



Low Visibility and Citation Crew's Deviation From Taxi Instructions Lead to Collision With MD-87

Runway visual range was about 200 meters/700 feet when the crew of a Cessna Citation CJ2 taxied on the wrong taxiway and into the path of a Boeing MD-87 that was taking off on the active runway at Milan, Italy.

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FSF Editorial Staff

At 0810 local time on Oct. 8, 2001, a Scandinavian Airlines System (SAS) Boeing MD-87 was being rotated for takeoff on Runway 36R at Milan (Italy) Linate Airport in instrument meteorological conditions when it collided with an Air Evex Cessna 525A (Citation CJ2) that had been taxied onto the active runway. The MD-87 became airborne briefly before descending to the runway, departing the runway and striking a baggage-handling building. Both airplanes were destroyed. The 110 occupants of the MD-87, the four occupants of the CJ2 and four people inside the baggage-handling building were killed. Four people inside the baggage-handling building were injured.

In a final report issued in January 2004, the Italian Agenzia Nazionale per la Sicurezza del Volo (ANSV) said, "It can be assumed that the immediate cause for the accident [was] the runway incursion in the active runway by the Cessna [crew]."

"The obvious consideration is that the human-factor-related action of the Cessna crew — during low-visibility conditions — must be weighed against the scenario that allowed the course of events that led to the fatal collision," the report said. "Equally, it can be stated that the system in place at Milano Linate airport was not geared to trap misunderstandings, let



alone inadequate procedures, blatant human errors and faulty airport layout."

The MD-87 captain, 36, had 5,842 flight hours, including 2,320 flight hours in type. He was hired by SAS in 1990. The first officer, 36, had 4,355 flight hours, including 1,978 flight hours in type. He was hired by SAS in 1997.

The CJ2 captain, 36, had a commercial pilot license and 5,000 flight hours, including 2,400 flight hours in type. The report said that most of his flight experience had been accumulated with "private organizations." The first officer, 64, had an airline transport pilot license and 12,000 flight hours, including 2,000 flight hours in type.

Both pilots had CJ2 type ratings and were employed by Air Evex, an on-demand aircraft operator based in Dusseldorf, Germany.

The report said that the licensing and qualifications of the controllers on duty when the accident occurred did not fully conform to the standards of International Civil Aviation Organization (ICAO) Annex 1 [*Personnel Licensing*]. For example, records for the acting tower shift supervisor and records for an assistant controller contained no indication that they had received recurrent training in the past 20 years.

Records showed that the CJ2 captain had landed at the Milan Linate airport five times between 1998 and 2000, and that the first officer had landed at the airport seven times between 1999 and 2001.



Boeing MD-87

The MD-80 series short/medium-range jet transports are derivatives of the Douglas DC-9, which first flew in 1965. Originally called the Super 80, the MD-80 has longer wings, a longer fuselage and more fuel capacity than the DC-9, and is equipped with a digital flight control system. The MD-80 prototype flew in 1979, and the airplane entered production in 1980 as the MD-81.

In 1987, McDonnell Douglas began production of the MD-87, a short-fuselage version designed to carry up to 139 passengers, compared with the 172-passenger capacity of its predecessors, the MD-81, MD-82 and MD-83.

Each of the MD-87's two Pratt & Whitney JT8D-217C turbofan engines is rated at 88.9 kilonewtons (20,000 pounds static thrust) and has an emergency thrust reserve of 3.8 kilonewtons (850 pounds static thrust).

Maximum takeoff weight is 63,504 kilograms (140,000 pounds). Maximum cruising speed is 0.76 Mach. Maximum landing weight is 58,060 kilograms (128,000 pounds).

McDonnell Douglas merged with The Boeing Co. in 1997. Production of MD-80 series airplanes was terminated in 1999.♦

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

The CJ2 crew had flown the airplane to Milan from Köln, Germany. The crew landed the airplane at 0659 after conducting an instrument approach to Runway 36R. Weather conditions reported by the tower controller when the crew was cleared to land included calm surface winds, general visibility 100 meters (328 feet) and overcast at 100 feet. Runway visual range (RVR) was 175 meters/600 feet touchdown, 200 meters/700 feet midfield and 225 meters/775 feet rollout.

