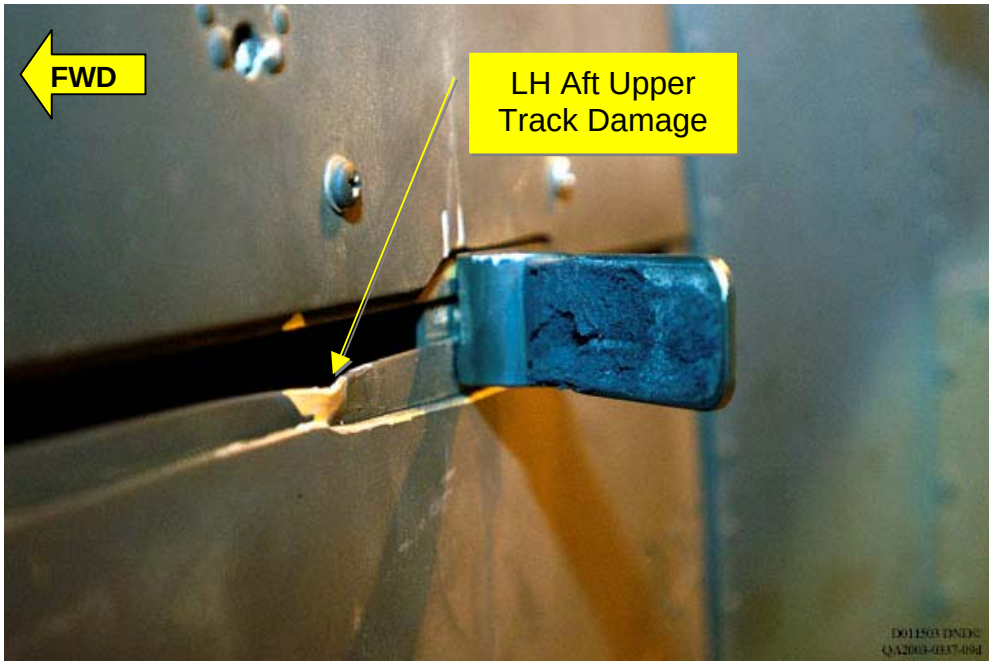

PHOTO 8
LH aft upper track damage consistent with the upper support roller being pulled from the track during the departure of the cargo door.

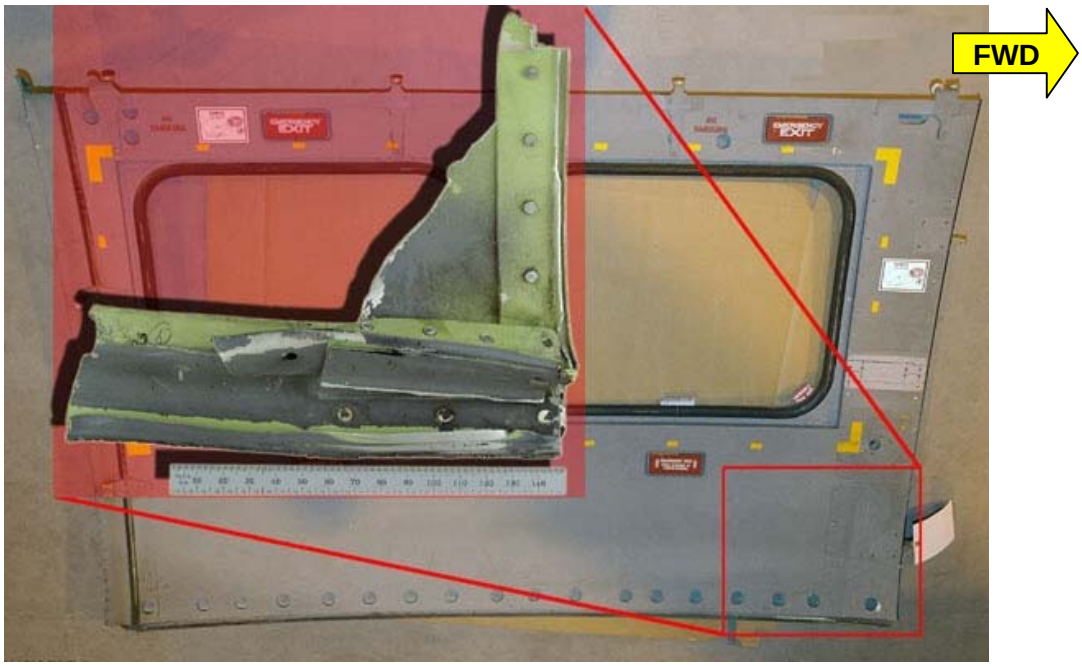

PHOTO 9
Inboard surface of recovered lower fwd corner of the LH cargo door.

