SERIOUS INCIDENT

Aircraft Type and Registration:	Cessna C208B Super Cargomaster, N967FE
No & Type of Engines:	1 Pratt & Witney PT6A-114A turboprop engine
Year of Manufacture:	1988
Date & Time (UTC):	23 September 2020 at 1716 hrs
Location:	Terrance B Lettsome International Airport, Tortola, British Virgin Islands
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to both main wheels and to the right landing gear leg fairing and baggage pod
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	1,878 hours (of which 174 were on type) Last 90 days - 143 hours Last 28 days - 44 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot was operating a cargo flight from San Juan, Puerto Rico to Tortola, British Virgin Islands. He discontinued the first approach due to poor weather. Following the second approach the aircraft made a hard landing that was 795 m beyond the threshold of the 1,206 m runway. During the landing roll the aircraft veered off the runway damaging the wheels, landing gear and baggage pod.

Data from the aircraft showed that the approach did not meet the operator's stable approach criteria. It also showed that the engine was running below the normal flight idle speed during the last few moments of the flight. Examination and testing found no evidence of anomalies with the engine. It was not possible to determine why the engine was operating below the normal idle speed whilst in flight.

It is likely that the pilot was experiencing high workload due to the unstable approach and poor weather and this may have limited his ability to deal with the situation. The operator intends to update its operations manual to state explicitly the altitude by which stable approach criteria must be achieved for all types of approach.

History of the flight

The pilot was operating a cargo flight from San Juan International Airport in Puerto Rico to Terrance B. Lettsome International Airport on Beef Island (Beef Island Airport) in the British Virgin Islands. He was scheduled to fly back later the same day. This was his only duty on the day and he reported that he was well rested. He checked the weather prior to the flights and believed the weather was good enough to make a visual approach at Beef Island.

The aircraft took off from San Juan at 1619 hrs (1219 hrs local time) and routed to the north-east climbing to 7,000 ft. Figure 1 shows the route flown.

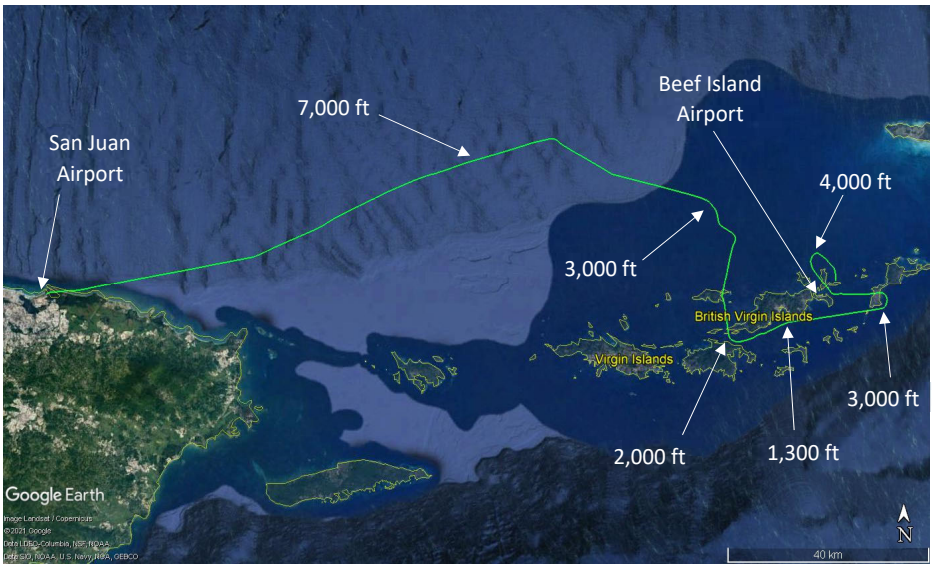


Figure 1

Route flown from San Juan to Tortola Airport

(Note: the aircraft's final position is north-east of the airport as the aircraft could not be tracked at low altitude)

At 1642 hrs the pilot started a descent and flew towards the western edge of Tortola. He contacted Beef Island Air Traffic Control and reported he was making a visual approach to Runway 25. ATC advised that the surface wind was from 180° at 12 kt and there were "SOME SHOWERS APPROACHING THE FIELD FROM THE SOUTH-SOUTHWEST AND LIGHT RAIN AT THE FIELD". The pilot initially reported that he would join "RIGHT DOWNWIND" which led ATC to believe the aircraft was approaching from the north and would be clear of the weather. At 1659 hrs the pilot advised ATC he was "TEN MILES FROM THE NORTH", but the aircraft was actually 10 nm west-southwest of the airport. When the aircraft was 5 nm to the south-west of the airport the pilot reported he was unable to see the airport and that he was going to divert back to San Juan. He requested a heading from ATC, but they were unable to give one as they do not have radar. They instructed the pilot to climb to 3,000 ft and contact San Juan ATC.

The pilot contacted San Juan ATC and was instructed to route directly to San Juan on passing 3,000 ft. Once routing to the north-west the pilot saw dark cumulus cloud ahead so

asked ATC for a right turn to avoid the weather. This routing took the aircraft overhead Beef Island Airport. As the aircraft passed over the airport at approximately 5,000 ft the pilot saw the runway and decided he could now attempt a visual approach. He informed ATC and was cleared for a visual approach to Runway 25.

