SERIOUS INCIDENT

Aircraft Type and Registration:	Britten-Norman BN2A-26, Islander, VP-MON
No & Type of Engines:	2 Lycoming O540 piston engines
Year of Manufacture:	1969
Date & Time (UTC):	22 May 2011 at 2154[1] hrs
Location:	John A Osborne Airport, Montserrat
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers -7
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	3,600 hours (of which 2,000 were on type) Last 90 days - 13 hours Last 28 days - 13 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft skidded after the pilot applied the brakes while landing on Runway 28 at Montserrat. As a result the pilot performed a touch-and-go and positioned for another approach to Runway 28. On landing after the second approach the aircraft skidded again when brakes were applied, and the pilot continued with the landing roll. However, believing there was insufficient runway remaining in which to stop the aircraft the pilot steered it onto a grass verge in an attempt to stop it before the end of the prepared surface. The aircraft came to rest beside the runway 46 m from its end. There were no injuries to the passengers and no damage to the aircraft. This was the pilot's first landing on Runway 28. No faults with the aircraft's brakes or braking system were found and there was no evidence that the aircraft had hydroplaned. An accurate runway friction assessment could not be obtained, but there had not been any pilot reports of poor friction prior to or after the incident. It was probable that a tailwind and/or a high touchdown airspeed caused the runway excursion. Issues identified by the investigation were pilot training, wind measurements, the aerodrome's weather limits, the APAPI approach angle, obstructions on the approach and the runway environment.

The AAIB published Special Bulletin (S2-2011) on 21 July 2011 concerning the VP-MON incident in which three Safety Recommendations were made. Three further Safety Recommendations are made in this final report.

Footnote

[1] All time are UTC. The local time is 4 hours behind UTC.

History of the flight

The aircraft was on a scheduled flight from VC Bird International Airport, Antigua, to John A Osborne Airport, Montserrat. Prior to departure the pilot checked the weather at Montserrat using a computer in Antigua. The departure and cruise from Antigua were uneventful. As the aircraft approached Montserrat the pilot was instructed to join left-hand downwind for Runway 10 and informed that the wind was from 090° at 5 kt. At the time there were two ATCOs on duty; the senior ATCO was taking a weather observation, the other was manning the Tower controller's position. Approximately three minutes later the ATCO advised the pilot that the wind was now from 360° at 3 kt. The pilot replied that he would nevertheless like to conduct an approach to Runway 10. However, the ATCO added that there were clouds at "APPROXIMATELY 600 FT[2] AND BELOW DRIFTING IN FROM THE WEST" with visibility of "LESS THAN 6 KM AT THE MOMENT". As a result the pilot requested Runway 28. He was instructed to report on final for Runway 28 and advised that the wind was from 350° at 4 kt. When the pilot reported that he was approximately 3 nm from landing the ATCO informed him that there was a light rain shower at the airfield. Shortly thereafter the ATCO reported that he could see VP-MON and cleared the aircraft to land on Runway 28, reporting a surface wind from 300° at 4 kt.

The pilot stated that he flew the approach at 70 kt and "felt" some updraughts and a tailwind component on short final. He added that the aircraft touched down in the area of the Runway 28 identification numbers. After he applied the brakes the aircraft skidded, so he decided to perform a touch-and-go and to make another approach to Runway 28. The passengers, the ATCOs and AFRS personnel stated that the aircraft appeared to have touched down approximately one third to halfway along the runway. At this point the senior ATCO took over the Tower controller's position in order to communicate with the pilot. After checking the pilot's intentions he transmitted to the pilot "YOU CAME IN A BIT TOO FAST THERE." The pilot replied "I COULD NOT SLOW DOWN, STILL……I GOT SOME WIND BEHIND ME." The senior ATCO remained at the Tower controller's position.

On short final during the second approach the ATCO informed the pilot that the wind was from 320° at 3kt. The pilot stated that he flew the second approach at 65 kt, and again experienced updraughts, possibly with a tailwind component on short finals, and touched down at 40 kt just past the runway threshold marker. The aircraft skidded again on the initial application of the brakes but he elected to continue with the landing roll. Most of the witnesses stated that the aircraft landed just before the Abbreviated PAPIs (APAPIs)[3] for Runway 28, which are located approximately 190 m from the Runway 28 threshold. During the landing roll he continued to "pump" the brakes but judged the aircraft might overrun the runway. Accordingly, he steered the aircraft right, onto a grass verge approximately 148 m from the end of the paved surface, in an attempt to slow the aircraft more effectively. The aircraft came to rest on the grass approximately 46 m from the end of the paved runway surface. The runway was described as "damp" by the pilot and most of the witnesses.

After the pilot had shut down the aircraft's engines he vacated the aircraft, followed by the passengers. There were no injuries to the passengers and no apparent damage to the aircraft. After the passengers had been

Footnote

[2] Above aerodrome level.

Footnote

[3] Abbreviated PAPIs consist of two lights to indicate the aircraft's runway approach angle to the pilot; PAPIs have four.

driven to the terminal in an airport vehicle the pilot started the aircraft's engines and taxied it to the apron without requesting permission from ATC. Having informed the operator's chief pilot and sought some engineering advice from an off-island maintenance engineer, the pilot left the airport by road.

The following morning the pilot flew the aircraft empty to Anguilla for a scheduled maintenance inspection.

Weather information

The Terminal Aerodrome Forecast (TAF) for John A Osborne Airport issued at 1000 hrs on 22 May 2011 stated that the surface wind was expected to be calm and the visibility in excess of 10 km, with scattered cloud at 2,200 ft aal. There was a 30% chance that between 1200 hrs on 22 May and 1200 hrs on 23 May of showers The surface wind was expected to become 10 kt from 120° between 1200 hrs and 1600 hrs.

The reported conditions at 2100 hrs were surface wind from 110° at 12 kt, visibility in excess of 10 km, broken cloud at 1,600 ft aal, temperature 26°C, dew point 25°C and QNH 1014 mb. There had been recent rain at the aerodrome and there was rain to the west.

The reported conditions at 2200 hrs were surface wind from 320° at 4 kt, visibility of 6 km, light showers of rain and thunderstorms, broken cloud at 600 ft aal, and few cumulonimbus clouds at 1,000 ft aal. The temperature and dew point were both 25°C and the QNH was 1015 mb.

The reported conditions at VC Bird International Airport, Antigua, just before departure at 2100 hrs, were surface wind from 100º at 8 kt, visibility in excess of 10 km, with few clouds at 1,900 ft aal. The temperature was 29ºC and the dew point was 25ºC and the QNH was 1013 mb.

Aircraft description and maintenance history

The aircraft, (Figure 1), was originally manufactured as an Islander BN2A and then later modified to a BN2A-26 which gives it a maximum takeoff weight (MTOW) of 6,600 lb and a maximum landing weight (MLW) of 6,300 lb. The aircraft is powered by two Lycoming O540 piston engines and can carry up to 10 people including the pilot. The aircraft is equipped with four conventional hydraulically operated brake units, one fitted at each main landing gear wheel, which are operated by toe brakes mounted on the rudder pedals.

