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Improvised GPS Approach Procedure And Low Visibility Set Stage for CFIT

The flight crew of the Ilyushin IL-76TD freighter conducted two approaches based on a user-defined global positioning system waypoint that incorrectly depicted the location of the runway threshold. The first approach led to a go-around. The second approach was not stabilized; the descent rate was high when the airplane struck rising terrain.

FSF Editorial Staff

About 1505 local time Jan. 31, 2003, an Ilyushin IL-76TD that was being operated on an unscheduled cargo flight struck terrain during an approach in instrument meteorological conditions (IMC) to Runway 14 at Cakung Airport near Baucau, Timor-Leste [East Timor]. The airplane was destroyed by the impact and postaccident fire. The six occupants — the captain, first officer, flight engineer, navigator and two loadmasters — were killed.

The Australian Transport Safety Bureau (ATSB), which conducted the accident investigation at the request of the government of Timor-Leste, said in its final report that the following were significant factors in the accident:

- "The flight crew did not comply with the published nonprecision instrument approach and/or missed approach procedures at Baucau during flight in [IMC];
- "The flight crew conducted user-defined nonprecision instrument approaches to Runway 14 at Baucau during flight in [IMC];
- "The pilot-in-command [captain] permitted the aircraft to descend below the MDA(H) [minimum descent altitude/height] published on both the Jeppesen and CAD [Timor-Leste Civil Aviation Division] Runway 14 instrument approach charts during flight in [IMC];
- "The flight crew did not recognize the increased likelihood and, therefore, risk of CFIT [controlled flight into terrain[1]]; [and,]
- "The flight crew did not recognize or treat that risk in a timely manner."

The airplane, manufactured in 1986, was owned by a company based in the United Arab Emirates and had been leased for one year to a company based in Laos. The lessor also provided the flight crew and the loadmasters. The Laotian company then subleased the airplane, flight crew and loadmasters to a company based in Cambodia. The report said that the Laotian company did not obtain consent from the owner of the airplane for the sublease, as required by the lease agreement.

On the day of the accident, the airplane arrived at Baucau after a flight of 5 hours, 29 minutes from Macau [a special administrative region of China near Hong Kong]. The flight was conducted for a company based in Singapore. The cargo was 31 tonnes (68,200 pounds) of telecommunications equipment.

The captain and the first officer held Russian airline pilot licenses and Laotian commercial pilot licenses. The captain had 14,500 flight hours. The first officer had 6,800 flight hours. Investigators were unable to determine their flight hours in type.

The flight engineer held a Russian flight engineer license and a Laotian flight engineer license, and had 5,100 flight hours. The navigator held a Russian flight navigator license with an IL-76 navigator-instructor type rating and a Laotian flight navigator license, and had 9,300 flight hours.

"Before the aircraft's departure from Macau, the flight crew was provided with notices to airmen (NOTAMs) and weather-forecast information for the planned flight," the report said. "The weather information provided to the flight crew did not include a terminal aerodrome forecast (TAF) or an aviation routine weather report (METAR) for Baucau. Those weather forecasts were not produced for Baucau."

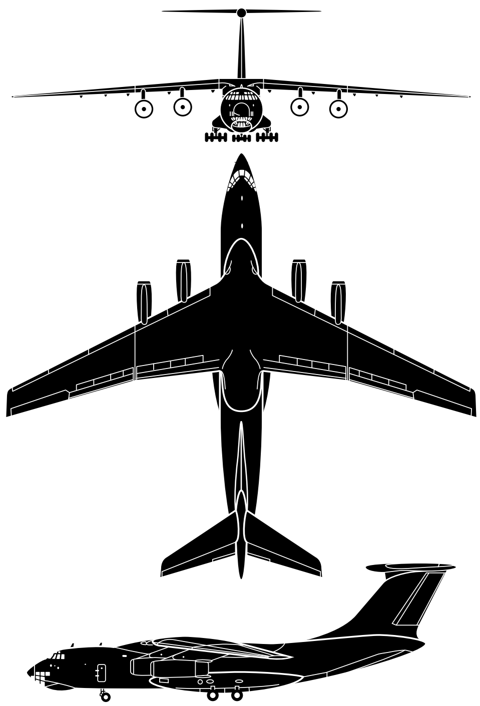
The weather information provided to the flight crew included a forecast of up to 7 oktas (seven-eighths)[2] cloud coverage below 4,500 feet, the lowest safe altitude on the last segment of their route — from Ambon, Indonesia, to Baucau.