The aircraft descended on a wide right base for Runway 25. The pilot described that as he turned onto the final approach, he could see there was a shower ahead, but he believed it was only light rain. However, as he entered the shower, he lost visual contact with the runway and elected to go-around. He stated that he applied full power and pitched up, but the aircraft did not climb. He was aware there were buildings on his left and hills on his right so he tried to climb straight ahead but the aircraft would not climb. The pilot described that "it felt like strong windshear" and he was unable to prevent the aircraft descending.

Two witnesses saw the aircraft approaching the airport, they described that when they first noticed the aircraft it was at approximately 200 ft but it was too high and travelling too fast to attempt a landing. They described seeing the aircraft continue at this height along the length of the runway and that as it passed Taxiway D it was "swaying side to side" before "the nose turned down" and it started to descend.

Both air traffic controllers recalled seeing the aircraft approaching the airport and then flying along the runway before making a sudden descent.

The aircraft landed on the centreline 795 m past the threshold (total landing distance available - 1,206 m). The right tyre burst on landing and the under-fuselage baggage pod contacted the runway. The aircraft travelled along the runway but as the speed reduced the pilot was unable to keep it on the centreline. The aircraft veered to the right onto the grass, coming to rest approximately 18 m to the north of the runway.

The pilot was not injured and was able to exit the aircraft normally.

Figure 2

N967FE after the incident

Figure 3

N967FE after the incident

Accident site

Figure 2 and 3 show the aircraft after the incident. Figure 4 shows the damage to the right wheel assembly and the aft fuselage. Figure 5 shows the location of the initial touchdown and the marks left on the runway.

Figure 4

Damage to right wheel assembly and under-fuselage baggage pod

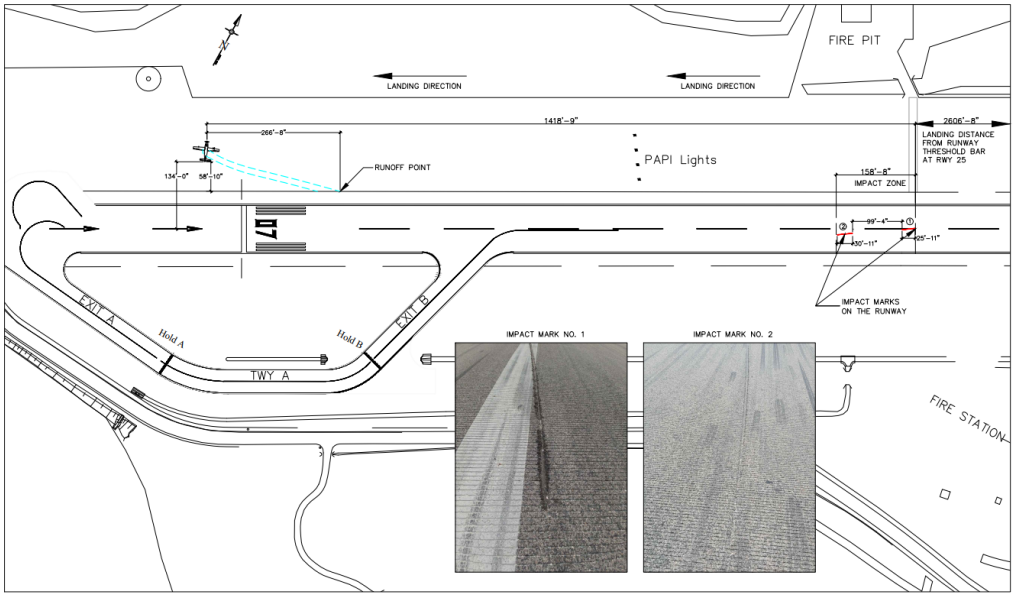


Figure 5

Aerodrome map showing initial impact marks and final position

Recorded information

Data recorders

N967FE was not fitted with a Flight Data Recorder or a Cockpit Voice Recorder, nor were these required to be fitted to this aircraft. However, the engine was fitted with a data recorder manufactured by the engine's manufacturer Pratt and Whitney Canada (PWC). This system, called an ADAS+[1] engine monitoring system, recorded several engine performance parameters including gas generator and propeller speed, inter-turbine temperature (ITT), fuel flow, and engine torque. It also recorded altitude, airspeed, whether any bleed air was being extracted from the engine core, setting of the Emergency Power Lever and outside air temperature. The ADAS+ system was installed when the aircraft was manufactured to assist with the diagnosis of engine related issues during the life of the aircraft and to collect engine trend data to allow the ongoing health of the engine to be monitored. The unit was downloaded by PWC as part of this investigation and used to produce the following plots.

Figure 6 shows a selection of the data for the whole of the incident flight, including the engine start and shutdown, that has been annotated to show the cruise, discontinued approach, visual approach and landing portions of the flight. Of note, the idle speed of the engine in the Cessna 208B Super Cargomaster can be selected by the pilot using the Fuel Condition Lever to either LOW IDLE or HIGH IDLE. LOW IDLE is used for ground operations, such as taxiing, whilst HIGH IDLE is used during flight. HIGH IDLE should be selected by the pilot prior to takeoff and LOW IDLE re-selected after landing. The position of the Fuel Condition Lever was not recorded but the data shows that the engine accelerated normally to LOW IDLE after start and that HIGH IDLE was achieved before taxi.

Footnote

[1] The ADAS+ system is an improved version of PWC's original Airborne Data Acquisition System.

