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

GROUP CHAIRMAN'S FACTUAL REPORT OF INVESTIGATION

CEN11IA379

By
Bill Tuccio

WARNING

The reader of this report is cautioned that the summary of a cockpit voice recorder audio recording is not a precise science. The summary or parts thereof, if taken out of context, could be misleading. The summary 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 summary as the sole source of information.

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August 31, 2011

Cockpit Voice Recorder - 12

Group Chairman's Factual Report
By Bill Tuccio

A. EVENT

Location:	Milwaukee, Wisconsin
Date:	June 6, 2011, 2132 Central Daylight Time (CDT)*
Aircraft:	Bombardier CL-600-2B19, N866AS
Operator:	Skywest Airlines, Flight 4443
NTSB Number:	CEN11IA379

B. GROUP

A group was convened on June 28, 2011.

Chairman:	Bill Tuccio National Transportation Safety Board
Member:	Eric West Air Safety Investigator Federal Aviation Administration
Member:	Bernard Pichette Production Test Pilot Bombardier
Member:	Dean VandeBrake Captain and Check Airman SkyWest Airlines

C. SUMMARY

On June 6, 2011, about 2132 central daylight time, N866AS, a Bombardier CL-600-2B19, operated as SkyWest Airlines flight 4443, landed with the right main landing gear retracted on runway 19R at the General Mitchell International Airport (MKE), Milwaukee, Wisconsin. The 2 pilots, 1 flight attendant, and 41 passengers reported no

* All times are expressed in central daylight time (CDT), unless otherwise noted.

injuries. All of the airplane occupants evacuated the airplane via the main cabin door. The scheduled domestic passenger flight was conducted under the provisions of 14 Code of Federal Regulations Part 121. Visual meteorological conditions prevailed and an activated instrument flight rules flight plan was on file. The flight departed Cincinnati/Northern Kentucky International Airport, near Covington, Kentucky, about 1951, and was destined for MKE. A solid-state cockpit voice recorder (CVR) was sent to the National Transportation Safety Board's Audio Laboratory for readout. The CVR group meeting convened on June 28, 2011 and a partial summary was prepared for the last 50 minutes of the 2-hour, 4-minute, 22-second digital recording.

D. DETAILS OF INVESTIGATION

On June 8, 2011, the NTSB Vehicle Recorder Division's Audio Laboratory received the following CVR:

Recorder Manufacturer/Model: **L-3 Communications FA2100-1020**
Recorder Serial Number: **000228060**

Recorder Description

Per Federal regulation, CVRs record a minimum of the last 30 minutes 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 30 minutes or 2 hours of CVR operation, depending on the CVR model. This model CVR, the L-3 Communications 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 that combines three audio sources: the captain's audio panel information, the first officer's audio panel information, and the observer's audio panel information. The 30-minute portion of the recording contains 4 channels of audio data; one channel for each flight crew and one channel for the CAM audio information.

Recorder Damage

Upon arrival at the audio laboratory, it was evident that the CVR had not sustained any heat or structural damage and the audio information was extracted from the recorder normally, without difficulty.

Audio Recording Description

For the 2-hour portion of the CVR recording, the CAM channel recording contained good quality[†] audio information, and the mixed flight crew channel contained excellent quality audio information. As shown in the table below, the 30-minute portion of the recording consisted of four channels of useable audio information. Each channel's audio quality is indicated in Table 1. Channel 1 also included an audio time mark every 4 seconds.

[†] See attached CVR Quality Rating Scale.

Table 1: Audio Quality

Channel Number	Content/Source	Quality
1	Observer/Flight Attendant	Excellent
2	First Officer	Excellent
3	Captain	Excellent
4	CAM	Good

Timing and Correlation

Timing of the summary was established by correlating CVR events to common events on the flight data recorder (FDR). Specifically, five radio transmissions recorded on the 30-minute CVR at elapsed times of 0001:05.900, 0001:24.495, 0008:22.799, 0008:36.159, and 0013:20.719, were correlated to the radio transmit microphone key parameter from the FDR at 428315, 428344, 428752, 428766, and 429051 Subframe Reference Numbers (SRN), respectively. Each of the five radio transmissions acted as an anchor point for a linear interpolation between the remaining CVR events. The interpolation resulted in the FDR SRN of 428315 corresponding to a 30-minute CVR elapsed time of 0001:05.500. The FDR SRN of 428315 corresponded to a UTC time of 0208:40 or, 2108:40 CDT. An offset of 2107:34.500 was added to the 30-minute CVR elapsed time to convert to CDT.