"The flight crew should therefore have been aware that a nonprecision instrument approach would most likely be required at Baucau," the report said.

The NOTAMs provided to the flight crew included information that air traffic service (ATS) at the airport was provided only to flight crews of airplanes involved in United Nations (U.N.) troop rotations at Baucau.

The airplane was in cruise flight at Flight Level 280 (approximately 28,000 feet) at 1426 when the captain, the pilot flying, briefed the other flight crewmembers that he would conduct a nondirectional beacon (NDB) approach at Baucau. (The flight crew conversed in Russian.) The briefing did not include weather conditions at the airport, the applicable minimum sector altitude or the MDA for the NDB approach.

"The flight instruments fitted in the occurrence aircraft provided readings of height, speed and distance in metric units," the report said. "The [captain's] briefing included information on the relevant heights for the missed approach procedure expressed in feet and not in their metric equivalents. None of the other crewmembers commented on that fact."



Ilyushin IL-76TD

Ilyushin in the late 1960s began designing a heavy jet transport to replace the Antonov An-12, a four-turboprop freighter used in military aviation and civil aviation. Design goals included the ability to carry 40,000 kilograms (88,184 pounds) of freight 5,000 kilometers (2,700 nautical miles) in less than six hours, to be operated on short, unprepared airstrips in adverse weather conditions typical of Siberia and to be maintained easily.

The prototype first flew in 1971, and production of a military version, the IL-76, began in 1975. Production of the IL-76T, a civil version with more fuel capacity and a heavier payload, soon followed. The original production airplanes have four Soloviev D-30KP engines, each rated at 117.7 kilonewtons (26,465 pounds) thrust.

The IL-76TD has four Soloviev D-30KP-1 engines, which maintain full power at warmer ambient temperatures, a greater fuel capacity and a higher maximum takeoff weight and payload.

The airplane accommodates five flight crewmembers and two freight handlers. Maximum payload is 48,000 kilograms (105,821 pounds). Maximum takeoff weight is 190,000 kilograms (418,874 pounds).

Takeoff distance (ground roll) is 850 meters (2,789 feet). Cruising speed is 405 knots to 432 knots at 29,000 feet to 39,000 feet. Maximum range with fuel reserves is 6,700 kilometers (3,618 nautical miles). Landing distance (ground roll) is 450 meters (1,477 feet).♦

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

The report cited findings by the Flight Safety Foundation (FSF) Approach-and-landing Accident Reduction (ALAR) Task Force that "omission of action/inappropriate action," including inadequate approach briefings, is a leading factor in approach-and-landing accidents and serious incidents.[3] The report said that of the 10 approach-briefing items recommended by the task force, the captain's briefing included only one (the initial steps of the missed approach procedure).[4]

"Thus, it resulted in the flight crew having a less-than-adequate awareness of all relevant factors associated with the intended arrival and landing phases at Baucau, and contributed to the steadily increasing risk of a CFIT event," the report said.

Procedures were published for NDB approaches to Runway 14 and Runway 32. During U.N. troop-rotation operations two days before the accident, the NDB monitor in the airport control tower indicated that the NDB was operating normally. Conversation among the IL-76 crewmembers recorded by the airplane's cockpit voice recorder (CVR) contained no indication that the NDB was not operating normally.

