Aviation Investigation Final Report

Location:	Abbeville, Alabama	**Accident Number:**	ERA17LA125
Date & Time:	March 8, 2017, 13:40 Local	**Registration:**	N196TP
Aircraft:	GROB AIRCRAFT AG G120TP-A	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	2 Serious
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

Shortly after takeoff on a local instructional flight, the turboprop engine's continuous ignition switch was turned off, where it likely remained for the remainder of the flight. The pilot, who was receiving instruction, performed flight maneuvers, after which the instructor took control of the airplane to demonstrate a simulated loss of engine power procedure. The procedure was initiated with the crew alerting system (CAS) circuit breaker pulled, per the operator's checklist, and the continuous ignition switch remained off, which was contrary to the recently amended procedure specified in the airplane's flight manual. As part of the procedure, while flying with the power lever at flight idle at 3,350 ft pressure altitude and about 1.8 nautical miles from the intended runway, the flight instructor slowly moved the condition/propeller rpm lever aft to the "low" gate detent. One second later, the engine indications began to decrease, consistent with an engine flameout. Although visual annunciations of an engine flameout would have been available to differing degrees on the flight displays, no aural annunciations occurred because CAS circuit breaker had been pulled.

The instructor continued the maneuver, unaware of the loss of power, and extended the landing gear on the downwind leg of the airport traffic pattern. While on the base leg of the traffic pattern, about 2.5 minutes after the engine flamed out, the instructor recognized the situation, turned toward the runway, and immediately called for an engine restart; at this time, the airplane was less than 100 ft above the ground. The pilot attempted to restart the engine, and the engine began to restart, but about 3 seconds later, the airplane impacted trees and the ground.

The engine was placed in the manufacturer's test cell and found to operate with minor discrepancies noted. The fuel control unit (FCU) was operationally tested at the manufacturer's facility and was found to provide a flow of 20.4 pounds-per-hour (PPH); the specification was 28.0 to 30.0 PPH. The low setting occurred at manufacturing and was attributed to a flow bench indication error.

The manufacturer had experienced engine flame-out issues during production acceptance flight testing. These instances were initially attributed to either rapid movement of the condition lever or the placement of the continuous ignition switch in the off position. To address the issue, the flight manual procedures for simulated forced landing events were updated to address these scenarios. Eight subsequent engine flame-out events were eventually attributed to be from a mis-set minimum flow test point of the FCU at manufacturing, the same condition as the accident FCU.

The FCU manufacturer identified 124 units that were possibly mis-set, and service bulletins were published by the FCU and engine manufacturers to address the low fuel flow of the suspect units.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The flame-out of the engine due to a mis-set fuel control unit at the time of manufacture. Contributing to the accident was the pilots' delayed recognition that the engine had flamed out, partially due to the operator's requirement to disable the crew awareness system.

Findings

Aircraft	Fuel control/carburetor - Incorrect service/maintenance
Aircraft	(general) - Not used/operated
Personnel issues	Use of checklist - Flight crew
Aircraft	Central warning - Not used/operated
Personnel issues	Use of equip/system - Flt operations/dispatcher
Personnel issues	Task monitoring/vigilance - Instructor/check pilot

Factual Information

History of Flight

Maneuvering	Simulated/training event
Approach-VFR pattern base	Loss of engine power (total) (Defining event)
Approach-VFR pattern final	Off-field or emergency landing
Approach-VFR pattern final	Collision with terr/obj (non-CFIT)

On March 8, 2017, about 1343 central standard time, a Grob Aircraft AG G120TP-A, N196TP, was substantially damaged when it was involved in an accident near Abbeville Municipal Airport (0J0), Abbeville, Alabama. The flight instructor and a pilot undergoing instruction (PUI) sustained serious injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 instructional flight.

The flight instructor stated that a preflight inspection was performed and no discrepancies were reported. The flight departed about 1303 from Dothan Regional Airport, Dothan, Alabama with about 1/2 capacity fuel load.

