Report 07-006, Hawker Beechcraft Corporation 1900D, ZK-EAK, landing gear malfunction and subsequent wheels-up landing, Woodbourne Aerodrome, Blenheim, 18 June 2007

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Hawker Beechcraft Corporation 1900D
ZK-EAK

landing gear malfunction and subsequent wheels-up landing

Woodbourne Aerodrome, Blenheim

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Abstract

On Monday 18 June 2007 at 0812, ZK-EAK, a Hawker Beechcraft Corporation 1900D, was on approach to land at Wellington when the landing gear failed to lower. The 2-pilot crew completed a missed approach and further attempted to lower the landing gear by both normal and emergency means. The landing gear remained retracted, so the crew elected to divert to Woodbourne where a wheels-up landing was made. The aircraft sustained moderate damage consistent with a wheels-up landing. There was no injury to the crew or the 15 passengers.

A fatigue crack in the hydraulic actuator for the right main landing gear allowed hydraulic fluid to escape, which prevented the crew lowering the gear by either the normal or emergency systems.

Safety issues identified included the need to improve the design and inspection of the hydraulic actuator and the serviceability of the hydraulic quantity low-level sensor. Until improved actuators were available, the inspections and limitations put in place by the operator should prevent a reoccurrence of the actuator failure. The United States Federal Aviation Administration, the airworthiness authority for the aircraft, in conjunction with the aircraft manufacturer, has alerted other operators of the Beechcraft 1900 to the actuator fault issue. Because of the action being taken by the operator, the New Zealand Civil Aviation Authority, the manufacturer and the Federal Aviation Administration, no safety recommendations were necessary.

Hawker Beechcraft 1900D ZK-EAK
landing at Woodbourne, 18 June 2007
(courtesy of The Marlborough Express)

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Abbreviations

º	degree(s)
ºC	degree(s) Celsius
ºM	degree(s) magnetic
ATC	air traffic control
ATIS	automatic terminal information service
Beech 1900D	Hawker Beechcraft Corporation 1900D
CAA	New Zealand Civil Aviation Authority
CVR	cockpit voice recorder
FAA	United States Federal Aviation Administration
FDR	flight data recorder
ILS	instrument landing system
km	kilometre(s)
m	metre(s)
mm	millimetre(s)
NTSB	United States National Transportation Safety Board
NZFS	New Zealand Fire Service
psi	pounds per square inch
QRH	quick reference handbook
RFS	rescue fire service
SCD	specification control drawing
SPAR	special aerodrome weather report
UTC	co-ordinated universal time

Data Summary

Aircraft registration:	ZK-EAK
Type and serial number:	Hawker Beechcraft Corporation 1900D[1], UE434
Number and type of engines:	2 Pratt and Whitney Canada PT6A-67D turboprops
Year of manufacture:	2002
Operator:	Eagle Airways Limited
Date and time:	18 June 2007, 0907[2]
Location:	Woodbourne Aerodrome, Blenheim latitude: 41° 36´ south longitude: 173° 52´ east
Type of flight:	scheduled air transport
Persons on board:	crew: 2 passengers: 15
Injuries:	crew: nil passengers: nil
Nature of damage:	moderate to aircraft
Captain's licence:	airline transport pilot licence (aeroplane)
Captain's age:	42
Captain's total flying experience:	9776 hours (3300 hours on type)
Investigator-in-charge:	I R M[c]Clelland

Acknowledgement

The Transport Accident Investigation Commission (the Commission) acknowledges the assistance provided by the United States National Transportation Safety Board (NTSB) during this investigation.

[1] Hawker acquired Beechcraft from Raytheon Aircraft Company in March 2007.
[2] Times in this report are New Zealand Standard Time (UTC + 12 hours) and are expressed in the 24-hour mode.

General area of occurrence

1 Factual Information

1.1 History of the flight

1.1.1 On Monday 18 June 2007, NZ2300 was a scheduled flight from Timaru to Wellington operated by Eagle Airways Limited (the operator), as part of the Air New Zealand group operations. The aircraft allocated for the flight was ZK-EAK, a Hawker Beechcraft Corporation 1900D (Beech 1900D). The crew, consisting of 2 pilots, had flown ZK-EAK to Timaru the previous evening and completed a post-flight inspection of the aircraft before securing it for the night. They then retired to local overnight accommodation in preparation for the scheduled 0710 departure to Wellington the next day.

1.1.2 The crew arrived at the aircraft at 0625 and completed their normal before-flight duties. Although it was dark, the aircraft was illuminated by tarmac floodlighting and the first officer had the use of a torch to assist in his pre-flight inspection. No anomalies regarding the aircraft were found. Fifteen passengers boarded and the aircraft was taxied for departure at about 0710. After take-off the aircraft was climbed to a cruising altitude of 21 000 feet (about 6900 m) and the flight progressed uneventfully north towards Wellington. The captain was the "pilot flying" for the leg to Wellington, with the first officer performing the duties of "pilot not flying".

1.1.3 As the aircraft descended approaching Cook Strait, the crew obtained the latest automatic terminal information service (ATIS) broadcast for Wellington that contained runway and weather information. The crew was told to expect an instrument landing system (ILS) approach for runway 16, with cloud as low as 1000 feet, visibility reducing from 20 km to 10 km in showers and a surface wind of 210 degrees (º) magnetic at 10 knots. The crew also received the current ATIS broadcast for Woodbourne Aerodrome, 5 km west of Blenheim, as this was the first diversion destination in the event the aircraft was unable to land at Wellington for any reason. The captain, sitting on the left, reported he was able to see Woodbourne clearly as the aircraft neared Cook Strait (see Figure 1).

1.1.4 At 0812 ZK-EAK was approaching the commencement of the ILS approach and the crew started to configure the aircraft for the approach and landing. Initial flap was extended and approaching the glide path the first officer moved the landing gear lever to lower the gear. Neither the captain nor the first officer heard any of the noises that would normally be associated with the landing gear extending into the airflow and locking down. They also observed that the landing gear indication lights did not change from the fully up indication.

1.1.5 The first officer returned the gear lever to the up position and at 0815 he advised air traffic control (ATC) that they had a landing gear problem and were initiating the missed approach procedure. The aircraft was climbed to above the cloud and levelled at 6000 feet. ATC gave radar vectors to take ZK-EAK initially to the west of Wellington.

1.1.6 The landing gear lever was selected down a second time and again there was no indication of any gear movement. The crew checked electrical switches and panels, and found nothing that would stop the gear lowering. The crew decided that before completing further fault analysis, the aircraft should be positioned in an area away from cloud and other traffic. Knowing the area around Woodbourne was clear of cloud, the first officer got ATC clearance to descend in that direction. The captain told the passengers what had happened and of their intention to divert to the Woodbourne area to hold.

1.1.7 The aircraft was established in a holding pattern clear of Woodbourne Aerodrome and the crew carried out the quick reference handbook (QRH) actions for manual extension of the landing gear. Control of the aircraft was passed to the first officer to allow the captain to operate the manual pump to lower the landing gear. The captain reported that as he operated the pump handle he felt no resistance or pressure that would normally be expected. After pumping the handle for some time without success, he lowered and secured the handle and assumed control of the aircraft again.

1.1.8 The first officer contacted the operator's maintenance facility at Woodbourne and briefed the staff on the situation. He also advised the Woodbourne aerodrome controller. The controller replied that a full emergency response had been activated. The first officer acknowledged that action.

1.1.9 The crew reviewed the QRH and repeated the actions for manual gear lowering, but the landing gear remained retracted. The operator's maintenance staff contacted the crew and offered several suggestions on possible causes and actions that might assist, including isolating electrical power to the landing gear motor, but the landing gear remained in the up position.