“The operator of the aircraft, Air Evex, was not certified to operate in weather conditions lower than [instrument landing system (ILS) Category I (CAT I) minimums], and his crews were not trained to perform landing and takeoff below ILS CAT I weather minimums,” the report said. (CAT I minimums include RVR 550 meters/1,800 feet and a decision height of 200 feet.)

The report said that information gathered during the investigation conflicted about whether the flight was conducted as a private operation or as a commercial operation. The owner of the CJ2, who also owned Air Evex, said that it was conducted as a private flight “for the transportation of business friends” and that the pilots were “operating [the private] flight outside their normal duty assignment.”

The flight plan filed for the flight from Milan to Köln indicated that it was an unscheduled air transport operation.

“A letter from Cessna Aircraft Co., signed by their sales manager, one of the [passengers aboard the accident airplane], gives confirmation to the company of the owner of the aircraft [of] their need to operate two [demonstration] flights, from Milano Linate to Paris Le Bourget and back to Milano Linate, at an agreed cost to be invoiced to Cessna Aircraft Co.,” the report said.

The report said that the other CJ2 passenger was “a prospective Cessna 525A customer.”

The airport had two runways: Runway 18L-36R, the main runway, was 2,440 meters (8,005 feet) long. Runway 18R-36L, the general aviation runway, was 600 meters (1,969 feet) long. Runway 36R was being used for takeoffs and landings at the time of the accident.

The MD-87 was parked on the North (main) apron, which was east-northeast of the threshold of Runway 18L. The CJ2 was parked on the West (general aviation) apron, which was west of the general aviation runway.

“While the North apron and the taxiway parallel to and east of Runway 18L-36R have been subject to upgrade in order to match ICAO requirements [for] signage and ground-movement management, the West apron, Runway 18R-36L, Taxiway R5 [which connects the West apron and the North apron, and is located north of both runways] and Taxiway R6 [which connects the West apron to the main runway, and is located

south of the general aviation runway] have not been updated,” the report said.

The MD-87 was departing on a scheduled flight to Copenhagen, Denmark. The report said that the airplane was properly equipped and certified, and that the flight crew was qualified to conduct flight operations in the low-visibility conditions that existed on the day of the accident.

At 0754, the MD-87 crew requested taxi clearance and was told by the ground controller to taxi to the ILS CAT III holding position for Runway 36R. A taxiway, called the main taxiway, was parallel and to the east of the main runway, and led from the North apron to the holding position, which is near the approach threshold of Runway 36R.

At 0759, the ground controller told the MD-87 crew to establish radio communication with Milan Tower when they taxied past the airport fire station. The crew established radio communication with the tower controller at 0801.

“Starting from this moment, the crew of the Boeing MD-87 and the crew of the Cessna 525A were tuned to two different assigned VHF [very-high-frequency] radio frequencies,” the report said. “The MD-87 crew could not have known about the Cessna’s movements.”

At 1805, the ground controller told the CJ2 crew to “taxi north” onto Taxiway R5 and to “call me back at the stop bar of the ... main runway extension.”

The stop bar comprised red lights marking a holding point near the extended centerline north of the main runway. The crew read back the clearance as follows: “Roger, via Romeo 5 and ... call you back before reaching main runway.”

The report said that the ground controller likely did not perceive the difference between the taxi clearance and the crew’s readback or might have believed the readback of “Romeo 5” was sufficient.

The controller then issued the same taxi clearance to the crew of another airplane on the West apron and told the crew that they would be following the Cessna. The report said that the clearance to the other aircraft was issued in Italian, a language with which the CJ2 crew was not fluent.

A yellow taxi line led from the parking area on the West apron south and then east. The line then split into two lines; one led north to R5, the other led southeast to R6.