Review of video recorded by an onboard audio/video device revealed that about 70 seconds after takeoff the continuous ignition was set to the “OFF” position and remained in that position for the duration of the video recording. The flight proceeded near Lake Eufaula, where according to the flight instructor, upon arrival, the Crew Awareness System (CAS) circuit breaker was pulled in accordance with the operator's developed upset prevention and recovery training (UPRT) checklist. The recorded onboard video showed that the CAS circuit breaker remained pulled for the duration of the video recording.

The flight instructor further stated that the PUI performed training maneuvers. Data downloaded from the airplane’s Flight Data Monitoring (FDM) device showed that this portion of the flight was about 22 minutes in duration. After completion, the flight instructor took the controls and proceeded to fly to 0J0, where he intended to demonstrate a simulated loss of engine power or practice power off (PPO) maneuver with plans to terminate it with a low pass over the runway.

According to the recorded video and FDM data, about 1340:54, the flight instructor discussed performing the simulated engine out and confirmed the power lever was at flight idle. At that time the engine indications were normal. At 1340:58, while flying about 3,350 ft pressure altitude and about 1.8 nautical miles southeast of the approach end of runway 35 at 0J0, the flight instructor pulled the condition (or propeller rpm) lever to, “a low idle.” He appeared to have a light touch (not quick or jerky) and moved it to the “low RPM” gate. It did not appear that the flight instructor lifted or moved the condition lever aft of the “low RPM” gate. The instructor pilot then appeared to verify it was still at the gate by wiggling the condition lever. One second later, at 1340:59, as the condition lever was at the gate (same position), the engine parameters consisting of N1, oil pressure, and turbine outlet temperature

(TOT) immediately began dropping outside previously stable levels as indicated in the video recording of the multi-function display (MFD), and in the FDM data, which was not aurally annunciated.

The flight continued towards 0J0 and at 1341:46, while about 1,600 ft southeast of the approach end of runway 35, the FDM data revealed oil pressure levels that would have resulted in a displayed "lo oil press" warning indication on the PUI primary flight display (PFD). About 5 seconds later, the airplane was abeam the approach end of runway 35, east of it, about 2,500 ft pressure altitude. The flight instructor added that he continued the maneuver while circling to land, and video indicated that at 1341:56, he acknowledged that the airspeed, which about that time was at 95 knots, was slow. Seconds later he acknowledged being a "little bit high" and discussed extending the upwind leg of the airport traffic pattern.

According to the video and FDM data, about 1342:19, while on the downwind leg of the airport traffic pattern for runway 35, the flight instructor began turning onto the crosswind leg of the airport traffic pattern, and discussed the importance of best glide speed in relation to the distance that the airplane could glide in an engine out condition. About 21 seconds later, while flying about 1,480 ft pressure altitude and 104 knots, the instructor discussed being at 1,400 ft mean sea level (msl) and appeared to be on the downwind leg of the airport traffic pattern for runway 35.

The flight instructor further stated that he lowered the landing gear and advised that he would, "…hold off on the flaps for now." The flight continued on the downwind leg of the airport traffic pattern for runway 35 and about 1343:09, when abeam the approach end of the runway about .5 nautical mile, or the "low key" position (see figure 1), the airplane was at 800 ft pressure altitude and 91 knots. About 5 seconds later, the audio recorded the first "chirp" from the aircraft's stall warning horn, and simultaneously, the PUI stated that he saw mist/smoke coming from the right side of the engine and that he smelled fuel, which he announced. The flight instructor turned onto the base leg of the traffic pattern, though he later indicated he did not smell fuel at that time. They both then noted a vapor outside from the right side of the engine, followed by a puff of white smoke.

