Cessna 152, G-BRCC

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Aircraft Type and Registration:	Cessna 152, G-BRCC
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1978
Date & Time (UTC):	31 May 1996 at 1218 hrs
Location:	Lydd Airport, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - 1
Injuries:	Crew - Fatal - Passengers - Fatal
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	380 hours (of which 242 were on type)
	Last 90 days - 3 hours
	Last 28 days - 3 hours
Information Source:	AAIB Field Investigation

History of the flight

The pilot had arranged to take a passenger for a local flightfrom Lydd, but the PA-28 was booked elsewhere. He therefore electedto undertake the flight in the Cessna 152, registration G-BRCC,which had been refuelled to full tanks earlier that morning.The aircraft took off at 1110 hrs, initially routing along thecoast towards Hastings. The aircraft then flew across to Folkestone,in order to overfly the home of the passenger. Contact was maintainedwith Lydd Radio throughout. The pilot called when west of Dymchurchin order to rejoin the Lydd circuit. He correctly read back theAFIS information that the runway in use was 22, left hand circuit,QFE 1018 mb. As there was no other circuit traffic at the time,the pilot made a straight-in visual approach to Runway 22, withthe surface wind passed as 220° at 16 kt.

As the aircraft flared for landing one eyewitness observed someyaw to the right to occur. At about this time, a divergent pitchoscillation was noted. During the third cycle, the aircraft wasobserved to commence a go-around. It entered a steep right turnat about 50 to 100 feet agl onto a downwind

heading. The normalcircuit pattern for Runway 22 at Lydd is left hand. After a shortperiod of time with the wings level on the downwind leg and withlittle additional climb, another steep bank to the right occurredas the aircraft turned back towards the runway threshold. Thebank steepened to more than 60° and the aircraft appearedto enter an incipient spin. It crashed onto open ground shortof the runway threshold, displaced slightly to the east of thecentreline. Both occupants sustained immediately fatal multipleinjuries.

Three eyewitnesses were interviewed who had observed the finalflight path, two were in the Tower Visual Control Room and a thirdon a golf course located to the north-west of the airfield. Witnesseswere not consistent in their perception of the direction of theincipient spin. Two said that the aircraft departed to the right,one thought it was to the left.

An aftercast from the Meteorological Office indicated that atthe time of the accident there was a ridge of high pressure establishedover the continent, maintaining a strong south-westerly surfaceairstream over southern England. The visibility was around 7km in haze, scattered cloud base 2,500 feet, temperature +15°C,QNH 1020 mb. The surface wind was from 240° at 15 to20 kt with gusts of 25 to 30 kt. The anemometer in the Towerwas reading 15 to 20 kt at the time of the accident. Some lightto moderate low level turbulence was reported by an instructorwho was airborne at the time, but the conditions had not changedsignificantly since the pilot's check flight earlier that morning. A strong wind warning was in effect for the airfield, forecastinggusts up to 35 kt. The pilot had been aware of this before theflight departed.

A check of the aircraft's weight and balance condition indicatedthat at the time of the accident, the aircraft weight was about1,600 lbs (within the maximum allowable of 1,670 lbs),and the centre of gravity was at 32.56 inches aft of datum(allowable range 31 to 36.5 inches aft of datum).

During examination of the wreckage, the pilot was found to havehad a knee board with departure information from Lydd recorded. He also had a copy of a Cessna 150/152 checklist, which was foundopen at Pre Take-off/After Take-off/Missed Approach/Cruise/Topof Descent page.

The passenger had no previous light aircraft flying experience. He was found in the wreckage to be holding a southern Englandhalf million scale topographical chart, folded into large sections,but not such as to show the area around Lydd. His camera wasrecovered from the wreckage and was found to contain a film showingthat he had taken a number of aerial photographs during the flight,although none were found which covered the period around the timeof the return to the airfield.

Pilot experience

The pilot completed his PPL training course at Lydd during 1985. In recent years the amount of flying he undertook had reducedconsiderably, such that 7.4 hours were completed during 1990,nil during 1991, 5.5 hours during 1992, 6.3 hours during 1993,4.4 hours during 1994 and 4.6 hours during 1995. The pilothad kept his licence current with the appropriate Certificateof Test or Certificate of Experience (13 month validity, minimum5 hours flying, of which at least 3 hours were as pilotincommand)in his flying log book. The latest Certificate of Experiencein the log book was signed on 28 May 1995, covering flights madeduring April 1995. There were no further flights between April1995 and May 1996.

In order to ensure revalidation, the pilot recommenced flyingfrom Lydd on 11 May 1996. He undertook a check flight of 1.2hours duration with an instructor in a Cessna 152. During thisflight

the following exercises were carried out: slow flight,stalls, steep turns, practice forced landings, circuits with touch-and-golandings, a go-around and a practice engine failure after takeoff.

