



# Aviation Investigation Final Report

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<b>Location:</b>	Fort Lauderdale, Florida	<b>Accident Number:</b>	ERA21LA336
<b>Date &amp; Time:</b>	August 21, 2021, 13:40 Local	<b>Registration:</b>	N277GM
<b>Aircraft:</b>	GULFSTREAM AEROSPACE G-IV	<b>Aircraft Damage:</b>	Substantial
<b>Defining Event:</b>	Preflight or dispatch event	<b>Injuries:</b>	14 None
<b>Flight Conducted Under:</b>	Part 91: General aviation - Personal		

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## Analysis

The flight crew, which consisted of the pilot- and second-in-command (PIC and SIC), and a non-type-rated observer pilot, reported that during takeoff near 100 knots a violent shimmy developed at the nose landing gear (NLG). The PIC aborted the takeoff and during the abort procedure, the NLG separated. The airplane veered off the runway, and the right wing and right main landing gear struck approach lights, which resulted in substantial damage to the fuselage and right wing. The passengers and flight crew evacuated the airplane without incident through the main cabin door.

Postaccident interviews revealed that following towing operations prior to the flight crew's arrival, ground personnel were unable to get the plunger button and locking balls of the NLG's removable pip pin to release normally. Following a brief troubleshooting effort by the ground crew, the pip pin's plunger button remained stuck fully inward, and the locking balls remained retracted. The ground crew re-installed the pip pin through the steering collar with the upper torque link arm connected. However, with the locking balls in the retracted position, the pin was not secured in position as it should have been. Further, the ground personnel could not install the safety pin through the pip pin because the pin's design prevented the safety pin from being inserted if the locking balls and plunger were not released. The ground personnel left the safety pin hanging from its lanyard on the right side of the NLG.

The ground personnel subsequently informed their ramp supervisor of the anomaly. The supervisor reported that he informed the first arriving crewmember at the airplane (the observer pilot) that the nose pin needed to be checked. However, all three pilots reported that no ground crewmember told them about any issues with the NLG or pins.

Examination of the runway environment revealed that the first item of debris located on the runway was the pip pin. Shortly after this location, tire swivel marks were located near the runway centerline, which were followed by large scrape and tire marks, leading to the separated NLG. The safety pin remained attached to the NLG via its lanyard and was undamaged.

Postaccident examination and testing of the NLG and its pins revealed no evidence of preimpact mechanical malfunctions or failures. The sticking of the pip pin plunger button that the ground crew reported experiencing could not be duplicated during postaccident testing. When installed on the NLG, the locking ball mechanism worked as intended, and the pip pin could not be removed by hand.

Although the airplane's preflight checklist called for a visual check of the NLG's torque link to ensure that it was connected to the steering collar by the pip pin and that the safety pin was installed, it is likely that none of the pilots noticed that the pip pin did not have its safety pin installed during preflight. Subsequently, during the takeoff roll, without the locking balls extended, the pip pin likely moved outward and fell from its position holding the upper torque link arm. This allowed the upper torque link arm to move freely, which resulted in the violent shimmy and NLG separation. The location of the debris on the runway, tire marks, and postaccident examination and testing support this likely chain of events.

Contributing to the PIC and SIC's omission during preflight was the ground crew's failure to directly inform the PIC or SIC that there was a problem with the NLG pip pin. The ground crew also failed to discard the malfunctioning pip pin per the airplane's ground handling procedures and instead re-installed the pip pin. Although the observer pilot was reportedly informed of an issue with a nose gear pin, he was not qualified to act as a required flight crewmember for the airplane and was on his cell phone when he was reportedly informed of the issue by the ramp supervisor. These factors likely contributed to the miscommunication and the PIC's and SIC's subsequent lack of awareness of the NLG issue.

## **Probable Cause and Findings**

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

The pilot-in-command's (PIC) and second-in-command's (SIC) failure during preflight inspection to ensure that the nose landing gear's pip pin was properly installed, which resulted in separation of the pip pin during takeoff. Contributing to the accident was the ground crew supervisor's failure to inform the PIC or SIC of the anomaly concerning the pip pin following a towing operation.

