



Fuel Imbalance Cited in Learjet 35A Control Loss

The U.S. Air Force said that the flight crew of a C-21A (military version of the Learjet 35A) did not have a checklist to help them correct a fuel imbalance that was caused by a fuel-pump malfunction. During approach for an emergency landing, the crew allowed airspeed to become too slow and made control inputs that caused the aircraft to depart from controlled flight.

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FSF Editorial Staff

On April 17, 1995, the flight crew of a U.S. Air Force C-21A (the Air Force designation for the Gates Learjet 35A) declared an emergency because of a fuel problem and diverted the flight to Thomas C. Russell Field in Alexander City, Alabama, U.S. The crew was maneuvering the aircraft for a visual approach to the airport when the aircraft struck terrain. The two flight crewmembers and six passengers were killed.

The Air Force said, in its final report, that the accident was caused by a combination of an aircraft mechanical malfunction, a flight-manual deficiency and human error.

“The investigating officer found that the mechanical malfunction consisted of the right standby [fuel] pump continuing to operate uncommanded after engine start,” the report said. “This malfunction resulted in fuel being pumped into the left wing and prevented fuel from being transferred to the right wing during normal transfer procedures. This condition caused a fuel imbalance.”

The report said that the Air Force C-21A pilot-training syllabus and the Air Force C-21A flight manual did not contain an available checklist for correcting a fuel imbalance that occurs during the transfer of fuel from the fuselage tank to the wing



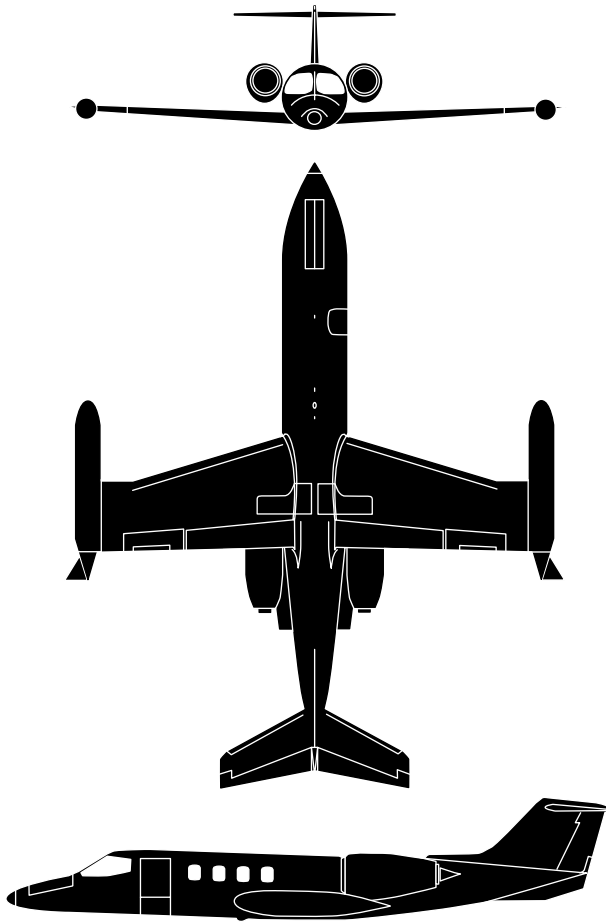
tanks. The checklist, “fuel imbalance during fuel transfer,” was published by the aircraft manufacturer in 1990.

“The Air Force, for whatever reason, did not contract for flight-manual updates from [the aircraft manufacturer] following our purchase of the airplane in 1984,” the report said. “This emergency procedure was included in civilian Learjet flight-manual updates published by [the manufacturer] subsequent to 1984. As a result, the Air Force training syllabus likewise did not include this emergency procedure.”

The report said that the flight crew believed incorrectly that fuel in the left wing had become “trapped” and that both engines were using fuel from the right wing.

“Because the crew did not have checklist or flight-manual guidance on this problem, the crew misanalyzed the malfunction,” the report said. “They failed to correct the fuel imbalance as a result, allowed their airspeed to become too slow for the aircraft’s configuration when attempting to land and then made control inputs that caused the aircraft to enter a flight regime from which they could not recover.”

The aircraft was operated by the 332nd Airlift Flight at Randolph Air Force Base (AFB), Texas. On the day of the



U.S. Air Force C-21A

C-21A is the U.S. Air Force designation for the Gates Learjet 35A, a light twin-turboprop business aircraft that first flew in 1973. The Air Force in 1983 contracted with Gates Learjet for the lease and logistical support of 80 C-21As, which replaced North American/Rockwell CT-39 Sabreliner aircraft for personnel transport, cargo transport and medical-evacuation missions.

The aircraft has accommodations for two pilots and up to eight passengers. Each of the two Garrett (now AlliedSignal) TFE731-2-2B engines is rated at 3,500 pounds (15.6 kilonewtons) static thrust. Maximum usable fuel capacity is 931 gallons (3,524 liters). Fuel is stored in two wing-tip tanks, two internal wing tanks and one fuselage tank.

Maximum takeoff weight is 18,300 pounds (8,300 kilograms). Maximum landing weight is 15,300 pounds (6,940 kilograms). Landing distance at maximum landing weight is 3,075 feet (938 meters). Power-off stall speed in landing configuration is 96 knots (178 kilometers per hour).

Source: *Jane's All the World's Aircraft*

accident, the aircraft was scheduled to be flown from Randolph AFB to Wright-Patterson AFB, Ohio, and then to Andrews AFB, Maryland, before being flown back to Randolph AFB. The scheduled flight crew duty period was 15 hours and 30 minutes.

The designated aircraft commander was an Air Force first lieutenant. He had 1,074 flight hours. He had 877 flight hours in the C-21A, including 672 flight hours as copilot and 205 flight hours as pilot.

