

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA21LA208

AIRWORTHINESS AND SYSTEMS FACTUAL REPORT

TABLE OF CONTENTS

A. ACCIDENT.....	3
B. AIRWORTHINESS AND SYSTEMS FACTUAL REPORT.....	3
C. SUMMARY	3
D. DETAILS OF THE INVESTIGATION	4
E. AIRPORT AND RUNWAY ENVIRONMENT	4
F. VIDEO OF ACCIDENT LANDING	9
G. AIRWORTHINESS EXAMINATION.....	15
H. AIR/ GROUND BRAKE SYSTEM OVERVIEW	19
I. AIR BRAKE FAILURE PERFORMANCE CONSIDERATIONS.....	21
J. DIGITAL ELECTRONIC ENGINE CONTROL DOWNLOAD	21

A. ACCIDENT

Location: Ridgeland, South Carolina
Date: May 5, 2021
Time: 1033 Local
1433 UTC
Airplane: Israel Aerospace Industries LTD Gulfstream G150, N22ST

B. AIRWORTHINESS AND SYSTEMS FACTUAL REPORT

NTSB IIC¹ Adam Gerhardt
National Transportation Safety Board
Washington, DC

NTSB Investigator Peter Wentz
National Transportation Safety Board
Washington, DC

Party Member Jason Arthur
Federal Aviation Administration
Columbia, South Carolina

Party Member Brittnee Kikolski
Gulfstream Aerospace Corporation
Savanna, Georgia

Party Member David Studtmann
Honeywell Aerospace
Phoenix, Arizona

C. SUMMARY

On May 5, 2021, about 1033 eastern daylight time, an Israel Aerospace Industries LTD Gulfstream G150, N22ST, was substantially damaged when it was involved in an accident at Ridgeland-Claude Dean Airport (3J1), Ridgeland, South Carolina. The two pilots and three passengers were not injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 executive/corporate flight.

¹ The Investigator-in-Charge originally assigned to the investigation retired from the NTSB and the investigation was reassigned in May 2023.

D. DETAILS OF THE INVESTIGATION

The accident site and wreckage were documented on May 5, 6, 2021 by FAA inspectors and Gulfstream representatives. The on-site activities were coordinated with the NTSB Investigator-in-Charge via teleconference. The wreckage was recovered from the accident site to Florida Air Recovery located in Jacksonville, Florida.

On September 30, 2021, two N1 Digital Electronic Engine Controls (N1 DEECs) were downloaded at the Honeywell Aerospace facility in Tucson, Arizona. The Cockpit Voice Recorder (CVR) was downloaded and summarized² at the NTSB Recorder's Laboratory in Washington, DC. This airworthiness and systems factual report details the factual findings pertaining the examination of the airplane and its components.

E. AIRPORT AND RUNWAY ENVIRONMENT

The airplane landed on runway 36 at 3J1 airport and subsequently came to rest about 400 ft past the end of runway 36 in marshy and wet terrain. The airplane sustained substantial damage to the wings and fuselage. Runway 36-18 was an asphalt runway measuring 4,200 ft long and 75 ft wide at an elevation of 85 ft. A precision approach path indicator (PAPI) with a 3° glidepath was located on the left side of the runway and a windsock³ was located near the middle of the runway.

² The CVR factual report is located in the NTSB Public Docket.

³ Per FAA Advisory Circular 150/5345-27, when fully extended the wind is about 15 knots. The windsock had the appearance of a standard design.