## Findings

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<b>Personnel issues</b>	Preflight inspection - Flight crew
<b>Personnel issues</b>	Use of checklist - Flight crew
<b>Personnel issues</b>	Lack of communication - Ground crew
<b>Personnel issues</b>	Total experience w/ equipment - Copilot
<b>Personnel issues</b>	Knowledge of equipment - Copilot

## Factual Information

### History of Flight

<b>Prior to flight</b>	Preflight or dispatch event (Defining event)
<b>Takeoff-rejected takeoff</b>	Landing gear collapse
<b>Takeoff-rejected takeoff</b>	Runway excursion

On August 21, 2021, about 1340 eastern daylight time, a Gulfstream Aerospace G-IV airplane, N277GM, was substantially damaged when it was involved in an accident at Fort Lauderdale Executive Airport (FXE), Fort Lauderdale, Florida. The 4 crewmembers and 10 passengers were not injured. The airplane was operated by the pilot in command (PIC) as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The PIC reported that after a routine taxi to the runway, he initiated the takeoff on runway 9. As the takeoff roll progressed the airplane accelerated as expected, normal callouts were made, and nothing was abnormal until the airplane reached about 100 to 110 knots, at which point he felt a “terrible shimmy” that progressively got “worse and worse.” He then recalled that it felt that as if the tires blew because the forward “deck angle” became lower. He initiated an immediate aborted takeoff with braking and thrust reversers and it seemed that the airplane was slowing; however, the airplane veered off the runway and the right wing and right main landing gear struck a concrete slab holding approach lighting equipment. The airplane came to a stop shortly after impacting the concrete slab.

The second-in-command (SIC) pilot reported that the taxi and initial takeoff roll were normal. As the airplane passed through 80 knots, he recalled feeling a “slight shimmy” and “a little rattle” between the rudder pedals, which “intensified dramatically.” Once the shimmy intensified, the PIC aborted the takeoff. During the abort procedure, it became apparent that “the nose gear collapsed.” After the airplane came to rest, he immediately got up, opened the main cabin door, and assisted the passengers in the emergency evacuation.

A third non-type rated observer pilot seated in the jumpseat reported a similar account of the takeoff and abort sequence.

Examination of the runway environment and accident site revealed that the airplane came to rest in a sandy grass area about 200 ft to the right of the runway 9 centerline. The left main landing gear did not collapse; however, the right main landing gear had punctured upward into the inboard aft section of the right wing, which resulted in substantial damage.

All major components of the nose landing gear (NLG), which had sheared from the airplane, were located on or near runway 9. The first item located on the runway, farthest from the main wreckage, was the NLG pip pin (upper torque link pin). It was found about 2,215 ft from the main wreckage. The bulk of the NLG came to rest near the runway centerline about 900 ft

farther down the runway from the pip pin. The safety pin that was normally installed through the pip pin was found intact still attached to the separated NLG by its lanyard cord.

Figure 1 shows a still image captured by the FXE Airport Authority drone shortly after the accident. Additional photographs have been added to the drone image to show the location of swivel tire marks and where components were located on the runway as noted with the red circles.

