**ACCIDENT**

| | |
|---|---|
| **Aircraft Type and Registration:** | Beech B200 King Air G-PCOP |
| **No & Type of Engines:** | 2 Pratt & Whitney Canada PT6A-42 turbo-prop engines |
| **Year of Manufacture:** | 2004 |
| **Date & Time (UTC):** | 28 March 2006 at 0832 hrs |
| **Location:** | Within the Scottish Terminal Manoeuvring Area |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - 2 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Overstress damage to outer wings and engines |
| **Commander's Licence:** | Airline Transport Pilot's Licence |
| **Commander's Age:** | 55 years |
| **Commander's Flying Experience:** | 6,524 hours (of which 180 were on type)<br>Last 90 days - 131 hours<br>Last 28 days - 34 hours |
| **Information Source:** | AAIB Field Investigation |

**Synopsis**

After takeoff and whilst in IMC, the commander noticed a gradual and progressive loss of information on his flight instruments, followed by a loss of radio communications. The commander concluded that the aircraft had suffered a major avionics failure. When ATC became aware of the loss of communications, they arranged for an RAF Tornado aircraft to intercept G-PCOP. While attempting to guide the aircraft below cloud, the RAF crew saw it enter cloud in an apparently uncontrolled fashion and they transmitted a 'MAYDAY RELAY' message. However G-PCOP re-appeared from the cloud. Eventually G-PCOP descended to VMC below cloud and landed at RAF Leuchars.

On the ground, with an electrical source attached to the aircraft, the instruments and radios worked correctly. The next day, after inspection, the aircraft was ferried by another pilot to Blackbushe for further examination. This revealed damage to the outer wing skins and wing leading edges. The damage to the aircraft was characteristic of it having been subjected to abnormally high flight loads and the outer wing panels had to be replaced. Despite extensive investigation, no defects were found with the electrical generation and distribution systems of the aircraft. Recommendations were made relating to information in the Airplane Flight Manual and to the certification standards of the aircraft.

**Aircraft description**

The aircraft, manufacturer's serial number BB-1860, was manufactured in 2004 and granted an EASA Standard Certificate of Airworthiness. It was fitted with Rockwell Collins 'Pro Line 21' avionics systems and cockpit displays. The Pro Line 21 system comprised a fully-integrated avionics suite and an Electronic Flight Instrumentation System (EFIS). The cockpit instrumentation consisted of two electronic Primary Flight Displays (PFD) and a single electronic Multi Function Display (MFD). Standby instrumentation was provided by a Goodrich Electronic Standby Instrument System (ESIS) which displayed attitude, altitude, airspeed and heading on a single display. An annotated photograph of the instrument panel is shown at Figure 1.

**Background to the flight**

The pilot involved in the accident was the Chief Pilot of a charter company and normally flew the Cessna 310 and the Beech 200 version fitted with electromechanical instruments. He had also agreed to deputise as necessary for the professional pilot of G-PCOP, a commercially owned Beech 200 equipped with Pro-Line 21 avionics and cockpit displays. There was no requirement for a conversion course to fly the Pro-Line 21 equipped aircraft but the accident pilot stated that he had flown