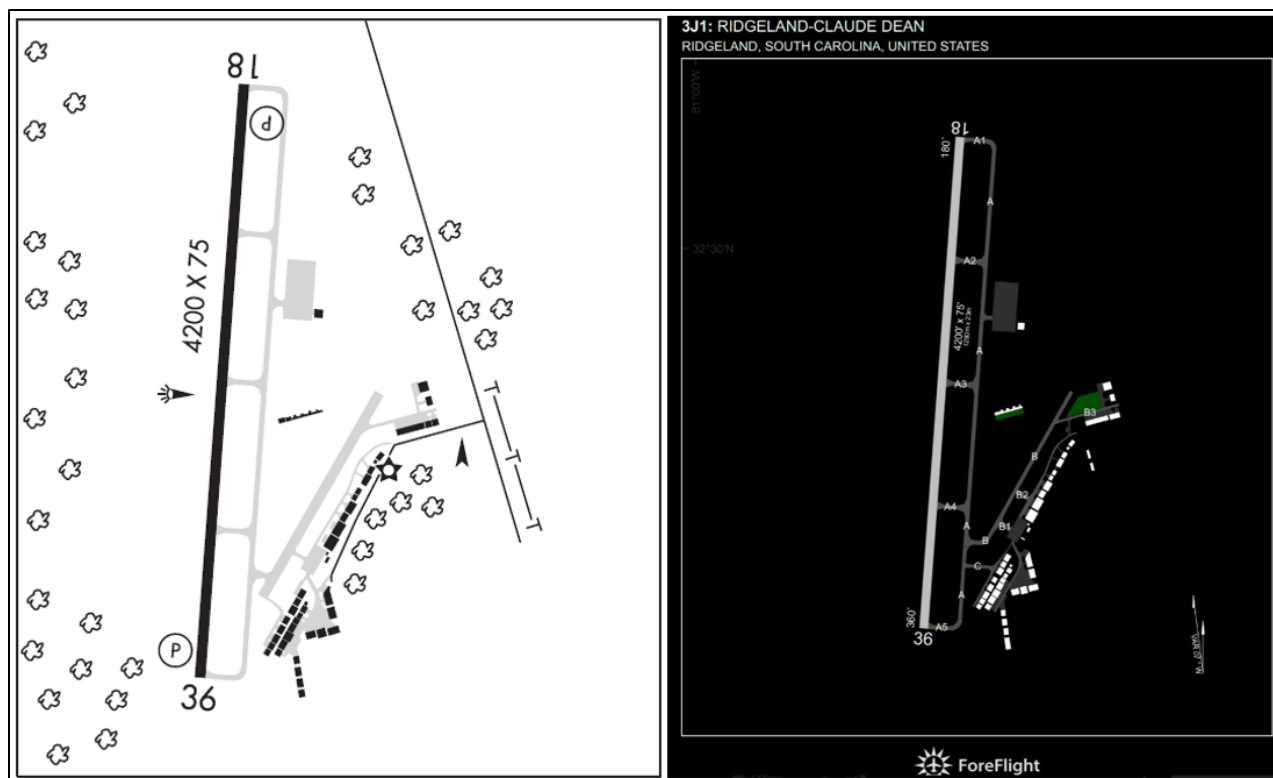


Figure 1: Overview of the FAA Chart Supplement and ForeFlight LLC airport diagrams.

Tire marks located on the runway were measured and correlated to the accident airplane's main landing gear orientation and tire width. Initial touchdown tire marks showed that the airplane landed approximately 1000 -1200ft down the runway, near taxiway alpha 4 (A4). Symmetrical tire tracks were visible down a large percentage of runway.

The majority of tire tread marks were viewed to be light and were not consistent with heavy braking or anti-skid operation, until the tracks reached the taxiway alpha 2 (A2) area about 1,000 ft from the end of the runway. Heavy braking tire marks were observed for about 50 ft in length in this area. The second area of heavy braking was identified at the runway identification numerical markings for runway 18 continuing off the runway. Tire marks consistent with heavy braking and anti-skid intermittent braking tire marks were observed.