“Flight records indicate [that he] was qualified and authorized to fly the mission as the aircraft commander,” said the report.

The aircraft commander completed Air Force pilot training in March 1993, was upgraded to C-21A copilot in June 1993 and was upgraded to C-21A first pilot in March 1994.

“His final upgrade to aircraft commander was completed Aug. 31, 1994,” the report said. “He was current, and no training deficiencies were noted.”

The designated copilot was an Air Force captain. He had 2,242 flight hours, including 933 flight hours in the Northrop T-38 and 588 flight hours in the Lockheed C-130. He had 527 flight hours in the C-21A, including 167 flight hours as copilot, 342 flight hours as pilot and 18 flight hours as instructor.

“Flight records indicate that [he] was qualified as [a C-21A] instructor pilot and authorized as the copilot for this mission,” said the report.

The copilot completed Air Force pilot training in December 1988 and served as a T-38 instructor until November 1991, when he began flying the C-130. He completed initial C-21A training in February 1994 and was upgraded to C-21A aircraft commander in May 1994.

“His final upgrade to C-21A instructor pilot was conducted locally with the 332nd Airlift Flight and [was] completed on Dec. 19, 1994,” the report said. “He was current, and no training deficiencies were noted.”

The report said that the pilots “received adequate crew rest” before reporting for duty at 0420 local. [All times in this article are Central Daylight Time.]

During their preflight inspection of the aircraft, the crew found that the flight data recorder circuit breaker was open. They attempted to reset the circuit breaker, but the circuit breaker remained open. A maintenance technician for Serv-Air, an Air Force contractor, also attempted unsuccessfully to reset the circuit breaker.

“A new flight data recorder was installed by the technician, but this did not correct the problem,” the report said. “Serv-Air personnel offered the crew a different aircraft, but the aircraft commander declined.”

The report said that Air Force regulations require an aircraft’s flight data recorder to be operational when the aircraft departs from its home base; the accident aircraft’s flight data

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Cockpit Voice Recorder Transcript, U.S. Air Force C-21A, April 17, 1995

(FSF editorial note: The following transcript is as it appears in the U.S. Air Force accident report, except for minor column rearrangement, interpolation of some times and addition of notes defining some terms that may be unfamiliar to the reader. Times are local. The transcript begins as the flight crew jettisons fuel from the left wing-tip tank; the aircraft is at Flight Level 390.)

AC = Aircraft commander
CO = Copilot
? = Speaker unknown
-I = Intra-aircraft communication
-R = Radio communication
() = Note inserted by accident investigators
CTR = Atlanta (Georgia, U.S.) Air Route Traffic Control Center
MAX = Maxwell Air Force Base dispatch
CVR = Cockpit voice recorder
GPWS = Ground-proximity warning system

Time Source Content

1801:02 AC-I Look how much trim I have in. I'm starting to take it out.

1801:03 CO-I OK.

1801:24 AC-I How much is in the wing tip now?

1801:26 CO-I Left tip is down to 300. The wings are still fine.

1801:28 CO-I Except it looks like we're starting to get an imbalance between the, the wings themselves now.

1801:30 AC-I Oh, how much?

1801:31 CO-I Ah, 200 ... 1200 in the right and, 13 left.

1801:33 AC-I That's no big deal.

1801:35 CO-I No ... doing the same thing though.

1801:36 AC-I Yeah, let's just get down. I don't like this. Heh, heh. (chuckles)

1801:40 AC-I It's just ... It feels ... You should fly it, it feels squirrely ... you know?

1802:02 CO-I Now it's just acting pretty normal.

1802:03 AC-I Yeah ...

1802:04 CO-I 200 pounds now.

1802:20 CO-I I landed once with a 600-pound imbalance.

1802:22 AC-I In this plane?

1802:23 CO-I We messed up the transfer ... 600 pounds. (chuckles) Yeah, we got another imbalance going. Look at this: 12, 13 fifty.

1802:26 AC-I OK. We need ... Can you, can you ask for a descent?

1802:34 CTR Kiowa 71, contact Atlanta 126.82, twenty-six eighty-two, and advise them when you have begun and when you have finished your, ah, fuel dumping, please.

1802:46 CO-R Kiowa 71, roger.

1802:48 CO-I It hasn't changed much from that. I'm gonna turn it off. It's been sitting there. ([The copilot] probably turns off the fuel jettison valves. Total dump time [approximately] 2.5 minutes.)

1802:50 CO-I It dumped it all in the first couple of minutes, and it hasn't changed, so ...

1802:52 AC-I Yeah, that's cool.

1802:53 CO-I But now you've got 150, almost 200 again.

1803:00 AC-I That's no big deal, just weird.

1803:04 CO-R Center, Kiowa 71.

1803:05 CTR Kiowa 71, go ahead.

1803:07 CO-R Yes, sir, we've completed our fuel dumping and, ah, just like to start a descent into Maxwell if we can.

1803:12 CTR 71, roger, descend and maintain FL 350.

1803:15 CO-R Kiowa 71, out of 390 for 350.

1803:16 CO-I OK, you got the radios, I'll make the inbound call.

1803:18 CTR Delta 604, descend and maintain FL 350.

1803:20 CO-I Is that us?

1803:22 AC-I Yeah, down to 35.

1803:24 CO-R Kiowa 71, down to 350, out of 39. ([The copilot] also answers Atlanta Center's call to Delta 604.)

1803:26 CTR OK.

1803:32 CO-I OK, you got victor one.

1803:34 CO-R Maxwell, Maxwell dispatch, Kiowa 71.

1803:38 MAX Pacer 81, Maxwell dispatch, go ahead, over?