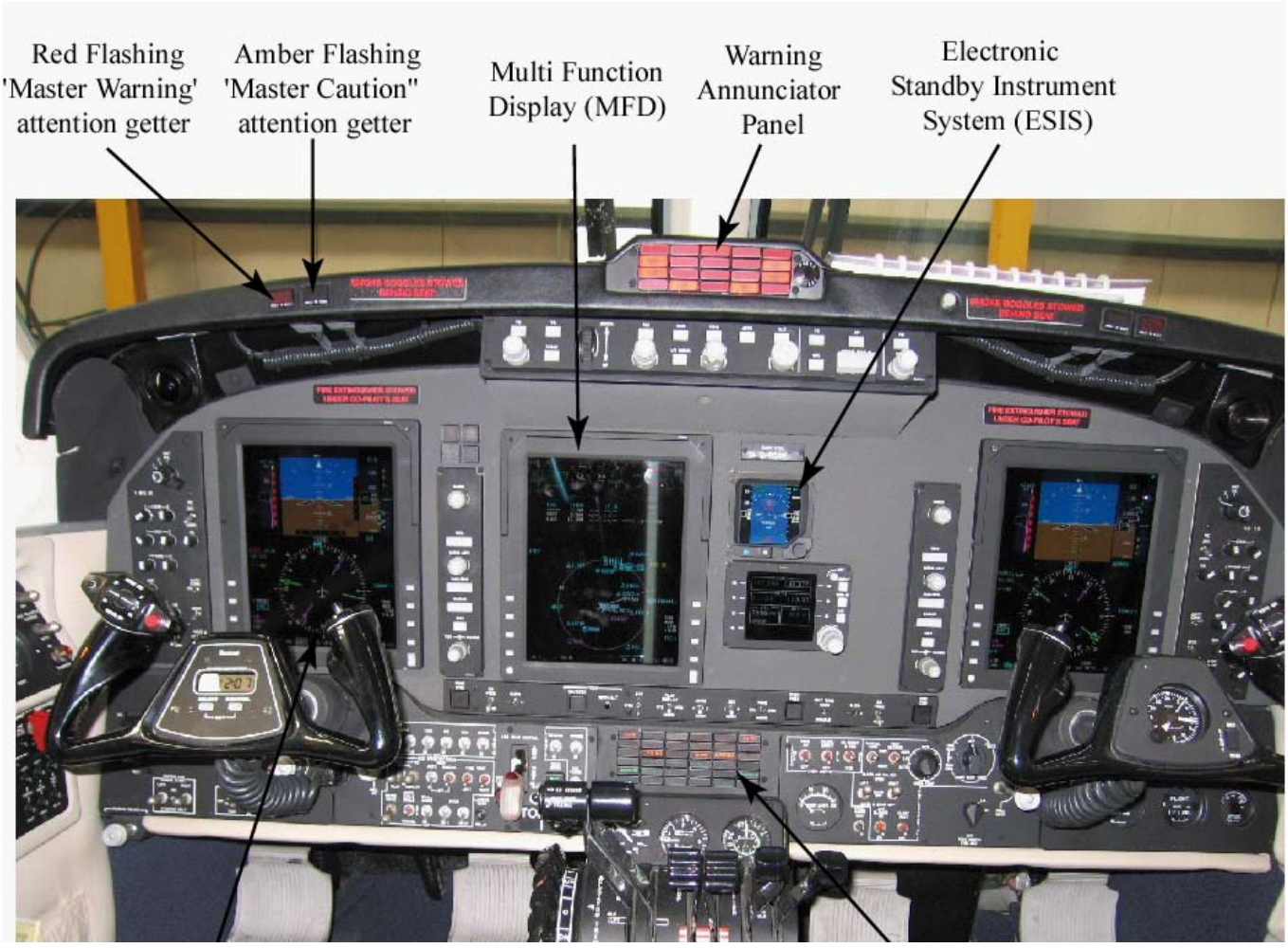


**Figure 1**

G-PCOP's instrument panel

some 10 flights in the aircraft before the accident. He had flown four sectors in the right hand seat with a commander from a TRTO[1] followed by six sectors with G-PCOP's customary commander during which the two pilots shared the P1 duties.

**History of the flight**

The commander planned a flight from Glasgow Airport to Peterborough (Conington) Aerodrome. There was one defect recorded in the aircraft's Technical Log indicating that the heading function of the ESIS was inoperative.

The commander began starting the engines using battery power at 0815 hrs; the right engine was started first and both engine starts were uneventful. He subsequently stated that all after-start checks were normal, including voltage checks of the battery and generators, and that the generator loadmeters were within 10% of each other. By 0818 hrs, the aircraft was cleared to taxi and by 0831 hrs it had been cleared for takeoff. The commander stated that before takeoff he selected both ENG AUTO IGN switches to ARM and both ENGINE ANTI-ICE switches to ON. He also recalled checking both the warning and caption panels and seeing no red or amber lights. To confirm that the correct checks were completed he used the Airplane Flight Manual positioned on the right pilot's seat.

After takeoff, the aircraft was transferred to Glasgow Approach control at 0832 hrs. By 0835 hrs control had been transferred to Scottish Radar and the aircraft was cleared to climb to FL100 on a heading of 150º. At 0836 hrs, the controller cleared G-PCOP for a further climb to FL150; this message was correctly acknowledged by the commander. One minute later, the controller noted a loss of secondary radar and made a radio check with the aircraft. There was no response and there was no further radio contact by any agency with G-PCOP throughout the remainder of the flight.