Figure 1

The incident aircraft VP-MON

No anti-skid system is fitted. Normal tyre pressure is 29 psi in the nosewheel tyres and 35 psi in the main wheel tyres. An optional panel-mounted Garmin GPS150XL GPS was fitted to the instrument console on VP-MON. The aircraft was not equipped with a Flight Data Recorder or a Cockpit Voice Recorder and neither was required.

The aircraft had accumulated 21,625 flying hours at the time of the incident and its last 100-hr maintenance inspection had been completed on 22 April 2011.

Aircraft examination

The locally based Accident Investigation Manager (AIM) carried out an external examination of the aircraft on the evening of the incident while it was parked on the aerodrome apron. He did not notice any damage to the aircraft and he took photographs of the tyres which did not reveal any flat spots to the visible areas. The pilot carried out his normal pre-flight checks with emphasis on checking the brakes and then flew the aircraft to the operator's maintenance facility in Anguilla where a scheduled 50-hr inspection was carried out. During this inspection the aircraft's brake system was examined and tested with no faults found. The brake liners on both left main wheels and the right inboard main wheel were found to be worn and consequently replaced. However, the maintenance engineer reported that the liners were not worn beyond limits and would not have affected normal brake operation. Both right main wheel tyres were found to be worn to near the tread limit and replaced. The aircraft was examined for damage but none was found.

Aircraft performance

Aircraft weights

The aircraft's MTOW and MLW are 6,600 lb and 6,300 lb respectively. Depending upon air temperature and pressure altitude these weight limits are reduced to account for reduced aircraft performance – this is referred to as the WAT (weight, altitude and temperature) limit. At the time of the incident the temperature at the airport was 25°C and the pressure altitude was 500 ft; this reduced the aircraft's MTOW and MLW to 6,275 lb. The WAT limit at the time of takeoff from Antigua, at 29ºC and a pressure altitude of 62 ft, was 6,280 lb.

The operator's chief pilot, the incident pilot and some of the operator's other pilots were not aware of the WAT chart in the aircraft's Flight Manual. The operator has subsequently produced a reference chart for use by its pilots to ensure they comply with the WAT limits.

The pilot calculated the aircraft's takeoff weight to be 6,284 lb and its landing weight to be 6,224 lb. This was calculated using assumed weights for the passengers and 80 lb for the seven passengers' hold baggage.

Calculations by the AAIB indicate that the takeoff weight was 6,504 lb, 224 lb above the Antigua WAT limit, and the landing weight was 6,444 lb, 220 lb in excess of that calculated by the pilot and 144 lb above the authorised maximum of 6,300 lb and 169 lb above the Montserrat WAT limit of 6,275 lb. This was calculated using assumed weights for the passengers, as directed by the operator's operations manual, and the passenger estimated weights of the baggage, excluding hand baggage, which they stated they had checked in. One passenger commented that one of his two hold bags was not available for collection after the incident, and therefore was probably not aboard. As a result the weight of his heaviest bag was not included in these calculations. See Table 1 below.

Landing distance required

For the conditions at the time of the incident (25°C and 500 ft pressure altitude) and at MLW, 6,300 lb,

(All weights in lb)	Pilot's calculations	AAIB calculations
Aircraft basic weight	4,419	4,419
Weight of passengers	1,425	1,425
Weight of baggage	80	300 (8 bags)
Weight of Fuel	360	360
Takeoff weight	6,284	6,504
Sector fuel	60	60
Landing weight	6,224	6,444

Table 1

Pilot's and AAIB weight calculations

the factored[4] landing distance required (LDR), from a height of 50 ft, on to a dry runway, in calm wind was 440 m and 524 m with a 5 kt tail wind. On a wet runway these distances are increased by a factor of 1.15[5] which results in an LDR of 506 m in a calm wind and 603 m with a 5 kt tailwind. If a runway is reported as being 'damp', dry figures can be used. These performance figures assume that full flaps are used and an '*appropriate threshold speed*'. According to the flight manual the threshold speed for a landing weight of 6,224 lb and 6,444 lb are 58 kt and 59 kt respectively.

The manufacturer does not publish LDR for weights above MLW. However, it estimated that the LDR at 6,444 lb in calm wind was 445 m and 533 m with a 5 kt tailwind. On a wet runway these distances increase to 511 m and 613 m respectively.

The manufacturer estimated that the un-factored landing ground roll distance (from touchdown to rest), in calm wind, at 6,444 lb, is 146 m; 166 m with a 5 kt tailwind[6]. On a wet runway, using a factor of 1.3[7], this increases to 190 m and 216 m with a 5 kt tailwind. At 6,224 lb the landing ground roll in calm wind is 144 m and 187 m on a wet runway, and 168 m with a 5 kt tailwind on a dry runway and 193 m on a wet runway.

Aerodrome information

John A Osborne Airport was opened in July 2005 and was built to replace the previous airport after eruption of the Soufriere Hills Volcano destroyed the capital Plymouth in 1997. Approximately two thirds of the island is vulnerable to volcanic hazard which limited the available locations for the new airport. The runway at John A Osborne Airport is 596 m long – a distance which includes a 28 m displaced threshold at each

Footnote

4 For public transport operations all takeoff and landing distances are increased by a safety factor. The landing distance from a height of 50 ft is multiplied by 1.43 to get the factored landing distance required. It is this figure that is used in the planning stages to determine if a runway is of sufficient length to land on.

5 The aircraft manufacturer does not publish landing distance data for wet runways, but according to OTAR 91 when the runway is wet the landing distance available should be at least 115% (factor of 1.15) of the landing distance required.

6 The tailwind ground roll estimates were calculated by the manufacturer using the actual wind strength rather than the scheduled performance requirement to use 150% of the tailwind.

7 The aircraft manufacturer does not provide landing ground roll figures for wet runways, but if the landing distance from 50 feet is increased by a factor of 1.15, then for the Islander aircraft the ground roll portion is increased by a factor of about 1.3 (because the airborne distance is not increased by the runway being wet).

end. The Eastern Caribbean Aeronautical Information Publication (ECAIP) states the declared distances for John A Osborne Airport shown in Table 2.

There are no overrun areas on either runway. At the end of each runway is a steep drop in excess of 200 ft. See Figure 2 for a diagram of the airfield.

There was one windsock located to the north of the Runway 10 threshold. In the AAIB's Special Bulletin (S2-2011) on the VP-MON incident published on 21 July 2011 the following Safety Recommendation was made:

Safety Recommendation 2011-077

The operator of John A Osborne Airport, Montserrat, should install a windsock and anemometer adjacent to the Runway 28 threshold.

Since this recommendation the airport operator has installed an additional windsock adjacent to the Runway 28 threshold. Furthermore, the airport issued NOTAM A1217/11 that stated:

'WIND INFORMATION GIVEN BY ATC MAY NOT TRULY REPRESENT CONDITIONS CLOSE TO OR IN THE VICINITY OF THE THRESHOLD OF RWY28. EXERCISE EXTREME CAUTION.'