1.1.10 The crew, having exhausted all possible options to lower the landing gear and aware of the amount of fuel remaining, prepared the aircraft for a wheels-up landing at Woodbourne. The first officer left his seat and individually briefed the passengers for the landing, including what they were required to do and when and how to exit the aircraft after landing. The first officer then checked passenger security and stowed all of the cabin bags in the front row of seats before returning to his seat.

1.1.11 The crew reviewed the QRH actions for a wheels-up landing, and after excess fuel had been used, turned off all non-essential electrical items, including pulling the landing gear control circuit breakers to prevent uncommanded movement of the landing gear. The crew set the flap to 17º and positioned the aircraft for a landing on runway 24. At about 0902 the aerodrome controller confirmed emergency services were in place[3] and cleared the aircraft to land.

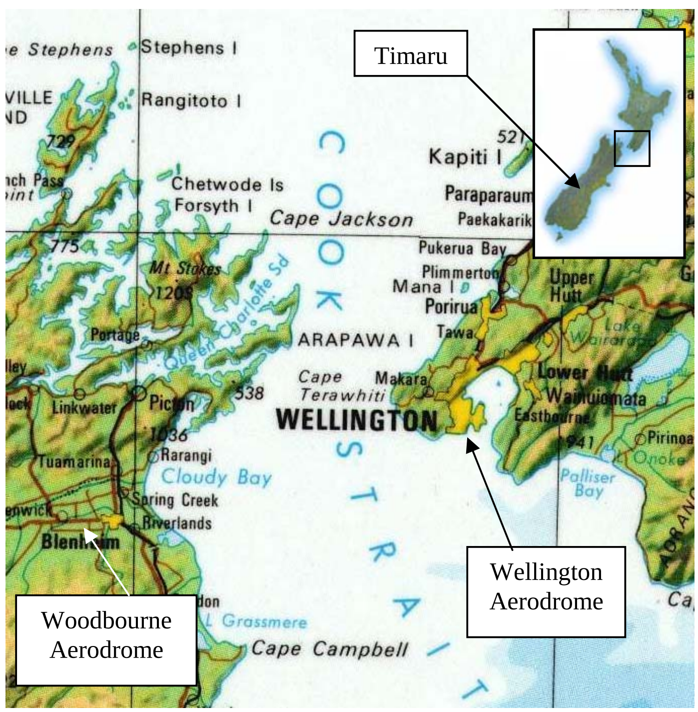

Figure 1
Location map

1.1.12 At about 500 feet, as ZK-EAK was turned to final approach, the first officer instructed the passengers to brace for the landing. At 0907, ZK-EAK touched down. On first contact with the runway, the first officer started to shut down the engines while the captain kept the aircraft straight. The aircraft took nearly 15 seconds to come to a halt, after which the crew completed securing the aircraft and the passengers started to vacate the aircraft using all 4 exits.

[3] The aerodrome rescue fire service supported by local fire and ambulance units.

1.1.13 On vacating the aircraft, the passengers and crew were met by the aerodrome rescue fire service (RFS) vehicles, which had sprayed fire retardant over the aircraft and around the area as a precaution, but there was no fire. Local fire service and ambulance units arrived in support. None of the occupants required assistance to vacate the aircraft and there were no injuries.

1.2 Wreckage and site information

1.2.1 Impact marks on runway 24 at Woodbourne showed ZK-EAK had touched down about 200 m past the threshold of the runway. The scrape marks were consistent with the strakes located at the rear of the fuselage striking the bitumen first near the runway centreline. Camera and video footage taken of the landing supported these observations.

1.2.2 Lateral scrape marks consistent with the right and then the left propeller striking the runway commenced about 48 m and 63 m respectively past the first touchdown point. The distance between the scrape marks indicated that the propellers had been rotating at high revolutions when they struck the runway.

1.2.3 Paint and other marks, consistent with the fuselage scraping along the runway, were evident for the next approximately 330 m. The total distance between the initial touchdown point and where ZK-EAK came to rest on about the runway centreline was measured as 422 m.

1.2.4 The aircraft's 4 exits, comprising the normal entry and exit door and the 3 over-wing emergency exits, were all used during the ground evacuation and operated as designed.

1.2.5 Both propellers were destroyed, with the engines requiring impact damage inspection and repairs. Severe scraping to the underside of the aircraft required major panel repairs and aerial replacements. Some impact damage was observed, mainly to the right side of the fuselage, as a result of the propeller blades disintegrating and sections striking the reinforced panelling. However, no items penetrated the fuselage.

1.2.6 ZK-EAK was lifted by crane and hydraulic pressure in the up-line released, allowing the landing gear to be lowered by hand and pinned into the down position. The aircraft was then towed to a hangar for further examination. The aircraft was repaired and returned to service nearly 3 months after the accident. The direct cost of repair was estimated by the operator to be about NZ$1.4 million.

1.2.7 The aerodrome re-opened about 5 hours after ZK-EAK landed.

1.2.8 Examination of the tarmac at Timaru where ZK-EAK had been parked overnight found no evidence of any fluid having leaked from the aircraft after arrival.

Weather information

1.2.9 The weather conditions at Wellington Aerodrome at the time ZK-EAK joined for the ILS approach were reported as follows:

> Surface wind 210º magnetic (ºM) at 10 knots. Visibility 20 km, reducing to 10 km with showers in the vicinity. Few cloud at 1000 feet and broken cloud at 1400 feet.[4] Temperature 7º Celsius (ºC) and a dew point of 6ºC. The reported 2000-foot wind was 170ºM at 15 knots.

1.2.10 A special aerodrome weather report (SPAR), was also valid for Wellington at this time and repeated the cloud levels detailed above. SPARs contained only those elements that were relevant to aerodrome approach minima or were significant to aircraft operation. The SPAR was updated at 0940 in response to lowering cloud levels, reported as scattered at 800 feet and broken at 1100 feet.

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[4] Cloud coverage was reported in eighths or oktas of the sky covered. Few was 1-2 oktas, scattered 3-4 oktas, broken 5-7 oktas and overcast 8 oktas.

1.2.11 The weather conditions at Woodbourne Aerodrome remained constant from 0726 to after ZK-EAK had landed at 0907, and were reported as follows:

> Surface wind 260ºM at 8 knots. Visibility 50 km with clear skies. Temperature 0ºC and a dew point of -4ºC. The forecast 2000-foot wind was 180ºM at 10 knots.

Aerodrome information

1.2.12 Wellington Aerodrome was both a domestic and an international aerodrome that handled aircraft capable of carrying up to 234 passengers. The aerodrome had one sealed runway, aligned 340/160º M. The runway was 1936 m long and 45 m wide. However, owing to displaced thresholds at both ends, the landing distance available was reduced to 1814 m. The runway had unobstructed approaches, but there were no overrun areas, with the ground dropping rapidly away at both ends to the sea.

1.2.13 The RFS at Wellington was equipped to a minimum of category 7.[5] This allowed for coverage of aircraft up to 49 m in length and 5 m maximum fuselage width, for example the Boeing 767-200 aircraft. The Beech 1900D required category 3 support – aircraft 12 m up to but not including 18 m, with a maximum fuselage width of 3 m.

1.2.14 Woodbourne Aerodrome, located 5 km west of Blenheim, served as a joint civil and military aerodrome. The Beech 1900 was the most common aircraft type to operate into Woodbourne. However, larger aircraft such as the C130 Hercules and Boeing 757 would also occasionally operate into Woodbourne and were capable of carrying up to 90 and 165 passengers respectively. The landing areas consisted of a sealed runway and 2 grass vectors, one grass vector paralleling the runway and a second crossing it at an oblique angle. The runway was aligned 060/240ºM and had unobstructed approaches from both directions. The runway was 1425 m long and 45 m wide, and the full length was available for landing. Limited overrun areas were available at both ends and off to the sides.