"At no time during the approaches did any of the flight crew make comment to suggest that the Baucau NDB was inoperative and therefore not available for the conduct of either of the published nonprecision approaches," the report said.

On the evening of the accident, however, the NDB monitor in the airport control tower indicated that the NDB was not operating. The report said that although the operating status of the NDB at the time of the accident could not be determined conclusively, the NDB likely was operating normally.

The airplane was about 300 kilometers (162 nautical miles) from the airport at 1428, when the captain told the first officer to establish radio communication with Baucau Tower and to obtain information on weather conditions and runway in use. During the next 23 minutes, the first officer radioed Baucau Tower 25 times but received no response.

The captain began the descent at about 1439. He disengaged the autopilot and hand-flew the airplane. At 1448, he asked the navigator for an altimeter setting.

"At the time of the occurrence, there was no method in place to provide the Baucau [altimeter setting] to aircraft operating into Baucau if they were not conducting U.N. troop rotations," the report said.

The navigator calculated the altimeter setting by subtracting the published airport elevation (62 hectopascals [hPa]) from the standard atmospheric pressure (1013.2 hPa) and converted the result (951 hPa) into millimeters of mercury (714 mm Hg). The report said that with this altimeter setting, the captain's altimeter showed the airplane's height above the airport (in meters), rather than height above sea level.

The Australian Bureau of Meteorology estimated that atmospheric pressure at Baucau at the time of the accident was about 1011 hPa. If this estimate was accurate, the captain's altimeter would have read about 20 meters (66 feet) too high, the report said.

The navigator established radio communication with Baucau Tower at 1453.

"A controller, who was present at Baucau [airport] at the time but not on operational duty, advised the flight crew that ATS was not available and that landing would be at the discretion of the flight crew," the report said. "The flight navigator acknowledged the controller's advice but did not seek information from the controller about the prevailing weather at the [airport or the current altimeter setting]."

At the time, moist onshore monsoon winds ascending the steep coastal terrain north of Baucau created IMC at the airport. Witnesses said that the cloud base was about 1,000 feet above ground level and visibility was about 1,500 meters (0.9 statute mile) — below published minimums for either NDB approach procedure.

The airplane was on a southwesterly heading as it neared the airport (Figure 1, page 4). The navigator recommended that the captain conduct an overflight of the airport before conducting an approach. The captain agreed and said that he would conduct the overflight on a heading of 135 degrees (the magnetic heading for Runway 14 published on the Jeppesen airport chart). The 135-degree heading did not coincide with the published NDB Runway 14 final approach course, which was 146 degrees. The captain did not brief the other flight crewmembers on how low he would fly the airplane during the overflight or during the approach.

The navigator said, "Yes, we'll turn left, and I'll give you the data for landing. Will be no problems."

The report said that neither the first officer nor the flight engineer asked any questions or expressed any concerns about the intended overflight and approach; neither pilot suggested an alternative plan.

During the overflight, the captain maneuvered the airplane according to the navigator's callouts of distance to the Runway 14 threshold and lateral-offset distance from the extended runway centerline. The callouts were based on a waypoint for the runway threshold that had been entered into the onboard global positioning system (GPS) navigation equipment.

The waypoint coordinates were derived from information published on the Jeppesen airport chart and NDB Runway 14 approach chart. The report said that the charts inaccurately depicted the NDB as being located northwest of Runway 14; the NDB actually was located off the right side of Runway 14. As a

