SERIOUS INCIDENT

Aircraft Type and Registration:	Let L-410 UVP-E, OK-LAZ
No & Type of Engines:	2 Walter M601E turboprop engines
Year of Manufacture:	1990 (Serial no: 902504)
Date & Time (UTC):	23 February 2017 at 0927 hrs
Location:	Isle of Man (Ronaldsway) Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	7,800 hours (of which 2,200 were on type) Last 90 days - 120 hours Last 28 days - 40 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft departed Isle of Man (Ronaldsway) Airport (IOM) on a commercial flight to Belfast City Airport (BHD), in a region affected by a deep low pressure system with associated strong surface winds. After one unsuccessful attempt to land at BHD in a strong crosswind, the crew diverted back to IOM.

When the aircraft landed at IOM the wind was gusting to 63 kt and creating a maximum crosswind component of 40 kt. After touchdown, nearby witnesses saw the right mainwheel lift off the ground and they estimated the left wingtip rolled to within approximately one metre of the runway surface before the landing was successfully completed.

The relevant maximum demonstrated crosswind component for the Let L-410 is 19.4 kt and this was included in the '*Performance Limitations*' section of the Airplane Flight Manual (AFM) but the aircraft operator did not apply a limiting component of crosswind to its operations. The only wind limit that was applied and used by the crew was 45 kt for ground operation.

Several safety actions have been taken including amendments to the aircraft operator's Operations Manual regarding crosswind operations.

One Safety Recommendation has been made to review the aircraft operator's operational processes, training and operator's guidance.

History of the flight

The two pilots were based locally in the IOM and they were rostered to report for duty at 0645 hrs to operate a return flight to BHD. The scheduled departure time was 0715 hrs and the return flight from BHD was scheduled to arrive back at IOM at 0850 hrs.

Weather information was downloaded by the pilots from a self-briefing facility in the aircraft operator's crew room at 0632 hrs. Meteorological Airfield Reports (METARs) and Terminal Aerodrome Forecasts (TAFs), along with NOTAM information, was requested for six airports; Belfast International (BFS), BHD, Blackpool, Dublin, IOM and Londonderry. However, weather reports for Blackpool and TAFs for BHD or Londonderry were not available at 0632 hrs[1]. A warning of north-westerly gales, affecting IOM between 0930 and 1300 hrs, had been issued by Ronaldsway Met Office at 0500 hrs and this had been passed to the operator's crew room.

Runway 26 was available at IOM and the 0620 hrs METAR stated the wind was from 230º at 32 kt gusting to (G) 45 kt, creating a maximum crosswind component of 22 kt. The 0455 hrs TAF was for the wind to veer and subside, and to be from 310º at 17 kt during the two hour period ending at 0800 hrs, but that it would then increase to 33 G 46 kt over the next two hours. The only wind limit considered by the crew was a maximum wind velocity of 45 kt for ground operation[2].

The surface wind at BHD, where Runways 04 and 22 were available, was reported at 0620 hrs to be from 230º at 9 kt but, because they received no TAF for this destination, the pilots reported afterwards that they selected two alternate airports; BFS and IOM. Runway 35 was available at BFS and during the morning the wind was forecast to be from 340º with a probability that it would temporarily increase to a mean speed of 33 kt. The crew created their Operational Flight Plan (OFP) to show IOM as the only alternate. Afterwards, the crew stated they considered BFS to be their first alternate and that IOM was their second, but the OFP only showed the longer of the two potential diversion routes. The ticket-selling company stated afterwards that BFS was its preferred commercial alternate, followed by IOM and then Dublin.

After proceeding to the aircraft, the crew were advised that the wind at IOM had changed and was now from 260º at 39 G 55 kt. Because this exceeded the ground operation limit, they delayed the flight, returned to the crew room and studied weather information that was now available for all six of the airports previously mentioned. This included the 0735 hrs TAF for BHD, which forecast that between 0700 and 1000 hrs the wind would become orientated across the runway at a mean speed of 20 kt.

The 0720 hrs METAR for IOM gave the wind from 250º at 33 G 47 kt but variable between 220º and 290º; with a NOSIG notation (indicating no significant changes) forecast over the next two hours. At 0750 hrs the crew learnt the wind was from 290º at 31 G 40 kt and as both these more recent reports were within the ground operation limit, they decided to

Footnote

[1] See *Meteorological information* for synoptic details and relevant METAR and TAF data.
[2] See *Aircraft operator's guidance*.

depart, with 550 kg of fuel on board. The minimum required fuel from the OFP was 453 kg, so they estimated they had sufficient fuel for an extra 20 minutes of flight time in the event of a diversion back to IOM.

Three passengers boarded and the aircraft taxied at 0810 hrs. Shortly afterwards, at the request of BHD ATC, the crew were informed that the wind at BHD was from 320º at 31 G 46 kt, and IOM ATC asked the crew for their intentions because BHD ATC had reported no other known aircraft movements. The crew elected to continue the flight and took off on Runway 26 at 0823 hrs, when the reported wind was from 290º at 21 G 41 kt. The co-pilot was the Pilot Flying (PF) and the commander was Pilot Not Flying (PNF).

No difficulties were encountered en route to BHD, and the PNF listened to the 0827 hrs Automatic Terminal Information Service (ATIS). This stated that Runway 22 was in use and quoted the 0820 hrs METAR[3], with the wind orientated across the runway at 25 G 40 kt. When the PNF contacted BHD ATC, he was told radar vectoring was available for an ILS approach to Runway 04 and that the wind was now from 320º at 28 G 43 kt. The PNF informed ATC they would make one approach but would go around if the approach was not stable.

The crew reported afterwards that they experienced continuous moderate turbulence during the latter part of the approach. The final wind check, given after they had been cleared to land, was from 320º at 35 kt. They judged that the aircraft operator's stable approach criteria[4] were met until the aircraft passed over the runway threshold, when turbulence de-stabilised the aircraft and they initiated a go-around.

ATC reported that the aircraft went around from approximately 20 ft above the runway at 0858 hrs and climbed straight ahead to 3,000 ft amsl, the standard missed approach procedure. The aircraft continued heading northeast until 0901 hrs when the PNF informed ATC they would not make a second approach and would return to IOM.

Once level at FL070, the PNF listened to the ATIS for the IOM, which stated Runway 26 was in use, it was wet, and detailed the 0850 hrs METAR[5], which noted that the wind was from 290º at 28 kt. The PF briefed for an approach with the flaps set to 18º, and a target V_{REF} of 105 kt[6]; with a "SLIGHTLY RIGHT CROSSWIND"[7]. After the brief was completed he commented on the intercom that the wind was "NOT SO CHALLENGING" at IOM but shortly after this ATC provided a special weather observation, timed at 0912 hrs, which stated the wind was now from 310º at 41 kt and gusting between 22 and 53 kt. When asked by ATC if they wished to make an approach, the PNF replied "OF COURSE". There was no recorded discussion between the pilots regarding the change to the wind[8] before the aircraft began descent in preparation for its approach.

Footnote

[3] See *Meteorological information.*
[4] See *Stabilised approach criteria.*
[5] See *Meteorological information.*
[6] V_{REF} is the landing reference speed, see *Stabilised approach criteria.* Note that a wind of 290º at 28 kt indicated a crosswind component of 14 kt.
[7] See *Recorded information.*
[8] The steady crosswind component was now 31 kt, increasing to 41 kt if the maximum gust was accounted for.

At 0913 hrs, the PNF informed the PF there was about 300 kg of fuel remaining and this was enough "FOR ONE MORE HOUR". Without further discussion, the crew accepted radar vectoring for an ILS approach to Runway 26, with the co-pilot remaining as PF. Before the aircraft was directed towards its final approach, ATC reported the wind was from 310º at 43 kt but gusting between 23 and 63 kt.

