National Transportation Safety Board
Aviation Accident Final Report

Location:	KAUNAKAKAI, HI	**Accident Number:**	LAX00FA191
Date & Time:	05/10/2000, 2031 HST	**Registration:**	N241H
Aircraft:	Rockwell NA-265-65	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	6 Fatal
Flight Conducted Under:	Part 91: General Aviation - Executive/Corporate		

Analysis

The airplane collided with mountainous terrain after the flight crew terminated the instrument approach and proceeded visually at night. The flight crew failed to brief or review the instrument approach procedure prior to takeoff and exhibited various cognitive task deficiencies during the approach. These cognitive task deficiencies included selection of the wrong frequency for pilot controlled lighting, concluding that the airport was obscured by clouds despite weather information to the contrary, stating inaccurate information regarding instrument approach headings and descent altitudes, and descending below appropriate altitudes during the approach. This resulted in the crew's lack of awareness regarding terrain in the approach path. Pilots approaching a runway over a dark featureless terrain may experience an illusion that the airplane is at a higher altitude that it actually is. In response to this illusion, referred to as the featureless terrain illusion or black hole phenomenon, a pilot may fly a lower than normal approach potentially compromising terrain clearance requirements. The dark visual scene on the approach path and the absence of a visual glideslope indicator were conducive to producing a false perception that the airplane was at a higher altitude. A ground proximity warning device may have alerted the crew prior to impact. However, the amount of advanced warning that may have been provided by such a device was not determined. Although the flight crew's performance was consistent with fatigue-related impairment, based on available information, the Safety Board staff was unable to determine to what extent the cognitive task deficiencies exhibited by the flight crew were attributable to fatigue and decreased alertness.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Inadequate crew coordination led to the captain's decision to discontinue the instrument approach procedure and initiate a maneuvering descent solely by visual references at night in an area of mountainous terrain. The crew failed to review the instrument approach procedure and the copilot failed to provide accurate information regarding terrain clearance and let down procedures during the instrument approach.

Findings

Occurrence #1: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: APPROACH

Findings
1. (F) TERRAIN CONDITION - MOUNTAINOUS/HILLY
2. (F) LIGHT CONDITION - NIGHT
3. (C) PREFLIGHT PLANNING/PREPARATION - INADEQUATE - FLIGHTCREW
4. (C) IFR PROCEDURE - NOT FOLLOWED - FLIGHTCREW
5. (C) CREW/GROUP COORDINATION - INADEQUATE - PILOT IN COMMAND
6. (C) BECAME LOST/DISORIENTED - INATTENTIVE - FLIGHTCREW
7. (C) DESCENT - INITIATED - FLIGHTCREW
8. (C) ALTITUDE/CLEARANCE - NOT MAINTAINED - FLIGHTCREW

Factual Information

1.1 HISTORY OF FLIGHT

On May 10, 2000, at 2031 Hawaiian standard time (HST), a Rockwell NA 265-65 Sabreliner corporate jet, N241H, collided with mountainous terrain 3.3 nautical miles (nm) southwest of the Kaunakakai Airport (PHMK), on the island of Molokai, Hawaii. The airplane was on a night visual approach for landing; it was destroyed in the collision sequence and post crash fire. Price Aircraft Company, LLC, of Broomfield, Colorado, owned the airplane, and they were operating it as a personal transportation flight under the provisions of 14 CFR Part 91. The airline transport pilot captain, commercial copilot, and four passengers sustained fatal injuries. Night visual meteorological conditions prevailed, and an instrument flight rules (IFR) flight plan had been filed. The flight originated from Tahiti (NTAA) in the mid Pacific Ocean at an estimated departure time of 1300 HST and made an en route refueling stop at Christmas Island (PLCH). It departed Christmas Island about 1600 HST for Maui (PHOG), Hawaii. It cleared customs in Maui about 1930 and departed for Molokai at 2008 HST. The accident site location was 21 degrees 07.634 minutes north latitude and 157 degrees 08.994 minutes west longitude.

The operator detailed the airplane's scheduled itinerary. The trip originated from Jeffco Airport (BJC) in Boulder, Colorado, on April 23, 2000, about 1800 central daylight time (CDT). This allowed the flight to arrive at its destination in Argentina in daylight conditions. Cumulative flight time for this trip was approximately 13 hours, and the flight made four intermediate stops for fuel and customs. The copilot for the trip to Argentina returned to the United States, and the copilot for the accident trip arrived in Argentina on May 7.