1803:40 CO-R This is Kiowa 71, how copy?

1803:42 MAX Pacer 81, Maxwell dispatch. You're coming in very broken. Say again, over?

1803:45 CO-R Maxwell dispatch, this is Kiowa 71, K I O W A, from Randolph. How copy?

1803:49 AC-I Make sure you tell them about the codes.

1804:00 CO-I We're not that far. (Radio music heard from Maxwell dispatch UHF radio. Probably a stuck mike.)

1804:02 CO-I I don't believe this!

1804:05 CO-R Maxwell dispatch, Kiowa 71 ...

1804:10 CO-I (sigh)

1804:15 CO-I I don't have the Volume 12 out.

1804:17 AC-I OK, I'll get it and hand it over to you.

1804:20 CO-I Want me to fly for a second while you look?

1804:22 AC-I OK, you have the aircraft?

1804:24 CO-I Yeah, my aircraft.

1805:00 CO-R Maxwell dispatch, Kiowa 71. (Maxwell dispatch answers, but is totally unreadable on UHF.)

1805:30 CTR Kiowa 71, contact Atlanta Center 128.72.

1805:34 AC-R 128.72, Kiowa 71.

1805:47 AC-R Atlanta Center, Kiowa 71, we're passing 36 for 350.

1805:54 CTR Kiowa 71, roger, I'll have a lower altitude in about 10 miles.

1805:59 AC-R Kiowa 71, roger.

1806:10 CO-I You wanna fly again, I gotta try to figure ... ?

1806:12 AC-I OK, I have the aircraft.

1806:15 CO-I These guys aren't answering. It sounds like they're playing the radio now. Comm, comm ... 122.85.

1806:20 CO-R Maxwell dispatch, Kiowa 71 on victor.

1806:24 MAX Kiowa 71, Maxwell dispatch, go ahead.

1806:26 CO-R OK, we finally got a good read, thanks, uh, we're, we've got a, uh, maintenance problem and we are heading into Maxwell. Do you know if Serv-Air's still around?

1806:34 MAX That's affirmative. What's your, ah, problem, over?

1806:40 CO-R OK, I'll give you the whole scoop here. We're a C-21. We have six passengers on board, three space-As, one civilian code three, an Air Force code five, um, we have a problem with our fuel transfer. We're getting a pretty significant fuel imbalance. We've already dumped fuel once, so we need the, uh, fuel system looked at. And our ETA to Maxwell is about twenty minutes. And, uh, well I guess we're Alpha three.

1807:15 MAX Kiowa 71, let me reconfirm. You're a C-21, you have 6 pax, 3 space-As, a civilian code 3, an Alpha 5, you have a fuel problem, be here in less than 20 minutes.

1807:22 CO-R That's affirmative, Kiowa 71.

1807:36 CTR Kiowa 71, descend and maintain FL 240. (Atlanta Center)

1807:37 MAX Kiowa 71, what's your tail number, over? (Maxwell dispatch)

1807:39 AC-R Down to 240, Kiowa 71.

1807:40 CO-R Kiowa 71, sorry about that, that's tail number 136.

1807:45 CO-I Jeez, man.

1807:47 AC-I I know. Let's just declare an emergency, man. (One of the pilots moves the altitude alerter out of 35,000, probably to set 24,000.)

1807:49 MAX Kiowa 71, see you in a little bit. Have a safe flight in.

1807:50 CO-R Kiowa 71.

1807:51 AC-I OK, it's pulling out of, it's just totally pouring out of the right side. That's what it seems like.

1807:53 CO-R Center, Kiowa 71.

1807:55 CTR Go ahead.

1807:56 CO-R Sir, we'd like to declare an emergency at this time for a fuel problem and, ah, get to Maxwell quick as we can.

1808:02 CTR Kiowa 71, roger, you're cleared direct Kiowa ... I mean, um, Maxwell, and understand you're declaring an emergency and, uh, you've got a fuel problem. Would you prefer to go to another airport?

1808:16 CO-R Uh, we can still take Maxwell I believe, we just need to get there quick as we can.

1808:23 CTR Roger.

1808:30 ?-I What our alternate? (Sounds like someone other than aircrew asked this.)

1808:34 AC-I Now see, look at the right ... look at the right wing, man.

1808:36 CO-I Yeah, it's just sucking everything out of it, isn't it?

1808:40 AC-I OK, let's see what's ... let's consider another air ... airport.

1808:45 CO-I Oh, I see what you mean ... that wing ...

1808:46 AC-I We need to get on the ground, man.

1808:47 CO-I ... the engines? My mistake, my mistake. 91 miles? What's the fuel flow? Are you all the way back at idle?

1809:00 AC-I Yeah.

1809:05 CO-I I don't know, Paul. 91 miles at this altitude? It's almost a glide.

1809:08 AC-I All right.

1809:25 AC-I Tell them we want lower. I'm not, I'm not stopping at 24.

1809:30 CO-R Center, Kiowa 71.

1809:32 CTR Kiowa 71, go ahead.

1809:34 CO-R Kiowa 71, sir, we need a descent below 24 as quick as we can.

1809:42 CTR OK, Kiowa 71, I'm working on it.

1809:54 CO-I Let me see, let me see ...

1809:56 AC-I We need to get down so our fuel flow will drop.

1809:57 CO-I I know, I know.

1809:58 CTR Kiowa 71, descend and maintain 17 thousand, the Atlanta altimeter, 29.98.

1810:04 CO-R 29.98, Kiowa 71.

1810:10 CO-I All right ... Are we going to make it? Let me see ...

1810:12 AC-I Now it's down to 8.

1810:14 CO-I ... other options, other options ...

1810:16 AC-I OK, find out ... we need to find out what the landing runway is.