At 0924 hrs, after the aircraft had become established on the ILS centreline and glideslope, ATC radioed clearance to land, with a reported wind of 300º at 41 kt but gusting between 31 and 63 kt. While receiving this message, the crew were also presented with an aural "GLIDESLOPE" caution and immediately after this the PF declared "1,000 FT STABILISED". At 0925 hrs, while the PNF was adjusting the propeller rpm, another aural "GLIDESLOPE" caution was annunciated and the PF immediately stated "CORRECTING". At 0926 hrs, following an automatically generated message stating the aircraft was at 500 ft agl, one further "GLIDESLOPE" caution was annunciated and the PF responded saying "CORRECTING, RUNWAY IN SIGHT".

The final wind check provided by ATC, approximately 35 seconds before the aircraft touched down, was from 300º at 48 kt, but gusting between 32 kt and 63 kt[9]. The commander reported afterwards that the runway was in sight at 600 ft.

Given the environmental conditions, ATC was concerned for the safety of the aircraft and its occupants when it landed, so the airfield Rescue and Fire Fighting Service (RFFS) had been placed on alert with two vehicles facing towards the runway, approximately 200 m from the touchdown zone. During the aircraft's approach, ATC discussed the situation with the Isle of Man Civil Aviation Administration because another of the same operator's aircraft had been blown onto its wingtip while taxiing in 2007[10], in winds greater than 45 kt, and both parties knew 45 kt was now the operator's maximum ground operation limit.

Four RFFS and two ATC witnesses reported that as the aircraft crossed the threshold it seemed unstable and it rolled considerably, causing the tip of the left wing (the downwind wing) to tilt down until it seemed in close proximity to the runway, before the wheels made first contact. The aircraft then bounced and rolled left again before touching down for a second time, on all three wheels.

After travelling along the runway for approximately 20 m, the right mainwheel was seen to lift off the ground and nearby RFFS witnesses estimated the left wingtip rolled to within one metre of the runway surface. The crew seemed aware of this roll because, approximately nine seconds after touchdown, the PF stated "AILERONS…GOOD…TOO MUCH ROLL". The commander stated afterwards that he thought all the wheels remained on the ground and that the aircraft responded to appropriate aileron control; he had no concern that the wingtip or the propeller might have been close to the ground.

Footnote

[9] Taking account of the full gust factor this indicates a crosswind component of 40 kt.
[10] See *Previous incidents*.

After landing the commander took control and the co-pilot commented "TAXI CAREFULLY WITH THE WIND". ATC then stated the surface wind was from 300º at 47 kt, but gusting between 32 kt and 63 kt and asked if they wished to taxi or to hold on the runway. The crew replied "WE WILL TRY AND TAXI AND IF WE CAN MAKE IT WE WILL VACATE, OTHERWISE WE NEED TO LEAVE THE AIRCRAFT HERE". The crew then accepted taxi instructions directing them towards the terminal but, 45 seconds later, as the aircraft was leaving the runway, ATC radioed to the crew, "DIRECTION FROM ISLE OF MAN CAA, HOLD POSITION." The aircraft stopped facing into the wind.

Both ATC and the Isle of Man Civil Aviation Administration later indicated that they were concerned that if the aircraft continued to taxi with the wind gusting to 63 kt an accident could occur. The Isle of Man Civil Aviation Administration therefore issued a directive[11] that the aircraft be held in its current position and it was subsequently shutdown into wind near the junction of Runway 26 and Taxiway C, with 220 kg of remaining fuel being recorded.

RFFS vehicles were positioned around the aircraft, to provide some screening from the wind, and a bus transferred the three uninjured passengers to the terminal building. The aircraft was later tied down until the wind subsided, (Figure 1).

ATC at BHD stated afterwards that no aircraft landed between 0749 and 0944 hrs due to strong crosswinds and associated turbulence. Another aircraft[12] was being vectored towards an approach when OK-LAZ went around but elected to divert to BFS when informed that the preceding aircraft had gone around. ATC at IOM also stated afterwards that six other flights (by other operators) that were scheduled to arrive were cancelled due, as far as was known, to the weather conditions.

Figure 1
Aircraft tied down at IOM

Footnote

[11] See *Isle of Man regulations.*
[12] This aircraft's limiting crosswind component of wind for landing was 32 kt.

Recorded information

The aircraft was fitted with a 30 minute duration solid state Cockpit Voice Recorder (CVR). This was successfully downloaded at the AAIB and excerpts from the recording are quoted in this report. In addition, a solid state Flight Data Recorder was downloaded with the assistance of the manufacturer. This showed that passing 1,000 ft agl on approach to Runway 26 at IOM[13], the aircraft's airspeed was stable at approximately 120 KIAS in a steady descent of around 1,000 ft/min. At approximately 850 ft agl, the aircraft stopped descending and the flightpath transitioned to a climb, reaching 950 ft agl, before a descent was re-established. This change in flightpath occurred over a period of 40 seconds and was accompanied by the airspeed fluctuating between 113 KIAS and 146 KIAS.

Passing 500 ft agl, the aircraft's rate of descent had reduced to approximately 440 ft/min with the airspeed decaying towards the lowest speed recorded on the approach of 107 KIAS. The aircraft then levelled at 390 ft agl and a generally increasing trend in airspeed was recorded until the final descent to the runway started. During the final descent, the airspeed fluctuated between 125 KIAS and 148 KIAS.

Aircraft information

The Let L-410 UPV-E is a high wing, twin-engined turboprop with 19 passenger seats. It has a maximum takeoff weight of 6,400 kg, a wingspan of 19.98 m and a wheel track of 3.65 m. For landing, the flaps can be set to 18º or 42º.

The aircraft is certified in accordance with Certification Specifications (CS) for Commuter Category Aircraft, CS-23. To be approved under CS-23 an aircraft must be demonstrated to be safe for taxiing, takeoff and landing with a 90º '*cross-component of wind velocity*' that is not less than 20% of the stall speed with idle power. CS-23 states that certain normal, abnormal and emergency procedures must be furnished in the AFM and this includes the maximum demonstrated crosswind for takeoff and landing and procedures and information pertinent to operating in crosswinds. Guidance in the Flight Test Guide section of CS-23 relating to crosswinds states:

> *'Crosswind. This regulation establishes the minimum value of crosswind that must be demonstrated. Since the minimum required value may be far less than the actual capability of the aeroplane, higher values may be tested at the option of the applicant. The highest 90° crosswind component tested satisfactorily should be put in the AFM as performance information. If the demonstrated crosswind is considered limiting, it should be introduced into Section 2 of the AFM.'*

Section 2 of the AFM for the Let L-410 is titled '*Limitations*' and there is a sub-section titled '*Performance Limitations*' which includes '*Wind Speed and Direction Limitations (Demonstrated Values)*' and states that 19.4 kt is the '*Maximum demonstrated component*

Footnote

[13] The final approach track for Runway 26 at IOM is situated over the sea until shortly before the runway threshold.

of crosswind' relating to '*dry and wet take-off and landing runways with pavement*'. No further procedures or information pertinent to operating in crosswinds is presented in the '*Normal Procedures*' section of the AFM (Section 4).

Meteorology - synoptic overview

At 0600 hrs on the morning of 23 February 2017 a deep low pressure system, named '*Storm Doris*' by the UK Met Office, was centred in the vicinity of Northern Ireland and the Isle of Man. The associated 0600 hrs chart for forecast weather below 10,000 ft (Figure 2), shows a cold front approaching the Isle of Man and a slow moving trough following behind. The centre of the low pressure system was expected to track across Northern Ireland, the Irish Sea and Northern England. The chart indicates that widespread moderate turbulence and occasional severe turbulence was forecast to the south of the warm front and therefore in the vicinity of the Isle of Man. Behind the frontal system, isolated cumulonimbus clouds were forecast and there is mention of associated heavy thunderstorms with small hail or snow pellets.