1.2.15 The RFS at Woodbourne was equipped to a minimum of category 4, covering aircraft up to 24 m in length with a maximum fuselage width of 3 m. For the emergency landing on 18 June the aerodrome RFS had all vehicles available and was capable of supporting category 6 requirements. On activation for the arrival of ZK-EAK, the aerodrome RFS was also supplemented by local New Zealand Fire Service (NZFS) units comprising 2 rescue tenders, 2 pump appliances and one tanker. An NZFS command vehicle from Nelson was also dispatched but was stood down before arriving at the aerodrome.

1.2.16 All established navigational aids at Wellington and Woodbourne were operating and available during the morning of 18 June.

1.2.17 Communication between ZK-EAK and ATC was via very high frequency radiotelephone and there were no reported problems.

Emergency services for Woodbourne

1.2.18 The aerodrome controller, on initiation of the aerodrome emergency plan, alerted the aerodrome RFS and also contacted emergency services at 0836 by use of the 111 system. Police, fire and ambulance services were activated in response. In addition to the NZFS elements described above, 2 ambulances were positioned at Woodbourne in preparation for the landing. A third ambulance arrived shortly after ZK-EAK landed and one further ambulance was also dispatched but was turned back while en route.

[5] The categories of rescue and fire fighting, categories 1 to 10, were described in International Civil Aviation document, Annex 14 Aerodromes, Chapter 9 Emergency and Other Services. Levels of extinguishing agents were also described.

1.2.19 Other emergency facilities or services alerted included the Nelson and Wellington rescue helicopter services and the Nelson Marlborough District Health Board hospital at Blenheim, although the latter was not informed until some 28 minutes after ZK-EAK had landed.

1.2.20 The Blenheim Hospital emergency department was equipped with 12 beds and 2 resuscitation rooms that could be used in an emergency. Any overload could be sent to either Nelson or Wellington, about 22 minutes' flying time away. Nelson Marlborough District Health Board contingency planning had included a scenario involving an airport accident with 30 casualties. A Health Board representative later informed the Commission that owing mainly to staff numbers, patient outcomes could be compromised if it were forced to admit more than 2 critically injured patients after an accident. The Health Board therefore did not consider Woodbourne Aerodrome to be the most suitable diversion aerodrome.

1.3 Personnel information

1.3.1 The captain was aged 42. He held an airline transport pilot licence (aeroplane) and a Class 1 medical certificate. He had flown 9776 hours, including 3300 hours on the Beech 1900D. He had joined the operator in August 1995 and obtained his captaincy on the Embraer EMB-110 Bandeirante aircraft in November 1996 and on the Beech 1900D in January 2002. He was based at Woodbourne.

1.3.2 The captain's last line check had been on 17 May 2007 and last instrument check on 24 February 2007. He had flown 165 hours in the previous 90-day period. The captain had been off duty on 15 June and recorded 4 hours' duty time on 16 June. On 17 June, the day before the occurrence, he flew ZK-EAK and recorded nearly 10 hours' duty, flying 6 sectors without incident. A walk-around inspection had also been performed before each flight, with no anomalies detected. He reported he was well rested on the day of the occurrence, having had a good-quality "7.5 hour sleep". He reported he was in good health on the day of the occurrence.

1.3.3 As part of his upgrade training, the captain had completed a manual extension of the landing gear and was familiar with the appropriate checklists.

1.3.4 The first officer was aged 32. He held a commercial pilot licence (aeroplane) and a Class 1 medical certificate. He had flown 2496 hours, including 410 hours on the Beech 1900D. He had joined the operator in November 2006 and was also based at Woodbourne.

1.3.5 The first officer's last line and instrument checks had been on 13 May 2007. He had flown 142 hours in the previous 90-day period and reported similar crew duty times as the captain. He reported he was in good health and well rested on the day of the occurrence, having had 7 hours of sleep the night before.

1.4 Aircraft information

ZK-EAK was a Hawker Beechcraft Corporation 1900D, a low-winged passenger aeroplane capable of carrying 19 passengers and a crew of 2. ZK-EAK was manufactured in the United States in 2002 and delivered new to the operator on 14 June 2002. The aeroplane was powered by 2 Pratt & Whitney Canada PT6A-67D turboprop engines, each driving a 4-bladed composite material propeller.

1.4.1 At the time of the occurrence the aeroplane had accrued 10 315 hours and 17 149 cycles.[6] A review of the aeroplane maintenance records showed it had been maintained in accordance with its approved schedules, including routine 50-hour, 100-hour and 200-hour checks. The most recent maintenance inspection had been a 50-hour check completed on 13 June 2007 at 10 297.8 hours and 17 122 cycles. The most recent annual maintenance review had been completed on 12 June 2007.[7] The next planned check, a 50-hour inspection, was due at 10 347.8 hours and the next 100-hour check due at 10 354.5 hours. There were no recorded or known defects that would have affected the safety of the aeroplane.

Landing gear

1.4.2 The Beech 1900D was fitted with hydraulically actuated, retractable tricycle landing gear. The nose gear retracted aft to leave the wheel partially protruding below the fuselage. The 2 main landing gear legs retracted forwards into the engine nacelles, leaving the 2 wheels of each leg also partly protruding below the engines and landing gear fairings. Three green indicator lights in the cockpit would illuminate when the landing gear was fully down and locked. The landing gear control handle would illuminate red when the landing gear was in transit and all lights would extinguish when the gear was fully up.

1.4.3 An electrically powered hydraulic pump located in the left wing immediately behind the leading edge near the fuselage provided a nominal system operating pressure of 2600 pounds per square inch (psi) to raise and lower the gear. The pump assembly, or power pack, also contained a selector valve, gear-up pressure switch, primary and secondary reservoirs and a low-fluid-level sensor. Plumbing for normal extend and retract modes was routed from the power pack to a single actuator for each landing gear leg.

1.4.4 The plumbing for normal landing gear extension ran to a shuttle valve located in the end cap of each actuator. Each shuttle valve was spring loaded to a position that allowed hydraulic fluid to flow into or out of the actuator cylinder. The retract mode plumbing was fitted to the opposite end of each actuator (see Figure 2).

1.4.5 When the landing gear control lever was moved to the up position, hydraulic fluid under pressure was directed to the retract side of the system. Once hydraulic pressure reached 200-400 psi at the retract end of an actuator, internal mechanical locks would release and the gear would start to retract. As the gear retracted and the actuator piston moved, hydraulic fluid would exit through the normal extend port and be carried back to the primary reservoir. Once fully retracted, the system pressure would increase until the pressure limit was reached, activating a pressure switch that interrupted current to the pump motor, shutting it off. The landing gear was then held in the up position by trapped hydraulic pressure. The same pressure switch would activate the pump motor should the pressure drop to the low pressure limit. An accumulator, pre-charged to 800 ± 50 psi, was designed to aid in maintaining the system pressure in the gear-up mode.

1.4.6 When the landing gear was selected down, fluid pressure from the retract side of the system was relieved and returned to the power pack primary reservoir through a pressure check valve. System fluid under pressure was then directed through the extend side plumbing to move the actuator piston to extend the gear. Once fully extended, an internal mechanical lock locked the actuator piston in place to lock the gear down. The locking mechanism made contact with a down position switch to stop the pump motor and illuminate the green down light on the flight deck.

[6] A cycle was considered to be one take-off and landing.
[7] An annual check of the aircraft and maintenance records to ensure it complied with its type certificate and was being correctly maintained.

1.4.7 Should the hydraulic reservoir fluid level become "critically low", a sensor in the power pack would illuminate a yellow HYD FLUID LOW annunciator light on the cockpit caution panel. The sensor unit included an integral self-test circuit, energised by a switch on the pilots' instrument panel. The caution panel lights and the self-test circuit were checked as part of the normal pre-flight inspection and found to be operating. It was subsequently found that the test facility tested the circuitry only and did not include the fibre-optic sensor located in the hydraulic reservoir.