In the ATC tower there was a stand-alone wireless weather station with an anemometer mounted on the roof. This was the primary device used to display the current wind to the ATCOs. There was also a mast-mounted anemometer on the grass between the fire station and the windsock, but this was only partially serviceable because the display, which was on the ATCO's console, received only wind direction information. There was another mast-mounted anemometer north of the tower, which had not been commissioned. The operator intended to relocate this on the grass west of the taxiway and put it into service. The aerodrome operator commented after the incident that it planned to complete this work by the end of August 2011. Air Safety Support International (ASSI)[8] stated that the anemometer has now been relocated and is operating.

RWY designator	TORA[1] (m)	ASDA[2] (m)	TODA[3] (m)	LDA[4] (m)	Remarks
10	553	553	623	540	THR DISP 30 M
28	553	553	830	540	THR DISP 30 M

Footnotes

1 Takeoff Run Available (TORA) is the length of runway declared available and suitable for the ground run of an aeroplane taking off.
2 Accelerate Stop Distance Available (ASDA) is the length of the TORA plus the length of the stopway, if provided and if capable of bearing the weight of the aeroplane under the prevailing operating conditions.
3 Takeoff Distance Available (TODA) is the length of the TORA plus the length of the clearway, if provided.
4 Landing distance available (LDA) is the length of runway which is declared available and suitable for the ground run of an aeroplane landing.

Table 2

Footnote

8 Air Safety Support International, a subsidiary company of the UK Civil Aviation Authority, has been designated by the Governor of Montserrat to perform the civil aviation regulatory tasks on behalf of the Governor.

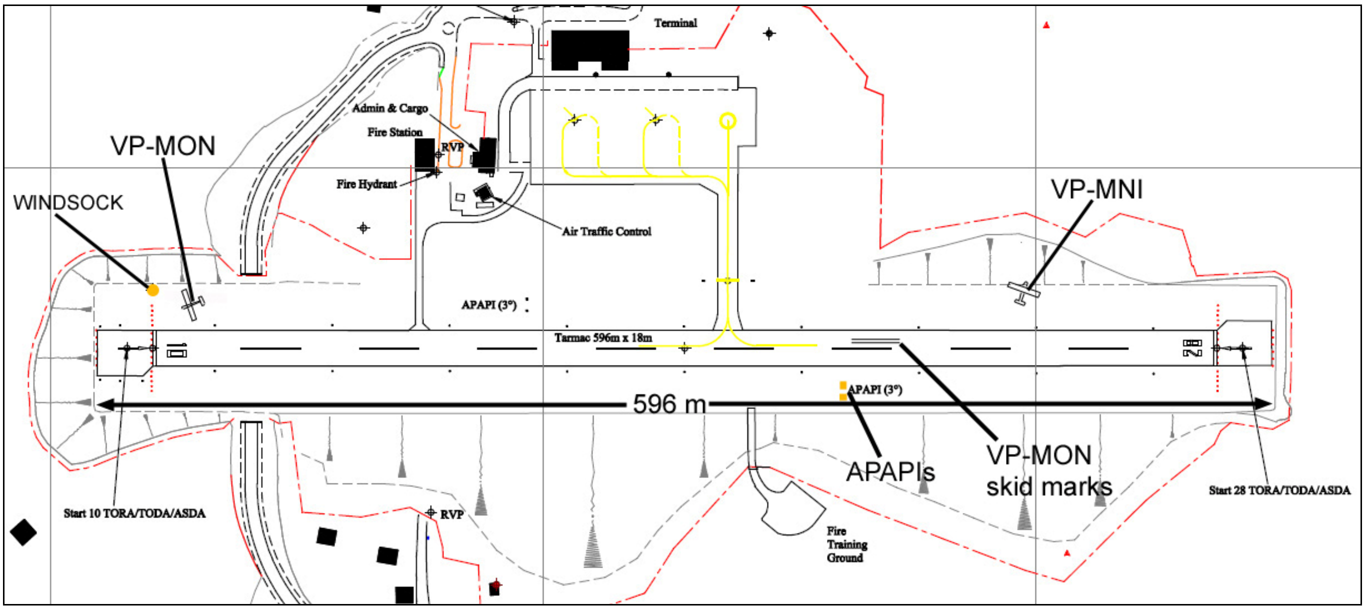

Figure 2

Aerodrome chart showing the post-incident location of VP-MON and the location of VP-MNI following its runway excursion accident on 17 April 2011

There are two sets of APAPIs positioned approximately 190 m from each runway threshold. These devices provide visual guidance to assist pilots to fly a specific approach angle. Both sets of APAPIs were set to an approach angle of 3°. When flying on a 3° approach path the pilot will see a red light and a white light. When flying below 3° they will see two red lights, and when flying above 3° they will see two white lights. 3° is a typical approach angle used at many airfields.

There is an aerodrome traffic zone, 5 nm in diameter centred on the airfield reference point from the surface to 4,500 ft aal, which is Class D airspace and operates VFR only. The VFR weather limits, as defined in the ECAIP, are 5 km visibility and 1,500 ft aal cloud base.

Local wind effects

It is not uncommon for the wind to be from significantly different directions at both ends of the runway with a northerly or southerly wind, because of significant terrain to the north and south of the airfield. Also, up and downdraughts are not uncommon on the approach to either runway.

Pilot approval

Prior to this incident the aerodrome operator required pilots to undergo a flight check before being permitted to operate at Montserrat Airport. This consisted of six takeoffs and landings at this airport under the supervision of a suitably qualified pilot, but there was no written requirement to be checked on the use of both runways, although the airport manager commented that he believed this requirement existed. The incident pilot had been checked on Runway 10 only.

In the AAIB's Special Bulletin (S2-2011) on the VP-MON incident published on 21 July 2011 the following Safety Recommendation was made:

Safety Recommendation 2011-078

The operator of John A Osborne Airport, Montserrat, in consultation with Air Safety Support International, should revise its operations manual to permit pilots to operate only to and from the runway on which they have been flight checked.

ASSI have subsequently issued *'Instructions for the Use of John A Osborne Airport'* detailing the training requirements for pilots using the airport. A copy of this instruction will be incorporated in the ECAIP and on the ASSI website. Since this incident the operator has flight checked all its pilots to use Runway 28.

Runway surface examination

The runway was inspected by the AIM the day after the incident and in June by the AAIB. There was a skid mark approximately 24 m long made by the aircraft's right main wheel tyres that started approximately 191 m from the beginning of the paved area of Runway 28 (163 m from the threshold), 12 m before the Runway 28 APAPIs. The aircraft's tyre marks continued along the runway until the left and right tyre marks left the paved surface about 115 m and 148 m from the end of the paved surface respectively.