“At the branching where the line parted, there were markings painted in yellow showing ‘R5’ and ‘R6,’ respectively, to the

left of each line,” the report said. “The [markings were] worn out, and they did not conform to the color, form or proportions described in ICAO (Annex 14 [Aerodromes]). ... There were no other indications, markings or signs identifying Taxiway R6 throughout its entire length.”

The report said that the West apron taxi lines were not depicted correctly in the Italian *Aeronautical Information Publication* (AIP Italy) or on Jeppesen charts and that the absence of direction signs, instruction signs, location signs and no-entry signs on Taxiway R6 made “situation awareness for the Cessna crew difficult.”

The CJ2 crew taxied southeast, onto Taxiway R6.

“The environmental situation for the Cessna crew was definitely such that it was possible to get lost in the dense fog and taxi the wrong way,” the report said. “However, ... it is more probable that the Cessna crew in fact believed that they were cleared to taxi via the path they effectively followed, Taxiway R6, even though they had repeated the taxi clearance via Taxiway R5.”

The report said that the crew had used Taxiway R6 after landing to taxi to the West ramp and that they might have expected to use that taxiway for departure.

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At 0808, the CJ2 crew told the ground controller that they were “approaching Sierra 4.” The ground controller asked the CJ2 crew to confirm their position. The crew said, “Approaching the runway ... Sierra 4.”

The report said that the marking “S4” identified one of five runway-holding positions near aircraft-parking stands that had been planned but not constructed for the West apron. S4 was near a taxiway leading to the general aviation runway.

The report said that no documentation was found of the existence or “operational meaning” of the five “Sierra” runway-holding-position markings on Taxiway R6 and that all controllers interviewed during the accident investigation said that they were not aware of the markings.

The controller told the CJ2 crew, “Roger, maintain the stop bar. I’ll call you back.”

At the time, visibility at the airport varied from 50 meters to 100 meters (164 feet to 318 feet), and RVR at the midpoint of the main runway (which had high-intensity lights) was about 200 meters. During the hour preceding the accident, airport controllers used both the English language and the Italian language in communications with the crews of 21 taxiing aircraft and three landing aircraft.

“Considering that each aircraft called more than one time during that time interval just prior to the accident, and given the existing meteorological conditions, the workload on both controllers

was demanding,” the report said. “They had no possibility to confirm (check) the position reported by aircraft by means of technical aids.”



Cessna Citation CJ2

Cessna Aircraft Co. announced in 1968 the development of an eight-seat executive jet called the Fanjet 500. When the prototype flew in 1969, the name was changed to Citation. Produced from 1971 to 1976, the Citation was succeeded by the Citation I, which has a longer wing and more powerful engines. Production of the Citation I was terminated in 1985.

Cessna introduced a successor to the Citation I, called the CitationJet, in 1990. The airplane has a shorter fuselage and wing than the Citation I, and is powered by two Williams FJ44 turbofan engines, each rated at 8.45 kilonewtons (1,900 pounds static thrust).

The CitationJet was succeeded in 2000 by the Citation CJ1 and the Citation CJ2, which have higher maximum takeoff, ramp and landing weights. The CJ2 has a longer wing, horizontal stabilizer and fuselage than the CJ1, and is powered by two FJ44-2C engines, each rated at 10.68 kilonewtons (2,400 pounds static thrust).

Maximum takeoff weight is 5,613 kilograms (12,375 pounds). Maximum cruising speed at 33,000 feet is 410 knots. Maximum certified altitude is 45,000 feet. Maximum landing weight is 5,216 kilograms (11,500 pounds).◆

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

An airport surface movement indicator (ASMI) radar system was installed at the airport to assist controllers in monitoring aircraft movements in low-visibility conditions. Nevertheless, the report said that the ASMI system had “some shortcomings,” including a record of poor reliability, and had been out of service since November 1999.

ANSV investigators did not interview the ground controller, the tower controller or the tower supervisor because “they made themselves unavailable pending the judicial procedure they [were] subject to in relation to the accident,” the report said.