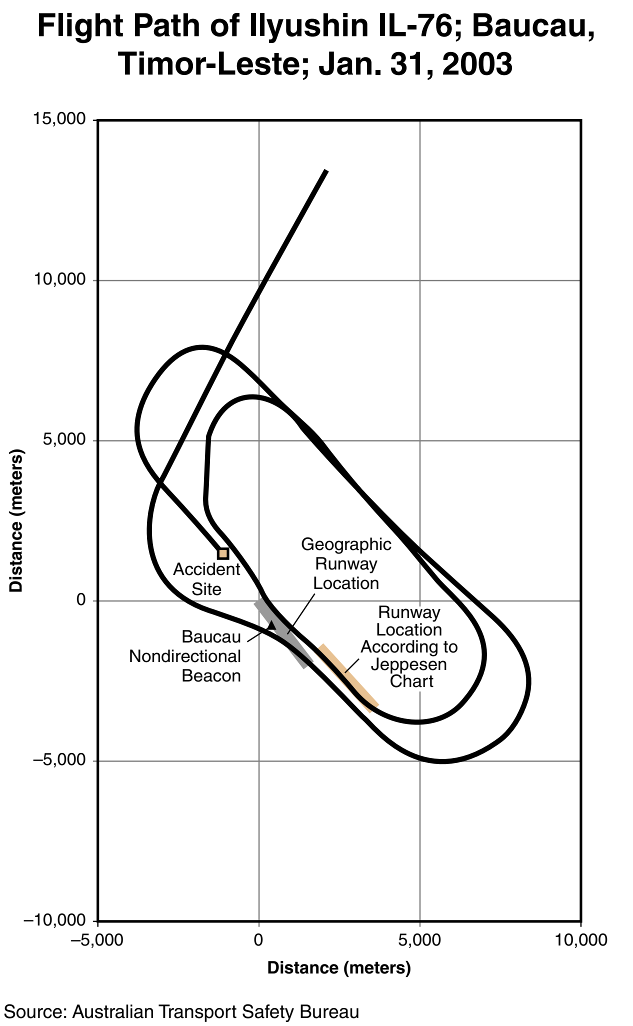


Figure 1

result, the waypoint entered into the GPS navigation equipment was about 2.5 kilometers (1.4 nautical miles) southeast of the runway threshold.

The flight crew conducted the overflight with the airplane's landing gear and flaps retracted (see photo, page 5). The airplane was 13.7 kilometers (7.4 nautical miles) from the NDB at 1451, when the captain said that he was maintaining an altitude 400 meters (1,312 feet) above airport elevation. The report said that at this time, the airplane was 178 meters (584 feet) below the published minimum safe altitude for the area.

The report said that because of a malfunction of the airplane's flight-data-acquisition unit, the flight data recorder (FDR) did not record radio altitude, vertical velocity or roll information.

The CVR recording indicated that the flight crew did not cross-check their barometric altimeters against their radio altimeters, set their radio-altimeter references ("bugs") to a minimum descent altitude, monitor the automatic direction finder to determine their position relative to the NDB or use the onboard navigation equipment to determine wind direction and speed.

The airplane was near the extended Runway 14 centerline at about 1454, when the navigator told the captain to turn left to a heading of 135 degrees. The captain did not begin the turn promptly, and the airplane was flown through the extended runway centerline. The navigator told the captain to turn left to a heading of 105 degrees.

"Had the aircraft been in VMC [visual meteorological conditions] at the time, and with the [airport] in sight, it is unlikely that the [captain] would have overshot the extended centerline," the report said. "Alternatively, the aircraft may have been in VMC, but the [airport] was not visible to the flight crew because it was obscured by cloud. The CVR data revealed that it was unlikely that the flight navigator saw the runway until the aircraft was almost overhead the runway."

The airplane passed over the departure end of Runway 14, and the captain flew the airplane to 500 meters (1,641 feet) above airport elevation. Following callouts by the navigator, the captain then flew a left-hand pattern to realign the airplane with the extended runway centerline for the first approach.

The airplane was on the downwind leg at 1457, when the navigator asked the captain if he could see the runway out his left window. The captain said no. The flight crew then configured the airplane for landing. During final approach, the crew again observed the runway sooner than they expected.

At 1459, the first officer said, "Threshold."

The captain said, "Threshold. We already passed [the] runway."

