# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

**Date:** April 15, 2002

**In reply refer to:** A-02-08

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On March 29, 2001, about 1902 mountain standard time (MST),[1] a Gulfstream III, N303GA, operated by Avjet Corporation, collided with terrain about 2,400 feet short of runway 15 at Aspen-Pitkin County Airport, Sardy Field (ASE), Aspen, Colorado, while attempting to land. The three crewmembers and all 15 passengers were killed and the airplane was destroyed. The flight was operating under 14 *Code of Federal Regulations* (CFR) Part 135 as a charter flight from Los Angeles International Airport (LAX), Los Angeles, California, to ASE. Although the National Transportation Safety Board's investigation of this accident is ongoing, preliminary findings have revealed a safety issue that warrants the Federal Aviation Administration's (FAA) attention.

**Background**

N303GA departed LAX about 1611 Pacific standard time (1711 MST) on an instrument flight rules (IFR) flight plan and entered the Aspen terminal area about 1843. The cockpit voice recorder indicated that the flight crewmembers planned to conduct a visual approach to runway 15. However, as they descended toward the airport, clouds and snow showers increased, obscuring the field. Weather conditions at the time were reported as follows: wind 250° at 3 knots, visibility 10 miles, light snow, few clouds at 1,500 feet, broken cloud ceiling at 2,500 feet, and broken cloud ceiling at 5,000 feet. As N303GA continued its approach, ASE air traffic controllers provided arriving flight crews vectors for the airport's VOR/DME-C instrument approach procedure[2] and advised them that visibility north of the airport (along the flightpath of the approach) was reduced to 2 miles.

About 1845, the pilots of a corporate jet airplane ahead of N303GA executed a missed approach because they could not adequately identify the runway environment; air traffic control (ATC) broadcast a general advisory that a missed approach was executed. About 1858, the pilots

[1] Unless otherwise noted, all times in this letter are mountain standard time, based on a 24-hour clock.

[2] VOR/DME stands for very high frequency omnidirectional radio range/distance measuring equipment. The "C" in the approach title indicates that the approach does not include a straight-in landing because it does not meet the criteria for course alignment and/or the maximum descent gradient.

of another airplane ahead of N303GA also executed a missed approach because they could not adequately identify the runway environment. N303GA, which was following vectors to the VOR/DME-C approach course, initially descended in accordance with published altitude limits. However, radar data indicate that about 1900, the airplane descended below the published minimum altitude of 10,400 for the segment of the approach being executed. At 1900:48, when the airplane's altitude was about 9,900 feet, the Aspen tower local controller asked the pilot if he had the runway in sight, and the pilot replied that he did. According to the controller, less than 1 minute later, she observed the airplane emerging from a snow shower at a low altitude and not aligned with the runway.[3] Radar data show that, about this time, the airplane started maneuvering to the runway, entering a steep left turn for final runway alignment. While in this turn, the airplane contacted terrain to the right of the extended runway centerline at an elevation of 7,915 feet mean sea level (msl) and 2,400 feet short of runway 15. The elevation at the approach end of runway 15 is 7,674 feet msl.

**Discussion**

Official sunset[4] at the accident site on March 29 was about 1828, which was about 33 minutes before the accident; however, according to Safety Board calculations, the sun would have set below the mountainous terrain about 25 minutes before the official sunset time. The shadow for the ridge immediately to the west of the accident site would have crossed the site 79 minutes earlier than official sunset. All eyewitnesses to the accident reported that lighting conditions were very dark at the time of the crash; one of the controllers described conditions as "very dark" right before the accident. Because of these low light conditions, the pilot of N303GA most likely would not have been able to see the unlighted terrain while maneuvering to land. Although he told the controller that he had the runway in sight as he approached the airport, having the (lighted) runway in sight would not adequately ensure that he could also have seen the intervening unlighted terrain, especially given a higher-than-normal descent rate and his maneuvering to align with an upsloping runway.[5]

The Safety Board's investigation revealed that the accident pilot received a preflight briefing over the phone from the Federal Aviation Administration (FAA) Flight Safety Service. During this briefing, the pilot was informed that ASE's VOR/DME-C approach procedure was

[3] The instrument approach path is from the left side of the extended runway centerline and requires a left turn for final alignment with the runway.