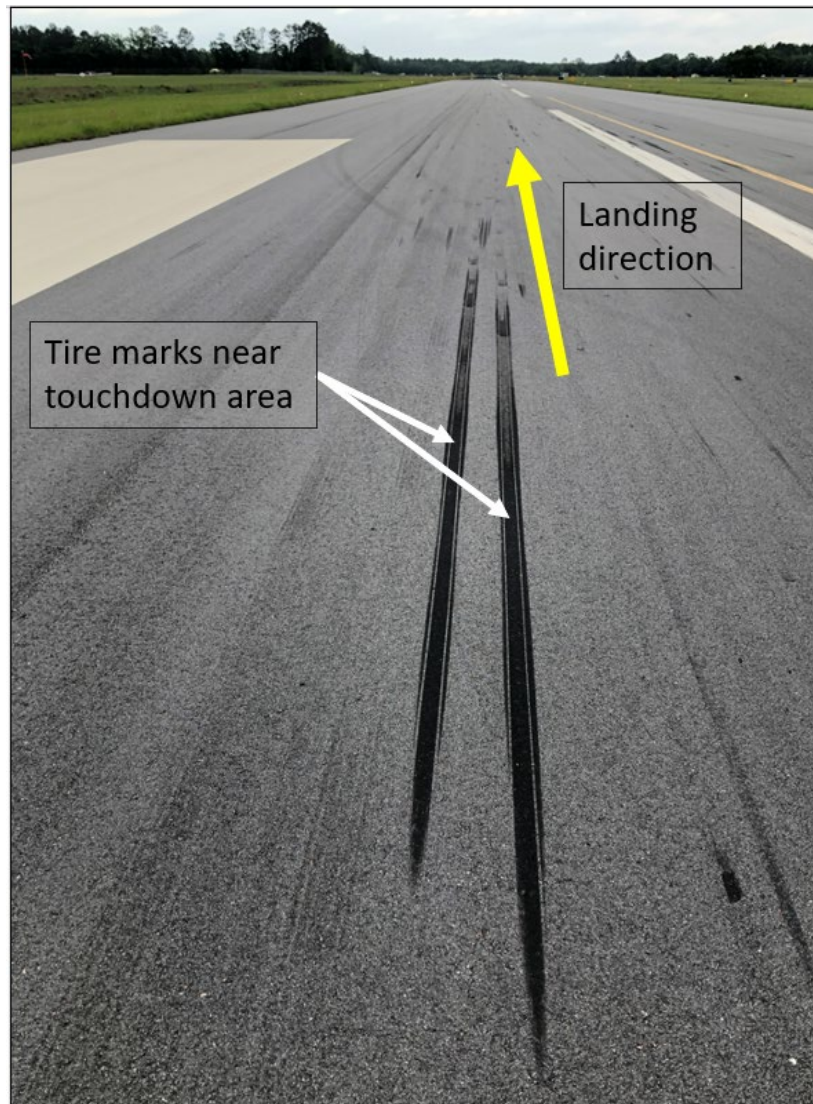


Figure 2: Overview of tire marks on runway

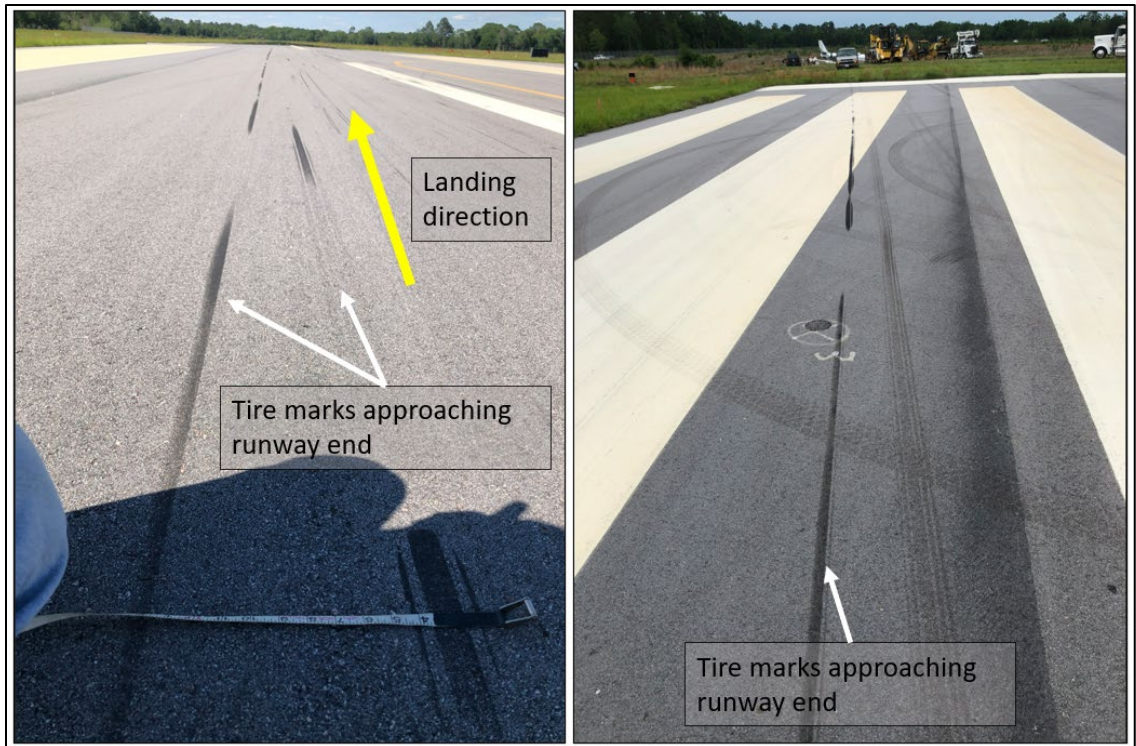


Figure 3: Overview of tire marks on runway.

