

FINAL REPORT

AAIU Synoptic Report No: 2007-010

AAIU File No: 2006/0071

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In accordance with the provisions of SI 205 of 1997, the Chief Inspector of Air Accidents, on 18 December 2006, appointed Mr Paddy Judge as the Investigator-in-Charge to carry out a Field Investigation into this Accident and prepare a Synoptic Report.

Aircraft Type and Registration:	Beech 65-A90 King Air, N712DB
No. and Type of Engines:	2 x PT6A-20
Aircraft Serial Number:	LJ311
Year of Manufacture:	1967
Date and Time (UTC):	22 August 2006 @ 15.39 hrs
Location:	Ireland West Airport Knock
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - Nil
Injuries:	Crew - Nil Passengers - Nil
Nature of Damage:	Distortion of wings and tailplane
Commander's Licence:	See 1.4 Personnel Information
Commander's Details:	Male, aged 48 years
Commander's Flying Experience:	753 hours of which 95 were on type
Information Source:	AAIU Field Investigation

SYNOPSIS

The aircraft took off at about 13.10 hrs UTC from Weston (EIWT) for Ireland West Airport Knock (EIKN) to practice flying instrument approaches. The Pilot flew a manual instrument approach in daylight Instrument Meteorological Conditions (IMC) followed by an overshoot. During the overshoot, at about 1,800 ft, the aircraft rolled to the right in excess of 90°. The non-flying Pilot took control and initially attempted to recover. He then decided to continue the roll to the right through 360°. With a high power setting and an inverted nose down attitude, altitude was lost and speed rose rapidly. In the recovery the aircraft was subjected to a gross over-speed with high G loading in avoiding ground contact. The flight returned to EIWT where it landed safely. There were no injuries. The aircraft, as a result of this event, is probably damaged beyond economic repair.

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NOTIFICATION

The Pilot did not report the accident. Over a month later an Inspector from the Irish Aviation Authority (IAA) discovered the damage to N712DB and the Air Accident Investigation Unit (AAIU) was notified.

This aeroplane is an American registered aircraft, based in Ireland, flown by pilots who are Irish citizens with addresses in Ireland but have American licences. As such, regulation of the aircraft and pilots' licences falls under the jurisdiction of the Federal Aviation Authority (FAA) of the United States. As Ireland is the State of Occurrence it is responsible for investigating the accident as detailed in Annex 13 of the International Civil Aviation Organisation (ICAO).

1. FACTUAL INFORMATION

1.1 History of the Flight

The flight was operated with the beneficial owner¹ as Pilot-Flying (PF) in the left seat. He was accompanied by the Pilot-Non-Flying (PNF) in the right seat who, for clarity in this Report, will be referred to as the PNF at all times. Both pilots have FAA licences and instrument ratings.

The purpose of the flight was to practice flying instrument procedures using a Garmin GNS 530 navigation system, which the PF had installed in the aircraft but was not particularly familiar with. However, the PNF was familiar with GNS 530 and willing to assist the PF with this learning process.

A Visual Flight Rules (VFR) flight plan was filed with ATC Shannon by the PNF on his mobile phone with the stated purpose of "*Calibration of aircraft*"².

The weather at EIKN got progressively worse as they flew to EIKN. On initial contact with EIKN ATC they were cleared to descend to 3,000 ft altitude and to self-position for an Instrument Landing System (ILS) approach to Runway (RWY) 27, with a 10 nm final. Two minutes later an aircraft, which had just landed, reported the cloud base at 180 ft, which the PNF overheard and acknowledged to ATC. They then stated that they would not be landing but "*what we're trying to do is calibrate an ILS on a Garmin 530*". They were then cleared by ATC to establish on the Localiser. Four minutes later they reported at 3,000 ft established on the localiser and requested a go-around with radar "*vectors for another ILS*" with an "*intercept from the north for calibration*". ATC informed them that there was no radar at EIKN and cleared them for a go-around with a right turn to the OK beacon (Initial Approach Fix RWY 27) for an NDB/ILS approach. They accepted the clearance and stated that they would be breaking off the approach at 600-700 ft above the airport. They were later requested to report breaking right which they acknowledged.