The report said that at this time, the airplane was about 1.04 kilometers (0.56 nautical mile) north of the threshold of Runway 14 and was heading almost directly toward the NDB. The navigator, who likely assumed that the airplane was overhead the runway when the captain said that they had passed the runway, applied a four-kilometer (two-nautical-mile) correction of the runway-threshold waypoint for the second approach. The correction placed the waypoint 1.65 kilometers (0.89 nautical mile) northwest of the runway threshold.

The captain flew the airplane to 400 meters above airport elevation and flew a left-hand pattern based on the navigator's callouts. At 1504:42, the navigator told the captain to turn left to a heading of 135 degrees. A few seconds later, he said, "Now we are crossing [the] landing heading; distance … is four kilometers [two nautical miles]."

At 1504:54, the navigator said, "On the right 200 meters; distance is three [kilometers (1.6 nautical miles)]." At the same nautical miles) from the runway.

The captain said, "OK." He maintained a heading of 136 degrees.

At 1505:07, the navigator said, "On radio altimeter, 300 we have. Continue descending. … Distance now is three [kilometers (1.6 nautical miles)]." A few seconds later, the navigator told the captain that the airplane was two kilometers (one nautical mile) from the runway threshold.

The airplane was about 200 meters (656 feet) above airport elevation at 1505:17, when the navigator said, "We are flying above again."

The captain increased the descent rate to about 1,080 meters per minute (3,543 feet per minute) and said, "Increased."

An airport building is shown in the foreground of a photograph taken during the flight crew's initial overflight of the airport. (Australian Transport Safety Bureau Photo)

time, the FDR recorded a sudden nose-down pitch change and a minimum-fuel warning, which indicated that two tonnes (4,400 pounds) of fuel remained for each of the four engines.

The report said that the minimum-fuel warning was a false warning triggered by the sudden pitch change. Investigators determined that the airplane had enough fuel to fly from Baucau to the alternate airport in Kupang, Indonesia, [380 kilometers (205 nautical miles) southwest of Baucau] and then to Makassar, Indonesia, [750 kilometers (406 nautical miles) northwest of Kupang]. Makassar was the en route stop planned for the crew's next flight, to Rayong, Thailand.

The report said that concern about schedule might have affected the flight crew's decision making.

"The aircraft was about nine hours behind schedule when it arrived at Baucau, and if the flight crew diverted to Kupang then returned to Baucau [when weather conditions improved], the aircraft would likely have been more than 12 hours behind schedule by the time it arrived at Rayong, Thailand," the report said. "Under those circumstances, the flight crew may have felt under pressure to place schedule before safety to expedite the flight to Baucau."

At 1504:59, the navigator told the captain to maintain the current heading and that the airplane was 3.5 kilometers (1.9

The flight engineer misunderstood the captain's statement as a command to increase thrust; he advanced the throttle levers and said, "Increased." The report said that this action likely was a significant distraction to the captain and probably diverted his attention from flying the airplane.

The captain said, "No, I increased vertical speed," and retarded the throttle levers. At the time, the airplane was descending through 162 meters (531 feet) above airport elevation. The published minimum descent height for the straight-in NDB Runway 14 approach is 531 feet.

"None of the other crewmembers commented on the high rate of descent or drew the [captain's] attention to the fact that the approach was unstabilized," the report said.

The report said that the captain and the first officer were looking outside the airplane, trying to establish visual contact with the ground, and were not monitoring the flight instruments. A high descent rate was maintained until less than two seconds before impact.

At 1505:31, the first officer said, "Ach, increase altitude!"

The captain applied nose-up elevator control but did not increase thrust. The report said that the captain's attempt to avoid impact was unsuccessful because of the airplane's inertia and close proximity to the terrain. The CVR recorded the first sound of impact at 1505:34.