Description of Audio Events

The recording began at 1934, when the aircraft was parked at Covington, Kentucky. The aircraft departed Covington at approximately 1950.

The summary efforts of the CVR group began when the aircraft was descending from 4,000 feet to 3,000 feet and was being vectored for an approach at MKE at 2050. The captain was the flying pilot. The aircraft was cleared for a visual approach to runway 19R with winds from 220 degrees at 4 knots, and then cleared to land by MKE tower at 2052.

At 2052:16, the autopilot was disconnected and the captain called for gear down and the before landing checklist. Immediately following the request, the cabin chime call button was recorded, followed by a sound similar to landing gear extension. Notably, this was the first of a total of six gear extension attempts by the crew during the flight.

At 2052:39, the captain called for flaps 30, to which the first officer acknowledged and noted a straight-in speed of 144 knots, and as part of the before landing checklist noted the flight attendant was notified.

At 2052:48, the first officer and captain noted a gear discrepancy indication, followed immediately by three chimes similar to the master warning, a tone similar to the configuration warning, and an engine indication crew alerting system (EICAS) automated verbal annunciation stating “gear disagree.” The captain directed the first officer to begin the gear down disagree quick reference handbook (QRH) procedure, and the captain confirmed he had the radios and the flight controls.

At 2053:16, the captain advised MKE tower to cancel the landing clearance as the crew needed to attend to the gear problem and requested to circle east of the field. The

tower assigned runway heading and an altitude of 4,000 feet. The captain informed the first officer he set flaps to 8.

The first officer began the gear down disagree QRH checklist at 2054:06, by reciting the checklist title and then steps number 1 and 2 of the QRH checklist on page 13-6[‡], regarding limiting the airspeed to not more than 200 knots and hydraulic 2 and 3B pumps to the on position. The first officer then noted pump 3B was on.

While the crew executed the QRH procedures for approximately the next 30 minutes, air traffic control (ATC) issued radar vectors to the aircraft. Generally, the captain was the flying pilot and communicated with ATC, while the first officer executed the checklists.

At 2054:41, the first officer continued the QRH procedure, reading the note associated with step number 2, directing the crew to maintain landing gear lever selection for at least thirty seconds prior to next up or down selection. Following the note, the first officer continued with step number 3 directing the landing gear lever up then down. The flight attendant made an announcement advising the passengers she was not sure what had happened, but that the crew would go back and land again.

At 2054:58, the sound of a bump was recorded, similar to the start of gear retraction. At 2055:11, the sound of air noise decreased, similar to the closing of the nose landing gear door, coincident with the first officer saying “30 seconds.”

At 2055:47, the crew agreed to “swing” the gear again, followed by the sound of a bump similar to landing gear extension. This was the second gear extension attempt. At 2056:02, ATC asked for the number of souls on board and fuel remaining in minutes, to which the captain responded “standby.”

At 2056:16, the first officer began to note, “now we’re not even gettin’—,” interrupted by three chimes similar to the master warning, followed by the EICAS voice stating “gear disagree.” The crew discussed cycling the hydraulic pumps.

At 2056:46, the first officer said, “go back on with that,” and then read the QRH boldface conditional on page 13-6, gear disagree warning message persists, followed by step number 4, landing gear manual release, pull to full extension. The crew then discussed cycling the gear again prior to the manual release attempt, as they had heard that cycling the gear multiple times may fix the problem. The captain directed the first officer to cycle the gear again.

At 2057:00, as the sound of a bump similar to gear retraction was recorded, the captain advised ATC there were 45 souls on board and 45 minutes of fuel. At 2057:12, the sound of air noise decreased, similar to the closing of the nose landing gear door.

At 2057:47, the first officer advised he was putting the gear down again, and the captain confirmed. At 2057:51, the sound of a bump similar to landing gear extension was recorded. This was the third gear extension attempt. At this time, the captain confirmed the flaps 8 maneuvering speed was 174 knots.