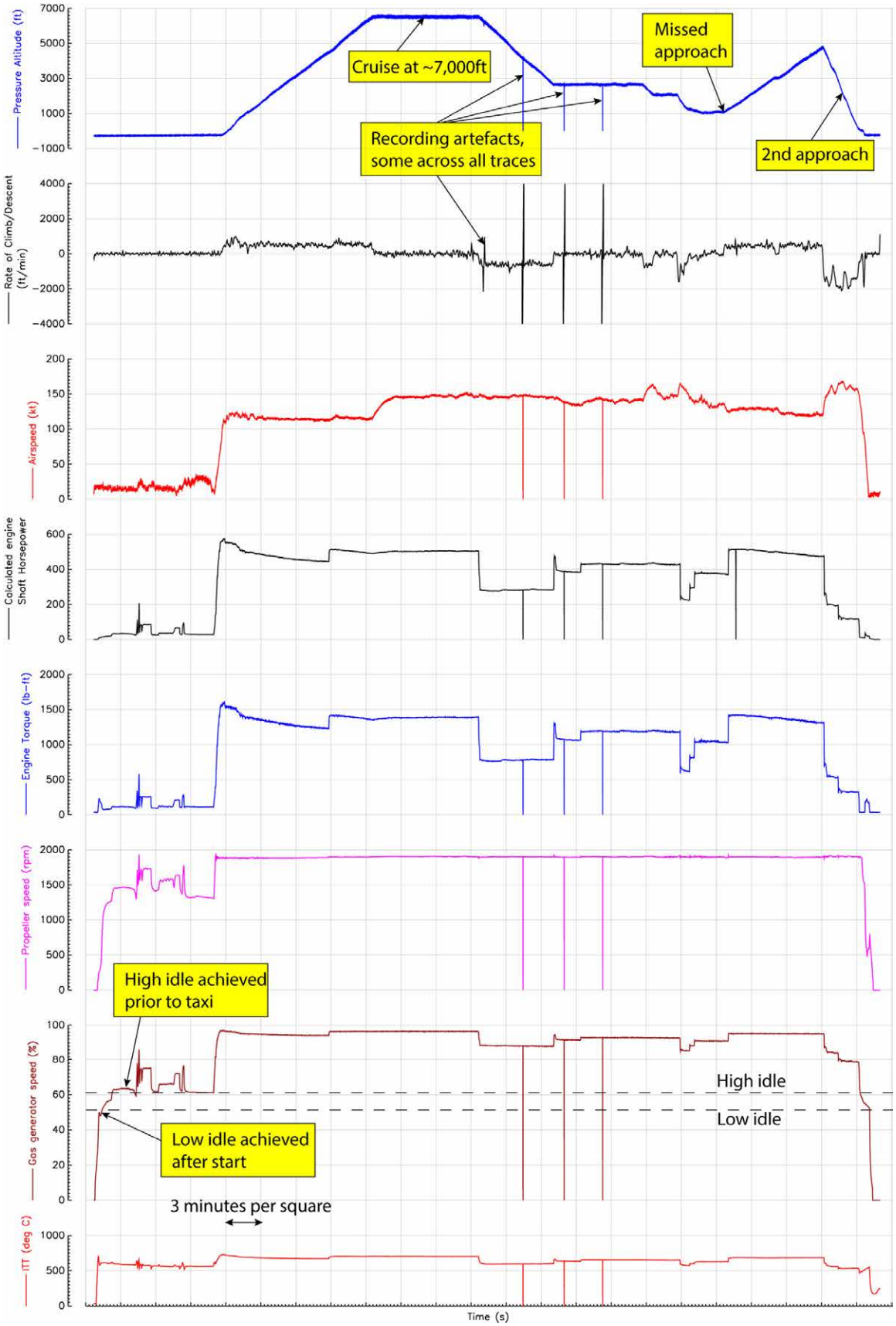


Figure 6

ADAS+ data for the whole of the incident flight

After the discontinued approach, N967FE climbed to approximately 5,000 ft before a second approach was commenced. An expanded view of data for this approach, from 1,000 ft aal, and the subsequent landing at Beef Island Airport is shown in Figure 7. The data shows that N967FE descended at 155 - 160 kt, 15 – 20 kt less than the aircraft's V_{NE} of 175 kt[2], with an average rate of descent of 1,400 ft/min until 350 ft aal. Approximately 30 seconds from landing, the power output from the engine substantially reduced, indicated by a reduction in gas generator speed and engine torque. The airspeed decreased and stabilised at approximately 95 kt and the aircraft flew level at 250 ft aal for a period of 10 seconds. However, the gas generator speed continued to decrease below the HIGH IDLE value expected in flight (62%) and propeller rpm also began to decay. Shortly afterwards, a high rate of descent, approaching 2,000 ft/min, developed as the aircraft passed through 150 ft aal. The gas generator speed, although not fully stabilised, was by this point decreasing towards LOW IDLE.

The position of the Emergency Power Lever, which would have allowed the pilot to directly modulate the fuel flow to the engine if deceleration of the engine was caused by a fuel control unit (FCU) malfunction, was recorded. This data shows that the Emergency Power Lever was not used to restore engine power.

The data also shows that on final approach there were no significant short-term changes in airspeed to indicate windshear.

