NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

November 18, 2019

Flight Data Monitoring (FDM) Device - Audio

Group Chairman's Factual Report
By Sean Payne

1. EVENT SUMMARY

Location:	Zaleski, Ohio
Date:	January 29, 2019
Helicopter:	Bell 407
Registration:	N191SF
Operator:	Viking Aviation, LLC.
NTSB Number:	CEN19FA072

On January 29, 2019, at 0650 Eastern standard time, a single-engine, turbine-powered, Bell 407 helicopter, N191SF, collided with forested, rising terrain about 4 miles northeast of Zaleski, Ohio. The helicopter was registered to and operated by Viking Aviation, LLC, doing business as Survival Flight, Inc., as a visual flight rules helicopter air ambulance flight under the provisions of *14 Code of Federal Regulations* Part 135 when the accident occurred. The certificated commercial pilot, flight nurse, and flight paramedic were fatally injured, and the helicopter was destroyed. Visual meteorological conditions existed at the departure location, and company flight following procedures were in effect. The flight departed Mt. Carmel Hospital, Grove City, Ohio at 0628, destined for Holzer Meigs Hospital, Pomeroy, Ohio, about 69 miles southeast.

2. GROUP

A flight data group was convened on June 12, 2019 at the Vehicle Recorder Division Laboratory at the National Transportation Safety Board (NTSB) headquarters in Washington, DC. The group members who participated are listed below:

Chairman:	Sean Payne Mechanical Engineer NTSB
Member:	Shaun Williams Investigator-In-Charge (IIC) NTSB

Member:	Nicholas Swann Aerospace Engineer NTSB
Member:	Gary Howe Crash Investigator Bell Helicopters
Member:	Royce Snider Fmr. S.M.E. Acoustics - Principal Engineer Certification and ODE Administrator Bell Helicopters

3. DETAILS OF INVESTIGATION

The NTSB Vehicle Recorder Division received the following global positioning system (GPS) device:

Device Manufacturer/Model:	Outerlink IRIS Data Comm Processor
Serial Number:	00254
Device Manufacturer/Model:	Outerlink IRIS Data Comm Dialer
Serial Number:	DCP00251

3.1. Flight Data Monitoring (FDM) Device Carriage Requirements

Per federal regulation 14 CFR 135.607, helicopters in air ambulance operations must be equipped with an approved flight data monitoring system capable of recording flight performance data. The system must receive electrical power from the bus that provides the maximum reliability for operation without jeopardizing service to essential or emergency loads and be operated from the application of electrical power before takeoff until the removal of electrical power after termination of flight.

This rule went into effect on April 23, 2018. The rule does not include the helicopter air ambulance operators perform periodic reviews of the flight data to ensure the data is valid, or use the flight data in any kind of flight operations quality assurance (FOQA) program. Additionally, there is no requirement that the FDM devices be certified to any crashworthiness standard.

3.2. Outerlink IRIS Description

The Outerlink IRIS is a lightweight flight data monitoring, recording and satellite communications device. The system consists of two main components, a control head (known as the dialer unit) that is installed in the helicopter's instrument panel as well as

a second processing device (processor) which is installed in the helicopter's avionics bay. The system provides instantaneous two-way communication between the helicopter's flight crew and any equipped ground operator (internet or telephone) via a global satellite network.

In addition to communications features, the device provides flight data monitoring features and the ability to record these functions. The unit contains an internal Attitude Heading Reference System (AHRS) as well as components that facilitate the input of ARINC avionic data streams. A typical configuration will record native AHRS data as well as a variety of ARINC labeled messages that could potentially record engine information.

The system can also record voice and video data. In a typical configuration, the helicopter's intercom system (ICS) is configured to interface with the IRIS device. The pilot's headset hot mic and ear cups are recorded to the IRIS through the ICS system. Additionally, a lipstick style video camera interfaces with the system and is set to record a view over the pilot's shoulder of the helicopter's cockpit, including the pilot's control stick inputs as well as portions of the instrument panel and windscreen.