The runway surface consisted of un-grooved asphalt and it was cambered to assist water drainage to the sides. A fire truck was used to spray water on the runway surface which revealed that the water drained to the sides of the runway, but there was some pooling of water at the runway edges where the surface joined the grass (Figure 3). Some runways at other airports have carrier drains, sometimes consisting of stone aggregate, between the runway surface and the grass surface which aides drainage.

Figure 3

Water sprayed onto the runway surface revealed some pooling at the edges

Hydroplaning

Dynamic hydroplaning can occur if an aircraft lands fast enough on a sufficiently wet runway. During hydroplaning the water cannot escape from the tyre footprint area, causing the tyre to be held off the pavement by a hydrodynamic force. The minimum hydroplaning speed for a wheel is based on its tyre pressure. For a rotating wheel the minimum hydroplaning speed, in knots, is $9\sqrt{p}$ where p is the tyre pressure in psi, and for a locked wheel it is $7\sqrt{p}$. If the main wheel tyres were inflated correctly to 35 psi, the minimum hydroplaning speed for a rotating wheel was 53 kt and the minimum speed for a locked wheel was 41 kt. The threshold speed for an Islander at maximum landing weight is 58 kt resulting in a touchdown speed of between 40 and 50 kt. Estimates on the minimum water depth required for hydroplaning vary from 1 mm to 3 mm.

Runway friction measurements

OTAR[9] 139.G.27 requires that:

> *'measurements of the friction characteristics of a runway surface shall be made periodically with a continuous friction measuring device using self-wetting features.'*

A 'continuous friction measuring device' continuously measures friction while it is being towed by a vehicle along the length of a runway. The operator of John A Osborne Airport used a 'continuous friction measuring' device called a 'GripTester'. The 'GripTester' is a three-wheel trailer (Figure 4), which measures friction using a braked wheel and the fixed slip principle. This braked wheel is fitted with a smooth tread tyre and is mounted on an axle instrumented to measure both the horizontal drag and the vertical load. From these measurements, the dynamic friction reading is calculated and transmitted to a data collection computer normally carried in the towing vehicle. The friction runs should be carried out on a dry runway using 'self-wetting' which involves spraying a controlled film of water in front of the measuring wheel that will result in a water depth of 1.0 mm.

According to OTAR 139.G.27:

> *'corrective maintenance action shall be taken when the friction characteristics for either the entire runway or a portion thereof are below a minimum friction level specified in ICAO Annex 14, Volume 1[10], Attachment A, Section 7.'*

Figure 4

'GripTester' continuous friction measuring device used by the airport operator

Footnote

9 OTAR is the Overseas Territories Aviation Requirements and Part 139 concerns 'Certification of Aerodromes'.

Footnote

10 Annex 14 Volume 1 is entitled '*Aerodrome Design and Operations*'

The minimum friction levels specified in Annex 14 for the 'GripTester' are:

- Design objective for new surface 0.74
- Maintenance planning level 0.53
- Minimum friction level 0.43

Corrective maintenance action should be initiated if the friction level drops below 0.53, and if the friction level drops below 0.43 the runway or a portion thereof should be notified as '*may be slippery when wet*'. According to OTAR 139.G.27:

> *'a portion of runway in the order of 100 m long may be considered significant for maintenance or reporting action'.*

ASSI have expanded on this by stating that:

> *'for a short runway where landing distance available may be limiting for a certain aircraft type, a 100 m length might be considered too long, and a 50 m length might be considered more appropriate for assessment of runway surface friction.'*

The airport operator carried out the first runway friction assessment on 20 June 2005 prior to the airport's opening using their 'GripTester'. With a dry runway and using 'self-wetting' the average friction measured was 0.52 and was fairly consistent both sides of the runway centreline. The following day the runs were repeated and the average friction measured was 0.71, with some variation. On the subsequent two days (22 and 23 June) the runway was wet and the average friction measured was 0.51 and 0.55 respectively. It is not known how soon after the runway surfacing these measurements were taken and there were no records of any corrective action. Between the airport opening in July 2005 and the VP-MON incident there was no record of any runway resurfacing works having been carried out.

On 30 March 2007 and 27 April 2007 some friction runs with self-wetting were carried out with average measurements between 1.0 and 1.2. 1.2 is the maximum possible measurement and is not normally achieved on a runway surface. Therefore, it is likely that an equipment or calibration problem caused these high readings. On 3 March 2009 some friction runs with self-wetting were carried out but the towing speed was too high to produce reliable results. The towing speed should be 65 km/hr with less than 5% variation, but the runs in March 2009 were carried out at speeds up to 94 km/hr. Due to staff changes no further information on the runs in 2007 or 2009 could be obtained.

Between 3 March 2009 and the VP-MON incident no further friction runs were carried out. The airport operator stated that this was due to an absence of trained personnel.

The John A Osborne Airport aerodrome manual stated:

> ***'9 Runway Surface friction Measurement***
>
> *9.1 A continuous friction measuring device is available.*
>
> *9.2 In order to provide a record of the reduction in friction characteristics with time, friction testing is carried out periodically but at not less than six-monthly intervals by the Operations Officer and the results reported to the Duty ATCO. Friction testing may also be carried out when the Aerodrome Manager so decides e.g. following a runway incident or particularly heavy rain.'*

In the AAIB's Special Bulletin (S2-2011) on the VP-MON incident published on 21 July 2011 the following Safety Recommendation was made:

Safety Recommendation 2011-079

The operator of John A Osborne Airport, Montserrat should ensure that a runway friction assessment is carried out at the earliest opportunity by a qualified person using suitable equipment.

The airport operator subsequently carried out some friction runs in July, August, September and October, but due to equipment problems no reliable data was obtained. It stated that it now has personnel trained to conduct friction measurements, and that technical problems with the equipment would be resolved on delivery of replacement parts.

The airport operator stated that apart from the VP-MON incident there had not been any other incidents where a pilot had reported poor braking performance due to a slippery runway.

Runway over-run areas

John A Osborne Airport is an ICAO Code 1 airport because its runway is less than 800 m long. A Code 1 airport with a non-instrument runway is not required to have a RESA[11] (Runway End Safety Area). The only ICAO Annex 14 and OTAR 139 requirement for the ends of a Code 1 non-instrument runway is that there is a 30 m 'Runway strip'. The definition of a 'Runway strip' is an area intended:

'to reduce the risk of damage to aircraft running off a runway; and to protect aircraft flying over it during take-off or landing operations'.

John A Osborne Airport satisfies this requirement by having a 28 m paved surface beyond each runway threshold in addition to a 2 m strip of grass. Beyond this 30 m strip there is a steep drop in excess of 200 ft at both ends of the runway, but this complies with ICAO and OTAR requirements. Figure 5 shows the steep drop at the end of Runway 28.

The ICAO and OTAR requirements for a Code 1 runway also specify that there is an obstruction-free area along the sides of the runway of at least 30 m from the runway centreline. The runway at Montserrat is 18 m wide and on both sides of the runway there is a flat area of grass about 23 m wide which satisfies the 30 m requirement. In the event of a possible over-run during landing, and assuming a safe go-around cannot be made, a pilot might attempt to steer the aircraft towards the sides of the runway rather than risk going off the end. However, at the end of Runway 28 where VP-MON came to rest there are steep drops beyond the 23 m grass area on both sides. The northern drop is shown in Figure 6, VP-MON came to rest 11 m from the edge of this northern drop.