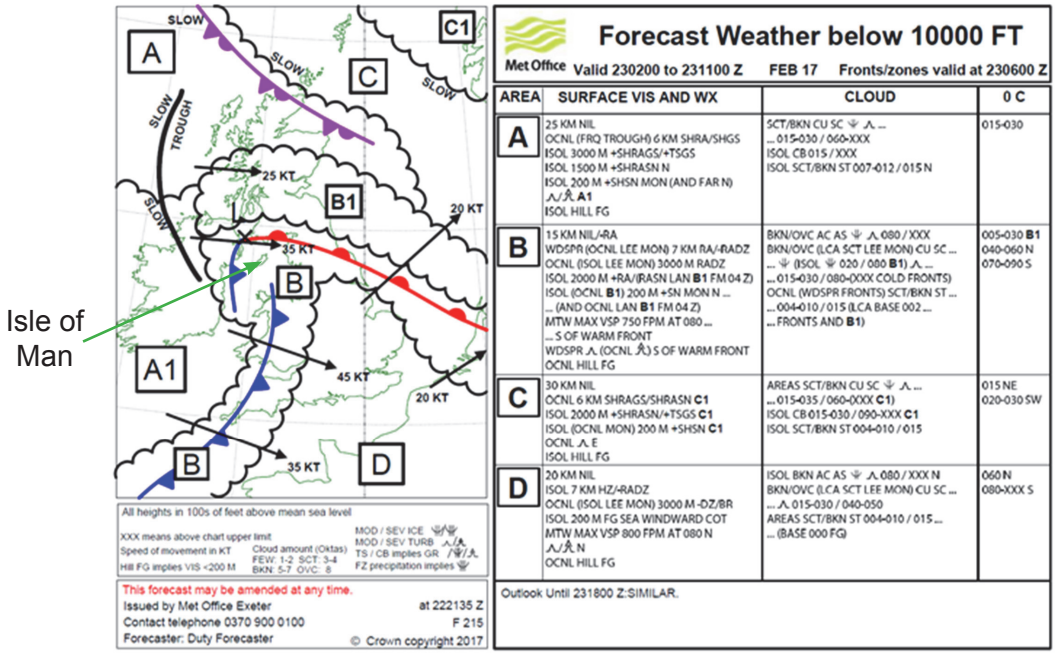

Figure 2

Met Office F215 Chart Valid between 0200 and 1100 hrs UTC on 23 February 2017

An aftercast from the Met Office reported that SIGMETs[14] for severe low level turbulence were issued for the area in which the aircraft flew. It was evident that the crew did not see these SIGMETs or the F215 chart, or other synoptic charts.

Footnote

[14] A SIGMET is a message advising of Significant Meteorological Information which concerns aircraft safety.

Meteorology - Isle of Man procedures

In the Isle of Man, weather reports and forecasts are produced by the Ronaldsway Met Office, located at IOM, in accordance with the procedures laid down in ICAO Annexe 3 '*Meteorological Services for International Air Navigation*', the UK Civil Air Publication (CAP) 746 '*Requirements for Meteorological Observations at Aerodromes*' and the UK Aeronautical Information Publication (AIP) Section GEN 3.5 '*Meteorological Services*'. The AIP states at paragraph 4.7 that:

> *'The Aerodrome Forecast (TAF) is the primary method of providing the forecast weather information that pilots require about an airfield in an abbreviated format. The TAF consists of a concise statement of the mean or average meteorological conditions expected at an aerodrome or heliport during the specified period of validity.'*

Paragraph 4.2.9 states:

> *'The issue of a new forecast, such as an aerodrome forecast, shall be understood to automatically cancel any forecast of the same type previously issued for the same place and for the same period of validity or part thereof.'*

The AIP advises pilots that:

> *'When necessary, the personal advice of a forecaster, or other meteorological information, can be obtained from the appropriate forecast office.'*

There is a duty forecaster available at IOM and a relevant telephone number is listed in the AIP, but he was not consulted by the crew or by the aircraft operator before this flight.

Concerning METARs the AIP states that a TREND is:

> *'… a forecast of significant changes in conditions during the two hours after the observation time.'*

Also CAP 746 states:

> *'A TREND forecast is a short period forecast, predicting significant weather changes that are likely to occur at the aerodrome in the two hours following the time of the meteorological observation. The TREND forecast may be appended to the METAR either by the forecaster or by the observer at aerodromes where procedures exist for obtaining the TREND message from the meteorological forecasting office.'*

Meteorology - IOM

The first METAR seen by the crew was produced at 0620 hrs and the wind was from 230º at 32 G 45 kt but BECMG[15] 310º at 17 kt. The available TAF, issued at 0455 hrs, forecast that between 0600 and 1500 hrs, the wind would be from 230º at 28 G 40 kt, BECMG between 0600 and 0800 hrs 310º at 17 kt, then BECMG between 0800 and 1000 hrs 310º at 33 G 46 kt but with a 30% probability that between 0900 and 1200 hrs it would temporarily be from 310º at 38 G 55 kt. The forecast visibility was 10 km or more, with few cloud at 1,500 ft aal, broken cloud at 3,000 ft and temporarily, between 0600 and 1500 hrs, visibility reducing to 7 km in rain and moderate rain showers, with broken cloud at 1,400 ft. There was a 30% probability between 0600 and 1100 hrs of visibility reducing further to 3,000 m with broken cloud at 800 ft. This TAF remained current until replaced at 0800 hrs.

The 0650 hrs METAR included the same trend message as the 0620 hrs report and the forecaster considered this consistent with the BECMG group in the TAF for the period 0600 to 0800 hrs. However, when the 0720 hrs METAR was written, new data indicated there might not be an initial reduction in wind strength when it veered, so the wind was stated as being from 250º at 33 G 47 kt, with its direction varying between 220º and 290º and with NOSIG appended to the METAR, indicating no significant change forecast within the next two hours. This was regarded by the forecaster as broadly consistent with the existing TAF, which had forecast that between 0800 and 1000 hrs the wind would become 310º at 33 G 46 kt and did not negate the forecast possibility of a temporary wind change to 310º at 38 G 55 kt between 0900 and 1200 hrs.

The 0750 hrs METAR stated the wind was from 270º at 30 G 42 kt but did not contain any trend forecast relating to the wind, nor did the subsequent METARs up until the time that the aircraft landed.

A replacement TAF was issued at 0800 hrs and this forecast that from 0900 to 1800 hrs the wind would be from 300º at 30 G 45 kt, with visibility of 10 km or more, scattered cloud at 700 ft, broken cloud at 1,400 ft, but temporarily between 0900 and 1100 hrs the wind would be from 320º at 36 G 55 kt, with visibility of 3,000 m in rain and moderate rain showers, with broken cloud at 700 ft.

The 0850 hrs METAR stated the wind was from 290º at 28 kt, with visibility of 1,800 m in heavy rain, the lowest cloud at 400 ft, temperature 6ºC, dew point 5ºC and QNH 977 hPa. The 0920 hrs report stated the wind was from 300º at 42 G 56 kt, with visibility of 4,000 m in rain, the lowest cloud at 500 ft, temperature 5ºC, dew point 3ºC and QNH 979 hPa.

Meteorology - Belfast City (destination airport)

The 0620 hrs METAR for BHD stated the wind was from 230º at 9 kt and the 0720 hrs report stated it was from 280º at 6 kt. The first TAF for the day was produced at 0717 hrs and this stated that between 0700 and 1000 hrs the wind would veer and increase to be

Footnote

[15] BECMG is the meteorological notation used in a TREND forecast which means becoming during the next two hours.

from 320º at 20 G 35 kt. This TAF was updated at 0735 hrs, without any change to the forecast wind, stating that between 0700 and 1200 hrs the visibility was likely to decrease temporarily to 3,000 m in showers of rain and sleet, with broken cloud at 800 ft.

