NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C.

June 6, 2012

SURVIVAL FACTORS SPECIALIST'S FACTUAL REPORT OF INVESTIGATION

A.	ACCIDENT	:	ERA12FA056
	LOCATION	:	Key West, Florida
	DATE	:	October 31, 2011
	TIME	:	1940 eastern daylight time (edt)[1]
	AIRPLANE	:	Gulfstream G-150, N480JJ

B. SURVIVAL FACTORS GROUP

Chairman:	Nora Marshall National Transportation Safety Board Washington, DC
Member:	Don Sposito Gulfstream Aerospace Corporation Dallas, TX
Member:	Darrell Hudson Hendrick Motorsports, LLC Concord, NC
Member:	Pete Meister B/E Aerospace, Inc. Medley, FL
Member:	Carey O'Kelley Federal Aviation Administration College Park, GA

C. SUMMARY

On October 31, 2011, at about 1940 eastern daylight time, an Israel Aircraft Industries G150, N480JJ, went off the end of the runway on landing roll out. The nose landing gear collapsed and the airframe sustained structural damage. Visual meteorological conditions prevailed and an instrument flight rules (IFR), flight plan was filed. The certificated airline transport rated pilot-in-command (PIC), airline transport rated co-pilot and one passenger reported minor injuries. One passenger sustained serious injuries. The flight

[1] Unless otherwise noted, all times herein are local time and based on the 24-hour clock.

departed from Witham Field Airport (SUA), Stuart, Florida at 1900 enroute to Key West International Florida (EYW), Key West, Florida. The flight was conducted under the provisions of 14 Code of Federal Regulations Part 91 as a personal flight.

D. DETAILS OF THE INVESTIGATION

1. Airplane Configuration

The accident airplane was configured with two pilot seats and six passenger seats (see figure 1). Two passenger seats were aft-facing and four passenger seats were forward-facing. For the purpose of this report, the seats are identified by row number and position on the left (L/H) or right side (R/H) of the cabin. Row 1 is at the front of the cabin and includes the aft-facing seats designated L/H #1 or R/H #2. Row 2 is the center row of seats the seats are designated L/H #2 or R/H #2, and row 3 is the aft row of seats designated L/H #3 or R/H #3.

The pilot seats were equipped with a 5-point restraint system and all passenger seats were equipped with lap belts and shoulder harnesses.

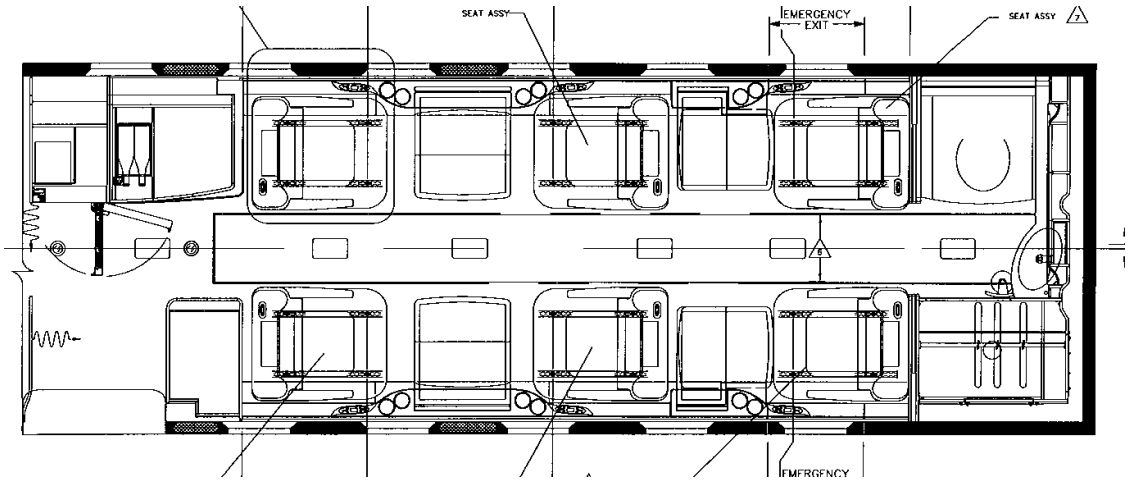

Figure 1
Cabin configuration (front of airplane on left).

2. Crew Information

There were two pilots on board. The captain and first officer were interviewed about the evacuation in November, 2011. See attachment 1 for interview summaries.

