NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, DC 20594

February 25, 2016

Onboard Image Recorder and Ground Video

Specialist's Factual Report
By Sean Payne

1. EVENT

Location:	Summerfield, Florida
Date:	April 6, 2014
Aircraft:	Vans Aircraft RV-7, N57DC
Operator:	Private
NTSB Number:	ERA14FA182

2. GROUP

A group was not convened.

3. SUMMARY

On April 6, 2014, about 1937 eastern daylight time (EDT), an experimental amateur-built RV-7, N57DC, was substantially damaged when it impacted terrain while maneuvering near Monroe Airpark (2FA2), Summerfield, Florida. The commercial pilot and the passenger were fatally injured. Visual meteorological conditions prevailed, and no flight plan was filed for the local flight. The personal flight was conducted under the provisions of 14 *Code of Federal Regulations* Part 91.

Witnesses reported that the pilot had been assisting with the production of a film throughout the afternoon, and that the purpose of the accident flight was to take video footage from the air. After departing from the grass runway, the airplane entered a circular orbit to the left. The airplane had completed three circuits, when during the fourth, it entered a rapid descent as engine power increased. During the descent, the wings rolled nearly level before the airplane impacted the ground in a nose low, slight left bank attitude.

4. DETAILS OF INVESTIGATION

On April 18, 2014, the National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following digital camera and memory devices:

Recorder Manufacturer/Model: **Canon EOS 5D Mark III**

Recorder Serial Number:	**132025XX0278**
Associated Optics:	**Canon 70-200mm IS II F/2.8**
Media:	**(1) 64GB CF[1] card, (1) 64GB SD[2] card**
Recorder Manufacturer/Model:	**Canon EOS 7D**
Recorder Serial Number:	**Unknown**
Media:	**File Transfer**

4.1.1. Recorder Description – Canon EOS 5D MK III

The Canon EOS 5D Mark III is a professional grade 22.3 megapixel DSLR[3] camera. It contains a full frame[4] CMOS[5] image sensor with an extended ISO[6] range of up to 102,400. It has a sophisticated autofocus system and can accept a wide range of lenses designed for the EOS camera family. It can record full HD video up to 30 fps at 1920 x 1080 pixels. Still images can be captured at a rate up to 6 fps. The EOS 5D Mark III has the option to allow an external GPS sensor to be added so that each image file can be geo-tagged with a GPS position and timing data.

4.1.2. Recorder Description – Canon EOS 7D

The Canon EOS 7D is a prosumer grade 20.2 megapixel DSLR camera. It contains an APS-C[7] CMOS image sensor with an extended ISO range of up to 51,200. It has a sophisticated autofocus system and can accept a wide range of lenses designed for the EOS camera family. It can record full HD video up to 60 fps at 1920 x 1080 pixels. Still images can be captured at a rate up to 10 fps.

4.2.1. Recorder Damage – Canon EOS 5D MK III

Upon arrival at the NTSB Vehicle Recorder Division, it was evident that the Canon EOS 5D MK III had sustained significant impact damage. Figure 1 shows the condition of the Canon EOS 5D MK III's camera body. The memory card door and battery compartment showed signs of impact damage. The top of the camera body was separated from the main camera's structure at a manufacture line. Numerous internal wires were exposed and damaged. The camera body's lens mount area exhibited deformation from impact. The Canon 70-200mm lens was largely intact (figure 2), however, the lens exhibited binding amongst the

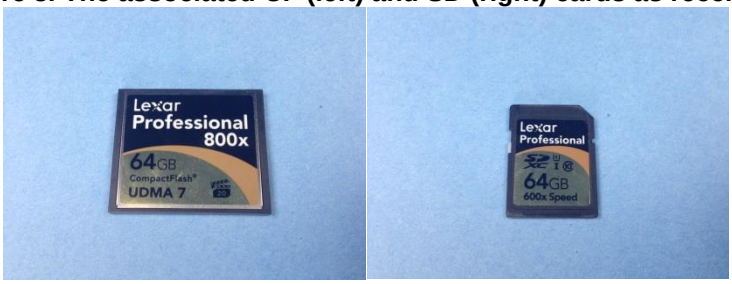
[1] CF – Compact Flash type memory card. A standard for nonvolatile memory card used in portable electronic devices.
[2] SD – Secure Digital type memory card. A standard for nonvolatile memory card used in portable electronic devices.
[3] DSLR – Digital Single Lens Reflex – A mirror and prism system that permits the photographer to view through the lens rather than a stand-alone viewfinder.
[4] Full Frame - A digital image sensor the equivalent size as that of traditional 35mm film cameras (36x24mm).
[5] CMOS - A digital image sensor consisting of an integrated circuit containing an array of pixel sensors.
[6] ISO - An International Organization for Standardization standard for film speed.
[7] APS-C - Advanced Photo System type-C – an image sensor format equivalent in size to negatives 25.1 x 16.7mm in size. Typically gives a 1.6x crop factor.