Towards the end of Runway 10 there are steep embankments on both sides of the runway located 23 m from the runway edge (Figure 2 and 10). The gradients of these embankments are within ICAO limits, but would cause damage to an aircraft hitting them at speed as in the case of the VP-MNI incident described later in this report. Along the southern edge of the runway there is also a ditch where the flat area of grass meets the southern embankment (Figure 7). The ditch, which serves as a drain and is about 4 feet deep,

Footnote

11 A change to ICAO Annex 14 to require a 30 m RESA for a non-instrument code 1 runway is currently under consultation.

Figure 5

View looking south-east at the end of Runway 28. VP-MON came to rest 46 m from this end.

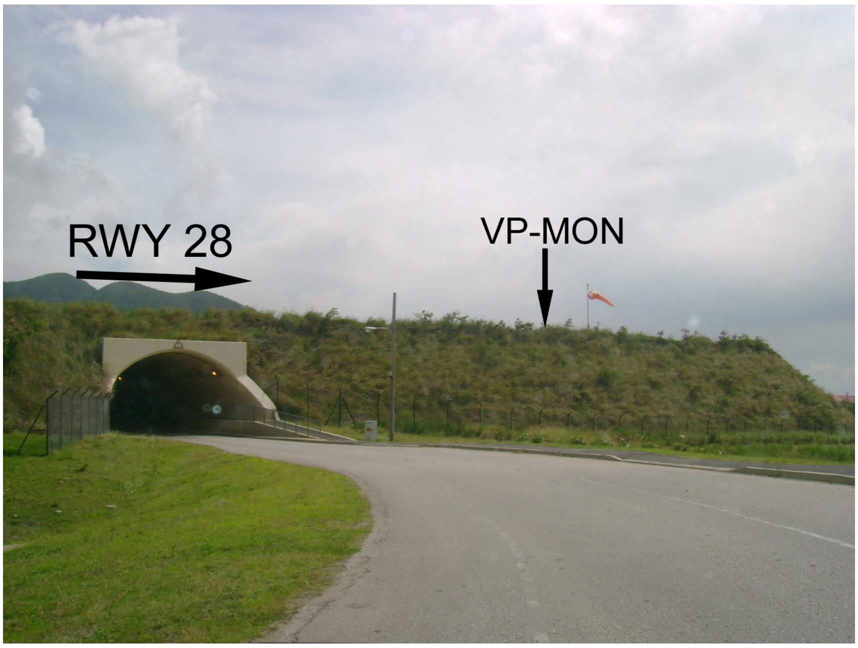

Figure 6

View looking south-west at the end of Runway 28 where VP-MON came to rest would cause damage to an aircraft hitting it at speed, but it is just outside the 30 m wide designated area and therefore in compliance with Annex 14. There is also a drain along the northern side of the runway, but it has been filled with earth and does not present a hazard to aircraft.

ICAO Annex 14 '*sets forth the minimum aerodrome specifications*' and states that '*the acceptable level of safety to be achieved shall be established by the State*.' OTAR 139 reflects these minimum specifications, but also requires that the operator has a Safety Management System. And according to OTAR 139.A.09 this Safety Management System shall include, as a minimum:

> *'(1) processes to identify actual and potential safety hazards and assess the associated risks; and*
>
> *(2) processes to develop and implement remedial action necessary to maintain agreed safety performance'*

The airport operator had not carried out a safety assessment on the risks associated with runway excursions.

Obstacle clearance areas

Below the approach area to Runway 28 there is a housing development on a hill called 'Lookout' located between 380 m and 650 m from the Runway 28 threshold (Figure 8). Its summit is approximately 40 to 50 ft above the runway. An aerodrome obstruction survey carried out in April 2009 revealed that there was a palm tree located on 'Lookout' which infringed the ICAO Annex 14 defined 'Approach surface' for a Code 1 airport. The 'Approach surface' is defined as an area extending from 30 m before the runway threshold out to 1600 m. According to ICAO no obstacle is

Figure 7

Ditch serving as a drain along the south side of the runway

permitted within a 5% gradient (2.86°) of this surface extending up from 30 m before the runway threshold. The palm tree penetrated this by 9 ft. In the two years since this survey was carried out the palm tree has grown and now penetrates this surface by a greater, as yet undetermined, amount.

ICAO also specifies obstacle clearance criteria for a 'Takeoff climb surface'. The dimensions and gradient of the 'Takeoff climb surface' are the same as for the 'Approach surface' for a Code 1 airport, but the 'Takeoff climb surface' starts at the 'runway end' (which includes the runway strip and/or clearway) and therefore is slightly more restrictive. According to the 2009 survey there were eight obstacles which penetrated the 'Takeoff climb surface', consisting of trees and bushes. The previously mentioned palm tree penetrated this surface by 16 ft.

Figure 8

Aerial view of approach area to Runway 28

The ECAIP entry for John A Osborne Airport contains an Aerodrome Obstacles table which states 'NO OBSTACLES'. The airport operator commented that it was attempting to have this information added to the ECAIP.

APAPI angle setting

The APAPIs were both set to an approach angle of 3°. According to ICAO Annex 14 the APAPI angle should be set to provide a safe margin from obstacles on the approach path when the pilot observes the lowest on-slope signal, i.e. one white and one red light. An illustration of an APAPI set to 3° is shown in Figure 9.

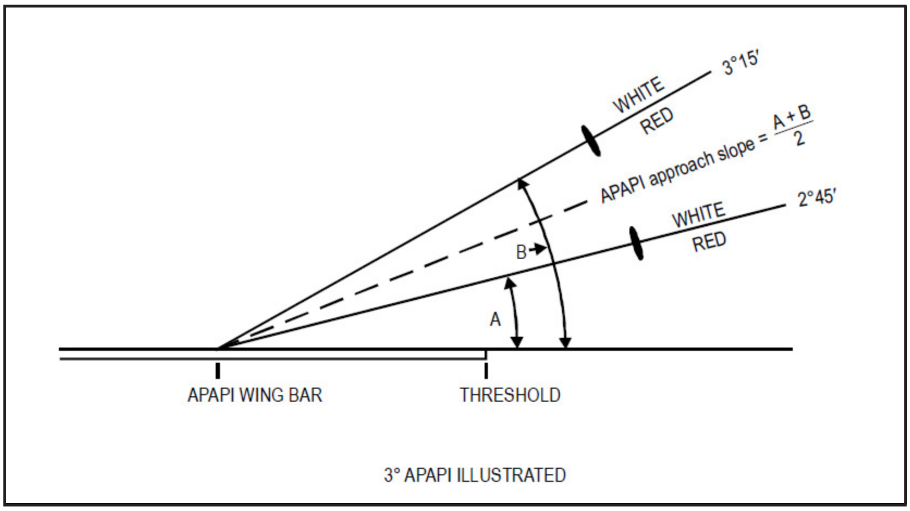

Figure 9

Illustration of a 3° APAPI angle setting (extract from ICAO Annex 14)

In the case of a 3° APAPI, the pilot should start to see two white lights if he flies above an approach slope of 3°15’ (3.25°) and two reds if he descends below a 2°45’ (2.75°) approach slope to the APAPI. According to the Annex 14 requirements any obstacle should be below A-0.9°. So in the case of John A Osborne Airport’s APAPI settings, all obstacles should be below 1.85° (as measured from the position of the APAPIs rather than from the runway threshold). The previously mentioned palm tree extends to 2.06° (based on the 2009 survey) and therefore penetrates the obstacle protection surface. An aircraft flying on a 2.75° glidepath (seeing one red and one white) would clear the top of this palm tree by 24 ft.

