NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Vehicle Recorder Division
Washington, D.C. 20594

GROUP CHAIRMAN'S FACTUAL REPORT OF INVESTIGATION

ERA14MA271

By
Joseph A Gregor

WARNING

The reader of this report is cautioned that the transcription of a cockpit voice recorder audio recording is not a precise science but is the best product possible from a Safety Board group investigative effort. The transcript or parts thereof, if taken out of context, could be misleading. The transcript should be viewed as an accident investigation tool to be used in conjunction with other evidence gathered during the investigation. Conclusions or interpretations should not be made using the transcript as the sole source of information.

NATIONAL TRANSPORTATION SAFETY BOARD
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April 7, 2015

Cockpit Voice Recorder

Group Chairman's Factual Report
By Joseph A Gregor

A. EVENT

Location:	Bedford, Massachusetts
Date:	May 31, 2014
Aircraft:	Gulfstream G-IV, N121JM
Operator:	Private
NTSB Number:	ERA14MA271

B. GROUP

A group was convened on June 10,2014.

Chairman:	Joe Gregor Electronic Engineer National Transportation Safety Board
Member:	Luke Schiada Investigator In Charge National Transportation Safety Board
Member:	Timothy Sorensen Aviation Accident Investigator National Transportation Safety Board
Member:	Tony James Air Safety Investigator Federal Aviation Administration
Member:	Al Moros Engineering Test Pilot Gulfstream Aerospace Corporation

C. SUMMARY

On May 31, 2014, about 2140 eastern daylight time, a Gulfstream Aerospace Corporation G-IV, N121JM, operated by Arizin Ventures, LLC, crashed after a rejected takeoff and runway excursion at Laurence G. Hanscom Field (BED), Bedford, Massachusetts. The two pilots, a flight attendant, and four passengers were fatally injured. The airplane was destroyed by impact forces and a post-crash fire. The personal flight, which was destined for Atlantic City International Airport (ACY), Atlantic City, New Jersey, was conducted under the provisions of 14 Code of Federal Regulations Part 91. An instrument flight rules flight plan was filed. Night visual meteorological conditions prevailed at the time of the accident.

A solid-state cockpit voice recorder (CVR) was sent to the National Transportation Safety Board's (NTSB) Vehicle Recorder Division for readout. The CVR group meeting convened on June 10, 2014 and a partial transcript was prepared for the 2-hour, 4-minute, 14-second digital recording (see attached).

D. DETAILS OF INVESTIGATION

On June 3, 2014, the NTSB Vehicle Recorder Division's Audio Laboratory received the following CVR:

Recorder Manufacturer/Model: **L-3/Fairchild FA2100-1020**
Recorder Serial Number: **Unknown (CSMU S/N 116733)**

Recorder Description

Per federal regulation, turbine engine powered aircraft operating under 14 CFR Part 135 must be equipped with a CVR that records a minimum of the last 2 hours of aircraft operation; this is accomplished by recording over the oldest audio data. When the CVR is deactivated or removed from the airplane, it retains only the most recent 2 hours of CVR operation. This model CVR, the L-3/Fairchild FA2100-1020, is a solid-state CVR that records 2 hours of digital cockpit audio. Specifically, it contains a 2-channel recording of the last 2 hours of operation and separately contains a 4-channel recording of the last 30 minutes of operation. The 2-hour portion of the recording is comprised of one channel of audio information from the cockpit area microphone (CAM) and one channel combining two audio sources: the pilot in command's audio panel information and the second in command's audio panel information. The 30-minute portion of the recording contains 4 channels of audio data; one channel for each flight crew, one channel for the CAM audio information and a fourth channel for the public address and third crewmember.

Recorder Damage

Upon arrival at the audio laboratory, it was evident that the exterior of the CVR had sustained significant heat damage (see Figure 1). The outer case was removed and the interior crash-protected memory module did not appear to have any heat or structural damage (see Figure 2). The memory board within the crash–protected case was checked for heat or structural damage and none was found. The digital audio was successfully downloaded from the memory board.

Figure 1. L-3/Fairchild FA2100-1020 CVR recovered from G-IV, N121JM.