¹ Under USA law only USA citizens are permitted to own USA registered general aviation aircraft (N-registered). To comply with this requirement, yet still allow a non-US citizen to own such an aircraft, there is a widespread practice whereby USA citizens sets up a company which is the FAA registered owner of the aircraft, known as the Trustee. The beneficial owner, the non-US citizen, then enters an agreement with the Trustee, and is known as a Trustor.

² Calibrating an aircraft, its instruments or ground equipment requires specialist equipment and personnel, none of which were on the aircraft and was thus outside the competency of this aircraft or its pilots.

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At 15.37:22 hrs they reported on the go-around. At 15.39:59 hrs ATC requested their altitude. They responded 7 seconds later saying “*N712DB is having trouble*” (in later debriefing the PNF stated that the aircraft was inverted when he made this transmission). When queried by ATC they responded with “*Hold on...*” At 15.41:08 hrs they reported “*just ran into trouble with the GPS so er we’re now level at 350³, we’re heading north*” and shortly afterwards at 15.41:21 hrs they said they were at a distance of 3.5 miles. On being instructed by ATC to maintain 3,000 ft they confirmed that and stated they were going back to EIWT.

The flight back was uneventful and the performance of the aircraft appeared unaffected by the event. After landing and shutdown they did not notice anything wrong with the aircraft and the PF was very surprised when his mechanic, who had inspected the aircraft, informed him of the extent of the damage.

Over a month later an IAA inspector, visiting EIWT, discovered that an insurance assessor was examining aircraft N712DB because of wing damage. The IAA then notified the AAIU who inspected the aircraft and contacted the owner requesting details. On his written report to the AAIU the PF stated that the accident was turbulence related.

1.2 Injuries To Persons

None

1.3 Damage To Aircraft

The skin on the top wing surface of both port and starboard wings was found buckled at the outer panel joint (**Photo 1**). The outer panel joint is a production joint, just outboard of the engines, where the outer section of the wing is bolted to the stub wing section. In addition ripples on the upper skin of both wings extend outboard from the joints (**Photo 2**).

Wrinkles were also found on the top and lower stub wing, in particular in the vicinity of the port wing root/fillet intersection. The stub wing section runs through the fuselage body to the production joint or outer panel joint for the opposite wing. The section is an integral component of the fuselage.

The top surface of the port tail-plane shows distortion near its root on the top surface.

The AAIU contacted the manufacturers of Beech Aircraft, the Raytheon Aircraft Company, who stated that the wing damage is representative of both excessive G and over speed. They estimate that the aircraft was subjected to at least 4.5 G. Based on the damage signatures on the wings, they indicated that both horizontal stabilizers would likely exhibit some twisting along their spans.

³ Probably meaning an altitude of 3,500 ft.

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1.4 Personnel Information

1.4.1 General

The PF, aged 48, has an FAA issued Private Pilot's Licence (PPL) with Instrument Rating (IR) that allows him to fly a multi-engine land, instrument airplane. The Investigation is satisfied that this licence was type proficient and IR current. The Pilot has however, been unable to produce an FAA medical certificate to validate his licence. The medical certificate produced by the Pilot was issued by an IAA approved Aero-Medical Examiner (AME) and refers to a UK PPL that the pilot also holds but which does not cover multi-engine aircraft. The AME was not an FAA approved aero-medical examiner. Accordingly, the Pilot's FAA licence was not valid. The Pilot claimed he was unaware that the medical did not validate an FAA licence.

The PNF, aged 41, had an FAA issued Commercial Pilot's Licence with Instrument Rating (IR) that allows him to fly a multi-engine land, instrument airplane. He did not have an instructor's rating. The Investigation is satisfied that this licence was type proficient, IR current and valid. The PNF confirmed he had about 2,000 hours on multi-engines, aerobatic aircraft and helicopters, had previously owned a similar type aircraft and was familiar with the GNS 530.

