

deHavilland DHC-5D Buffalo, #103, C-GCTC, 1984 Farnborough Airshow

This is an original writing by Jim Watson, November 30, 2005

Scope

This document will provide some background, and a different point of view for consideration, with respect to the crash of the DHC-5 Buffalo at the Farnborough Airshow. Everything written is the opinion of the writer, based upon first hand knowledge of the situation from the point of view of the pilot of the aircraft.

Background

The DHC-5 Buffalo was a successor to the deHavilland DHC-4 Caribou military transport. It first flew in the mid 1960's. The anticipated market with the US Army, did not come to be, and thus the first major customer was the Canadian Armed Forces.

Like all of its predecessors, it had remarkable short takeoff and landing ability. It also had excellent soft and rough field ability. It was operationally similar to the C-130, albeit with less payload and speed. In total, 126 were manufactured from 1965 until 1987. Later models were designated "D" models, denoting more powerful engines, among other improvements.

The Aircraft and Trip

The Buffalo transport which crashed in Farnborough was manufactured by deHavilland Canada in 1980. It was used by deHavilland in application for Canadian Type Certification of the type to enable sale for civilian use. It was operated extensively as a demonstration aircraft, participating in many airshows and demonstrations to customers.

It was included in deHavilland's demonstration at the 1984 Farnborough airshow along with Dash 7, C-GNBX #1, DHC-6 Twin Otter, C-GFJQ # 774, and for it's first trans Atlantic flight, the first Dash 8, C-GDNK, #1. In order that there was every possible opportunity for a successful passage of the Dash 8, the Buffalo was held back in Toronto so as to assure that upon the arrival of the Dash 8 at it's first stop, any necessary repair parts (should something become unserviceable) could be carried by the Buffalo.

Each of the four aircraft carried additional passengers and equipment as necessary. The Buffalo, being the transport, carried most of the freight, and a few passengers who were willing to travel in less style. As the aircraft all flew with full fuel, their full payload capability was not used. The Buffalo was piloted by Bill L., and copiloted by Brad F. Brad was new to deHavilland, and this was his first experience on the Buffalo. Bill was a very experienced test pilot, both on deHavilland aircraft, and formerly with the RAF and exchange to the USAF. He

had been an RAF Red Arrows (aerobatic demonstration team) leader. He was also the recipient many honors, including three from the queen.

Bill's flying experience on STOL transport aircraft, included many hours flying the "Augmentor Wing". This highly modified Buffalo was a NASA project to explore extreme STOL operations with two jet engines similar to those found in the AV8 Harrier, able to vector their thrust, and divert some of it out through the wing flaps for very low speed lift and control. In conventional Buffalo aircraft, he performed extensive demonstration flying, which included landing and taking off in a 600' long parking lot in hot and high conditions in Phoenix, Arizona, and really not using all of the available space!

As the Dash 8 flight progressed with no problem, we in the Buffalo were able to depart, flying to Goose Bay, Labrador, and on to Reykjavik, Iceland for our first rest stop. Upon departure from Reykjavik, the blade pitch control system for the right propeller was not functioning correctly, and the RPM of that propeller varied so as to be noticeable, and result in comment among the group. We arrived in Farnborough with no further difficulty.

Farnborough

The flying demonstrations at the Farnborough airshow are strictly governed, and Bill (having flown numerous airshows there) was well familiar with the rules. In particular, flying on the crowd side of the runway centerline was absolutely not permitted. A couple of days after our arrival, the daily flying displays began. As is the case with any flying involving showing off, pilots are inclined to extract the most dramatic performance form the aircraft. We all know the increased risk of failure to be expected immediately after someone says "watch this....". Farnborough was no exception. The SBAC (who run the show) are certainly aware of this, and do their best to reduce the risks, but every company is trying to look spectacular, and how do you prevent sensationalism?

The Buffalo and Twin Otter are two of few aircraft in which it is mechanically possible to fly the aircraft with the propellers selected into, and creating reverse thrust. This is not an operation which is approved or suggested by the manufacturer. But that does not mean that it is not done. It is this capability which makes the Buffalo able to appear dramatic in its approach and landing in the hands of a very skilled pilot. I have no reason to think that such operations were not expected of the pilots, whether suggested or not. The many, many past occasions in which this technique had been successfully employed in a Buffalo, or Twin Otter, had certainly resulted in favorable comments to the pilot about the demonstration from within the company.