Flightradar24 data

N967FE's flightpath was tracked by Flightradar24, a commercial flight tracking website. Figure 1 shows the aircraft's route from San Juan to Beef Island Airport.

Closed-circuit television (CCTV)

CCTV at the airfield captured N967FE approaching the airfield and the subsequent landing. Figure 8 shows the aircraft approaching from the east. Figures 9 and 10 shows the aircraft descending towards the western end of the runway. Figure 11 shows the touchdown with the aircraft banked to the right.

Radio communications

Communications between Beef Island Airport ATC and N967FE were recorded. A transcript of the communication assisted in determining the history of the flight.

Footnote

[2] V_{NE} is the aircraft maximum (never exceed) speed limitation

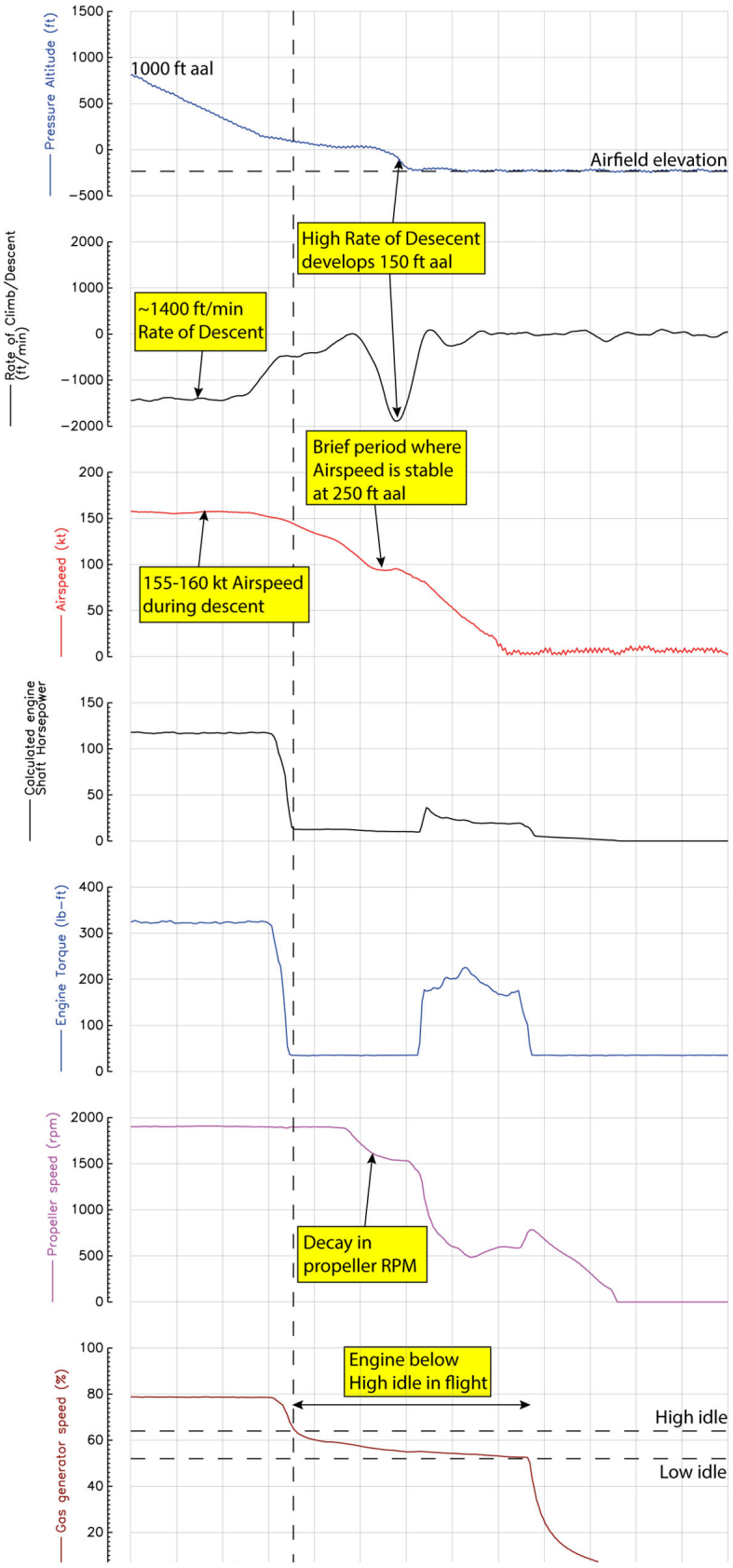


Figure 7

ADAS+ data from 1,000 ft aal for the incident flight

Figure 8

CCTV looking East at time 1715:29 hrs

Figure 9

CCTV looking West at time 1715:45 hrs

Figure 10

CCTV looking West at time 1715:48 hrs

Figure 11

CCTV looking West at time 1715:49 hrs

Aircraft information

The Cessna C208B Super Cargomaster is a single engine high-wing cargo aircraft with a maximum takeoff weight of 3,977 kg. It is powered by a Pratt & Whitney PT6A-114A turboprop engine and has fixed tricycle landing gear. The pilot has three main engine controls: a power lever used to control the engine power output, a propeller lever which is used to control the propeller rpm and a Fuel Condition Lever that is used to control the engine idle speed and to shut the engine down by cutting off the fuel flow. The Fuel Condition Lever has three positions: CUT-OFF, LOW IDLE and HIGH IDLE. In addition, there is an Emergency Power Lever which can be used to control the engine power if the normal controls become ineffective.