The airplane struck trees, and the right wing tip struck and severely damaged a partially constructed house; the occupant of the house was not injured. The airplane then struck rising terrain consisting of coral outcrops on the extended runway centerline about 1.9 kilometers (1.0 nautical mile) northwest of the airport, near the village of Caicido. Elevation of the accident site was 1,565 feet —164 feet below the published Runway 14 threshold elevation (1,729 feet).

"Three residents from Caicido village witnessed the aircraft emerge from low cloud, close to the ground, just before it impacted terrain," the report said. "One of the residents was standing near trees that were struck by the aircraft shortly after it first contacted the ground. Another of the residents was blown to the ground by jet blast from the aircraft as it flew past that resident just before impact."

Aircraft rescue and fire fighting services arrived at the accident site about five minutes after the accident. Weather conditions at the accident site included low clouds, light rain and visibility between 200 meters and 300 meters (656 feet and 984 feet). Several postaccident fires continued to burn until after 1640; one was described as a "major fire that was flaming bright white."

During postaccident autopsies, the occupants of the airplane could not be identified positively because of the severity of their injuries.

"Similarly, toxicological examinations could not be performed on all of the occupants," the report said. "The investigation was therefore unable to determine whether any physiological factors may have adversely affected the performance of any of the flight crew."

The CVR recording contained no aural warnings from the airplane's ground-proximity warning system (GPWS). A GPWS warning of excessive descent rate should have begun about nine seconds before impact. Investigators were unable to determine if the GPWS was operating normally.

"None of the components of the GPWS system were identified within the aircraft wreckage," the report said. "It was therefore not possible to conduct a technical investigation of all the elements comprising the GPWS to positively determine its serviceability prior to impact."

The report said that the accident resulted from the following factors:

- "Environmental threats, in terms of the poor prevailing weather conditions at Baucau and the sharply rising terrain beneath the intended approach path to Runway 14;
- "Poor planning by the flight crew;
- "Poor flight crew coordination;
- "The flight crew's noncompliance with standard operating procedures;
- "Their disregard of the published instrument approach procedures;
- "Their intentional descent below the published MDA(H); [and,]
- "Their apparent lack of appreciation and/or disregard of the risks associated with their proposed actions."

The report said, "The user-defined procedure formulated by the flight crew for the approaches to Baucau deviated from normal practice [and] bypassed all the safety criteria and risk treatments inbuilt into the design of the published nonprecision instrument approach procedures. … The flight crew, as a team, appeared to lack both situational [awareness] and terrain awareness during the approaches at Baucau. … None of the flight crew recognized the need for a missed approach until the point where the collision with terrain was almost certain."

The report cited the FSF *CFIT Checklist* as an important tool for assessing the risk of CFIT.[5] Using the checklist, investigators found that the risk of CFIT for the planned flight from Macau to Baucau was high. The report said that the flight crew did not appear to be aware of that risk or to recognize the increased risk associated with their decision to conduct the improvised approach procedure at Baucau.

Based on the findings of the accident investigation, ATSB made the following recommendations:

- "The government of Timor-Leste [should] liaise with United Nations Air Operations to develop and promulgate approved instrument approach [charts] and [airport] charts for Baucau, Timor-Leste, as a matter of urgency to enhance flight safety of aircraft operations into Baucau;
- "The government of Timor-Leste [should] liaise with Jeppesen Sanderson to ensure that Jeppesen Sanderson is provided with current, approved data for appropriate instrument approach [charts] and [airport] charts for Baucau, Timor-Leste, and that charts approved by the government of Timor-Leste are promulgated by Jeppesen Sanderson, to enhance flight safety or aircraft operations in Baucau;
- "The government of Timor-Leste [should] review the appropriateness of the current provision of [ATS] and facilities to non-United Nations aircraft operations into

Baucau, Timor-Leste, in the interest of enhancing flight safety of aircraft operations into Baucau;

- "The government of Timor-Leste [should] liaise with United Nations Air Operations to expedite procedures for notifying pilots of aircraft operating into Baucau on operations other than U.N. troop rotations, with current weather details and altimeter subscale settings;

- "The government of Timor-Leste [should] liaise with United Nations Air Operations to review operations at [airports] in Timor-Leste by non-United Nations aircraft with the view of improving the safety of those operations; [and,]

- "United Nations Air Operations [should] assist the government of Timor-Leste to develop and promulgate approved instrument approach [charts] and [airport] charts for Baucau, Timor-Leste, as a matter of urgency, to enhance flight safety of aircraft operations into Baucau."