1810:18 CO-I 81 miles? I want the straight in ... ?

1810:20 AC-I Runway 15.

1810:22 CO-I 15? We'll go right to a straight base to 15?

1810:24 AC-I Yeah.

1810:30 CO-I The fuel's gonna go left if it's sucking it down ... I think it's as high a rate as you can ... That's what it seems ...

1810:38 AC-I I'm trying, you know?

1810:40 CO-I Yeah, I know, I know.

1810:42 AC-I Can you, can you set it? Can you set it in there for me? ([The aircraft commander] asks [the copilot] to set the altitude alerter.)

1810:44 CO-I Yeah.

1810:47 AC-I Ask him what they're landing, Maxwell's landing.

1810:49 CO-R Center, Kiowa 71, ah, can you ...

1810:52 CTR 71, roger.

1810:55 CO-R Ah, just ... can you find out what Maxwell's landing for us? We'd like 15.

1811:00 CTR Kiowa 71, stand by.

1811:10 CO-I 75 miles out. At this altitude, let's see, uh ...

1811:14 AC-I OK, I'm going to shallow the descent.

1811:20 CO-I Paul, if I transfer fuel ... Is there anything wrong with transferring now?

recorder was not operational when the aircraft departed from Randolph AFB.

The crew and six passengers were aboard when the aircraft, call sign Kiowa 71, took off from Randolph AFB at 0623. The aircraft was landed at Wright-Patterson AFB at 0844. Four passengers remained at Wright-Patterson AFB, and five additional passengers boarded the aircraft for the flight to Andrews AFB.

“There are no indications that the preflight activities were other than normal at Wright-Patterson AFB,” the report said. “Fuel was not purchased, and the takeoff was on time [at 0958].”

The aircraft was landed at Andrews AFB at 1057. All of the passengers deplaned. The crew requested a full load of fuel and told Serv-Air maintenance technicians that they had been unable to transfer fuel from the wing tanks to the fuselage tank. [See Appendix, page 12, for details about the C-21A fuel system.]

A Serv-Air maintenance technician removed the fuel-control panel from the aircraft and replaced the fuselage-tank transfer/fill switch. While working on the fuel-control panel, the maintenance technician reset the flight data recorder circuit breaker. The report said that the circuit breaker remained closed.

The maintenance technician told the crew that replacement of the fuselage-tank switch had not corrected the problem and that he was going to try to correct the problem by replacing the fuel-control relay panel.

One crewmember asked how much time was required to replace the panel. The maintenance technician said that it was a time-consuming job because the fuel-control relay panel is in the tail of the aircraft.

“[The crewmember] said that if it would take too long, not to worry about it [i.e., replace the fuel-control panel] since the fuselage ... tank was full and [since] they had not had trouble earlier in the day getting fuel out of the fuselage tank,” the maintenance technician said. “[The crewmember said] that they would be able to take the aircraft the way it was.”

The aircraft departed from Andrews AFB at 1638 — 38 minutes after the scheduled departure time, because some passengers had been late in arriving. The flight crew's instrument flight plan listed three hours and 45 minutes as the expected flight time to Randolph AFB. The aircraft commander was the pilot flying.

The aircraft was in cruise flight at Flight Level (FL) 390 at 1753 when the crew began to transfer fuel from the fuselage tank to the wing tanks. The crew did not know that the right standby fuel pump was operating and was preventing fuel from being transferred from the fuselage tank to the right wing. The

1811:24 AC-I I wouldn't want to do anything, to tell you the truth.

1811:30 AC-I I don't understand what's going on.

1811:35 AC-I It's going to have ... it's gonna have an early flameout, Paul.

1811:40 CO-I I know.

1811:45 AC-I Let's, um, let's just get set up for the approach ... left base.

1811:50 CO-I What are other runways in the area? Maxine?

1812:00 CO-I And we're how many miles out? Don't get down so quick, you'll have to level off and push it up again.

1812:06 AC-I OK.

1812:14 CO-I I'm reading this ... there's, there's Matley field. I'm not sure which that is, but it's down there. And we're only 29 miles from it.

1812:18 AC-I OK.

1812:20 CO-I Run out of alternate groups, dude.

1812:22 AC-I OK.

1812:37 CTR Kiowa 71, contact Atlanta Center 120 point 45.

1812:41 CO-R 120.45, Kiowa 71.

1812:43 AC-I Make sure they know we're emergency.

1812:45 CO-I I will.

1812:47 CO-R Atlanta Center, Kiowa 71, emergency aircraft out of, 18-four for 1 7 thousand to Maxwell.

1812:53 CTR Kiowa 71, 120 point 45.

1812:58 CO-R Sorry, I didn't switch.

1813:00 CO-R Center, Kiowa 71.

1813:02 CTR Kiowa 71, go ahead.

1813:04 CO-R Sir, emergency aircraft out of 18 for, ah, 1 7 thousand to Maxwell.

1813:08 CTR Roger, Kiowa 71, do you need lower at this time?

1813:10 AC-I Yes.

1813:12 CO-R Kiowa 71, affirmative, we need to not to have to level off here, yes.

1813:16 CTR Kiowa 71, say again, do you need lower at this time or not?

1813:18 AC-I Yes.

1813:20 CO-R Affirmative.

1813:21 CTR Kiowa 71, descend and maintain 1 1 thousand, Maxwell altimeter is 29.96.

report said that both standby fuel pump switches were in the "off" position. [If a standby fuel pump switch is in the "on" position, the standby pump automatically is deactivated under normal conditions when the fuselage-tank switch is selected to "transfer."]

Postaccident examination showed that bearings in the right standby pump were in a deteriorated condition and that the pump had required higher-than-normal electrical current for rotation. The higher-than-normal electrical current had caused progressive damage to two contacts in the fuel-control relay panel and eventually had caused the contacts to bond together.