At 0809, the ground controller — who likely interpreted the CJ2 crew’s report that they were “approaching the runway” to mean that they were on Taxiway R5 near the extended centerline north of the main runway — told the CJ2 crew to “continue your taxi on the main [North] apron, follow the Alpha line.” The crew read back the clearance, and the controller said, “This is correct, and please call me back entering the main taxiway.”

The CJ2 crew continued taxiing on Taxiway R6. The report said that the controller’s instruction to call back when on the main taxiway “might have created in the pilot’s mind the [perception] that they had to cross rapidly the [main] runway to reach the ‘Alpha line’ on the main taxiway.”

The report said that the airplane was taxied over runway-holding-position markings on the taxiway and past a lighted runway-holding-position sign and a lighted “CAT III” sign and onto the main runway [about 1,560 meters (5,118 feet) from the departure threshold of Runway 36R].

At the same time that the ground controller told the CJ2 crew to continue taxiing, the tower controller cleared the MD-87 crew for takeoff. The CJ2 was being taxied across the middle of the runway on a heading of about 135 degrees when it was struck by the MD-87, which was being rotated for liftoff about 38 seconds after the takeoff was begun.

“Approximately one second prior to the collision, an additional large elevator nose-up command was registered by the MD-87 DFDR [digital flight data recorder],” the report said. “It is probable that the flight crew of the MD-87 had a glimpse of the Cessna just prior [to] the collision; this is suggested by an unintelligible exclamation recorded on the CVR [cockpit voice recorder].”

The CJ2 split into three main sections. The front section and the mid section were destroyed by fire; the tail section was damaged by fire.

The MD-87’s right main landing gear and right engine separated from the fuselage during the collision. The crew moved the

throttle levers full forward, but left-engine thrust did not increase. The report said that the left engine likely had been damaged by ingested debris. The airplane became airborne for 12 seconds, reaching a height of 35 feet before the left engine seized.

“The IAS [indicated airspeed] increased up to (a calculated) 166 knots, but the MD-87 descended abruptly, making contact with the runway with the left main landing gear, the truncated right main landing gear leg and the tip of the right wing,” the report said. “Maximum available reverse thrust [from the left engine] was selected, directional control of the aircraft was attempted and the brakes [were] applied. Such attempts were only partially successful due to the altered geometry and balance of the aircraft, and the residual effectiveness of flight controls in combination with the right wing tip dragging [on] the grass.”

The MD-87 slid off the runway, veered right and struck the baggage-handling building, which was about 460 meters (1,509 feet) from the runway. The report said that the aircraft’s residual speed on impact was 139 knots.

“[The] aircraft broke apart at impact with the building,” the report said. “The forward part of the fuselage remained outside the building. The wing assembly detached from the fuselage, slid into the building and [erupted in flames]. The empennage broke off and remained outside the building.”

Fire destroyed the building and portions of the MD-87 wreckage.

The report said that the occupants of the MD-87 died from “the sudden traumatic collision associated with the consequences of instantaneous impact kinetic deceleration on vital human functions; ... fire was not the cause for any of the fatalities.”

Eight people were in the baggage-handling building when it was struck by the MD-87. Two security officers and two baggage handlers were “victims of the fire that spread furiously inside the building,” the report said. “Another baggage handler suffered extremely severe injuries but survived. Three other baggage handlers sustained minor injuries and were back to work within the month.”

One passenger in the CJ2 died from traumatic injury. Carbon residue found in the upper respiratory cavities of the other passenger and the pilots indicated that they died from the “combined effect of traumatic events and fire exposure,” the report said.

The report said that the MD-87 flight crew’s actions after the collision to effect directional control of the airplane might have prevented the airplane from veering farther right and striking the airport’s main building.

“The professional performance of the crew during the few seconds from aircraft collision to final stop shows a consistent and correct control of the crippled aircraft’s trajectory and path which may have averted a higher-proportion disaster,” the report said.

