



Flight Crew's Failure to Perform Landing Checklist Results in DC-9 Wheels-up Landing

The captain ignored several cues that the unstabilized approach should have been aborted. These included excessive airspeed, an alert from the ground-proximity warning system, lack of green lights signaling that the landing gear was down and locked, and the sounding of the gear-warning horn.

FSF Editorial Staff

The crew of the Continental Airlines (COA) DC-9-32 landed wheels up on Runway 27 (photo, page 3) at Houston (Texas, U.S.) Intercontinental Airport (IAH). The airplane slid 2,089 meters (6,850 feet) before coming to rest in the grass about 43 meters (140 feet) left of the runway centerline (Figure 1, page 4).

No fatalities or serious injuries occurred, but 12 minor injuries to passengers were reported in the Feb. 19, 1996, accident. The aircraft received substantial damage. Because the estimated repair costs exceeded its insured value of US\$2.56 million, the aircraft was scrapped.

The accident occurred during daylight, in visual meteorological conditions (VMC).

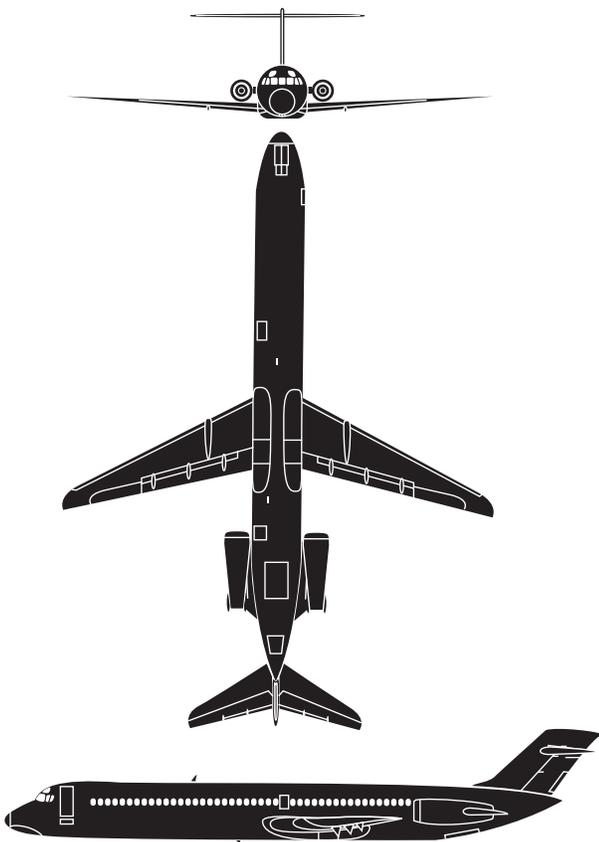
The U.S. National Transportation Safety Board (NTSB) determined that "the probable cause of this accident was the captain's decision to continue the approach contrary to COA standard operating procedures that mandate a go-around when an approach is unstabilized below [152 meters (500 feet)] or a ground-proximity warning system alert continues below [61 meters (200 feet)] above field elevation [AFE]. ...



"The following factors contributed to the accident: (1) the flight crew's failure to properly complete the in-range checklist, which resulted in a lack of hydraulic pressure to lower the landing gear and deploy the flaps; (2) the flight crew's failure to perform the landing checklist and confirm that the landing gear was extended; (3) the inadequate remedial actions by COA to ensure adherence to standard operating procedures; and (4) the [U.S.] Federal Aviation Administration's [FAA's] inadequate oversight of COA to ensure adherence to standard operating procedures."

The pilots of the accident flight were a reserve flight crew that had flown a scheduled passenger flight from IAH to Washington (D.C., U.S.) National Airport (DCA) on the night before the accident flight. The flight arrived at DCA at 2127 hours local time. "The captain arrived at the hotel about 2220 ... after what he described as a longer-than-usual van ride, went straight to his room and went to bed immediately," the report said.

The captain said that he awoke at 0500 and arrived at the aircraft at 0620.



McDonnell Douglas DC-9

The twin-turboprop short/medium range McDonnell Douglas DC-9 was first flown in 1965 and has been stretched to increase passenger seating in several subsequent versions. It has a maximum takeoff weight of 44,450 kilograms (98,000 pounds) and a maximum cruising speed at 7,620 meters (25,000 feet) of 909 kilometers per hour (491 knots). The Series 30 has a range of 2,388 kilometers (1,120 miles) at an altitude of 9,150 meters (30,000 feet) with reserves for a 370-kilometer (174-mile) flight to an alternate and a 60-minute hold at 3,050 meters (10,000 feet).

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

The night before the accident flight, the first officer arrived at the hotel at 2230. He awoke at 0500 to prepare for the departure of the crew van at 0600.

COA Flight 1943 (the accident flight) departed DCA at 0650 with 82 passengers, two flight crew members and three flight attendants aboard, the report said. The first officer was the pilot flying, and the flight proceeded uneventfully to the Houston area.

At 0840:42 local time, the flight crew was in contact with the Houston FAA air route traffic control center (ARTCC) and

was cleared to descend from 10,675 meters (35,000 feet) to 3,965 meters (13,000 feet). About one minute later, the captain read the descent checklist. "The first officer asked the captain to verify that the calculation of [244 kilometers per hour (kph) (132 knots)] as the target airspeed for the approach to IAH was correct, to which the captain replied in the affirmative," the report said.

As the aircraft was descending through 5,795 meters (19,000 feet), the first officer called for the in-range checklist. "Between 0845:37 and 0846:10, the captain referred to each of the seven items on the in-range checklist, in the correct order, except for the fourth item, 'Hydraulics,' to which the captain did not refer," the report said.

The seven items on the in-range checklist were:

- "Fuel Boost Pumps, Quantity";
- "No Smoke & Seat Belt Signs";
- "Flight Instruments, Altimeters";
- "Hydraulics";
- "Shoulder Harness";
- "Approach Briefing"; and,
- "Sterile Cockpit Light."

The first officer responded "checked set" to the third item, and "on" to the fifth item. The flight was cleared to intercept the localizer course for the Runway 27 instrument landing system (ILS).

Approach Checklist Requested

The first officer called for the approach checklist. "Between 0854:49 and 0855:18, the captain referred to the first four of the nine items on the checklist," the report said. "At 0855:27, the checklist was interrupted by the first officer informing the captain that he intended to use manual spoilers and 40 degrees of flaps for landing."

The report continued: "The captain resumed completing the checklist at 0855:56, and accomplished the next three items before he was interrupted again at 0856:06, when the controller transmitted, 'Continental nineteen forty-three, [20.9 kilometers (13 miles)] from the [outer] marker, maintain two thousand till established on the localizer, cleared ILS two seven approach.'"

The controller instructed the flight "to maintain a speed of [352 kph (190 knots)] or faster to the outer marker and to contact the [Houston FAA air traffic control (ATC)] tower."



After a wheels-up landing, the Continental Airlines DC-9-32 continued on a trajectory close to the runway centerline for 1,525 meters (5,000 feet), then departed the left side of the runway. The aircraft stopped on the grass adjacent to the upwind end of the runway. (Photo: U.S. National Transportation Safety Board)

the report said. “According to the captain, the ATC request to maintain [352 kph] or faster to the marker was not unusual at IAH on a visual flight rules (VFR) day.”

