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Nonadherence to Approach Procedure Cited in Falcon 20 CFIT in Greenland

Investigators believe that the flight crew observed airport lights during a nighttime nonprecision instrument approach and, to save time, proceeded visually toward the airport. The crew encountered the black-hole effect[1] and were not aware of the airplane's height above terrain.

FSF Editorial Staff

About 0443 coordinated universal time [0143 local time] Aug. 5, 2001, a Dassault Falcon 20 that was being operated on a charter cargo flight struck terrain 4.5 nautical miles (8.3 kilometers) southwest of Narsarsuaq (Greenland) Airport during final approach to Runway 07 in dark nighttime visual meteorological conditions. The airplane was destroyed. The commander, first officer and passenger were killed.

The Danish Aircraft Accident Investigation Board (AAIB) said, in its final report, that "a combination of nonadherence to the approach procedure and the lack of vertical-position awareness was the causal factor to this CFIT [controlled flight into terrain][2] accident."

The report said, "Several of the most common factors found in CFIT accidents were present in this accident. The flight crew did not follow standard operating procedures (SOPs) (adherence to the approach procedure, altitude calls, checklist reading). Furthermore, the ground-proximity warning system (GPWS) was inoperative and the flight crew were exposed to peak fatigue. The absence of CRM [crew resource management] and nonadherence to SOPs removed important defenses in preventing CFIT.

"In this accident, the aircraft was capable of being controlled and was under control of the flight crew until impact. Nothing indicated that the flight crew were aware of their proximity to the mountainous terrain. Consequently, this is considered to be a CFIT accident."

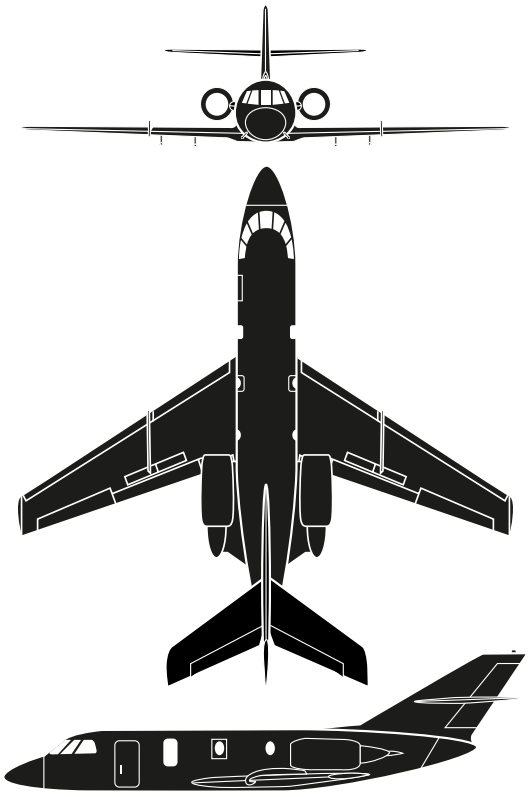
The commander, 56, first officer, 40, and passenger, 36, held airline transport pilot licenses.

"Even though the passenger was type-rated as copilot on the aircraft, he could not be considered as a relief pilot since there were no approved rest facilities on board the aircraft," the report said.

Investigators were not able to obtain documentation of the pilots' flying experience.

The airplane, manufactured in 1966 and registered in Germany, was operated by a company owned by the commander. The first officer was the company's director of maintenance, crew training and ground operations. The passenger was employed as a first officer. The company had four other employees.

The company was approved under European Joint Aviation Requirements to conduct passenger flights, cargo flights and medical service flights with a Falcon in the International Civil Aviation Organization (ICAO) European Region and Mediterranean Region.



Dassault Mystère/Falcon 20

In the early 1960s, Avions Marcel Dassault (now Dassault Aviation) and Sud-Aviation (later Aérospatiale and now the European Aeronautic Defence and Space Co. [EADS]) began development of a light twin-turbofan executive transport. The prototype Mystère 20 flew for the first time in May 1963, and production began in 1965. The Business Jets Division of Pan American World Airways marketed the airplane in North America as the Fan Jet Falcon. The airplane later was marketed as the Falcon 20 outside France and as the Mystère 20 in France. (The smaller, less-powerful Mystère/Falcon 10 was introduced in 1973.)