"This caused the pump to run continuously throughout the flight and [to] prevent fuel transfer from the fuselage tank to the right wing," the report said. "In fact, fuel would also transfer from the right wing to the left [wing] when the crossflow valve between the wings opened automatically during the transfer procedure."

Postaccident simulations of the standby-fuel-pump malfunction showed that a fuel imbalance would increase at a rate of 150 pounds (68 kilograms) per minute when fuel was transferred from the fuselage tank.

"According to cockpit voice recorder discussions, the aircrew noticed that the left wing-tip [tank] had become 800 pounds [363 kilograms] heavier than the right [wing-tip tank] during the transfer, and they attempted to analyze the malfunction and correct the imbalance," the report said. "A fuel-imbalance-during-fuel-transfer malfunction [however] is not included in the Air Force training syllabus, nor is the procedure contained in the C-21A checklist."

The report said that in January 1993, another C-21A flight crew observed a fuel imbalance while transferring fuel from the fuselage tank and had corrected the problem by opening the circuit breaker for the standby fuel pump in the wing that contained less fuel than the other wing.

"When questioned as to why he suspected the standby pump [was] running, [the aircraft commander] indicated he had been informally introduced to this malfunction while attending simulator training at SimuFlite," the report said. "The procedure is covered in civilian Learjet training, and a procedure entitled 'fuel imbalance during fuel transfer' is part of the civilian checklist."

The "fuel imbalance during fuel transfer" checklist recommends that, if normal procedures for correcting a fuel imbalance are not effective, the crew should open the circuit breaker for the standby fuel pump in the "light wing" (i.e., the wing containing less fuel than the other wing).

The checklist said, "This problem is a system failure allowing the standby pump to run whenever the circuit breaker is in."

1813:22 (One of the pilots moves the altitude alerter out of 17,000, probably to set 11,000.)

1813:26 CO-R Kiowa 71, 1 7 for 1 1 thousand, 29.96.

1813:30 CO-I 29.96 set.

1813:32 AC-I 29.96 set.

1814:00 CO-I 60 miles?

1814:08 CO-I Paul, let me tell you, don't, let's not configure until we're on final. Real short final. Can we run through the descent check, please?

1814:19 AC-I Let's find out what the landing runway is. It doesn't really matter, find out what the winds are. I'm just going to take 15. Tell 'em we're taking 15.

1814:23 CO-I No choice. 60 miles, we should be pretty close. ([The copilot] is probably checking the fuel gauges.) Call them and ask for a closer airfield.

1814:26 AC-I Huh?

1814:28 CO-I Call 'em and ask for a closer airfield.

1814:29 AC-I OK.

1814:31 CO-I This arrow's just coming down too fast.

1814:33 AC-I Let's see where one is.

1814:48 CO-I Ah, Matl- Matley. It's got ... in these places.

1814:58 CO-R Center, Kiowa 71.

1815:03 CO-R Center, Kiowa 71.

1815:08 CO-R Center, Kiowa 71.

1815:10 CTR Kiowa 71, go ahead.

1815:11 CO-R Center, Kiowa 71, we need ah, we need to change the airfield, to get to the closest piece of pavement we can land on. I'm looking at Moton field. You know anything about that field?

1815:23 CTR Kiowa 71, we got an airport at ah, 12 o'clock and 12 miles. It's Alexander City. I'll get you a runway length here in just a second. Just stand by.

1815:34 CO-R OK, Kiowa 71, we need it ASAP, sir, ah, we're not going to have engines shortly.

1815:38 CTR OK, the runway length at Alexander City is a hard surface at 4400 feet ...

1815:42 CO-I 4400?

1815:44 AC-I 2400.

1815:45 CTR ... runway 18/36, at 12 o'clock and 10 miles.

1815:46 CO-I How much did he say?

The report said that when the accident crew used normal procedures for balancing the wing tanks, the fuel imbalance became worse.

“The pressure generated by the operating right standby pump would not have allowed fuel to come into the right wing [the light wing] when following these procedures,” said the report.

At 1756, the copilot told the Atlanta Air Route Traffic Control Center (Atlanta Center) controller, “Sir, we need to revise our flight plan. We’re having a problem getting some fuel out of one of our wings. Can we get vectors to Maxwell Air Force Base? And we’re going to need to dump fuel for about five minutes.”

The copilot told the controller that the estimated time en route to Maxwell AFB (which is in Alabama) was about 28 minutes and that fuel remaining in the aircraft after they dumped fuel would be sufficient for about two hours of flying.

“We’re not going to dump a whole lot,” the copilot said. “We just need to even the wings. We got a pretty good imbalance going.”

The copilot used the cabin speaker to tell the passengers about the fuel problem and the diversion.

“We’re having a fuel problem,” he said. “We can’t get it out from one of our wings. The plan right now is to go to Maxwell Air Force Base, have the problem worked on ... , get some gas and continue on to Randolph. The problem is we can’t get fuel out of one of our wings. We just want to look and make sure. We’re not sure. Sorry.”

The crew at 1800 began to dump fuel from the left wing-tip tank. The report said that the crew dumped all of the fuel from the left wing-tip tank.

The aircraft commander told the copilot that he was reducing the amount of aileron trim that he had been using to keep the wings level.

“Look how much trim I have in,” he said. “I’m starting to take it out.”

The copilot said, “Except it looks like we’re starting to get an imbalance between the wings [the wing tanks] themselves now.”

When the aircraft commander asked how much of an imbalance existed, the copilot said, “Ah, 200 [pounds (91 kilograms)].”

The aircraft commander said, “That’s no big deal.”

The copilot said, “No ... doing the same thing, though.”