lens's internal glass elements. The recovered CF and SD cards associated with the camera were intact and appeared undamaged (Figure 3).

Figure 1. The Canon EOS 5D MK III as received by the laboratory.

Figure 2. The Canon 70-200m F/2.8 IS II.

Figure 3. The associated CF (left) and SD (right) cards as received.



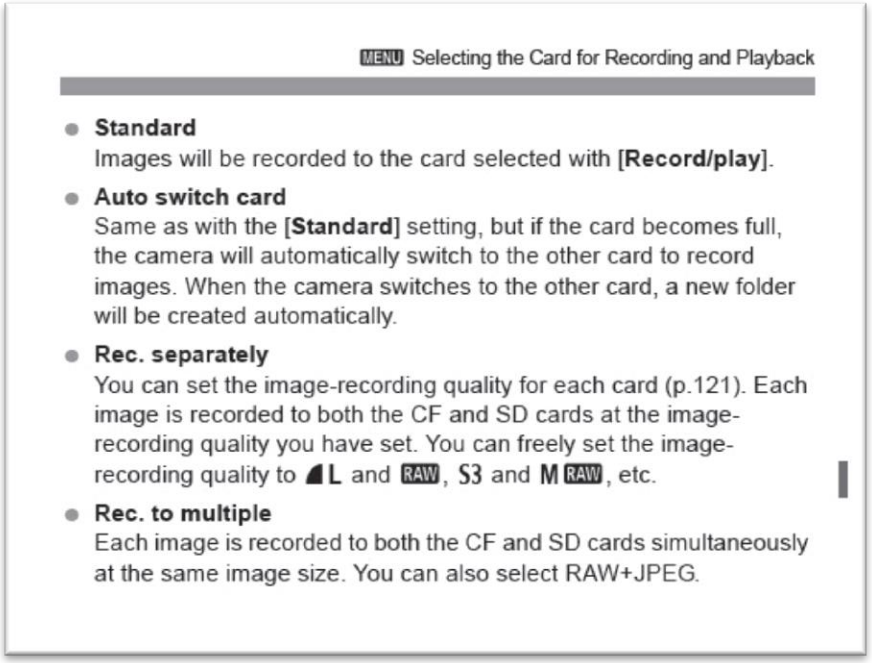
4.2.2. Recorder Damage – Canon EOS 7D

The Canon EOS 7D was in use by a ground observer and was not shipped to the NTSB Vehicle Recorder Laboratory for evaluation.

4.3.1. Video Files and Data Recovery – Canon EOS 5D MK III

The Canon EOS 5D MK III has two memory card slots. One memory card slot is used for SD style memory cards and the other slot is used for CF style memory cards. The camera permits the user with a range of selectable modes that allows the still and motion imagery to be written to either the SD card, the CF card or both card simultaneously. Figure 4 is an excerpt from the camera's user's manual on page 119 which provides a table of selectable physical memory operation modes.

Figure 4. A table of selectable memory operation modes from the Canon EOS 5D MK III's user manual.



MENU Selecting the Card for Recording and Playback

- **Standard**
  Images will be recorded to the card selected with [**Record/play**].
- **Auto switch card**
  Same as with the [**Standard**] setting, but if the card becomes full, the camera will automatically switch to the other card to record images. When the camera switches to the other card, a new folder will be created automatically.
- **Rec. separately**
  You can set the image-recording quality for each card (p.121). Each image is recorded to both the CF and SD cards at the image-recording quality you have set. You can freely set the image-recording quality to ◢L and RAW, S3 and M RAW, etc.
- **Rec. to multiple**
  Each image is recorded to both the CF and SD cards simultaneously at the same image size. You can also select RAW+JPEG.