The pilot's next flight was on the morning of the accident, whenhe arranged to undertake another check flight, this time in aPA-28-151 aircraft with a different instructor. A similar flightprofile was followed, with the exception that no go-around waspractised on this occasion. Neither instructor made any significantadverse comment about the pilot's performance during either ofthe check flights.

Medical aspects

The post-mortem examination on both occupants did not reveal anymedical condition which could have caused incapacitation duringthe flight, nor were there any indications that drugs or alcoholhad played any part in the event.

There was a medical anomaly involving the pilot's condition.He had renewed his Class One medical on 4 May 1996, whichincluded an Electro-CardioGram (ECG). This was initially regardedwith some suspicion but, on review and taken in conjunction withthe previous ECGs on file, it was concluded that the tracingswere, in fact, normal.

The pilot's General Practitioner (GP) was not his CAA AuthorisedMedical Examiner. The pilot had been to his GP on 16 April 1996,complaining of palpitations he was experiencing. These had apparentlybeen present for some years but had become more prevalent andtroublesome, with episodes immediately after waking, taking foodand precipitated by energetic exercise. It was not clear whetherthe heart beat was irregular or merely unduly vigorous, but itdid not result in pain or loss of consciousness, merely discomfort. The pilot's GP did not appreciate that flying was involved andso made no recommendation about it. The pilot was referred fora consultant's opinion and a 24 hour ECG tape, but this had nottaken place by the date of the accident.

The pilot made no mention of the symptoms or consultant referralwhen renewing his aviation medical certificate some two weekslater. The questionnaire associated with the aircrew medicaldoes not query whether the applicant is currently undergoing anyform of consultation (merely referring to *'medications currentlyprescribed'*, and *'have you a history of....'*) whichmay be regarded as ambiguous. The proposed wording of the newJAA Application for an Aviation Medical Certificate poses thespecific question *'Visits to medical practitioner since lastmedical exam. YES/NO'* with a request for further detailsif the question is answered in the affirmative. This should removeany possible ambiguity.

The aviation pathologist who carried out the post-mortem examinationfound it difficult to assess the significance of the palpitationsto the accident. Given the pilot's history, he considered thatit seemed unlikely if they had occurred in flight that they wouldhave caused a loss of consciousness. However, the unpleasantsensation which had been described as accompanying them mighthave been sufficient, had it occurred during the approach or landing,to make co-ordination and concentration difficult.

Accident Site

GBRCC struck the ground 156 metres short of the thresholdof Runway 22, 47 metres to the left of the runway centreline. The impact was within the airfield boundary, on flat horizontalground covered with long grass. Initial impact was onto the leftwing outboard leading edge, followed by

ground impact of the leftmainwheel, the propeller, the nosewheel and the left side of theforward fuselage. The aircraft came to rest inverted and substantiallyintact around 2 metres south-east of the initial impact point.

Examination of the site and the wreckage showed that the aircrafthad impacted the ground in a steep descent while rolled approximately45° left and pitched 45° nose down relative to the horizontal. The speed had been relatively low and the evidence showed thatthere had been very little horizontal speed component but a moderatelyhigh descent rate. The impact heading was easterly. There wereno signs from the wreckage or ground marks of a substantial rateof aircraft rotation.

Detailed Wreckage Examination

The aircraft sustained heavy crushing damage to the forward partof the left wing, partial failure of the wing to fuselage attachments,bending failure of the tailboom and moderate deformation of thecabin structure. The empennage escaped virtually undamaged.The aircraft had been complete at impact.

The engine remained generally intact; examination with the assistanceof the engine manufacturer revealed no signs of pre-impact problems. Signs were found indicating that the engine had been turningat the time of the accident but, given the steep impact, the powerlevel could not be quantified. The evidence suggested that appreciablequantities of fuel had been present in each wing tank (one tankper wing) at the time of the accident.

Primary and secondary flight control systems were examined indetail; all the components of the systems were recovered. Nosigns of pre-accident defects or failures of the primary flightcontrols were found. The possibility of a control restrictioncould not be totally dismissed but appeared to have been unlikely. It was not possible to reliably establish the pitch trim setting.

Both seats remained in the cabin attached to the floor rails andthe plunger securing each seat on the rail in the fore and aftsense had been engaged in the rail at the time of impact.