Shortly after takeoff, the commander noted that the left EFIS display indicated a failure of the Flight Management System (FMS) which had been selected as the primary navigation source. He had then selected VOR as the primary source but shortly afterwards all three EFIS displays became intermittent and then went blank. By then, the aircraft was with Scottish Radar and the commander decided to return to Glasgow Airport. However, he then became aware that the radio was not operating. He assumed that he had a major avionics failure and concentrated on the ESIS display indications until the aircraft had climbed clear of cloud and was level at FL150. Whilst he was considering his options, he became aware of an RAF Tornado aircraft on his left side.

The RAF crew had been on a training flight and had received a request from ATC at 0858 hrs to assist a small aircraft that was in distress. By 0910 hrs, the Tornado was alongside G-PCOP. In accordance with the advice given in the CAA Publication '*Safety Sense Leaflet 11: Interception Procedures*', the RAF pilot rocked his aircraft's wings to indicate that the crew wanted G-PCOP to follow them. Seeing the same manoeuvre in response from G-PCOP's pilot, the RAF crew were confident that he would follow them and they started turning towards Prestwick. However, the RAF crew lost sight of G-PCOP as it moved towards the rear of the Tornado. The commander of G-PCOP subsequently commented that he had not been fully aware of the meaning of the signals from the RAF aircraft and had started heading in a north-easterly direction where the weather was forecast to be better.

**Footnote**

[1] Type Rating Training Organisation.

Subsequently, the commander of G-PCOP saw the Tornado in various positions around the aircraft and eventually was aware that the RAF crew were indicating that he should descend. The ESIS was still operative so the commander initiated a descent. However, as his aircraft entered cloud, the ESIS display started to "flash on and off" and the commander could only make out the horizon indication on the display. By then G-PCOP was in a steep descent in cloud and the commander had great difficulty in recovering the aircraft into a climb. He eventually achieved straight and level flight above cloud but he had been aware of some slight negative 'g' during the recovery manoeuvres. His ESIS display was, by then, inoperative.

The Tornado crew saw G-PCOP enter cloud in an attitude that they considered was uncontrolled and so they had declared a 'MAYDAY'. However shortly afterwards, G-PCOP re-appeared from the cloud in a steeply banked climb and entered another layer of cloud. The RAF crew reported the situation to ATC and were eventually informed that radar contact with G-PCOP had been achieved. Shortly afterwards, they were alongside the aircraft but between cloud layers.

During the subsequent period of straight and level flight, one passenger in G-PCOP used his mobile telephone to contact Edinburgh ATC to inform them of the situation. They arranged for Leuchars ATC to telephone the passenger to advise him that RAF Leuchars was the planned landing airfield. In company with the RAF aircraft, the commander eventually found sufficient gaps in the cloud and descended to VMC below cloud. He then identified his geographical position and, after manually pumping down the landing gear, made a flypast over the runway at RAF Leuchars before landing at 1025 hrs. The aircraft had been airborne for almost two hours and had been without electrical power for at least 90 minutes.

Throughout the flight, the commander considered that the workload involved in maintaining controlled flight had made fault finding "almost impossible". After the flight he stated that he had seen no warning or caution lights illuminate during the flight and he could not recall whether he had checked the voltage/loadmeter gauges or the battery ammeter gauge during the flight. He did recall looking at the battery and generator switches and that they appeared to be ON. He also confirmed that before landing at Leuchars he had attempted, unsuccessfully, to reset both generators.

**Subsequent flight**

Once on the ground, the commander checked the battery voltage and noted that it was very low. He also reset the passenger oxygen masks which had deployed during the flight. The commander telephoned the aircraft's maintenance organisation for advice. At their suggestion he arranged for electrical power to be applied to the aircraft and this resulted in all the aircraft's systems appearing to work normally.

