ATR72-212, G-BYTP

AAIB Bulletin No: 9/2001 **Ref: EW/C2000/10/06** **Category: 1.1**

Aircraft Type and Registration:	ATR72-212, G-BYTP
No & Type of Engines:	2 Pratt and Whitney Canada PW-127 turboprop engines
Year of Manufacture:	1996
Date & Time (UTC):	10 October 2000 at 1924 hrs
Location:	Bournemouth Airport
Type of Flight:	Public Transport
Persons on Board:	Crew -4 - Passengers - 40
Injuries:	Crew -None - Passengers - None
Nature of Damage:	Collapsed nose landing gear
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	17,200 hours (of which 1,620 were on type)
	Last 90 days - 139 hours
	Last 28 days - 52 hours
Information Source:	AAIB Field Investigation

History of the flight

The aircraft was carrying out a flight scheduled to depart from London Gatwick Airport at 1725 hrs and to arrive at Jersey Airport, Channel Islands, at 1835 hrs. The crew of two pilots and two cabin crew members had reported for duty at 1245 hours and operated one uneventful round trip flight to Guernsey, Channel Islands, on the same aircraft before the accident flight.

The aircraft took off at 1739 hrs and climbed up to a cruise level of FL160. Flight conditions were reported to be good with occasional light turbulence. The weather forecast for Jersey indicated a change was expected between 1600 and 1900 hrs from clear weather with strong westerly winds to cloud, rain and strong southerly winds. Prior to descent the First Officer (FO), who was designated as the handling pilot, briefed for a Runway 27 ILS approach at Jersey. On first contact with Jersey Air Traffic Control (ATC) the crew were informed that the runway in use had just been changed to Runway 09. There was some discussion between the pilots regarding the reported surface wind of 170°/30 kt and the flight manual was checked to confirm the crosswind limit of 30 kt for the aircraft. It was decided that the FO would fly the approach with the commander following through on the controls. The FO accordingly gave a briefing on the details of the Runway 09 ILS approach.

At 1813 hrs the following weather observation was passed to the crew by Jersey ATC: VISIBILITY 3KM, HEAVY RAIN SHOWERS, BROKEN CLOUD AT 600 FEET, BROKEN CLOUD AT 1,000 FEET AND SURFACE WIND 180°/20 KT.

The aircraft was given radar vectors towards the extended centreline of Runway 09 and cleared to descend to 3,000 feet amsl. The crew could see weather radar returns indicating the possibility of turbulent conditions in the vicinity of the approach. The level of turbulence being experienced by the aircraft increased during the descent and a master caution alert sounded. The "Flight Controls" (FLT CTL) amber caution light and local stick pusher "Fault" light were illuminated. The crew carried out the appropriate drill from the QRH which required the stick pusher system to be switched off. For extended periods during subsequent turbulence the FLT CTL light illuminated and the master caution alert sounded but with no associated local alert light.

When at 3,000 feet and heading south towards the approach further turbulence was encountered and the commander decided that it was too severe to continue. The aircraft was climbed back up to 6,000 feet. At 1833 hrs another attempt was made to establish on the approach but again turbulence was too severe. This time the autopilot disconnected on several occasions and the FO advised the commander that the aircraft controls felt unusually heavy and he did not feel competent to be flying the aircraft in the conditions. The commander took over control of the aircraft, re-engaged the autopilot and at 1837 hrs accepted vectors again towards the approach. This time the aircraft established on the ILS and descended to 1,700 feet amsl but further turbulence was encountered and the approach was discontinued at 1845 hrs. The autopilot remained engaged for the remainder of the flight until just before landing at Bournemouth.

By this time a number of the passengers and one cabin crew member were suffering from airsickness. The cabin crew handed out cold towels in an attempt to alleviate the symptoms. They also advised the FO of the cabin situation.

The commander decided the flight would have to be diverted and, after finding that the Guernsey weather was unsuitable, Southampton was preferred. En route to Southampton the crew calculated that sufficient fuel was on board to return to Gatwick and accordingly requested a route change from ATC. A few minutes later they were advised that Gatwick Airport was closed due to an incident and was not expected to re-open for several hours. The flight thus continued towards Southampton until ATC advised the crew that Southampton was busy and there could be a delay for landing. As a result the crew requested a diversion to Bournemouth and were then cleared to proceed there. Some minutes later they were informed that there were now no delays at Southampton and so revised their destination once more. The weather conditions at Southampton where Runway 20 was in use were, surface wind 160°/9kt, visibility 8km, rain and drizzle with broken cloud at 1,200 feet. An approach briefing for an ILS 20 approach at Southampton was given by the commander who remained the handling pilot.