“Yeah, let’s just get down,” the aircraft commander said. “I don’t like this.”

1815:48 AC-I 2400 feet.

1815:49 CO-R Sir, is there anything longer than that around?

1815:56 AC-I We gotta make Maxwell.

1815:58 CO-I I don't know if we're gonna make it, Paul, we got 250 pounds here.

1815:59 CTR Not within, ah, 40 miles, sir.

1816:04 AC-I Sonovabitch. (whisper)

1816:06 CO-I How much did he say it had?

1816:08 AC-I He said 2400 feet, let's see ... make sure it's 2400.

1816:10 CO-R Sir, was that, ah, 2400 feet?

1816:13 CTR OK, the airport at 12 o'clock and, ah, 7 miles is 4400 feet. I have an airport off your right wing and 22 miles is 5400 feet.

1816:23 AC-I We'll take the one 12 o'clock.

1816:24 CO-R Sir, we'll take the one at 12 o'clock.

1816:27 CTR Roger, 12 o'clock and ah ...

1816:30 CO-I Look, just right there, Paul. Right there, Paul.

1816:31 CTR ... actually now it's 1 o'clock and 5 miles ...

1816:32 AC-I I don't see it.

1816:33 CTR ... and you're cleared, ah, for emergency descent down into that airport.

1816:34 CO-I Drop the spoilers, man, drop them, drop them.

1816:35 CTR It's Alexander City, 1 o'clock and 6 miles.

1816:37 AC-I I don't see it, man.

1816:38 CO-R Kiowa 71, sir, we have it in sight.

1816:40 CTR Roger, thank you.

1816:41 CO-I It's right down here, right down here.

1816:42 AC-I Take the plane.

1816:43 CO-I I have the aircraft.

1816:45 AC-I You have the aircraft. Spoilers are out. (Approximately 4 seconds of audible pitch trim, indicative of extension of spoilers.)

1816:48 CO-I Right there.

1816:51 AC-I I don't see it, man.

1816:55 CO-R Center, Kiowa 71.

1816:57 CTR 71, go.

1816:58 CO-R Sir, please clear everybody out of our way. We're on, ah, I guess a left base to this runway.

At 1803, the copilot told Atlanta Center, "We've completed our fuel dumping and [would] like to start a descent into Maxwell if we can."

The controller told the crew to descend to FL 350.

The report said that the crew then observed that fuel quantity was decreasing rapidly in the right wing tank, that the left wing tank was full and that the left wing-tip tank had begun to fill with fuel.

"This was most likely the result of the crossflow valve being left open after previous attempts to balance the wings," said the report. [With the crossflow valve open, the operating right standby pump would have moved fuel from the right wing into the left wing.]

At 1807, the copilot told the Atlanta Center controller, "Sir, we'd like to declare an emergency at this time for a fuel problem and, ah, get to Maxwell quick as we can."

The controller told the crew to fly direct to Maxwell AFB and asked if they would prefer to go to another airport.

The copilot said, "We can still take Maxwell, I believe. We just need to get there quick as we can."

The report said that the crew became increasingly concerned about the rapid reduction of fuel in the right wing tank.

At 1808, the aircraft commander said, "Look at the right wing, man."

The copilot said, "Yeah, it's just sucking everything out of it, isn't it?"

"Let's consider another airport," the aircraft commander said. "We need to get on the ground."

The copilot requested a lower altitude. Atlanta Center told the crew to descend to 17,000 feet.

The report said that the crew believed that both engines were operating on fuel from the right wing tank and that fuel starvation and flameout of both engines was imminent.

"Absent other guidance, the crew incorrectly concluded that the right wing was providing fuel to run both of the engines and that the fuel on the left side was trapped," said the report.

[Depletion of fuel in the right wing tank would cause the right engine to flame out; the left engine would continue to operate on fuel from the left wing tanks.]

At 1811, the aircraft commander said, "I don't understand what's going on. ... It's gonna have an early flameout, Paul." [Both pilots were named Paul.]

1817:03 CTR Kiowa 71, roger, you're cleared for a visual approach.

1817:06 CO-R Kiowa 71.

1817:13 CO-I Can you see it?

1817:14 AC-I Yeah, I think so.

1817:15 CO-I Look at that.

1817:16 AC-I Yeah.

1817:16 CO-I Is that a runway?

1817:17 AC-I Yeah, it is a runway. Tell you what, man.

1817:18 CO-I We're not gonna do it.

1817:25 AC-I How ya going to do it?

1817:27 CO-I We're gonna do a little 'S' and turn around, OK?

1817:36 CTR ... break. Kiowa 71, contact Montgomery Approach 121.2.

1817:38 CO-I That's us, 121.2.

1817:39 AC-R 121.2, Kiowa 71.

1817:41 AC-I You see it?

1817:42 CO-I I'm looking.

1817:43 AC-I Right there ... You see it?

1817:45 CO-I Yeah, I gotta turn here.

1817:46 AC-I OK, we can make a left downwind.

1817:47 CO-I Hang on, hang on a second. We're too close.

1817:49 AC-I Can we make it to the runway? ... Level off. (Approximately 4 seconds of audible pitch trim, indicative of retraction of spoilers.) You see it?

1817:59 CO-I We got a heck of an imbalance here.

1818:01 AC-I Yeah, make a downwind.

1818:09 CO-I I'm gonna drop the gear and flaps.

1818:14 AC-I OK, you gonna make a downwind, right?

1818:15 CO-I Yeah, left base, do a left base.

1818:16 AC-I 12 o'clock.

1818:19 CO-I Is that for me? Low fuel, Paul.

1818:21 AC-I I hear ya. I hear ya, man.

1818:23 CO-I OK, let's get ready for flaps 20.