The Mystère 20/Fan Jet Falcon has General Electric CF700-2B engines, each rated at 4,200 pounds (1,905 kilograms) thrust. The last civilian version of the airplane, the Mystère/Falcon 20F, has CF700-2D-2 engines, each rated at 4,500 pounds (2,041 kilograms) thrust. Dassault developed a Falcon 20G, with Garrett AirResearch (now Honeywell) ATF 3-6 engines and greater fuel capacity, for sale to the U.S. Coast Guard in the early 1980s. The Mystère/Falcon 20F was replaced in 1983 by the Mystère/Falcon 200, which has ATF 3-6 engines and greater fuel capacity.

The Mystère 20/Fan Jet Falcon accommodates two pilots and eight passengers in standard cabin configuration or up to 12 passengers in optional cabin configurations. Maximum takeoff weight is 11,600 kilograms (25,573 pounds). Maximum landing weight is 11,000 kilograms (24,250 pounds).

Maximum cruising speed at 25,000 feet is 464 knots. Economy cruising speed at 40,000 feet is 405 knots. Range at economy cruising speed with fuel reserves is 2,350 kilometers (1,269 nautical miles). Stall speed is 86 knots.♦

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

"The operator was not approved by the German aviation authorities to operate in the North Atlantic [Region] and the North American [Region]," the report said. "The AAIB is of the opinion that this finding did not have major impact on the sequence of events, but it is possible that the flight crew's lack of thorough familiarity with operation in the above-mentioned ICAO areas might have been a minor stress factor."

The day before the accident, the flight crew conducted a charter flight from Hanover, Germany, to Palma de Mallorca, Spain. The flight began at 1217. The crew was scheduled to conduct another charter flight that evening — departing from Gdansk, Poland, at 2000 to arrive in Louisville, Kentucky, U.S., at 0900. Because of a two-hour delay in Palma de Mallorca, however, the airplane arrived at Gdansk at 2106.

The airplane was refueled, and the flight crew loaded the cargo, which consisted of 209 boxes of automotive parts weighing 1,567 pounds (711 kilograms). The flight crew did not leave a copy of the weight-and-balance documents at the airport, as required by the company's operations manual. Nevertheless, the report said that the airplane likely was within weight-and-balance limits.

The airplane departed from Gdansk at 2218. The crew landed the airplane at Copenhagen, Denmark, and at Keflavik, Iceland, for refueling. Current weather reports for Narsarsuaq were not available in Keflavik.

"The handling agent directed the commander's attention to the lack of updated weather reports for [Narsarsuaq], but the commander seemed not to be concerned," the report said. "It was the general opinion of the handling agent that the commander seemed stressed."

The flight plan for the flight from Keflavik to Narsarsuaq listed Kangerlussuaq, Greenland, as the alternate airport. [Kangerlussuaq, also called Soendre Stroemfjord, is about 389 nautical miles (720 kilometers) northwest of Narsarsuaq.] The report said that two alternate airports should have been listed on the flight plan because no weather reports for Narsarsuaq were available in Keflavik.

The airplane departed from Keflavik at 0300. The first officer was the pilot flying. The airplane was in cruise flight at Flight Level (FL) 260 (approximately 26,000 feet) and about 50 nautical miles (93 kilometers) east of Narsarsuaq at 0423, when the commander established radio communication with Narsarsuaq Flight Information Service (FIS). The commander told the FIS operator that they expected to be over the Narsarsuaq nondirectional beacon (NDB) at 0438.

The FIS operator told the flight crew that they were cleared to conduct a descent and to report descending through FL 195.

Control of the airplane was transferred to the commander, who had experience in flight operations at Narsarsuaq. At

0434, the first officer told the FIS operator that the airplane was being flown through FL 195. The FIS operator told the flight crew to report 10 nautical miles (19 kilometers) from the airport.

During the descent, the flight crew reviewed the procedure for the NDB/distance-measuring equipment (DME) approach to Runway 07. No other instrument approach procedures were available at the airport.

At 0437, the first officer told the FIS operator that the airplane was 10 nautical miles from the airport. The FIS operator told the crew to establish radio contact with Narsarsuaq Airport Flight Information Service (AFIS).