The flight instructor later reported it was at that moment, at 1343:30, that he recognized that, "the engine had failed" which he realized as he had lost 10 knots of airspeed and the rate of descent increased. The video showed that the flight instructor stated, "start, start the engine", while he later reported he continued to fly the airplane. The flight path depicted a continuing left turn towards the runway, and the FDM data showed N1, N2, and TOT climbing consistent with a restart attempt at 1343:41. The airplane at that time was under 100 ft above ground level as determined by the radar altimeter. While flying about 61 knots indicated airspeed, the airplane collided with trees, then the ground. The video portion of the recording ended at 1341:02, though audio continued to be record. The sound of impact was recorded at 1343:44, while audio and data ended two seconds later.

Both pilots exited the airplane, and after notifying the operator of the accident, they walked to the airport and were taken to a hospital for treatment.

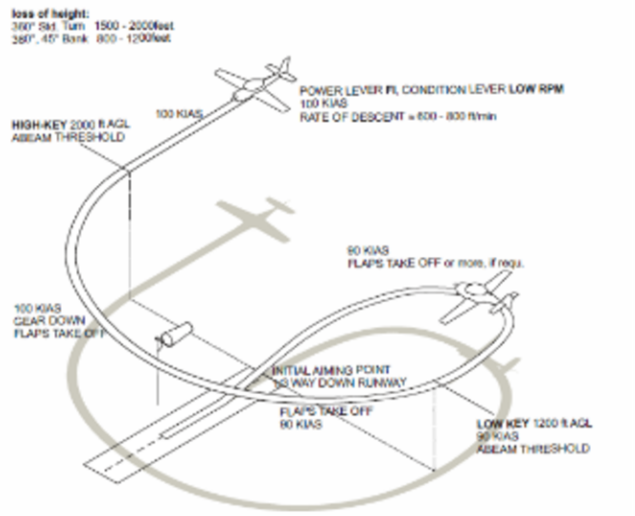

Figure 1 - Illustration From Airplane Flight Manual Depicting High and Low Key Positions

Flight instructor Information

Certificate:	Airline transport; Commercial; Flight instructor	**Age:**	67,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	5-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Helicopter; Instrument airplane; Instrument helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	August 4, 2016
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	September 12, 2016
Flight Time:	17000 hours (Total, all aircraft), 82 hours (Total, this make and model)		

Student pilot Information

Certificate:	Airline transport; Private	**Age:**	46,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	5-point
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	September 20, 2016
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	September 28, 2016
Flight Time:	4004 hours (Total, all aircraft), 7 hours (Total, this make and model), 3350 hours (Pilot In Command, all aircraft), 20 hours (Last 90 days, all aircraft), 10 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	GROB AIRCRAFT AG	**Registration:**	N196TP
Model/Series:	G120TP-A NO SERIES	**Aircraft Category:**	Airplane
Year of Manufacture:	2016	**Amateur Built:**	
Airworthiness Certificate:	Aerobatic; Utility	**Serial Number:**	11096
Landing Gear Type:	Retractable - Tricycle	**Seats:**	2
Date/Type of Last Inspection:	March 4, 2017 100 hour	**Certified Max Gross Wt.:**	3340 lbs
Time Since Last Inspection:	15 Hrs	**Engines:**	1 Turbo prop
Airframe Total Time:	96.4 Hrs as of last inspection	**Engine Manufacturer:**	Rolls-Royce
ELT:	C126 installed, activated, did not aid in locating accident	**Engine Model/Series:**	M250-B17F
Registered Owner:	CAE USA, Inc.	**Rated Power:**	
Operator:	CAE USA, Inc.	**Operating Certificate(s) Held:**	None

Each seat was equipped with an Electronic Flight Instrument System (EFIS) PFD and MFD, called integrated display units (IDU). Integrated into them was a CAS which monitored a wide variety of parameters and provided aural and visual annunciations for conditions that demanded pilot awareness, such as low oil pressure which was a red warning on the IDU and a synthesized spoken indication to the flightcrew by announcing “check oil”; however, with the CAS circuit breaker pulled the low oil pressure would not have been annunciated aurally.