1818:29 AC-I I'm transferring forward.... Bring it out, like that, you're gonna ...

1818:39 CO-I How's it look now?

1818:40 AC-I Looks good, looks good.

1818:49 AC-I Gear down. Flaps 20.

1818:50 CO-I Don't put anything down. Nothing down, nothing down.

The copilot said, "I know."

At 1813, Atlanta Center told the crew to descend to 11,000 feet.

The copilot told the aircraft commander that they were 60 nautical miles (111 kilometers) from Maxwell AFB and recommended that they request clearance to land at a closer airport. The aircraft commander agreed.

At 1815, the copilot told Atlanta Center, "We need to change the airfield, to get to the closest piece of pavement we can land on."

The controller said, "Kiowa 71, we got an airport at 12 o'clock and 12 miles. It's Alexander City. I'll get you a runway length here in just a second. Just stand by."

"OK, Kiowa 71, we need it ASAP [as soon as possible], sir," the copilot said. "We're not going to have engines shortly."

"OK, the runway length at Alexander City is a hard surface at 4,400 feet," said the controller.

The crew then discussed whether the controller had said the runway was 4,400 feet (1,342 meters) long or 2,400 feet (732 meters) long.

At 1816, the copilot asked the controller, "Sir, was that, ah, 2,400 feet?"

The controller said, "OK, the airport at 12 o'clock and, ah, seven miles is 4,400 feet. I have an airport off your right wing and 22 miles [that] is 5,400 feet."

"Sir, we'll take the one at 12 o'clock," the copilot said.

The controller told the crew that they were cleared for an emergency descent to the Alexander City airport.

The copilot said that they had the airport in sight. [Alexander City is approximately 38 nautical miles (70 kilometers) northeast of Maxwell AFB.]

The aircraft commander told the copilot that he did not have the airport in sight. The copilot attempted to point out the airport, but the aircraft commander said, "I don't see it." The aircraft commander then transferred control of the aircraft to the copilot.

"Take the plane," the aircraft commander said.

"I have the aircraft," the copilot said.

The copilot then told Atlanta Center, "Sir, please clear everybody out of our way. We're on, ah, I guess a left base to this runway."

1818:52 AC-I OK, don't turn, don't turn ... 'cause you're gonna be close.

1818:54 CO-I How am I looking?

1818:56 AC-I Let's just drop it and go. Let's drop all of it.

1818:57 CO-I OK.

1818:58 AC-I Gear down. Gear down.

1818:59 CO-I No. Stand by. Stand by.

1819:01 AC-I Gear down. Gear down, man.

1819:02 CO-I No, not yet, not yet.

1819:06 CO-I (Gear horn extinguishes, probably as [the aircraft commander] pushed the thrust levers up above 55 degrees.) Paul, push the airspeed... Push the power up a little bit for me. Push the power up for me, bud.

1819:12 AC-I Gear down, man.

1819:14 CO-I I can't, Paul.

1819:17 GPWS Terrain, terrain, terrain. (Sound of gear doors opening and gear coming down.) Terrain, terrain. Whoop, whoop. Pull up.

1819:20 AC-I All right, all right, make it ... that's right.

1819:21 CO-I Paul, Paul, push the power up. Push the power up.

1819:22 AC-I All right, man. All right. All right. All right. Stay on the ball. Center the ... step on the ball. Step on the ball. Let's make a left turn.

1819:32 CO-I I got the left turn. I got the left turn.

1819:34 AC-I No, a right turn. Make a right turn.

1819:36 CO-I No.

1819:38 AC-I Right turn, step on the ball.

1819:40 CO-I Right turn. right turn.

1819:42 AC-I Step on the ball, power's coming up. Step on the ball. Step on the ball, power's coming up.

1819:56 CO-I Paul, I can't. I can't turn.

1820:00 AC-I OK. Make a left turn. Make a left turn. (Sound of whining down on CVR channels 1 and 4.)

1820:03 CO-I Paul, I can't.

1820:05 AC-I I'm pushing the rudder. I'm pushing the rudder.

1820:11 CO-I Paul, do I have any engines? Paul, no.

1820:13 AC-I Yes.

The controller cleared the crew to conduct a visual approach to the airport and told them to change frequencies to Montgomery (Alabama) Approach Control.

"They acknowledged the radio-frequency change but never checked in with approach control," said the report.

The aircraft was northeast of the airport at 8,800 feet and was descending at 5,600 feet per minute with the wing-lift spoilers extended when the copilot told Atlanta Center that they were on a left base for the runway. [Airport elevation is 686 feet.]

"Eyewitness testimony, cockpit voice recorder [information] and flight data recorder information indicate that the crew attempted to fly a visual traffic pattern to Runway 18 but were in a poor position to complete the approach and landing," the report said. "They subsequently elected to enter a left downwind leg for Runway 36."

The aircraft was at 3,200 feet at 1817 when the aircraft commander told the copilot to "level off." The crew retracted the spoilers.

The copilot said, "We got a heck of an imbalance here."

The report said that as airspeed was reduced, aileron authority diminished "and, because of the fuel imbalance, the aircraft became difficult to control."

"Simulator tests under these conditions required [the pilot flying to keep] both hands on the yoke for directional control," the report said. "Simulator turns to the left were rapid, and turns to the right were nearly impossible."

The copilot, flying from the right seat, did not have a good view of the runway and asked the aircraft commander for help in positioning the aircraft on downwind and in beginning the turn toward the runway.

"How's it look now?" the copilot said.

"Looks good, looks good," the aircraft commander said. "Gear down Flap 20."

"Don't put anything down," the copilot said. "Nothing down, nothing down." [Earlier in the flight, when the crew was discussing their plan to divert to Maxwell AFB, the copilot had recommended that they delay reconfiguring the aircraft for landing until they were on short final approach.]