The first officer told the AFIS operator that the airplane was being flown through FL 130.

"The AFIS operator reported that there was no reported traffic in the [airport area] and that the flight crew could make an approach by their own discretion," the report said.

The AFIS operator told the crew that weather conditions at the airport included surface winds from 080 degrees at 24 knots, 10 kilometers (six statute miles) visibility with light rain, broken clouds at 6,000 feet, an overcast at 9,000 feet, surface temperature 14 degrees Celsius (C; 57 degrees Fahrenheit [F]) and dew point 3 degrees C (37 degrees F). The AFIS operator also provided the current altimeter setting.

A note on the approach chart said, "Adhere strictly to prescribed procedure due to high surrounding terrain."

Runway 07 was 1,830 meters (6,004 feet) long and had runway-end-identifier lights, high-intensity runway-edge lights and a precision approach path indicator (PAPI). The report said that the PAPI could be used only within 2.0 nautical miles (3.7 kilometers) of the runway threshold. Runway touchdown zone elevation was 11 feet.

"At the time of the accident, the lighting to Runway 07 and the [airport-]identification beacon were turned on and were operational," the report said.

The NDB/DME approach chart indicated that the minimum safe altitude (MSA) west of the NDB (located on the airport) was 7,100 feet and that the MSA east of the NDB was 8,900 feet. A note on the approach chart said, "Adhere strictly to prescribed procedure due to high surrounding terrain." No air traffic control approach radar services or terminal radar services were available.

The published approach procedure included a procedure turn northeast of the NDB and a teardrop-type approach pattern southwest of the NDB; the outbound course was 279 degrees, and the inbound final approach course was 073 degrees. The procedure had to be conducted within 12 DME (i.e., 12 nautical miles of the DME facility).

The procedure called for the flight crew to cross the NDB outbound at 5,800 feet. The minimum altitude at the final approach fix, which was at 9.0 DME inbound, was 3,100 feet. The minimum altitude at the 5.0-DME fix was 2,100 feet. The missed approach point was at 4.0 DME; the report did not specify the minimum descent altitude for the approach.

At 0440:26, the cockpit voice recorder (CVR) recorded a flight crewmember's callout that the airplane was 6.0 DME outbound; 26 seconds later, the CVR recorded a callout of 8.0 DME outbound. The report said that the airplane's groundspeed was about 277 knots. A note on the approach chart said, "Procedure restricted to max IAS [maximum indicated airspeed of] 220 knots."

At 0441:45, the CVR recorded a callout that the airplane was on base leg.

"It is the opinion of the AAIB that the flight crew, [during] the inbound turn, got visual contact with the aerodrome and, in order to save time, decided to continue the flight with visual reference to the aerodrome," the report said. "They set an almost direct course to the aerodrome. … The flight crew hereby made a procedural-decision error, since the approach procedure clearly stated a strict adherence to the procedure [was required] due to the high surrounding terrain.

"The commander was familiar with the area, and it is possible that his overconfidence might have influenced the flight crew's decision making."

Soon after the base-leg callout, the commander told the first officer to extend the landing gear.

"With reference to the CVR readout, there were no audible flight crew callouts concerning the use of checklists, altitude checks and [SOPs] during the descent, the initial [approach phase] and the final approach phase," the report said.

The flight crew likely conducted the descent with reference to the airport lights and did not cross-check their flight instruments.

"The flight crew were preoccupied with maintaining visual reference during the descent and did not adequately monitor the aircraft flight instruments," the report said. "They were hereby exposed to the 'black hole' phenomenon, resulting in a lack of vertical-position awareness. Consequently, they misjudged the aircraft's true altitude and were not aware of their proximity to the terrain."

At 0442:29, the first officer told the AFIS operator that the airplane was on final approach to Runway 07.

"The AFIS operator reported the threshold wind for Runway 07 to be 070 degrees at 22 knots, gusting to 29 knots, and the runway to be free," the report said. "The AFIS operator made a visual scan of the approach sector, but he did not see the aircraft, as he normally would have when an aircraft was established on final [approach on a] dark night and under similar weather conditions."

The AFIS operator made several radio transmissions to the crew, but there was no reply. After being told by flight information center personnel in Canada and Iceland that the aircraft had not landed at another airport, the AFIS operator notified the rescue coordination center in Soendre Stroemfjord that the Falcon was missing.