3. Passengers

There were two passengers on board and neither passenger was interviewed for this report. According to HMS staff, a male passenger was seated in Seat L/H #2 and a female passenger was seated in Seat R/H #2.

4. Airplane Damage and Wreckage Site

The accident airplane, a G150, Serial Number 241, N480JJ, left the paved runway, crossed 600 feet of unpaved runway safety area (RSA), then traveled an additional 220 feet. The nose of the airplane came to rest about three feet from an airport perimeter fence and the left wing was partially immersed in a shallow salt pond. The fuselage and right wing were resting on dry land at the edge of the salt pond.

The accident airplane was transported from Key West, FL to Atlanta Air Salvage on two trucks which departed Key West on December 1 and December 2, 2011.

The Survival Factors Group was formed on March 6, 2012 at Griffin, GA for the purpose of documenting the passenger cabin and passenger seats. The Survival Factors Group did not examine the airplane at the accident site; however one member of the group was on scene during the initial documentation. For information about the condition of the cabin and passenger seats before the airplane was moved from the accident site, refer to Factual Report of On-scene Cabin Documentation.

4.1 Seat Information

The cabin interior was installed at the Gulfstream Completion Center in Dallas, Texas, and delivered into service on February 6, 2008. The cabin seats were installed on January 18, 2008. See attachment 2 for an excerpt of the Gulfstream Installation Log Book entry for seat installation.

The seat part numbers and seat positions were specified in Gulfstream Seat Installation Drawing GA322080012 (Revision E) (2007-03-08). According to the Seat Installation Drawing's Table 1, the seat part numbers for specific locations and orientations are listed below:

Seat Position 1 (L/H #1)	Aft Facing	Seat Part Number 3AEF0101029
Seat Position 2 (R/H #1)	Aft Facing	Seat Part Number 3AEF0101030
Seat Position 3 (L/H #2)	Fwd Facing	Seat Part Number 3AEF0101009
Seat Position 4 (R/H #2)	Fwd Facing	Seat Part Number 3AEF0101010
Seat Position 5 (L/H #3)	Fwd Facing	Seat Part Number 3AEF0101041
Seat Position 6 (R/H #3)	Fwd Facing	Seat Part Number 3AEF0101042

The design of an aft-facing seat differs from a forward-facing seat because the aft-facing seat has two backrest locks and a forward-facing seat has one backrest lock. According to a representative from the seat manufacturer, two locks are needed for an occupied aft-facing seat in order to accommodate the occupied seat loading.

The seats installed in the cabin were B/E Aerospace G150 Stratas Single Passenger Fixed Base seats. The Stratas seat model also has a floor tracking version which has different installation instructions and a different part number for the shear plunger bolt. The seat manufacturer's representative indicated that, at the time of the accident, no floor tracking seats were in service. However shear plunger bolts for tracking seats were found in the field and those bolts are 0.79 inches longer than shear plunger bolts for the fixed base installation seat. The tracking seat's longer bolt has the same material properties as the shear plunger for the fixed base seat.

The fixed base seat is designed to attach to the floor track with four lower fitting housings. To install the seats, the shear plunger is raised to maximum height to allow for positioning the seat track fastener studs into the seat track. The seat is then slid forward or aft ½ inch and the shear plunger is tightened so that is at or below the top surface of the lower fitting housing. The shear plunger is supposed to be tightened to a torque value of 30-50 in. lb. See figure 2.