On descending through FL80 the FO switched to the second radio and spoke to his company operations department. They advised him that due to terminal area congestion at Southampton it would be better for the management of the passengers if the aircraft were to go to Bournemouth. The crew discussed this between themselves, decided that they could accommodate the request, and obtained clearance to Bournemouth once again. The FO was off the ATC frequency for 4 minutes while these arrangements were discussed.

En route to Bournemouth the commander gave an approach briefing for the ILS 26 approach there. The briefing was interrupted on 5 occasions by ATC communications with the aircraft and there were a further 6 such communications while the crew were carrying out the approach checklist. The aircraft was however established on the ILS approach at 9 nm with the checks completed. On final approach information regarding windshear below 500 feet reported by a previous landing aircraft was relayed to the crew by Bournemouth Tower ATC.

There was moderate rain on the approach and the surface wind, reported one minute before touchdown, was 180°/17 kt. The commander disengaged the autopilot at 230 feet agl. The aircraft landed on the runway in a nose down attitude on the nose landing gear and rebounded into the air. Nose down elevator was applied and held resulting in a series of divergent bounces which ultimately caused the nose landing gear leg to collapse. The aircraft came to rest on the runway and shortly afterwards the commander initiated a passenger evacuation. All the passengers evacuated the aircraft safely and the airport fire services were on the scene promptly.

Passenger evacuation

There were four emergency escape routes available from the passenger cabin of the aircraft. The aft port side door was the normal entry door and had steps available. With the nose landing gear collapsed the steps were at an unusual angle but were able to be used. The aft starboard side service door was partially blocked by bags which had moved forward with the retaining cargo netting and was therefore not opened. In the forward part of the cabin the aircraft had two Type III emergency escape exits. Both of these were opened and used for the evacuation. Some of the less able passengers required assistance from the more able, due to a 1.8 metre drop to the surface from the exit door sills. There were no escape slides fitted to these openings and there was no certification requirement for there to be any.

The airport fire service deployed rapidly upon receiving the alarm but then had to proceed with caution up the runway to avoid running into persons in the dark. After the evacuation the crew had some difficulty accounting for all the passengers around the aircraft due to the difficult weather conditions.

Meteorological conditions

The United Kingdom (UK) weather was influenced by a complex low pressure system. There was an occluded front lying between Devon and the Channel Islands, moving rapidly east. The southern UK was experiencing a strong south westerly airflow with extensive cumulus cloud giving rise to rain showers and thunderstorms. The 1920 hrs METAR for Bournemouth was recorded as follows: Surface wind 180°/15 gusting 25 kt, visibility 6000 metres, rain, scattered cloud at 1,000 feet, overcast cloud at 1,500 feet, temperature 10°C, dewpoint 9°C and QNH 974 mb. It was dark and the runway lighting was set at 3%.

Communications

It was observed from the recorded ATC tapes that the southern UK radio frequencies used by the aircraft were extremely busy, with almost continuous use for some periods. Communications between the two pilots were made using the flight intercom system. They both commented that to maintain a listening watch under these conditions occupied a lot of their attention.

The senior cabin crew member operated at the rear of the aircraft and so most of the communications with the flight deck were made using the cabin interphone system. The FO made all the interphone communications with the cabin crew during the flight. He also made the calls to the company operations department on the second radio box. There was not any guidance in the company operations manual as to when might be an appropriate time to make company calls.

The company operations manual contained guidance on standard callouts to be made and these were used by both pilots during the flight. There was a requirement for a sustained deviation of 10 kt or more from the target airspeed to be brought to the handling pilot's attention by the non-handling pilot. There were no instances of such a call being made by either pilot during the flight although deviations in excess of this were recorded on the FDR.

Engineering investigation

On-site examination

Runway 26 had a landing distance available of 1970 metres. The aircraft had come to rest 205 metres short of the end of the runway. The nose landing gear (NLG) leg was folded backwards underneath the fuselage which had come to rest on part of the nose wheel axle and the NLG doors. The nose wheel assembly was still attached to the leg together with the axle, left wheel and tyre. Both tyres had burst and the left remained with its wheel but the right was found 370 metres from the aircraft.