Narsarsuaq police were notified at 0645 and began searching the approach path for the airplane at 0656. A helicopter crew found the wreckage at 0807.

"At approximately 0443:07 hours, the aircraft impacted in landing configuration mountainous terrain at approximately 700 feet MSL [mean sea level]," the report said. "On the CVR readout, there were no audible flight crew callouts immediately before impact."

The airplane had been in a wings-level attitude on impact.

"The wreckage-trail track had a direction of approximately 110 degrees magnetic," the report said. "The wreckage pattern observed was consistent with a controlled shallow descent. The wreckage trail was approximately 165 meters [541 feet] long by 30 meters [98 feet] wide. … Throughout the wreckage trail, fuel colored the vegetation.

"The aircraft started to break up from the beginning of the wreckage trail. During the breakup, the cargo exited the aircraft and was spread over a relatively large area of the last part of the wreckage trail. … When the aircraft came to a stop, the fuselage, the right wing and the cockpit caught fire … and were burned out."

There were no indications that the flight crew had used cargo restraints (e.g., nets and tie-down rings).

"Improperly restrained cargo can be hazardous since cargo movement can alter the aircraft's center of gravity," the report said. "However, it is the opinion of the AAIB that the volume of the cargo within the cabin area [from which the passenger seats had been removed] made it almost impossible for the cargo to move significantly in flight and thereby contribute to the accident."

The report said that the accident was not survivable because of the impact forces and fire.

"The commander had been thrown from the aircraft," the report said. "The autopsy report of the commander revealed that he did not use his shoulder harness. The first officer was found in the right-hand flight crew seat in the cockpit. Both hip [harness] and shoulder harness were fastened. The passenger [who had been seated in the observer's seat with the hip harness fastened] was found in the left-hand side of the cockpit."

The report said that when the accident occurred, the flight crew likely had been awake for about 22 hours, had flown about 9 hours 25 minutes and had been on duty for nearly 17 hours; German aviation regulations limit duty time to 14 hours.

The report included the following information on circadian physiology from the February 1997 issue of *Flight Safety Digest*:[3]

> ***When the accident occurred, the flight crew likely had been awake for about 22 hours, had flown about 9 hours 25 minutes and had been on duty for nearly 17 hours.***

On a 24-hour basis, [body temperature, hormone secretion, digestion, physical and mental performance, mood and many other body functions] fluctuate in a regular pattern with a high level at one time of day and a low level at another time. The circadian (*circa* = around, *dies* = day) pattern of wakefulness and sleep is programmed for wakefulness during the day and sleep at night. The circadian clock repeats this pattern on a daily basis. Certain hours of the 24-hour cycle — that is, 0200 to 0600 — are identified as a time when the body is programmed to sleep and during which performance is degraded.

"It is possible that an underestimation by the flight crew of their fatigue contributed to improper decision making, lack of situational awareness and thereby to their failure to properly execute the approach," the report said. "In combination with fatigue, another contributing element to the accident might have been stress, since the flight was chartered to deliver the cargo in [Louisville] at 0900 hours on Aug. 5, 2001. When leaving [Gdansk], the flight was more than two hours late."

Investigators did not determine whether the airplane's emergency locator transmitter (ELT) activated on impact.

"However, even if the ELT had activated, no equipment capable of receiving the [ELT] signal on 121.5 MHz [megahertz] or homing in on the signal was available at [the airport]," the report said.

The airplane's flight data recorder (FDR) was not significantly damaged during the accident, but the recorded data ended at a cruise altitude. Investigators found internal damage to the recorder.

"It could not be determined when this damage occurred or why," the report said. "Based on the available information, it was concluded that the accident flight data were not recorded on the FDR."

The CVR recorded no GPWS warnings. The report said that with the airplane in landing configuration, GPWS warnings of excessive sink rate and excessive terrain-closure rate "can be very short or nonexistent." Nevertheless, investigators concluded that the GPWS was inoperative.

The company did not operate the Falcon under the provisions of a minimum-equipment list (MEL); Dassault's master MEL for the airplane permitted flights to be conducted under specific conditions with the GPWS inoperative.