The Timor-Leste CAD recommended that the International Civil Aviation Organization "publicize the safety information contained in this final report [and] encourage all non-English-speaking contracting states to translate and distribute this accident report in the native language of their crews to improve their understanding of the safety information contained in this report."

The report said that safety actions resulting from the accident included the following:

- CAD issued a NOTAM prohibiting flight crews of aircraft other than aircraft involved in U.N. operations from conducting NDB approaches at Baucau;

- CAD said that it would include information in its *Aeronautical Information Manual* prohibiting flight crews from conducting user-defined GPS approaches;

- CAD and Jeppesen withdrew their Baucau airport charts and NDB approach charts; CAD subsequently issued updated charts;

- CAD coordinated with Australian ATS authorities and Indonesian ATS authorities to ensure that flight crews entering Timor-Leste airspace would be required to establish radio communication with Dili Comoro (Indonesia) Approach, so that they would be provided with a level of ATS service; and,

- The United Nations said that it would consider, on a case-by-case basis, providing ATS at Baucau to flight crews of aircraft involved in non-U.N. humanitarian flights.♦

[FSF editorial note: This article, except where specifically noted, is based on Australian Transport Safety Bureau *Aircraft Accident Report: Controlled Flight Into Terrain; Ilyushin IL-76TD, RDPL-34141; Baucau, Timor-Leste; 31 January, 2003*. The 144-page report contains illustrations and appendixes.]

Notes

1. Controlled flight into terrain (CFIT) 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.

2. International Civil Aviation Organization (ICAO). *Manual of Aeronautical Meteorological Practice*. Document no. 88960AN/893/4. Chapter 2, *Meteorological Observations and Reports*. 2.3.10 "Cloud." ICAO said that cloud amount is reported with the abbreviations "SCT" (scattered) when sky coverage is 1–4 oktas (one-eighth to four eighths), "BKN" broken when sky coverage is 5–7 oktas, and "OVC" (overcast) when sky coverage is 8 oktas.

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

4. FSF ALAR Task Force; FSF Editorial Staff. "ALAR Briefing Notes." *Flight Safety Digest* Volume 19 (August–November 2000). ALAR Briefing Note 1.6 said that an approach briefing should include the following aspects of the approach and landing: "minimum safe altitude (MSA); terrain, man-made obstructions and other hazards; approach conditions (weather conditions, runway conditions); instrument approach procedure details, including the initial steps of the missed approach procedure; stabilization height [1,000 feet above airport elevation in instrument meteorological conditions or 500 feet above airport elevation in visual meteorological conditions]; final approach descent gradient (and vertical speed); use of automation (e.g., lateral navigation [LNAV] and vertical navigation [VNAV]); communications; abnormal procedures, as applicable; and [review and discussion of the] FSF *Approach-and-landing Risk Awareness Tool*.

5. The FSF *CFIT Checklist*, an element of the FSF *ALAR Tool Kit* developed to increase the awareness of flight crews and aircraft operators of the risks of CFIT during specific flights, includes risk-related numerical values for a variety of factors about the destination (e.g., air traffic control services, the type of approach expected to be conducted, weather conditions), the company (e.g., safety culture, standard operating procedures), the flight crew (e.g., training) and aircraft equipment. The user scores each factor to derive a numerical total that reflects the relative risk for the specific flight.

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