Particularly close scrutiny was given to the flap system. Thisconsists of a flap surface on each side of the aircraft (Fig 1),each carried on two fixed flap tracks mounted behind the rearspar of the wing. The carriage at each flap track station consistsof two flap-mounted rollers, attached between a pair of carrierplates mounted near the front of the flap, and located in curvedslots in the track. The rollers run on needle roller bearings. In the case of the aft rollers, steel washers are installed onthe roller bearing on either side, interposed between the flaptrack and the flap carrier plates, and a single nylon washer isinstalled on one side of the track. Flap surfaces are controlledby a mechanical system operated by a bellcrank in the right wingdriven by an electric motorised actuator. The right flap is drivendirectly from the bellcrank by an operating rod; the left flapis driven from the bellcrank by a cable-pulley loop system locatedin the rear part of the wing. Flaps can be set from 0° (retracted)to 30° (full).

Requirements in the CAA/LAMS/FW/1978 Schedule for scheduled maintenanceof the flap system are (Section 7, Item 7), at 150 Hourand Annual Checks, 'Flying Controls: Inspect - hinges; brackets;push-pull rods; bellcranks; control horns; balance weights; cables;pulleys; chains; tubes; guides and fairleads; rollers; tracksand rails; screw jacks/rams, including auxiliary gearboxes

orother power-operated systems. Check - turnbuckles/locking devicesin safety. Inspect - flap asymmetric protection mechanisms.'

The possibility of GBRCC having experienced flap asymmetryduring the go-around, with the left flap having remained extendedfurther than the right flap, was considered during a detailedexamination of the flap system. The flap selector was found inthe flaps fully retracted position and the flap actuator extensioncorresponded to flaps fully retracted and, as it could not havebeen backdriven during the impact, had clearly attained this positionbefore the accident. Both flaps were found fully retracted, butclear evidence of their position at the time of impact could notbe found. Examination showed that the Down cable was broken inthe wing centre section, but the evidence provided no positiveindications as to when this failure had occurred; it was possiblethat the cable had been overloaded due to displacement of theleft wing relative to the fuselage during the ground impact.The Up cable remained intact but part of the flange of a pulleyin the right wing over which the cable passed had broken off,consistent with the effects of cable overtension. The pulleychanged the cable direction by 40° and calculations showedthat the geometry change associated with the pulley damage wasequivalent to approximately 0.25 inch linear extension ofthe Up cable. This would be equivalent to between approximately0.5 to 1.5° of flap travel increment, depending on the flapangle. The other pulleys in the system remained essentially intactand in place. The amount of additional asymmetry that could resultfrom elastic deformation of the flap system could not be quantified.

All the flap rollers and their bearings were found in place andundamaged; most of the flap carrier plates exhibited appreciablewear from the forward rollers, in the form of annular groovesworn by the roller end faces. The wear was generally more severeon the carrier plates of the left flap, particularly on the outboardpair where grooves 0.10 to 0.15 inch deep had been worn.

Abnormal markings were found on the left flap outboard track,consisting of severe notching of the right side of the track adjacentto the aft slot by the mating steel washer of the roller/washerassembly. The damage was indicative of a heavy juddering-typemotion of the roller assembly in the flap retracting directionbetween approximately 15° and 5° flap angle. Some markingswere also found on the left flap inboard track, correspondingto approximately 15° flap angle. It appeared from the evidencethat the abnormal flap track markings may have resulted afterpartial extension of the left flap during the impact as a resultof overtension of the flap cable system due to wing displacement. The absence of any failure that would have allowed substantialslack in the Up cable-pulley system, such as a break in the Upcable, precluded the possibility of a gross flap asymmetry (inthe sense of greater left flap extension) during the go-aroundhaving occurred. However, the possibility of a partial asymmetry,that had been accommodated by deformation of the cable-pulleysystem and the damage to the pulley in the right wing, could notbe totally dismissed.

Aircraft Background

Maintenance records indicated that the aircraft (Serial No 15280986)had been constructed in the USA in 1978 and exported to the UKin 1989. In 1991 it had been bought by the owner at the timeof the accident and leased to a succession of operators. It didnot fly for 3 months around the end of 1995. At the timeof the accident it had accumulated approximately 6,030 flyinghours. The engine had operated for approximately 1,000 hourssince its last overhaul in 1994. The records indicated that theaircraft and engine had been maintained in accordance with theCAA/LAMS/FW Maintenance Schedule.

Previous Cases

Reports were found of 4 occurrences of asymmetric flap in flighton aircraft models with a similar type of flap system. Availableinformation was as follows:

1. Cessna 172, Oct 85 - [AAIB Bulletin 1/86]:

Following a simulated overshoot at 4300 ft agl withfull (40°) flap, the flaps were retracted in 10° stages,retrimming between every stage. On selection of 0° flapfrom 10°, a loud bang was heard and the aircraft rolled right. The instructor had to apply full left aileron and rudder andclose the throttle to arrest the roll. Having regained a wingslevel attitude he observed that the left flap was fully deployed. Control during an emergency descent was just possible providedthe power was below 1600 RPM. After landing it was foundthat the aft roller bearing assembly at the outboard support forthe left flap had fractured and broken up due to fatigue. Thishad severely worn the flap track slot and pieces of the rollersleeve had broken off and jammed between the roller and the slot,resulting in overload failure of the flap up drive cable to theleft flap which was then free to blow back to the full flap position.

