



National Transportation Safety Board Aviation Accident Final Report

Location:	West Palm Beach, FL	Accident Number:	MIA02LA060
Date & Time:	02/14/2002, 0649 EST	Registration:	N777TY
Aircraft:	Gulfstream Aerospace G-V	Aircraft Damage:	Substantial
Defining Event:		Injuries:	2 None
Flight Conducted Under:	Part 91: General Aviation - Positioning		

Analysis

After a normal taxi and takeoff, the airplane's landing gear would not retract after liftoff. After unsuccessfully attempting to raise the landing gear manually, the flight crew elected to return to the airport. During the landing flare, the ground spoilers deployed when the throttles were brought to idle. The airplane descended rapidly and landed hard, and the right main landing gear collapsed. The investigation determined that a mechanic had wedged wooden sticks into the airplane's weight-on-wheels (WOW) switches to force them into the ground mode while the airplane was on jacks during maintenance. The mechanic said that he used the sticks to disable the WOW switches to gain access to the maintenance data acquisition unit, which was necessary to troubleshoot an overspeed alert discrepancy. After the maintenance was performed, the sticks were not removed, and the airplane was returned to service. No notation about the disabled WOW switches was entered in the work logs. Postaccident ground testing of the accident airplane's cockpit crew alerting system and examination of flight data recorder (FDR) data determined that the system was functioning properly and that it produced a blue WOW fault message, an amber WOW fault message, and a red GND SPOILER warning message when the accident flight conditions were recreated. The messages produced were consistent with FDR and cockpit voice recorder (CVR) information. Ground spoilers will deploy when the throttles are brought to idle if the spoilers are armed and the WOW switches are in the ground mode. The G-V Quick Reference Handbook (QRH) cautions flight crews not to move thrust reverser levers and to switch the GND SPOILER armed to off following an amber WOW FAULT message. A red GND SPOILER message calls for the flight crew to disarm the ground spoilers and pull the circuit breakers to make sure the spoilers are not rearmed inadvertently. Based on CVR information, there was no indication that the flight crew followed checklist procedures contained in the G-V's QRH that referenced WOW faults or GND SPOILER faults. Preflight checklist procedures also called for the flight crew to conduct a visual inspection of the WOW switches.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The flight crew's failure to follow preflight inspection/checklist procedures, which resulted in

their failure to detect wooden sticks in the landing gear weight-on-wheel switches and their failure in flight to respond to crew alert messages to disarm the ground spoilers, which deployed when the crew moved the throttles to idle during the landing flare, causing the airplane to land hard. Contributing to the accident was maintenance personnel's failure to remove the sticks from the weight-on-wheels switches after maintenance was completed.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings

1. (F) MAINTENANCE,SERVICE OF AIRCRAFT/EQUIPMENT - IMPROPER - OTHER MAINTENANCE PERSONNEL
2. (F) LANDING GEAR - FOREIGN OBJECT
3. (C) PREFLIGHT PLANNING/PREPARATION - INADEQUATE - FLIGHTCREW

Occurrence #2: HARD LANDING
Phase of Operation: LANDING - FLARE/TOUCHDOWN

Findings

4. (C) PROCEDURES/DIRECTIVES - NOT FOLLOWED - FLIGHTCREW
5. (F) FLT CONTROL SYST,WING SPOILER SYSTEM - DEPLOYED INADVERTENTLY

Factual Information

History of Flight

On February 14, 2002, about 0649 eastern standard time, a Gulfstream Aerospace G-V, N777TY, owned by Ty Inc. and operated by BB Five Inc., as a 14 Code of Federal Regulations Part 91 positioning flight, landed hard at West Palm Beach International Airport, West Palm Beach, Florida. The airplane sustained substantial damage. The airline transport pilot-rated captain and first officer were not injured. Visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed. The flight, the first following maintenance to correct a discrepancy, was originating at the time of the accident with a destination of Teterboro, New Jersey.