Aircraft examination

The aircraft was examined by the operator. Damage was found to the left and right main wheel assemblies, the right landing gear fairing, the right axle cover, the nosewheel steering bungee and the DME[3] antenna. A scrape mark was found on the aft of the cargo pod where it had contacted the runway but this was found to have only damaged the paint. A Hard Landing inspection was carried out, no structural damage was found.

Once the airframe damage was repaired, a subsequent engine run, on 7 October 2020, identified a lack of engine response to throttle movement. As part of fault finding, in accordance with the maintenance manual, the P3[4] line and P3 filter were replaced and the Py[4] line was blanked at the FCU[5] to eliminate it from the fault finding. This had no effect on the engine operation and as a result the FCU and the engine fuel pump assembly were replaced. These units had been fitted approximately six flying hours before the occurrence on 23 September 2020. Once the replacement components had been installed and tested the aircraft was returned to service.

Meteorological information

The air traffic controller on duty when the incident occurred reported that at the time of the incident visibility from the northwest clockwise to the east was in excess of 10 km and the cloud ceiling was scattered at 1,800 ft. There was light rain on the field but it did not obscure visibility on the final approach to Runway 25 as Virgin Gorda (7 nm away) was still visible. However, there was reduced visibility to the south. He recalled that when he saw the aircraft start to sink, he immediately looked at the wind for Runway 25 and Runway 07. One was showing 170° at 3 kt and the other was variable at 2 kt.

The meteorological actual report issued by the airport at 1700 hrs reported the surface wind was from 150° at 14 kt, visibility was 2 statute miles, there was a rain shower over the field, the cloud was scattered at 1,700 ft, temperature was 28°C, dew point was 24°C and the pressure was 29.95 inches of mercury. The report at 1800 hrs recorded the surface wind

Footnote

[3] Distance Measuring Equipment
[4] P3 and Py are designations of internal engine pressures that are used to assist it in controlling the engine.
[5] The FCU is the normal device used to control the engine in response to pilot inputs, ambient conditions and relevant engine parameters, by metering the appropriate amount of fuel to the engine.

was variable at 2 kt, visibility was 10 statute miles, there was a thunderstorm over the field, the cloud was few at 1,000 ft, temperature was 29°C, dew point was 26°C and the pressure was 29.93 inches of mercury.