At 2058:20, three chimes similar to the master warning were recorded, followed by the EICAS voice stating “gear disagree.” The crew then discussed the position of the hydraulic pump switches, and first officer re-read step number 2 of the QRH referring to hydraulic 2 and 3B pumps on. The first officer then suggested raising the flaps, turn the pumps off, and then try to “slam it with extra pressure again.” The captain concurred and directed the first officer to raise the flaps. The first officer then went to the auto position on “the two.”

[‡] The QRH procedures referenced in this report can be found appended to the docket material associated with this case.

At 2059:44, the sound of a bump similar to gear retraction was recorded. The captain told the first officer to brief the flight attendant on their status while he was waiting. At 2059:57, the sound of air noise decreased, similar to the closing of the nose landing gear door.

At 2100:04, the sound of a hi-lo chime, similar to the flight attendant call button, was recorded followed by the voice of the flight attendant on the intercom. The first officer advised the flight attendant of the gear issue and that the crew was working the issue. The flight attendant asked the first officer to talk to the passengers, and the first officer agreed. The first officer made the announcement approximately 10 minutes later at 2110:31.

At 2100:25, the crew agreed to swing the gear again, and at 2100:29, the sound of a bump similar to landing gear extension was recorded. This was the fourth gear extension attempt. The first officer noted “its rotating between what it wants to do,” followed by three chimes similar to the master warning, and the EICAS voice stating “gear disagree.” The captain noted there was sufficient fuel for additional attempts and directed the first officer to swing the gear again.

At 2101:06, the sound of a bump similar to gear retraction was recorded. At 2101:19, the sound of air noise decreased, similar to the closing of the nose landing gear door. The first officer then said he would “go this way” and “hit it just as it is on the way down.”

At 2101:31, the sound of a bump similar to landing gear extension was recorded. This was the fifth gear extension attempt, and was followed by three chimes similar to the master warning, and the EICAS voice stating “gear disagree.”

At 2102:12, the sound of a bump similar to gear retraction was recorded. At 2102:24, the sound of air noise decreased, similar to the closing of the nose landing gear door. At 2102:47, the first officer recited out loud QRH page 13-7, step number 5 and 6, hydraulic 3A and 3B pumps off, hydraulic page verify system 3 pressure. The first officer then advised the captain of the next part of the checklist procedure requiring the use of the manual gear release handle if there was no down and lock. The first officer then advised he was going to put the gear down again.

At 2103:41, the sound of a bump similar to landing gear extension was recorded. This was the sixth and final gear extension attempt, and was followed by three chimes similar to the master warning, and the EICAS voice stating “gear disagree.”

At 2104:15, the first officer reviewed the QRH page 13-6, step number 4, landing gear manual release, pull to full extension.

At 2104:35, the sound of a squeak was recorded, followed by three chimes similar to a master warning and an EICAS voice stating “nose door.” The captain asked the first officer if he pulled the landing gear manual release handle all the way up. As the sound of three additional squeaks were recorded, the first officer confirmed the handle was all the way up. The first officer then asked the captain if the handle should pop back down “like that,” and the captain said it should not. At 2105:57, the sound of three chimes similar to a master warning were recorded followed by an EICAS voice stating “nose door.”

At 2105:11, the first officer read QRH page 13-6, item number 4 and summarized the associated notes 1 and 2 regarding the pulling of the landing gear manual release; the nose door open warning message display; and the force required to pull the landing gear manual release handle. The first officer then read the caution advising that nose

wheel steering may not be available on landing, and the bold face conditional, landing gear is down-and-locked—noting the gear was not down.

At 2105:27, the first officer read QRH page 13-7, step number 5, hydraulic 3A and 3B pumps off. The captain confirmed, and the first officer then said, "that off, that off." This was followed by the sound of a single chime, similar to the master caution. The first officer then read step number 6, hydraulic page, verify system 3 pressure decreasing, and the captain noted the pressure was at zero.

As the first officer began to read a note associated with step number 6, at 2105:50, ATC inquired about the status of the gear issue and the first officer stopped checklist execution. The captain advised ATC the aircraft could not get both main landing gear down and that they were declaring an emergency. He said they would need another 10 or 15 minutes to run some procedures. ATC advised they had three more arrivals and would then bring the aircraft in, and the captain concurred with ATC's plan. The captain then advised the first officer he declared an emergency.