1.4.2 PF Interview

The approach was joined at 3,000 ft with some light turbulence being experienced. He disconnected the autopilot and manually flew the approach down to about 1,400 ft, (i.e. a height of about 735 ft above the airport as EIKN altitude is 665 ft). At that point a go-around was executed with the gear being raised and flaps partially retracted. The PF's memory was that while still heading westerly in the climb, at a speed about 140 knots and approximately 1,800 ft, they had a sudden jolt and the aircraft rolled to the right. It did not respond to left aileron input. The PF conceded that it is possible he might have begun the turn to the right but essentially they were still on a general westerly heading. He said he did not believe he had become distracted and that he was very conscious of what he was doing. The PNF joined him on the controls during the upset and he let him take control as he was a much more experienced pilot.

The PF did not remember any negative G during the roll manoeuvre but was very aware they were close to the ground and thinks the minimum height might possibly be 800 ft. On recovery the artificial horizons were toppled but settled down afterwards. He remembered the gear being up but thought first stage of flaps was still out throughout the manoeuvre. He had never done aerobatics and had no idea of G forces involved, as he had not experienced them previously. He did not know the maximum speed reached but was very conscious of the altitude reducing.

The PF told the Investigation that after the event they used the autopilot on the way back and that they had had a fright. He said they did not speak much during the remainder of the flight. The PF claimed he went back and thought nothing more about the aircraft until his engineer rang to inform him of the damage. He said he was surprised.

The PF stated that he had felt a certain level of security by having an experienced pilot along in the right hand pilot's seat. The PF regarded the PNF as a much more experienced pilot and referred to him as his "mentor" and "guru" on a number of occasions.

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The PF stated in his interview the incident was probably turbulence related, as the weather was poor on the day. He later reaffirmed that opinion in a subsequent communication to the Investigation.

1.4.3 PNF Interview

The PNF stated that he had earlier filed the initial flight plan from his mobile with Shannon ATC. They had overshot a couple of minutes earlier and still had partial flaps out. He was examining the approach chart at the time and said in a later interview that he had not noticed any significant turbulence. He looked up and saw that the bank angle was already over 90° with an accelerating high roll rate. He grabbed the controls and initially attempted to recover by rapidly applying left aileron, which had little affect. He then decided to continue the roll to the right through the remainder of a 360° roll. With high power setting and a nose down attitude, altitude was lost and speed rose rapidly. Due to his position in the cockpit he was unable to reach the throttles, which were at a high power setting. As the aircraft rolled inverted the artificial horizon toppled and he could see the roof of the canopy getting darker as they neared the ground. He continued the roll until brightness showed in the canopy again, applying full backpressure to the controls. They climbed up to 3,500 ft and headed north.

The PNF stated that he thought maximum speed reached was probably between 280-300 knots and he possibly pulled about 5 G on the recovery (a figure that closely tallies with the manufacturer's assessment). He did not know the minimum height reached but felt they were close to the ground inverted, as it got dark. He was not aware of any significant turbulence, jolt or G force that caused him to look up. He had just routinely glanced up from examining the chart when he noticed the excessive bank angle.

In subsequent communications to the Investigation the PNF stated that he was aware he was not qualified for aircraft calibration and should more accurately have described the purpose of the flight as GNS 530 familiarisation with which he was assisting. He also stated that at no time was he or did he assume the role of instructor and confirmed that he never considered the accident as turbulence related.

1.5 Aircraft Information

1.5.1 Aircraft Airworthiness

The aircraft has an FAA approved Certificate of Airworthiness. The validity of this certificate is conditional on maintenance and Airworthiness Directives (AD) being kept up to date. The investigation is not aware of any outstanding defects or ADs that would have affected the airworthiness of the aircraft or its suitability for the intended flight.

The aircraft is fitted with an optional Saunders Spar Strap. This Supplementary Type Certificate (STC) modification is an F.A.A. approved wing spar reinforcement designed to reduce the possibility of wing separation in models of King Air aircraft. It is advertised as designed to prolong the life of the existing wing spar structure and to provide a greater margin of safety against overload failure in severe turbulence.

The weight and balance of the aircraft was not a factor in this accident.

The aircraft is fitted with two PT6A-20 reverse flow turbo propeller engines which were not a factor in this accident.

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1.5.2 Flight Manual Limitations

The aircraft is certified as a “Normal Category Aircraft” and its Flight Manual states that all aerobatic manoeuvres including spins are prohibited.