1.4.8 A manual or emergency landing gear system was provided as a back-up for the electrically powered system. A hand pump, located between the left pilot's seat and centre instrument pedestal, could be used to pump hydraulic fluid manually from the secondary reservoir to the 3 landing gear actuators. Before operating the pump to lower the gear, pilots were directed to pull the landing gear control circuit breaker, place the landing gear control lever in the down position then operate the pump. Pumping would continue until the green GEAR DOWN indicator lights illuminated. The lever was not to be lowered to the floor or retaining clip during pumping as this relieved any pressure built up. It was considered unlikely that a trained pilot would inadvertently lower the lever to the level of the securing clip while pumping, as their hand would likely strike the floor first.

1.4.9 The aircraft manufacturer considered the normal and emergency means of lowering the landing gear to be independent systems. The hydraulic reservoir was composed of 2 interconnected storage tanks with a primary tank mounted inside a secondary tank. The primary tank supplied fluid through an output fitting to the electrically driven hydraulic pump. The secondary tank supplied the hand pump or emergency system. The outlet for the secondary system was below the normal outlet, thus ensuring a supply of fluid to the emergency system should the reservoir level drop below the normal outlet. A shuttle valve located in the end cap of each actuator ensured only normal or emergency hydraulic pressure entered the end cap at one time. Plumbing for normal and manual retraction joined before running to the 3 actuators.

1.4.10 The majority of the landing gear components installed on the aircraft at the time of the occurrence, including the 2 main gear hydraulic actuators, had been fitted new to the aeroplane during production. Maintenance documentation recorded the power pack being replaced twice in the 6 months before the accident. On 2 January 2007, the landing gear failed to extend by normal means and was lowered using manual gear extension. The landing gear motor relay and several other electrical items were replaced as a result. The power pack was also replaced as a precaution owing to the hydraulic pump exceeding its continuous operating time limit. The aircraft had accrued 9420 hours at this time.

1.4.11 On 21 January 2007, some 108 flying hours later, the power pack was found cycling every 20 to 30 seconds and was replaced. On 23 January a hydraulic fluid leak was observed under the left wing. Inspection identified a loose swivel joint in the retract line. Joint unions were tightened and "numerous retractions" carried out without any sign of further leaking. The aircraft then flew a further 660 hours before the accident on 18 June 2007.

1.4.12 Physical inspection of hydraulic system fluid was a maintenance action, with the fluid level being checked every 100 flight hours. Pilots were not required to check hydraulic quantity as part of their normal pre-flight inspections, but were trained to look for any leaks or abnormalities during their inspections before each flight. There was no record of any replenishment of the aircraft's hydraulic fluid reservoir since the maintenance action on 23 January. The hydraulic system held about 4.75 litres of hydraulic fluid.

Checklist

1.4.13 The initial QRH actions for manual extension of the landing gear were as follows:

If the Landing Gear fails to extend after placing the landing gear control down, perform the following:

1 Landing Gear Relay Circuit Breaker (pilot's right subpanel)…PULL
2 Landing Gear Control……………………………….CONFIRM DOWN
3 Alternative Extension Handle…………………UNSTOW AND PUMP
a Pump handle up and down until the three green gear-down annunciators are illuminated.
b While pumping, do not lower handle to the level of the securing clip, as this will result in loss of pressure.

Three green gear-down annunciators are illuminated → ***No*** (go to "If one or more green gear-down annunciators…")

↓ ***Yes***

4 Alternate Extension Handle……………………………………….STOW
5 Landing Gear Controls………………………….DO NOT ACTIVATE
a The landing gear control and the landing gear relay circuit breaker MUST NOT BE ACTIVATED.
b The landing gear should be considered UNSAFE until the aeroplane is on jacks and the system has been cycled and checked.

If one or more green gear-down annunciators do not illuminate for any reason and a decision is made to land in this condition:

6 Alternate Extension Handle………………………..CONTINUE PUMPING
a Continue to pump the handle until maximum resistance is felt.
b When pumping is complete, leave handle at the top of the stroke. DO NOT LOWER AND STOW.

(Prior to landing repeat above actions.)

Flight recorders

1.4.14 ZK-EAK was fitted with a cockpit voice recorder (CVR) and a flight data recorder (FDR), which were removed and secured after the occurrence. Because sufficient information was available from the FDR, recorded ATC data and both pilots, the CVR data was not downloaded.

1.4.15 Data from the FDR was downloaded and reviewed. The information showed no anomalies with the exception of no data input for the landing gear extend and retract pressures. How long the 2 inputs had not been recorded could not be confirmed.

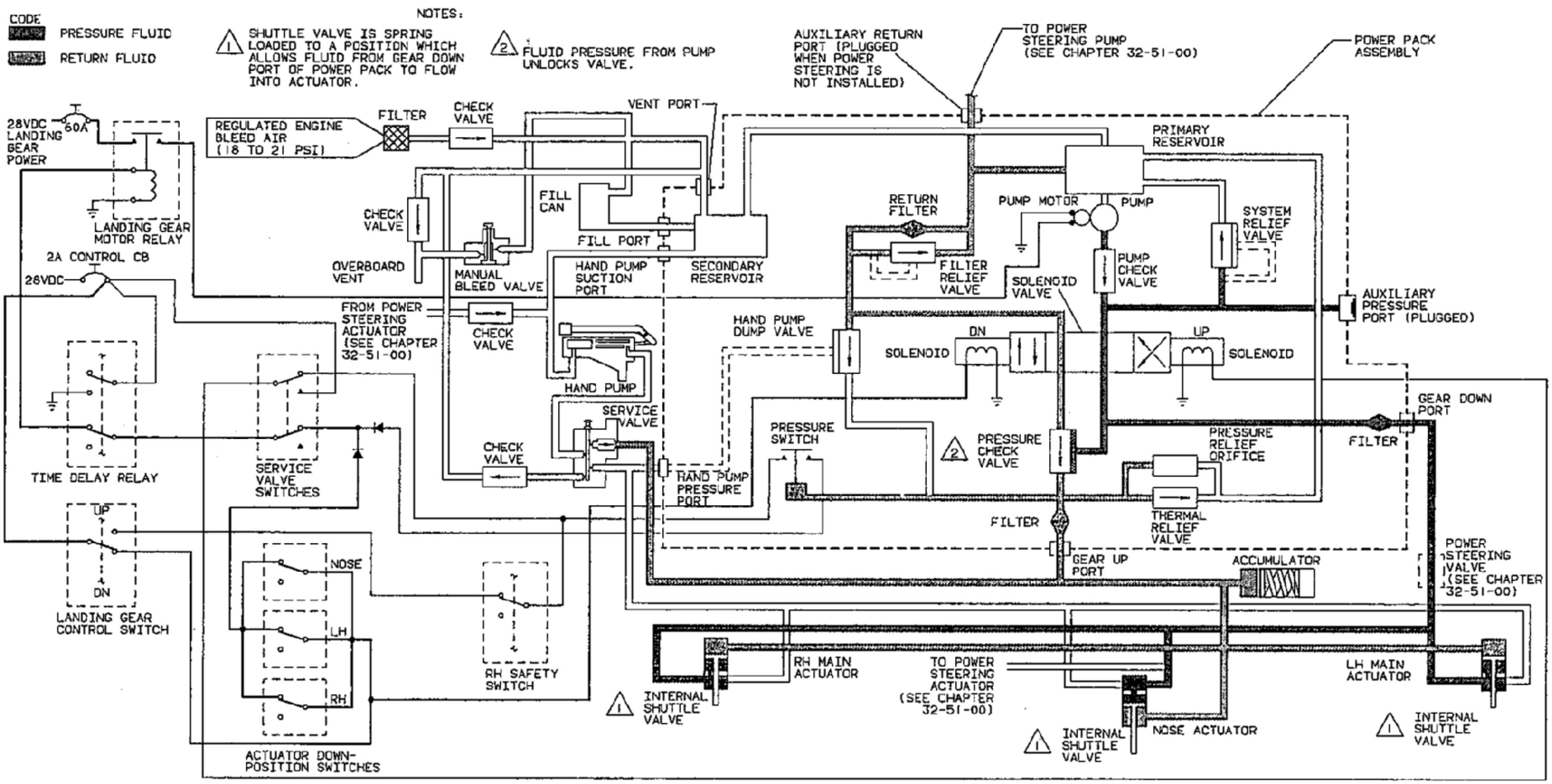

Figure 2
Hydraulic landing gear diagram (normal extend mode)