The 0750 hrs METAR stated the wind was from 300º at 25 G 40 kt and the 0820 hrs report stated it was from 320º at 25 G 40 kt, visibility in excess of 10 km, with showers of rain, the lowest cloud at 900 ft, temperature 3ºC, dew point 1ºC and QNH 981 hPa.

Meteorology - other airports

Belfast International Airport

At 0559 hrs the TAF for BFS indicated that between 0600 and 0900 hrs the wind would be from 340º at 26 G 36 kt, with a 30% probability of this strengthening temporarily between 0600 and 1200 hrs to 33 G 46 kt.

Before departing IOM, the crew saw the 0720 hrs METAR for BFS which stated the wind was from 320º at 26 G 42 kt, visibility 6 km in rain, scattered cloud at 400 ft, broken cloud at 700 ft and also at 1,200 ft, temperature 6ºC, dew point 5ºC and QNH 977 hPa.

At 0850 hrs, shortly before the aircraft went around at BHD, the BFS METAR stated the wind was from 320º at 23 G 33 kt, visibility 9 km in rain, broken cloud at 1,100 ft and also at 1,500 ft, temperature 4ºC, dew point 3ºC and QNH 986 hPa.

Dublin Airport

The weather data seen by the crew included the 0600 hrs METAR for Dublin (where Runway 28 was available), with the wind from 250º at 42 G 53 kt but the forecast was for a 40% probability of a temporary change between 0600 and 0800 hrs for the wind to be from 270º at 40 G 60 kt. It was then forecast to BECMG, between 0700 and 0900 hrs, from 290º at 30 G 45 kt and between 0900 and 1200 hrs from 300º at 30 G 40 kt.

The 0900 hrs METAR stated the wind was from 290º at 29 G 49 kt, visibility 10 km or more, few cloud at 1,500 ft, broken cloud at 2,600 ft, temperature 6ºC, dew point 2ºC and QNH 990 hPa.

Glasgow Prestwick Airport

The crew did not obtain weather information for Glasgow Prestwick Airport which is approximately 67 nm northeast of BHD and where Runway 03 was available. The 0501 hrs TAF stated the wind would be from 040º at 17 kt, visibility 10 km or more, scattered cloud at 3,000 ft, with temporarily between 0600 and 1300 hrs visibility 6 km in rain, broken cloud at 800 ft and a 40% probability of temporarily, between 0600 and 1100 hrs the wind being from 010º at 20 G 30 kt, visibility 1,200 m in heavy sleet with snow and broken cloud at 300 ft.

The 0720 hrs METAR stated the wind was from 020º at 7 kt but the direction variable between 340º and 050º, visibility 10 km or more in rain, few cloud at 800 ft, broken cloud at 2,400 ft, temperature 5ºC, dew point 3ºC and QNH 977 hPa.

The 0850 hrs METAR stated the wind was from 020º at 10 G 20 kt with the direction variable between 350º and 060º, visibility 10 km or more in light rain, few cloud at 1,000 ft, scattered cloud at 1,900 ft, temperature 3ºC, dew point 1ºC and QNH 980 hPa.

Crew information

The commander was a Hungarian national and the co-pilot was a Czech national but, based on the CVR data, they conversed in English.

The commander's total flying experience was 7,800 hours of which 2,200 hours were on type. The co-pilot's total flying experience was 1,052 hours of which 509 hours were on type, including 19 hours in the last 28 days. He also held the post of Deputy Flight Operations Manager for the aircraft operator.

After the flight, the commander reported that following the go-around from BHD he did not ask ATC about the latest conditions at BFS, or whether other aircraft were landing there, because he judged "the same sort of wind was prevailing at both BFS and IOM". When asked if he considered taking over the PF duties for the approach to IOM once the wind increased significantly, he stated there would have been no advantage for him to have been PF, even though he had more flying experience, because as PNF he had oversight of what was taking place.

Operational information

Wind limits

The aircraft Operator's Manual (OM) included the information from the AFM relating to the maximum demonstrated component of crosswind. In common with the AFM, this information was presented in the '*Limitations*' section of the OM Part B, rather than the '*Normal procedures*' section, while the '*Performance*' section stated:

> *'Maximum crosswind component*
>
> *The maximum crosswind component in which the aeroplane has been demonstrated to satisfactory for takeoff is 20 knots at 90° to the direction of take-off. The demonstrations were made with both engines operating and lateral controllability on the ground was close to being limiting.'*

The OM included no other relevant crosswind limit or guidance and there is no evidence crews were trained to handle the aircraft in crosswinds of more than 19.4 kt.

The only other wind limits included in the OM[16] were the '*Aircraft ground operation wind speed limits*' which instructed a commander with more than 300 hours experience on type to regard 45 kt wind speed from any direction as limiting for ground operation and to calculate this by adding half of the gust factor to the stated steady wind speed. A commander with less than 300 hours on type was to use 40 kt as the limit.

Footnote

[16] Advised in the Operator's 'Safety Bulletin No. *01/16*'.

Flight planning

The OFP was produced by the crew once they had selected BFS as their first destination alternate and IOM as their second, but the OFP showed just one diversion route, so only the navigational information and the fuel required for diversion back to IOM from BHD was shown on the OFP. The OM Part A stated that the OFP must show route information for destination '*alternate(s)*'. The distance allowed for a diversion from BHD to IOM was 58 nm[17]. This equates to the direct airway routing from BHD to IOM via the IOM VOR and does not allow any track miles for the missed approach procedure at BHD (involving a climb straight ahead to 3,000 ft amsl), nor for an approach procedure at IOM.

The technical log indicated 550 kg of fuel was on-board at the start of the flight while the minimum required fuel from the OFP was 453 kg. This included 195 kg to taxi-out and for the 30 min flight to BHD, 82 kg for a 16 min diversion back to IOM, 150 kg of final reserve fuel and 25 kg for contingency fuel (1 kg was not accounted for). The OM Part A stated that contingency fuel of not less than 50 kg should be included in fuel calculations[18].

The OM Part A instructed pilots to select two alternate airfields if no meteorological data for the destination is available before departure, or if the weather reports or forecasts for the destination indicate that, during a period commencing one hour before and ending one hour after the estimated time of arrival, the weather conditions will be below the applicable planning minima. Consideration must be given to the forecast weather conditions for a destination alternate for the time period from one hour before until one hour after the aircraft's likely estimated time of arrival there.

When interpreting meteorological information, the guidance states:

> *'For planning purposes an aerodrome shall be considered below minimum if the steady crosswind exceeds the prescribed limitations.'*

The OM guidance on forecasts of deteriorating weather was that meteorological PROB or TEMPO prefixes '*may be considered whenever judged operationally significant*'. It suggested that if a forecast deterioration of this type involved precipitation (rain, snowstorms or thunderstorms), it should be carefully evaluated and the carriage of up to one hour's extra fuel considered, while probable, temporary deterioration due to other forms of weather should be '*fully considered*'.

Operational support

In accordance with the OM Part A, the Operations Control Centre (OCC) was tasked with supporting the crew during flight planning while the Flight Operations Manager (FOM) was to be available for the commander to consult in regard to selection of alternate airfields and when weather creates any '*irregularity in operations*'.

Footnote

[17] The comparable distance to Prestwick from BHD is approximately 12 nm further.
[18] Contingency fuel is required to be carried in addition to final reserve fuel.

The decision to operate the flight was taken at 0750 hrs when the 0455 hrs IOM TAF remained valid. The 0800 hrs IOM TAF and the 0750 hrs BHD METAR would have been available to the OCC and the FOM once the crew had returned to the aircraft but before it took off. It was not evident that any discussions took place between the crew and the OCC or the FOM concerning the decision to operate the flight in the prevailing conditions.