There are numerous houses on ‘Lookout’ hill, all below the 1.85° obstacle protection surface for the APAPI. The house which comes closest to penetrating the surface is located on the extended runway centreline 395 m from the runway threshold. The roof of this house reaches to 1.54° from the APAPI. An aircraft flying on a 2.75° glidepath would clear the roof of this house by 40 ft. There are no obstacles on the approach to Runway 10 so a 3° APAPI setting is within limits.

On 28 February 2011 a commercial flight inspection organisation conducted an in-flight assessment of the APAPIs at John A Osborne Airport. This company was contracted with the agreement of the ECCAA (Eastern Caribbean Civil Aviation Authority) to conduct annual flight testing of navigation aids, including PAPIs, for most of the Eastern Caribbean nations. In the case of Montserrat this was also agreed with ASSI. The company’s flight inspection report for the APAPIs at John A Osborne airport included pilot comments which stated ‘*Approach on 28 too close to houses, appearance of boxes on 10 is not clear*. In this report the flight inspector stated:

> *‘Fly ability check only no actual angle measurement done. Runway 10 there appeared to be not a large enough space (angle wise) between the two light boxes and they appeared quite pink rather than having a clear red/white definition. Runway 28 was clearer and spacing appeared to be better but following approach angle was not comfortable and with known wind shear at airport – quite dangerous.’*

Both the pilot and flight inspector rated the APAPI systems as ‘*Unsatisfactory’*, although the overall assessment was deemed ‘*Satisfactory with consideration to the limitations and restrictions stated*’, although no limitations or restrictions were stated in the report.

No action was taken by the operator of John A Osborne Airport when this report was issued. The airport manager in post at the time of the VP-MON incident had taken over in April 2011 and had not been aware of this report until he initiated an investigation in September 2011. ASSI were also not aware of this report until they were sent a copy by the airport manager in September 2011.

In September 2011, at the request of the airport manager, the flight inspection organisation provided some clarification of the conflicting conclusions of ‘*Unsatisfactory’* and ‘*Satisfactory’* in their report. The company stated that with hindsight they should have separated the reports for the Runway 10 APAPI and the Runway 28 APAPI. They had concluded that the Runway 10 APAPI system was not performing correctly and should not be used in its current state and was ‘*Unsatisfactory’*; whereas they determined that the Runway 28 APAPI system was performing correctly but was set too low. They stated:

> *'Local pilots have reported that they usually fly a higher glidepath angle and we recommend that the PAPI angle should be set higher to accommodate this operational environment.'*

Following verbal discussions between the previous airport manager and the organisation at the time of the inspection, it was considered that the Runway 28 APAPIs could continue to be used with consideration to the local conditions, but that the Runway 10 APAPIs should not be used in their current state.

Aircraft operator's operations manual

The aircraft operator's operations manual (OM) contained a section on accident and incident reporting detailing their definitions and actions to be taken in the event of any such occurrence.

The OM states the following in the section on flight procedures:

> *'Approach to Land Procedures*
>
> *All Company aircraft are to be operated in such a way that they are stabilised on final approach to land with landing flap selected within +15 kts of the threshold speed at 500' AGL.'*

The pilot stated that, though he possessed a copy of the OM, he was not aware of the contents of these sections.

Pilot's experience

The pilot of VP-MON had over 2,000 hrs experience on the Britten-Norman Islander. He started working for the operator on 11 May 2011 and on 13 May 2011 successfully completed a flight check to operate at Montserrat. However, he only completed takeoffs and landings using Runway 10. This incident occurred on the pilot's first landing on Runway 28.

The pilot commented that he had considerable experience flying around mountains, having operated at airports in Jamaica and Santa Domingo on several occasions. He had also worked in the Turks & Caicos Islands for approximately six years.

Pilot's comments

The pilot commented that he did not use the panel mounted GPS in the aircraft to give him an indication of the aircraft's ground speed on the approach.

He added that he was not aware of the VFR weather limits to operate into Montserrat. He stated that he made an assessment of whether to make an approach on the conditions passed by ATC. He also stated that he would not land on either runway if a tailwind were reported.

Chief pilot's comments

Training

The operator's chief pilot commented that he taught pilots to fly an initial 6-8º approach to Runways 28 and 10 that reduces as the aircraft approaches the runway, when it would be clear of the worst turbulence. However, this is not intended for every eventuality. He commented that this was to try to keep the aircraft above the worst turbulence and added a safety factor for the windshear frequently encountered on short final. He also instructed pilots to monitor the GPS ground speed readout on short final to get an indication of tailwinds.

The chief pilot added that he taught pilots to flare the aircraft as close as possible to the white threshold line. He stated that, depending on speed, the touchdown point would normally be abeam the tower on Runway 10 (which is 166 m from the runway threshold). This is a similar distance from the threshold of Runway 28 to where VP-MON probably touched down, based on the skid marks.

ATCOs comments

The senior ATCO stated that during his training he learnt that the weather limits for operations at Montserrat were 5 km visibility and a minimum cloud base 1,500 ft aal. However, when he returned to Montserrat to start controlling, the previous Airport Manager instructed controllers that it was acceptable for aircraft to operate in 5 km visibility and clear of cloud with the surface in sight[12]. This instruction was published in the ATC tower.

Since this incident the current Airport Manager has instructed the ATCOs that the correct minima are 5 km visibility and a cloud base of 1,500 ft aal.