1.5 Tests and research

1.5.1 Initial examination of ZK-EAK found the hydraulic reservoir empty of fluid. However, when electrical power was applied to the aircraft, there was no caution panel light illuminated that would normally warn pilots of low hydraulic fluid levels. The fault was traced to the low-level quantity sensor located in the hydraulic reservoir.

1.5.2 Hydraulic fluid was found sprayed around the inside of the right main wheel well and running rearwards from the wheel well to the trailing edge of the underside of the wing. Hydraulic fluid was also found streaked down the right side of the fuselage as far back as the strakes at the tail of the aircraft. The hydraulic reservoir was partially replenished and the hand pump used to pressurise the system. Fluid was soon observed flowing from the top side of the hydraulic gear actuator for the right main landing gear. The actuator was removed and fluid was found seeping from a crack in the end cap (see Figure 3).

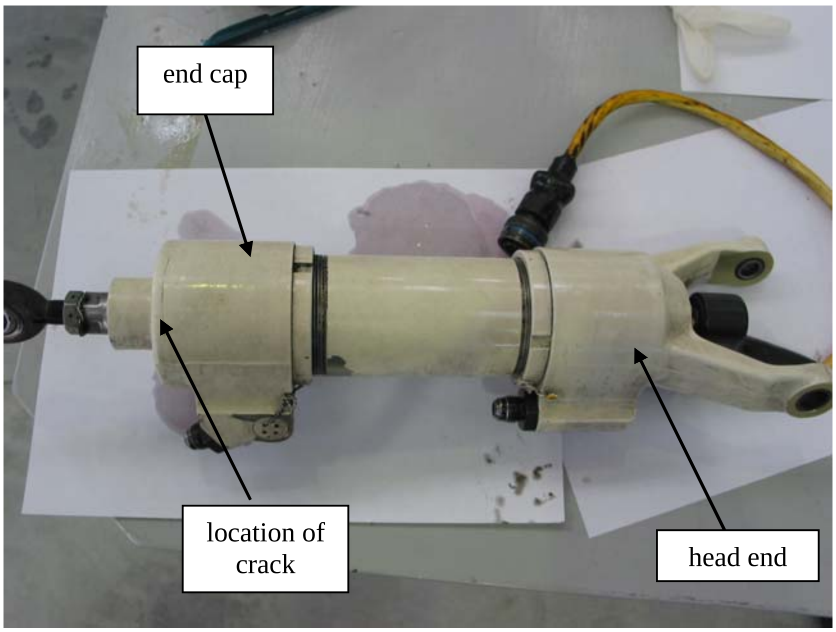

Figure 3
Actuator after removal from ZK-EAK

Figure 4
Close-up of crack

1.5.3 A replacement actuator was fitted to ZK-EAK, the hydraulic reservoir replenished and several gear retractions and extensions completed successfully. Manual or emergency cycling of the gear was also completed. The landing gear performed according to specifications. Checks of the main landing gear rigging before and after the actuator was replaced found it to be within documented limits. Despite functioning correctly, the operator as a precaution replaced the hydraulic power pack, including the low-level sensor.

1.5.4 The failed actuator was a Frisby Airborne Hydraulics[8] component, part number 114-380041-**15**, serial number 1145A. The actuator had been fitted new to the aircraft on production and at the time of the accident had accrued the same hours and cycles as the aircraft – 10 315 hours and 17 149 cycles.

1.5.5 The failed actuator from ZK-EAK was passed to the NTSB for metallurgical examination with assistance from the actuator manufacturer. Representatives of the aircraft manufacturer also attended.

1.5.6 While waiting for the results of the metallurgical testing, the remainder of the operator's aircraft were checked for failed actuators. The actuators were subjected to an initial visual examination followed by "eddy current" testing.[9] No cracks were identified. The age and cycles of the failed actuator from ZK-EAK were determined to be about the average for the operator's fleet of aircraft. The highest-time actuators in the operator's fleet had accrued 11 943 hours and 19 772 cycles. This was well below the hours and cycles accrued for the same type of actuator installed on other Beech 1900 C or D model aircraft worldwide. Having informed the aircraft manufacturer and with no evidence of a wider problem, either from within the operator's fleet of aircraft or worldwide, the operator recommenced flying operations 3 days after the event as aircraft were checked and cleared.

1.5.7 On Monday 24 September 2007, during a routine pre-flight inspection, the crew of ZK-EAF, another of the operator's Beech 1900D aircraft, observed a pooling of hydraulic fluid near the right main landing gear. The hydraulic reservoir was checked and the level found to be "slightly below full". The actuator was removed and closer examination identified a crack in the same location as the crack in the actuator from ZK-EAK.

1.5.8 An ultrasonic test[10] was developed by the operator and the remainder of the operator's Beech 1900D aircraft were checked. A further 12 actuators were found to have possible cracks. The suspect actuators included both left and right main landing gear actuators, but the cracks were all in the same location on the actuators. The actuators had all accrued more than 16 000 cycles since new.

1.5.9 The operator, as a precaution, elected to replace all actuators that had accrued more than 10 000 cycles before returning the aircraft to service. Further, until the manufacturers of the actuators and the aircraft had determined a satisfactory remedy, the operator initiated an ultrasonic testing programme every 1000 cycles. In conjunction with the New Zealand Civil Aviation Authority (CAA), details of the testing programme were passed to other New Zealand Beech 1900 operators for use on their aircraft as well.

1.5.10 The actuator from ZK-EAF had accrued 11 460 hours and 19 093 cycles and, like the actuator from the accident aircraft ZK-EAK, had been installed during aircraft production. The actuator from ZK-EAF was subjected to metallurgical examination in New Zealand to support the work done by the NTSB.

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[8] Later becoming Triumph Actuations Systems, part of the Triumph Group Company.
[9] Passing an electrical current over a structure to detect any surface anomalies or flaws.
[10] The directing of high-pitched sound waves to detect anomalies within an object.

Metallurgical examinations

1.5.11 The cracks in the 2 actuators were both in similar positions in the end caps – in line with the inside corner radius of the end cap. The crack in the actuator from ZK-EAK was nearly 50 mm long and covered an arc of about 120º (see Figure 4). The crack in the ZK-EAF actuator was about 25 mm long.

1.5.12 Cuts were made at both ends of the visible cracks for both actuators, and the fracture surfaces exposed for closer examination. A closer view of the exposed surfaces, in particular the internal surfaces, identified numerous individual ratchet marks, "consistent with fatigue initiating from multiple origins before propagating into a unified crack front" (see Figures 5, 6 and 7). Closer examination of the radius identified in Figure 5 revealed a distinct crack originating in the radius (see Figure 8) and smaller cracks in its vicinity (see Figure 9). Examination showed the cracks were coincidental with circumferential machine marks resulting from manufacture.