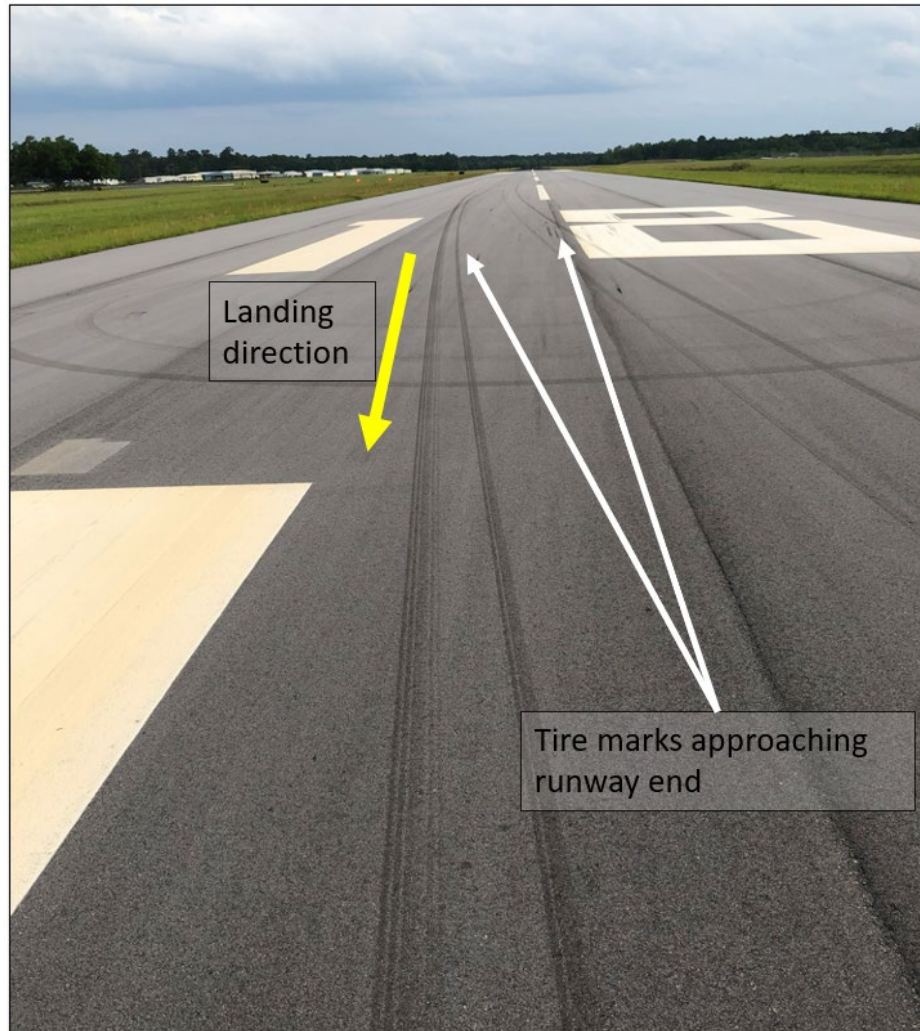


Figure 4: Overview of tire marks on runway.



Figure 5: Tire marks approaching runway end.

F. VIDEO OF ACCIDENT LANDING

A cell phone video taken by an individual located at the 3J1 airport captured about 15 seconds of the accident airplane's final approach, the entirety of the landing roll, and a few seconds of the runway excursion. The video is available in the public docket.

When the airplane touched down, smoke was briefly observed to emanate from the main landing gear tires. About four seconds after touchdown, the airport's windsock comes into view. The windsock while in camera view throughout the ground roll indicated a quartering tailwind at varying speeds. At moments, the windsock was nearly fully extended.

About five seconds after touchdown, the right engine came into view and the thrust reverser was observed to be deployed. The video captured sound that was consistent with engine thrust reversers deploying. The left engine thrust reverser did not come into view until 11 seconds after touchdown, and it was observed to be deployed. Throughout the entirety of the landing roll, the air brakes were not observed to deploy on either wing.



Figure 6: Still view of landing video about 4 seconds after touchdown.

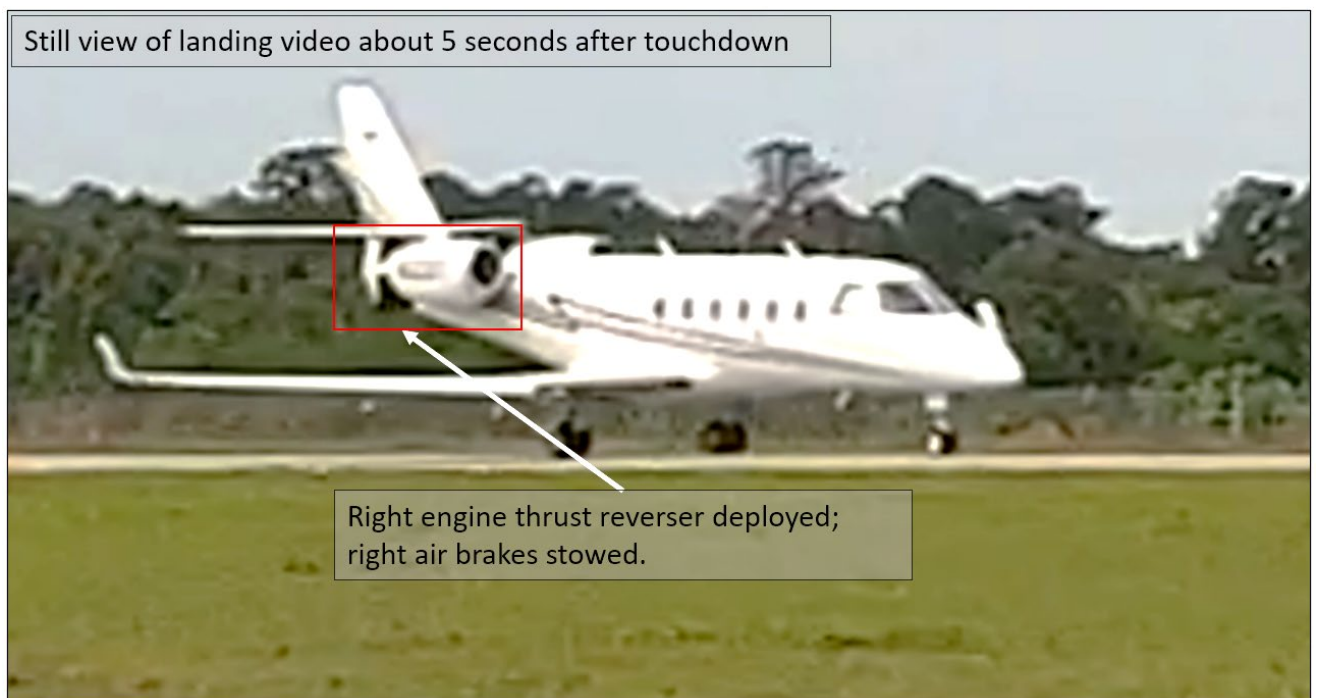


Figure 7: Still view of landing video about 5 seconds after touchdown.