The current IAH hourly weather observation when the crew flew the approach was: 305 meters (1,000 feet) scattered, measured ceiling 549 meters (1,800 feet) broken, 823 meters (2,700 feet) overcast, visibility 16 kilometers (10 miles), temperature 20 degrees C (68 degrees F), dew point 17 degrees C (63 degrees F), surface wind 210 degrees at 22 kph (12 knots).

The captain made the landing public address (PA) announcement, contacted Houston tower and was cleared to land. “At 0858:08, the captain said, ‘Now, where was I,’ referred to the last two items on the approach checklist and stated, ‘Approach check complete,’” the report said.

Thirty seconds later, the captain commented, “Aw shoot. I can’t play tennis when it’s like this ... well maybe this afternoon it’ll clear up. Actually I’ve still got a lot of time.”

The first officer said, “Go slats and five.”

The captain responded, “[Flaps] are going to five.”

After the accident, the captain recalled “that he felt the slats extend, and the first officer recalled that the blue ‘SLATS EXTEND’ light illuminated,” the report said.

“Between 0859:14 and 0859:37, the captain engaged the first officer in nonessential conversation about the weather,” the report said. Shortly thereafter, the first officer asked the captain whether they were to maintain 190 knots to the outer or the middle marker. Most of the discussion that ensued was

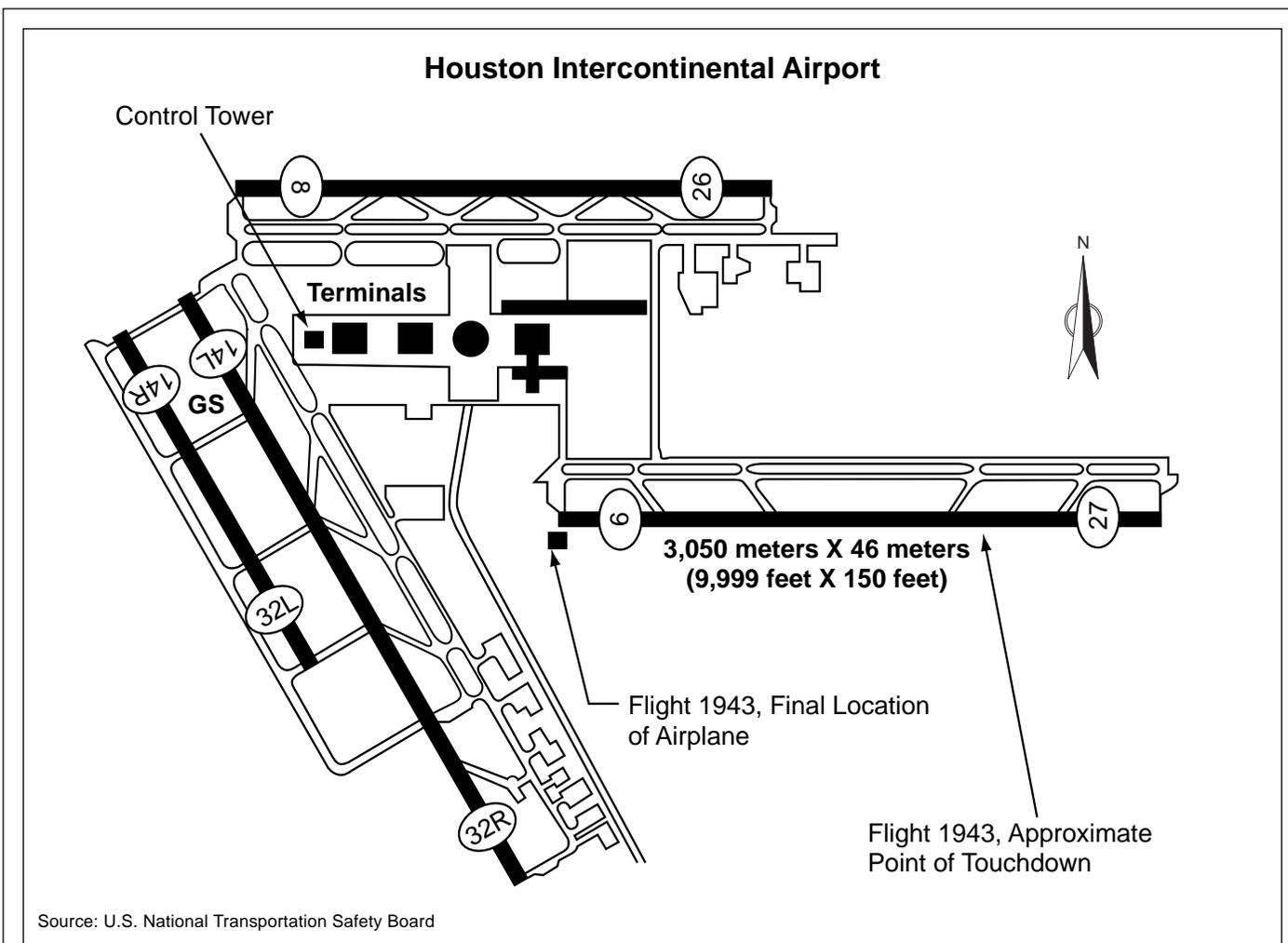


Figure 1

unintelligible on the cockpit voice recorder (CVR). Following the accident, “the first officer reported that he had noticed the flap gauge indicating zero degrees at 0900 and that his subsequent remarks had been in reference to the flap gauge,” the report said.

First Officer Realized Flaps Not Extended

When the flight had crossed the outer marker, the first officer called for the flaps to be further extended to 15 degrees. In an interview following the accident, “the first officer indicated that at this point he realized that the flaps had not extended and touched the flap gauge to show the captain that it indicated zero,” the report said. The captain said that he responded by confirming that the flap handle was positioned to 15 degrees.

At 0900:35, “three intermittent sounds from the landing gear-warning horn were produced, according to the first officer, by the captain rapidly moving the throttles back and forth,” the

report said. The captain then said, “Well we know that, you want the gear.” (The first officer later told investigators that he did not know what the captain intended by the comment, “well we know that”)

The first officer called, “Gear down.” Two seconds later, the sound of a thump, similar to the sound of a DC-9 gear handle being moved to the down position, was heard on the CVR.

At 0900:41, “the first officer called for the landing checklist and the flaps to be extended to 25 degrees,” the report said. Five seconds later, the landing gear-warning horn sounded. “During the next 12 seconds, the first officer called for the flaps to be extended to 40 degrees and then to 50 degrees.”

At 0900:58, “the airplane was traveling at [400 kph (216 knots)] indicated airspeed, approximately 154 meters [504 feet] [AFE], and 34 seconds from touchdown,” the report said. Seconds later, the first officer asked, “Want to take it around?” The captain replied, “No, that’s all right. [Unintelligible word] keep your speed up here about uh”

Fast Approach Prevented Time for Discussion

Following the accident, the captain commented about his decision to continue the approach: “It was a VFR day, we had a [3,050-meter (10,000-foot)] runway, we had gear and flaps, I felt there was not a problem,” the report said.