Engineering support arrived at RAF Leuchars the next day and the pilot returned to Leuchars to liaise with the engineers but, according to them, he did not mention any unusual 'g' excursions. The only entry in the aircraft's Technical Log described a total electrical failure so the engineers carried out a detailed examination of the aircraft's electrical systems. Both aircraft batteries were replaced and a full and successful check was made of the aircraft electrical system. Then, with no further indications of unserviceability, it was decided that the aircraft would be positioned to Blackbushe Airport for more detailed examination. The incident pilot was unavailable on the day so another pilot flew the aircraft to Blackbushe on 31 March. The incident pilot was unable to brief the positioning pilot about his in-flight experiences and when the latter pilot carried out

a pre-flight inspection, he did not notice any external signs of airframe damage. However, at Blackbushe it was found that the aircraft's outer wing panels had some wrinkling and there was bulging in the wing skins. The engines were also removed for examination.

**Weather information**

The synoptic situation at 0600 hrs showed low pressure over northern parts of the British Isles with an occluded front moving across Scotland during the morning. In the area around Glasgow, Prestwick and towards Edinburgh, the cloud structure was: FEW/SCT (few or scattered) stratus base 200 to 600 ft with tops at 1,200 ft; BKN/OVC (broken or overcast) strato-cumulus and/or nimbo-stratus base 1,500 ft with tops between 15,000 and 19,000 ft; and further layers above. There were forecast breaks in the cloud from the east of Edinburgh towards Leuchars. The freezing level was at 3,000 ft.

The METAR for Glasgow at 0820 hrs was as follows: surface wind 340º/ 02 kt; visibility 9,000 metres in rain; cloud FEW at 600 ft and BKN at 1,000 ft; air temperature +8ºC and dew point +7ºC; QNH 981 mb.

**Recorded information**

There was no requirement for a Flight Data Recorder (FDR) to be fitted to the aircraft and none was fitted. Although not required by regulation, a 30-minute Cockpit Voice Recorder (CVR) was fitted. However, the CVR circuit breaker was not pulled after the landing at RAF Leuchars and so the CVR data from the accident flight was overwritten before it could be downloaded.

A radio recording was available of the Glasgow and Scottish Radar frequencies. The recording confirmed that G-PCOP's commander requested engines start at 0815:20 hrs and requested taxi clearance at 0818:30 hrs. At 0821:20 hrs, G-PCOP was transferred to 'Tower' and was cleared for departure at 0831:05 hrs. By 0835 hrs, the aircraft was identified by 'Scottish Radar' and cleared to climb to FL100 on a heading of 150º. At 0836:10 hrs, the aircraft was further cleared to FL150 and this clearance was correctly acknowledged by G-PCOP's commander. This was the last transmission received by the aircraft and at 0837:20 hrs, 'Scottish Radar' made a check call following the loss of secondary radar.

**Electrical generation and warnings**

All the aircraft's systems were powered electrically. Electrical generation was provided by a 28V DC starter-generator on each engine with emergency standby power provided by a single nickel-cadmium battery. The generators were controlled by a pair of switches beneath a guard labelled MASTER SWITCH to the left of the control column, as shown in Figure 2. If the generators drop off-line, the switches do not move and must be moved to the GEN RESET position to bring the generators back into operation. Unguarded ENG AUTO IGN, ENGINE ANTI-ICE and IGNITION AND ENGINE START switches were clustered near the generator and battery master switches.

The overhead panel was fitted with two DC load and voltage meters together with a battery ammeter. This could be used to confirm the voltages on both electrical buses and to establish whether the battery was being charged or discharged.

In the event of complete DC generation failure, the aircraft battery was certified to provide power for 30 minutes; this duration depends on the pilot recognising the problem and shedding non-essential electrical loads. All of the non-essential components of the Pro Line 21 system would lose power automatically. If load-shedding was not actioned and both the landing gear and flaps were


**Figure 2**

Lower left instrument panel switches

operated, the manufacturer estimated that the aircraft battery would be capable of powering the aircraft's systems for approximately 10 minutes. The ESIS had its own independent battery supply in the event of a loss of electrical generation. The ESIS battery was certified to provide sufficient power for a minimum of 30 minutes.

The aircraft was fitted with an un-dimmable multi-caption warning panel on the top of the instrument panel glare shield, together with a red master warning light in front of each pilot. An additional and dimmable caution/ advisory annunciator panel was installed centrally below the MFD, see Figure 3. This panel contained amber caution captions, linked to a master caution light next to the master warning light, and green advisory captions.