The CF card was read on a PC via a forensic write blocker. The CF card's contents revealed a folder structure consistent with operating a Canon SLR type

digital camera. The folder structure did not contain any still or motion imagery. The card was determined to be blank[8].

The SD card was read on a PC via a forensic write blocker. The SD card's contents revealed a folder structure consistent with operating a Canon SLR type digital camera. The SD card contained 123 media files. Of the 123 media files, the card contained 63 .JPG[9] files. Of the 63 .JPG files, six files were determined to have been taken while inside the aircraft during the accident flight. These files exhibited properties of being captured during a video recording[10]. Some of the other .JPG files were taken outside of the aircraft and contained pictures of the exterior of the aircraft prior to the accident flight.

60 .MOV[11] video files were found within the same folder structure. Of the 60 .MOV files, three .MOV recordings were taken during the accident flight from inside the cockpit. None of the three files recorded the accident sequence.

Typical of imaging equipment and recordable media involved in high impact scenarios, there is a possibility for the occurrence of a power interruption, battery ejection or memory card ejection during recording. In these scenarios, the potential exists for files captured during the impact sequence to exist on the imaging device's memory card in either a corrupt or incomplete[12] state.

The SD card was forensically searched in an effort to find hidden, corrupt or incomplete files. The forensic search revealed one .MOV recording which captured a portion of the accident sequence as well as one .JPG file captured during the accident sequence .MOV recording. Audio for the recovered .MOV file was recovered from another portion of the memory card and then correlated with the recording. Table 1 lists the contents of the SD card relevant to the inflight portion of the accident flight as well as the two recovered media files recovered as a result of the forensic search. The filenames for the media files appear in chronological order, the time given using the Canon EOS 5D MK III time stamped as the time created.

[8] A reference to blank does not include any contents in which were erased from a card but still forensically present. A forensic examination of the card for deleted and missing imagery was not conducted due to the fact that there were no digital records indicating the camera operator was using the CF card on the day of the accident.

[9] .JPG – Joint Photographic Experts Group. A common format for exchange of digital photos.

[10] The Canon EOS 5D MK III is capable of capturing still images during a video recording. The operation is executed by using the camera's normal shutter release while simultaneously recording video. For additional information, see the Canon EOS 5D MK III user manual, page 119.

[11] .MOV – A file extension associated with media using the QuickTime file format.

[12] The file will not show in a normal folder structure when the memory device is connected to a PC.

Table 1. A list of media files taken in the aircraft during the accident flight[13].

File Name	Type	Time Created	Recovery Method
0R8A3022.JPG	Still Photo	7:27:44 PM EDT	Normal Read
0R8A3023.MOV	.MOV File	7:32:49 PM EDT	Normal Read
0R8A3024.MOV	.MOV File	7:33:09 PM EDT	Normal Read
0R8A3025.JPG	Still Photo	7:33:25 PM EDT	Normal Read
0R8A3026.JPG	Still Photo	7:33:50 PM EDT	Normal Read
0R8A3027.JPG	Still Photo	7:34:19 PM EDT	Normal Read
0R8A3028.JPG	Still Photo	7:34:32 PM EDT	Normal Read
0R8A3029.JPG	Still Photo	7:35:05 PM EDT	Normal Read
0R8A3030.MOV	.MOV File	7:35:26 PM EDT	Normal Read
0R8A3031.MOV	.MOV File	Unknown[14]	Forensic Recovery
0R8A3032.JPG	Still Photo	7:36:07 PM EDT	Forensic Recovery

4.3.2. Video Files – Canon EOS 7D

A file transfer for the Canon EOS 7D contained 39 .MOV files. Of the 39 .MOV files, eight files showed the aircraft operating during the accident flight. Seven other .MOV files showed the aircraft operating during a previous non-accident flight at the same location.

4.4. Timing and Correlation

The times used in this report are expressed as local time of the accident (EDT).

Timing information from the files taken with the Canon EOS 7D (the ground based camera) were aligned to the timing information provided by the Canon EOS 5D MK III using an event captured by both cameras.