“The first officer later stated that there was no time for discussion with the captain because the approach was so fast.” At 0901:00, the first officer said, “I don’t have any flaps.” The report said that “in his postaccident statement, the captain reported that ‘the aircraft did not feel as though we had 50 [degrees] flaps (didn’t balloon and aircraft didn’t slow).’ The CVR does not indicate that the landing checklist was ever started.”

Following the accident, “neither pilot recalled seeing ‘any’ landing gear indicator lights; both pilots recalled the gear handle being moved to the down position,” the report said. “The first officer stated that he did not hear the landing gear–warning horn. The captain stated that he heard the horn sound momentarily and thought that it sounded because he put the flaps to 25 degrees before the gear was down and locked.”

On the DC-9, the landing gear–warning horn sounds when the throttles are retarded to idle if the landing gear is not down and locked. The warning horn can be silenced by depressing a cut-off button on the instrument panel.

“The warning horn will also sound, regardless of throttle position, if the landing gear is not down and locked, and the flap handle is moved beyond the approach (15-degree) setting. In this condition, the horn cannot be silenced and will continue to sound until the gear is down and locked, or [until] the flap handle is retracted to a setting of 15 degrees or less,” the report said.

At 0901:07, “the landing gear–warning horn stopped sounding,” the report said. The first officer then said, “I can’t slow it down here now.”

The captain replied, “You’re all right.”

Seconds later, the first officer said, “We’re just smokin’ in here.”

GPWS Alerted Three Times

At 0901:13, “the ground-proximity warning system (GPWS) alerted ‘whoop whoop pull up’ three times, and silenced at 0901:18,” the report said. “During the second GPWS alert ... the landing gear–warning horn resumed sounding and continued to do so until after touchdown. According to the

first officer, the captain reached up to the overhead panel as the GPWS was alerting. The captain did not recall doing this and stated that he had interpreted the GPWS alerts as a high–sink rate warning.”

The GPWS on the accident aircraft was configured to alert the pilots under any of the following combinations, the report said:

- “Below [152 meters] above ground level (AGL) with the landing gear handle not in the down position;
- “Between [152 meters] and [61 meters] AGL with the gear handle down, but the flap handle selected to the landing position, and a rate of descent exceeding certain values; [and],
- “Below [61 meters] AGL with the gear handle down, but the flap handle not selected to the landing position.”

The report noted: “If a pilot chooses to land with less-than-normal landing flaps, the flap configuration warning can be disabled by activating a flap-override switch installed on the overhead panel. This switch affects only the GPWS warnings associated with flap position; the other warning modes remain active. All warnings are inhibited below [15 meters (50 feet)] AGL.”

At 0901:18, the first officer asked, “Want to land it?”

The captain replied, “Yeah.”

According to the first officer, the captain then took control of the airplane. The report said: “The transfer of control from the first officer to the captain occurred as the airplane was traveling at [377 kph (204 knots)] indicated airspeed, approximately [49 meters (161 feet)] AFE, and 12 seconds from touchdown. At 0901:24, the first officer asked the captain, ‘You want it?’ and the captain said, ‘Yeah.’”

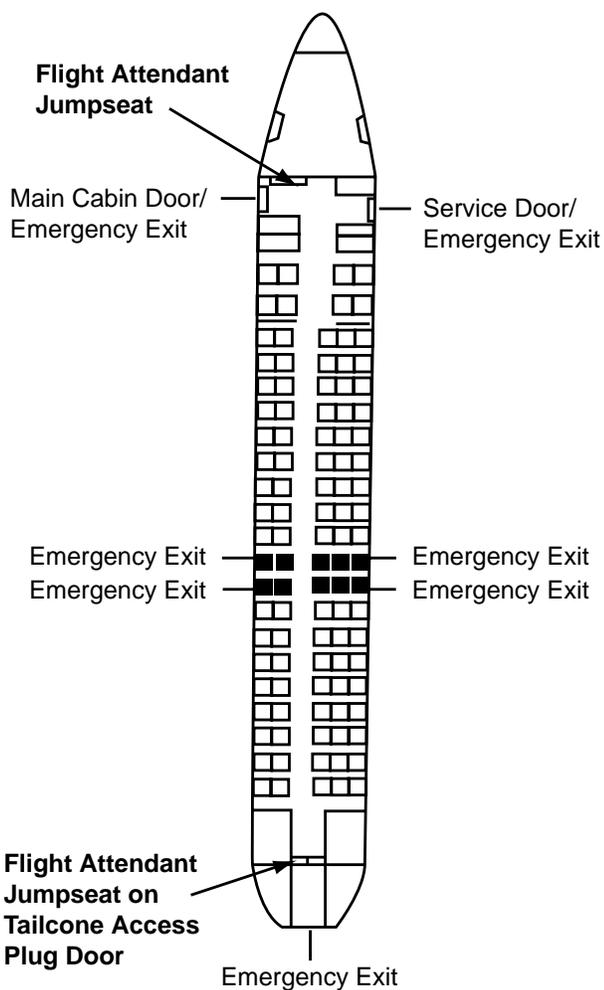
The report said that “according to the captain, the first officer was ‘uncomfortable with the situation and relinquished the controls.’ The captain stated that at the time he took over, the airspeed was high but he felt comfortable.”

Eight seconds later, “the airplane touched down hard with the wheels up at [357 kph (193 knots)] indicated airspeed,” the report said. “As the airplane slid down the runway, two controllers on duty in the tower and two airport groundskeepers observed smoke and fire coming from beneath the airplane.”

The airplane touched down approximately 1,006 meters (3,300 feet) from the approach end of Runway 27. Physical evidence

“The captain stated that at the time he took over, the airspeed was high but he felt comfortable.”

Accident DC-9 Cabin Configuration



Source: U.S. National Transportation Safety Board

Figure 2

indicated that the airplane remained close to the runway centerline for approximately 1,525 meters (5,000 feet), then departed the left side of the runway approximately 2,053 meters (6,730 feet) after it began.

“The airplane stopped on a magnetic heading of 255 degrees, about [2,089 meters (6,850 feet)] from the initial touchdown point,” the report said. “It came to rest on its lower fuselage in the grass adjacent to the takeoff end of the runway about [43 meters (140 feet)] left of the runway centerline.”

The first officer said that when the airplane had stopped, he made a PA announcement, “Remain seated, remain seated, remain seated.” The report said: “According to the captain, he called for the evacuation checklist, pulled both engine-fire handles and moved both fuel-control levers to ‘OFF.’ The first officer read the evacuation checklist, and the captain accomplished the items.”

After the airplane had stopped, the “A” flight attendant (in the front of the cabin) entered the cockpit and told the flight crew there was smoke in the cabin. The captain ordered an evacuation of the aircraft. The “A” flight attendant “opened the left forward cabin exit, inflated the slide and directed the passengers at the front of the cabin out this exit,” the report said.

The “B” flight attendant (in the middle of the cabin) “directed passengers out the overwing exits,” the report said. “[The ‘B’ flight attendant] stated that with the exception of one elderly man who required assistance, all the passengers were evacuated in less than one minute.”