1.5.13 The design drawings for the actuator specified an inside corner radius for the end cap of 0.06 inches (1.52 mm). The radii for both actuators were measured and determined to be within the design tolerance range of 1.27 mm to 1.78 mm, with the actuator from ZK-EAK in the mid-range and the actuator from ZK-EAF at the lower limit. The wall thickness was 7 mm, which also corresponded to design specifications (see Figure 7).

1.5.14 High-magnification examination of the section cap from ZK-EAF identified fatigue striations. The crack striations had propagated across the end cap wall until about 0.4 mm from the edge, where it sheared apart. Examination of the striations showed that the crack propagation rate increased as it progressed across the fracture surface and grew in length. Eight sample points across the fracture surface were examined in detail to give a more accurate assessment of the total time to failure.

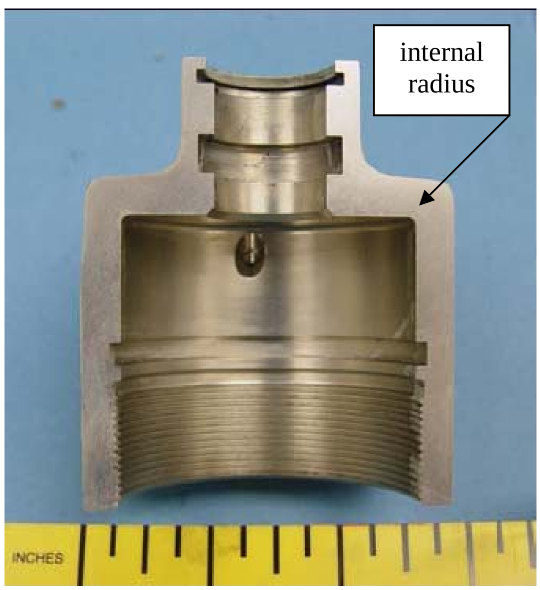
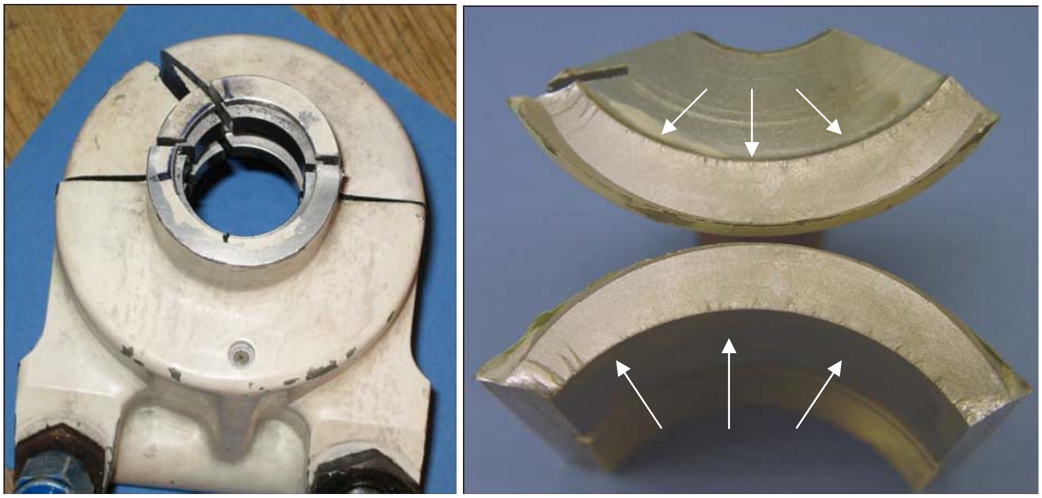
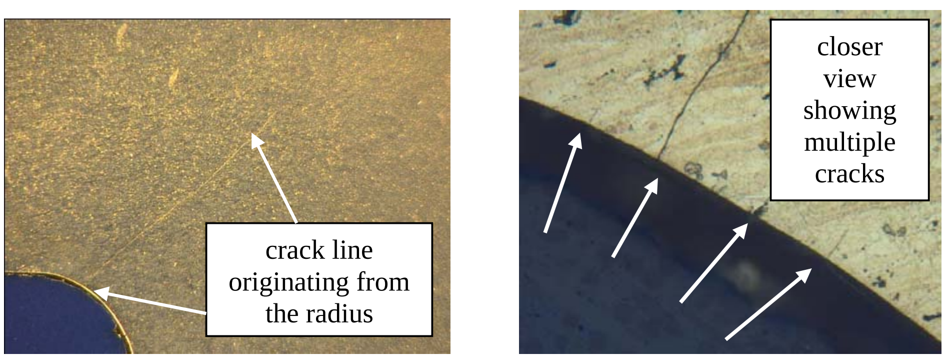


Figure 5
Sectional view of end cap from ZK-EAK
(Courtesy of NTSB)



Figures 6 and 7
Sectioned end cap and fracture faces from ZK-EAK
(Courtesy of NTSB)

1.5.15 A summation of the striation counts at the 8 points gave a total measurement of 11 960 striations across the 6.6 mm of the wall. The striations equated to cycles and therefore it was calculated that after initiation of the crack, it reached a critical size after 11 960 cycles. The crack had sheared the last 0.4 mm of the wall and allowed hydraulic fluid to leak from the actuator.[11]



Figures 8 and 9
Close-ups of cracking in end cap from ZK-EAK
(Courtesy of NTSB)

1.5.16 The end cap material was subjected to hardness testing and micro-structural examination and determined to be in accordance with design specifications. The actuator, including the end cap, matched design drawings provided by the manufacturer. Examination also determined that the inside of the actuator cap was covered by an anodised aluminium oxide layer, about 7 microns thick. The anodising had been completed after machining of the actuator components during manufacture.[12]

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[11] The metallurgy report and findings conducted on the actuator from ZK-EAF were later validated by the NTSB.
[12] The anodising provided a hardened layer for increased wear resistance. It was also more brittle in character and therefore more prone to cracking when compared with softer or more malleable metals.

1.5.17 During the NTSB examination, a representative of the aircraft manufacturer produced a third actuator that had been removed from a United States operator's aircraft after it was found leaking hydraulic fluid during a ground inspection, and had been recently forwarded to Hawker Beechcraft. Examination of the cap displayed signature marks[13] similar to the 2 cracked end caps from Eagle Air. The actuator had accrued 20 848.7 hours and 30 017 cycles since manufacture, and 15 188.7 hours and 20 854 cycles since overhaul for unrelated defects.

1.6 Other information

1.6.1 In 1997 the actuator manufacturer notified the aircraft manufacturer that 3 actuators sent for overhaul had been found to have cracks in their head ends.[14] As a result the internal radius in the head end was increased from 0.010 inches (0.254 mm) to 0.090 inches (2.286 mm) and the wall thickness increased. The actuator manufacturer reviewed the design of the rest of the actuator and, based on the information available, reported to the aircraft manufacturer that its review indicated no need for further change.

1.6.2 Consequently the actuator manufacturer issued a service bulletin in October 1997 recommending the replacement of the head end cap installed on actuators with part numbers 114-380041-**11** and 114-380041-**13.** In January 1998 the aircraft manufacturer issued a service bulletin supporting the replacement action. The actuators installed on the operator's fleet of aircraft were 114-380041-**15** models that incorporated the redesigned head end.

1.6.3 The actuator manufacturer later informed the Commission that during the review it had asked the aircraft manufacturer about the accuracy of the load and pressure data contained in the specification control drawing (SCD)[15] for the actuator. According to the actuator manufacturer, the aircraft manufacturer had advised that a flight test was being considered to examine the operational loads and pressures. The flight test results were not passed to the actuator manufacturer until after the accident involving ZK-EAK.

1.6.4 In May 2008, the aircraft manufacturer advised the Commission that following the NTSB examination of the actuator from ZK-EAK, a further 4 incidents of cracked actuator end caps had been reported to the manufacturer. These involved 3 different operators around the world and occurred between 5 December 2007 and 8 March 2008. In all of these cases the leaking actuator had been detected before flight and no damage had been incurred.