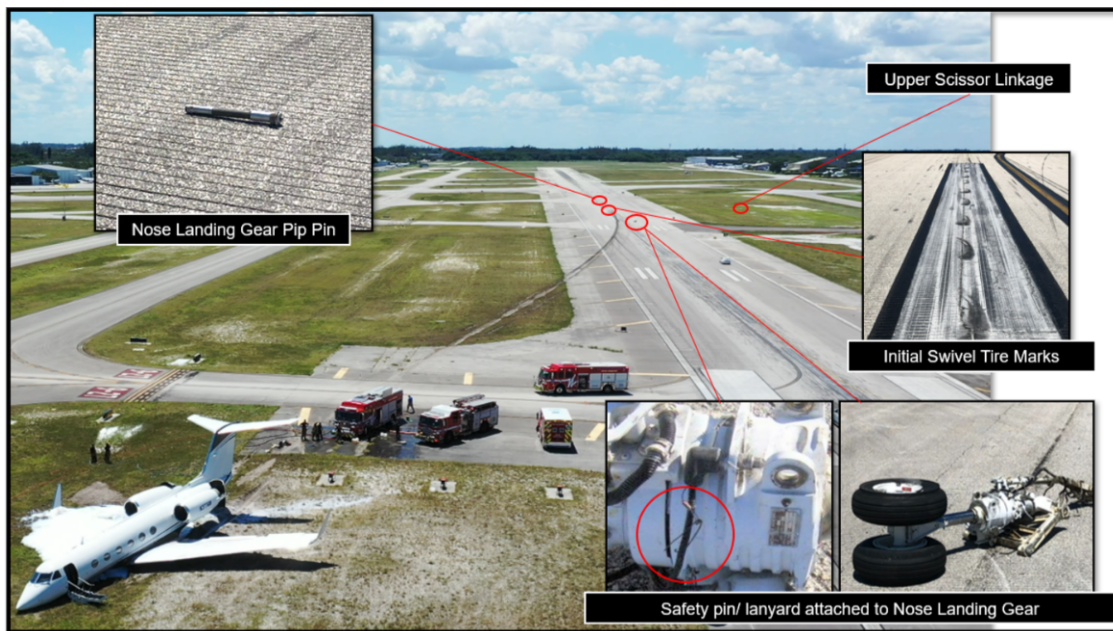


Figure 1: Overview of the main wreckage and runway environment (Source: FXE Airport Authority)

### Nose Landing Gear Pins and Operation

According to Gulfstream Technical Publications, the NLG was equipped with a removable pip pin that enabled the upper torque link arm (or upper scissor linkage) to be disconnected from the steering collar for additional steering movement for towing operations. The pip pin incorporated a plunger button that when depressed retracted a set of locking balls on the opposite end of the pin to enable the removal of the pin. When the plunger button was released, the balls locked in an extended position, which physically prevented pin movement through the steering collar receptacle.

The pin retention system incorporated two additional safety features. The first was a lanyard cable with a smaller safety pin that was to be inserted into its respective hole in the end of the pip pin once the plunger button was fully retracted. The second was an additional lanyard with a clip that attached to a handle on the plunger end of the pip pin. According to Gulfstream representatives, the primary purpose of the second lanyard was to ensure that the pip pin remained with the NLG when it was removed during towing operations; it served no purpose in ensuring that the pip pin remained secured when it was installed through the upper torque link arm.

Figure 2 shows the accident NLG, the pip pin, and the safety pin installed during postaccident examination and testing. The NLG and pip pin as found did not possess the second lanyard, safety clip, or handle that was called for in the Gulfstream Technical Publications.