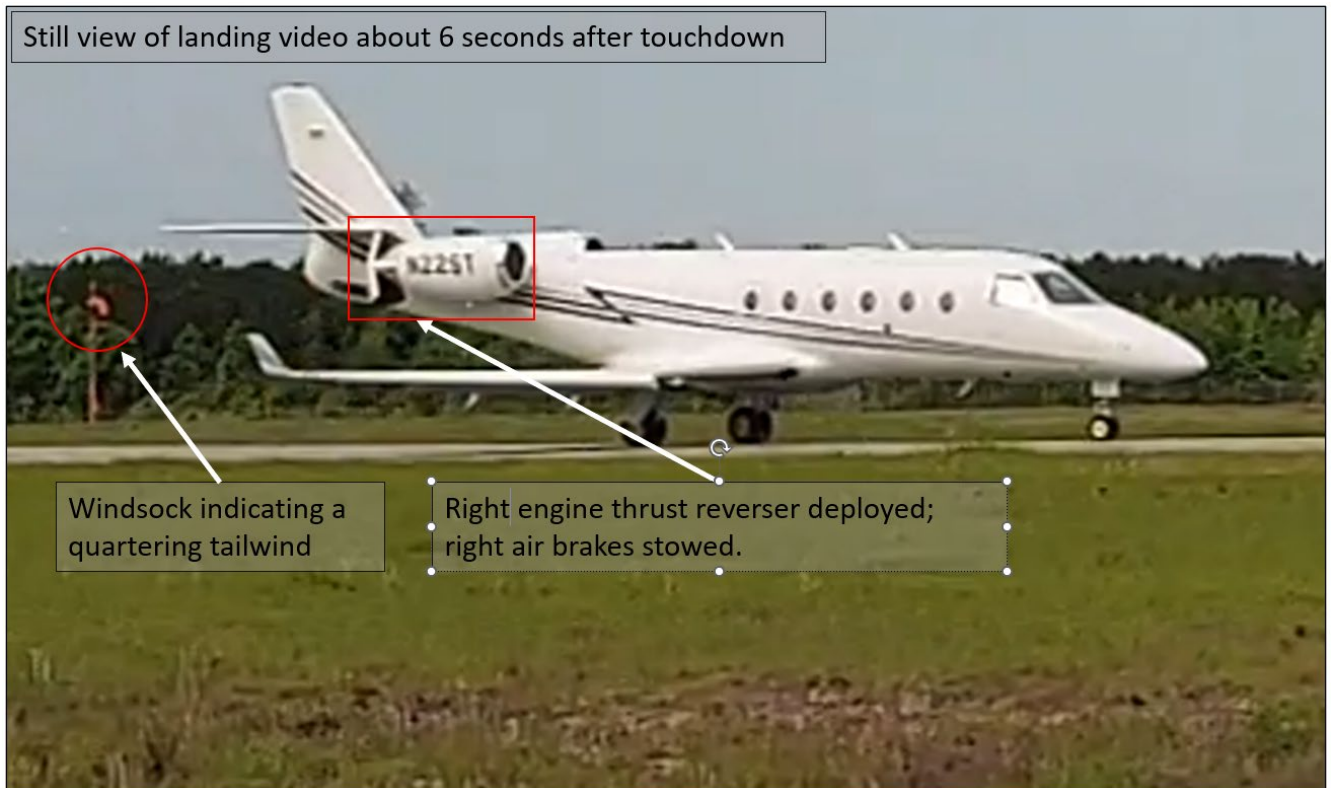


Figure 8: Still view of landing video about 6 seconds after touchdown.

