Serious Incident

Aircraft Type and Registration:	ATR 72-212A-600, EI-HDK
No & Type of Engines:	2 Pratt & Whitney Canada PW127M turboprop engines
Year of Manufacture:	2016 (Serial no: 1334)
Date & Time (UTC):	14 August 2023 at 1327 hrs
Location:	Liverpool Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew – 5 Passengers – 66
Injuries:	Crew – None Passengers – None
Nature of Damage:	Main landing gear changed due to hard landing
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	3,160 hours (of which 2,927 were on type) Last 90 days – 82 hours Last 28 days – 28 hours
Information Source:	Aircraft Accident Report Form submitted by the commander and further enquiries by the AAIB

Synopsis

The aircraft was making an approach to Runway 09 at Liverpool Airport. As it crossed the runway threshold it entered heavy rain and the visibility reduced to near zero. The airspeed reduced and the rate of descent was maintained which resulted in a hard landing. The commander took control and executed a missed approach, landing without further incident.

Analysis of FDR recordings and meteorological reports suggests that the aircraft probably encountered an increasing tailwind as it crossed the runway threshold, whilst flying through heavy rain.

History of the flight

The crew were scheduled to operate a passenger service from Dublin to Liverpool Airport. After the first takeoff they returned to Dublin due to a pitot heat failure. The crew changed aircraft to EI-HDK and took off a second time bound for Liverpool, approximately 90 minutes behind schedule. The co-pilot was pilot flying. During the cruise the commander listened to the ATIS for Liverpool which indicated Runway 09 was in use with surface condition 5/5/5[1], wind from 150° at 12 kt gusting 22 kt and varying from 110° to 170°, visibility 10 km with 7 km to the south-east, temperature 20°C, rain showers in the vicinity and QNH 1003 hPa.

Footnote

[1] The runway surface was condition code '5' in all thirds of the runway. Condition code 5 on this day meant the runway surface was covered by visible dampness or water up to and including 3 mm depth.

The crew briefed that, due to the gusts, the commander might need to perform the landing if the weather did not improve.

When speaking to Liverpool Approach the commander obtained a wind report, indicating from 150° at 7 kt, so the crew agreed the co-pilot would fly the landing. The crew noticed some red radar returns on the weather radar close to the airport, which they thought were rain. The tower controller reported that there was a shower to the south. The aircraft was stable on the approach by 1,000 ft aal and when cleared for landing, the surface wind was reported as from 220° at 5 kt. The commander commented that it was now a tailwind and advised the co-pilot to "keep an eye on the power if the wind changes." As the aircraft continued the approach it encountered some rain but the crew maintained sight of the runway and approach lights. On short final the rain became increasingly heavy and the commander switched the windscreen wipers to FAST for both screens. He asked the co-pilot "do you want me to take it?" but the co-pilot confirmed he was content to continue. The commander recalled they were still visual with the runway as the aircraft passed over the runway threshold but, passing 50 ft, the rain intensity increased and the visibility rapidly deteriorated. The co-pilot recalled the flight deck "going dark, like someone had pulled the curtains". The commander recalled the aircraft seemed to suddenly and firmly touchdown as the visibility reduced to near zero. He immediately took control and executed a missed approach.

When the aircraft had climbed away the tower controller reported that the rain was now clearing and the surface wind was now from 220° at 7 kt, offering an approach to Runway 27. The crew accepted and started to position for a second approach, but the controller then advised that an inspection was required due to the amount of water on the runway, so they discontinued. The controller subsequently advised that the runway was wet with standing water on the shoulders and that taxiway E, F and G were flooded, so the aircraft would need to vacate on taxiway D or C. The aircraft was then vectored to the south to avoid the weather which was now tracking to the north. The commander made an approach to Runway 27 and an uneventful landing.

Once parked on stand the crew checked the aircraft g-meter, which had recorded a 2.8 g during the first landing.

After the incident the commander commented that the approach had been stable to 50 ft with very little fluctuation in speed. He considered that the aircraft encountered a downdraught in the heavy rain shower and commented that the near zero visibility would have required a go-around regardless of the hard landing.

Recorded information

Both the CVR and FDR captured the full duration of the incident flight.

Cockpit Voice Recorder

The cockpit voice recordings corroborated the pilots' recollection of the incident. The sound of rain against the windshield was faintly audible on the pilot microphones and became slightly more audible as the aircraft approached the runway.

The CVR captured the sound of the aircraft's radio height callouts from 50 ft to 10 ft. The time between these callouts was short and indicated that the vertical speed was not reducing before the heavy landing.

The CVR recorded the sound generated by the heavy landing. The commander's call to go-around was recorded approximately 4 seconds later.

Flight Data Recorder

Figure 1 shows pertinent FDR parameters recorded from 1,000 ft agl until the go-around after the hard landing.