Crew resource management

Standard Operating Procedures (SOPs) were described in Chapter 2 of the OM Part B which stated:

> *'…operations are based on the optimum use of Crew Resource Management. The principle of continuous mutual briefing and assistance shall be applied at all times. In normal cockpit work the commander shall endeavour to establish open communication between crew members.'*

The manual continued by stating that clear crew co-ordination is especially important in abnormal situations, so there should be '*clear and precise work distribution*' and crews should operate on the '*closed-loop principle*' where '*each crew member is always informed and kept in the loop*'. There was no guidance given on other aspects of crew resource management (CRM) such as the evaluation and management of threats, problem solving and decision making.

Stabilised approach criteria

For an approach with flaps set to 18º, the V_{REF} from the AFM is 89 KIAS, irrespective of the aircraft weight, and the maximum approach speed is 135 KIAS, which is the limiting speed with the landing gear selected down or with flaps set to 18º. The OM advised that the V_{REF} be increased (up to a maximum of 15 kt) by adding a value equal to half the headwind component in excess of 10 kt plus the full gust value, to give an adjusted V_{REF}.

The aircraft operator's SOP is for approaches to be stabilised by 1,000 ft aal in Instrument Meteorological Conditions (IMC) and by 500 ft aal in Visual Meteorological Conditions (VMC). To be stabilised the aircraft is to be on the desired flight path in landing configuration with only small changes in heading and pitch required to maintain that path, a maximum '*sink rate*' of 1,000 ft/min and with the airspeed between V_{REF} and V_{REF} + 20 KIAS, (using the adjusted V_{REF}). When the aircraft passes 1,000 ft aal in IMC or 500 ft aal in VMC the PNF is to annunciate this and also to state 'NOT STABILISED' if the stabilised approach criteria are not met, in which case the PF is to initiate a go-around.

For the aircraft to be considered stabilised when crossing the runway threshold the maximum speed should be the adjusted V_{REF} + 10 KIAS.

Glideslope caution

During an ILS approach the aircraft's Enhanced Ground Proximity Warning System (EGPWS) produces an aural 'GLIDESLOPE' caution if the aircraft deviates below the ILS glideslope. The operator's requirement is for the PF to respond by making a correction to

regain the glideslope but if this is not successful, or if the aircraft is below 500 ft aal, the PF is to initiate a go-around. However, the OM also contained the following statement:

> *'In VMC conditions and in day with sufficient visual reference, must not take into account the caution.'*

Reporting time

In accordance with EASA regulations, the OM Part A stated the aircraft operator will:

> *'specify reporting times that allow sufficient time for ground duties.'*

and:

> *'In general these times will not be less than 30 minutes prior Scheduled OFF Block Time.'*

The OM was approved by the CAA of the Czech Republic.

Regulatory oversight

This aircraft operator's licences were issued by the CAA of the Czech Republic, which is responsible for oversight of the company in accordance with EASA regulations. However, Part-ARO of Commission Regulation (EU) 965/2012 requires States to cooperate with respect to the safety of operations in the territory of a National Aviation Authority (NAA) which is not the certifying authority.

The Isle of Man is a UK Crown Dependency, but is not an EU Member State and it has its own Civil Aviation Administration that is responsible for the Island's aviation safety. It is an Isle of Man requirement that aircraft registered in a foreign country obtain a Foreign Carrier Permit to operate commercial flights to or from the Island, while the UK has to provide a permit for commercial flights to or from the UK from a non-EU Member State. Consequently, the administration of Foreign Carrier Permits for commercial flights between the UK and the Isle of Man is delivered by the UK CAA in co-ordination with the Isle of Man Civil Aviation Administration. This operator had been issued with such a permit for its operation between the Isle of Man and the UK on behalf of the ticket-selling company.

According to the UK CAA "following a number of operational incidents", the Czech and UK CAAs had participated co-operatively to oversee this aircraft operator in a trial sponsored by the EASA. This trial between selected EASA Member States was initiated in response to the European Plan for Aviation Safety (EPAS 2016-2020 and 2017-2021). It tasked the EASA and Member States to implement cooperative oversight and disseminate best practices on how NAAs can better work together and participate in the oversight of organisations/ persons certified by another Member State.

The EASA stated that:

> *'Co-operative oversight allows the Member State's competent authority to gain a better understanding of safety risks, related to aviation activities of organisations/persons active in its territory, but certified by the competent authority of another Member State. This extension of the traditional oversight scope has clear advantages in terms of exchange of information between competent authorities, but it also triggered a number of questions regarding the meaning of cooperative oversight, the practical implications for authorities, the necessary tools that need to be in place, the link with the authority's management system, as well as the link with the existing SACA (Safety Assessment of Community Aircraft) program. The trial project was initiated to address these issues.'*

The UK CAA stated that its joint oversight with the CAA of the Czech Republic identified shortcomings in management structure, operational procedures and in the way the operator's crew were trained, particularly in threat and error management principles. Although the oversight trial was completed once a programme to address these deficiencies had been agreed, the two NAAs continued to work together to secure further safety and compliance improvements by the operator. To retain its Foreign Carrier Permit the operator had to submit monthly updates and consequently the UK CAA learnt that the newly appointed FOM lacked, in its view, the appropriate experience, knowledge and authority to hold this post, while his deputy also had very little operational experience.

On 22 February 2017, representatives of the UK CAA met their Czech counterparts and requested that inspectors from the two NAAs perform a cooperative audit of the operator at IOM to confirm that safe operations could be guaranteed by the new management structure. The next day this serious incident occurred and, after informing the CAA of the Czech Republic, the UK CAA suspended the Foreign Carrier Permit and issued a Direction under the UK Air Navigation Order, instructing the operator to suspend UK Commercial Air Transport operations indefinitely.

Both NAAs agreed that a crosswind limit of 19.4 kt should have been applied for takeoff and landing. The CAA of the Czech Republic also stated this was the limit that was accounted for when the pilots' type ratings were issued and it also noted the ground operation limit related to aircraft taxiing and was not a takeoff and landing limit.

Isle of Man regulations

The Isle of Man aviation regulations are contained in the Air Navigation (Isle of Man) Order 2015. The Isle of Man Civil Aviation Administration stated that Article 13(1) to the Order was applied when directing that the aircraft stop taxiing. This Article empowers the Administration to issue an operator with a directive:

> *'that an operation is prohibited, or must be limited or is subject to specified conditions, in the interests of safe operations.'*

A subsequent paragraph in the Article states, that the reason for issue of the directive, its applicability and duration and the action required by the operator must be given.

Rule 40 of the Rules of the Air Regulations which apply to the Isle of Man states:

> *'An aircraft shall not taxi on the apron or the manoeuvring area of an aerodrome without the permission of either -*
>
> *(a) the person in charge of the aerodrome; or*
>
> *(b) the air traffic control unit or aerodrome flight information service unit notified as being on watch at the aerodrome.'*

Several UK CAPs have been adopted by the Isle of Man and this includes CAP 493 '*Manual of Air Traffic Service – Part 1*'. This states:

> *'In order to execute his duties, an aerodrome controller has authority over aircraft, vehicles and personnel on the manoeuvring area and aircraft moving on the apron.'*

EU regulations

Regulation (EU) 216/2008, '*The Basic Regulation*' regarding flight preparation, states at Annex IV, paragraph 2.a.4:

> *'Information regarding meteorological conditions for departure, destination and, where applicable, alternate aerodromes, as well as en route conditions, must be available to the flight crew. Special attention must be given to potentially hazardous atmospheric conditions.'*

Regulation (EU) 923/2012, '*The Standardised European Rules of the Air*' (SERA), stipulates certain prefight responsibilities for the pilot in command before a flight. At paragraph SERA.2010 (b) it states:

> *'Before beginning a flight, the pilot-in-command of an aircraft shall become familiar with all available information appropriate to the intended operation. Pre-flight action for flights away from the vicinity of an aerodrome, and for all IFR flights, shall include a careful study of available current weather reports and forecasts, taking into consideration fuel requirements and an alternative course of action if the flight cannot be completed as planned.'*

Regulation (EU) 965/2012 on air operations refers to the selection of aerodromes at CAT.OP.MPA 180 and this states that any required, alternate aerodrome(s) are to be specified on the OFP.