The airplane was also equipped with a solid state digital FDM system which recorded over 100 aircraft and flight parameters as well as audio and video signals, and an onboard image recorder that recorded and retained video and audio to a secure digital (SD) card. The FDM with SD card, onboard image recorder with SD card, and each EFIS display were retained by NTSB and sent to the NTSB Vehicle Recorder's Laboratory for read-out.

According to individuals who flew the airplane with their instructor on two separate flights earlier that day, there were no reported engine abnormalities during either flight which each lasted 1.4 hours. The PUI for each flight reported the PPO maneuver was not performed.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	DHN,401 ft msl	**Distance from Accident Site:**	23 Nautical Miles
Observation Time:	13:53 Local	**Direction from Accident Site:**	214°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	3 knots / None	**Turbulence Type Forecast/Actual:**	/ Unknown
Wind Direction:	320°	**Turbulence Severity Forecast/Actual:**	/ Unknown
Altimeter Setting:	30.3 inches Hg	**Temperature/Dew Point:**	22°C / 7°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Dothan, AL (DHN)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Abbeville, AL (0J0)	**Type of Clearance:**	VFR flight following
Departure Time:	13:04 Local	**Type of Airspace:**	

Airport Information

Airport:	Abbeville Municipal Airport 0J0	**Runway Surface Type:**	Asphalt
Airport Elevation:	469 ft msl	**Runway Surface Condition:**	Unknown
Runway Used:	35	**IFR Approach:**	None
Runway Length/Width:	2900 ft / 80 ft	**VFR Approach/Landing:**	Forced landing;Traffic pattern

Wreckage and Impact Information

Crew Injuries:	2 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Serious	**Latitude, Longitude:**	31.594165,-85.237777

Examination of the accident site and wreckage at the accident site was performed by representatives of the operator, airframe manufacturer, and engine manufacturer who were overseen by a Federal Aviation Administration inspector. The airplane was located in a wooded area about 775 ft and 183° from the approach end of runway 35 at 0J0.

Examination of the accident site revealed the airplane was upright with the left wing attached, while the right wing was separated at the wing root and found resting near the right side of the fuselage with several tree impacts to the leading edge. The empennage was displaced nearly 90° to the left, and the flaps were retracted. Both main landing gear were extended but were collapsed to the left. All components necessary to sustain flight remained attached or were found in close proximity to the main wreckage. Examination of the cockpit revealed the “CAS Mute” circuit breaker was out, the continuous ignition switch was off, the power lever was at flight idle and the condition lever was at the cutoff/feather position.

Examination of the engine at the accident site revealed it remained securely attached to the airframe. The propeller gearbox was fractured from approximately the 3 o’clock to 9 o’clock positions just forward of its mating flange with the accessory gearbox. Continuity of N1 and N2 was confirmed, and the compressor air inlet was impacted with dirt. The compressor bleed valve was in the open position, and the plunger could be manually actuated. All engine fuel lines, pneumatic lines, and oil lines were visually and tactilely examined and all “B” nuts were finger tight with no evidence of leakage. The fuel filter bowl contained clear, clean fuel, and residual fuel was noted in the fuel line at the fuel nozzle. The wreckage was recovered for further examination.

Examination of the airplane following recovery revealed that all fuel line “B” nuts in the cockpit were tight. The motive flow fuel return line was crushed and cracked and was noted to leak fuel during pressure testing. No obstructions were noted from the left collector tank to the engine-driven fuel pump. Approximately 16 ounces of straw-colored fuel were drained from the fuel line between the left wing root and the engine-driven fuel pump. The detents of the power and condition levers at the pedestal were satisfactory. The engine was removed for operational testing at the engine manufacturer’s facility.

In advance of operational testing of the engine, the impact-damaged propeller gearbox was removed and replaced. The engine was placed in a test cell and operated but did not produce full rated power. The engine responded normally during rapid reduction of the power and condition levers; however, rapid advancement of the power lever could not be accomplished due to limitations of the test cell. The fuel control unit (FCU) was removed from the engine for additional testing.