At 2106:41, the first officer again attempted to resume reading the QRH, but paused for an ATC transmission. ATC asked if the aircraft would like to fly-by the tower to visually check the landing gear. The captain agreed, pending the completion of some checklist items.

At 2106:58, the first officer resumed QRH page 13-7 checklist, reading verbatim the note following step number 6, related to hydraulic system 3 pressure. He then read the conditional statement, when hydraulic system 3 pressure is less than 200 psi. The first officer then read step number 7, hydraulic 3A and 3B pumps, on, followed by the associated note related to possible nose gear retraction.

At 2107:27, the first officer read step number 8, landing gear manual release, stow. He then stated, "okay well we didn't…skip that…so these notes just have to do with that." The first officer then continued, reading the bold faced conditional item on QRH page 13-7, gear disagree warning message still persists, responding yes and then read verbatim step number 9 and the associated note: landing gear up/unsafe landing procedure, accomplish, refer to emergency 13-9, and the note regarding the possibility of hydraulic 3 hi temperature messages. He then noted the end of the checklist procedure. The first officer concluded by noting the checklist on QRH page 13-9 remained to be executed.

At 2108:02, the crew then discussed landing with all gear up as opposed to landing with partial gear down or just the nose wheel. The crew considered the inconsistent behavior of the gear indications thus far. The crew then verified they had reached the end of the procedure.

At 2108:34, ATC advised the crew vehicles would be on the runway to observe the fly-by. The captain then asked to be vectored back for the fly-by, telling ATC the main gear was in question. Approach provided vectors back towards the airport, noting there would be two more arrivals prior to the aircraft fly-by. The first officer confirmed the QRH 13-7 checklist was done and that there was a continuation procedure. Following a single chime, the captain noted "I turned that off so it would bleed off." ATC then asked for a speed of 170 knots and the captain acknowledged.

At 2109:36, the captain asked the first officer to talk to the flight attendant and update her on the situation and then make a passenger announcement to likewise update the passengers. Following the sound of a hi-lo chime, the first officer was recorded speaking to the flight attendant on the intercom, advising her of the tower fly-by to check the landing gear. The flight attendant advised the passengers looked

worried and she would appreciate a passenger announcement. The first officer then made a passenger announcement informing the passengers of the landing gear issue, the pending fly-by, and that after the fly-by the passengers would be updated again.

At 2112:06, as the aircraft was being vectored for the fly-by, the captain and first officer discussed fuel concerns and calling "Atlanta Radio" to inform them of the situation. After discussion, the crew decided not to call Atlanta Radio. ATC then advised the aircraft the airport was 12 o'clock and 22 miles. The captain advised the first officer to run through all checklists one more time to make sure they didn't miss anything.

At 2113:18, the first officer began re-execution of the checklists. The first officer confirmed with the captain the appropriate checklist was the "gear down disagree checklist." The first officer then paraphrased QRH 13-6, gear down disagree checklist, items number 1 and 2; the note for item 2 regarding maintain gear selection for 30 seconds; item number 3 regarding selection of gear up then down; the conditional instruction regarding gear disagree warning message persists; and item number 4 regarding the landing gear manual release. He then paused, and there was verbal recitation of note 1 and 2 related to item number 4, regarding nose door open warnings and the force required for the manual gear release handle. The caution regarding the lack of nose wheel steering was not heard on the recording. The first officer then read the conditional statement on QRH 13-6, "landing gear is down-and-locked," noting it was not.

At 2113:37, the captain again encouraged the first officer to make sure all the checklists were done. The first officer continued at 2114:19, reading QRH 13-7, item number 5 regarding hydraulic pumps 3A and 3B; then item number 6 regarding the hydraulic page display to verify system 3 pressure decreasing; then the note to item 6 regarding reducing system 3 pressure below 200 psi; the conditional statement regarding when hydraulic system 3 pressure is less than 200 psi; item number 7 regarding hydraulic 3A and 3B pumps on; the note for item number 7, regarding the nose gear may lose downlock or retract; item number 8 regarding the landing gear manual release stow instruction; notes 1 and 2 to item number 8, regarding the possibility the main gear or nose gear may retract, and the possibility of a hydraulic 3 high temperature caution. The first officer then read the conditional of QRH 13-7, "gear disagree warning message still persists." He then read item number 9, noting the landing gear up/unsafe landing gear procedure, accomplish, and noting the need to execute QRH procedure "emer thirteen nine." He then read the note to item number 9 regarding a hydraulic high temperature warning, followed by noting the end of the checklist.