According to flight crew statements, they arrived at the fixed-based operator at 0545. The crew stated that they conducted an exterior preflight of the airplane and found everything "satisfactory." The crew also stated that they checked the cockpit and started the engines about 5 minutes later. The engine start was delayed to allow the first officer to retrieve an expense report from a rental car.

According to the cockpit voice recorder (CVR), the crew performed the required before-takeoff checklists while taxiing to the active runway. The flight was cleared for takeoff at 0018:16 CVR time (all CVR times refer to those recorded by the CVR and have not been coordinated with eastern standard time). At 0018:58 CVR time, the first officer asked the captain, "ground spoilers when you want em," and the captain replied, "now." V1 and rotate callouts were recorded at 0019:36.

At 0019:50, the first officer stated, "no lock release," followed by "I betcha we got a WOW [weight on wheels], yeah? ... we gotta a WOW fault" and "now we gotta [expletive] unsafe gear." The CVR recorded the sound of the triple chime, which ended at 0020:25. The flight crew stated in a February 14, 2002, statement that "the landing gear failed to retract" after liftoff. They also stated that they performed "override procedures," with "no change" in the indication. The crew added that the "landing gear handle [was] returned to normal down position" and that they performed the landing-gear-failed-to-retract checklist in the airplane's Quick Reference Handbook (QRH). The crew stated: "After climbing to assigned altitude of 2000 [feet] we addressed the Blue CAS [crew alerting system] message L WOW & R WOW PWR FAIL per checklist. ... We checked and reset CBs [circuit breakers] with no change in message. We proceeded with previous plan to land aircraft and evaluate situation."

In a March 29, 2002, statement, the flight crew stated that they encountered a red ACFT CONFIGURATION CAS message and a "red light in gear handle," which extinguished when the landing gear handle was returned to its normal position. The flight crew stated that "at this time there were no RED or AMBER CAS messages, only BLUE ADVISORY MESSAGES."

CVR information indicated that, after takeoff, the flight crew attempted to troubleshoot the problem by checking CBs. There was no reference to the QRH checklist. Flight data recorder (FDR) data indicated that the logic for the illumination of the amber WOW FAULT and blue WOW FAULT would have been met first, followed by the red GND SPOILER message.

CVR information also indicated that, after checking the CBs, the flight crew then concentrated on preparation for landing, including reprogramming the flight management system to indicate less fuel so they could legally land. At CVR time 0027:42, while on final approach, the

pilot asked, "we have three green, spoilers armed?" The copilot responded, "Yep." At 0028:29 CVR time, the first officer stated, "right, left and right WOW switches are ... not working." According to the flight crew, the power levers were "retarded to idle approximately 15 feet above ground. At that point, the aircraft suddenly and abruptly descended to the runway with a very hard landing." FDR data indicated that the ground spoilers deployed at 57.7 feet on the radar altimeter, and the aircraft impacted the ground with a vertical acceleration of 4.25 G. The sound of ground impact was recorded at CVR time 0028:51. According to the CVR, the copilot stated, "you know what it was?" and the captain asked "what?" The first officer replied, "[expletive] spoilers," and the captain responded, "blew it."

Aircraft System Description and Testing

According to Gulfstream, if the ground spoilers are armed, they will deploy automatically if the throttles are brought to idle. The spoilers are armed at takeoff to help stop the airplane if the takeoff is aborted. After the airplane is airborne, the WOW switches, located on each main landing gear, switch to the air mode and inhibit the spoilers from extending if the throttles are brought to idle in flight. The spoilers will deploy in flight if the throttles are retarded with the WOW switches in the ground mode with the spoilers armed, according to Gulfstream. WOW and other system faults are displayed on the cockpit CAS with blue, amber, and red representations based on the severity of the detected fault.