1.6.5 A review of global landing accidents involving Beech 1900 aircraft identified 4 other accidents similar to ZK-EAK's, where the aircraft had landed with all the wheels retracted. In 3 of those accidents the pilots had forgotten to lower the gear owing to other distractions. In the remaining accident a maintenance error had prevented the gear being extended. In one of the 4 accidents several passengers had sustained minor injuries. No injuries had been reported in the other 3 accidents. The safety manager for the aircraft manufacturer considered the aircraft had good wheels-up landing capability.

Actuator design specifications

1.6.6 On 11 July 2008, the actuator manufacturer informed the Commission that it believed the original actuator design had been based on inaccurate information provided to it by the aircraft manufacturer. The actuator manufacturer contended that the SCD had understated the operational loads and pressures experienced by the actuator and significantly misstated the degree of fluctuations in pressure during landing gear extension. As a result, the actuator manufacturer said, the actuator would not achieve the intended 50 000-cycle life.

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[13] Similarities in fracture type and location.
[14] The opposite end to the fatigue cracks found on ZK-EAK and ZK-EAF.
[15] The SCD set the design and operating criteria for a component to be manufactured and installed on an aircraft.

1.6.7 On 7 November 2008, the aircraft manufacturer informed the Commission that the SCD defined the endurance test, which included relevant operating pressures for 50 000 cycles. The aircraft manufacturer contended that in early 2008 the actuator manufacturer had advised that the original endurance testing by Frisby, the original manufacturer, had not been accomplished according to the SCD. The aircraft manufacturer advised that no change to the endurance test defined in the SCD was planned, and following a review of flight test data was satisfied that the SCD endurance test load on the end cap, if properly performed, exceeded the loads applied in flight.

1.6.8 In response to the above, the actuator manufacturer advised that the actuator had been tested to the loads and pressures stated in the SCD, but not to the loads and pressures revealed by the flight test data. Also the flight test data showed the actual pressures to be greater than the SCD indicated and the end cap experienced 2 pressure peaks, not one, during a cycle. The actuator manufacturer further advised that as a result of the incident concerning ZK-EAK, the aircraft manufacturer had requested that the end cap be redesigned to meet the loads and pressures determined by the test flight data.

1.6.9 The aircraft manufacturer commented that during qualification testing the actuator manufacturer had discovered wear in the rod bore and as a result the bore had been hard-coat anodised. Only after the accident involving ZK-EAK did the aircraft manufacturer find out that the entire end cap had been hard-coat anodised. The aircraft manufacturer believed this may have been the reason for the formation of the fatigue crack in the end radius, with the anodising providing a more brittle surface conducive to cracking at relatively low tensile stress values. Therefore, cracks in the anodised layer could have initiated cracks in the underlying aluminium alloy compound.

1.6.10 At the time of writing this report, the aircraft manufacturer and actuator manufacturer were in ongoing discussions over the design specifications and testing for the actuator.

2 Analysis

2.1 The incident flight on 18 June 2007 was a regular public transport flight that was routine until intercepting the instrument approach in preparation for landing at Wellington.

2.2 The landing gear would not lower because a fatigue crack in the hydraulic actuator for the right main landing gear assembly had propagated through the thickness of the end cap wall, allowing the hydraulic system to be depleted of fluid. This prevented a build-up of pressure on the extend side of the system, which would normally have started moving the actuator and relieved up-line pressure, thereby lowering the gear.

2.3 With no evidence of any hydraulic fluid loss on the ground at Timaru and the crew being able to raise the landing gear by the normal means, it was very likely that the actuator had failed during the flight north. However, the lack of a low-quantity warning light precluded an exact determination of the time of failure.

2.4 The failure of the hydraulic low-level sensor was unrelated to the failure of the actuator. A caution panel alert informing the crew that the hydraulic fluid quantity had reached a critically low level could have assisted the pilots in understanding why they were unable to lower the landing gear. It may not have given sufficient warning to permit the crew to slow the aircraft and extend the landing gear, either normally or by using the hand pump as directed in the QRH. Had the gear started to lower, there may have been insufficient fluid, and therefore pressure, to lower and lock all the wheels fully, particularly the nose wheels, which had to extend forward against the airflow. The crew could have then been in a worse situation with the landing gear partially extended and not locked.

2.5 The hydraulic system was a fully contained system that did not require regular replenishment. Scheduled maintenance was therefore restricted to a check every 100 flight hours or before an aircraft was returned to service following planned maintenance. There was no recent history of the hydraulic system needing replenishing or any evidence of leakage. Therefore, had the crew of ZK-EAK checked the hydraulic level before departing Timaru, they would likely have found it to be full.

2.6 Following the incident, the operator initiated an inspection programme to ensure the serviceability of the sensors on the remaining aircraft in the fleet. See section 4 Safety Actions, for further comment.

Actuator failure

2.7 The fault in the head end on earlier models of the actuator had been corrected by improving the design. A review by the actuator manufacturer of the complete actuator assembly at the same time determined no further changes were necessary, noting that the internal radius in the end cap already exceeded the radius of the failed head end by as much as 6 times.

2.8 The 114-380041-**15** model of actuator was an on-condition item, meaning it could remain in operation until a fault developed. Examination of the actuators from ZK-EAK and ZK-EAF confirmed they met original design specifications. The internal radius for the actuator from ZK-EAF was, however, at the lower limits of the tolerances allowed.

2.9 The fractures in the actuators from ZK-EAK and ZK-EAF originated from the same part of the actuator end cap, namely the inside corner radius. The fractures were the culmination of numerous small fatigue cracks that had joined to produce a unified crack front. The crack front eventually propagated through the thickness of the end cap wall and reduced its capability to withstand normal operational pressure until it eventually failed. Most, if not all, of the cracks coincided with machining marks on the inside radius of the end cap. The cracking initiated in the more brittle 7-micron-thick anodised aluminium oxide layer and progressed through to the underlying aluminium material.

2.10 Machining of components will leave marks that will be evident if sufficient magnification is available. The effects can be reduced by finishing before any anodising of the component is completed. The degree of finishing can be agreed by the parties involved or determined by the manufacturer to ensure the final product meets specifications.

2.11 For ZK-EAF it was calculated that initiation of the crack failure occurred after 11 960 cycles. With a total time in service of 19 093 cycles, it can be calculated that the crack initiated after the aircraft had completed 7133 cycles.

2.12 At 10 314 hours and 17 149 cycles, the actuator from ZK-EAK was not the highest-time actuator in service with the operator. Six of the operator's aircraft had actuators with more than 11 000 hours and 19 000 cycles, the highest being 11 943 hours and 19 772 cycles. However, most of the operator's 12 actuators that were identified as possibly having a fatigue crack were the actuators that had accumulated the most cycles. The third failed actuator, presented by the aircraft manufacturer, had accrued over 50% more cycles than the operator's aircraft.

2.13 The type of alloy material used in the construction of the actuator was found to meet the manufacturer's design criteria and was suitable for the task. The failure can, therefore, be attributed to the original specification control design being inadequate, the surface finish specification being inadequate for the design loads, the internal radius being too small for the design loads, the surface finishing and internal radius combined with the effects of hard-coat anodising being inadequate for the design loads, or a combination of these factors.

2.14 An improvement in the standard of surface finishing, a redesign of the profile around the radius, or a complete redesign of the actuator would be an acceptable solution to prevent further premature failures. A combination of all would provide a more robust product. Alternatively, imposing operating limitations, in terms of cycles or hours, could ensure the actuators were removed well before any sign of failure.