There were no marks on the runway of the first and second touchdowns. The first marks evident were rubber marks from the right main wheels, 10 metres to the right of the centreline and 695 metres from where the aircraft came to rest. This was probably the third touchdown and metallic scrapes indicated that the nosewheel rim had also been in contact with the runway at this stage and the nosewheel tyres had burst. Pieces of right nose wheel rim were found approximately 180 metres beyond the initial marks. There were no runway marks at this point, but the wheel rim had evidently broken at this fourth touchdown. 110 metres further along, more marks indicated a heavy nosewheel contact at the fifth and final touchdown. This consisted of an imprint from the wheel on the runway, followed by scrapes from the axle indicating that the nose landing gear had broken at this point. As the right nose wheel and tyre broke up they momentarily became trapped under the fuselage, causing damage to both the underside of the fuselage and the runway for approximately 4 metres as they were dragged along. The aircraft was 4 metres to the right of the centreline at the time the nose gear collapsed, but was returning to the centreline. There were some further lighter scrapes, indicating contact between the runway and the NLG doors. The nose of the aircraft was less than a metre from the centreline as it came to rest.

The lack of any tip damage indicated that the propellers had not contacted the ground. All main wheel tyre pressures were similar and within the required limits.

Some creases were visible in the skin on the right hand side of the fuselage in the window belt above the main landing gear (MLG): this was thought by the manufacturer's representative to have occurred during the touchdown sequence. There was also distortion in the web of fuselage Frame 27, again above the area of the MLG.

Flying controls

Control of the aircraft was via ailerons, elevators and rudders, connected to the cockpit controls by means of mechanical linkages. The control surfaces were mechanically and aerodynamically balanced. Following the accident a 'full and free' check was carried out on the elevators and no malfunctions were found. All stabiliser mounts were inspected with no signs of damage evident.

The aircraft was equipped with a primary stall warning (stick shaker) and secondary stall warning (stick pusher). Operation of both these warnings was signalled by alpha probes positioned on either side of the front fuselage. If the difference between the alpha probes was greater than 4°, a fault light was activated (Amber Fault legend plus single chime, master caution light and FLT CTL caution light).

Landing gear

The aircraft was fitted with a retractable tricycle landing gear. The nose landing gear (NLG) retracted forward and consisted of a leg strut, incorporating a shock absorber, the nose wheel steering system and a drag brace. The latter supported the gear and kept it locked down. The NLG leg was of a barrel type with two ribbed arms connected to the fuselage via pivot pins. The NLG gear failed rearwards, with the right pivot pin being pulled out causing damage to its associated fuselage frame. The left rib arm had failed in overload.

Each main landing gear (MLG) consisted of a trunnion, a trailing arm, a shock absorber and a side brace which contained the locking and unlocking system for the gear, which retracted inboard into the fuselage. The trailing arm was fitted with an axle, carrying the two wheels, and was attached to the lower part of the shock absorber. The oleo-pneumatic shock absorber absorbed landing energy and provided an elastic suspension. It was pivoted between a pin fitted to the trunnion leg and a universal joint on to the trailing arm.

The oleos, which were charged with nitrogen and hydraulic fluid, appeared to be more compressed than normal. The visible part of the lower oleos below the cylinders was 1 cm as opposed to a reportedly normal measurement of between 2-3 cm. However, the pressure of the nitrogen was checked and found to be within limits.

During the touchdown the right wheel had contacted the MLG doors, allowing three nuts on the underside of each door to score the tyres over their entire circumferences. Subsequent examination of the MLG at the manufacturer showed no breakup within the shock absorber, however the MLG attachment lugs had been distorted.

Aircraft information

The aircraft had 900 kg of fuel remaining at the time of landing giving an endurance of approximately 90 minutes.

The anti-icing equipment fitted to the aircraft prevents ice formation in specific areas but ice on other parts of the airframe may still degrade the performance. When atmospheric icing conditions (TAT 7°C or less and visible moisture present) were encountered the selection of anti-icing was required. This action reschedules the angle of attack stall alert threshold to give the stall warning, stick shake and subsequent stick push at higher speeds. Thus, with anti-icing selected on, an adjustment to the approach reference speeds (icing speeds) was also required. Normal minimum approach speed (Vref) was 1.23 times the reference stalling speed (VS) but for 'icing speeds' this increases to 1.32 VS.