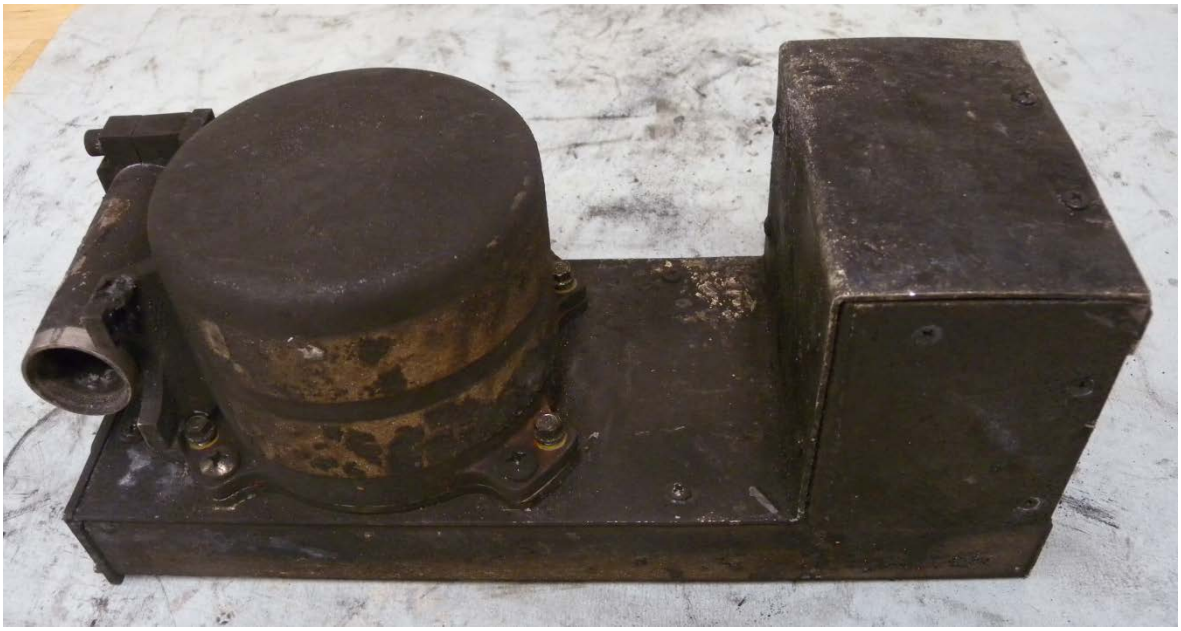
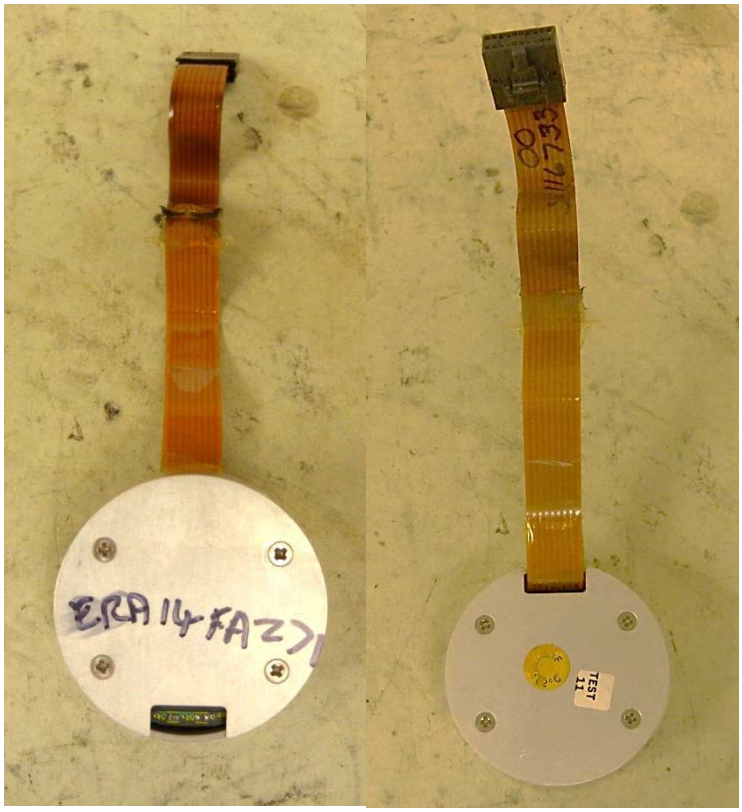


Figure 2. Memory module from the FA2100-1020 (after cable replacement).