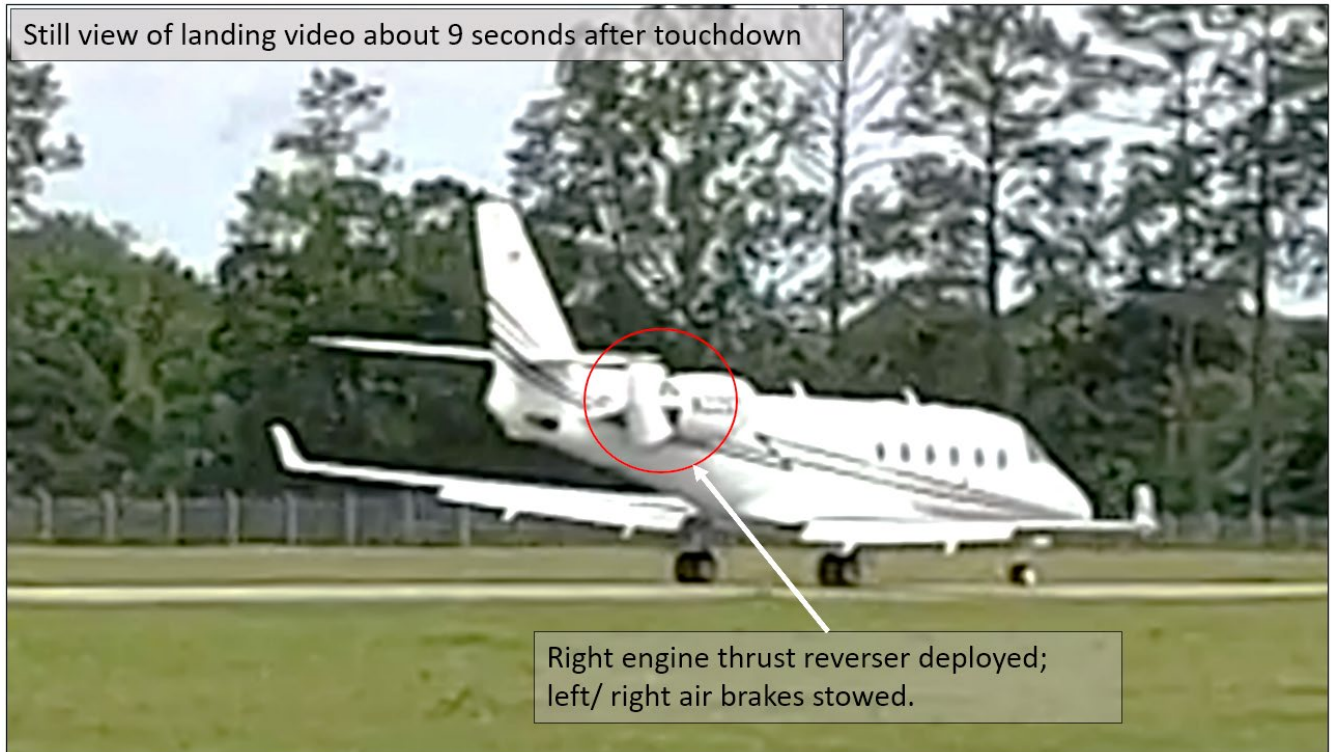


Figure 9: Still view of landing video about 9 seconds after touchdown.



Figure 10: Still view of landing video about 11 seconds after touchdown (About 1,000 ft of runway remaining).



Figure 11: Still view of landing video about 18 seconds after touchdown, about one second before the airplane departs the runway.



Figure 12: View of the airplane at the accident site.



Figure 13: March 19, 2021, still view of video from the accident airplane turning off 3J1 runway 36 at alpha 2 (A2) taxiway after landing, with air brakes deployed.

G. AIRWORTHINESS EXAMINATION

Landing Gear

The nose gear appeared folded under the aircraft and the nose gear tires were detached from the gear. The left main landing gear (MLG) and doors remained intact. The right MLG was sheared from the airplane and only remained attached to the aircraft via one wire electrical harnesses and two flexible hydraulic lines.

The right MLG wiring harness for the Weight on Wheels (WOW) switch and wheel speed sensors were found disconnected. Visual inspection indicated no obvious damage to the wire harness connector. Further inspection at the accident site found that the airplane's connector bayonets were sheared consistent with the connector detaching during the runway departure.

The main hydraulic reservoir sight glass was viewed to be empty. No fluid was observed on the runway. Note, the right MLG hydraulic lines were sheared during the runway excursion which compromised the hydraulic system and its ability to retain fluid. The auxiliary hydraulic reservoir was found full, and the accumulator had pressure one day after the accident.



Figure 14: View of the left and right MLG as viewed during the recovery operation.



Figure 15: Views of the left MLG post-recovery.



Figure 16: View of the right MLG post-recovery.

Left Wing

The left wing was substantially damaged during the impact sequence. The outboard and inboard flaps were found set to 40°. The air brakes/ spoilers were found in the stowed position.

Right Wing

The right wing was substantially damaged during the impact sequence. The right flap actuator screw had separated from its attachment area and the flaps were found in an undetermined position. The air brakes/ spoilers were found in the stowed position.

Cockpit

The flap selector was found set to flaps full 40°. The air brake switches as found were as follows: The flight A/B switch was found set to the retract position and the ground A/B switch was found set to land. The air brake switches when tested with an electrical multimeter at the accident site both produced normal currents.