Runway reporting

The Aerodrome Manual states that ATCOs are to report the degree of contamination by water to pilots using the following terminology:

> *'DAMP — When the surface shows a change of colour due to moisture*
>
> *WET — When the surface is soaked but no significant patches of standing water are visible*
>
> *WATER PATCHES — When significant patches of standing water are visible*
>
> *FLOODED — When extensive standing water is visible.'*

Previous serious landing incident

On 17 April 2011 another Britten-Norman Islander, registration VP-MNI, operated by the same operator as VP-MON, departed the side of the runway at John A Osborne Airport[13]. The aircraft had departed from VC Bird Airport, Antigua, and was making an approach to Runway 10 at John A Osborne Airport at about 1915 hrs. After a normal touchdown the pilot applied the brakes and noticed that there was no response from the right brake pedal. While maintaining directional control with the rudder the pilot tried to 'pump' the brake pedals but this had no effect on the right brakes. To avoid departing the end of the runway the pilot allowed the aircraft to turn left onto grass just beyond the taxiway exit. The aircraft struck the embankment located 23 m north of the runway edge, approximately 150 m from the end of the runway. The impact, which was estimated by the pilot to be at approximately 10 kt, resulted in damage to the nose structure and caused the nose landing gear leg to collapse (Figure 10). The left wing tip leading edge was also damaged when it struck the embankment. The seven passengers were able to exit the aircraft via the main door after the aircraft came to rest. The loss of right braking was attributed to trapped air in the hydraulic lines which was probably introduced during a right brake O-ring seal replacement prior to the accident flight. Following this repair work the right brakes had not been bled in accordance with the aircraft maintenance manual (AMM).

ASSI oversight of John A Osborne Airport

ASSI is responsible for the oversight of John A Osborne Airport which includes carrying out annual audits. The last audit of the airport prior to the VP-

Footnote

12 'With the surface in sight' means the pilot being able to see sufficient surface features or surface illumination to be able to maintain the aircraft in a desired attitude without reference to any flight instrument.

Footnote

13 For full details see AAIB report in Bulletin 2/2012.

Figure 10

Northern embankment near the end of Runway 10 where VP-MNI came to rest (southern embankment visible in the distance)

MON incident was carried out on 22 to 23 July 2010 and the findings were published in October 2010[14]. The primary findings were that the airport operator needed to establish a maintenance programme, and develop a Safety Management System Manual, and that there were some deficiencies in the Aerodrome Manual. The inspection did not cover all aspects of the airport operation and did not mention the lack of recent friction measurements or note any issues surrounding obstacle clearance or APAPI angle settings.

In October 2011 ASSI carried out another audit of the airport operator and their findings included the following:

(1) runway friction monitoring should be resumed as soon as possible

(2) all aerodrome obstacles should be assessed and then removed or marked, and obstacles that cannot be addressed are to be documented in the AIP and Aerodrome manual

Landing incidents and accidents

The Flight Safety Foundation published a report "*Reducing the Risk of Runway Excursions - Report of the Runway Safety Initiative*" in May 2009.

It stated that during the 14-year period from 1995 to 2008, commercial transport aircraft were involved in a total of 1,429 accidents involving major or substantial damage. Of those, 431 accidents (30%) were runway-related. Of these, 417 (97%) were runway excursions.

The number of runway excursion accidents was more than 40 times the number of runway incursion accidents, and more than 100 times the number of runway confusion accidents. Over the past 14 years,

Footnote

[14] ASSI have stated that alhough the report was not issued until October 2010, the findings were issued and signed as accepted by the airport manager at the end of the audit on 23 July 2010.

there has been an average of almost 30 runway excursion accidents per year for commercial aircraft, while runway incursion and confusion accidents combined have averaged one accident per year.

Forty-one of the 431 runway accidents involved fatalities. Excursion accidents accounted for 34 of those fatal accidents, or 83% of fatal runway-related accidents. Over the 14-year period, 712 people died in runway excursion accidents, while runway incursions accounted for 129 fatalities and runway confusion accidents accounted for 132 fatalities.

During the 14-year period, the number of takeoff excursion accidents decreased. However, the takeoff excursion accident trend has levelled off. During the same period the number of landing excursions showed an increasing trend.

An in-depth study was conducted of all runway excursion accidents from 1995 to March 2008 to investigate the causes of runway excursion accidents and to identify the high-risk areas. Landing excursions outnumber takeoff excursions approximately 4 to 1 with the principal risk factors being a fast approach and touching down long.

The Flight Safety Foundation published the following in its Approach and Landing Accident Reduction Briefing Note 7.1, Stabilized Approach:

'**Recommended Elements of a Stabilized Approach**

All flights must be stabilized by 1,000 feet above airport elevation in instrument meteorological conditions (IMC) or by 500 feet above airport elevation in visual meteorological conditions (VMC). An approach is stabilized when all of the following criteria are met:

1. *The aircraft is on the correct flight path;*
2. *Only small changes in heading/pitch are required to maintain the correct flight path;*
3. *The aircraft speed is not more than VREF + 20 knots*[15] *indicated airspeed and not less than VREF;*
4. *The aircraft is in the correct landing configuration;*
5. *Sink rate is no greater than 1,000 feet per minute; if an approach requires a sink rate greater than 1,000 feet per minute, a special briefing should be conducted;*
6. *Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft operating manual;*
7. *All briefings and checklists have been conducted;*
8. *Specific types of approaches are stabilized if they also fulfil the following: instrument landing system (ILS) approaches must be flown within one dot of the glideslope and localizer; a Category II or Category III ILS approach must be flown within the expanded localizer band; during a circling approach, wings should be level on final when the aircraft reaches 300 feet above airport elevation; and,*

Footnote

[15] This report is primarily focused on public transport aircraft larger than an Islander. The recommended maximum speed for the Islander is V_{REF} +15 kt as stated in the operator's OM.

> 9. *Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.*
>
> *An approach that becomes unstabilized below 1,000 feet above airport elevation in IMC or below 500 feet above airport elevation in VMC requires an immediate go-around.*
>
> *Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force (V1.1, November 2000)'*

Analysis

General

Based on the position of the initial skid marks, VP-MON touched down at a point that under normal conditions and at a normal touchdown speed should have enabled to aircraft to stop safely on the runway. During the incident the pilot reported difficulty decelerating the aircraft; he steered the aircraft off the runway because he was concerned that it would not stop before the end of the prepared surface. No technical faults with the brakes or braking system were found so the possible factors considered were: hydroplaning, runway surface friction and high touchdown speed resulting either from a tailwind or excessive airspeed on approach, or from both.

Although there had been a light rain shower at the airport prior to the incident, the runway surface was described as 'damp' by the pilot and by the majority of the witnesses. For hydroplaning to occur a water depth of at least 1 mm to 3 mm is required, which would give the appearance of a 'wet' runway rather than a 'damp' one. Furthermore, the skid marks on the runway indicated that there was good friction contact between the runway surface and the tyres, which would not occur had the aircraft hydroplaned after touchdown.

Runway friction

When the runway friction was first assessed in 2005 the friction level was determined to be at the limit of the maintenance planning level of 0.53, although there was one day when the friction was measured as high as 0.71. Due to the variation in results it is difficult to determine what the new runway friction level was. Subsequent measurements in 2007 and 2009 were not carried out correctly, either because the equipment was not calibrated correctly or the towing speed was too high. The airport operator has made a number of attempts to obtain accurate friction measurements since the VP-MON incident but have been unable to do so because of equipment problems and a lack of staff training.