Data is recorded in three places on the IRIS system, an SD card and two solid-state disks (SSD) in both the dialer and the processor unit. The pedestal mounted control head contains a removable SD card which records only flight data. In an abrupt power loss situation, such as an accident, the SD card is not likely to contain the latest information.

Inside the control head and the processor unit, a SSD is configured to record flight data, audio and video data. Data recorded by the unit reaches the SSD first and is then dispatched to the SD card (applicable data only). The SSD can be accessed through a hardwire ethernet connection on the back of each device or the unit can be disassembled and the SSD can be read independently. The IRIS system runs on a version of the Linux operating system.

The device is designed to close recorded files every 100 milliseconds, reducing the potential for lost data in abrupt power loss scenario. The manufacturer reports that the device is not crashworthy (as defined by ED155 or ED112), however, the manufacturer has a crash hardened memory that is available for purchase. As of August 2019, the manufacturer reported that the crash hardened memory option has not been purchased by any customer.

3.3. Data Recovery

For a detailed description of how audio and data was recovered from the device please refer to Flight Data Monitoring (FDM) Device – Data – Group Chairman's Factual Report, which can be found in the public docket for this investigation.

3.4. Audio Recording Description

For a description of recorded data recovered from the device, please refer to Flight Data Monitoring (FDM) Device – Data – Group Chairman's Factual Report, which can be found in the public docket for this investigation.

Each channel's audio quality is indicated in Table 1.[1] The source of each channel is also noted in table 1. The source of channels 3 through 6 could not be determined. According to the manufacturer these channels would have recorded audio as mixed into the pilot's and flight crew's headsets.

Table 1: Audio Quality.

Channel Number	Content/Source	Quality	Duration
1L	Cockpit Area Mic (Left)	Poor	25m 22s
1R	Cockpit Area Mic (Right)	Poor	25m 22s
2	Dispatch Radio	Poor	25m 21s
3	Unknown	Unusable	25m 21s
4	Unknown	Unusable	25m 21s
5	Unknown	Unusable	25m 21s

3.5. Timing and Correlation

Timing on the transcript was established by correlating an audio event to a corresponding recorded data event from the FDM. Specifically, the moment the helicopter transitioned from idle power toward flight power. This occurred at 3m 35.081 seconds into the audio recording. To correlate this to the recorded flight data for collective PLA, the following equation was used:

Recorded Audio Elapsed Time + 22,902 seconds = EST

3.6. Summary of Audio Events

Raw audio files from both the dialer unit as well as the processor unit were download and decompressed using the manufacturer's software. Downloads of these two units resulted in identical audio file sets. Additional recordings from the Operations Control

[1] See attached Audio Quality Rating Scale.

Center (OCC) were also utilized. Those audio recordings are transcribed in the right column of the transcript.

Cockpit Area Microphone (CAM) – Channels 1L and 1R

Sound spectrum information from the CAM channels (1L & 1R) is discussed in the report the Flight Data Monitoring (FDM) Device – Sound Spectrum Study – Group Chairman's Factual Report and can be found in the public docket for this accident.

In general, channels 1L and 1R captured the sound of the engine and at times, rotor blade noise and human voice. The audio quality is described as poor. The NTSB audio quality rating scale defines "poor" audio quality as the following:

> 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.

The audio quality rating scale is appended to this report as attachment 1.

Using the available audio, the FDM Audio group members generated a transcript of the material at the NTSB Vehicle Recorder Laboratory in Washington, D.C. The audio was filtered extensively in order to attempt to capture voice and engine audio data conclusively. The result was the transcript of what could be transcribed attached below.

The NTSB's CVR transcript legend is also appended. NTSB convention shows that a single unintelligible word is displayed as an asterisk (*). Up to three unintelligible words are displayed as three asterisks (* * *). A phrase or sentence more than three words is displayed as no more than three asterisks (* * *).