2.15 With the initial evidence pointing to an isolated problem with the right actuator on ZK-EAK, the operator acted appropriately in checking the remainder of the fleet, including using an eddy current test, before returning other aircraft to service. It was not until 14 weeks later, when the fault with ZK-EAF was discovered, that there was an indication of a wider problem with the actuator. The use of an ultrasonic test, which was able to penetrate below the surface and detect anomalies, helped to identify the extent of the problem and generated positive action by the aircraft and actuator manufacturers. Ultrasonic testing was an improvement on the eddy current test, but the test still needed to be refined to ensure the results were accurate.

2.16 The 5 other cases of actuator failure that were detected before flight probably occurred when the landing gear was lowered, or soon afterwards. The performance of a thorough pre-flight inspection worked in these cases. For ZK-EAK the failure occurred after moving away from the overnight parking spot at Timaru and probably when the gear was raised.

2.17 The aircraft manufacturer considered the normal and emergency means of lowering the landing gear to be 2 separate systems. However, both the normal and emergency lowering systems were rendered unserviceable by a single point failure in the actuator that prevented the build-up of extension pressure. The reliability of this component therefore needs to be improved to prevent a reoccurrence that may unnecessarily endanger the aircraft and its occupants.

2.18 The contention by the actuator manufacturer that the design of the actuator had been based on inaccurate data supplied by the aircraft manufacturer, and the counter argument of the aircraft manufacturer that the actuator had not been properly tested and the end cap had been anodised without its knowledge, had not been resolved at the time of writing this report. While either situation could contribute to premature failure of the end cap, it did not explain why only the actuator from ZK-EAK and others from the operator’s fleet, plus several other overseas aircraft, had failed so early when compared with most actuators still in service with far more hours and cycles.

2.19 Until a more permanent solution has been developed by the manufacturer of the actuators, and approved by the aircraft manufacturer, the inspection regime initiated by the operator and to be approved by the United States Federal Aviation Administration (FAA) should provide adequate protection against a reoccurrence of this type of event. See section 4 Safety Actions for further comment.

Landing: Wellington or Woodbourne

2.20 The decision to divert and land at Woodbourne, not Wellington, was the responsibility of the pilots, having considered all the information available to them. While the runway at Wellington was longer, the unobstructed approach and clear flat areas surrounding the runway at Woodbourne were preferable. The Woodbourne runway was adequate in length, with the aircraft eventually using only about 600 m of the available 1425 m.

2.21 The weather at Woodbourne was also more suitable, with calm conditions and a clear sky. This allowed for a longer stabilised visual approach to land. At Wellington, the crew would have needed to fly an instrument approach through cloud, and would have been unlikely to become visual with the runway until descending through about 1000 feet, equating to about 5 km to fly to the threshold.

2.22 The pilots were based at Woodbourne and therefore more familiar with this aerodrome and its surrounds. Wellington Hospital, as a main centre hospital, would have had the capability to handle an accident involving an aircraft significantly larger than the Beech 1900 aircraft. However, the emergency services available at Woodbourne, while not as extensive as at Wellington, were capable of handling 5 or 6 seriously injured victims and numerous minor injuries, with any overflow being taken by helicopter to Wellington or Nelson.

2.23 The Beech 1900, as was proved in this incident, had good wheels-up landing characteristics. The crew's landing technique was in accordance with procedures and helped to ensure a good outcome and mitigated any risk of injury to the occupants. The aerodrome emergency services were adequate and well prepared for such an eventuality.

2.24 The delay in the hospital being notified of the emergency could have had significant consequences had there been numerous or significant injuries. Following the incident, the various emergency organisations involved reviewed the handling of the emergency to identify any lessons learnt. Refer to section 4 Safety Actions for further comment.

2.25 A final but secondary consideration for the pilots would have been the larger-scale disruption that would have occurred had the crew landed at Wellington, a busy international airport. ATC estimated that the closure of Wellington for 5 hours on a Monday morning would have caused about 100 flights to be diverted or delayed, affecting potentially several thousand inbound and outbound passengers. International flights scheduled to arrive early afternoon would also have been affected.

3 Findings

Findings are listed in order of development and not in order of priority.

3.1 The records for the aircraft showed it had been maintained in accordance with documented manuals.

3.2 A fatigue crack in the actuator developed over time, estimated to be about 11 900 cycles, and reached a critical size during the flight to Wellington.

3.3 The crack allowed hydraulic fluid to vent overboard and, because of the landing gear system design, the crew were prevented from lowering the landing gear by any means.

3.4 Published emergency procedures for performing a wheels-up landing, and the crew's adherence to those procedures, mitigated as much as possible the risk of injury to the occupants of the aircraft, and minimised the damage that the aircraft sustained.

3.5 The decision to divert the aircraft from Wellington to Woodbourne, which had lesser emergency response capability, was reasonable because the weather conditions and environs at Woodbourne increased the chances of a successful landing, and the emergency response capability at Woodbourne was designed for such an event.

Following the discovery of the second failed actuator, an inspection regime developed by the operator helped to identify other defective actuators and prevented any further occurrences.

3.6 The actuator from ZK-EAK, and some other actuators on the operator's fleet of aircraft, failed well before their intended design life because of one or any combination of the following factors:

- the original design specification not representing the actual in-flight loads and pressures on the actuator
- inadequate specification for or adherence to surface finishing during manufacture
- the internal radius of the end cap being too small
- the hard-coat anodising being more brittle and therefore more prone to cracking at lower tensile stress than the underlying compound..

3.7 The Commission was unable to determine the precise cause of the fatigue crack owing to conflicting evidence provided by the aircraft manufacturer and the manufacturer of the actuators over the design and construction of the actuators. This was the subject of continuing discussion between the 2 parties.

3.8 The judicious and combined response to the landing gear failure by the operator, the CAA, overseas safety agencies and the aircraft manufacturer in developing an inspection programme and initiating a review of the fatigue life and design of the actuator, should provide a long-term solution to the problem.

4 Safety Actions

4.1 On receiving notification that the hydraulic low-level sensor input to the FDR had not been recorded for some time, the operator, at the request of the manufacturer, instigated a programme to check the serviceability of the sensor system on all aircraft in the fleet. Two further sensors were found to be faulty. As a result the manufacturer issued a maintenance instruction alerting other operators and requiring an examination of the sensor every 1200 flight hours.

4.2 The operator advised that while waiting for a formal response by the manufacturer to the ZK-EAK actuator failure, the ultrasonic testing of the actuators every 1000 cycles would continue, with the actuators being replaced after 10 000 cycles.

4.3 Triumph Actuation Systems and Hawker Beechcraft, with input from the FAA and the NTSB, reviewed the airworthiness of the hydraulic actuator installed on the Beech 1900 C and D models. In mid-April 2008, Hawker Beechcraft issued Mandatory Service Bulletin SB 32-3870, regarding the inspection and replacement of main landing gear actuators part number 114-380041**-11/-13/-15**. The Bulletin directed a visual inspection of the actuators within the next 50 flight hours or 3 days, whichever occurred first. This was to be followed by ultrasonic testing within the next 600 cycles or 3 months, whichever occurred first, and thereafter every 1200 cycles. A temporary revision, TR 32-4, was subsequently issued to both 1900D and 1900/1900C Maintenance Manuals to continue the inspections described in the Mandatory Service Bulletin.

4.4 Hawker Beechcraft requested that the FAA make the bulletin an Airworthiness Directive to ensure that the actions were complied with by operators.

4.5 The Nelson Marlborough District Health Board advised that the "St John ambulance and the Emergency Ambulance Communications Centre have worked towards an improved txt/messaging alert system", which was now active. The Woodbourne crash fire alert text now included Blenheim and Nelson Hospitals.

Approved on 23 April 2009for publication

Hon W P Jefferies
Chief Commissioner

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07-001	Boeing 777 A6-EBC, incorrect power and configuration for take-off, Auckland International Airport, 22 March 2007
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