The approach reference 'bug card' was completed by the crew for the approach at Jersey using a landing mass of 18.2 Tonnes (T). The reference speeds for icing conditions at 19T were correctly used and a wind factor of 10 kt increment was added to the Vref giving an approach target speed (VAPP) of 120 kt. The same 'bug card' and speeds were also used for the approach at Bournemouth, which was conducted at 17.5T. Were the card to have been revised for 18T using the same criteria the new VAPP would have been 117 kt.

For this aircraft at a mass of 18T the VS was calculated at 81 kt, the normal minimum approach speed was 99 kt, and minimum approach speed for icing was 107 kt. The maximum recommended increment of 15 kt for wind factor would have given a maximum allowable VAPP for 18T of 122 kt or 1.51VS. The actual aircraft airspeed averaged over the last 10 seconds of the approach was 138 kt, or 1.7VS.

The aircraft type was not equipped with a lift dump system. Retardation is normally assisted by the selection of ground idle after touchdown and then reverse as required. Go-arounds can be performed if required after touchdown until the selection of ground idle.

The original stall warning and identification system was disabled if a split of more than 4 degrees between the vanes was detected. This feature was considered unacceptable by the CAA and as a result the manufacturer introduced changes to this system for UK certification. The changes included the deletion of a 4 second time delay within the logic train that triggered the 'FLT CTL' caution if the alpha probes differed by more than 4 degrees.

Rear baggage area

The rear baggage area located at the aft of the cabin had retaining nets secured in place which were found to be slack. This allowed some bags to move forward from the hold area. Two different types of cargo net have been fitted to this baggage area on ATR-72 aircraft. This aircraft was fitted with the earlier standard of net which allowed a greater range of adjustment than the more recent type, thus giving considerably more adjustment than was required to secure baggage. The strap fastenings were designed such that it was simple to pull them tight but difficult to release them if they were fully tightened. As a result in everyday use there was a reluctance to fully tighten them. The company operations manual indicated that it was the responsibility of the cabin crew to ensure that all cargo netting was secured. Diagrams and instructions for how to do this were not included.

Flight recorders

Cockpit voice recorder

The CVR fitted was a L3 Communications model A200S, which employed a solid state recording medium and was of two-hour duration. For the final 30 minutes this contained recordings on 4 independent channels, one for each of the two flight crew members, one for the Public Address (PA) and FDR synchronisation signals, and one for the cockpit area microphone. For the total two hour duration there were also two separate channels recorded, the crew and PA/SYNCH channels combined into one, and the area microphone channel. The recording started just after the aircraft pushed back for departure, so the entire flight was recorded on the CVR.

Flight data recorder

The DFDR was a L3 Communications (formerly LORAL) model F800 recording sequentially onto six tracks, and contained in effect an endless loop recording a total duration of approximately 25 hours. On replay it was found that the quality of data was very poor. Of the six tracks, two contained very little or no decodeable data. The others contained a number of areas where there were extensive periods of indecipherable data and many isolated instances of poor data. Fortunately the accident flight was recorded on one of the better tracks but still had many areas of very poor data quality. On the accident flight data was lost in many areas, but particularly significant was a data loss during the initial touchdown phase of the landing. For this area the signals from the recorder were digitised and an attempt was made to decode them by eye. This recovered some additional data but two short periods of less than one second were not recoverable. Examination of the signals indicated that the recorder had rapidly changed speed during a period of high g loading to the airframe. No attempt was made to recover data during other areas of data loss. The isolated areas of loss seemed to be more prevalent during the passage of the aircraft through areas of significant turbulence during the attempted approaches to Jersey. It is not uncommon for this type of recorder to show such data losses during turbulence or high loading. The more extensive periods of data loss were not explainable.

Below 9,000 feet in the descent to Jersey the aircraft encountered some severe turbulence. The recorded normal acceleration indicated that there were generally fluctuations between 0.5 and 1.5g with several peaks ranging from 0.25 to 1.75g. These were particularly prevalent during the level flight at 3,000 feet. During this period an audio alert was heard to sound intermittently. It was apparent that the crew were getting a FLT CTL caution. The DFDR recorded both left and right vane angle and these readings were fluctuating considerably. Because of the low sampling rate and poor data quality, it was not possible to be certain but it is likely that the difference in recorded incidence between left and right was occasionally greater than 4°, which would trigger a caution. This was repeated intermittently during periods of high turbulence in subsequent stages of the flight.