The guidance material to CAT.OP.MPA.185 includes a table relating to the application of aerodrome forecasts for flight planning. Where a TAF or TREND indicates a deterioration, from one hour before until one hour after the estimated time of arrival at a destination or

destination alternate, and the change is prefixed BECMG, the mean wind forecast is to be considered relevant and gusts may be disregarded, from the start time of the change. Where a change is forecast as a probable, temporary change it may be disregarded.

Aircraft operator's initial report

The operator carried out an internal investigation and produced an initial report which classified the occurrence as an '*incident'*. It identified a number of causal factors and laid out a corrective action plan. This report was prepared before the UK CAA suspended the Foreign Carrier Permit, causing the operator to cease IOM operations.

In view of the weather situation and especially considering the strong crosswind reported at BHD immediately before takeoff, the report noted that '*the decision to perform the flight could be disputed*'. It stated that the crew's assessment of the available weather data was '*too narrow*' and noted they did not consult '*other operational personnel in charge*'.

The report considered whether more fuel might have been carried, but noted that the operator's guidance to the crew for such circumstances was lacking. Having elected to fly an approach at BHD, the report endorsed the crew's decision to go around but indicated that with a relatively low fuel state, BFS might have been a better airport to divert to. Once en route to IOM, the wind at the surface increased above the operator's ground limit but the crew were committed to continuing due to the fuel state. However, the report acknowledged they could have declared a fuel emergency (an intention to land with less than final reserve fuel) and proceed to another suitable airport, such as Blackpool.

Because the operator's opinion was that the demonstrated crosswind figure was not limiting, the report concluded that the '*operation was legal*', except for landing in a wind beyond the ground operation limit. It commended the piloting skills that led to a '*safe landing'*.

The corrective actions recommended in the initial report included a reassessment of the operator's wind limits for the aircraft and a review of crew training for IOM operations. Another recommendation was for the responsibilities of ground operations staff to be re-defined so as to better support flight crew preparation, decision making and associated liaison with the ticket-seller. It was also suggested that the operator needed to increase its compliance monitoring activity at IOM.

Aircraft operator's final report

On 30 June 2017 the operator completed an internal investigation and wrote a final report which was passed to the CAA of the Czech Republic. This report recommended that crosswind limits shown in the OM be revised but it supported the crew's decision to operate the flight because '*they found themselves in a complicated situation due to inconsistent weather information'*. It highlighted the 0650 hrs IOM METAR, suggesting this made it reasonable to plan to use IOM as a diversion until 0850 hrs. The report did not mention the aircraft's departure time was 0810 hrs; making it likely the aircraft would arrive back at IOM later than 0850 hrs in the event of a diversion and that forecast weather conditions until one hour after such an arrival time had to be considered.

The final report concluded that the crew's final decision to land at IOM was '*reasonable*' but indicated there were deficiencies in threat and error management which required safety action.

Aircraft operator's further comments

The aircraft operator believed that the IOM METAR data, when viewed in retrospect, may have misled the crew. The operator noted the 0620 hrs and 0650 hrs reports assessed the wind was BECMG 310º at 17 kt, while the 0720 hrs report stated that the wind was from 250º at 33 G 47 kt but variable between 220º and 290º and with no significant change expected during the following two hours. The last METAR to be available before the aircraft departed was the 0750 hrs and this stated the wind was from 270º at 30 G 42 kt, with no wind-related trend forecast. Because these METARs were prepared after the 0455 hrs TAF, the operator suggested it was reasonable for the crew to rely on them rather than the TAF, for guidance on likely changes to the weather in the near-term. The operator referred to the UK AIP paragraph 4.2.9 (see *Meteorology - Isle of Man procedures*) and suggested this gave the crew authority to disregard the TAF in favour of a METAR issued at a later time.

Commenting on the past shortcomings identified by the CAA of the Czech Republic and UK CAAs in its crew's threat and error management, the operator stated that remedial training had been given to the pilots in December 2016.

The operator supported the crew's decision that led to the co-pilot handling the aircraft for the approach and landing.

Previous occurrences

OK-UBA, Let L-410, IOM, 18 January 2007

While taxiing at IOM, with a wind velocity from 260º at 37 G 57 kt, the right wing lifted and the left wingtip struck the ground, causing damage to the wingtip fuel tank. This was investigated by the AAIB and reported in Bulletin 8/2007. The aircraft operator subsequently imposed a maximum wind limit for ground operation[19].

IOM ATC Report, 30 December 2015

A Mandatory Occurrence Report (MOR) was submitted to the Isle of Man Civil Aviation Administration after another of the aircraft operator's Let L-410s landed on Runway 21 when the reported wind velocity was from 210º at 45 G 65 kt. After landing the pilot shutdown the aircraft on a taxiway because of the strong wind. ATC filed the MOR knowing (from the AAIB's 2007 report) that a maximum wind limit of 45 kt applied for ground operation and because of concern for the safety of those on-board, while disembarking on an exposed taxiway in 65 kt gusts of wind.

Footnote

[19] See *Wind limits.*

EASA Safety Information Bulletin

In 2014 the EASA published a Safety Information Bulletin (SIB) titled '*Aeroplane Operations in Crosswind Conditions*'[20]. The SIB's objective is:

> *'to raise awareness on the risks associated with operations in strong and/or gusty crosswind conditions, with the purpose of adding emphasis to the relevant portions of pilot training and providing flight crews with unambiguous information to support their decision making processes.'*

The SIB highlights a report by the German Federal Bureau of Aircraft Accidents Investigation (BFU) into a crosswind related serious incident[21] and also a study by the National Aerospace Laboratory of the Netherlands (NLR)[22] which associated gusty crosswinds (and also tailwinds) to wingtip strikes, tail strikes, hard landings and runway excursions.

One of the recommendations made by the SIB was:

> *'Operators and training organisations should consider publishing operational crosswind limitations which take into account their operational experience and the operating environment (e.g. runway width and state, prevailing weather conditions, etc.). These limits should be based on the AFM maximum demonstrated crosswind value, when more limiting values are not published in the limitation section of the AFM. Operators should also carefully consider including the gust factor in the operating limitations, following the manufacturer's recommendations, if any.'*

Analysis

The aircraft had diverted to IOM after an attempted landing at BHD, where strong winds and associated turbulence affected the approach, and the crew could have used their first nominated alternate airfield, which was nearby and where the wind was orientated close to the runway axis. After landing at IOM the right mainwheel lifted and RFFS witnesses estimated the left wingtip rolled to within approximately one metre of the runway surface.

Wind limits

According to CS-23 an aircraft must be demonstrated to be safe for taxiing, takeoff and landing with a 90º '*cross-component of wind velocity*' that is not less than 20% of the stall speed with idle power and '*the highest 90° crosswind component tested satisfactorily should be put in the AFM as performance information. If the demonstrated crosswind is considered limiting, it should be introduced into Section 2 of the AFM*.' For this aircraft, Section 2 of the AFM, the '*Limitations*' section, stated the '*Maximum demonstrated*

Footnote

[20] EASA Safety Information Bulletin No 2014-20.
[21] BFU report 5X003-0/08 dated March 2010.
[22] The NLR study of *Near Ground Wind Gust Detection* can be found at http://www.nlr-atsi.nl/downloads/analysis-of-existing-practices-and-issues-rega.pdf

component of crosswind' for '*dry and wet take-off and landing runways with pavement*' is 19.4 kt. The presence of this information in the Section 2 of the AFM and also in the '*Limitations*' section of the aircraft operator's OM implies that during test flying the maximum demonstrated crosswind was considered limiting.