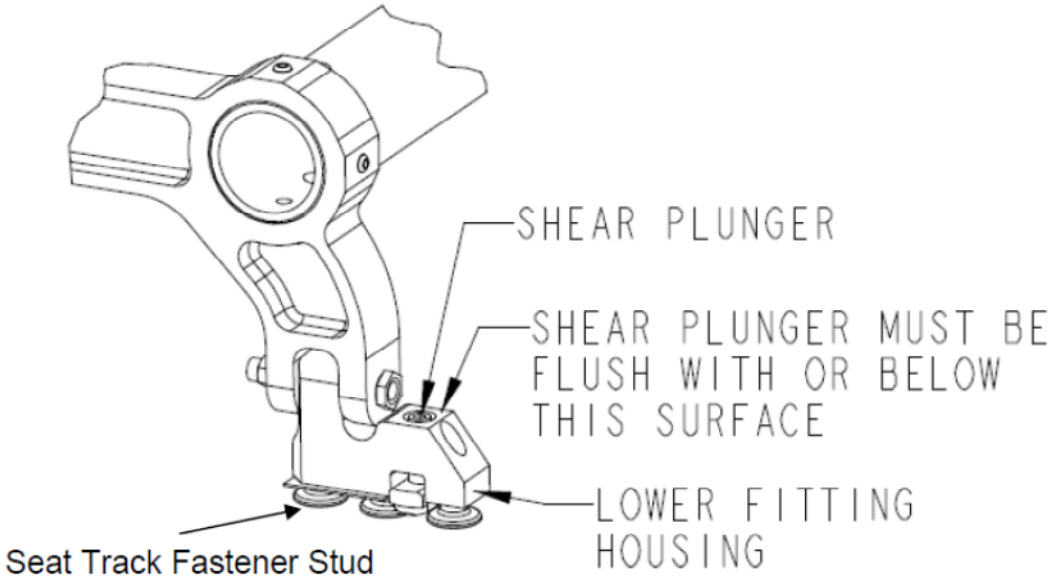

Figure 2
Fixed base floor fitting.

4.2 Seat and Cabin Documentation at Key West, Florida

The cabin was inspected and documented in Key West, Florida, on November 2, 2011. The group found that Seat L/H #2 separated from the seat track and the seat's shear plungers were not tightened so the plungers were at or below the top surface of the lower fitting housing. The other five cabin seats were properly installed with the shear plungers positioned at or below the top surface of the lower fitting housing. Please see Factual Report of On-scene Cabin Documentation.

4.3. Survival Factors Group Seat and Cabin Documentation in Griffin, GA

The Survival Factors Group examined the cabin on March 6, 2012, at Atlanta Air Salvage Griffin, GA, and documented the following information:

4.3.1. Passenger Seat and Restraint Information:

Data plate information for each seat position is listed below:

Left No. 1 Seat (L/H #1):

Model No.:	3AEF0101(010)
Serial Number:	071128-02
Compliance:	TSO C127a Type A[2]
Item:	SGL. TRK/SWL FF 16G
Seat Assembly:	G150 202-2280-07
Restraint:	5-02-5G5868SAG REV D[3]

Right No. 1 Seat (R/H #1):

Model No.:	3AEF0101(009)
Serial Number:	071128-01
Compliance:	TSO C127a Type A
Item:	SGL. TRK/SWL FF 16G
Seat Assembly:	G150 202-2280-07
Restraint:	5-02-5G5868SAG REV D

Left No. 2 Seat (L/H #2):

Model No.:	3AEF0101(030)
Serial Number:	071128-04
Compliance:	TSO C127a Type A
Item:	SGL. TRK/SWL RF 16G
Seat Assembly:	G150 202-2280-07
Restraint:	5-02-5G5868SAG REV D

Right No. 2 Seat (R/H #2):

Model No.:	3AEF0101(029)
Serial Number:	071128-04
Compliance:	TSO C127a Type A
Item:	SGL. TRK/SWL RF 16G
Seat Assembly:	G150 202-2280-07
Restraint:	5-02-5G5868SAG REV D

[2] The FAA issued authorization for the seat's TSO on January 29, 2007.

[3] All passenger restraints were manufactured by Schroth.

Left No. 3 Seat (L/H #3):

Model No.:	3AEF0101(041)
Serial Number:	071228-05
Compliance:	TSO C127a Type A
Item:	SGL. TRK/SWL FF 16G
Seat Assembly:	G150 202-2280-07
Restraint:	5-02-5G5868SAG REV D

Right No. 3 Seat (R/H #3):

Model No.:	3AEF0101(042)
Serial Number:	071128-06
Compliance:	TSO C127a Type A
Item:	SGL TRK/SWL FF 16G
Seat Assembly:	G150 202-2280-07
Restraint:	5-02-5G5868SAG REV D

The passenger seat shrouds were found detached from the seats and each seat shroud contained a life vest.

Seats L/H #1, R/H #1, RH # 2, L/H #3, R/H #3 were installed per the Instructions for Continued Airworthiness (ICA) and the shear plungers were flush with the top surface of the lower fitting housing.

Seat L/H #2 was found partially installed in track.[4] The Survival Factors Group removed Seat L/H #2 from the seat track for examination. A piece of test track was used to fit-check all four fixed floor fittings. The installation of the test track confirmed that all four plunger studs were in accordance with the B/E Aerospace Component Maintenance Manual (CMM) and were the proper length and could be installed flush.