The report said that runway incursion is a global aviation safety problem that currently is being addressed in Europe by the *European Action Plan for Prevention of Runway Incursions*. The action plan was developed by a task force formed by the European Organization for the Safety of Air Navigation (Eurocontrol), the Group of Aerodrome Safety Regulators, ICAO and the Joint Aviation Authorities. The action plan includes methods of addressing runway-incursion safety issues involving airports, communications, air traffic services and regulations [see “European Air Traffic Controllers Assert Influence to Prevent Runway Incursions,” *Airport Operations* Volume 30 (March–April 2004)].

Based on the findings of the investigation, ANSV on Jan. 20, 2004, made the following recommendations:

The MD-87 flight crew’s actions after the collision to effect directional control of the airplane might have prevented the airplane from veering farther right and striking the airport’s main building.

- The Italian Ministry of Infrastructure and Transport should work with international air transport organizations for “a full and quick implementation of the *European Action Plan for Prevention of Runway Incursions*”;
- The Ministry of Infrastructure and Transport and the Ente Nazionale per l’Aviazione Civile (ENAC; the Italian civil aviation authority) should “ensure that the design and operation of all aerodromes are in compliance with the safety standards specified in ICAO Annex 14”;
- The Ministry of Infrastructure and Transport and ENAC should “ensure that all aerodromes in Italy have a functional safety management system, according to ICAO Annex 14”;
- The Ministry of Infrastructure and Transport, ENAC and the Ente Nazionale di Assistenza al Volo SpA (ENAV; the Italian air navigation service provider) should “ensure that competence-maintenance [programs] and requirements for recent experience for ATC [air traffic control] personnel fully comply with ICAO Annex 1 standards”;
- ENAC and ENAV should “ensure that all required information to operate safely [is] contained in *AIP* Italy and updated as needed”;
- The Ministry of Infrastructure and Transport and ENAC should “forward proposals to ICAO regarding mandatory

installation of cockpit voice recorder equipment in aircraft operated under an AOC [air operator certificate] or equivalent approvals”;

- The Ministry of Infrastructure and Transport and ENAC should “evaluate the need to design airport emergency plans applicable to all Italian airports in accordance with ICAO (Annex 14, paragraph 9.1.12) provisions and to establish guidelines applicable to all Italian airports”;
- ENAV and ENAC should evaluate a requirement for ATC tower personnel to periodically review existing markings, lighting systems and signs on airport-maneuvering areas; and,
- ENAC should request that all Italian airport authorities increase “in low-visibility-condition operations, the random checking of aircraft [documents] and the licenses and qualifications of the pilots.”♦

[FSF editorial note: This article, except where specifically noted, is based on the English-language translation of the Italian Agenzia Nazionale per la Sicurezza del Volo (ANSV) *Final Report: Accident Involved Aircraft Boeing MD-87, registration SE-DMA, and Cessna 525-A, registration D-IEVX, Milano Linate Airport, October 8, 2001*. The 603-page report contains illustrations and appendixes.]

Further Reading From FSF Publications

FSF Editorial Staff. “Audit of ATC Operational Errors Prompts Call for Mandatory Remedial Training.” *Airport Operations* Volume 29 (September–October 2003).

FSF Editorial Staff. “New Strategies Prevent ATC Clearances for Operation on Closed Runways.” *Airport Operations* Volume 29 (July–August 2003).

FSF Editorial Staff. “Maintaining Visual Aids Helps to Prevent Runway Incursions.” *Airport Operations* Volume 28 (May–June 2002).

FSF Editorial Staff. “Controller’s Misperception of Aircraft Positions Sets Stage for Collision on Runway in Paris.” *Accident Prevention* Volume 59 (May 2002).

U.S. Federal Aviation Administration. “Runway Incursion Severity Trends at Towered Airports in the United States: 1997–2000.” *Flight Safety Digest* Volume 21 (February 2002).

FSF Editorial Staff. “Airport-operations Simulation Aids Evaluation of Strategies to Prevent Runway Incursions at LAX.” *Airport Operations* Volume 28 (January–February 2002).

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