The relevant flight manual limitations are as follows:

- Normal speed range for the aircraft is from 89 to 208 knots.
- VMO or the Velocity Maximum Operating is 208 knots with flaps up.
- VFE for maximum speed with partial flaps (35%) extended is 174 knots.
- The maximum design manoeuvring speed is 169 knots; above this speed, controls should be used with caution.
- Maximum G loading: + 3.7 g to –1.68 g

1.5.3 Aircraft Navigational Information

The aircraft is equipped with a full set of flight instruments and is capable of being flown from either the left or right hand sides in IMC conditions.

The GNS 530 is a GPS navigation system, which stores a Jeppesen Database that is regularly updated. The GNS 530 contains details of airports, runways, approaches and airways while providing a moving map display thus providing situational awareness for the pilot through a worldwide land geographic coverage. It does not, however, have any capability to store a record of in-flight data, unlike basic GPS models. Current international technical standard requirements do not require certified aircraft GPS systems to have a track memory capability.

The aircraft is not fitted with a Flight Data Recorder (FDR) or a Cockpit Voice Recorder (CVR) as there is no requirement that they should be fitted when the aircraft is operated in a private category. Therefore there is no independent record of the event other than the peripheral ATC tapes and witness accounts from both pilots.

1.5.4 Aircraft Mechanical Information

There is no evidence of any system or control malfunction. This is supported by the fact that the aircraft flew normally back to base subsequent to the event without any roll right tendency.

1.6 Meteorology Information

1.6.1 General

Records from the EIKN ATC tapes indicate that at 15.24 hrs a previously landing aircraft reported breaking out at 180 ft above the airfield and that at 15.26 hrs the tower gave a weather report to a departing aircraft similar to the METAR below but with a wind velocity of 210°/13 kts.

The METAR at 15.30 hrs for EIKN, 9 minutes before the accident, shows a wind of 190°/12 kts but varying in direction from 160° to 230°, visibility at 4,500 metres in light rain with broken clouds at 100 ft and overcast at 500 ft. Both temperature and dew point were 15°C. Atmosphere pressure was standard at 1013 Hpa.

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1.6.2 Met Éireann Aftercast

Following the PF's statement that the accident was caused by turbulence the Investigation requested an aftercast from Met Éireann for that area and time on the 22 August 2006 between 1,400 ft and 1,800 ft. The following are the relevant parts of the report.

The area in which the accident occurred was in a very humid warm sector situation. At 15.30 hrs EIKN reported a cloud ceiling at 400 ft. Given this fact, the frontal nature of the situation and evidence from satellite imagery it is reasonable to suggest that there existed broken and overcast layers of stratiform, stable cloud from at least 400 ft upwards.

The winds at the surface were 190°/14 kts with a reported varying direction of 160° to 230° with light rain and drizzle. At 1,500 ft the winds would have been approximately 220°/25 kts. Due to the high freezing level, circa 10,500 ft, and the absence of convective type cloud, the icing risk in this situation was nil at the level at which the event occurred.

Mountain wave activity was not likely to have been present at the time of the accident. Archived satellite data showed no evidence of the lee clouds typical of a mountain wave scenario. The representative upper air soundings (tephigrams) lack the inversion required for mountain wave development. Also, the vertical wind profile taken from the sounding did not show the winds increasing with height to the extent considered necessary for mountain wave or rotor formation. As the area was in a warm sector with essentially stable cloud formations of stratified cloud and, as wind velocities were relatively low, turbulence of a moderate or severe level was unlikely.

1.7 ATC Records

Following notification of the accident by the IAA the AAIU immediately requested copies of Shannon Radar data. This data would have been useful to the Investigation, as previous experience has shown that Shannon Radar has coverage in the EIKN area down to approx 500 ft above ground level. These records were no longer available, due to the time lapse from the occurrence, as routine radar records are only retained for one month. This data would have tracked the location and altitude of the aircraft down to a low level and thus allowed the AAIU to reconstruct its flight path. Consequently the Investigation was considerably hampered by the fact that the only recorded information available was the EIKN Tower record, a copy and transcript of which was provided by EIKN ATC. Part of this record has already been detailed in **1.1 Factual Information**, and was used to verify meteorological reports.