Following the test track fit check inspection; Seat L/H #2 was reinstalled into the airplane's floor track. Although the carpet made it difficult to align the seat into the track during initial installation, Seat L/H #2 was reinstalled according to the Instructions for Continued Airworthiness (ICA) and all four plungers were flush. The tracking on Seat L/H #2 operated normally after it was reinstalled.

Seat L/H #2's forward inboard and rear outboard floor fitting showed evidence of wear on the bottom of the studs and plunger. Corresponding wear was observed on the top of the seat track. See photos in attachment 3.

[4] The on-scene investigation found seat L/H #2 completely separated from the track.

Seat R/H # 2 was found tracked full forward and inboard from the taxi, takeoff and landing (TTOL) position. The position of the seat could not be released until it was manually overridden.

No permanent floor deformation was observed in the area of occupied seats L/H #2 and R/H #2.

The inboard forward plunger bolt hex head recess at R/H #1 showed tooling marks.

The passenger seat restraint systems were manufactured by Schroth and were approved as part of the seat TSO.

- R/H #2 restraint: Male half of restraint had a crease in the webbing approximately 24 ¼ inches measured from attach fitting to bar on lap belt adjuster.

- L/H #2 restraint: Male half of restraint had a crease in the webbing approximately 37 1/8 inches from attach point to bar on lap belt adjuster.

4.4. Gulfstream Alert Service Bulletin

Gulfstream issued Alert Service Bulletin (ASB) No.150-25A-139 on November 11, 2011. The Subject of the ASB was "Inspection of Passenger Seats for Proper Installation." The bulletin was issued because, "Gulfstream recently discovered that the cabin seat removal and installation procedure referenced in the Gulfstream Completion Center Maintenance Handbook (CCMH) required clarification. A detailed review of the procedure revealed it to be inaccurate for the type seat installed in the G150 aircraft. The potential exists for an improperly installed seat to separate from the tracks during aircraft operations."

The ASB provided instructions for a one-time visual inspection and torque check of all single seat track fitting plungers for correct engagement and torque. Additionally, it provided a temporary revision into the CCMH until the CCMH was revised.

As of January 11, 2012, the results of the inspection of 96[5] of 98 airplanes were reported to Gulfstream and included reports of anomalies on 12 of the 96 airplanes. The anomalies included plungers with incorrect torque values, plungers that were too long,[6] and one airplane in which all five cabin seats were improperly installed seats similar to Seat L/H #2 in the accident airplane.

[5] The reported results did not include the accident airplane.
[6] According to the B/E Aerospace representative the floor tracking seat shear plunger bolts were ordered and shipped by part number.

4.5. Seat Guidance

4.5.1. Gulfstream Completion Center Maintenance Handbook (CCMH):

The CCMH is a delivery document that defines the configuration of a serial number specific aircraft. The CCMH provides guidance to maintenance personnel for the components for the Gulfstream G150 Completion and to "direct them in the proper procedures for maintaining the aircraft in an airworthy condition." The introduction to the CCMH states: "Notice: this completion center maintenance handbook contains information related to completion center installations and modifications. It supplements but does not in any way supersede the basic airplane maintenance manuals. This manual is not be utilized for performing maintenance. For maintenance instructions, please refer to appropriate maintenance manual or instructions for continued airworthiness provided for the interior installation."

Gulfstream Publication Change Request #54727 was submitted on 11/03/2011 and requested a change to the G150 CCMH to "Revise/update removal/installation procedures and operational test of cabin seating per G150 ICA G150 ICA GA 32204A211."

4.5.2. Instructions for Continued Airworthiness (ICA)

Gulfstream issued Maintenance and Operations Letter (MOL) G-150-MOIL-12-0001 on March 14, 2012. The subject of the MOL was "Revised Seat Removal/Installation Procedures for Cabin Interior Instructions for Continued Airworthiness (ICA) Documents." The MOL was issued to "ensure the respective cabin interior ICAs reflect the updated seat removal and installation procedures that were referenced in ASB 150-25A-139 Rev 1" and provided instructions for Operators to download the appropriate ICA document for their floor plan.

According to Gulfstream staff, Gulfstream has reviewed the ICA's for the G150 Executive Cabin Interior STC in regard to Single Seat locations by part number. Gulfstream plans to revise the Six Passenger ICA (GA32204A206) to provide added clarity by adding Single Seat part numbers by location data.[7]

4.5.3. Component Maintenance Manual (CMM)

B/E Aerospace provided Gulfstream with Component Maintenance Manual 25-24-78 Rev. B with illustrated parts list issued May 24, 2006. Instructions for seat installation

[7] Gulfstream plans to have the updated completed by the end of June, 2012.

into the airplane were called out on page 7001 2A. At the request of Gulfstream, B/E Aerospace issued three revisions (C, D, and E) following the accident. Rev. E was released on 1/19/2012. The CMM provided information on two types of seat installation: tracking and fixed seats. The accident airplane's seats were a fixed installation.