During the evacuation, “access to the tailcone exit was blocked,” the report said. “One passenger stated that the tailcone access–plug door [Figure 2] could not be fully opened because a seat belt restricted its movement. The ‘C’ flight attendant [located in the rear of the aircraft] stated that she could not completely remove the plug door because of the jumpseat shoulder harness. She redirected the passengers at the rear of the plane to the overwing exits.”

After the passengers were evacuated, the flight attendants exited, followed by the flight crew. The report noted: “Six passengers reported that they sustained minor injuries, and six passengers reported that they sustained smoke inhalation. One passenger was transported to a local hospital with complaints of back pain and released the same day.”

Although several passengers reported seeing smoke come from beneath the cabin floor after the airplane had stopped, “no evidence of a sustained fire was found,” the report said. Investigators examined the airplane, and found scorched paint and burned electrical wiring in the center section dry bay, located below the cabin midsection.

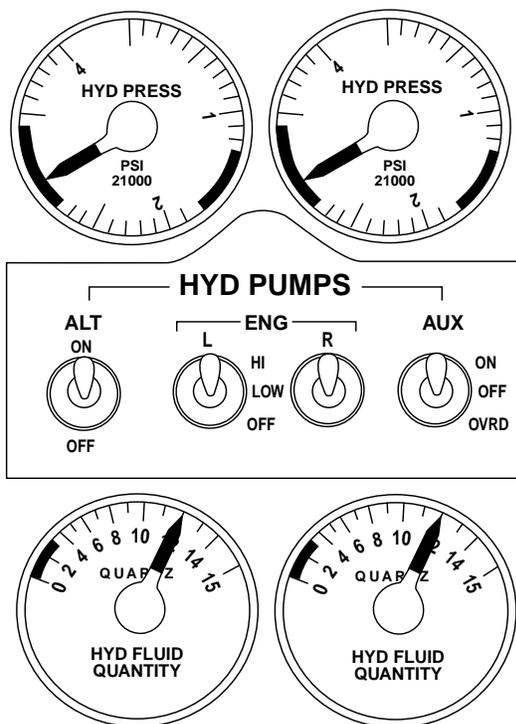
When investigators examined the cockpit, they found the landing-gear handle in the down position and the flap handle set to 50 degrees. “The left and right engine-driven hydraulic pump switches were in the ‘LOW’ position, and the ALT and AUX hydraulic pump switches were in the ‘OFF’ position.

“The left hydraulic system gauge indicated 1,600 psi [pounds per square inch], and the right gauge indicated 0 psi.” (Figure 3, page 7, shows a DC-9 hydraulics panel in high-pressure configuration. Photo, page 7, right, shows the equivalent panel on the accident aircraft after the accident, in low-pressure configuration.)

Captain Had Extensive Experience On Several Different Aircraft

The captain, 50, held an airline transport pilot (ATP) certificate, with type ratings for the Boeing 727, Boeing 737 and DC-9,

DC-9-32 Hydraulics Panel in High-pressure Configuration



Source: U.S. National Transportation Safety Board

Figure 3

and ratings for airplane single- and multi-engine land. He had approximately 17,500 hours of flight time. In the 24 hours before the accident, the captain flew six hours. In the 30, 60 and 90 days before the accident, he flew 29, 60 and 87 hours, respectively. The captain held a current FAA first-class medical certificate with the restriction that he wear near-vision glasses while flying.

The captain was a U.S. Air Force flight instructor during the Vietnam War, the report said. After leaving the Air Force, he was employed by the FAA as an aviation safety inspector and by Braniff Airways as a flight engineer on the Douglas DC-8 and B-727. The captain was hired by COA in 1984 as a second officer in the B-727. In 1985, he upgraded to first officer, and accumulated 5,000 hours of flight time in that position. In 1993, he transitioned to the B-737, and accumulated 1,100 hours of flight time as a first officer on that aircraft. In 1995, he upgraded to captain.

In June 1995, the captain transitioned to the DC-9. Following his initial operating experience (IOE), the captain successfully completed a line check, where he was rated above average in technical proficiency (flying skills and procedural and aircraft knowledge), and in leadership and teamwork.



Accident airplane's hydraulics panel in low-pressure configuration. (Photo: U.S. National Transportation Safety Board)

When reviewing his DC-9 training for investigators, “the captain could not recall whether he had practiced no-flap landings in the simulator or received specific simulator training on hydraulic system problems,” the report said. “He did not remember having any previous events in the DC-9 concerning hydraulic system configuration.”

The captain said that “a ‘norm’ existed for the first officer to make hydraulic system configuration changes; he was aware that this was not standard operating practice, which [practice] assigned the task to the pilot not flying at all times,” the report said. “He said he conducted his cockpit according to standard operating practice, because he was new to the airplane, and he did not expect first officers to configure the hydraulic pumps.”

The captain accumulated approximately 220 flight hours as a reserve captain on the DC-9. “At the time of the accident, he was the most junior captain on the DC-9 at the Houston base,” the report said. “The captain indicated to [NTSB] investigators after the accident that he had been concerned with the regularity and amount of his flying time in the DC-9, and frequently volunteered to pick up trips to build more time. He also said that he did not feel comfortable in the aircraft, because he was not flying as often as he would have liked.”

**Cockpit Voice Recorder Transcript,
Continental Airlines Flight 1943,
Feb. 19, 1996**

Time	Source	Content
0855:27	CAM-2:	We'll go manual spoilers.
0855:29	CAM-1:	Oh, very well.
0855:31	CAM-2:	Forty flaps.
0855:32	CAM-1:	Forty flaps?
0855:34	CAM-2:	Roger dodger.
0855:35	CAM-2:	#, you scared me half to death.
0855:39	CAM-1:	I'm just tryin' to.
0855:56	CAM-1:	**** mode selector ... yeah and ** two lights ****. *** and that's not going to change much. I'll just leave it there.
0856:02	NAV-1:	[Sound of Morse code identifier "IGHI" starts and to the end of the recording.]
0856:06	APR:	Continental nineteen forty-three, thirteen miles from the marker, maintain two thousand till established on the localizer, cleared ILS uh, two seven approach.
0856:10	CAM:	[Sound of short tone]
0856:13	RDO-1:	Two thousand till established, cleared for uh, two seven approach, Continental nineteen forty-three.
0856:19	CAM-2:	I'm going to intercept the glide path up here ... TANKS is at six.
0856:38	CAM-1:	** crummy weather. What's this? # how can I play tennis if it's raining.
0857:02	APR:	Continental nineteen forty-three, on your speed uh, one nine zero or faster to the marker and contact uh, the tower, one two five three five.
0857:11	RDO-1:	Two five three five, Continental nineteen forty-three.
0857:14	CAM-1:	OK.
0857:15	CAM-2:	They're out of the way, huh?
0857:22	CAM-1:	You've been up all night too.
0857:31	PA-1:	We're about ah, ten miles outside the airport, flight attendants be seated for arrival.
0857:37	CAM:	[Sound of stabilizer-trim-in-motion horn]
0857:47	CAM:	[Sound similar to landing gear-warning horn]

First Officers Describe Captain as Capable, Competent and Personable

Investigators interviewed pilots who had flown with the captain prior to the accident. "The chief pilot at Houston, who had flown with the captain when [the captain] was a first officer on the B-727, said that the captain was conscientious, had an excellent record and that pilots liked flying with him," the report said.