[4] At sunset, the center of the sun is 0.8333° below the horizon and its top edge is at the horizon. According to the U.S. Naval Observatory, the times of sunrise and sunset cannot be computed precisely because "the actual times depend on unpredictable atmospheric conditions that affect the amount of refraction at the horizon. Thus, even under ideal conditions (for example, a clear sky at sea) the times computed for rise or set may be in error by a minute or more. Local topography (for example, mountains on the horizon) and the height of the observer can affect the times of rise or set even more."

[5] The approach end of runway 15 is at an elevation of 7,674 feet; its opposite end is at 7,820 feet, giving the runway an upward slope. Making an approach to an upsloping runway at night can aggravate a visual illusion known as the "black hole approach illusion." A pilot experiencing this illusion is not able to judge the runway's relationship to areas of unlighted terrain in the vicinity and flies a descent that is much more rapid than it should be, leading to CFIT or descent below intervening terrain. For more information, see R.F. Haines and C.L Flatau, *Night Flying*, 1st ed. (Blue Ridge Summit, PA: TAB Books, 1992) 105-111.

not authorized for use at night.[6] Title 14 CFR 1.1 defines the term "night" as "the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time." According to the U.S. Naval Observatory, morning civil twilight begins and evening civil twilight ends "when the center of the Sun is geometrically 6 degrees below the horizon." In most of the continental United States, civil twilight roughly correlates to the 30-minute period before official sunrise and after official sunset.[7]

According to an evaluation prepared by an FAA flight inspection crew, ASE's approach procedure is prohibited at night because there are numerous areas of unlighted rising terrain near the final approach course and the airport's traffic pattern areas; when it is dark, pilots may not be able to safely maneuver to land while avoiding this unlighted terrain. According to the Flight Safety Foundation's "Approach and Landing Accident Reduction CFIT [controlled flight into terrain]" checklist, limited lighting, a non-precision approach, and mountainous terrain are high-risk factors for CFIT.

Safety Board investigators determined that the combined effects of the surrounding terrain's high elevation and weather conditions created twilight and nighttime conditions much earlier than would have occurred in non-mountainous terrain and in clear weather. Therefore, it became apparent during the Board's investigation that the aeronautical definition of "night" does not adequately describe the conditions under which darkness exists in mountainous terrain and, therefore, use of this term may not adequately restrict potentially hazardous flight operations.

During civil twilight, the decrease in ambient illumination and resulting decrease in contrast between objects and the background scene diminishes a pilot's ability to visually distinguish between terrain features and the sky and to visually detect unlighted obstacles. According to a United States Air Force study published in 1971,[8] visual detection of unlighted ground targets decreased by 39 percent under conditions that simulated the ambient light at sunrise or sunset and decreased by 75 percent under conditions that simulated the ambient light at the end of evening civil twilight or the beginning of morning civil twilight as compared to target detection capabilities under full sunlight conditions.

During evening civil twilight, the ambient light decreases by two orders of magnitude over a span of about 30 minutes. The ability of a pilot's eyes to fully adapt to the dark involves a gradual process that takes place over a similar time span. However, because the sky can be much brighter than terrain features during civil twilight, thereby exposing pilots to higher ambient light levels at altitude before descent, the process of dark adaptation can be delayed and its effectiveness, therefore, diminished. In addition, the rapid decreases in ambient illumination during approach and descent may be more pronounced in mountainous areas where terrain

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[6] The nighttime prohibition on ASE's VOR/DME-C approach procedure was contained in Notice to Airmen 1/3034.

[7] H.W Leibowitz and D.A. Owens, "Can Normal Outdoor Activities Be Carried Out During Civil Twilight?," *Applied Optics* Vol. 30 No. 24 (1991): 3501-3503.