Audio Recording Description

For the 2-hour portion of the CVR recording, each channel contained good quality[1] audio information. As shown in the table below, the 30-minute portion of the recording consisted of three channels of useable audio information. Each channel's audio quality is indicated in Table 1. Channel number three did not contain any audio information (nor was it required by Federal regulations). The poor quality of the pilot's HOT microphone channels may be attributable to a lack of headphone use.

Table 1: Audio Quality

Channel Number	Content/Source	Quality
1	SIC[2]	Good
2	PIC[3]	Poor
3	Other	n/a
4	CAM[4]	Poor

[1] See attached CVR Quality Rating Scale.
[2] Second in Command's HOT microphone.
[3] Pilot in Command's HOT microphone.
[4] Cockpit Area Microphone.

Timing and Correlation

Timing with respect to flight data recorder (FDR) data was obtained by correlating common events recorded on both the CVR and the FDR. Specifically, seven radio transmissions that the aircraft made during the last 30 minutes of the CVR recording were correlated to the radio transmit microphone key parameter from the FDR. Once a correlation between the two recorders was established, a reference to local time was determined based on ground radar data.

Timing on the final transcript was established by correlating the local time of the accident to the corresponding sounds recorded on the CVR. The CVR events were offset to reflect the local eastern daylight time of the accident, based on correlation with surface radar according to the following formula:

(Seconds elapsed since midnight, EDT) = (FDR SRN) – 70003 seconds.

Description of Audio Events

The recording began at 1936:10 EDT with the CVR recording sounds consistent with the aircraft on the ground. At 1952:55.9 EDT, a radio call was made to ground control asking to extend the departure clearance for late passengers. Over the next approximately one hour the CVR recorded sounds consistent with two personal cell phone calls. At 2052:51.3, the HOT microphone channels recorded a radio transmission announcing that “Information Juliet” was current.

The transcript began at 2110:19.7 (see attached). The recording ended at approximately 2140:24.5 EDT. Due to the poor quality of the CAM recording, and the apparent lack of HOT microphone use during certain timeframes in the recording, it is possible that some crew communication and cockpit sounds were not intelligibly recorded.

Joe Gregor
Vehicle Recorder Division

CVR Quality Rating Scale

The levels of recording quality are characterized by the following traits of the cockpit voice recorder information:

Excellent Quality — Virtually all of the crew conversations could be accurately and easily understood. The transcript that was developed may indicate only one or two words that were not intelligible. Any loss in the transcript is usually attributed to simultaneous cockpit/radio transmissions that obscure each other.

Good Quality — Most of the crew conversations could be accurately and easily understood. The transcript that was developed may indicate several words or phrases that were not intelligible. Any loss in the transcript can be attributed to minor technical deficiencies or momentary dropouts in the recording system or to a large number of simultaneous cockpit/radio transmissions that obscure each other.

Fair Quality — The majority of the crew conversations were intelligible. The transcript that was developed may indicate passages where conversations were unintelligible or fragmented. This type of recording is usually caused by cockpit noise that obscures portions of the voice signals or by a minor electrical or mechanical failure of the CVR system that distorts or obscures the audio information.

Poor Quality — Extraordinary means had to be used to make some of the crew conversations intelligible. The transcript that was developed may indicate fragmented phrases and conversations and may indicate extensive passages where conversations were missing or unintelligible. This type of recording is usually caused by a combination of a high cockpit noise level with a low voice signal (poor signal-to-noise ratio) or by a mechanical or electrical failure of the CVR system that severely distorts or obscures the audio information.

Unusable — Crew conversations may be discerned, but neither ordinary nor extraordinary means made it possible to develop a meaningful transcript of the conversations. This type of recording is usually caused by an almost total mechanical or electrical failure of the CVR system.

Transcript of a L-3/Fairchild FA2100-1020 cockpit voice recorder, serial number Unknown (CSMU S/N 116733), installed on an Gulfstream GIV (N121JM), which crashed during takeoff from Laurence G. Hanscom Field (BED) in Bedford, Massachusetts.