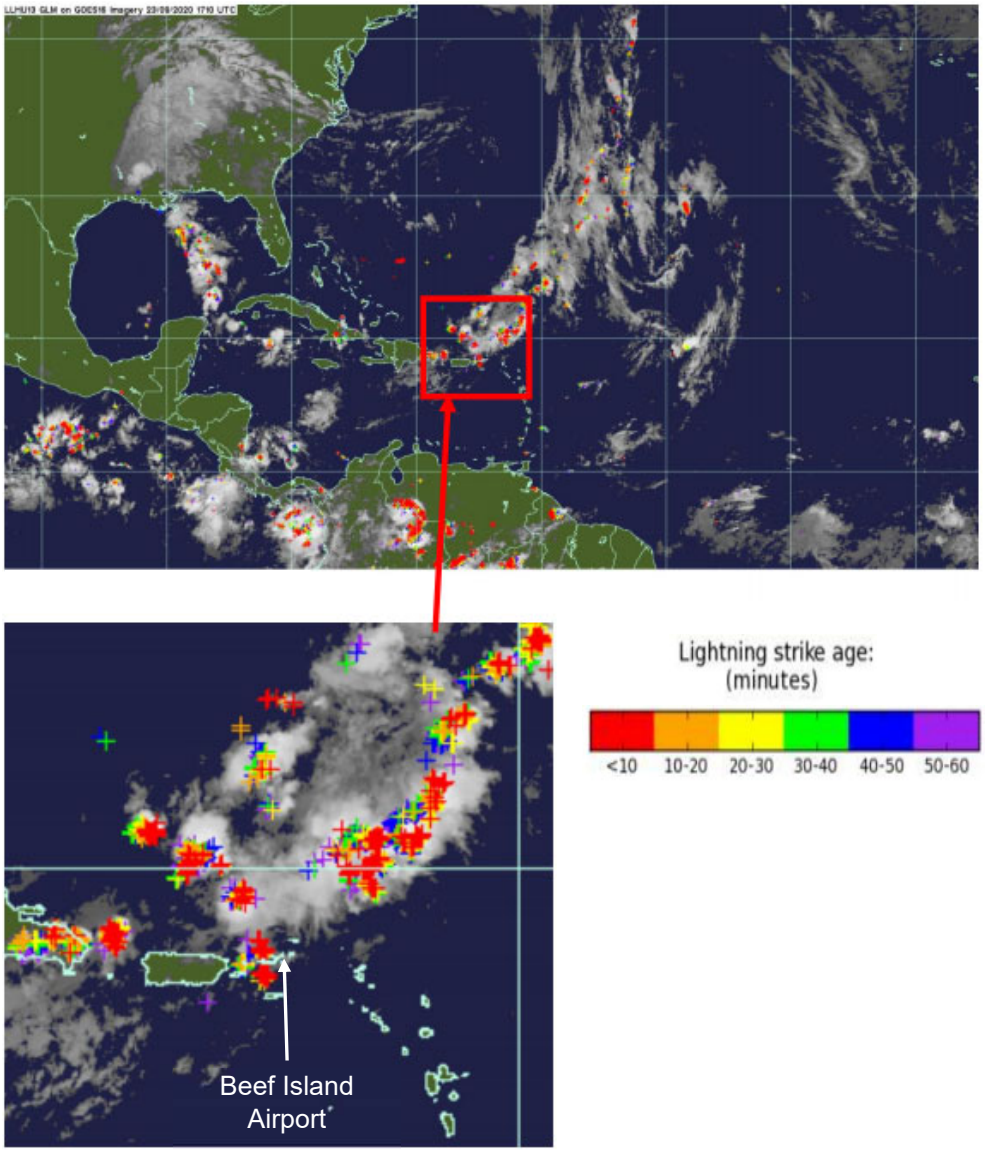


Figure 12

Satellite image of the Caribbean with Lightening activity overlaid valid at 1710 hrs

Figure 12 shows a satellite image displaying a band of cloud with embedded thunderstorm activity extending from the mid-Atlantic towards the Caribbean, the majority of the activity remained to the north of the British Virgin Islands, but there were several active thunderstorms surrounding the territory at 1710 hrs. Figure 13 shows a radar image valid at 1710 hrs, obtained from the US weather radar situated in San Juan (140 km to the west of the accident site). The bright echoes on the radar picture indicates heavy showers over both the British and US Virgin Islands. These showers correlate well with the areas of thunderstorm and lightning activity in Figure 12.

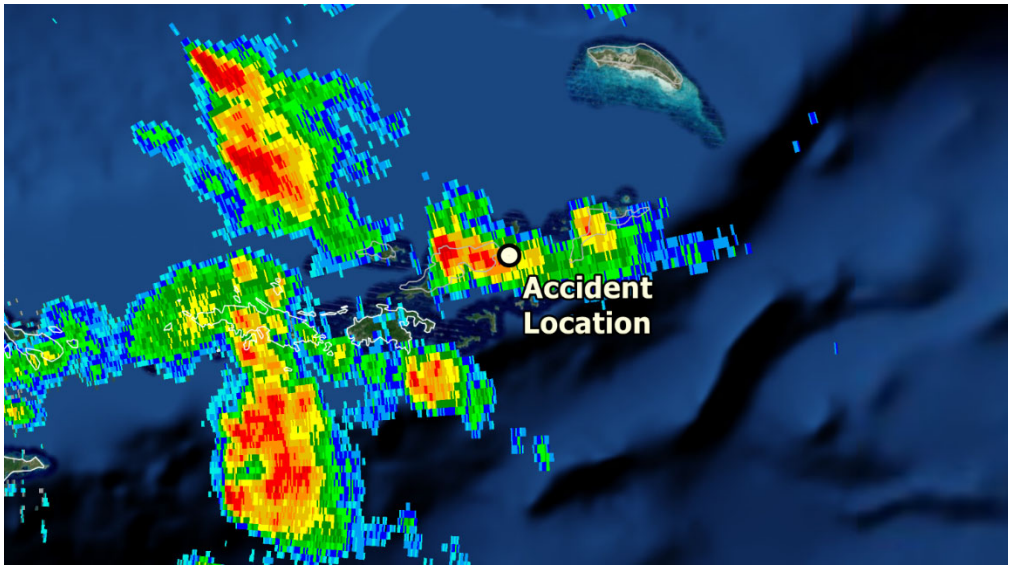


Figure 13
Radar image valid at 1710 hrs

Aerodrome information

Terrance B Lettsome International Airport is situated on a small island (Beef Island) on the eastern end of Tortola. It has a single asphalt runway orientated 07/25 which is 1,416 m long and 30 m wide. Terrain effects the approach to both ends of the runway. Runway 07 is the predominate runway used due to the prevailing wind. Runway 25 has a landing distance available of 1,206 m.

Runway 25 has PAPI[6] on the south side of the runway set to indicate a 3.5° approach slope. RNAV(GNSS)[7] instrument approaches are published for both runways. The RNAV approach to Runway 25 is a straight-in approach constructed with a 3.3° approach slope.

Pilot information

The pilot held an FAA Commercial Pilot's Licence with valid multi engine and single engine ratings. He held a valid Class 1 medical. He had a total flight time of 1,878 hours of which 174 hours were on the Cessna C208B. He joined the operator 8 months before the incident in February 2020.

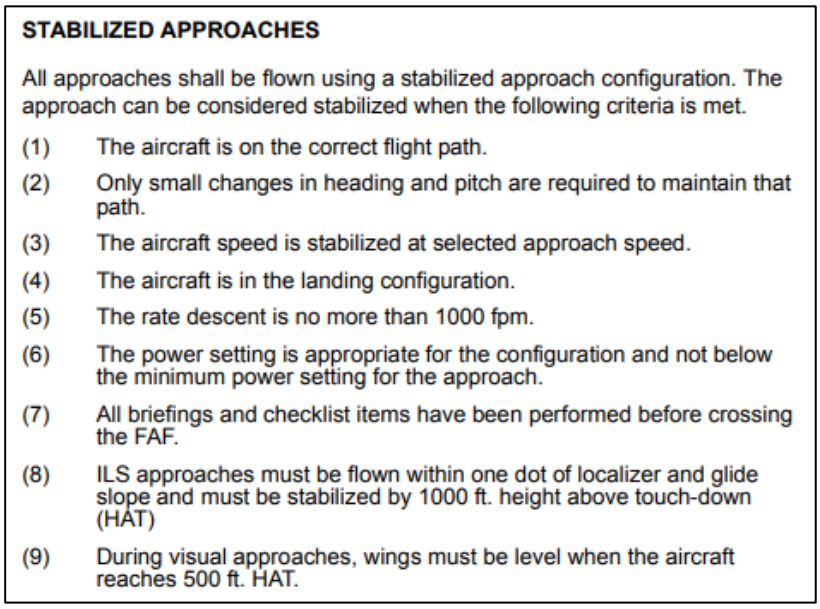
He had flown to Beef Island Airport many times before and had flown the same route two days before the incident. The pilot commented that most of his approaches to Beef Island had been to Runway 07.