On the final attempt to make an approach at Jersey just before reaching 1,700 feet amsl there were two severe fluctuations from 0.4 to 1.7g and the turbulence appeared to worsen. The crew were told by ATC they were 6 miles from touchdown with a wind of 180°/26 kt and were asked to contact tower, but they were unhappy with the approach and decided to go around.

On the final approach at Bournemouth the aircraft intercepted the glideslope at 2,000 feet amsl. A plot of selected parameters below 800 feet on the approach is shown at Figure 1 *(jpg 134kb)* and a detailed plot of the landing is shown at Figure 2 *(jpg 82kb)*. The sounds of heavy touchdowns were heard on the CVR. The maximum values of recorded normal acceleration were not particularly high for the first three touchdowns recording a maximum of 1.7g, however, because of the data loss problems previously mentioned the precise values for the last two touchdowns could not be accurately determined. The aircraft slid along the runway as the FO made an emergency call saying that they had "lost a nosewheel". When the aircraft came to rest the commander decided on an emergency evacuation of the aircraft.

Flight crew experience

Prior to flying the ATR-72 the commander had spent 26 years flying medium and heavy jet aircraft types. The jet types were different from this aircraft in several significant ways. Firstly there were not different speed schedules for icing conditions. Secondly the aircraft were all equipped with ground spoilers for lift dump at touchdown.

Both flight crew members reported that in their experience it was not unusual for the aircraft to 'skip' on touchdown and this was what they perceived had happened after the first touchdown.

The FO stated that the turbulence experienced during the flight was more severe than any he had experienced previously. Neither pilot was aware that in turbulence the separate movement of the two angle of attack vanes may be sufficient to activate the FLT CTL caution. This information was not published in any of the manuals available to the flight crew although some other pilots familiar with the type stated that they knew it to be a normal occurrence.

Analysis

Flight recorder information

As the aircraft flew the final approach at Bournemouth with the autopilot engaged there were oscillations in airspeed, attitude and control positions indicative of turbulent conditions however the aircraft remained well aligned to the ILS. Fluctuations in indicated airspeed increased below 300 feet and, after the autopilot was disconnected at 230 feet, the activity in the control positions increased as the pilot manually flew the aircraft in the turbulent conditions. Some 20 seconds before the autopilot was disconnected the torque was increased from 20 to 35%, and further increased from 35 to 40% after the autopilot was disconnected. During this period airspeed rose from a mean of 120 kt to a mean of 138 kt. After the autopilot was disconnected the aircraft deviated slightly above the glideslope reaching a maximum of about 1.5 dots (equivalent to 25 feet) at about 0.7 mile from touchdown. It appeared that the aircraft required a much lower pitch attitude to maintain the glideslope at these higher speeds, up to -6.5 degrees (nose down) as opposed to about -4 degrees at 120 kt. By about 50 feet the aircraft had virtually come back onto the glideslope, as power was reduced. The flare was initiated at about 40 feet and a speed of 140 kt as the aircraft pitched up from -6.3 to -2.5 degrees. The rate of descent appeared to have been almost arrested when at 14 feet the airspeed rose rapidly from 139kt to 149kt and then fell equally rapidly to 125kt. This would be indicative of wind shear and the rate of descent increased during this event. The aircraft touched down initially with a pitch attitude of -2.7 degrees. During the subsequent divergent porpoising manoeuvres, nose down elevator was held, which at times reached the maximum elevator value.

In the absence of very high acceleration readings additional work was done to try and understand the reason for the nosegear collapse. Figure 2 shows a plot of the pitch attitude and the rate of pitch derived from it, together with the associated elevator demand. More frequent readings of height above the runway were derived from the accelerometer recordings. This is also shown compared with the radio altitude readings, and indicate a good agreement except at the later end where the effects of bad data readings become apparent. The airspeed and normal acceleration readings are also shown on this plot together with the nosewheel descent rate which was derived from the pitch rate, the approximate position of the nosewheel forward of the rotation axis and the rate of descent derived from the calculated height above the runway.