[8] J. L. Porterfield, H.C. Self, S.A. Heckart, E. P. Hanavan, and D.F. McKechnie, *Airborne Visual Reconnaissance as a Function of Illumination Level,* AMRL Technical Report 71-9 (Wright-Patterson AFB, OH: U.S. Air Force Aerospace Medical Research Laboratory, DTIC No. 728 629, 1971).

features may rise well above the horizon, even further reducing ambient illumination levels at lower elevations. A pilot's ability to visually detect terrain features and unlighted obstacles can be further impeded during civil twilight as a result of an observed tendency among individuals to visually focus on a point nearer than the point of intended focus when in low illumination conditions.[9]

According to a 1991 review of research on visual factors associated with twilight conditions,[10] low visibility conditions will further reduce luminance levels and the contrast between objects and the surrounding scene. Therefore, the weather conditions at the time of the Aspen accident, which consisted of snow and cloud cover over the airport and approach course, likely further degraded the pilots' ability to detect unlighted terrain and obstacles.

The night prohibition on ASE's VOR/DME-C approach and similar restrictions at other airports recognize and attempt to address the hazards associated with operations over unlighted terrain in the dark by prohibiting night operations. However, the Safety Board is concerned that prohibitions aimed at preventing the hazards associated with flight operations in darkness do not take into account that conditions other than the official onset of "night" (such as high terrain, low visibility weather conditions, combined with human physiological factors) can significantly degrade the amount of ambient light available, creating twilight or nighttime conditions outside of the officially defined periods.

The Board notes that the FAA has recognized, in other contexts, that the threshold of a hazardous low light condition is not always readily defined and may not be adequately captured by the aeronautical definition of "night." For example, 14 CFR 91.157, "Special VFR [visual flight rules] weather minimums" states that special VFR operations may not be conducted between sunset and sunrise unless the pilot is IFR-qualified and the aircraft is IFR-equipped. However, visual transitions from instrument approaches (like that conducted by the pilot of N303GA) are often conducted in weather conditions similar to those in which special VFR applies (that is, visibility of 1 to 3 miles and clear of clouds), which makes the challenge of maintaining visual contact similar in both circumstances. In addition, guidance provided in FAA Order 7110.65, "Air Traffic Control," regarding light intensity settings for approach lights authorizes local facilities to deviate from the guidelines[11] "to meet local atmospheric, topographic, and twilight conditions." Similar exceptions to airfield and aircraft lighting are allowed in Alaska, where a low-light period is defined as that time during which "a prominent unlighted object cannot be seen from a distance of 3 statute miles or the sun is more than 6 degrees below the horizon."

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[9] H.W. Leibowitz and D.A. Owens, "Night Myopia and the Intermediate Dark Focus of Accomodation.," *Journal of the Optical Society of America*, Vol. 65, No. 10 (1975): 1121-1128.

[10] Leibowitz and Owens, *Applied Optics* Vol. 30 No. 24 (1991): 3501-3503.

[11] Paragraph 3-4-5 in the Order provides the following guidance for approach light settings at night: Step 1 when visibility is greater than 3 miles; Step 2 when visibility is 1 to 3 miles inclusive; Step 3 when visibility is less than 1 mile (and/or 6,000 feet or less of the runway visual range [RVR] on the runway served by the approach light system and RVR); and Steps 4 and 5 when requested.

To summarize, the following factors contribute to a diminished capability among pilots to visually detect unlighted terrain and obstacles during civil twilight and during other low-visibility periods outside official "nighttime":

- high local terrain that reduces ambient light levels and reduces visual contrast between objects in the visual scene;
- low visibility conditions that further reduce ambient light levels and visual contrast between objects;
- rapid changes in ambient light levels during approach and descent that may occur more quickly than the time needed to adequately adapt to the dark; and
- a tendency to visually focus on a point nearer than the point of intended focus when in low illumination conditions.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Revise any restrictions and prohibitions that currently reference or address "night" or "nighttime" flight operations in mountainous terrain so that those restrictions and prohibitions account for the entire period of insufficient ambient light conditions, and ensure that it is clear to flight crews when such restrictions and prohibitions apply. (A-02-08)

Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

*Original Signed*

By: Marion C. Blakey
Chairman