Footnote

6 Precision Approach Path Indicators.
7 RNAV – Area Navigation, GNSS – Global Navigation Satellite System.

Organisational information

The operator's operations manual stated that all approaches shall be flown using a stable approach configuration. The criteria are shown in Figure 14.



STABILIZED APPROACHES

All approaches shall be flown using a stabilized approach configuration. The approach can be considered stabilized when the following criteria is met.

(1) The aircraft is on the correct flight path.

(2) Only small changes in heading and pitch are required to maintain that path.

(3) The aircraft speed is stabilized at selected approach speed.

(4) The aircraft is in the landing configuration.

(5) The rate descent is no more than 1000 fpm.

(6) The power setting is appropriate for the configuration and not below the minimum power setting for the approach.

(7) All briefings and checklist items have been performed before crossing the FAF.

(8) ILS approaches must be flown within one dot of localizer and glide slope and must be stabilized by 1000 ft. height above touch-down (HAT)

(9) During visual approaches, wings must be level when the aircraft reaches 500 ft. HAT.

Figure 14
Operator's stable approach criteria extracted from their operations manual

Other than for an ILS approach, the manual does not specify the altitude at which the criteria must be achieved. However, the operator advised that they would expect an aircraft on a visual approach to be stable from 'pattern altitude'. The manual states that '*normal traffic pattern altitudes for all company flights shall be 1500 ft agl for turbine powered aircraft*'. Following the incident, the operator intends to update its operations manual to explicitly state the altitude by which the criteria must be achieved for all approaches.

The operator was in the process of installing the Appareo Vision 1000 flight data monitoring system on all its aircraft which comprises a forward looking camera, GPS, attitude and rate sensors. However, the system had not been installed on N967FE when the incident occurred. The system would allow the operator to monitor approach stability, manage trends and, where necessary, enhance training. The operator reported it intends to have the system installed on all aircraft by February 2021.

Technical examination

FCU and fuel pump examination

The FCU, fuel pump assembly and P3/Py lines removed from the aircraft were sent to the engine manufacturer for examination and test. When the FCU was unpacked on arrival, it was found that blanking caps, normally fitted when the component is removed, were not fitted to the P3 line adaptor. The examination and testing did not identify any anomalies that would have contributed to the reported event.

Other engine related information

The FCU and fuel pump assembly that were previously installed on the aircraft had been in operation for approximately 345 flight hours. They were removed from the aircraft on 15 September 2020 (a week before the incident flight) because the engine would not initially respond to power demands, although it did after several attempts. These components were also sent to the engine manufacturer for inspection and test.

Testing of the previously installed FCU found that the setting of the cut-off valve was interfering with the HIGH IDLE fuel flow. Depending on how the aircraft Fuel Condition Lever was rigged this could have resulted in unstable fuel flow at HIGH IDLE which could cause the reported engine behaviour event. It is not known when the adjustments to these settings were made. Examination of the fuel pump assembly did not identify any anomalies. After replacement of this FCU and fuel pump assembly, ground engine run tests were completed satisfactorily, and the aircraft returned to service, operating without reported incident until the occurrence on 23 September 2020.

Analysis

The aircraft was making a visual approach to Beef Island Airport when the pilot reported that the aircraft entered a rain shower and he decided to go-around. However, he reported that the aircraft did not climb. The aircraft was seen on CCTV and by several witnesses flying level, at approximately 300 ft and high speed, along the runway before descending steeply to the ground. It landed firmly, two thirds of the way along the runway, leaving scrape marks on the runway surface, and then left the paved surface during the landing roll.

Data from the aircraft showed that the approach did not meet the operator's stable approach criteria. At 1,000 ft aal the aircraft's airspeed was between 150 and 160 kt and remained above 150 kt until the aircraft was at 350 ft aal. This was significantly above the target approach speed of 110 kt with the flaps retracted reducing to 85 kt with flaps extended. From 1,000 ft aal the average rate of descent was 1,400 ft/min; much greater than the 1,000 ft/min criteria in the operator's operations manual.

The investigation considered three factors which could have contributed to the incident: an aircraft anomaly which prevented the aircraft from climbing, windshear on the approach or the unstable approach leading to high pilot workload.

Aircraft anomaly

The aircraft was not examined by the AAIB or any other safety investigation authority. The pilot did not report any technical fault with the aircraft after the incident.

Two weeks after the incident and following repairs to the aircraft, the operator reported that during ground runs the engine did not respond to throttle movements. The FCU, fuel pump and pressure sensing lines were replaced, and the aircraft returned to service. The engine has been operating normally since it was returned to service.