The first touchdown was with -2.7 degrees (nosedown) pitch at a speed of 125 kt. The body angle with all three gears on the ground is approximately one degree nose down, hence this touchdown would appear to have been just nosewheel first, or with the slight left roll may have been left main and nose gears together. After this touchdown the aircraft pitched up slightly reaching an attitude of -0.5 degrees, and the elevator nose down demand increased from about 7 degrees to a maximum of 12 degrees. As a result of this the aircraft bounced into the air and under the effect of the nose down pitch demand started to pitch down, reaching a pitch rate of 5 deg/sec before the next touchdown. This occurred with a -5.7 degree pitch attitude at a speed of 124 kt IAS. This and subsequent touchdowns were characterised by a double peak on the normal acceleration record indicating the points at which the nose gear touched followed by the main gear. The DFDR did record discretes indicating when both main gears and when all gears were in contact with the ground. These were sampled only at once per second, and as the touchdowns were so brief, they may not have recorded the event. The peak Normal acceleration recorded for this touchdown was about 1.7g as the main wheels touched.

The aircraft then completed a further three bounces of increasing severity with progressively higher nose wheel descent rates of 10 feet/second for the third touchdown and 13 feet/second for the fourth touchdown. The figure for the final touchdown could not be calculated because of loss of recorded data.

Operational information

The aircraft carried out the final descent through atmospheric icing conditions and, in accordance with the operations manual, icing speeds were used for landing. Given the surface temperature of 10°C and the time spent at approach altitudes it is unlikely that any ice was actually present on the airframe. Therefore the increased speeds used for icing on this occasion were probably higher than those required by the condition of the airframe. During the final approach the aircraft remained close to the glideslope and to the target airspeeds until the autopilot was disconnected at 230 ft agl. After this the torque and correspondingly the airspeed increased. These factors combined with the use of a 'bug card' for 19T resulted in the aircraft arriving at the touchdown area with significant excess speed.

The excess speed during the final stages of the approach, if observed by the commander, was probably considered by him to be manageable as there was ample runway length available. He may have been unaware of the potential handling difficulty in attaining a correct touchdown attitude and subsequently keeping the aircraft down on the runway at such an excess speed. The magnitude of the actual excess speed may not have been apparent when compared with the 'bugged' target speed. Despite a speed averaging 18 kt above target in the final stages there was no monitoring call from the FO bringing it to the attention of the commander.

To maintain the descent path with the excess speed the aircraft required a lower than normal pitch attitude. As the pitch attitude increased at the start of the flare there was a significant gust of wind resulting in a momentary small increase and then a loss of headwind of 15 kt. Rain and darkness cause a loss of environmental texture and these conditions would have degraded the commander's perception of height. These factors probably caused the aircraft to contact the ground earlier than he intended. On touchdown a large amount of energy was absorbed by the nose landing gear structure and the aircraft rebounded with a marked pitch up effect. This was countered by the commander with a sustained nose down elevator input. The aircraft then underwent a series of bounces during which there were very rapid changes in pitch and which were outside the previous experience of the pilots.

The rear stowage cargo nets were inadequately secured and thus not effective. This probably arose from difficulties previously experienced during routine use. Forward movement of baggage from the rear stowage obstructed the aft starboard side door but this did not ultimately affect the progress of the evacuation. It is therefore recommended that the operator review the training procedures and instructions given to crew members in the securing of cargo nets and baggage to ensure that crew are adequately trained in their use.

Human factors

At the time of the accident the aircraft had been airborne for 1 hr 40 minutes. This was a much longer flight than scheduled and there had been an unusual number of re-planning decisions. The existence of a rapidly moving frontal system through the area of the flight operation resulted in constantly changing weather at each of the airports considered for use by the crew. The workload and stress level on the crew was high for extended periods. The FO was off the ATC frequency making company calls at a time of high workload. This did not result in any missed calls or instructions but did increase the pressure on the commander.

It is likely that the decision making capacity of the flight crew was degraded by events earlier in the flight. After the initial touchdown there was a short period during which a go-around could have been successfully performed. The initial bounce however was perceived by the crew as a 'skip' and as such not an unusual event. The sustained nose down elevator input increased the severity of each successive bounce making a go-around more difficult because of the very rapid changes in pitch that resulted.