If a problem occurred with an aircraft system, dependent on the severity of the defect, either a warning or caution caption would illuminate together with the associated master warning or caution lights. The master warning and master caution lights could be extinguished but the captions would remain illuminated until the affected system was restored. A failure of either or both generators would illuminate the master caution light together with an associated L GEN and/or R GEN amber caution caption(s).

**United Kingdom Generic Requirement (GR) No 4**

Generic Requirement No 4 was contained within CAP 747, '*Mandatory Requirements for Airworthiness*'. Its purpose was to ensure that 'certain aircraft' under 5,700kg maximum authorised weight provided the pilot with a clear and unmistakable warning in the event of a loss of electrical generation. The requirement stated:


**Figure 3**

Caution/Advisory annunciator panel

> *'2.2 Clear visual warning shall be provided, within the pilot's normal line of sight, to give indication of, either:*
>
> *a. reduction of the generating system voltage to a level where the battery commences to support any part of the main electrical load of the aircraft, or*
>
> *b. loss of output of each engine driven generator at the main distribution point or busbars'*

EASA Certification Standard CS 23.1322 defined a warning indication as '*red and non dimmable*'.

**Initial investigation**

After landing, the aircraft was connected to a ground power supply and all the electrical systems came back on-line. An inspection of the aircraft was carried out at RAF Leuchars by staff from the aircraft's maintenance organisation in conjunction with the aircraft manufacturer's technical representative. The inspection was conducted in the open and after rainfall. Despite extensive troubleshooting, no defects were identified with the electrical generation and distribution systems of the aircraft.

After the ferry flight to Blackbushe, additional airframe inspections in a hangar revealed damage to the outer wing skins and leading edges, characteristic of the aircraft being subjected to high flight loads. Externally this damage was difficult to detect without the use of a high-intensity mobile light source and it would probably have been masked by raindrops on the wings at Leuchars.

**Subsequent investigation**

The outer wing sections were disassembled and both outer wing spars showed clear evidence of overstress, which required replacement of the outer wings. No evidence of overstress was found elsewhere on the airframe. Due to the loss of engine indications and the damage identified in the outer wings, both engines and their propellers were removed for disassembly and inspection by their respective manufacturers.

Further tests of the aircraft's electrical system, carried out in conjunction with the AAIB, failed to identify any defects which could have resulted in the loss of electrical power. Subsequent tests were designed to evaluate the aircraft systems under degraded electrical power as reported by the commander during the accident. These tests were delayed until November 2006 when the engines had been re-installed after inspection, and after replacement outer wings had been fitted.

Test 1:

In the first test, the ESIS was switched on and external electrical power was then removed from the aircraft. Although the ESIS battery was only certified for 30 minutes of operation, the ESIS continued to operate on battery power for in excess of 85 minutes. The battery used for the test was new.

Test 2:

The second test was carried out, using a new main battery, to determine the probable order and timing of system failures on the flight and to verify whether it was possible to reset the generators with a fully depleted battery. A new battery was used to provide optimum electrical storage and charging conditions. It was not possible to determine accurately the condition of the aircraft's main battery at the time of the accident.

Using information from the commander and the aircraft's checklists, both engines were started without using external power and the aircraft was configured to replicate, as closely as possible, the electrical loads during the accident flight. The pitot heat system was not activated and the electrical load from raising the landing gear could not be accurately reproduced. Both generators were taken 'off-line' which illuminated the associated L GEN and R GEN captions, together with the flashing master caution lights. Resetting the generators extinguished the lights and captions. After allowing the battery to recharge for a period of five minutes, both generators were 'tripped' again and the aircraft's systems monitored. The battery ammeter indicated that the battery was being discharged but the deflection of the gauge needle was small. Also, from the pilot's seat, it was difficult to determine whether the reading was positive or negative. After five minutes, the battery voltage had dropped from 24 V to 20 V and the illuminated L GEN and R GEN captions had dimmed such that it was not possible to confirm that they were illuminated. Nine minutes into the test, with a battery voltage of 14 V, the FMS and the right PFD shut down, displaying a red FMS caption on the left PFD. After nine and a half minutes, the FD, GPWS, RA, and WS captions illuminated on the left PFD and the single MFD began to flicker. At 13 minutes, with a battery voltage of 6 V, the MFD and the left PFD shut down and all radio communications were lost. After 35 minutes of operation on battery power, with both DC buses indicating 0 V, both generator switches were moved to GEN RESET and then to ON; all aircraft electrical systems came back on line and both DC buses indicated 29 V. It was noted that there was no information contained in the aircraft Flight Manual to advise operators that the generator switches were self-powered and required no battery voltage for activation. Discussions with other Beech 200 operators indicated a general lack of awareness of this information.