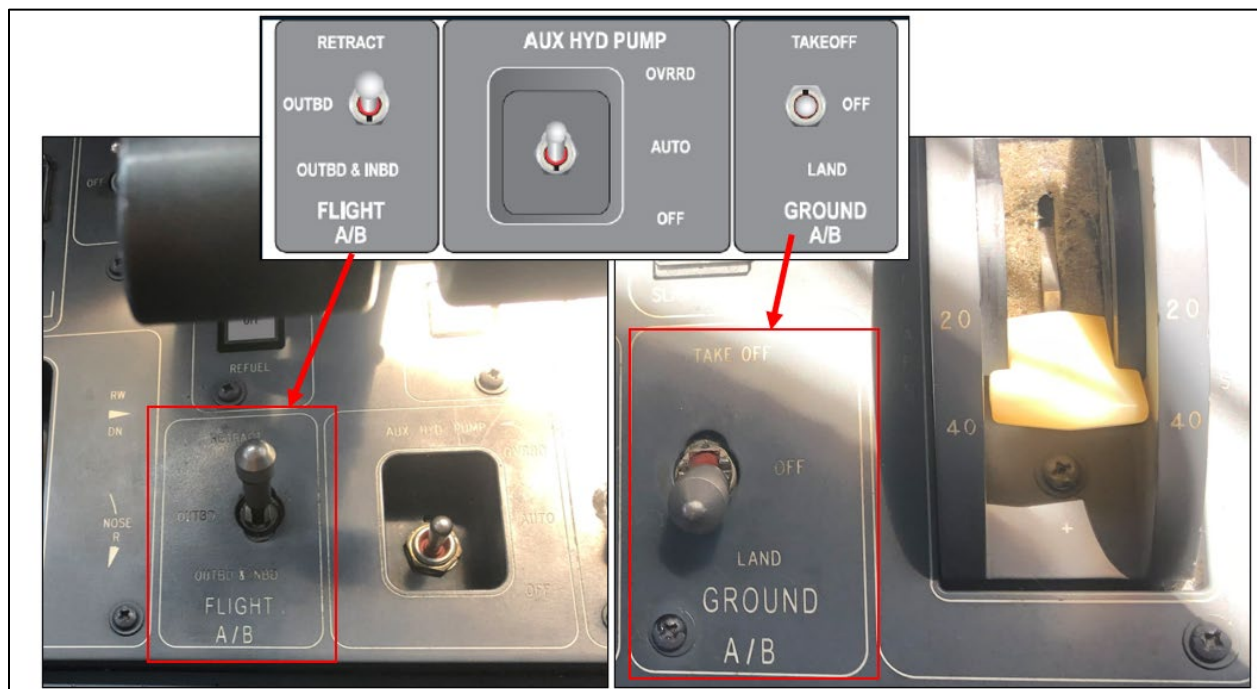


Figure 17: View of the air brake switches as found post-accident.

The throttle quadrant microswitches electrical currents were tested and measured with an electrical multimeter. The left throttle microswitch functioned per design when tested with the multimeter. The right throttle microswitch testing was inconclusive. The right throttle microswitch when initially tested without manipulating the throttle measured a resistance at ~600 ohms, which was not consistent with normal resistance, nor consistent with the left throttle microswitch reading. When the

right throttle was touched slightly, resistance was lowered. Further manipulation of the right throttle brought the electrical resistance to normal readings.

H. AIR/ GROUND BRAKE SYSTEM OVERVIEW

The wings have four control surfaces per wing that are electrically controlled and hydraulically operated. The air brakes system may be operated in flight by operating the inboard surfaces and on the ground by operating the inboard and outboard surfaces.

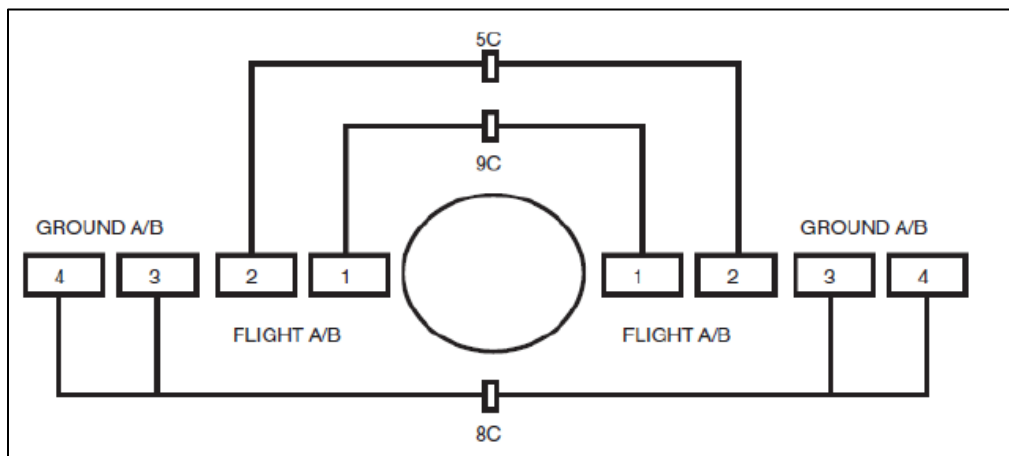


Figure 18: Overview of the air and ground brake orientation on the wings (Image Courtesy Gulfstream Aerospace Corporation Flight Manual)

Air Brake Actuator

All eight hydraulic actuators are double acting, single rod cylinders with internal mechanical lock device which lock the actuator in the retracted position.

Air Brake Selector Solenoid

The selector valve is a four-way, two-position, solenoid operated hydraulic valve. The extension mode is initiated by energizing the solenoid. The solenoid is spring-loaded in its retracted mode. When the valve is energized, fluid pressure is routed to the actuator to open the mechanical locks and deploy the surfaces.

Air Brakes Limit Switch

Advisory messages are initiated through the display control unit which performs control logic by eight double pole limit switches, one per air brake surface.

Operational Summary

The air brakes may be operated in two modes: In the air as Air Brakes-Air, and on ground, as Air Brakes-Ground. When the system is actuated, the air brakes extend simultaneously and symmetrically. The control logic will cause retraction of the air brakes in case the extension is not simultaneous and symmetrical. When airborne, hydraulic pressure forces the surfaces to the closed position as long as the solenoid selector valve is de-energized. Mechanical locks in the actuator hold the surface closed in case the hydraulic power supply fails with the surfaces in the closed position. Energizing the solenoid valve causes the hydraulic pressure to open the mechanical locks of the actuator and extend the actuator. In case of hydraulic power supply failure with air brake surfaces open, the surfaces are free to move according to the aerodynamical loads on the wing.