It indicates that EI-HDK was in a stable descent with no significant airspeed or engine torque changes until the aircraft descended through 50 ft agl at point A. FDR parameters recorded a small and gradually increasing pitch-up input on the control column from this point. The flare was initiated at point B, where the aircraft reached 30 ft agl at an airspeed of 109 kt.

The FDR recorded vertical acceleration data eight times per second. It recorded a vertical acceleration of 2.8 g when the aircraft touched down (point C). The recordings indicate that the vertical speed was around –670 fpm and the airspeed reduced to 95 kt at this point. Increasing engine torque and pitch attitude are shown at point D, consistent with the commander's call to go-around recorded on the CVR. Point E, approximately 5 seconds after the hard landing, shows a positive vertical speed as the aircraft climbed away from the runway.

The wind speed and direction are calculated by the Flight Management System (FMS) based on ground speed, estimated ground track, heading and true airspeed. The outputs of these calculations are displayed on the pilots' Navigation Displays and were recorded to EI-HDK's FDR once per second.

The recordings indicate that the aircraft was flying with a crosswind from the right, which changed direction between points B and F to give an increasing tailwind component. After point F, the recordings indicate that the wind returned to a crosswind from the aircraft's right. There was no significant change in the aircraft's heading during this time.

Wind speed and direction changes are reflected in FMS calculations following changes to the parameters used to calculate it. The FMS uses an algorithm which smooths the input measurements over a time lag, to avoid large instantaneous changes being displayed to the pilots. This means that the wind changes displayed to the crew, and recorded to the FDR, may lag real-time winds conditions experienced by the aircraft.