*Associated switch layout*

On the pilot's left subpanel there were two switches that control the auto ignition system. These were surrounded by a white border line and labelled ENG AUTO IGN (see Figure 2). Below and to the left of these switches were two other switches, again surrounded by a white border and labelled IGNITION AND ENG START. Both sets of switches were of similar design and operated in the same sense. The auto ignition switches were normally selected to the ARM position immediately before takeoff. With the engines running, operation of the IGNITION AND ENG START switches would engage the starter circuit and would also trip both DC generators off-line, illuminating the flashing master caution light and the respective caution captions.

*Aircraft manufacturer's information*

Activation of the engine start switches with the engines running will not cause the starter to engage the engine but, in addition to tripping off the generators, it will have two more highly undesirable effects: the starters draw a heavy current which drains the main battery very quickly and the generators cannot be reset until the switches are returned to the OFF position. The aircraft manufacturer estimated that, if the ignition and engine start switches were inadvertently switched to the ON position just before takeoff, the battery would be unable to support the aircraft's systems within six to seven minutes.

The avionics manufacturer confirmed that if the aircraft had suffered a progressive failure of its electrical supply, this should have been recorded on both the Maintenance Diagnostic Computer (MDC) and Flight Management Computer (FMC). Both were removed and their non-volatile memories were downloaded by the manufacturer in the presence of the AAIB.

In the event of a complete electrical generation failure, power to the MDC would be lost immediately preventing fault recording. To record a flight log, the MDC logic required an airspeed of 80 kt and a signal from the weight-on-wheels switch indicating that the aircraft was airborne. The MDC contained 100 recorded flight logs. The logs were not date or time 'stamped' so it could not be determined if the MDC logic had been satisfied and a log recorded for the accident flight. The only fault data recorded was related to the troubleshooting carried out after the accident flight. This data included when an individual engine generator had been 'tripped'. The FMC contained no data relevant to the accident flight.

**Analysis**

Because the aircraft's outer wing panels had to be replaced, this serious incident subsequently became an accident as defined in the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996. However, the extensive engineering investigation could not identify a malfunction within the aircraft's systems that would explain the situation experienced by the commander.

The fact that the MDC failed to record any fault information for the accident flight suggested that the aircraft had suffered a simultaneous loss of both DC generation systems early in the flight, or that the aircraft's systems were being supported by battery power before the MDC flight log logic had been satisfied. Although a transient fault could not be eliminated, an examination of the circumstances of the accident indicated that inadvertent switch selections by the commander could explain the scenario.

There is no doubt that both generators went off-line at some stage and did not come back on-line. In the absence of any identified technical malfunction, the possibilities

were that neither generator had been switched ON or that they had both been inadvertently switched OFF.

It was considered highly unlikely that neither generator had been switched ON after engine start. Firstly, the commander stated that he had checked the generator loads after engine start and that they were within the required parameters. Secondly, a check of the timings showed that the radios stopped working in the accident some 21 minutes after engine start. During tests, it was noted that with a new battery the radios stopped working after 13 minutes.

However, if during the pre-takeoff checks, the IGNITION AND ENGINE START switches had been selected to 'ON' rather than the ENG AUTO IGN switches, the result would have been that the generators would have been tripped off-line. This action would have resulted in the battery being unable to support the aircraft systems within about six to seven minutes. Examination of the radio recording indicates that the aircraft radios were inoperative some five minutes after takeoff. Although this timing would support the hypothesis, the inadvertent tripping of the generators would still have illuminated the master caution lights on the glareshield and the associated L GEN and R GEN amber annunciator lights. However, depending on when any incorrect switch selection was made, the illumination of amber caution lights would not cause the same concern as the illumination of red warning lights. It was possible that the commander may have cancelled the caution as a reflex action and then did not critically examine the lights on the caution panel. Tests indicated that these lights would have dimmed within about five minutes of the generators going off-line.