The flight plan initially filed with Shannon ATC centre was a VFR flight plan. On approaching EIKN the crew confirmed with ATC that they were VFR. Subsequent to the occurrence the aircraft left the area on a VFR flight plan at 3,000 ft. At no stage in the record was the flight plan changed to IFR though these conditions prevailed.

2 ANALYSIS

2.1 Pilot Interviews

Both pilots were interviewed by the Investigation together and subsequently separately. The PF had limited time on the aircraft (95 hrs) but had flown it regularly on trips abroad. He felt that he would like assistance, which the PNF offered to give, in becoming more familiar with the procedural aspects of operating a GNS 530.

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During the flight they intended to fly GPS approaches at EIKN to achieve interceptions of the ILS. The PNF, with experience of multi-engines, aerobatic aircraft and helicopters and previous familiarity with the GNS 530, was more experienced.

2.2 Damage

The skin buckling at the outer panel joint on top wing surface is more significant on the port (**Photo 1**) than the starboard wing. This is consistent with concurrent application of right roll and high G. This buckling is termed “compression buckling” and is caused by wing overload.

The upper skin ripples in **Photo 2** that extend outboard from the joint on both wings are symptomatic of gross over speed and occurs as aerodynamic forces push the wings up and aft. In this case drag would have been particularly high as the flaps were partially extended at the time of the occurrence. With a VFe of 174 knots and a possible speed reached between 280-300 kt this damage is not surprising as the exceedence could be in excess of 160% of VFE.

The wrinkles on the top and lower stub wing are early forms of compression buckling and indicate probable distortion of the stub wing, an integral and major structural component of the fuselage.

The top surface of the port tail-plane also shows distortion (oil-can effect), near its roots, indicating that the tail plane also exerted downward force beyond design limits during the occurrence, which is consistent with a heavy pull back on the controls at high speed. This probably confirms the assessment of the aircraft manufacturer that the horizontal stabilizers would likely exhibit some twisting along their spans.

In view of the age of the aircraft, the fact that both wings are buckled at the production joints and more critically with distortion in the stub wing, it is probable that the aircraft was damaged beyond economical repair.

2.3 GPS

The panel-mounted GNS 530 GPS does not have a track memory feature. Therefore the Investigation was unable to create the aircraft's flight path from GPS data. This data deficit was exacerbated, as the radar data was subsequently lost due to the failure to report the incident. The Investigation has learned that the International design specifications, as issued by the FAA, EASA and other organisation, do not require aircraft GPS equipment to have internal self-contained track memory modules. The need for this feature may not be recognised because when GPS is used in FDR equipped aircraft, the track information is usually stored in the FDR.

However, as the use of installed GPS units spreads to small aircraft that are not normally fitted with FDR's, there is no resource onboard that records track information. This omission is not due to any technical complexity issues, as tracking technology is invariably installed on cheap hand-held GPS receivers.

Experience has shown that GPS track information, where available to accident investigations, has proved most useful. Therefore the Investigation recommends that the international standards for aircraft-certified GPS units be modified to include a track and altitude memory feature.

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2.4 Discussion

2.4.1 Aircraft Operation

Both pilots agree that the occurrence was not due to aircraft, systems or flight control problems. The fact that the aircraft flew normally subsequent to the event without any roll right tendency also leads to the conclusion that this event was not caused by either control or mechanical problems.

Although the weather was poor, meteorological analysis suggests that icing was not an issue and that significant turbulence was unlikely to be a factor. The more experienced PNF has stated he did not consider the accident as turbulence related. ATC tapes record the initial report from the aircraft after the upset as having trouble with the GPS. If the crew had considered that the event was turbulence related it is probable that they would have immediately reported that to ATC. The fact they did not do so is significant.