LEGEND

CAM	Cockpit area microphone voice or sound source
HOT	Flight crew audio panel voice or sound source
RDO	Radio transmission from N121JM
GND	Radio transmission from the Hanscom ground controller
TWR	Radio transmission from the Hanscom airport tower controller
-1	Voice identified as the second in command
-2	Voice identified as the pilot in command
-3	Voice identified as cabin crewmember
-?	Voice unidentified
*****	Unintelligible word
#	Expletive
@	Non-pertinent word
( )	Questionable insertion
[ ]	Editorial insertion

Note 1: Times are expressed in eastern daylight time (EDT).

Note 2: Generally, only radio transmissions to and from the accident aircraft were transcribed.

Note 3: Words shown with excess vowels, letters, or drawn out syllables are a phonetic representation of the words as spoken.

Note 4: A non-pertinent word, where noted, refers to a word not directly related to the operation, control or condition of the aircraft.

TIME and SOURCE	INTRA-COCKPIT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
19:36:10.0	**Start of Recording**		
21:10:19.7	**Start of Transcript**		
21:10:19.7 **CAM**	[unintelligible vocalizations].		
21:15:04.6 **CAM**	[unintelligible vocalizations].		
21:16:31.3 **CAM**	[unintelligible vocalizations].		
21:17:35.3 **CAM-3**	[unintelligible vocalizations consistent with speech outside of the cockpit].		
21:28:04.2 **CAM-?**	* *.		
21:28:07.9 **CAM-1**	probably.		
21:28:17.1 **CAM-?**	* *.		
21:28:42.6 **CAM-3**	can you check with @ to see if he called uhm @, when you got (down) there?		
21:28:46.7 **CAM-2**	I think he just did.		
21:28:48.9 **CAM-?**	* * *.		
21:28:53.1 **CAM-3**	alright, you jumpin up?		

TIME and SOURCE	INTRA-COCKPIT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
21:28:58.6 **CAM-?**	* *.		
21:29:28.1 **CAM-3**	* *.		
21:29:34.1 **CAM-3**	*.		
21:29:49.2 **CAM**	[reduction of background noise followed by mechanical sounds]		
21:30:02.7 **CAM-2**	* * @ asked me to ask you whether you called @ already.		
21:30:07.8 **CAM-1**	@ yeah.		
21:30:08.4 **CAM-2**	okay. that's what I told I thought so. Just wanted make sure.		
21:30:24.3 **CAM**	[sounds consistent with engine start]		
21:31:14.5 **CAM**	[sounds consistent with engine start]		

TIME and SOURCE	INTRA-COCKPIT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
		21:31:15.9 **ATIS**	Hanscom tower information Juliet zero zero five one Zulu. winds three zero zero at three. visibility one zero. sky clear. temperature niner. dewpoint four. altimeter three zero two seven. arriving departing runway one one. visual approach in use. taxiway Mike from runway five * Hill hangar's closed. readback all hold short instructions advise on initial contact you have information Juliet.
21:32:37.3 **CAM**	[sound similar to thump]		
21:32:41.3 **CAM**	[sound similar to click]		
21:32:42.5 **CAM**	[sound similar to click]		
21:32:44.1 **CAM**	[sound similar to click]		
21:32:45.4 **CAM**	[sound similar to click]		
21:32:48.6 **CAM**	[sounds similar to multiple clicks]		
		21:31:52.1 **RDO-1**	and Hanscom ground Gulfstream one two one Juliet Mike at Jet Aviation with ah Juliet ready to taxi.
21:32:57.1 **CAM**	[sounds similar to click and thump]		

TIME and SOURCE	INTRA-COCKPIT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
21:32:58.1			
CAM	[sound similar to thump]		
		21:32:02.6	
		GND	Gulfstream one two one Juliet Mike Hanscom ground runway one one taxi via Sierra Tango Echo cross runway five midfield.
		21:32:16.0	
		RDO-1	okay I'm sorry ah what was that again for Juliet Mike?
		21:32:18.7	
		GND	Gulfstream one Juliet Mike from Jet runway one one taxi via Sierra Tango Echo cross runway five midfield.
21:32:22.1			
CAM	[sounds of engine noise changing]		
		21:32:24.6	
		RDO-1	Sierra Tango Echo cross runway five one two one Juliet Mike thanks.
21:32:52.9			
CAM-2	yeah the diagram there's a connector here Mike guess they're not using that.		
21:33:01.9			
CAM-1	ah used to be able go out that way.		
21:33:04.1			
CAM-2	yeah now -		
21:33:04.3			
CAM-1	but they got the ah taxiway all dug up.		