At 2115:41, the captain and first officer discussed if there were any other abnormal procedures they can think of. They agreed there was nothing left to do except QRH 13-9. ATC then advised the aircraft the airport was 12 o'clock and 10 miles. The captain acknowledged the airport was in sight. ATC cleared the aircraft for the visual approach to runway 19R and told the aircraft to contact tower.

At 2116:11, the Milwaukee Tower cleared the aircraft for a low approach to 19R. The crew discussed a flap 45 degree setting for the gear up landing, and a flaps 20 degree setting for the fly-by with a speed of 148 knots. The sound of three rapid chimes were then heard, similar to autopilot disconnect, followed by the captain confirming the autopilot was off. The captain told the first officer they would land after the low approach as fuel was becoming low.

At 2118:33, the sound of a continuous tone was heard, similar to a configuration warning. The captain asked the first officer to cancel the warning by turning off the "D-C-U," further noting they would have "no protection."

At 2119:07, the electronic ground proximity warning system (EGPWS) stated "five hundred," followed by "too low terrain" warnings. The captain asked the first officer to cancel these warnings. An unknown voice on the radio asked the aircraft to turn off their landing lights, though the transmission was not acknowledged.

At 2119:40, the EGPWS stated "one hundred." Shortly thereafter the captain asked for flaps 8.

At 2119:57, the tower advised the main gear appeared to be up, notably without specifying which of the main gear. The first officer told the captain they now had a green light on the left gear. The captain decided with this information to land with the gear down. The tower then clarified that the left and nose landing gear appeared to be down, the right gear was up and "in the well." The tower then asked the aircraft intentions. The captain advised the first officer they would do left traffic and land, and the first officer so advised the tower. The tower cleared the aircraft to land at their discretion on 19R with left traffic, advising winds from 230 degrees at 4 knots. The first officer acknowledged.

At 2121:00, the captain directed the first officer to talk to the flight attendant and advise her: they were 2 minutes out from landing, the captain would give the brace signal, and she should not evacuate unless she saw a need to evacuate. The captain then told the first officer after talking to the flight attendant to make a passenger announcement. The captain concluded by advising he had the flight controls and the radio. The first officer clarified the captain's instructions.

At 2121:42, following a hi-lo chime, the first officer spoke to the flight attendant on the intercom. The first officer and flight attendant discussed and confirmed: the right main gear would not extend, she should wait for the brace signal, do not evacuate unless she saw a need to evacuate otherwise only evacuate on command of the crew, the first officer would make a passenger announcement, and that she had 2 to 3 minutes to prepare the cabin. The flight attendant noted she did not have much time and she would only teach the passengers the brace position.

At 2121:43, the captain noted he set flaps 20, while the first officer made a passenger announcement. The first officer informed the passengers they would land with the right main landing gear in the up position, the passengers should listen to the flight attendant instructions, and they should not evacuate unless directed to do so by the crew.

At 2123:24, the flight attendant could be heard briefing the passengers on the public address system regarding the emergency landing. Items mentioned included: the brace position; emergency landing preparation; seat belts low and tight; making sure seat back pockets were empty; nothing in laps; no sharp objects in seat backs; all carry-ons fully forward against the bar under the seat; tray tables up; seat backs up; and review the safety card. The flight attendant also asked if any airline crew, police, firefighter, or military personnel were on board. She reiterated not to evacuate, telling the passengers it was safer to stay on board than evacuate, unless told to evacuate. She also advised passengers to take off their glasses and stow them in their socks.

At 2123:24, while the flight attendant was briefing passengers, the captain told the first officer he would turn base when the flight attendant's light went off. He confirmed the landing gear was down, except for the known right gear exception. He then asked

the first officer to verify all checklists were completed. The first officer noted he had one checklist remaining.