A ground test of the airplane's CAS was performed on April 16, 2002, at the General Dynamics Aircraft Services facility in West Palm Beach, Florida, under the supervision of the National Transportation Safety Board investigator-in-charge and the Federal Aviation Administration (FAA). Test results indicated that, with the main landing gear WOW switches in the ground mode, the ground spoiler armed, with airspeed signals above 60 knots, and the radio altimeter above 150 feet, the CAS would display the following messages: GND SPOILER (red); WOW FAULT (amber); and WOW FAULT (blue). (See the "Summary Report of Results of the Ground Test of Gulfstream G-V s/n 508, N777TY" attached to this report.)

CVR and FDR information was also examined at the Safety Board's headquarters in Washington, D.C. The Safety Board review concluded that the CAS was working properly and was delivering fault indications consistent with the conditions of the accident flight. Engineering studies conducted by Gulfstream were also reviewed. The Gulfstream review confirmed the results of the supervised ground tests and concluded, based on FDR data, that the CAS was displaying the proper fault conditions. Gulfstream stated that a WOW PWR FAIL CAS message is generated only when the WOW system fails to give an indication of either on ground or in air and would not have been generated if the WOW was working properly.

Aircraft Maintenance

During several previous flights, pilots of the accident airplane reported an erroneous overspeed warning that occurred while climbing through 2,200 feet at 225 knots "with no other CAS messages." The accident airplane was flown to the General Dynamics Aviation Services facility in West Palm Beach to correct the problem, and work began on February 11, 2002. While the airplane was on jacks for a tire change, a mechanic disabled the WOW switches to simulate that the WOW was in the ground mode and to gain access to the maintenance data acquisition unit to troubleshoot the overspeed discrepancy. The mechanic placed a wooden stick (also described as a Popsicle stick or tongue depressor) in the WOW switches to disable them. The sticks were not removed after the work was completed. The inspector who returned the

airplane to service was not aware that the WOW switches had been disabled, and no notation was made in the work logs. A mechanic and inspector signed off on the work order on February 13, 2002, at 0750. (A copy of the facility's maintenance and inspection record is attached to this report.)

An FAA investigator arrived at the accident site at 1000 on the day of the accident. He reported that the airplane was still on the runway and that it was raining. The FAA investigator stated that the "right main gear had been pushed through the wing, spilling fuel." He reported that he learned the next day that a "mechanic had removed from both main gear weight-on-wheels switches pieces of a tongue depressor used to indicate that the aircraft had weight-on-wheels while on jacks." The investigation determined that two General Dynamics Aviation Services employees observed the wooden sticks while taking pictures of the wreckage about 0715. The employee who found the sticks in the WOW switches stated that he was "very surprised" and "removed the Popsicle sticks off the right gear and rushed to the other side and found another ... that I also removed." He stated that he showed them to the other employee and informed the operations manager when they returned to the office.

References

The Gulfstream G-V AFM Section 3, Abnormal Procedures section 3-18-80, lists the following procedures in the event of a WOW failure to shift to air mode after takeoff:

WARNING: DO NOT RETARD POWER LEVERS TO IDLE IN FLIGHT. GROUND SPOILERS MAY DEPLOY.

1. Check Flight Controls Synoptic to determine which WOW signal has failed.
2. Appropriate WOW CB PULL
LEFT WOW: POP, C-1 RIGHT WOW: CPOP, C-1
After Landing:
3. Speed Brakes EXTEND
4. Reinstate WOW CB to regain ground mode.

NOTE: Once below 50 knots, airplane WOW will shift to the GROUND mode.

According to the G-V QRH, the following procedures should be accomplished if an amber WOW FAULT message illuminates:

CAUTION: DO NOT MOVE THRUST REVERSER LEVERS.

1. Select GND SPLR OFF/ARMED switch to OFF.
2. Pull the following CBs to force WOW signal to the AIR mode:
 - LEFT WOW: POP, C-1
 - RIGHT WOW: CPOP, C-1
3. On landing, close CBs.
4. See WOW Fails to Shift to AIR Mode After Takeoff, page EG-13 [in the QRH].

Page EG-13 in the QRH calls for the same procedures listed in AFM section 3-18-80.