4.6. Seat Removal/Reinstallation

According to the Hendrick Motorsports aviation director of maintenance, Seat R/H #1 was removed and reinstalled by a technician on June 19, 2008 to facilitate cleaning a beverage spill.

According to Gulfstream Work Order (WO#) SC188828, (see attachment 3) all of the seats in the cabin were removed and reinstalled during work performed at a Gulfstream facility in Savannah, Georgia, that was completed on 1/05/2010.

According to Gulfstream Work Order (WO#) SC228125 (see attachment 3), Seats L/H #1, R/H #1, R/H #2, and R/H #3 were removed and reinstalled during work performed at the Gulfstream facility in Savannah, Georgia, that was completed on 12/15/10.

4.7. Cabin Door and Overwing Emergency Exits

The main cabin door was opened and closed without difficulty by Atlanta Air Salvage staff.

Both overwing emergency exits were opened and reinstalled without difficulty by the Survival Factors Group.

4.8. Miscellaneous Cabin Equipment

The cockpit fire extinguisher, located behind the captain's seat, was not installed in its brackets. According to Gulfstream staff, the fire extinguisher was removed from the bracket during the on-scene investigational brake checks.

5.0 Occupant Injuries

All four occupants were transported to Lower Keys Medical Center. One passenger was seriously injured and three occupants sustained minor injuries. See Attachment 4 for description of injuries.

5.1 Injury Table

	Cockpit Crew	Flight Attendant	Passengers	Others	Total
Fatal	0	0	0	0	0
Serious	0	0	1	0	1
Minor	2	0	1	0	3
None	0	0	0	0	0
Total	2	0	2	0	4

6. Emergency Response

6.1 Airport

The Key West International Airport (EYW) is owned and operated by Monroe County. The airport has a single runway and is a Class 1, Index B Airport. Runway 9/27 is a 4801 x 100 feet asphalt/grooved runway. An engineered material arresting system (EMAS) 340 feet in length by 120 feet in width was located at the departure end of runway 9. The safety area at the departure end of runway 27 was 400 feet wide and 600 feet long. See attachment 2 for RSA photos.

6.1.1. Runway Safety Area Improvements

On September 29, 1989, the FAA issued FAA Advisory Circular 150/5300-13, *Airport Design*, Table 3-3, *Runway Design Standards for Aircraft Approach Categories*, which specifies that the standard runway safety area (RSA) should have a width of 500 feet (centered on runway centerline) and a length of 1,000 feet beyond each runway end.

In September 1999 the FAA initiated an effort to examine the RSAs at all Part 139 certificated airports. The purpose of the inventory was to: (1) document all objects and natural features in the standard RSA that could pose increased risk for aircraft that leave the runway surface; (2) develop a preliminary plan for improving safety areas to the maximum extent practicable; (3) identify incremental improvements that would reduce the hazard to aircraft even when a completely standard RSA is not practicable.

On May, 17, 2000, EYW began an RSA study that was presented to the FAA in April, 2001. See figure 3 for the planned modification to the RSA footprint that according to the study improved safety to the greatest extent practicable and satisfied state and federal environmental resource permit requirements. Construction began on improved RSAs in May, 2010 (see attachment 5 for a chronology of events related to the RSA improvements). The RSA with EMAS was completed on the east end of the runway in October 2010; and the RSA extension at the west end of the airport was completed in May 2011.

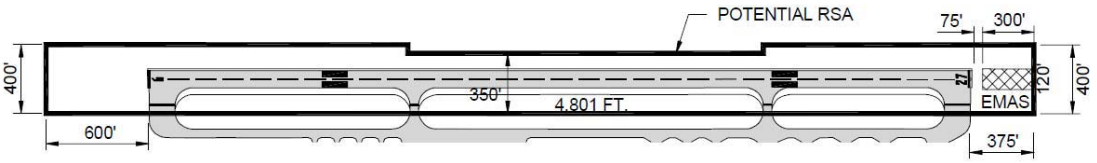

Figure 3
Proposed RSA.