At 2124:58, the first officer began reading QRH 13-9, the landing gear up/unsafe landing procedure. He read and considered the following: item number 1 following preliminary caption, regarding descent and fuel planning; the four notes following the preparation section and the various combinations of landing gear disagreements and associated flight control inputs; item numbers 1 through 6, including the note regarding crew and flight attendant briefing. Notably, item number 5, regarding circuit breaker 1A15, took approximately 15 seconds to execute due to its location in the cockpit. The first officer then continued onto page QRH 13-10, reading or performing items as follows: opened the flight compartment door as per item number 7; tightened and locked shoulder harnesses as per item number 8; noted they should plan to land flaps 45 as per item number 9. At this time the captain sets flaps 30.

The first officer continued with the approach section of the QRH 13-10 checklist: left and right packs off as per item number 1; pressure control manual as per item number 2; manual altitude as per item number 3. The first officer continued into the section, "when the aircraft is completely depressurized," reading but not performing item number 4, regarding left and right 10th stage closed.

At 2128:56, the first officer continued reading the QRH 13-10 checklist, noting the emergency lights on as per item number 5, and then the 500 foot brace for impact passenger announcement. Continuing into the before touchdown section, the first officer read item number 1, regarding the APU fire push; item number 2 regarding airplane attitude and the associated note regarding minimum forward speed less than stick shaker speed. The first officer then read the after landing section of the checklist, both the gear collapse "yes" and "no" conditional pathways and associated items 1 through 3 and 1 and 2, respectively.

At 2129:12, the sound of click is heard, similar to the flap handle followed by the captain noting "one thirty six."

At 2129:44, the first officer noted the cabin was almost fully depressurized. The captain then reminded the first officer about the brace at 500 feet.

At 2130:39, the first officer noted the cabin was completed depressurized, and he closed the 10th stage and turned the emergency lights on. The first officer then read the APU fire push, item number 1 of the before touchdown section. The captain told the first officer to perform the APU fire push, and the first officer confirmed execution.

At 2131:44, the captain asked the first officer to "give that handle one final tug." This is followed by the sound of four squeaks, similar to the landing gear manual release handle being moved.

At 2131:58, Milwaukee Tower confirmed the landing clearance on 19R and advised the winds were from 230 degrees at 5 knots.

At 2132:06, the captain asked the first officer to give the brace announcement. The first officer is then heard saying "brace brace brace" on the PA. This is followed by the faint voice of the flight attendant (not on PA) repeating stay calm and remain seated throughout the approach and landing rollout.

At 2132:38, the captain encouraged the first officer to call out anything he did not like. This was followed by an additional sound of a squeek.

At 2133:03, the CAM recorded sounds of bumping and scraping, similar to touchdown and the wing contacting the runway. The before landing checklist was not

recorded at any time during the emergency landing. During the rollout, the first officer commented, “lookin’ good man.”

Just prior to the aircraft coming to a stop at 2133:40, the crew asked the tower if there was any indication of fire. The tower replied sparks were visible, but no fire was observed, and that the rescue trucks were right behind the aircraft. When the aircraft came to a stop at 2133:40, sounds of cheers and applause were recorded from the passengers.

After the aircraft came to a stop, the crew shut down both engines and agreed to evacuate the cabin through the main cabin door. The first officer made a passenger announcement, stating, “plan on making cabin door evacuation.” Simultaneously, the captain opened the flight deck door and directly advised the passengers and flight attendant to evacuate in an orderly fashion out the main cabin door.

The first officer pushed the left and right hand fire buttons. The first officer also advised the tower of the evacuation. The captain asked the first officer to exit the aircraft and assist with the evacuation, having the passengers group by a nearby fire engine.

At 2135:18, the captain was heard talking to operations personnel either on a radio or cell phone, informing them of the gear up landing. During this time passengers were heard exiting the aircraft and thanking the captain as they exited.

The recording ended at 2138:38 as the passengers were evacuating the aircraft.

As part of the Safety Board’s accident investigation process, the flight crew was invited to review the CVR transcript and suggest corrections or additions. They declined the invitation.

Bill Tuccio
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.