Fifteen minutes before landing the crew were advised the wind was from 310º at a maximum of 53 kt, suggesting a crosswind component of 41 kt. When ATC provided landing clearance the reported wind was from 300° at 41 kt but gusting between 31 and 63 kt, meaning there was a maximum crosswind component for this landing of 40 kt, which is approximately twice the maximum demonstrated value for certification purposes.

The OM included the statement that with a 20 kt crosswind during takeoff '*lateral controllability on the ground was close to being limiting.*' Indeed, the OM contained no other guidance concerning handling the aircraft during crosswind takeoff and landings, nor concerning the value of crosswind gust factor to be taken into account when calculating the crosswind[23], nor was there any recommendation concerning circumstances in which the maximum demonstrated crosswind might be exceeded. Additionally, the CAA of the Czech Republic stated that the maximum value of crosswind component accounted for when the pilots' type ratings were issued was the maximum demonstrated component (19.4 kt).

The SOP was for the ground operation limit to be applied to determine if an airfield was useable or not, even though this limit should only have applied to taxiing manoeuvres. Moreover, the guidance in the OM that an airfield is to be considered as '*below minimum*' at the planning stage if the steady crosswind exceeds the '*prescribed limitations',* was not followed. Before takeoff, the IOM forecast, covering the period the aircraft might have had to divert back there, was for the surface wind to be from 310º at 33 G46 kt, meaning the crew should have assumed a crosswind component of 25 kt (disregarding the forecast gusts).

Meteorology

The storm affecting the flight was named '*Storm Doris*' by the Met Office and severe turbulence and very strong winds were forecast at lower levels in the region. Destination and destination alternate airfields ought to have been chosen after study of the anticipated path of the storm and the available runway directions at various airfields. Study of the Met Office's F215 would have provided information concerning en route conditions and may have alerted the crew to certain hazardous atmospheric conditions eg occasional severe turbulence and, behind the frontal system, thunderstorms.

The aircraft operator rostered the crew's reporting time 30 minutes before the scheduled departure time. The crew downloaded the weather data 13 minutes before the reporting time, suggesting that they began their duty approximately 15 minutes before the rostered time, to have sufficient planning time before proceeding to the aircraft. This suggests that the 30 minutes between crew report time and departure that was approved by the CAA of the Czech Republic was insufficient for flight planning.

Footnote

[23] The EASA SIB 2014-20 recommends the full value of the crosswind gust factor be used.

Only six airfields appear to have been considered by the crew, with significant gaps in the data available from these airfields. No data was obtained for alternative airfields that were within reasonable flying time but further from the expected path of the storm, such as Prestwick.

When the flight was delayed, because the surface wind at IOM exceeded the ground operation limit, the crew had further time available for planning. They obtained updated reports for the same six airfields, but did not consult the FOM or OCC or discuss the situation with the forecaster at Ronaldsway Met Office.

According to the aircraft operator's final report, the crew referred to the IOM METAR's in preference to the valid TAF before finally deciding to operate the flight. However the AIP states that a new forecast cancels '*any forecast of the same* type', so a METAR does not cancel a TAF. Furthermore, the AIP states '*The Aerodrome Forecast (TAF) is the primary method of providing the forecast weather information that pilots require about an airfield*'.

A METAR TREND only forecasts changes that are expected in the two hour period following the observation, therefore the TAF was the only forecast available before departure which was valid for the time period specified in the OM.

The aircraft operator's initial report concluded that it was questionable if the flight should have departed in the forecast conditions, and that the crew made '*too narrow*' an assessment of the available weather data, with insufficient support from the operator. TAFs and METARs appear to have been the only meteorological information the crew considered before the flight.

Flight to BHD

The aircraft operator's initial report appropriately questioned the decision to continue the flight when it was known there was a crosswind of 31 kt gusting to 46 kt at BHD and that no other aircraft were moving at that airport. Severe turbulence was forecast at low level between IOM and BHD and the crew would have been aware of this had they studied the relevant Met Office chart.

The aircraft took off from IOM with a crosswind component of 20 kt and later made an approach to BHD in a crosswind that was gusting to 43 kt. Continuous moderate turbulence was experienced during the approach and at all times the reported wind significantly exceeded the maximum demonstrated crosswind component by a significant margin. The conditions were such that usually it would be expected that a go-around be initiated earlier than the reported height of approximately 20 ft above the runway.

Although the crew stated afterwards that they considered BFS to be their primary alternate airfield, they did not ask ATC for an update on the BFS weather before heading back towards IOM. This indicates that either they did not fully appreciate the synoptic situation, with the wind at IOM likely to veer and increase above that experienced on departure (as forecast by the TAF), or that they were too focussed on IOM as their preferred alternate airfield.

The commander's statement after the flight that he considered the winds at BFS and IOM to be "similar" indicates that he did not give due consideration to the orientation of the runways. The mean wind forecast at BFS was 33 kt and aligned close to the axis of an available runway, while the mean wind forecast at IOM was of a similar strength but from 50º right of an available runway orientation. Also, BFS was the airfield the crew said was their planned primary alternate, as well as being the ticket-seller's preferred commercial alternate, and the mean wind there was not forecast to exceed the aircraft operator's ground limit.

The crew's focus on returning to IOM indicates they formed a mental or cognitive bias towards returning there after deciding to show it as the only alternate airfield on the OFP.

Return to IOM

During the flight back to IOM the crew learnt that the surface wind was now from 310º at 41 kt and gusting between 22 and 53 kt[24]. The CVR indicates they did not discuss the threats this could pose or consider any alternative courses of action, which suggests that they did not regard this as a significant safety threat. However, the lack of any relevant exchange between the two pilots is at odds with the operator's policy of keeping each other '*in the loop'*, to ensure a shared mental model, which is essential to achieve good CRM. It also indicates that the threat and error management training given to the crews in response to the concerns of the CAA of the Czech Republic and UK CAA in 2016 may not have been effective.

If the crew had discussed the problem they might have generated some alternative options. With only 300 kg of fuel remaining, their options were limited but, if they had received effective CRM training, they ought to have considered and discussed all possibilities, such as diverting elsewhere, even if this meant declaring a fuel emergency (an intention to land with less than final reserve fuel remaining). The co-pilot stated afterwards that they continued towards a "briefed, challenging crosswind landing" but the CVR did not record them discussing the challenges and they did not talk about the threats posed by the wind when it changed first from 290º at 28 kt to 310º at up to 53 kt or when it increased further and gusted to 63 kt, which was greater than forecast.

No discussion took place between the crew concerning the potential effect that a crosswind of 40 kt or greater might have when the aircraft touched down. The OM states that with 20 kt of crosswind, lateral control is considered '*limiting*' during takeoff, so it might have been appropriate to discuss the effects of a strong crosswind between themselves and also to warn ATC of a potential difficulty. In fact ATC was aware that the aircraft was landing with a wind velocity that considerably exceeded the operator's ground limit and took the precaution of having the RFFS on standby for the landing.

Approach stabilisation

The approach was made in IMC until the crew reported becoming visual with the runway at 600 ft aal. The adjusted V_{REF} used by the crew was 105 KIAS, the maximum speed at

Footnote

[24] A wind of 310°at 53 kt for Runway 26 represents a crosswind of 41 kt.