The fuel control unit was transported for testing by NTSB personnel to Honeywell's facility in South Bend, Indiana. Also present for testing were representatives from CAE USA, and Rolls-Royce. Visual examination of the FCU revealed safety wire and lead seal(s) consistent with manufacturing were in-place. During testing at the Minimum Flow & Acceleration Test Point (5.010), it flowed 20.4 pounds-per-hour (PPH) while the specification limits at that test point were 28.0 to 30.0 PPH. The unit was tested again at the same test point and flowed 20.2 PPH. Minor out of tolerance discrepancies were also noted with the FCU, but they were insignificant. Honeywell personnel indicated that the low reading was not field adjustable. The unit was not disassembled and was subsequently returned to the salvage facility where the airplane was secured.

Tests and Research

Model DP-P2 Turbine Engine Main Fuel Control Unit

The model DP-P2 turbine engine main fuel control unit was the basic component of the engine fuel controlling system. It was a pneumatic mechanical device which scheduled fuel flow to the engine, providing proper engine operation during all starting and load operating conditions. It is composed of two functional groups consisting of the fuel section and scheduling section. Fuel scheduling is accomplished by moving the governor bellows which is mechanically connected to the metering valve through the torsion shaft.

The fuel control was mounted on the engine accessory gear case and was driven at a speed proportional to gas producer turbine speed (N1). Sensing parameters required by the fuel control to properly schedule fuel flow were:

(1) Throttle angle
(2) Fuel inlet pressure (P1)
(3) Compressor discharge pressure (PC)

Accident Fuel Control Unit

The main fuel control unit was manufactured by Honeywell in December 2015, and was bench tested at their Rocky Mount, NC facility. The recorded Minimum Flow & Acceleration Test Point (5.010) at final testing was 30.0 pounds-per-hour (PPH). The FCU then passed testing on engine at Rolls-Royce in March 2016. There was no record that the FCU had been returned to Honeywell since manufacture.

Previous Fuel Control Unit Issues

According to information from Rolls-Royce, since July 2016, the airframe manufacturer reported 8 other engine flame-out events, which mostly occurred during new airplane production acceptance testing, although 3 occurred with delivered airplanes. The engine conditions reported for the engine flame-out events were similar to the conditions of the accident scenario in that:

- The power lever was first moved to flight idle
- The condition lever was then moved aft to the "low" gate position
- The engine flame-out occurred almost immediately after the condition lever was placed in the "low" gate position
- The continuous ignition switch was in the off position.

Of the 8 other events, the FCU's were sent to Honeywell's facility in Malta and all had the minimum flow setting on the FCU out of limits on the low side.

According to information from the airplane manufacturer, on April 24, 2016 during a customer acceptance flight of a G120TP-A (same model as the accident airplane), of airframe serial number 11082, while performing a simulated engine failure with the continuous ignition off, the engine flamed out. An inflight restart was successfully initiated immediately, and the airplane was landed without further incident. As a result of the event, it was believed that the engine was susceptible to flame-out when the power lever was moved forward with the condition lever at low rpm at altitudes higher than 10,000 feet. The airplane flight manual (AFM) procedure for Simulated Forced Landing did not require at that time to turn on the Continuous Ignition; however, the training syllabus (unapproved guidance material for training), recommended the use of Continuous Ignition when performing that maneuver.

The airframe manufacturer notified European Union Aviation Safety Agency (EASA) of the April 24th event on April 27, 2016, and the following day the "Simulated Forced Landing" procedures of the AFM were changed by the airframe manufacturer requiring the continuous ignition on and by slowly moving the condition lever to the low rpm position. EASA subsequently approved the AFM changes in early June 2016.

Subsequently on May 17, 2016, during flight testing, the flame-out issue was repeated by retarding/slamming the condition lever aft with the Continuous Ignition off.