When pilots who had flown with the captain in the year before the accident were interviewed, "many of them did not remember flying with him," the report said. "First officers who did remember flying with the captain described him as capable, competent and personable. One characterized the atmosphere in the cockpit while flying with the captain as light and jovial and said [that] he 'wasn't completely all business.' One indicated that the tone in the cockpit while flying with the captain was closer to the 'norm' developed on the line rather than standard operating practice as taught during training."

The report noted: "Two first officers who flew with the captain in the fall of 1995 said that because the captain was new to the DC-9, he was a little slow at times, but that his procedures and airplane handling skills were good. One first officer said that he did not enjoy flying with the captain, but could only describe the reasons as a difference in style and 'vague discomfoting things.'"

A first officer who had flown with the captain in the same month as the accident flight "described the first leg of a trip in which the captain had difficulty making crossing restrictions [which limit the aircraft's altitude and/or airspeed at a navigation fix] while flying a standard terminal arrival route into a busy airport in the northeast corridor," the report said.

"The first officer characterized the captain's behavior during the approach as 'slow to develop with what was happening.' He felt that the captain had mixed up step-down fixes on the arrival. He attributed this to the captain's lack of recent flying experience and lack of experience in northeast corridor operations. According to the first officer, the captain's remaining legs were routine."

The accident flight's first officer, 37, held an ATP certificate, with type ratings for the Learjet and Sabreliner, and an airplane multi-engine land rating. He had 2,200 hours of flight time. In the 24 hours before the accident, the first officer flew six hours. In the 30, 60 and 90 days before the accident, he flew 11, 51 and 111 hours, respectively. The first officer held a current FAA second-class medical certificate with no restrictions.

"Before becoming employed by COA, the first officer was a pilot in the U.S. Air Force, where he flew [the McDonnell

0857:49 CAM-?: **.

0857:55 RDO-1: Continental nineteen forty-three with you for two seven.

0857:58 TWR: Continental nineteen forty-three, Houston tower runway two seven. Cleared to land, wind two four zero at seven.

0858:02 RDO-1: Cleared to land two seven, Continental nineteen forty-three.

0858:04 CAM-2: Cleared to land.

0858:06 CAM-1: Cleared to lando.

0858:08 CAM-1: Now, where was I. Aah, b-b-b-b-b-aaaaah, air conditioning auto shutoff is armed, briefing has been made. Approach check is complete.

0858:40 CAM: [Sound of tone similar to altitude alert.]

0858:43 CAM-1: Cleared to lando.

0858:44 CAM-2: Cleared to land.

0858:48 CAM-1: Aw shoot. I can't play tennis when it's like this ... well maybe this afternoon it'll clear up. Actually I've still got a lot of time.

0859:00 CAM-2: Go slats and five.

0859:03 CAM: [Sound of click]

0859:03 CAM-1: [Flaps] are going to five.

0859:14 CAM-1: I was watching the news this morning and said it was going to be nice out. They lied.

0859:30 CAM-1: Look at the ground, it doesn't look like much rain. It's overcast.

0859:31 CAM-2: Dismal.

0859:35 CAM-1: That's not too bad. We don't worry about.

0859:37 CAM-2: Yeah. *** might be rather pleasant *.

0859:50 CAM-2: One ninety to the marker.

0859:51 CAM-1: [Sound of whistling]

0859:52 CAM-2: The middle marker?

0859:53 CAM-1: To TANKS.

0859:55 CAM-2: One ninety to the middle marker or to TANKS?

0859:59 CAM-1: TANKS. *** Whatever you want.

0900:00 CAM-2: Heh.

0900:01 CAM-2: Well **. I wonder if ***.

0900:05 CAM-2: ***** .

Douglas] F-4 [Phantom], Sabreliner and Learjet aircraft," the report said. In 1988, the first officer was hired by COA as a second officer on the B-747, and accumulated approximately 575 hours in that position. In 1989, he took a leave of absence for four years to fly the Cessna A-37 (a light attack jet) in the U.S. Air Force Reserve.

In 1993, the first officer returned to COA and began transition training as a second officer on the McDonnell Douglas DC-10. "He had difficulty completing the simulator training in the DC-10 and had to repeat the curriculum, starting with primary systems (ground) school in November 1993," the report said. "The vice-president of training for COA indicated that repeating training was not unusual for a second officer coming back to line operations after a four-year leave of absence."

The first officer completed his IOE, passed a line check, and accumulated approximately 78 hours of flight time in the DC-10 during the first four months of 1994. To remain based in Houston, the first officer transitioned to the Airbus A300, and accumulated approximately 128 hours as a second officer in that aircraft.

Complaint Against First Officer Registered by A300 Captain

While he was a second officer on the A300, "the first officer was removed from the line for 60 days and sent for a fit-for-duty evaluation following an incident at an IAH security checkpoint, and an A300 captain's complaint about his cockpit behavior," the report said. "While proceeding to the gate for the first leg of a trip with the A300 captain, the first officer failed to respond to a request by security personnel that he pass through a second magnetometer."

The report continued: "After flying with him for six legs, the A300 captain complained to the Houston [COA] chief pilot's office, and later to the FAA principal operations inspector (POI) for COA, that the first officer had questioned his authority, demonstrated nonstandard behavior in the cockpit and ignored security personnel."

As a result of these two incidents, "the first officer was removed from duty, and the Houston chief pilot started an investigation and evaluation," the report said. "No concerns about the first officer's professional competence were identified during the investigation." After successfully undergoing a fit-for-duty examination and a proficiency check, the first officer was returned to duty.

When interviewed by NTSB investigators following the accident, the first officer said that "the A300 captain's complaint resulted from what he said was a 'personality clash' precipitated by the security checkpoint incident," the report said. "He [the first officer] said a contributing factor was his

0900:11 CAM-1: Runway in sight.

0900:13 CAM-2: There's TANKS ... so uh, flaps fifteen.

0900:16 CAM-1: **.

0900:33 CAM-1: I think the flaps *.

0900:35 CAM: [Three intermittent sounds similar to landing gear-warning horn.]

0900:37 CAM-1: Well we know that, you want the gear.

0900:38 CAM-2: Gear down.

0900:39 CAM: [Sound of tone similar to altitude alert]

0900:40 CAM: [Sound of thump]

0900:41 CAM-2: Landing check, twenty five in (the green).

0900:46 CAM: [Sound similar to landing gear-warning horn starts and continues.]

0900:50 CAM-2: (Flaps forty).

0900:53 CAM: [Momentary interruption of sound similar to landing gear-warning horn]

0900:56 CAM-2: (Here comes) fifty.

0900:58 CAM-1: Fifty flaps.

0901:00 CAM-2: * I don't have any flaps.

0901:01 CAM-1: ****.

0901:02 CAM-2: Want to take it around?

0901:03 CAM-1: No, that's all right. * keep your speed up here about uh, ...

0901:07 CAM: [Sound similar to landing gear-warning horn stops.]

0901:08 CAM-2: I can't slow it down here now.

0901:10 CAM-1: You're all right.

0901:10 CAM-2: ... We're just smokin' in here.