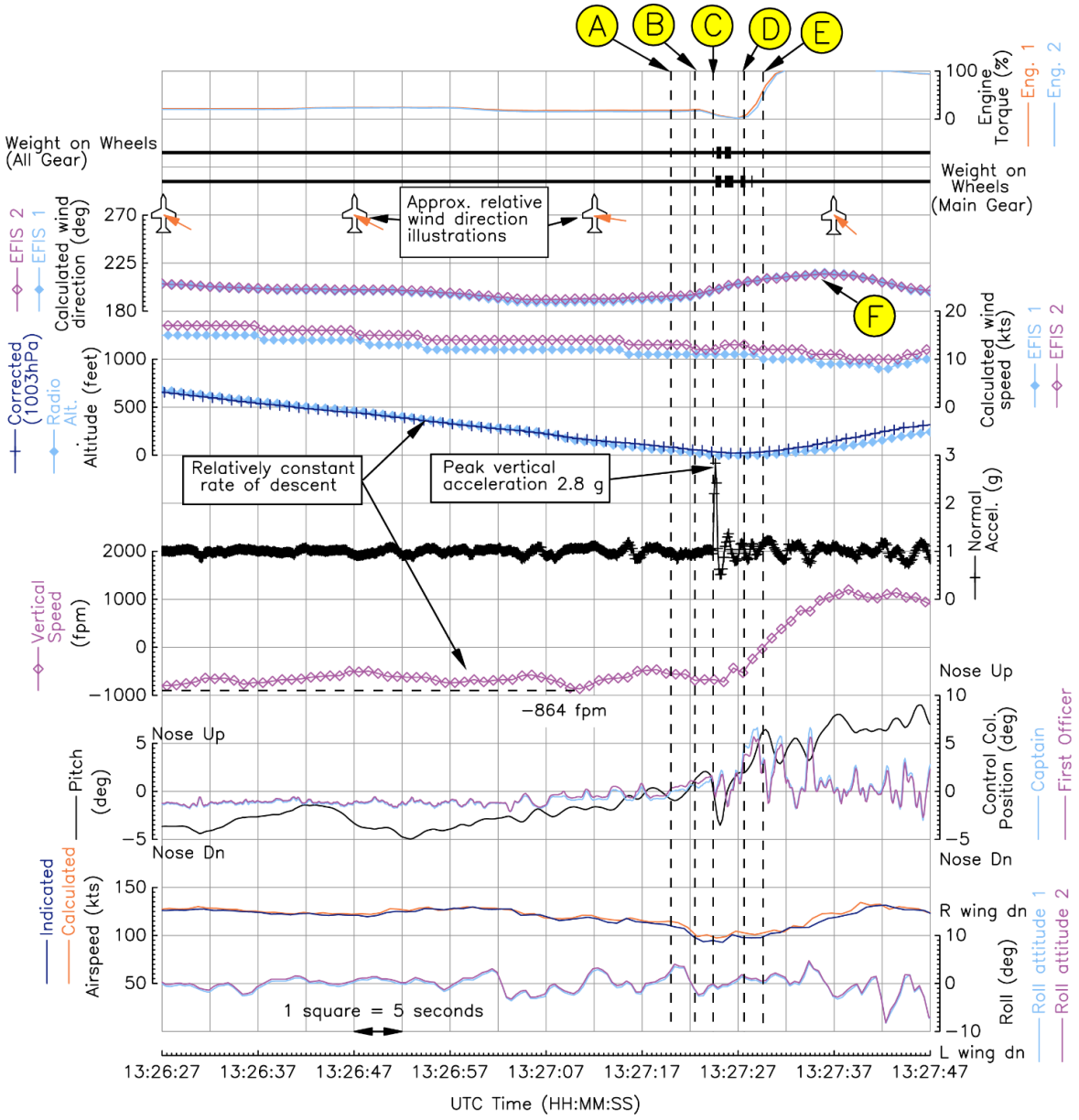

Figure 1

Pertinent parameters recorded by the FDR.

Aircraft examination

There was no obvious damage to the aircraft, but following analysis of the flight data the manufacturer advised the operator to change both main landing gear assemblies. The assemblies were sent to the manufacturer for further mechanical analysis and overhaul.

The aircraft returned to service on 30 August 2023.

Meteorology

Forecast conditions

The TAF issued for Liverpool at 1059 hrs stated that temporarily between 1200 hrs and 1700 hrs the visibility would be 7,000 m in rain showers and rain, and the cloud would be broken at 800 ft. It gave a 30% probability of temporary visibility of 3,000 m in heavy rain showers between 1200 hrs and 1600 hrs, and from 1400 hrs until 1700 hrs a 30% probability that temporarily the wind would be from 290° at 15 kt gusting to 25 kt with cloud broken at 400 ft.

This was updated at 1337 hrs to contain temporary visibility of 3,000 m in heavy rain showers and hail between 1300 hrs and 1700 hrs. A further update was issued at 1349 hrs which included a 40% chance that temporarily the wind would be from 290° at 15 kt gusting to 25 kt, visibility would be 2,000 m in heavy thunderstorms and hail, with cloud broken at 300 ft.

Actual weather conditions

The METAR issued just prior to the incident at 1320 hrs gave a surface wind from 160° at 10 kt, visibility greater than 10 km, showers in the vicinity, few clouds at 900 ft, scattered cloud at 1,700 ft, broken cloud at 2,600 ft, temperature 19°C, dew point 18°C and a QNH of 1003 hPa.

The METAR issued just after the incident at 1350 hrs gave a surface wind from 200° at 9 kt, visibility greater than 7 km but 2 km to the south-east, light rain, few clouds at 100 ft, scattered cloud at 1,500 ft, broken cloud at 3,300 ft, temperature 17°C, dew point 17°C, QNH 1003 hPa and recent rain.

Flight crew

The commander had a total of 3,160 flying hours of which 2,927 was on the ATR 42/72. He had 1,135 hours in command.

The co-pilot had a total of 1,290 flying hours. He had 172 hours on the ATR 42/72 having recently started his first airline flying job.

Analysis

As the aircraft crossed the runway threshold it entered heavy rain, and visibility reduced to near zero. The airspeed decayed at this point, with no corresponding increase in engine thrust. As the co-pilot increased pitch in the flare the vertical speed did not reduce before the main landing gear touched down on the runway. This resulted in a hard landing at a vertical speed of about –670 fpm. The commander took control and executed a missed approach.

The pilots recalled the visibility rapidly deteriorating as the aircraft crossed the threshold. It is likely the reduced visibility made it difficult to detect visually that the rate of descent was not reducing. A probability of heavy rain was included in the forecast but the view from the

flight deck, the reports from the tower controller, and the indications on the flight deck did not give advance warning of the severity of the weather that the aircraft encountered. After the incident, the forecast was updated to include a probability of thunderstorms, hail and lower visibility.

The recorded windspeed and direction suggests that the tailwind component increased at the time of the hard landing. The gradual variation around point F in Figure 1 is typical of instantaneous wind direction changes, appearing as a "smooth curve" in the recording due to the wind calculation algorithm. The start of the change coincides with a reduction in airspeed after point A in Figure 1, suggesting that the airspeed reduction as EI-HDK crossed the runway threshold may have been due to an increased tailwind.

The FDR recorded the vertical acceleration reaching 2.8g when the hard landing occurred. There is no evidence that the maximum vertical acceleration significantly exceeded the recorded value, though the investigation did not rule out that the peak vertical acceleration may have been reached between the times its measurement was sampled by the recording system.

Conclusion

It is likely the aircraft encountered an increase in tailwind in heavy rain as it crossed the runway threshold, which resulted in a hard landing. The commander executed a go-around and made a second landing attempt which was uneventful.

Inspection of the aircraft identified no physical defects but following a review of the vertical acceleration experienced during the landing, the main landing gear assemblies were replaced. The aircraft returned to service on 30 August 2023.