The time correlation between the Canon EOS 7D and the Canon EOS 5D MK III was determined to be as follows:

Canon EOS 7D – 1,596.7 seconds = Canon EOS 5D MK III

Later, the overall time correlation to for both cameras were brought into alignment to EDT by finding the offset of the first emergency service call which was captured by the Canon EOS 7D. Emergency service records indicate that the call was received at 7:39 P.M. EDT.

The overall time correlation to EDT for each camera is as follows:

Canon 5D MK III + 1560 seconds = EDT

[13] Times in this section account for the time correlation in section 4.4. They are listed in EDT.

[14] The creation time of the original recovered file was unknown, however, the creation time of forensically recovered video still file 0R8A3032.JPG was shown as 7:36:07 PM EDT. The time at which video still 0R8A3032.JPG was identified in 0R8A3031.MOV and the time was offset accordingly.

Canon EOS 7D + 36.7 seconds = EDT

An uncertainty in the exact moment the emergency service call began on the video recording results in an estimated error of +/- 15 seconds.

4.5. Summary of Recording Contents

In agreement with the Investigator-In-Charge, a video group did not convene and a summary report was prepared.

Files from both the Canon EOS 5D MK III and the Canon EOS 7D were combined in a non-linear video editor[15] to produce one video file containing time synchronized images, displaying the aircraft's accident flight as one linear occurrence. The master video file created is used in this section to summarize the accident occurrence.

Non-Accident Flight Video Files

Two video files, MVI_0752.MOV and MVI_0753.MOV, taken by the ground observer using the Canon EOS 7D showed the aircraft operating in flight in close vicinity of ground actors[16]. In file MVI_0752.MOV, the aircraft maneuvered below tree top level to overfly a group of actors. In file MVI_0753.MOV, the aircraft maneuvered in the same manner.

Accident Flight Video Files

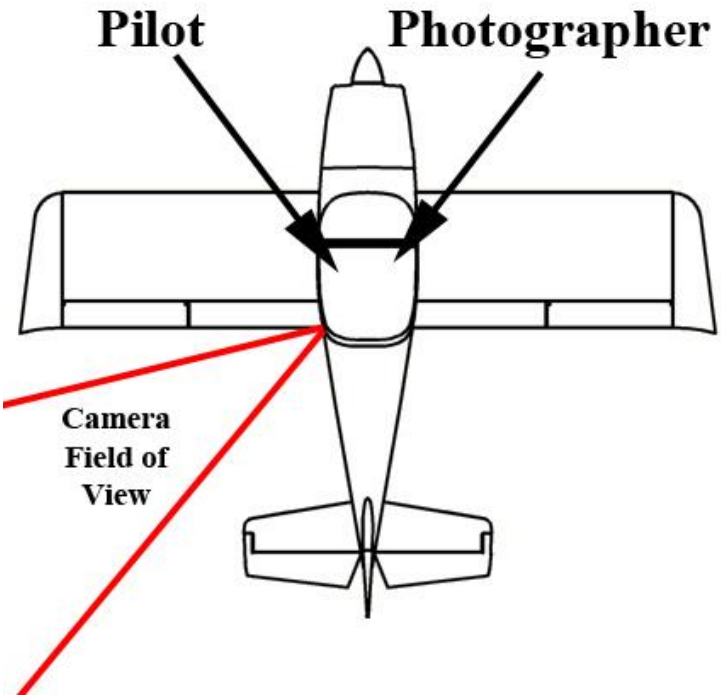
This portion of the report summarizes video evidence from both the ground observer using the Canon EOS 7D as well as onboard footage recovered from the Canon EOS 5D MK III.

An onboard recording began at 7:33:09 PM EDT taken from the right seat passenger's position pointing toward the left rear quarter of the aircraft. Figure 5 describes the camera operator's position and the field of view during most of the onboard recordings. The aircraft began its takeoff roll and engine power was heard being advanced smoothly to a high power setting. The aircraft began rolling down a grass airstrip.

[15] Non-linear video editor – A software editing suite that allows manipulation of electronic video file types without destroying or altering the source material.

[16] The photographic equipment that generated the files used for this report were being used to film an independent film.

Figure 5. A diagram of the aircraft's occupants as well as the camera's field of view.



At 7:33:12 a ground recording began showing the aircraft on takeoff roll. The aircraft became airborne and departed the grass strip normally. The file ended at 7:33:29.