The commander would have been conscious that if the approach were discontinued the aircraft would have to make another in similar conditions or divert to Southampton once again. Once visual contact had been acquired and the decision to land been made it would have needed a positive stimulus to change his decision. The FO had conducted all the communications with the cabin crew and was aware that there were distressed passengers on board who required assistance. His confidence in the aircraft was undermined during the flight as a result of three factors; firstly the turbulence, secondly the repeated FLT CTL caution and finally the autopilot dropping out. These concerns may have affected his capacity to monitor the final stages of the flight. Prior knowledge of the likelihood of the activation of the FLT CTL caution as a result of turbulence could have alleviated some of this. It is therefore recommended that ATR supply information to operators of ATR72 aircraft, fitted with the stall warning and identification modification for UK certification, to advise crews of the possibility of the 'FLT CTL' caution being triggered by turbulence. (This situation may also be applicable to some ATR42 aircraft).

DFDR data loss

There were extensive areas of non-recoverable data on the DFDR, including two entire tracks, which alone covered an 8-hour period of recording. It is therefore considered to be fortunate that any recordings of the accident flight were present on the recorder. The types of data loss appeared to fall into two categories. There were extensive areas of data loss covering longish periods including the two complete tracks; the reasons for these data losses were not apparent. During the areas of severe turbulence and the landing impacts, small areas of data were lost when loading or impacts were most severe. Examination of the signals determined that this was due to large and rapid fluctuations in tape speed. Some, but not all of these data losses would be recoverable by a lengthy manual decoding process. For at least the previous 25 hours the achieved performance of the recording system on this aircraft fell well below that expected of an accident data recorder, which should continue to perform even in adverse conditions. DFDRs are routinely checked for data quality, but if, as is often the case, only the latest recorded section of data is replayed this could have occurred when data was being recorded correctly and the problem would have been missed. The standard by which the F800 was manufactured was FAA TSO C51a. This TSO was cancelled in 1996. The effect of this was to prohibit the manufacture of the F800 recorder, although it could still be maintained and the manufacture of spares was still permitted. There are, therefore, many of the units still in use. In 2000 the manufacturer issued field service bulletin F800DFR FSB 033, which inform users of the F800 that replacement tape stocks would be depleted by July 2002. This would mean that from that date the numbers of F800 DFDRs in service should gradually reduce. It is not possible to be sure for how long the F800 would remain in use. Apart from in this accident, the F800 DFDR has a history of poor performance for accident investigation purposes.

In 1994 an Excalibur Airways Airbus A320 took off with the slats locked out. The F800 DFDR provided no useful information during take off and initial climb or final approach and landing. This was attributed to the wrong standard anti-vibration mounts being fitted. The details of this are in AAR 2/95. As a result of this the manufacturer issued field service bulletin FSB028 which reminded users of the importance of the correct vibration tray installation. In G-BYTP the mounts appeared to be of the right type, and in the correct positions. However it was the manufacturer's view that any degradation in their performance could have led to recording problems. They therefore proposed to re-issue the field service bulletin as a reminder to users.

In 1999 a Greek registered Dassault Falcon 900 encountered a severe in-flight upset in which 5 passengers were killed. The Greek authorities asked for AAIB's assistance to recover some areas of bad data from the F800 recorder fitted to the aircraft. The area of error covered almost all of the extremely dynamic manoeuvre. After about a week of work, only about 50% of the information could be recovered.

It is known that the Bureau Enquetes Accidents (BEA) in France have experienced numerous difficulties with the F800 recorder and have considered a recommendation to have it banned. AAIB has also unsubstantiated reports of numerous in-service difficulties with the F800 recorder.

It is therefore recommended that the CAA should review the in-service performance of the LORAL model F800 recorder. If confirmed to be not satisfactory for accident investigation purposes they should remove it from the approved list of recorders that may be fitted to aircraft.

Summary of safety recommendations

Recommendation 2001-68

It is recommended that the operator review the training procedures and instructions given to crew members in the securing of cargo nets and baggage to ensure that crew are adequately trained in their use.

Recommendation 2001-69

It is therefore recommended that ATR supply information to operators of ATR72 aircraft, fitted with the stall warning and identification modification for UK certification, to advise crews of the possibility of the 'FLT CTL' caution being triggered by turbulence. (This situation may also be applicable to some ATR42 aircraft).

Recommendation 2001-70

It is recommended that the CAA should review the in-service performance of the LORAL model F800 recorder. If confirmed to be not satisfactory for accident investigation purposes they should remove it from the approved list of recorders that may be fitted to aircraft.