0901:13 CAM-4: Whoop whoop pull up, whoop whoop pull up, whoop whoop pull up.

0901:15 CAM: [Sound similar to landing gear-warning horn starts and continues to after impact.]

0901:18 CAM-2: Want to land it?

0901:19 CAM-1: Yeah.

0901:20 CAM-2: Your airplane. Captain's airplane.

status as a nonunion reserve pilot who had obtained a line to fly [monthly trip schedule] for the entire month.”

The report continued: “At the time, COA’s pilot union was at an impasse in its contract negotiations with the company, and it recommended that pilots not fill open time so that the company would have to call in extra pilots. The first officer did not support the union and did not heed their recommendations. The A300 captain was a union member.”

The first officer told investigators that this incident “was ‘terribly damaging’ to him personally and professionally,” the report said. “After the incident, [the first officer] adopted what he described as a mode of ‘captain management’ to preclude a recurrence of another similar event. In this mode, he would constantly interpret what the captains he flew with really meant or really wanted. He indicated that it was necessary for him to play along and ‘not stir the hornet’s nest.’ Even though he had been cleared of the accusations, and the record of the incident had been removed from his personnel file, the first officer felt like he was being watched.”

First Officer Upgraded To First Officer on DC-9

Following his return to duty, the first officer transferred to COA’s Greensboro, North Carolina, U.S., base and upgraded to first officer on the DC-9. “As part of his upgrade training, he completed a one-day CRM [crew resource management] course,” the report said. “He said that it was his understanding that according to company CRM policy, the captain has final authority, and there was not a company policy instructing first officers to take control if necessary.”

The report noted: “The first officer failed to complete DC-9 simulator training on his first attempt because of a slow instrument scan. He repeated all the simulator sessions and completed the training in February 1995. The simulator instructor said the first officer was average and stated that his problem was not unusual for pilots upgrading after extended time in the second officer position.”

The first officer completed his IOE and passed a line check. “The captain who gave the first officer IOE said that he had good skills, improved over time, was receptive to input and eager to learn,” the report said.

After accumulating approximately 450 flight hours as a reserve pilot on the DC-9, the first officer participated in a recurrent LOFT [line-oriented flight training] simulator session and completed a proficiency check. “The instructor for the LOFT and proficiency check said [that] the first officer provided substantial input to the captain during the LOFT session and did an ‘excellent’ job in the proficiency check. He characterized the first officer as ‘above average’ and ‘more than qualified’ at the time he saw him,” the report said.

0901:24 CAM-2: You want it?
0901:25 CAM-1: Yeah.
0901:32 CAM: [Sound of impact and loud rattling and rumbling starts and continues.]
0901:56 RDO-1: Tower, nineteen forty-three on runway two seven needs some help.
0902:01 CAM: [Sound of one-second tone]
0902:03 CAM: [Sound of loud rattling and rumbling stops.]
0902:05 CAM: [Sound of a one-second tone]
0902:06 END OF RECORDING

CAM = Cockpit area microphone voice or sound source
RDO = Radio transmission from accident aircraft
APR = Radio transmission from Houston approach control
TWR = Radio transmission from IAH control tower
PA = Transmission made over aircraft public address system
-1 = Voice identified as captain
-2 = Voice identified as first officer
-3 = Voice identified as female flight attendant
-4 = Aircraft mechanical voice
-? = Voice unidentified
* = Unintelligible word
= Expletive
() = Questionable insertion
[] = Editorial insertion
... = Pause

Source: U.S. National Transportation Safety Board

When asked about his systems training, the first officer said that he “did not remember any instances in line operations or training on the DC-9 where the hydraulic system was not configured for landing during the in-range checklist,” the report said. “He remembered covering material about the hydraulic system configurations on the DC-9 during ground school. He said that some captains had asked him to make hydraulic system configuration changes even when he was the flying pilot and it was not his responsibility.”

Investigators interviewed several pilots who flew with the first officer in the year before the accident. “Several captains described him as quiet, with good pilot skills and an adherence to procedures that reflected his military training,” the report said. “Two captains described the first officer as technically proficient but ‘meticulous,’ and stated that his slow and deliberate approach to cockpit procedures was frustrating.”

The report noted: “In the summer of 1995, a captain complained to the Greensboro chief pilot about the first

officer’s performance and lack of CRM skills in the cockpit. The captain had flown about 40 legs with the first officer over a one-month period. The Greensboro DC-9 lead line-check airman was tasked with evaluating the complaint and assigned a check airman to fly with the first officer.”

The report continued: “The first officer was not aware of the complaint or that he was being evaluated. The check airman reported that the first officer was still learning techniques, but overall was very professional, [and that he] communicated and was part of the crew. Based on this report, no further action was taken by the chief pilot’s office.”

The NTSB said that VMC had prevailed, and the weather was not a factor in the accident. The NTSB “considered the role that the ATC request to maintain [352 kph] to the outer marker [played] in the accident,” the report said. “The captain had substantial experience flying into IAH during his 12-year career at COA. He told investigators that the ATC request was not unusual during VMC conditions at IAH. The first officer demonstrated some confusion about the request, but his actions to configure the airplane for landing were timely and appropriate upon passage of the outer marker.”

“The [NTSB] concludes that the ATC request to maintain [352 kph] to the outer marker did not contribute to the accident because it did not affect crew actions, decision making or situational awareness,” the report said.

Because the airplane’s hydraulic system was not configured for landing, there was insufficient pressure to lower the landing gear and the flaps. “The flight crew failed to detect this configuration error and continued its approach into Houston,” the report said. “Comments on the CVR and postaccident statements by the flight crew indicate that both pilots recognized that the flaps did not deploy after the flaps were selected to 15 degrees, but the flight crew did not determine the cause of this problem or execute a go-around.”

No Landing Checklist Performed

The investigation revealed that “the landing checklist was not performed, and the flight crew did not confirm that the gear was down and locked,” the report said. “The gear-warning horn sounded during the approach, indicating that the landing gear was not extended, but it was ignored. When the airplane descended through [152 meters] AFE, it was traveling [155 kph] faster than the target airspeed of [244 kph]. ...

“Although, under COA standard operating procedures, this excessive airspeed mandated that the approach be discontinued, the captain rejected a go-around request from the first officer, who was the flying pilot. The GPWS sounded an alert 19 seconds before impact and was ignored. Unaware that the gear was not down, the captain assumed control of the airplane and made a wheels-up landing.”

The report noted that “performance deficiencies exhibited by the flight crew during this flight include: (1) failure to configure the hydraulic system for landing during the performance of the in-range checklist; (2) failure to detect initially that the flaps did not extend; (3) failure to determine the reason the flaps did not extend after detection; (4) failure to perform the landing checklist and to confirm the landing gear status; and (5) failure to discontinue the approach.”

Investigators reviewed three possible reasons for the captain’s omission of the hydraulics while conducting the in-range checklist:

- “The captain was interrupted or distracted;
- “The checklist item, ‘Hydraulics,’ was obscured by a fold in the checklist; [and,]
- “The captain expected the first officer to complete the hydraulics item because of the existence of an informal ‘norm.’”