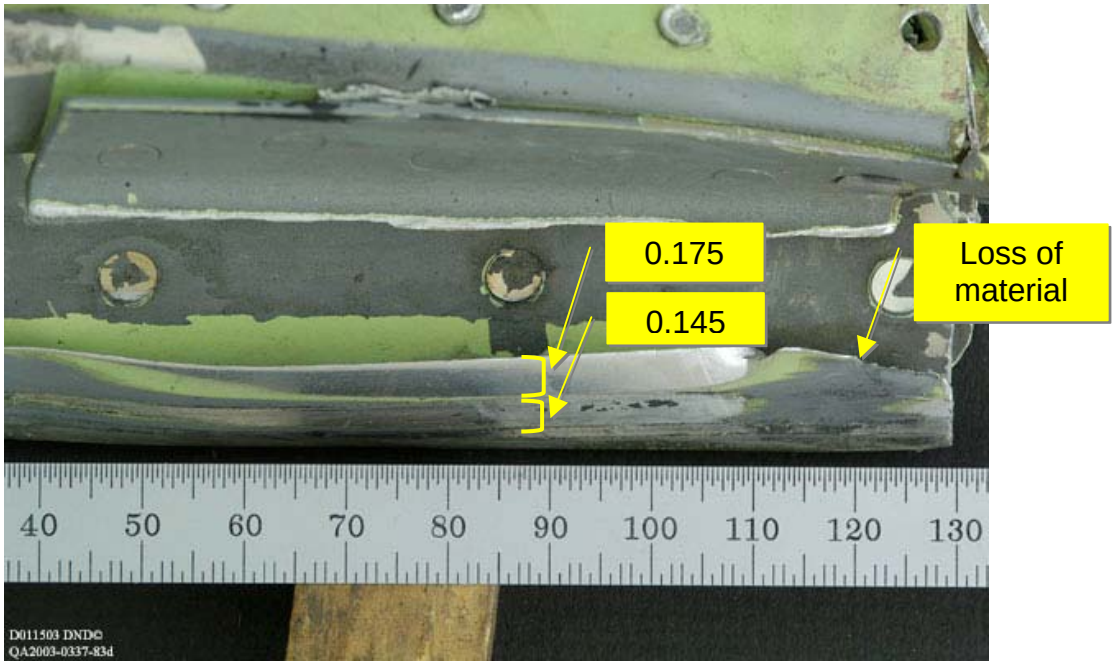

PHOTO 10
Close up of recovered inboard surface of lower fwd corner of the LH cargo door with two distinct horizontal parallel wear marks.

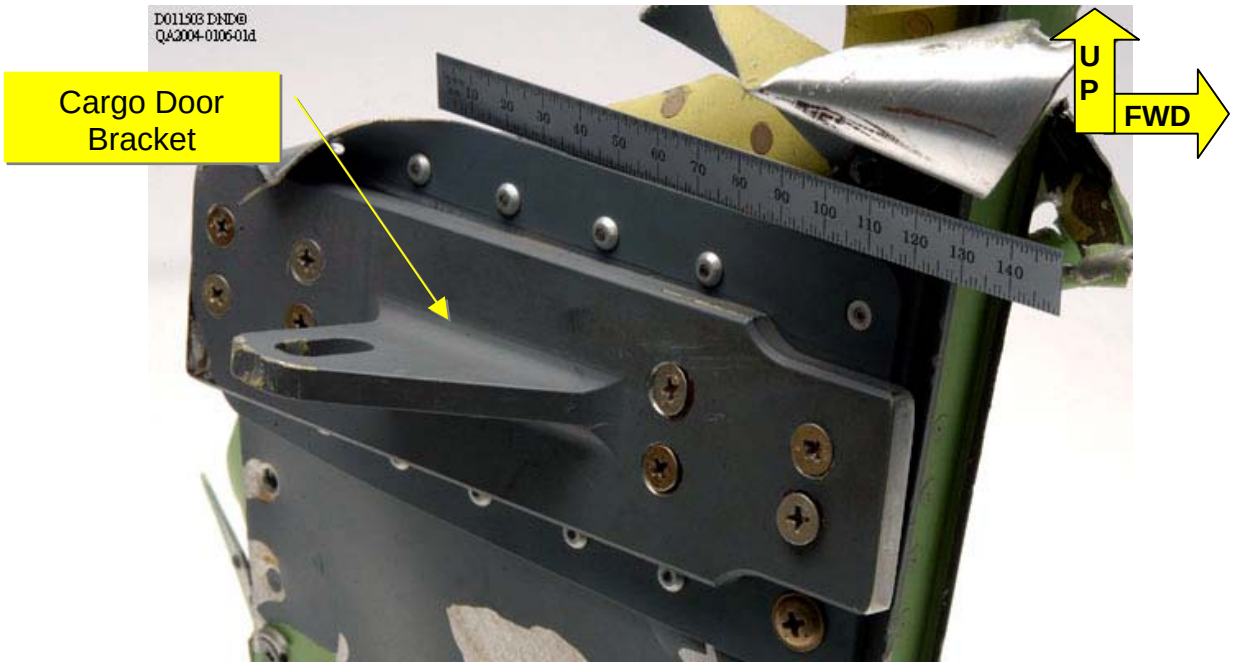

PHOTO 11
The door portion of the LH door holdback bracket from aircraft CH146434 with no obvious damage or distortion.