The Demonstration Flight

I had the great pleasure to be invited to fly as a cockpit jump seat observer during the Buffalo demonstration two days prior to its final flight. This was a coveted honor. As I was, and am, also a pilot, being onboard was acceptable to them. I still have the security pass which allowed my passage to the flight line. The jump seat folded out into the cockpit passageway, offering a spectacular view, blocked only by Bill's hand on the power levers (which are ceiling mounted in the Buffalo). The use of the four point harness is required.

The demo flight lasted only about four minutes, and was woven into the flights of the other deHavilland aircraft. The flight predictably involved a super STOL takeoff, and steep climbout, followed by a steep departure turn. A few minutes of airwork, followed by a steep approach, during which propeller pitch in the "beta" (beginning of reverse) range was selected. The effect of this technique was remarkable in that the extreme nose down attitude of the aircraft did not result in the build up of speed one would normally expect. The down side though, is that the aerodynamic effect of the elevators is markedly diminished, as the disrupted airflow tends to blanket the horizontal stabilizer. It is therefore necessary to assure that forward pitch is again selected prior to flare to assure that the full effect of the stabilizer and elevator is available for flare at the already low airspeed. It is noteworthy that in this (and many) engine control systems, the engine power, and blade pitch settings are both controlled by the power levers. In the Buffalo, rolling the power lever handles opened gates which enable the selection of beta thrust. This is approved for ground operation only according to the manual.

The low power position of the levers is therefore in the midpoint of their travel, not in the full aft (through the gate) position as would be the case for piston engined systems. So moving the power levers forward from the idle stop, increases engine power, and increases the blade pitch (within a range) to maintain the desired engine speed and torque, producing increasing forward thrust. Opening the gate, and moving the levers aft of the idle stop, increases engine power, and decreases the blade pitch to produce first flat pitch (or diskings), then increasing reverse pitch. In total, producing increasing reverse thrust. Obviously, a part of the blade pitch control system takes the signal from the selected power lever position, to determine if there would be a forward, or through flat to reverse blade angle change, accompanying the increase in engine power selected by the movement of the power levers. It was a matter of record that there had been accidents in other Buffalo aircraft which were the result of loss of control, following the rapid selection of reverse thrust upon touchdown, and the signal not being correct. One propeller moved into reverse blade angle, the other did not. Thus as the power levers were moved back, considerable reverse thrust was created on one side, while forward thrust was created on the other. This invariably resulted in a loss of directional control during the rollout, and runway excursion. This makes the confirmation of the blade angle achieved

prior to the selection of much reverse power, a wise pilot action. (more recent beta thrust designs include provision for informing the pilot of the blade angle range).

On the day of the loss of the Buffalo, the wind was gusting so as to be a quartering tailwind bowing toward the crowd side of the runway. The runway direction was reversed for the show, only if absolutely necessary, because the crowd viewing area is more to one end, so the runway operation portion of the demonstrations would be much less visible to the crowd – a vital consideration to make the most of the Buffalo STOL demo! So on goes the show – with the least favorable wind direction.

The video shows the tight turn onto final, with the very steep approach angle. At this point, the performance of the aircraft (though on the edge of the limit) is still workable. Beta power is selected, and it's still working okay. As the aircraft is being blown across the runway, toward the crowd, the turn is tightened away from the crowd. As the power is selected back toward forward thrust, power is developed in both engines, as indicated by the torquemeters for the engines. The aircraft suddenly turns again toward the crowd side. More control and power are applied to correct this, but the plane is still going down at quite a rate. Bill is getting control of the aircraft, and it is coming around as desired, but altitude runs out. The resulting very hard landing causes a complete failure of the wings. As the engines are pulled down, the propellers and gearboxes are torn apart. Indeed, it was reported that debris flew over the crowd, but there were no injuries. The small amount of fuel carried explodes, but the aircraft occupants are unaware that this has happened, and fear a fire when they come to rest. They get out really fast! The jump seat occupant for this flight is E.L., who is not known by me to be a pilot. He literally tears the roof hatch off its hinges when he forces it open.

Due to the incredible rigidity of the Buffalo fuselage nobody is injured. Indeed, the demo was flown with the rear loading ramp partly opened, and it still operated normally following the accident. This was a huge testimonial to the quality of the aircraft, and was much touted by the sales staff!