The onboard recording continued to capture the aircraft in flight. The camera operator continued to capture a view outside of the left rear three-quarter canopy bubble for most of the recording. The aircraft appeared to be in a gradual left turn for most of the recording. The camera operator appeared to be attempting to film the ground, however, reflections from the aircraft's bubble canopy were apparent throughout the recording. Around 7:33:53 PM EDT, the aircraft appeared to briefly level its wings and possibly maneuver in another direction. At this time, the aircraft's engine noise was heard being reduced to a lower power setting.

Around 7:34:10, the aircraft was back to conducting a left turn and a group of actors on the ground came into view. Around the same time, at 7:34:05, a ground recording was started showing the aircraft in a gradual left turn circling the group of actors. The ground recording ended at 7:34:24 as the aircraft continued to conduct a left bank turn around the group of actors.

At 7:34:33, another ground recording began and showed the aircraft in a left bank turn continuing around the group of actors. The ground recording ended at 7:34:53 showing the aircraft continuing to conduct a left bank turn around the group of actors.

The aircraft continued to maneuver, for the most part, in a gradual left bank turn. At 7:35:07, another ground based recording began. The recording continued to

show the aircraft in a left bank turn, at times the aircraft appeared to have a slight nose up pitch attitude. The aircraft appeared to track across the ground at a slow speed and a high power setting. The ground based recording ended at 7:35:49.

In the cockpit, the camera operator had ended one video recording at 7:35:10 and began a new recording at 7:35:26. The perspective was the same and showed the aircraft in a left banked turn around the group of actors. The recording ended at 7:35:56, at which time a slight increase in power setting was heard.

Between 7:35:56 and 7:36:07 no video evidence was captured by either the ground based camera or the passenger camera operator inside the accident aircraft.

At 7:36:07, the forensically recovered onboard video file began. It showed the aircraft at first in a left bank turn which then appeared to become level. The trailing edge of left main wing came into the camera's field of view. A video still (a forensically recovered .JPG file 0R8A3032.JPG) was taken at 7:36:10 PM EDT. The aircraft continued back into a left bank turn, a small group of tightly clustered actors were seen in the camera's field of view. Around 7:36:18, the camera's motion became erratic, exhibiting an up and down shaking motion. Within the onset of the camera's erratic motion, several thumping sounds in the background were heard. On second later at 7:36:19, the power setting was heard changing to a high power setting. Between 7:36:20 and 7:36:21, the sound of the engine briefly decreased then rapidly increased in noise level. Overall, the sound was associated with a rapid increase of engine power. Throughout this portion of the recording the camera's motion suggested the aircraft had become unstable in flight. At 7:36:21, the camera's motion is once again erratic. The camera showed a view of only ground features in the immediate vicinity of the aircraft. As the motion became erratic, ground features in the camera's field of view moved up toward the top of the frame. During the time of camera motion instability, the camera never captured any portion of the cockpit. Since the ground features moved up toward the top of the camera's frame, and the camera's field of view never captured any part of the cockpit, this suggested that the aircraft had begun to roll steeply left[17]. Around the same time, a voice was heard on the audio tracking exclaiming, "Oh [expletive]".

From 7:36:22 to 7:36:25 no video evidence was captured or recovered[18].

[17] Referring to figure 5, the camera's field of view was still in the direction of the left rear of the aircraft. As the aircraft rolled left with the camera still pointed outside of the aircraft, ground features were seen moving up in the camera's frame. There were no indications that the camera operator's intended positioning of the camera had changed considerably. This suggested the aircraft rolled left as opposed to the camera having been pointed downward by the camera operator.

[18] In high impact scenarios it is typical some amount of video data is lost as a result of the camera buffering an amount of video prior to the data reaching the camera's physical media.

At 7:36:25, the ground observer began a recording that showed the aircraft in a 90 left bank and a nose-down attitude. The engine was heard operating at a high power setting. No engine anomalies were heard. By 7:36:26, the aircraft had leveled its wings but was still at a nose-down attitude and below tree top level. A white vapor cloud was briefly present upon impact. At 7:36:27, the aircraft impacted terrain approximately wings level at a nose-down angle to the horizon. The camera was dropped by the ground observer and the recording was eventually ended at 7:49:29 as emergency response vehicles were arriving.