The initial problem noted by the commander occurred shortly after takeoff when his workload was high, partly due to the weather conditions. In that situation, it was sensible to concentrate on flying the aircraft accurately until it was at a safe altitude and in steady flight. The commander achieved these conditions but when he attempted to inform ATC of his decision to return to Glasgow, he became aware that his radio was not operating. Subsequently, the commander commented that his workload was so high that he found fault finding "almost impossible". However, at one stage he was clear of cloud and at FL150 and this would have been an opportune time to evaluate his situation and at least attempt to reset the generators. Subsequent tests indicated that resetting the generators should have fully recovered all the aircraft's systems.

The commander stated that he attempted to reset the generators just prior to landing at Leuchars. If the problem was caused by having the start switches in the ON position, then he would have been unable to reset the generators until he noticed his mistake and selected the start switches to the OFF position. This factor lends further credence to the scenario that the generators were tripped off-line just before takeoff by the pilot inadvertently operating the IGNITION AND ENGINE START switches instead of the ENG AUTO IGN switches.

The Flight Manual did not include any information to the effect that the generators could be activated with zero battery voltage and several Beech 200 pilots thought that a minimum battery voltage was required to activate a generator. Moreover, it did not make clear that the generators could not be reset if the IGNITION AND ENGINE START switches were in the ON position. Although most pilots would attempt to reset generators regardless of battery voltage, it would be appropriate for the aircraft manufacturer to include this information in the Flight Manual because if a pilot had inadvertently

operated the wrong pair of switches, a generator reset would be impossible until the mistake was corrected. Accordingly it was recommended that:

**Safety Recommendation 2007-022**

The Raytheon Aircraft Company should amplify the information in the Beech 200 series Airplane Flight Manuals to reflect that the generators can be reset regardless of battery voltage but they cannot be reset if the IGNITION AND ENGINE START switches are in the ON position.

When the RAF aircraft came alongside, its crew provided full assistance to the commander of G-PCOP. Unfortunately, he was not fully aware of the meaning of the signals from the RAF crew. Safety Sense Leaflet 11 detailed the procedures in the event of an interception, and because interception was a fundamental part of the RAF crew's daily job, they were intimately aware of the signals and responses. However, the commander of G-PCOP was much less familiar and, as a single pilot operating with an emergency, he could not have been expected to consult any available document during the accident. Nevertheless, it was clear that the RAF crew persevered with attempts to assist the commander of G-PCOP and they played an important part in ensuring that the aircraft landed safely.

Irrespective of the causal factors in this accident, other aspects raised legitimate concerns. Firstly, the aircraft did not meet the CAA and EASA airworthiness requirements with respect to generator warning systems. After being briefed by the AAIB shortly after the accident, in June 2006 the CAA made a safety recommendation to the EASA. The Authority recommended that the EASA should release an Airworthiness Directive to ensure that the aircraft type complies with the requirements of EASA CS 23.1309(b)(3) and 23.1353(h) by providing red warning annunciations when both generators are off-line, and a 'low volts' warning when the aircraft battery is supporting any part of the aircraft's electrical load. The AAIB fully supports this recommendation which is being actively considered by the EASA.

Secondly, in the event of double generator failure the main instrument display should continue to operate for an estimated 30 minutes, with appropriate load shedding. At the same time, the ESIS display would be powered from its dedicated battery for the specified 30 minutes (although in tests it lasted for longer than the specified time). If the pilot is aware of reversion to battery power, 30 minutes should usually be sufficient time in which to take appropriate action. However, if the pilot is unaware that both generators are off-line, in this aircraft variant both the main and standby instruments could fail in succession. Consequently, this eventuality lends further weight to the safety recommendation made by the CAA to the EASA.

With the aircraft safely on the ground at RAF Leuchars, it was checked for the reported electrical problem but not for any possible overstress, primarily because no 'g' excursions were reported to the engineers by the incident pilot. This resulted in a flight in an aircraft with damaged outer wings and potentially damaged engines.