The report concluded: “The [NTSB] found no evidence indicating that the captain was interrupted or distracted during the performance of the in-range checklist, that the omitted checklist item was obscured or that the captain believed the first officer would configure the hydraulic system. The [NTSB] was unable to determine the specific reason for the captain’s omission of the ‘Hydraulics’ item on the in-range checklist.”

The report noted that “the COA DC-9 flight manual states that both pilots are responsible for visual confirmation that all checklist items are completed. The first officer’s response to two items on the checklist, ‘Flight Instruments, Altimeters’ and ‘Shoulder Harness,’ indicates that he was aware that the in-range checklist was being completed. However, the first officer did not detect the captain’s omission of the ‘Hydraulics’ item. ...

“Hydraulics” Items Placed Too Low on In-range Checklist

“If the hydraulic system is not configured properly during performance of the in-range checklist, the error can initially be determined only by direct observation of the hydraulic pump switches and pressure gauges. Because the flaps and landing gear are not typically extended until the later stages of an approach, the next opportunity for the flight crew to detect such an error occurs during a period of higher workload when there is less time for problem diagnosis.

“The [NTSB] concludes that the ‘Hydraulics’ item is placed too low on the in-range checklist, rendering it vulnerable to

omission,” the report said. “Therefore, the [NTSB] believes that the FAA should require all DC-9 and MD-80 operators with the ‘HI, LOW, OFF’ hydraulic switch configuration to revise their checklists to emphasize the importance of the ‘Hydraulics’ item by placing it as the first item on the in-range checklist (or equivalent), and requiring that both pilots verbally verify hydraulic pump switch settings and system pressures.

“The NTSB concludes that both the captain and first officer recognized that the flaps had not extended after the flaps were selected to 15 degrees,” the report said. “As the pilot not flying, the captain had primary responsibility for initiating diagnosis of the reason for the flap extension problem. The first officer communicated the anomaly to the captain using nonverbal and verbal messages.”

The captain’s statements to investigators “indicate that he received the first officer’s message,” the report said. “However, the captain’s diagnosis was limited to confirmation that the flap handle was positioned properly and making throttle movements. These ineffective actions suggest that the captain was confused and not able to comprehend the information that was available to him. This type of behavior is consistent with the effects of fatigue.”

“Although he placed the gear handle in the down position, the captain never initiated the [landing] checklist.”

Investigators reviewed the flight crew’s failure to perform the landing checklist and confirm the position of the landing gear. “In accordance with company procedures, the first officer called for the landing checklist after the gear-down call,” the report said. “Although he placed the gear handle in the down position, the captain never initiated the checklist.”

The airplane did not slow during the approach because the flaps never extended. “Traveling at a speed of approximately [370 kph (200 knots)], the airplane covered the distance between the outer marker and the runway threshold in about 75 seconds,” the report said. “If the target approach speed of [244 kph] had been maintained, it would have taken about 115 seconds to cover this distance. The increase in speed allowed the flight crew very little time to address the flap problem and configure the airplane for landing.”

Within 27 seconds, the captain commented about the flaps, the first officer said, “I don’t have flaps,” the captain manipulated the throttles and responded to the first officer’s gear-down command, the flaps-25 command, the flaps-40 command and the flaps-50 command. “The captain had very little time to react to the directives he was being given by the first officer. The first officer’s rapid calls for 40 degrees and then 50 degrees of flaps probably interrupted the captain as he was initiating the landing checklist.”

Both pilots told investigators that they recalled the gear handle being moved to the down position. But the following cues

were available to indicate that the gear was not down and locked, the report said:

- “There was no increase in cockpit noise after the gear handle was placed in the down position, as there would have been if the nose-gear doors had opened and the gear extended into the slipstream;
- “The red ‘gear-unsafe’ lights and the amber ‘gear door–open’ light, which would have illuminated when the gear were in transition, remained off;
- “The green gear lights, which would have illuminated when the gear were down and locked, remained off; [and,]
- “The gear-warning horn sounded almost continuously after the flap handle was moved to 25 degrees.”

The report noted that neither pilot responded to the gear-warning horn. “The reason for this may be that the gear-warning horn frequently sounds during routine operations, and it can be perceived by pilots as a nuisance alarm. For example, the horn sounds during approaches whenever the throttles are reduced to idle and the landing gear is not down, a condition that is not always consistent with a dangerous configuration. ... In this case, however, the horn sounded after the gear handle was placed down and the flap handle was moved to 25 degrees. These conditions were outside the traditional ‘nuisance’ envelope. ...

“The [NTSB] concludes that the pilots failed to perform the landing checklist and to detect the numerous cues alerting them to the status of the landing gear as a result of their focus on coping with the flap-extension problem and the high level of workload because of the rapid sequence of events in the final minute of the flight. The [NTSB] also concludes that had the landing checklist been properly performed, the flight crew would have detected the failure of the landing gear to extend.”

Investigators reviewed the flight crew’s failure to discontinue the approach when it became unstabilized below 152 meters, as directed by COA standard operating procedures. “The first officer told [NTSB] investigators that his goal after recognizing that the flaps were not extended was to get the captain to initiate a go-around,” the report said. “When the captain denied the first officer’s request to go around and told him to keep his speed up, the first officer did not challenge the captain’s statement.”

The report noted: “The first officer’s failure to question the captain’s decision to continue the approach was inconsistent with the CRM training he had received that emphasized the

importance of sharing doubts with other crew members and quickly resolving conflicts.”

During the investigation, the first officer said that “he believed his career would be in jeopardy if another captain complained to management about him,” the report said. “Although the first officer failed to overtly challenge the captain’s decision to continue the approach, he did continue providing information to the captain about the quality and stability of the approach. ... The [NTSB] concludes that although the first officer was unwilling to overtly challenge the captain’s decision to continue the approach, he did attempt to communicate his concern about the excessive speed of the approach to the captain.”

The NTSB recommended that the FAA “require all POIs of [U.S. Federal Aviation Regulations (FARs)] Part 121 carriers to ensure that the carriers establish a policy and make it clear to their pilots that there will be no negative repercussions for appropriate questioning in accordance with CRM techniques of another pilot’s decision or action,” the report said. “In addition, the [NTSB] believes that the FAA should require all POIs of [FARs] Part 121 carriers to ensure that CRM programs

provide pilots with training in recognizing the need for, and practice in presenting, clear and unambiguous communications of flight-related concerns.”

The NTSB said that “the captain’s rejection, without any discussion, of the first officer’s go-around request was inconsistent with the CRM training concerning decision making that he had received The captain stated after the accident that he was aware that the first officer was uncomfortable with the approach, but that the captain felt comfortable continuing with the landing.”

“ ... Had the landing checklist been properly performed, the flight crew would have detected the failure of the landing gear to extend.”

The GPWS alerted 19 seconds before the accident aircraft touched down, but the warning was not heeded by the captain, the report said. “The COA DC-9 flight manual current at the time of the accident stated that any GPWS warning that occurred or continued below [61 meters] AFE mandated a go-around regardless of flight conditions.”

The report noted that “there was no safety-of-flight reason for the captain to land the airplane, and there was sufficient fuel on board to abort the landing and make another approach Consequently, the [NTSB] concludes that there was no compelling reason for the captain’s decision to land the airplane; multiple signals and guidance indicated that the approach should be discontinued, as did COA’s standard operating procedures.”