There have not been any other pilot reports of a slippery runway since the VP-MON incident or prior to the incident. When runway surfaces start to become slippery in the wet it is usually followed by a number of pilot reports – as in the case of the runway excursion incidents investigated by the AAIB at Bristol International Airport in 2007 (see AAIB Formal Report 1/2009). Since there were also no obvious surface defects or unusual surface deposits on the runway, it is probable that the friction level was at an acceptable level.

Nevertheless, it is important that an accurate friction assessment is carried out and therefore Safety Recommendation 2011-079 is still considered open. ASSI have supported this recommendation and have raised friction measuring as a finding in their latest audit of the airport operator.

Weather

At 2100 hrs the cloud was broken at 1,600 ft aal. As the aircraft commenced its first approach the ATCO reported the cloud base was "APPROXIMATELY 600 FT AND BELOW DRIFTING IN FROM THE WEST". Just after the incident there were light showers of rain and thunderstorms, and broken cloud at 600 ft aal. It can thus be seen that at the time of the incident the cloud base was likely to have been below 1,500 ft aal. The ATCO's were working to 5 km visibility and clear of cloud. Had they been operating to a 1,500 ft aal cloud base the airfield could have ceased VFR operations, albeit temporarily, until the weather improved. Additionally had the pilot known of the 1,500 ft cloud base weather limit he might have decided either to hold until the weather improved or divert to Antigua.

An anemometer placed closer to the Runway 28 threshold would have enabled the ATCO to provide the pilot with a more representative indication of the wind there as recommended in Safety Recommendation 2011-077.

There is only one windsock located close to the Runway 10 threshold. Had there been one close to the Runway 28 threshold the pilot may have had a visual indication of any tailwind present.

Training

The pilot had not been flight checked to operate from or to Runway 28. Had he been he would have been familiar with the approach over the hill at 'Lookout', and the associated local conditions on the approach to Runway 28 and may have been more adept at making an approach to Runway 28. Had there been a requirement for pilots to use only runways on which they had been flight checked he might have held off until Runway 10 was suitable, or diverted to Antigua.

Aircraft handling

The chief pilot commented that he instructed pilots to monitor the GPS ground speed readout, on short finals, to get an indication of tailwinds. Had the pilot made use of the GPS's ground speed readout he might have gained an appreciation of any tailwind component.

The pilot stated that he "felt" a tailwind during both approaches. If there was a tailwind it would have increased the aircraft's ground speed, which would have required an increased rate of descent to maintain an appropriate approach path. If not monitored closely, and without timely reduction in the aircraft's power to maintain the appropriate approach speed, this would have further increased the aircraft's ground speed and landing roll. The pilot had sufficient fuel to delay further approaches until the weather and wind were more suitable to make an approach on Runway 10, or to divert to Antigua.

The operator and its pilot were not aware of the WAT limit at the time of the incident. The operator has since produced a reference chart to ensure they comply with it.

The AAIB calculated that the aircraft landed 144 lb above the MLW of 6,300 lb and 169 lb above the WAT limit for the conditions at the time. However, the calculated effect of being above MLW and above the WAT limit was a minimal increase on the ground roll of about 3 m. Although it appears to have touched down at an appropriate distance from the threshold, at the operator's suggested touchdown point, the witnesses stated that it was "fast" when it did so. While the aircraft's actual airspeed could not be determined it is likely that, due to a tailwind and possible excessive approach speed, the aircraft's ground speed would have been fast, leading to an increased landing roll. The landing roll would also have been increased by the aircraft's excessive weight.

The pilot stated he was not aware of the conditions for a stabilised approach. Awareness of the requirement to fly a stabilised approach and the associated conditions might have informed a decision to go-around, as he did after his first approach. With the cloud base likely to have been below 1,500 ft the pilot would not have had the opportunity to establish the aircraft on an appropriate approach angle from a suitable distance. He would have had to intercept it, having flown below the low cloud base, at a shorter distance from the runway. This would have complicated the task of establishing a stabilised approach in the prevailing conditions.

Runway over-run areas

VP-MON came to rest 46 m from the end of the paved surface of Runway 28, beyond which is a steep drop, and 11 m from the edge of the steep drop on the northern side of the runway. When landing on Runway 10 the options for preventing a runway over-run are to veer to the left into a steep embankment or to the right into a ditch followed by a steep embankment. Although the runway environment is compliant with the minimum specifications in ICAO Annex 14, there are significant hazards associated with an aircraft departing the ends or the sides of the runway. In light of the incidents to VP-MON and VP-MNI the airport operator should carry out a risk assessment of the hazards associated with runway excursions as part of its Safety Management System. Accordingly, the following Safety Recommendation is made:

Safety Recommendation 2012-010

It is recommended that the operator of John A Osborne Airport, Montserrat, carry out a risk assessment of the hazards associated with runway excursions and implement any necessary mitigating action.

Obstacles and APAPIs

A survey carried out in 2009 revealed a palm tree obstacle which infringed the 'Approach surface', as defined in ICAO Annex 14, and a total of eight obstacles, consisting of trees and bushes, which infringed the 'Takeoff climb surface'. The airport operator had not taken any action either to remove these obstacles or have them listed in the ECAIP. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2012-011

It is recommended that the operator of John A Osborne Airport, Montserrat, remove the obstacles that infringe the ICAO Annex 14 'Aerodrome Design and Operations' takeoff and approach surfaces.

Even after removing these obstacles to gain compliance with Annex 14, the houses on 'Lookout' hill will remain; one of these houses will be cleared by about 40 feet if a pilot flies the 3° APAPI approach path to Runway 28. The flight inspection company reported that the APAPI angle of 3° resulted in an approach that was too close to houses, and was '*quite dangerous*' when also taking into account the known wind shear issues. No action was taken by the airport operator in response to their report. Pilots often fly a steeper approach than 3° towards Runway 28 because of the houses and wind shear, but in these cases the APAPI provides limited visual guidance because above an approach path of 3.25° the pilot will only see two white lights.

If the APAPI angle had been set higher it might have assisted the pilot of VP-MON in judging his approach towards an unfamiliar runway without worrying about flying too close to the houses. However, any effect on landing distances must also be taken into account when evaluating an increase in APAPI angle. Consideration should also be given to relocating the APAPIs closer to the Runway 28 threshold to reduce any increase in landing distance. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2012-012

It is recommended that the operator of John A Osborne Airport, Montserrat, review the Runway 28 APAPI position and angle setting to improve obstacle clearance on the approach.

The airport operator has changed the APAPI angle for both runways to 3.5°. The installation was found satisfactory by a commercial flight inspection organisation and a further review of the APAPI positioning is planned.

Conclusion

No faults were found with the aircraft's braking system and there was no evidence that the aircraft had hydroplaned. An accurate runway friction assessment could not be obtained, but there were no pilot reports of poor friction prior to or after the incident. A tailwind and/or high touchdown airspeed would have increased the landing distance required by the aircraft. Issues identified by the investigation were pilot training, wind measurements, the aerodrome's weather limits, the APAPI approach angle, obstructions on the approach and the runway environment.