It is noteworthy that neither pilot noticed negative G during the manoeuvre. This indicates that, in acrobatic terms, a Barrel Roll was performed and not a Slow Roll where negative G is experienced. A Barrel Roll is essentially a horizontal helix. However, too slow an entry, or an interrupted entry as in this case, results in a large nose drop before becoming inverted with a resultant spiral dive developing with rapid loss of altitude. In either roll case, entry is similar to commencing a turn. The significant point here is that there is little or no G change entering a Barrel Roll until almost inverted and, in IMC conditions, no peripheral vision clues to cause concern. Therefore maintaining a constant and good instrument scan in IMC is of critical importance.

The most likely scenario, since the ATC clearance was to turn right after go-around, is that that the occurrence was originated by the PF commencing a turn to the north using aileron input which, sustained, led to an accelerating roll rate that was not noticed by either pilot. This roll rate led to loss of control of the aircraft by the PF. The purpose of the flight was to practice navigation procedures using the GNS 530. To what extent this may have been a distraction following the initiation of the go-around is unknown even though it was not in use at the time but ultimately both situational awareness and control was lost by the PF.

2.4.2 Human Factor Issues

Overall the Investigation formed the opinion that the PNF appeared to have portrayed an image of confidence, proficiency and experience to a less experienced and possibly impressionable PF. Part of this image was assisted by the fact that the stated purpose of the flight was “calibration”, not practicing instrument approaches, which was above the experience level of the PF.

The resulting cross-cockpit relative experience gradient gave the PF a feeling of comfort and security. However, the following facts lead the Investigation to query who was really in command, the inexperienced PF or the more experienced and confident PNF in the right hand seat, as:

- The PNF stated that he filed the flight plan.
- The voice signature on the ATC record of the flight indicates that the PNF operated the radio before, during and after the event, even when inverted.

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- No pause existed at any time between an ATC query and the immediate response of the PNF.
- The PNF took control when he observed the approaching inversion.

Inter pilot relationships are fraught with Crew Resource Management (CRM) issues where pilot roles are ill defined. The PF stated that he considered the PNF as “very experienced” and his “guru and great mentor”. Thus an experience, confidence and emotional imbalance was probably generated which appears to have affected the cross-cockpit command gradient with the PF/Commander/Beneficial-owner in the left seat consequently deferring to the PNF and not monitoring his flight instruments as carefully as was needed.

Although the relationship stated was of two associates going for a flight together, one assisting the other, in reality the outcome was a quasi-instructional one for which the PNF was untrained. Consequently his CRM skills were lacking and he did not monitor the flying pilot as closely as was required in the circumstances.

It is, however fortunate that the PNF was there as it is unlikely that the PF would have otherwise survived the event. On the other hand it is questionable if the PF would have got himself into that situation if the PNF had not been there in the first place.

3. CONCLUSIONS

(a) Findings

1. The PF’s licence was not valid, as his aero-medical is not recognised by the FAA.
2. The aircraft was operated in IMC conditions on a VFR flight plan.
3. Although the weather at EIKN was poor, turbulence was unlikely to be a causal factor.
4. During the go-around procedure the PF lost situational awareness and control resulting in the aircraft being inadvertently rolled in IMC conditions.
5. The PNF recovered the aircraft from an inverted position.
6. The damage was caused by the recovery during which both Flight Manual and design limitations were substantially exceeded.
7. The PF (and beneficial Owner) did not notify the accident in contravention of Air Law.
8. This investigation was hampered by the fact that the ATC Radar recordings were no longer available. This was due to the accident not being reported by the PF in a timely manner as required by S.I. 205 of 1997.
9. This investigation was also hampered by the fact that the GNS 530 does not record any flight data.

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(b) Probable Cause

1. The probable cause of the accident was loss of control of the aircraft by the PF during the go-around procedure.
2. An additional factor was the relative inexperience of the PF.

(c) Contributory Cause

1. Inadequate monitoring by the PNF.

4. SAFETY RECOMMENDATIONS

1. The relevant Technical Standards Order working group within the FAA, and the JAR Technical Standards Order working group within European Aviation Safety Agency, should consider amending the certification requirements for airborne GPS receivers to require the inclusion of a memory module that would record details of the aircraft's track and altitude. ([SR 09-2007](#))

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Photo 1
Buckling on port wing at outer wing panel joint



Photo 2
Upper skin rippling on starboard wing outside outer wing panel joint

- END -