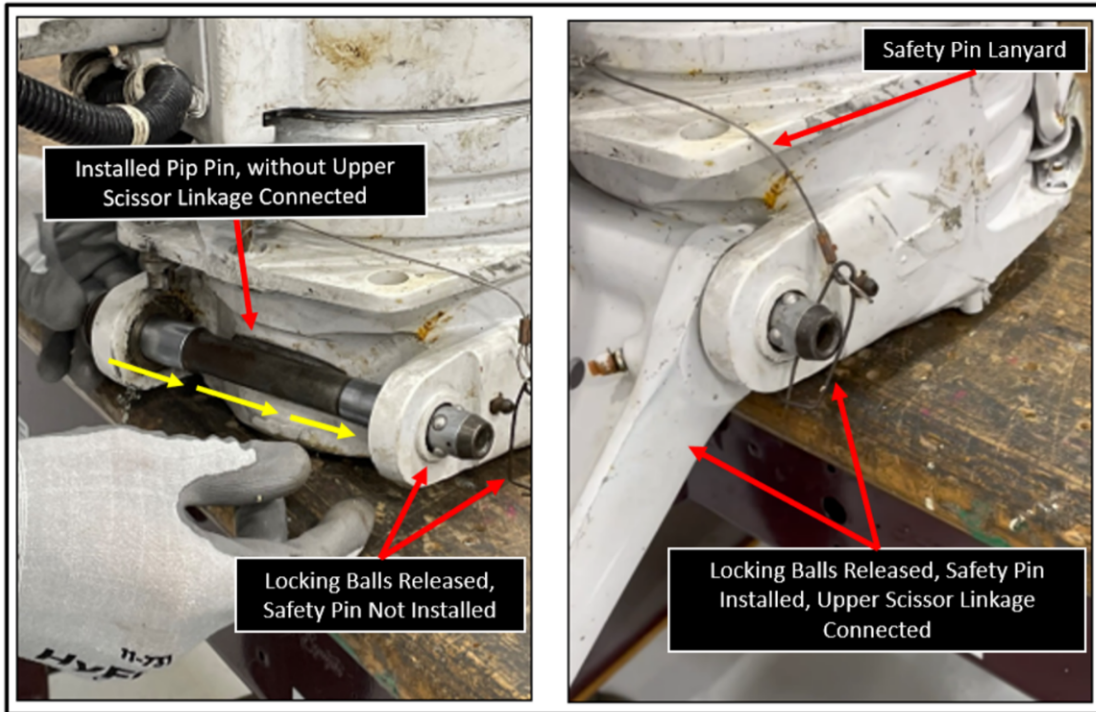


Figure 2: View of the NLG and pip pin installed during postaccident examination testing

Detailed instructions were provided in the airplane’s handling handbook on how to release and re-install the pip pin for towing. The instructions stated in part, that the pip pin should be inspected to “ensure locking balls work freely when plunger is depressed” and to “ensure locking balls cannot be moved when plunger is released”. The handbook further stated to discard pip pins that failed this inspection and cautioned that:

**DEFECTIVE OR IMPROPERLY INSTALLED PIP PIN CAN CAUSE EXTENSIVE DAMAGE TO AIRCRAFT.**

According to the Gulfstream G-IV pilot’s preflight checklist, the NLG and wheel area must be checked and the “torque link” must be “PINNED / SAFETIED.”

#### Examination of the Nose Landing Gear and Pins

Postaccident examination and testing of the separated NLG and its pins revealed no anomalies. The pip pin displayed some exterior damage due to its impact with the runway. It

could be inserted into position and the plunger and locking balls operated without issue. With the plunger and locking balls released, the safety pin was inserted into the pip pin without issue. Attempts were made to remove the pip pin by hand, with the locking balls released, but as designed, the balls prevented the pin from being removed from the upper torque link arm; the pip pin could not be removed either with or without the safety pin installed. The NLG and pip pin as found did not possess the second lanyard, safety clip, or handle that is normally attached.

#### Details of the Towing and Preflight

The ground personnel involved in towing the airplane to the fixed-base-operator (FBO) ramp were interviewed. Two ramp personnel reported that they used an electric tow cart to move the airplane a few hours before departure. When they arrived at the airplane, the three landing gear tow pins were inserted on the nose and main landing gear, and the NLG upper torque link arm was already disconnected with the pip pin installed in the steering collar. After an uneventful tow, one ramp crewmember removed the pip pin without issue, however, he noticed that the locking balls and plunger button were stuck in (depressed). He reported that the “the button was stuck in” and all of the locking balls were stuck in. He reported that he was familiar with this type of pin device but had never experienced this type of issue before.

The ground personnel attempted to release the plunger button by shaking the pin, and they “tapped” on the pin with a wooden chock, however, the locking balls and plunger would not release. The ground personnel reported that they took no further actions to get the plunger unstuck and that they re-inserted the pip pin in the steering collar with the upper torque link arm attached. They attempted to insert the safety pin hanging from a lanyard connected to the NLG; however, one ramp crewmember reported that he knew that if the plunger button and locking balls remained depressed, the safety pin could not be inserted due to its design. The safety pin was left hanging on the right side of the NLG.

The ground personnel alerted their ramp supervisor to the issue with the NLG pip pin as the flight crew had not yet arrived at the airplane. According to the ramp supervisor, he told the first crewmember who arrived at the airplane, “per tow team, check your nose pin.”