Channel 2

Channel 2 captured audio similar to dispatch radio calls made between the helicopter and the operator's dispatcher. The majority of the dispatch audio recorded on channel 2 was unusable. Portions of the conversation detected were consistent with a dispatch audio recording obtained by the IIC and were not transcribed since a better recording was available. The audio track was reviewed for other voice data and no useable audio was able to be detected. The audio track was largely unusable.

Channels 3, 4 & 5

The audio tracks on these channels were filled with cracking and popping noises. The audio quality is described as unusable. The NTSB audio quality rating scale defines "unusable" audio quality as the following:

> 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.

No voice or engine audio was detected, the audio tracks were entirely unusable.

OCC Audio

OCC audio was recorded on the ground and was provided by the operator. OCC audio was transcribed separate from the audio transcription group. The audio information appears in the right column of the transcript. In general, OCC audio appears in the right column and in separate rows. When OCC audio matched that of the Female Voice, it was entered on the same row, but in the right column.

3.7. Audio Quality in Other Outerlink IRIS Investigations

The NTSB investigated the crash of a Eurocopter EC-135 in Chicago, IL (CEN18FA259) that occurred on July 7, 2018. The accident EC-135 contained an Outerlink IRIS FDM device. The report, Flight Data Monitoring (FDM) Device – Audio – Group Chairman's Factual Report, described the devices six audio channels as being either "good" or "fair" quality. The recordings, at times, exhibited cracking, popping and click sounds similar to those recorded on channels 3, 4, and 5 of the IRIS device discussed in this report.

The manufacturer of the device was signed on as a party member to the investigation in Chicago (CEN18FA259) and assisted the NTSB in performing the download of the IRIS device. As such, the manufacturer was authorized to hear portions of the recording that contained the cracking, popping and click sounds. As a result of that investigation, the manufacturer investigated the issue and issued new firmware release that "conclusively resolves" the issue. The firmware release was available on November 7, 2019. The Outerlink representative stated that the accident helicopter in this case, N191SF, did not contain the firmware patch on its IRIS unit at the time of the accident. As of August 1, 2019, the representative stated that over 50% of the IRIS fleet had been updated and of the remaining 50% that had not been updated, 40% will be updated in August 2019 (all operated by a single operator). The representative stated that in order to update the remaining 10% of IRIS units, Outerlink intends to issue a mandatory service bulletin by the end of the month (August 2019).

Transcript of an Outerlink IRIS FDM device, serial number 00254/DCP00251, installed on a Bell 407 which crashed near Zaleski, Ohio.

LEGEND

CAM	Cockpit area microphone
FV	Female Voice
OCC	Communications transcribed from the Operations Control Center
OFV	Secondary female voice (Other Female Voice)
Pilot-OCC	Pilot communicating electronically to OCC
-?	Voice unidentified
*	Unintelligible word
#	Expletive
@	Non-pertinent word or a person's name
( )	Questionable insertion
[ ]	Editorial insertion

Note 1: Times are expressed in local time (CDT).

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-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
0623:12.4 **START OF RECORDING** **START OF TRANSCRIPT**			
06:23:28.0 **FV**	hey guys.		
06:23:29.4 **OFV**	* * *.		
06:23:33.0 **FV**	what?		
06:23:38.5 **FV**	oh (hey ben/that's not bad) - (oh that's bad)		
06:23:41.5 **FV**	I was just (textin'/touchin') you		
06:23:46.1 **FV**	yeah - right onnn.		
06:23:49.6 **FV**	(alright good to meet) *.		
06:23:56.0 **FV**	this is fun I know * * *.		
06:24:00.4 **FV**	(does it/that's it) - what the hell's * * *		
06:24:04.9 **FV**	no that's what (we're after) * * *.		
06:24:08.3 **FV**	that's what he said I think.		