"Though the master MEL stated that the GPWS may be inoperative, the AAIB finds it hazardous to operate in mountainous terrain without an operable GPWS," the report said. "An operable GPWS would have assisted in restoring the flight crew's situational awareness by providing them with appropriate advisories and cues about their proximity to terrain and would have reduced the likelihood of this accident occurring."♦

[FSF editorial note: This article, except where specifically noted, is based on Danish Aircraft Accident Investigation Board final report no. HCL 49/01. The 26-page report contains illustrations and appendixes.]

Notes

1. The *black-hole effect* typically occurs during a visual approach conducted on a moonless or overcast night, over water or over dark, featureless terrain where the only visual stimuli are lights on and/or near the airport. The absence of visual references in the pilot's near vision affect depth perception and cause the illusion that the airport is closer than it actually is and, thus, that the aircraft is too high. The pilot may respond to this illusion by conducting an approach below the correct flight path (i.e., a low approach).

2. *Controlled flight into terrain* (CFIT), as defined by the Flight Safety Foundation (FSF) CFIT Task Force, occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew. This type of accident can occur during most phases of flight, but CFIT is more common during the approach-and-landing phase, which begins when an airworthy aircraft under the control of the flight crew descends below 5,000 feet above ground level (AGL) with the intention to conduct an approach and ends when the landing is complete or the flight crew flies the aircraft above 5,000 feet AGL en route to another airport.

3. FSF Fatigue Countermeasures Task Force. "Principles and Guidelines for Duty and Rest Scheduling in Corporate and Business Aviation." *Flight Safety Digest* Volume 16 (February 1997).

Further Reading From FSF Publications

FSF Editorial Staff. "Improvised GPS Approach Procedure and Low Visibility Set Stage for CFIT." *Accident Prevention* Volume 61 (August 2004).

FSF Editorial Staff. "Failure to Comply With Nonprecision Approach Procedure Sets Stage for Regional Jet CFIT at Zürich." *Accident Prevention* Volume 61 (June 2004).

Veillette, Patrick R. "Controlled Flight Into Terrain Takes Highest Toll in Business Jet Operations." *Flight Safety Digest* Volume 23 (May 2004).

FSF Editorial Staff. "Noncompliance With Instrument Approach Procedures Cited in King Air CFIT Accident in Australia." *Accident Prevention* Volume 60 (November 2003).

FSF Editorial Staff. "Failure to Maintain Situational Awareness Cited in Learjet Approach Accident." *Accident Prevention* Volume 60 (June 2003).

FSF Editorial Staff. "Sabreliner Strikes Mountain Ridge During Night Visual Approach." *Accident Prevention* Volume 60 (April 2003).

FSF Editorial Staff. "Reduced Visibility, Mountainous Terrain Cited in Gulfstream III CFIT at Aspen." *Accident Prevention* Volume 59 (November 2002).

FSF Editorial Staff. "Cargo Airplane Strikes Frozen Sea During Approach in Whiteout Conditions." *Accident Prevention* Volume 59 (January 2002).

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Roelen, A.L.C.; Pikaar, A.J.; Ovaa, W. "An Analysis of the Safety Performance of Air Cargo Operators." *Flight Safety Digest* Volume 20 (July 2001).

FSF Approach-and-landing Accident Reduction Task Force; FSF Editorial Staff. "ALAR Briefing Notes." *Flight Safety Digest* Volume 19 (August–November 2000).

FSF Editorial Staff. "Learjet Strikes Terrain When Crew Tracks False Glideslope Indication and Continues Descent Below Published Decision Height." *Accident Prevention* Volume 58 (June 1999).

Sumwalt, Robert L. "Enhancing Flight-crew Monitoring Skills Can Increase Flight Safety." *Flight Safety Digest* Volume 18 (March 1999).

FSF ALAR Task Force; FSF Editorial Staff et al. "Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and Controlled-flight-into-terrain Accidents." *Flight Safety Digest* Volume 17 (November–December 1998) and Volume 18 (January–February 1999).

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Staff: Roger Rozelle, director of publications; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; Linda Werfelman, senior editor; Rick Darby, associate editor; Karen K. Ehrlich, web and print production coordinator; Ann L. Mullikin, production designer; Susan D. Reed, production specialist; and Patricia Setze, librarian, Jerry Lederer Aviation Safety Library

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