TIME and SOURCE	INTRA-COCKPIT COMMUNICATION CONTENT
21:33:34.9	
CAM-2	go to one one * * Tango to cross five right?
21:33:41.0	
CAM-1	ah Sierra Tango- eh Sierra Echo Tango cross runway five yes.
21:34:29.5	
CAM-2	taxiway-
21:34:30.8	
CAM-1	Sierra Tango Echo
21:34:32.3	
CAM-2	(thank you)
21:35:53.6	
CAM-2	cleared to cross, right?
21:35:54.6	
CAM-1	yup cleared to cross.

TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
21:36:16.4	
GND	Gulfstream one Juliet Mike on the other side of five you contact the tower have a good flight.
21:36:20.6	
RDO-1	Juliet Mike have a good evening now.
21:36:55.1	
RDO-1	and Hanscom tower Gulfstream one two one Juliet Mike will be ready when reaching.
21:37:00.1	
TWR	* one two one Juliet Mike Hanscom tower turn right heading two five zero runway one one cleared for takeoff.

TIME and SOURCE	INTRA-COCKPIT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
21:37:03.1			
CAM-?	*.		
		21:37:07.9	
		RDO-1	okay after departure it'll be a left turn heading two five zero and we're cleared for takeoff one two one Juliet Mike.
		21:37:12.9	
		TWR	that's a right turn.
		21:37:14.3	
		RDO-1	a right turn two five zero one two one Juliet Mike.
		21:37:16.9	
		TWR	thank you.
21:37:20.2			
CAM-3	I tried him but I didn't get him *.		
21:37:21.7			
CAM-1	oh I got @ he's ah he's was gonna run out and get something to eat and I told him we'd be there about twenty after ten.		
21:37:22.7			
CAM-3	(okay).		
21:37:27.8			
CAM-3	(okay).		
21:38:26.8			
HOT	[sound similar to seat belt chime].		
21:38:33.9			
CAM-2	we're cleared for takeoff?		
21:38:34.8			
CAM-1	cleared for takeoff right turn heading two five zero.		

TIME and SOURCE	INTRA-COCKPIT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
21:38:37.2			
CAM-2	'kay.		
21:39:05.9			
CAM	[sound similar to power increase]		
21:39:21.1			
CAM-2	it says rudder limit light is on.		
21:39:23.9			
CAM-1	what's that?		
21:39:24.7			
CAM-2	the rudder limit light is on.		
21:39:26.4			
CAM-1	are you using your rudders?		
21:39:27.8			
CAM-?	no * *.		
21:39:31.1			
CAM-?	huh.		
21:39:33.7			
CAM	[sound similar to power increasing further]		
21:39:45.5			
CAM	[sound similar to ground roll]		
21:39:45.7			
CAM-?	*.		
21:39:46.6			
CAM-2	couldn't get * * * *.		
21:39:51.3			
CAM-1	eighty.		
21:39:57.5			
CAM-1	V-1.		

TIME and SOURCE	INTRA-COCKPIT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
21:39:58.9			
CAM-1	rotate.		
21:39:59.9			
CAM-2	(steer) lock is on.		
21:40:02.7			
CAM-2	(steer) lock is on.		
21:40:03.7			
CAM-2	(steer) lock is on.		
21:40:04.4			
CAM-2	(steer) lock is on.		
21:40:05.2			
CAM	[sounds similar to thump and squeak]		
21:40:06.6			
CAM-2	(steer) lock is on.		
21:40:07.5			
CAM-2	(steer) lock is on.		
21:40:12.6			
CAM-2	(steer) lock is on.		
21:40:14.3			
CAM-2	I can't stop it.		
21:40:16.2			
HOT	[sound of triple chime].		
21:40:19.6			
CAM-2	oh no no.		
21:40:21.0			
CAM	[sound of impact].		

TIME and SOURCE	INTRA-COCKPIT COMMUNICATION CONTENT	TIME and SOURCE	AIR-GROUND COMMUNICATION CONTENT
21:40:24.5	**End of Recording**		
21:40:24.5	**End of Transcript**		