The report said: “The captain’s improper decision to land was consistent with his behavior as recorded by the CVR during the final 30 minutes of the flight. His behavior was that of a passive, distracted pilot and not that of an active member of

the flight crew ensuring the safety of the flight. He repeatedly deviated from standard operating procedures, failed to adhere to the sterile cockpit rule, ignored warnings and did not utilize effective CRM techniques.”

The report said that the captain’s behavior during the accident flight was “inconsistent with the descriptions of the captain as capable, competent and personable, made by the first officers he had flown with in the year before the accident.”

When interviewed by investigators, the captain was unable to explain his behavior during the accident flight. The captain said that nothing affected his performance on the day of the accident. Investigators, however, “considered the possibility that fatigue may have affected the captain’s behavior,” the report said.

The captain said that before the accident flight he had an “unrestful night” and “was awakened by traffic and outside noises during the night, but did not remember how many times,” the report said.

On the night before the accident, when the first officer arrived at the hotel at 2230, he discovered that his crew bag was still at the airport. He telephoned the station manager to locate his bag.

The first officer “said that he was ‘miffed’ about [his] missing bag,” the report said. “He went to sleep about 2330 ... and did not sleep very well. He said he doesn’t sleep well the first night in a strange bed, and he was concerned about the loss of his bag. ... The first officer described himself as an evening person and that he usually wakes up around 0900. ... The first officer said that he was tired and felt that fatigue affected his ability to make decisions at the end of the flight.”

The night before the accident flight, the flight crew had a rest period of nine hours and 23 minutes, “which was 38 minutes longer than COA’s minimum block-to-block rest period of 8 hours [and] 45 minutes,” the report said. “However, because of travel to and from the hotel, the amount of sleep time obtained by the flight crew that night was less. The captain had the opportunity for 6.0 to 6.5 hours of sleep, and because of his efforts to locate his crew bag, the first officer had the opportunity for only 5.5 hours of sleep.”

The report also said that “the captain indicated that when he is off duty, he normally gets about nine hours of sleep each night and feels tired the next morning if he gets fewer.”

About two hours after the accident flight had departed DCA, the CVR recorded the captain saying to the first officer, “You’ve been up all night too.” The report said, “This statement

suggests the captain knew that neither pilot had obtained a restful night’s sleep. ...

“The captain made conflicting statements about fatigue. He initially stated that he felt tired on the day of the accident, but later he stated that he was not tired at the time of the accident, and he did not believe that fatigue was a factor in the accident.

“The captain’s deficient decision making at the end of the flight and his inability to effectively process the rapidly changing information concerning abnormal system operation are consistent with the effects of fatigue. There is evidence that obtaining two hours less sleep than normally is required by an individual can degrade alertness and performance.”

Investigators “found no evidence that the pilots had accumulated a sleep debt over the days preceding the accident; therefore, the fatigue they may have experienced was not long term,” the report said. The NTSB concluded that “the flight crew’s degraded performance is consistent with the effects of fatigue, but there is insufficient information to determine the extent to which it contributed to the accident.”

“[The captain’s] behavior was that of a passive, distracted pilot and not that of an active member of the flight crew ensuring the safety of the flight.”

Investigators reviewed the adequacy of COA oversight of company operations and the adequacy of FAA oversight of COA. “The COA Flight 1943 accident was the third flight crew-involved accident at COA in 28 months,” the report said. “The frequency of these accidents suggests that the company response and FAA oversight after the previous accidents may have been inadequate.”

The NTSB concluded that “there were deficiencies in COA’s oversight of its pilots and the [FAA] POI’s oversight of COA,”

the report said. “In addition, the [NTSB] concludes that COA was aware of inconsistencies in flight crew adherence to standard operating procedures within the airline; however, corrective actions taken before the accident had not resolved this problem.”

The NTSB recommended that the FAA “require COA to audit its internal oversight process and correct deficiencies in the oversight process that allow deviations from standard operating procedures and violations of Federal regulations to go uncorrected, and to develop a specific plan to reinforce the importance of adherence to standard operating procedures among pilots,” the report said. “In addition, the [NTSB] believes that the FAA should audit its surveillance of COA en route operations to determine if the surveillance is adequate to identify procedural deficiencies in COA’s operations.”

Following the Flight 1943 accident, “COA independently initiated a comprehensive evaluation of checklist philosophy, usage and format across its fleet,” the report said. “The

evaluation is ongoing, and COA has received guidance from experts on human factors in this effort. According to COA management personnel, the company intends to modify its checklists to comply with guidelines for checklist design and usage derived through NASA [U.S. National Aeronautics and Space Administration]-sponsored research.”

The report said, “The [NTSB] is encouraged by the steps that COA has taken to bring its checklists into compliance with contemporary human factors research on checklist design and usage.”

The NTSB recommended that the FAA “require that POIs review the checklists of air carriers operating under [FARs] Parts 121 and 135 to ensure that they comply with the guidance presented in the FAA report entitled *Human Performance Considerations in the Use and Design of Aircraft Checklists* [January 1995; unnumbered], and require that any checklists that do not comply with the guidance be revised accordingly,” the report said.

Investigators reviewed the difficulties experienced by the “C” flight attendant when she attempted to remove the tailcone access–plug door during the evacuation. The investigation revealed that the flight attendant was unable to remove the door “because one of the aft jumpseat shoulder harness straps was buckled to the lap belt, which tied the plug door to the aft cabin bulkhead,” the report said. “Fortunately, the lack of availability of the tailcone exit did not preclude a timely and successful evacuation.”

Investigators examined the DC-9 plug door training device at COA’s Houston flight attendant training facility, and found that seat belts and shoulder harnesses were not installed in the trainer. “Therefore, it was not possible for flight attendants to practice attempting to remove the plug door with the shoulder harness straps buckled to the seat belt and gain hands-on experience with the problem this creates,” the report said.

The investigation also revealed that the COA in-flight manual current at the time of the accident “did not mention the need to ensure that the jumpseat shoulder harness straps are unbuckled from the lap belts before attempting to remove the plug door,” the report said. “The [NTSB] concludes that COA flight attendants received inadequate information and training on the operation of the DC-9 tailcone access–plug door.”

The report noted that, as a result of the investigation, “COA has equipped its DC-9 plug door trainer in Houston (as well as those at its flight attendant training facilities in Newark, New Jersey [U.S.] and Cleveland, Ohio [U.S.]) with shoulder harnesses and seat belts. In addition, COA revised the in-flight

manual to include information on the consequences of attempting to remove the plug door without first ensuring that the shoulder harness straps are released.”

The NTSB recommended that the FAA amend its *Flight Standards Handbook Bulletin* “to include a requirement that if any portion of a restraint system is attached to the tailcone access–plug door in the aircraft that might interfere with the opening of the door, the plug door training device must be equipped with the entire restraint system,” the report said. ♦

Editorial note: This report was adapted from *Wheels-Up Landing, Continental Airlines Flight 1943, Douglas DC-9, N10556, Houston, Texas, February 19, 1996*. Report no. NTSB/AAR-97/01, prepared by the U.S. National Transportation Safety Board. The 93-page report contains illustrations and appendices.

Further Reading From FSF Publications

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