"OK, don't turn," the aircraft commander said. "Don't turn ... [because] you're gonna be close."

The aircraft was at 2,030 feet when the gear-warning horn sounded. The aircraft commander said, "Gear down. Gear down."

The copilot said, "No. Stand by. Stand by."

1820:14 CO-I Not so fast. (Yaw damper disengages.)

1820:16 AC-I Yes, yes, you have engines. (Sound of whining up then down on CVR channels 1 and 4.) You have engines. You have engines. We need engines.

1820:22 CO-I Paul, what ... ?

1820:23 AC-I We need engines. We need engines. Step on the ball.

1820:26 CO-I Paul, I have no ... Paul, no, no. ([The aircraft commander] steps on the left rudder against [the copilot's] right rudder.)

1820:27 AC-I Yes. Yes. Step on the rudder. Step on the rudder.

1820:28 CO-I Paul, no. Paul. Paul, don't.

1820:32 (Impact approximately 31:40 from CVR start time.)

Source: U.S. Air Force

“Gear down,” the commander said. “Gear down, man.”

“No, not yet, not yet,” the copilot said.

The copilot then asked the aircraft commander to “push the power up a little bit for me.” The report said that the sound of the gear-warning horn stopped, indicating that the aircraft commander had increased power.

The aircraft commander said, “Gear down, man.”

The copilot said, “I can't, Paul.”

The cockpit voice recorder then recorded the sound of gear doors opening and the landing gear extending.

The copilot told the aircraft commander to “push the power up.”

The aircraft was at about 1,500 feet and was one mile (1.9 kilometers) southwest of the runway at 1819 when the copilot began a left turn.

“Approximately halfway through the final turn and one mile due south of Runway 36, the aircraft abruptly rolled out, flew through the extended [runway] centerline and continued in an east, northeasterly direction ... approximately 800 feet above the ground,” said the report.

The report said that the copilot had rolled out of the turn to regain lateral control of the aircraft. The aircraft was flown northeast for approximately 20 seconds.

The aircraft commander told the copilot several times to “step on the ball.”

The report said, “Analysis of the engines and engine-sound tracings indicates that both engines were operating and that [the right engine] was operating at a reduced thrust setting ... This suggests that the crew may have advanced the thrust levers asymmetrically in an attempt to counteract the effects of the fuel imbalance.”

The report said that the aircraft commander, to center the ball in the slip indicator, applied pressure on the left rudder, against pressure that was being applied on the right rudder by the copilot.

The aircraft commander said, “Step on the rudder. Step on the rudder.”

The copilot said, “Paul, no. Paul, don't.”

The report said that the application of left rudder caused the aircraft to roll left rapidly.

“The flight manual warns: ‘Improper rudder input in conjunction with overly aggressive single-engine power application may cause loss of aircraft control. Recovery may not be possible,’” the report said. “Simulator tests under these conditions revealed that attempting to coordinate flight by centering the ball on the slip indicator would cause the aircraft to roll uncontrollably. Recovery at such a low altitude was not possible.”

Witnesses said that the aircraft was flying just above the treetops when it rolled inverted, entered the trees and struck the ground three miles (5.6 kilometers) east of the airport.

The report said that the aircraft exploded upon impact and burned.

“Analysis reveals that the aircraft impacted heading northeasterly (049 degrees) in an inverted attitude, right wing down 20 degrees and 45 degrees nose down,” the report said. “The wreckage pattern covered an area approximately 350 feet [107 meters] long and 100 feet [31 meters] wide along heavily wooded, downsloped terrain.

“Most of the aircraft was broken into small pieces, with the exception of the cockpit, right wing, tail section and engines. The cockpit came to rest very near the impact crater with the engines continuing another 115 feet [35 meters] and coming to rest in a small stream.”♦

[Editorial note: This article, except where specifically noted, was based on the U.S. Air Force *Aircraft Accident Investigation Report, C-21A 84-0136, 17 April 1995, Alexander City, Alabama*. The 703-page report contains diagrams and photographs.]

Appendix C-21A Fuel System Details

- The aircraft can carry approximately 2,390 pounds (1,084 kilograms) of fuel in the two wing-tip tanks, 2,508 pounds (1,138 kilograms) of fuel in the two internal wing tanks and 1,340 pounds (608 kilograms) of fuel in the fuselage tank;
- Fuel from each wing tank is supplied to the engine on the same side of the aircraft; the fuel system does not have engine-crossfeed capability (i.e., fuel from the right wing tanks cannot be provided directly to the left engine, and fuel from the left wing tanks cannot be provided directly to the right engine);
- Fuel from the wing-tip tanks is depleted first. Gravity causes approximately half of the fuel in the wing-tip tanks to flow into the wing tanks; jet pumps in the wing-tip tanks move fuel remaining in the wing-tip tanks to the wing tanks;
- The flight crew uses a two-position ("xfer" and "fill") switch either to transfer fuel from the fuselage tank into the wing tanks and wing-tip tanks, or to fill the fuselage tank with fuel from the wing tanks and wing-tip tanks;
- The crossflow valve between the wing tanks opens automatically when fuel is transferred from the fuselage tank to the wing tanks and wing-tip tanks. The crossflow valve is opened manually during refueling and to balance the fuel loads in the wing tanks and wing-tip tanks;
- Standby electric fuel pumps in the wing tanks are activated automatically during engine start and during transfer of fuel from the wing tanks to the fuselage tank. The standby fuel pumps can be activated manually when an engine-driven fuel pump fails and to balance fuel in the wing tanks and wing-tip tanks; and,
- Fuel-dump valves in the wing-tip tanks can be activated manually to jettison fuel from the wing-tip tanks.♦

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