6.1.2. EMAS at EYW

On November 3, 2011, at 1213 eastern standard time, a Cessna Citation, N938D, with two pilots and three passengers overran the east end of runway 9, crossed 35 feet of deflector area and continued for 148 feet into an EMAS. None of the occupants reported any injuries. (see NTSB incident report ERA12IA060 for additional information and a video of the airplane entering the EMAS).

6.1.3. NOTAM - Runway Rubber Removal

EYW issued a NOTAM on September 30, 2011 indicating that the airport would be closed during the evening hours of October 2-4, 2011 for rubber removal (see attachment 6).

EYW runway was closed for three consecutive nights to do rubber removal and restriping of the centerline. The work was completed at 0600 on Wednesday October 5, 2011.

EYW does not have friction testing equipment and did not perform friction testing, nor were they required to perform friction testing, before or after the rubber removal.

6.2. Aircraft Rescue and Firefighting (ARFF)

According to a report by the EYW Airport Manager to the FAA, the incident was reported by the Air Traffic Control (ATC) tower to Key West International Airport Aircraft Rescue and Firefighting (ARFF - Station 7) at 1943[8] and by the on-site Monroe County Sheriff's Office (MCSO) personnel at 1944. ARFF reported to the accident scene along with

[8] Although, the Monroe County ARFF incident report indicated that Station 7 responded on-scene at 1957, the incident commander reported that the airport manager's narrative report accurately reported Station 7's arrival time at 1946 and Station 8's arrival at 1957.

MCSO, both arriving at 1946. ARFF Units 7, 107, and 207 responded. Monroe County Fire Rescue (MCFR) Station 8 was also dispatched to assist ARFF at 1946 and reported arrival at 1957. They were met at the west gate and were escorted to the scene of the incident. See attachment 7 for the ARFF report.

6.2.1 ARFF Station 7

ARFF Station 7 was staffed by MCFR. Three vehicles and two firefighters and a captain responded from ARFF Station 7. There was no fire associated with the accident. The incident commander and one firefighter were interviewed (see attachment 1 for interview summaries).

6.2.2. ARFF Station 7 Vehicles

See attachment 6 for a list of ARFF equipment.

The following three Station 7 vehicles responded to the accident.

- ARFF 7 was a 2007 Oshkosh Striker 4X4 equipped with 1500 gallons of water, 210 gallons of AFFF and 500 lbs of dry chemical fire retardant.

- ARFF 107 was a 1998 Oshkosh T-1500 4X4 equipped with 1500 gallons of water, 210 gallons AFFF and 500 lbs. of Halotron. Fire extinguishers on the vehicle include one (1) Halotron 1-2-A 10-B; c and one (1) Purple K-120-B:C

- ARFF 207 was a 2001 Ford Triton V-1—4X4 quick response vehicle equipped with 300 gallons of water and 40 gallons of AFFF. Dry chemical discharge rate is at least 5 lbs per second. Fire extinguishers on the vehicle include one (1) 4-A; 60B: C and one (1) carbon dioxide 10-B:C and one (1) combustible metals D, Amerex brand 30 lb. with no UL listing.

MCFR Station 8 is located off the airport approximately 4 miles from Station 7. Station 8 responded with an engine and ambulance and 3 firefighters.

6.3 Law Enforcement Response

A Monroe County sheriff's deputy and an airport security technician responded to the accident site from the Sheriff's Office Station located at ARFF Station 7.

7. Miscellaneous:

7.1 Inertial Switch

According to AMM (Aircraft Maintenance Manual) 23-70-00, Page 1, in the event of a crash, or whenever the aircraft exceeds 6G vertically or 3G longitudinally, the inertial switch opens to remove 28 Vdc from the CVR. This prevents recorded data from being lost. The switch is equipped with a light to indicate when G limits have been exceeded. There is a reset pushbutton mounted on the switch near the light. After G limits have been exceeded, the inertial switch must be reset with the pushbutton before the CVR will record. Reset also turns off the indicator light. The inertial switch is located in the left console.

Nora C. Marshall
Senior Advisor, Human Performance and Survival Factors Division

Attachments:

Attachment 1: Interview Summaries

Attachment 2: Gulfstream Installation Log Book Excerpt, Excerpts from Work Order (WO) No. SC188828 and WO# SC228125

Attachment 3: Photographs

Attachment 4: Injury Chart

Attachment 5: Runway Safety Area (RSA) Improvement Chronology

Attachment 6: Rubber Removal NOTAM

Attachment 7: Airport Rescue and Firefighting (ARFF) Report