Ground operation includes all eight surfaces and is controlled by the GROUND A/B switch. When deployed, the air brakes dump lift from the wing when aborting takeoff or on landing. Flight operation is controlled by the FLIGHT A/B switch.

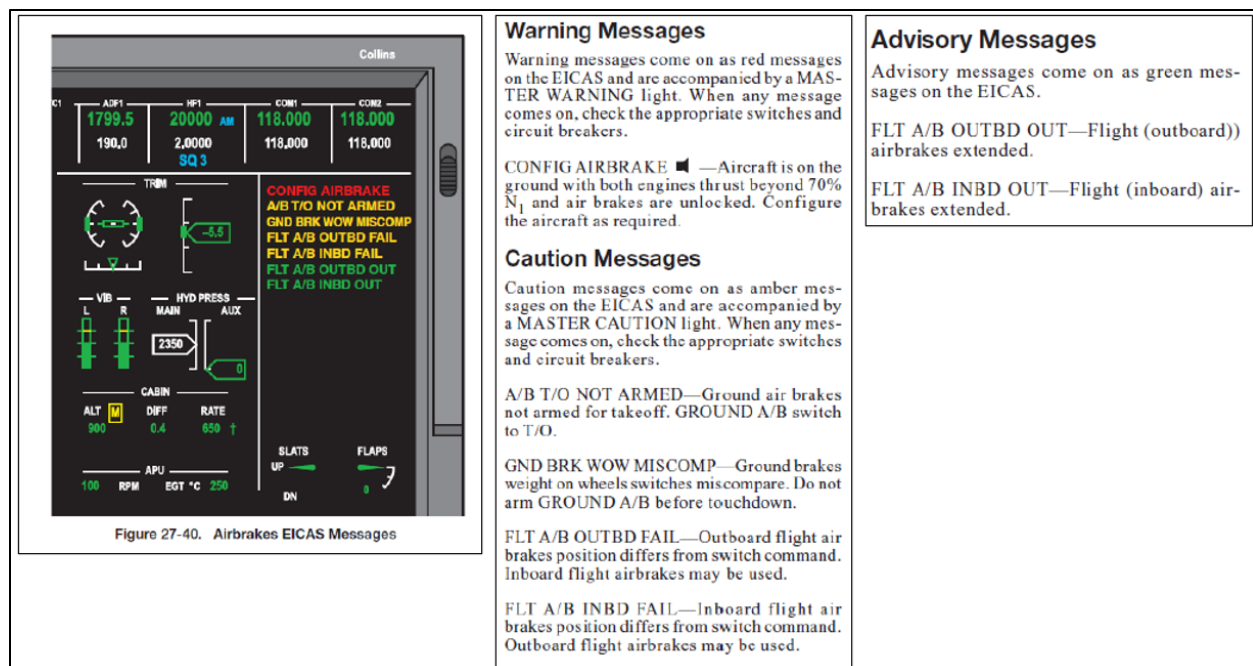


Figure 19: Gulfstream flight manual description of air and ground brake warning, caution, and advisory messages.

Air Brakes - Ground Deployment Requirements/ Logic

- Aircraft electrical power
- Main system hydraulic pressure
- Minimum one of two MLG WOW in ground mode
- Both throttle quadrant angle levers below 18°
- Ground A/B Switch in LAND mode

Summary of System Testing

- Ground A/B switch tested, electrically functional.
- Left throttle microswitch functional, right throttle microswitch testing inconclusive.
- MLG WOWs functional (*required for thrust reverser deployment*)

I. AIR BRAKE FAILURE PERFORMANCE CONSIDERATIONS

According to the airplane flight manual, if the ground air brakes are inoperative for landing, landing performance is affected. If all ground air brakes are inoperative, the landing distance must be increased by 30%.

GROUND A/B FAILURE DURING LANDING		
If ground air brakes are inoperative for landing, landing performance is affected. Apply the following correction factors:		
Landing Distance (LFL)	All ground air brakes (8 surfaces) are inoperative	Add 30%
	All flight air brakes (4 surfaces) are inoperative	Add 15%

Figure 20: Airplane flight manual air brake failure excerpts

Gulfstream Aerospace completed a landing distance performance calculation utilizing tabular data and the application iPreFlight with data consistent to the accident flight parameters. The performance application could only accept a maximum of a 10 knot tailwind, given that was the limiting tailwind speed listed in the airplane flight manual.

The unfactored landing distance was 3,034 ft, before considering the 30% increase with inoperative ground air brakes. Adding the 30% resulted in a ground roll landing distance of 3,944 ft. The accident airplane landed about 1,000 ft down the 4,200 ft runway.

J. DIGITAL ELECTRONIC ENGINE CONTROL DOWNLOAD

On September 30, 2021, two N1 Digital Electronic Engine Controls (N1 DEECs) were downloaded at the Honeywell Aerospace facility in Tucson, Arizona.

The download of the incident recorder data and fault history data from both N1 DEECs was completed successfully. The data indicated that both engines were operating normally and responding to power lever inputs throughout the approach

and landing roll. The data also shows that both of the thrust reversers deployed for approximately 21 seconds, approximately 2 seconds after touchdown.

Submitted by:

Adam Gerhardt
Senior Air Safety Investigator