According to the QRH, section "Messages and Annunciations," page MA-5, the red "GND

SPOILER" message calls for the flight crew to reference the QRH, section "Ground Spoiler Failure Inflight," page ED-9. Page ED-9 states the following:

Ground Spoiler Failure Inflight

1. GND SPLR OFF
2. GND SPOILERS CB (CPOP, E-2) PULL

The QRH preflight checklist, "exterior preflight inspection," calls for the following to be accomplished on the right fuselage and wing and left fuselage and wing preflight checks:

MLG WOW Switch Check

MLG Wheel Well Area Check

The airplane was released to Mr. John Hong Principle Advisor for Business Affairs, on behalf of the owner, on April 16, 2002.

This report was modified on November 20, 2006.

Pilot Information

Certificate:	Airline Transport; Flight Instructor	Age:	58, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	Toxicology Performed:	No
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	Last FAA Medical Exam:	11/12/2001
Occupational Pilot:		Last Flight Review or Equivalent:	08/31/2001
Flight Time:	13280 hours (Total, all aircraft), 1227 hours (Total, this make and model), 10279 hours (Pilot In Command, all aircraft)		

Co-Pilot Information

Certificate:	Airline Transport	Age:	56, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Right
Other Aircraft Rating(s):	None	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	Last FAA Medical Exam:	11/02/2001
Occupational Pilot:		Last Flight Review or Equivalent:	12/14/2001
Flight Time:	18477 hours (Total, all aircraft), 450 hours (Total, this make and model), 18145 hours (Pilot In Command, all aircraft), 50 hours (Last 90 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Gulfstream Aerospace	Registration:	N777TY
Model/Series:	G-V	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Transport	Serial Number:	508
Landing Gear Type:	Retractable - Tricycle	Seats:	10
Date/Type of Last Inspection:	01/27/2002, AAIP	Certified Max Gross Wt.:	90900 lbs
Time Since Last Inspection:	1945.6 Hours	Engines:	2 Turbo Fan
Airframe Total Time:	1945.6 Hours at time of accident	Engine Manufacturer:	BMW Rolls-Royce
ELT:	Installed, not activated	Engine Model/Series:	BR700-710A1-1
Registered Owner:	BB Five Inc.	Rated Power:	14750 lbs
Operator:	BB Five Inc.	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Dawn
Observation Facility, Elevation:	PBI, 19 ft msl	Distance from Accident Site:	
Observation Time:	0653 EST	Direction from Accident Site:	
Lowest Cloud Condition:	Scattered / 3000 ft agl	Visibility	10 Miles
Lowest Ceiling:	Overcast / 9000 ft agl	Visibility (RVR):	
Wind Speed/Gusts:	6 knots /	Turbulence Type Forecast/Actual:	/
Wind Direction:	330°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	30.12 inches Hg	Temperature/Dew Point:	15° C / 13° C
Precipitation and Obscuration:			
Departure Point:	Palm Beach, FL (PBI)	Type of Flight Plan Filed:	IFR
Destination:	Teterboro, NJ (TEB)	Type of Clearance:	IFR
Departure Time:	0640 EST	Type of Airspace:	Unknown

Airport Information

Airport:	West Palm Beach Int. (KPBI)	Runway Surface Type:	Asphalt
Airport Elevation:	19 ft	Runway Surface Condition:	Dry
Runway Used:	27R	IFR Approach:	ILS
Runway Length/Width:	7989 ft / 150 ft	VFR Approach/Landing:	Full Stop; Precautionary Landing

Wreckage and Impact Information

Crew Injuries:	2 None	Aircraft Damage:	Substantial
Passenger Injuries:	N/A	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	2 None	Latitude, Longitude:	26.681111, -80.106111

Administrative Information

Investigator In Charge (IIC):	Alan J Yurman	Report Date:	11/20/2006
Additional Participating Persons:	Frank Donovan; FAA; Fort Lauderdale, FL		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov , or at 800-877-6799. Dockets released after this date are available at http://dms.nts.gov/pubdms/ .		

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The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report. A factual report that may be admissible under 49 U.S.C. § 1154(b) is available [here](#).