Surveillance video captured the ramp personnel’s troubleshooting of the pin, the flight crew’s preflight, and the airplane’s taxi from the ramp toward the runway. The ramp supervisor reviewed the surveillance video and identified the observer pilot as the flight crewmember he reportedly told to check the pip pin. At the time, he believed that this flight crewmember was “probably the co-pilot” rather than the PIC. The ground personnel reported that they did not discuss the pip pin issue with the other pilots who arrived after the observer pilot.

The observer pilot reported that he had received permission from the PIC to join the flight as an observer for general pilot development, as he had just finished ground school training for the G-IV. He was in training to become a first officer with a Part 135 charter operator run by the

PIC. He reported that prior to the other pilots' arrival, he removed the three gear tow pins and placed them on the airstairs.

The observer pilot further reported that he was on the telephone with a friend when ramp personnel approached him. He asked the ramp personnel for ice and newspapers, and the ramp personnel asked him if he needed anything else, such as fuel, to which the observer pilot said he was not sure and he was waiting for the other pilots to arrive. The observer pilot stated that none of the ramp personnel informed him to check the NLG pip pin or "anything related to the aircraft." He reported that the SIC arrived, and they did a full preflight and walkaround.

The observer pilot recalled that the SIC reviewed the NLG in detail, and they both observed that the "really big pin [pip pin]" was installed. The pin appeared to be flush and was "all the way in." He stated that, "I can tell you 200 percent that he was pointing at that [pip] pin." The SIC further explained to him that the NLG will not be steerable without this pin, and it was the "most important pin." He could not recall if the smaller safety pin was also installed into the larger pip pin.

The SIC reported that during his preflight inspection of the NLG, the pip pin was installed and "flush". He could not recall whether the safety pin was also installed; however, he did not see any safety pin dangling on the NLG. He reported that it was his understanding that a visual inspection is required of the pip pin, and he did not have the "authority" to insert the pip pin if it was not in place. He believed the pins should be inserted by maintenance or ramp personnel. He reported that neither the ground personnel nor the observer pilot informed him of any issue with the pip pin.

The PIC reported that prior to taxi, the SIC performed a "complete walkaround." This was his first time flying with the SIC. He added that it is his standard practice to do a "final look" to ensure the pip pin is installed and that the fuel cap doors and chocks are closed/ removed. He did not recall seeing any safety pin dangling next to the pip pin. He reported that over the years of flying the G-IV, once or twice, he experienced a situation in which the safety pin was found not installed prior to taxi. Concerning the accident flight, he reported that neither the ramp personnel nor the SIC or observer pilot informed him that there was an issue with the pip pin.

The SIC reported that he had not attended formal ground school or taken a practical examination to obtain his G-IV "SIC Privileges Only" type rating. He received a logbook endorsement from a type-rated captain he had previously flown with per Part 61.55(d)(1). He reported that he was "limited in what I know with the aircraft."

The cockpit voice recorder (CVR) and flight data recorder (FDR) were downloaded and reviewed at the National Transportation Safety Board Vehicle Recorders Laboratory in Washington, DC. Both the FDR and CVR simultaneously stopped recording before the runway excursion. The high-amplitude shimmy present in the nose gear likely created enough of a moment in the tail where the G switch was located to stop the recorders. Prior to the end of data, a normal accelerating takeoff was observed, with a peak airspeed of 122 knots reached.



## Additional Information

Following the accident, the FBO reported that they updated standard operating procedures for ground personnel to ensure that the PIC, or SIC in the event the PIC is unavailable, is made aware of anomalies or damage to the aircraft.

### Pilot Information

<b>Certificate:</b>	Airline transport; Commercial	<b>Age:</b>	59, Male
<b>Airplane Rating(s):</b>	Single-engine land; Multi-engine land	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>	Helicopter	<b>Restraint Used:</b>	4-point
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	
<b>Medical Certification:</b>	Class 1 With waivers/limitations	<b>Last FAA Medical Exam:</b>	March 17, 2021
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	November 2, 2020
<b>Flight Time:</b>	20053 hours (Total, all aircraft), 3120 hours (Total, this make and model), 17900 hours (Pilot In Command, all aircraft), 184 hours (Last 90 days, all aircraft), 49 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