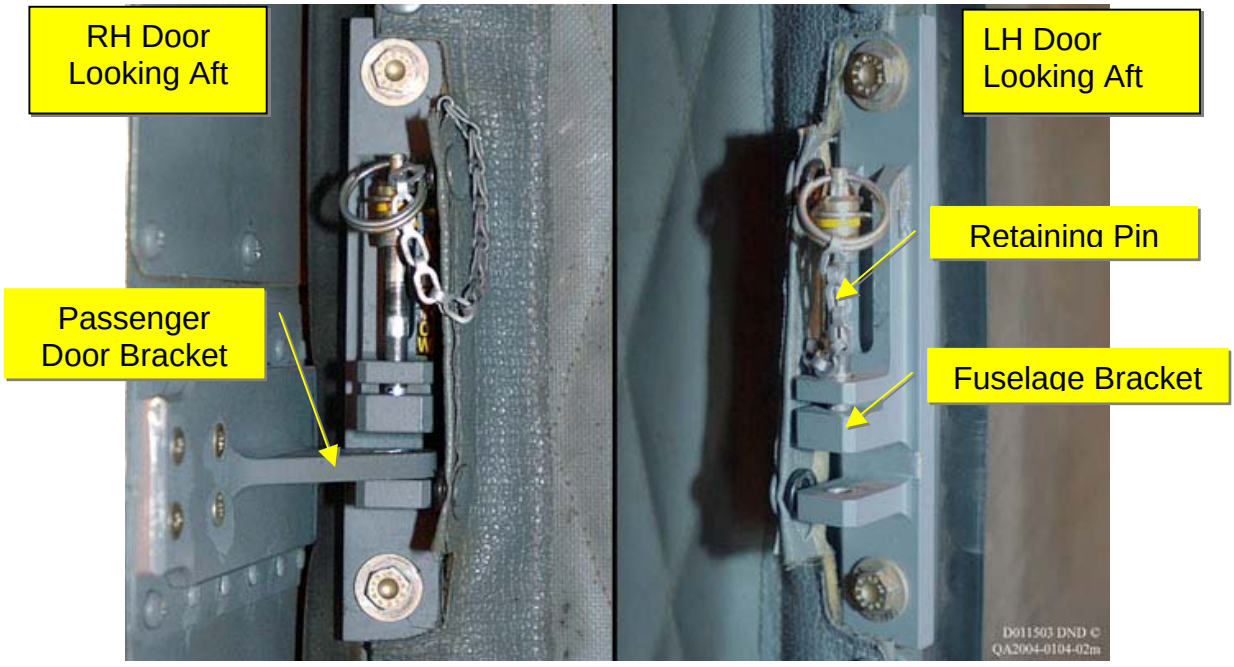

PHOTO 12
RH and LH holdback bracket of aircraft CH146434 with the RH door in the full back and unpinned condition. The LH door was in this state at the time the door departed the aircraft.

PHOTO 13
Damage to one of the main rotor blade from aircraft CH146434.

ANNEX B: List of Acronyms and Abbreviations

1 Cdn Air Div	1 Canadian Air Division
AA	Aeronautics Act
ACAIRS	Aircraft Accident Investigation Reporting System
AIA	Airworthiness Investigative Authority
ASL	Above Sea Level
CF	Canadian Forces
CFTO	Canadian Forces Technical Orders
CGCM	Canadian Government Catalog of Materiel
CV/FDR	Cockpit Voice / Flight Data Recorder
DFS	Director of Flight Safety
DND	Department of National Defence
DGAEPM	Director General Aerospace Engineering Project Management
DAEPM (TH)	Director Aerospace Engineering Project Management (Transport & Helicopter)
DZ	Drop Zone
FE	Flight Engineer
FS	Flight Safety
FSIR	Flight Safety Investigation Report
FSIS	Flight Safety Information System
FPM	Feet per Minute
HUMS	Heath Usage Monitoring System
HQ	Headquarters
IAS	Indicated airspeed
IIC	Investigator-In-Charge
Inch	Inch - Inches
JM	Jump Master
KIAS	Knots Indicated Airspeed
LH	Left Hand
MND	Minister of National Defence
NDHQ	National Defence Headquarters
NRC	National Research Council
OEM	Original Equipment Manufacturer
PMQ	Private Military Quarters
P/N	Part Number
QETE	Quality Engineering Test Establishment
RH	Right Hand
ROARM	Record of Operational Airworthiness Risk Management
SI	Special Inspection
Sqn	Squadron
TASET	Tactical Aviation Standardization and Evaluation Team
Vne	Velocity-not-to-exceed
VFR	Visual Flight Rules
WDI	Wind Drift Indicator
WSM	Weapon System Manager