Examination and testing of this FCU, fuel pump and sense lines did not identify any anomalies that could have contributed to the event or the lack of engine response during the subsequent ground tests following the airframe repairs.

A different FCU and fuel pump, that were removed from the aircraft six flying hours prior to the incident, were found to have adjustment settings that could have caused the lack of response seen in a previous event on 15 September 2020. There was no record of the rigging settings of the aircraft's engine controls so it was not possible to draw any conclusions about what effect the rigging of these controls may have had on the engine operation.

The actual position of the engine control levers during the accident flight could not be confirmed as they are not recorded.

Analysis of the data recovered from the aircraft showed that the engine was operating at a typical HIGH IDLE speed prior to takeoff and that the engine operated normally during the flight. However, during the approach the engine decelerated below HIGH IDLE. Being below HIGH IDLE in isolation would not have prevented the engine from accelerating if the pilot advanced the power lever. The possible causes for the engine to decelerate below HIGH IDLE include pilot selection of low idle, an FCU malfunction or a blockage of the pressure sensing lines.

The operator trained its pilots to select HIGH IDLE during the before takeoff checklist and return it to LOW IDLE when clearing the runway after landing; and that it should remain at HIGH IDLE throughout the flight. It considered it unlikely that the pilot would have inadvertently or intentionally moved the lever back from HIGH IDLE in flight. The operator reported that it was not aware of any instances of pilots doing this during their pilot checking programme.

No fault was found with the FCU or the pressure sensing lines that were replaced but, it is possible there was a temporary blockage or debris upstream of the P3 filter that was dislodged during the remedial work. It is also possible that there was a temporary blockage where the P3 line enters the FCU; this debris could have been dislodged during removal or transport to the engine manufacturer as blanking caps were not fitted to the P3 line adaptor. If there was a blockage this could have caused the engine to not respond to the power lever. In this case, the only way to increase power would have been to use the Emergency Power Lever.

Windshear

Satellite and radar images showed active thunderstorms to the west of the airfield at the time of the incident with multiple lightning strikes recorded in the previous ten minutes. It is therefore possible that windshear was present. However, ATC reported that they checked the wind when they saw the aircraft descending rapidly and did not see anything which suggested windshear. They reported that there was light rain at the airfield and the visibility in the direction the aircraft was approaching from was greater than 7 km.

The data from the aircraft did not show any rapid airspeed changes or turbulence which might indicate windshear.

Unstable approach and workload

The pilot was experienced flying this aircraft and familiar with Beef Island Airport. However, it was notable that he incorrectly reported his position and intentions to ATC. He reported that he was north of the island and would join "right downwind" when in fact he was south-west of the island and joining from the south (left downwind). This might suggest the pilot's workload was quite high and he was prioritising flying the aircraft and navigating probably due to the challenging weather conditions.

The second approach commenced from overhead the airfield at 5,000 ft. Recorded data showed the aircraft was above the normal profile with a high rate of descent and high speed throughout the approach. The aircraft did not meet the stable approach criteria specified by the operator. When the aircraft was 30 seconds from touchdown the airspeed was still over 150 kt. It is likely that the high energy approach would further increase the pilot's workload.

ATC reported that the visibility in the direction the aircraft was approaching from was greater than 10 km and the cloud was scattered at 1,800 ft. However, the pilot reported that he decided to go-around because he lost sight of the runway when he entered a rain shower that was heavier than he anticipated. Although, prior to the point where the aircraft started to fly level, where the pilot reported he tried to go-around due to entering a rain shower, the aircraft was already in a position from which it would have been challenging to land safely.

The aircraft is fitted with an Emergency Power Lever which can be used to supply fuel to the engine if the FCU malfunctions. If the engine does not respond to power lever movement and the pilot suspects a malfunction of the FCU the Pilot Operating Handbook directs the pilot to use the Emergency Power Lever. However, on the accident flight the pilot reported that he did not have time to consider using the Emergency Power Lever. If the engine did not respond it is likely that any increase in workload caused by the weather conditions and the high energy approach would have reduced the pilot's capacity to diagnose the problem and respond appropriately.

The operator intends to update its operations manual to state explicitly the altitude by which stable approach criteria must be achieved for all types of approach.

Prior to the incident the operator was installing a flight data recording system on all its aircraft. However, it had not been installed on the incident aircraft at the time of the incident. The system allows the operator to monitor approach stability and hence manage trends and enhance training. The operator reported that it expected to have all its aircraft fitted with the system by February 2021.

Conclusion

The aircraft made a hard landing two thirds of the way along the runway and left the paved surface during the landing roll.

Recorded data showed the engine speed reduced below HIGH IDLE shortly before landing but this would not have prevented the engine accelerating. No evidence was found of a technical anomaly with the aircraft or its engine that would have contributed to the event. Although the FCU was removed due to a later issue, no attributable faults were found. However, a temporarily blocked sense line could cause these symptoms. No blockage was found, but the possiblility of a temporary blockage could not be excluded.

Weather conditions for windshear were present in the area but the evidence suggested the aircraft was not affected by windshear. The approach was unstable, and it is possible that this increased the pilot's workload making it more challenging for him to deal with the situation in which he found himself.

Safety action

The operator intends to update its operations manual to state explicitly the altitude by which stable approach criteria must be achieved for all types of approach.

Published: 22 April 2021.