So why the loss of directional control? Consider what would happen if the right propeller (which had problems in Reykjavik) did not move as expected from beta blade angle to forward blade angle when it was selected to do so? The forward thrust on the left side, coupled with the beta thrust on the right, and the quartering tail wind, would really make the plane difficult to control. This would be complicated by the need to prevent a turn into the crowd. The pilot would not have time to diagnose the problem, and would just instinctively fly the plane. It would require lots of control to counteract the asymmetric thrust and tailwind, and the prop hung up in beta would continue to blanket that half of the tail, greatly reducing its effectiveness in raising the nose to flare.

The deHavilland company position was “pilot error”, and yes the pilot did fly with no margin for a problem – and had a problem. This was done in accordance with the desires of the pilot’s superiors in the company, who, of course, later denied such instruction. When Bill returned to Canada, and was told that his resignation had been accepted. It had not been offered! After a short legal battle, with which I had a distance participation, deHavilland agreed to pay him through to his retirement, and allow him to collect a pension. He did not fly for deHavilland again though.

Life Goes On

Bill went on to a fascinating career ferrying every kind of plane (from single Cessna and Pipers to BAE 146) all over the world. I was privileged to fly on a number of these flights with him, and provide positioned aircraft for him for many others. He passed away, along with another highly experienced test pilot whom I also knew, in a crash attributed to the failure of a new autopilot installation to release control back to the pilots. They valiantly steered the crippled plane away from a populated area, preventing much greater loss. The type of plane involved had never been involved in a fatal accident prior to this crash, for its 15 plus years in commercial service.

Other Factors to Consider

deHavilland, and others will suggest that this accident was the result of pilot error only. Why do I disagree? Listen carefully to the audio track associated with the BBC video (knowing that there is a two second delay, owing to the speed of sound – I did the math). On this sound track the distinct sound of the right engine “spooling up” for a second or so the instant before the sound of the ground strike, and propeller breaking up can be heard. It was both my, and Bill’s opinion that this engine acceleration was the result of the right propeller blade angle beginning to move through the flat pitch position, toward forward pitch. In flat pitch, there would be very little torque drag, and the engine (with the power level selected well forward) would accelerate rapidly. This can be easily heard in the original audio. This corresponds perfectly to Bill’s observation that the asymmetry began to reduce itself, and the plane returned to being controllable, but there was just not enough altitude left. This pitch change difficulty is consistent with other accidents, and problems experienced with this propeller in Reykjavik. It also helps to explain why a very competent and well practiced pilot was unable to maintain control of a plane he knew very well. The Buffalo 5D has engines of such power that light, single engine performance is exceptional. Such power would obviously make asymmetric extra challenging, if you were not expecting it.

In recovering the plane from the runway, the crews (with deHavilland permission) tore apart what remained of the propeller hubs and gearboxes, making a meaningful investigation impossible. The pilot error explanation was an easy sell, and it was left that way.

With my “ride home” in pieces, I was able to fly back to Canada as the third pilot in the Twin Otter. Another fascinating (and happily uneventful) experience!

So what did I learn from this? When ever I say “watch this” then I fly a plane, I leave just a little more margin than I otherwise would. So the demonstration is not the very most the plane and I could accomplish, I still have that extra margin, and I still get lots of compliments!

I learned lots from Bill. He kept me safe while I perfected techniques I never imagined possible. I saw things all over the world as his student, and am very much better for it. Thanks to him, I am more safe, I will carry a part of him forward to pilots I help along the way.



Buffalo C-GCTC on approach days earlier

The scanned report written by Bill L. follows...

SUPPLEMENTARY STATEMENT TO ACCIDENT INVESTIGATION BRANCH 2nd January 1984

Since the Buffalo accident at Farnborough on 4 Sep 84 I have been off work on the orders of Mr [redacted] of DeHavilland Canada and I have not been a party to the inquiry conducted by that company. Various statements to the media have been made by DHC and others that appear to throw the blame for the accident upon me, although the only official inquiry is that by the AIB at Farnborough.

I am now in the UK at my own expense and have come to throw all the light that I can on the basis of new memories and information that has emerged since the accident.