Honeywell Investigation of Fuel Control Out of Tolerance Issues

Honeywell personnel reported that prior to the accident, they had investigated reports of FCU's with low readings at Test Point 5.010. Their investigation postaccident attributed the low readings to be from a test bench indication issue (reading within limits but not accurately reading actual fuel flow). In an effort to isolate the problem, Honeywell added a master flow meter on the suspect test bench and identified the inaccurate readings when compared to the master flow meter. They had also identified FCU's that resulted in engine flame-out. In those instances, the common theme was that test point 5.010 the fuel flow was actually set to between 15 and 20 PPH (too low), which was also attributed to be associated with the inaccurate test bench reading at manufacture.

Honeywell Corrective Action Regarding Mis-Set Fuel Control Units

As a result of Honeywell's investigation, they published on July 5, 2018, Service Bulletin GT-73-0397, which advised of quality control escapes of the listed FCU's.

Rolls-Royce Corrective Action Regarding Mis-Set Fuel Control Units

As a result of Rolls-Royce's investigation, they instituted a special check during operational testing in their test cell to detect the low fuel flow state. They also published on July 20, 2018, Commercial Engine Bulletin (CEB) 73-2041, which reiterated the quality escapes of the listed FCU's. The CEB specified an on-airframe test to identify if the FCU had a mis-set fuel value at the minimum flow check.

Propeller Governor and Propeller

The propeller governor was a positive displacement type pump that produced 340 psi output greater than the inlet value. According to a representative of the governor manufacturer, with an adequate oil supply and no cavitation or air introduced into the system, 3 psi at the inlet of the propeller governor would be adequate to allow for normal governor operation. A review of data revealed after 1302:45 (takeoff) to the end of recorded data, the oil pressure never went below 3 psi.

Operator Postaccident Fuel Control Test Results

Postaccident, the operator complied with the engine and FCU manufacturer service bulletins and found the FCU's of 3 of the 6 airplanes they fly to be out of adjustment.

Postaccident Simulator Testing For Cockpit Annunciations and Automatic Shedding

Postaccident, simulator testing was performed to determine what annunciations would have been available to the flightcrew members at and after the engine flamed out. Aural annunciations were muted because the Crew Awareness System (CAS) circuit breaker had been pulled in accordance with the operator's developed upset prevention and recovery training (UPRT) checklist. Since the minimum fuel flow issue at the fuel control unit was not duplicated, it was simulated by placing the fuel selector to the off position. As part of the simulation, the bus tie switch was in the auto position. The simulation determined that about 3 to 4 seconds after the fuel supply was turned off, the master caution illuminated, red X's were over the engine indications on the multi-function display (MFD) in front of the flight instructor, generator off annunciation was briefly flashing on the primary flight display (PFD) in front of the flight instructor, followed by "Aux Sensor" annunciation. Also, within 3 to 4 seconds, volt, oil lo pressure, auxiliary sensor, and bus tie off annunciations were visible on the PFD in front of the PUI. There were no engine related warnings on the PFD in front of the flight instructor. The MFD in front of the PUI indicated the live engine parameters out of normal range (e.g. TRQ 0%, N1 0 RPM, OIL Pressure 0 PSI, etc.

The airframe manufacturer reported that with automatic load shedding because the bus tie switch was in the auto position, the main bus was not powered. Because it was not powered, X's over the engine indications in front of the flight instructor were provided to indicate data failure. That was because the main bus powered the Data Acquisition Unit channel B which provided data to the engine indication and crew alerting system of the MFD in front of the flight instructor.

Administrative Information

Investigator In Charge (IIC):	Monville, Timothy
Additional Participating Persons:	Clay Perkins; FAA/FSDO; Birmingham, AL Brian Barry; CAE USA; Dothan, AL Dave Riser; Rolls-Royce; Indianapolis, IN Lee G Fisher; Honeywell Aerospace; South Bend, IN Christian Sturm; Grob Aircraft SE; Tussenhausen Dietmar Nehmsch; German Federal Bureau of Aircraft Accident Investi; Braunschweig
Original Publish Date:	December 3, 2020
Last Revision Date:	
Investigation Class:	Class 2
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=94842