1,000 ft and below for a stabilised approach was therefore 125 KIAS and the target speed to cross the threshold was 115 KIAS. The recorded data shows the airspeed varied between a minimum of 107 KIAS and a maximum of 148 KIAS during the final approach. There were therefore exceedences of the limiting speed of 135 kt for the landing gear and for the flaps set to 18º, as well as exceedence of the 125 KIAS stable approach speed.

On three occasions during the approach the aircraft deviated below the glideslope causing 'GLIDESLOPE' cautions to be annunciated by the EGPWS. The PF responded to these by declaring he was "CORRECTING", an action first taken slightly below 1,000 ft aal, in IMC, which led to the aircraft climbing 100 ft while the airspeed fluctuated by 33 KIAS. To be considered stable the desired approach path has to be maintained using only small adjustments to heading or pitch and the airspeed should be maintained between V_{REF} and V_{REF} + 20 KIAS. The PNF is required to inform the PF if the approach is not stable and the PF is then to initiate a go-around, but the PNF said nothing in response to the glideslope deviation or the speed fluctuations.

The final 'GLIDESLOPE' caution was annunciated below 500 ft aal, the PF responded with "CORRECTING, RUNWAY IN SIGHT" and the flight data shows a correction to the glideslope was made. This action is consistent with the OM which indicates the caution can be ignored below 500 ft aal by day, with the runway in sight.

Fuel considerations

At the start of the flight there was 550 kg of fuel on the aircraft and the crew believed they required a minimum of 453 kg, so they were carrying 97 kg of extra fuel. However, if the required contingency fuel of 50 kg had been accounted for, rather than the 25 kg actually accounted for, then the crew would have calculated that they had 72 kg of extra fuel on-board, enough for approximately 14 minutes of flight.

During the flight 330 kg of fuel was burnt and this was 53 kg more than the OFP predicted[25]. It is likely this additional fuel was burnt during the missed approach at BHD and while manoeuvring for the approach to IOM, as neither of these portions of the flight were accounted for in the OFP figures. If this additional 53 kg had been allowed for and the correct contingency fuel included, the OFP would have shown a minimum required fuel for the sector of 531 kg, meaning that there was actually 19 kg of extra fuel on board, and not 97 kg. 19 kg of fuel would be enough for approximately 4 minutes of flight.

The aircraft operator's initial report noted that the OM lacks guidance on the carriage of extra fuel when operating in a region where widespread weather issues are forecast. This crew would have been better placed if they had taken enough fuel to allow a diversion to an airfield beyond the direct path of the storm and, if additional fuel had been carried, they would have had more options available when the wind at IOM increased and veered.

Footnote

[25] 550 kg of fuel was on-board and 220 kg was recorded at shutdown, so 330 kg was used. The OFP predicted 195 kg for the taxi out and the flight to BHD and 82 kg for the diversion to IOM; 330 – 195 – 82 = 53 kg of additional fuel burnt.

Arrival at IOM

There was credible witness evidence that the aircraft rolled considerably as it approached the runway and that the right mainwheel lifted off the ground after touchdown, causing the left wingtip to roll to within one metre of the runway surface. The crew did not know the wheel lifted or observe the ground clearance of the wingtip but the co-pilot was sufficiently concerned to state 'TOO MUCH ROLL'. It is therefore apparent that lateral control difficulties were experienced while landing due to the very strong, gusting crosswind.

Immediately after landing, the crew began to taxi the aircraft in a wind which exceeded the ground operation limit of 45 kt; the steady wind speed was 47 kt and with the addition of half of the gust factor the total applicable wind was 55 kt. This suggests the crew were not fully aware of the risk that the lightly loaded aircraft might be blown onto its wingtip, even though this had happened to another of the same operator's aircraft at IOM in 2007, in lighter winds. IOM ATC and the IOM Civil Aviation Administration knew about the previous accident and were concerned for the safety of those on board this aircraft.

The aircraft required ATC permission to taxi on the manoeuvring area and this permission was withdrawn when ATC passed on the directive from the IOM Civil Aviation Administration, which brought the aircraft to a halt into wind. The aerodrome controller has authority over an aircraft on the ground and although the directive from the IOM Civil Aviation Administration for the aircraft to cease taxiing may be unusual, it was apparently made with the aim of preventing an accident.

Conclusion

The prime causal factor in this serious incident was the decision to land with a maximum crosswind component of 40 kt[26], which is approximately twice the maximum demonstrated certification value of 19.4 kt. In the view of the aircraft operator, there was no specific crosswind limit the crew needed to consider when deciding whether to operate the service or not. However, the OM Part A refers to a crosswind limit when it states:

> *'For planning purposes an aerodrome shall be considered below minimum if the steady crosswind exceeds the prescribed limitations.'*

and other evidence from the AFM and the OM indicates that the maximum demonstrated crosswind component of 19.4 kt was limiting.

Several contributory factors were also apparent:

1) By only studying weather reports for six airfields and without referring to any meteorology charts, the crew had insufficient information to assess the prevailing weather conditions en route and the storm's path.

Footnote

[26] When ATC provided landing clearance the reported wind was from 300° at 41 kt, but gusting between 31 and 63 kt giving a maximum crosswind component for of 40 kt.

2) The aircraft operator believed that a valid TAF could be disregarded upon the subsequent issue of a METAR that included a TREND forecast.

3) The aircraft operator did not provide adequate oversight to a flight in airspace affected by this storm. The commander did not refer to the available weather forecast charts and neither the OCC nor the FOM reviewed the situation with him, or suggested he seek guidance from the duty forecaster.

4) The fuel figures presented on the OFP did not account for the correct level of contingency fuel and did not allow for a realistic alternate routing. The aircraft had sufficient fuel for the sector, but the crew did not have as much extra fuel on-board as they believed they had, and the OM offered little guidance on the carriage of extra fuel when there was a possibility of widespread, adverse weather conditions.

5) The OFP only showed navigational and fuel information for the second of two selected alternates. However, the two Belfast airports are in close proximity so the lack of navigational information for the routing to the first alternate may not have been problematic in this instance.

6) The CVR evidence, that evolving threats did not precipitate verbal discussion between the pilots, indicates they had not been effectively trained in respect to CRM, and to threat management in particular. The OM appeared to lack guidance concerning the evaluation and management of threats, problem solving and decision making.

7) The approach became unstable before visual flight conditions were achieved, but the crew did not discuss this, and the required SOPs were not followed.

8) The limiting airspeed for flight with gear down and for flight with flaps extended was exceeded but no corrective action was taken.

9) The crew began taxiing the aircraft in a wind which was stronger than the wind which blew a similar aircraft onto its wingtip at IOM in 2007 and which exceeded the ground operation limit introduced after the 2007 accident.

Safety actions and Recommendation

As a result of this serious incident the CAA of the Czech Republic stated that several safety actions have been completed, including:

1. The aircraft operator has increased the time allocated between crew report and the scheduled departure time to 60 minutes and incorporated this in OM Part A.

2. The aircraft operator has updated the crosswind limits in OM Part B. No details of the changes have been provided except a statement that the OM now offers guidance for taking off and landing in a crosswind, and that the EASA SIB 2014-20 has been taken into account.

3. The CAA of the Czech Republic has also stated that recent audits of the aircraft operator have focussed on hazard identification and safety risk management, with particular focus on operations in hazardous weather conditions.

These safety actions address some of the factors identified in this report but there appear to be a number of issues concerning operational control and supervision which still require attention. While this investigation highlighted certain of the operator's policies and procedures which did not comply with regulatory requirements, it is possible that there are areas outside the scope of this investigation that may also require review. To ensure that the aircraft operator's processes and procedures are effectively compliant with the applicable regulations the following safety recommendation is made:

Safety Recommendation 2018-005

It is recommended that the Civil Aviation Authority of the Czech Republic review Van Air's operational processes, training and operator's guidance to ensure that they are effectively compliant with the applicable regulations for commercial air transport operations.