### Co-pilot Information

<b>Certificate:</b>	Airline transport; Commercial	<b>Age:</b>	29, Male
<b>Airplane Rating(s):</b>	Single-engine land; Multi-engine land	<b>Seat Occupied:</b>	Right
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	4-point
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	Airplane single-engine	<b>Toxicology Performed:</b>	
<b>Medical Certification:</b>	Class 1 Without waivers/limitations	<b>Last FAA Medical Exam:</b>	April 1, 2021
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	July 15, 2021
<b>Flight Time:</b>	1617 hours (Total, all aircraft), 204 hours (Total, this make and model), 943 hours (Pilot In Command, all aircraft), 32 hours (Last 90 days, all aircraft), 0 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	GULFSTREAM AEROSPACE	<b>Registration:</b>	N277GM
<b>Model/Series:</b>	G-IV NO SERIES	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>	1989	<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Transport	<b>Serial Number:</b>	1124
<b>Landing Gear Type:</b>	Retractable - Tricycle	<b>Seats:</b>	22
<b>Date/Type of Last Inspection:</b>	June 4, 2021 Continuous airworthiness	<b>Certified Max Gross Wt.:</b>	75000 lbs
<b>Time Since Last Inspection:</b>		<b>Engines:</b>	2 Turbo jet
<b>Airframe Total Time:</b>	12990 Hrs as of last inspection	<b>Engine Manufacturer:</b>	ROLLS-ROYC
<b>ELT:</b>	Installed, not activated	<b>Engine Model/Series:</b>	TAY MK 610-8
<b>Registered Owner:</b>	SN 1124 LLC.	<b>Rated Power:</b>	13850 Lbs thrust
<b>Operator:</b>	On file	<b>Operating Certificate(s) Held:</b>	None

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Day
<b>Observation Facility, Elevation:</b>	FXE,14 ft msl	<b>Distance from Accident Site:</b>	0 Nautical Miles
<b>Observation Time:</b>	13:53 Local	<b>Direction from Accident Site:</b>	252°
<b>Lowest Cloud Condition:</b>	Clear	<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	None	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	9 knots /	<b>Turbulence Type Forecast/Actual:</b>	None / None
<b>Wind Direction:</b>	130°	<b>Turbulence Severity Forecast/Actual:</b>	N/A / N/A
<b>Altimeter Setting:</b>	29.99 inches Hg	<b>Temperature/Dew Point:</b>	34°C / 23°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	Fort Lauderdale, FL (FXE)	<b>Type of Flight Plan Filed:</b>	IFR
<b>Destination:</b>	Las Vegas, NV (LAS)	<b>Type of Clearance:</b>	IFR
<b>Departure Time:</b>	13:40 Local	<b>Type of Airspace:</b>	Class D

## Airport Information

<b>Airport:</b>	FORT LAUDERDALE EXECUTIVE FXE	<b>Runway Surface Type:</b>	Asphalt
<b>Airport Elevation:</b>	13 ft msl	<b>Runway Surface Condition:</b>	Dry
<b>Runway Used:</b>	09/27	<b>IFR Approach:</b>	None
<b>Runway Length/Width:</b>	6002 ft / 100 ft	<b>VFR Approach/Landing:</b>	None

## Wreckage and Impact Information

<b>Crew Injuries:</b>	4 None	<b>Aircraft Damage:</b>	Substantial
<b>Passenger Injuries:</b>	10 None	<b>Aircraft Fire:</b>	None
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	14 None	<b>Latitude, Longitude:</b>	26.198586,-80.165403

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Gerhardt, Adam
<b>Additional Participating Persons:</b>	A.D. Barker; FAA FSDO; Miramar, FL Filippo Ventura; Gulfstream Aerospace Corporation; Savannah, GA
<b>Original Publish Date:</b>	May 10, 2023
<b>Last Revision Date:</b>	
<b>Investigation Class:</b>	<a href="#">Class 3</a>
<b>Note:</b>	The NTSB did not travel to the scene of this accident.
<b>Investigation Docket:</b>	<a href="https://data.ntsb.gov/Docket?ProjectID=103739">https://data.ntsb.gov/Docket?ProjectID=103739</a>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).