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
06:24:11.2 **FV**	Ohhh.		
06:24:14.6 **FV**	(yeah I thought that's what he said but - (let me uh - not very strong * * *.		
06:24:27.2 **FV**	just wanted to confirm you're going to * * (for today).		
06:24:41.9 **FV**	you guys (want) * * * .		
06:24:49.0 **FV**	oh umm I think (it) --		
06:24:56.0 **FV**	so it's (supposed/usually) down at the (blade/lake) * * *.		
06:25:03.7 **FV**	but yeah.		
06:25:23.5 **FV**	* * operator * * *.	06:25:23.5 **Pilot-OCC**	and operations fourteen - just want to confirm what city that's in.
		06:25:31.0 **OCC**	survival fourteen that is in Pomeroy - Pomeroy- Ohio for Holzer Meigs- uhhh - looks like its a heading of one forty one by sixty nine.
06:25:47.5 **FV**	copy that * * *.	06:25:47.5 **Pilot-OCC**	copy that - fourteen.

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
06:25:52.5 **FV**	alright *.		
06:26:15.8 **FV**	yeah.		
06:26:17.0 **FV**	there's a * * *.		
06:26:28.0 **FV**	* * *.		
06:26:36.6 **FV**	* * *.		
06:26:47.5 **CAM**	[Sound similar to an increase in engine power.]		
		06:27:29.0 **Pilot-OCC**	operations - fourteen - can I get some coordinates from you?
06:27:34.5 **CAM**	[Sound similar to engine power at in a flight power setting.]		
		06:27:38.0 **OCC**	* fourteen - absolutely - uhh looks like its gunna be north three niner zero three - two eight - by west - eight two zero zero eight eight.
06:27:59.4 **FV**	* * *.	06:27:59.4 **Pilot-OCC**	copy that – fourteen.
06:28:17.0 **CAM**	[Sound similar to takeoff.]		

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
		06:29:19.0 **OCC**	(go) fourteen (off).
		06:29:28.9 **Pilot-OCC**	go for fourteen.
		06:29:32.1 **OCC**	fourteen - at your earliest convenience - uh just go ahead and give me your flight release.
06:29:46.7 **FV?**	* * *.	06:29:46.7 **Pilot-OCC**	ohh copy that I'm uhhh green in all categories - same crew as last night - aaand uhh - no P Rs or maintenance.
		06:30:05.0 **OCC**	copy that – green across the board – no P Rs no maintenance – same crew gulf hotel and I'll get you the O-C-M when you land.
		06:30:26.7 **Pilot-OCC**	copy that we're ready for patient information.
		06:30:39.0 **OCC**	copy that - patient's in the E R at Holzer Meigs - going to the E R at Riverside Methodist - we are responding to a [Patient information has been redacted.]
06:31:05.6 **FV**	* * *.	06:31:05.6 **Pilot-OCC**	copy that - fourteen - and I'll give you my flight plan - we got three on board - seven sixty on fuel and twenty-eight minutes.
		06:31:14.7 **OCC**	copy that. three seven sixty and twenty-eight.

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
06:31:50.0 **FV**	* * * (yeah) * * *		
06:32:03.1 **FV**	* * *.		
06:32:54.8 **FV?**	* * *.		
06:33:45.8 **FV?**	* * *.		
06:37:32.9 **FV**	[Sound similar to raised female voice.]		
06:38:25.2 **FV**	* * *.		
06:39:49.5 **?**	* * *.		
06:40:37.2 **?**	* * *.		
06:43:25.1 **FV**	* * *.		
06:43:48.0 **FV**	* * *.		
06:46:35.1 **CAM**	[Sound similar to main rotor blade slap.]		
06:46:57.4 **FV**	let's uh * * (we're going to/we're gunna) alter (our/the) heading * * *.		

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
06:48:05.4 **FV**	* * *.		
06:48:27.5 **CAM**	[Sound similar to main rotor blade slap.]		
06:48:58.7 **CAM**	[Whining sound, potentially aerodynamic in nature. Lasts until the end of the recording. See Sound Spectrum Study for additional information.]		
0649:08.94 **END OF TRANSCRIPT** **END OF RECORDING**			

Attachment I

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.