2. Cessna 150, Dec 88 - [CAA Database]:

On flap up selection during an air test a loud report was heardand the left flap was observed to be 2-5° from the upposition. Reselection to full down and up gave satisfactory operation.

3. Cessna 150, Aug 95 - [CAA General Aviation Safety Leaflet (GASIL)2-96]:

The instructor was demonstrating the use of full 40° flapto the student. At the end of the demonstration, he applied fullpower and began to retract the flaps back to the zero degree position. There was a loud bang from the roof, just above his head, followedby a rapid rolling to the right. He reduced power to idle andcontrolled the aircraft with aileron and rudder. On looking around,he found that the left-hand flap was still in its 40° position,whereas the right-hand flap was nearly fully retracted. He returnedwith reduced speed and carried out a safe landing. Engineeringinvestigation showed that the left-hand flap cable had failed.

4. Cessna 172, Florida - [Manufacturer's report]:

On flap retraction the left flap remained down. The rolling tendencywas controlled. Subsequently a loud bang was heard and the leftflap fully retracted.

Service Bulletin

Cessna Service Bulletin SEB953 published 10 March1995, noted "Service experience indicates the potential forwearing of the flap support by the flap rollers. To assist inpreventing this condition from occurring, an inspection of theflap supports and rollers along with a modification to installstainless steel washers on each side of the forward rollers shallbe accomplished. Failure to accomplish this inspection and modificationcould result in damage to the flap supports and/or loss of flapcontrol." Model effectivity included a range of 150, 152,170, 172, 175, 180, 182, 185, 188, 206, 207 and 210 models. Compliancewas recommended within the next 100 hours of operation or12 months, whichever occurred first. The Bulletin requiredinspection of the roller assemblies for wear or damage; inspectionof the flap support arms for wear by the rollers and the blendingout of

any grooves present, to a maximum depth of 0.020 inch;and the addition of a washer on either side of each forward roller.

The Service Bulletin was not made mandatory by the CAA and hadnot been accomplished on G-BRCC; the accident occurred approximately14 months and 646 flying hours after the issue of theService Bulletin.

Recommendations

Although considerable wear and abnormal marking of GBRCC'sflap system was found, there was no positive evidence to indicatethat flap asymmetry played a part in causing the accident. However,the possibility remained, and the previous cases identified showedthe potential for flap system wear to produce severe aircraftcontrol problems. While none of the 4 known cases had resultedin an accident, it was notable that at least 2 of them had beenat altitude and the recovery to a landing had been flown by aninstructor, with considerable difficulty.

Recommendation 9737

It is recommended that the CAA reconsider Cessna Service Bulletin SEB953with a view to making it mandatory.

Reports of service experience had apparently led the aircraftmanufacturer to recommend measures aimed at preventing recurrenceof cases of severe flap system wear and possible flap controlsystem failure. It is likely that the manufacturer, with a widerange of service experience and research information available,would be in a much better position than an aircraft owner/operatorto judge the effectiveness of a modification in preventing a particularfailure. There would seem little doubt that the flap system inspectionand modification measures recommended by the manufacturer representeda significant improvement to the system and would impose no majorpenalty on owners/operators. However, the measures have not beenmade mandatory by the FAA or the CAA and the CAA has specifiedthat the incorporation of manufacturer recommended or mandatedmeasures should be at the discretion of owners/operators. Inthe light of the above, Recommendation No 9737, madefollowing an accident to Piper PA38112, GBGZWon 26 August 1996, is restated:-

Recommendation 9738

It is recommended that the CAA review their procedures for classifyingairworthiness improvement measures published by aircraft or equipmentmanufacturers, that are applicable to UK registered aircraft,when they are recommended or categorised as mandatory by the manufacturer. Consideration of the improvement measures, if necessary in conjunctionwith the prime certificating authority, should take account ofthe manufacturer's known service experience. It is proposed thatthe CAA should require that such measures are incorporated onUK registered aircraft or publish its reasons for leaving themas optional to assist owner/operators in exercising their discretion.

Similar AAIB Recommendations were made in 1994 (No 94-30, AAIBReport 6/94) and 1997 (No 97-6, AAIB Bulletin 3/97 and No 97-11,AAIB Bulletin 5/97).