At the time of the accident I was sure that I had done a good job of saving life in an aircraft that had, inexplicably, gone almost completely out of control. I was shocked at the reaction of DHC and others that sought to put the blame entirely on my shoulders. After some weeks of fruitless self-examination an acquaintance called me to say that he had made a video copy of the TV accident shots, studied them many times and come to the conclusion that the aircraft had entered an incipient spin to the right under asymmetric thrust and drag as a result of the right propeller going into the reverse range whilst the left was in forward. His comments sparked off many memories and I was immediately convinced that he was right, the symptoms fitted exactly with my memories and my observation of control deflections etc, and my emotions both during and after the accident.

There is a technique used by some Buffalo display pilots of "tickling beta" to adjust the speed toward final approach speed before starting final approach. The technique consists purely of selecting the power levers slightly into the beta range and hearing the propellers respond, immediately speed tends towards approach speed (65 knots in this case) the power levers are returned to forward of the idle stop. I emphasise that the technique is used in display only, is only done at a safe height (above 400 feet for example), is not continued on final approach and the propellers are only selected slightly into the beta range.

As the speed fell to around 90 knots (approx) I selected positive thrust, I was on base leg at around 600 feet at this time. Shortly afterwards the aircraft went out of control into an incipient spin to the right, I did not consciously recognise it at that time but took the appropriate recovery automatically, ie full left rudder and elevators toward neutral until the spin stopped. I was then pointing toward the crowd and being blown further on-crowd by the cross-wind. In order to point the aircraft into a safe direction I took off the left rudder whereupon the aircraft yawed and rolled to the right and I reapplied full left rudder to align the aircraft on a right side-slipping descent to the runway. I was unable to use much elevator as the aircraft was only under marginal control and any further up-elevator would re-induce the incipient spin.

I remember using considerable forward power selections on both engines from a height of at least 400 feet but my memory is that it made the situation much worse. I also remember being undecided about the necessity for power as the IAS was 85 knots (20 knots above Vref), but I used power anyway as I was prepared to try anything to change a disastrous situation.

At around 400 feet I already knew that the aircraft was ~~was~~ lost and I had decided to use what little control remained to minimize the impact, I considered that we would survive the crash but I was prepared for some injuries. I emphasize that elevator was not available as my experience told me that we were on the very edge of a further spin and any increase in elevator would precipitate total loss of control.

I finally achieved a stable side-slipping descent with full left rudder. I remember debating the use of aileron but was reluctant as (I now realize) to use left aileron to correct the right wing down as it would be "out-spin" and hence cause further control loss.

During the very final part of the approach the right propeller appeared to come back into the normal positive range, reducing the pro-spin force and thus making more elevator available and I was able to slightly raise the nose and reduce the rate of descent.

To amplify the sequence of events concerning "tickling beta"; during the pull up after the high speed pass and before commencing finals, the power levers were closed to idle, as speed falls to 135 knots gear and flap is lowered, whilst still at the top of the turn an assessment is made of the rate of decay of speed toward Vref and, if desirable, a slight "tickle of beta" is made, as the speed falls toward Vref (say at 85-90 knots) power levers are re-applied forward of idle and the descent commenced as speed reaches Vref. Thereafter the power levers are always in the forward range.

R.E.W. L. [REDACTED]

There is a technique also by some Buffalo pilots of "tickling beta" and toward final approach speed before starting final approach. The pilot considers purely of adjusting the power levers slightly into the beta range and hearing the propellers speed, immediately adjust back toward approach speed (135 knots in this case) the power levers are returned to forward of the idle stop. I emphasize that the technique is used in a pull up only, in all other cases at a safe height (above 400 feet for example), is not achieved on final approach and the propellers are only adjusted slightly into the beta range.

As the speed fell to around 80 knots I applied full left rudder. I was on the edge of control at around 100 feet. The aircraft was in a steep climb and I was not able to see the runway. I was not consciously aware of it at that time but luck and appropriate recovery automatically, full left rudder and elevators toward neutral until the spin stopped. I was then pointing toward the crowd and banked sharply further on-crowd by the crowd-wind. In order to point the aircraft into a safe direction I took off the left rudder whereupon the aircraft yowed and rolled to the right and I re-applied full left rudder to align the aircraft on a right side-slipping descent to the runway. I was unable to use such elevator as the aircraft was only under marginal control and any further up-elevator would re-induce the incipient spin.

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