The operator said their last conversation with the captain was on May 8, about 2200 Argentine time. On May 9, the airplane departed Esquel (SAVE), Argentina, and made a stop in San Carlos de Bariloche (SAZS), Argentina, to pickup a passenger. It made stops in Chile (SCIE), Easter Island (SCIP), and Tortegegie (NTGJ) for fuel and customs en route to Tahiti. The operator estimated the flight arrived in Tahiti in the early evening hours. Tahiti is in the same time zone as Hawaii.

The copilot telephoned his dispatch office about 0800 HST on May 10, the day of the accident. He said they originally planned to stay in Tahiti until Friday, May 12. However, the airplane's owner left his luggage in Argentina and wanted to continue to his home on Molokai. The crew planned to stop at Christmas Island for fuel, but Christmas Island required 24-hour advance notification for intended fuel purchases. The captain was attempting to get this requirement waived; if he succeeded, they would leave later that day. Otherwise, the copilot said they would leave early on the 11th. He said he would inform dispatch either way, but they did not hear from him.

The crew filed a Jeppesen dataplan indicting an estimated time of departure of 1200 HST from Tahiti. It estimated 3 hours 14 minutes en route to Christmas Island. Another dataplan indicated an estimated time of departure of 1600 HST from Christmas Island. Estimated time en route to Maui was 2 hours 55 minutes.

The Safety Board investigator-in-charge (IIC) reviewed transcripts of recorded radio transmissions between the crew and various Federal Aviation Administration (FAA) air traffic control (ATC) facilities. The transcripts indicated the airplane landed on Maui about 1920

HST. US Customs agents began clearing the flight about 1930. The agents reported the crew was in good spirits; however, one pilot mentioned it had been a long day.

The IIC reviewed a transcript of the cockpit voice recorder (CVR) made by the CVR group. The CVR transcript times did not exactly match the ATC transcript times. The IIC used the ATC times as the reference time and blended pertinent CVR information in at the appropriate relative time. All times listed are in HST. Evidence from the CVR group indicated that the captain was flying the airplane and the copilot broadcast all radio transmissions.

Safety Board staff converted recorded radar data to latitude and longitude coordinates. The IIC reviewed and plotted the computed data. The airplane transmitted a secondary beacon code of 6005 throughout the flight. Mode C reported altitudes were corrected msl (mean sea level) altitudes.

The local controller in the Maui Airport Traffic Control Tower (ATCT) told the crew to file their flight plan to Molokai with the Honolulu Automated Flight Service Station (AFSS) on frequency 123.6.

The copilot contacted the AFSS at 1926:05 while on the ground at Maui. He filed an IFR flight plan from Maui to Molokai. The CVR transcript does not indicate that the crew briefed or reviewed the route of flight or approach. The copilot requested "eight thousand feet, three thousand feet, we'll say three thousand feet." This request did not include route of flight. Clearance delivery responded that preferred routing to Molokai would be "Victor six Blush, Victor eight, and minimum en route altitude is six thousand feet." The copilot responded that they could accept that altitude and routing.

Victor six was the 320-degree radial from the Maui (OGG) VORTAC (very high frequency omni-directional radio range/Tactical Air Navigation). Blush intersection was the point where Victor eight (the 056-degree radial from the Molokai (MKK) VORTAC) intersected Victor six.

At 2002:26, the Maui ATCT said "cleared to Molokai as filed, maintain six thousand and fly heading three four zero, departure one two zero point two, squawk six zero zero five." The copilot requested and received verification of the routing. The CVR transcript indicated that the crew began setting their instruments. The captain told the copilot he thought they would receive radar vectors and would not even get on the airway.

At 2008:11, on frequency 118.7, Maui ATCT cleared the airplane for takeoff on runway 02. About 2 minutes later they instructed the crew to contact Departure Control.

Departure Control established radar contact about 2010, and instructed the crew to join Victor six. The captain asked the copilot to set "that number for me." The copilot responded "three twenty." The captain remarked "join it, we're past it." The copilot agreed. The captain queried, "right then?" At 2010:37, the copilot asked Departure Control to verify that it was a left turn to intercept their assigned radial. Departure advised them to turn to 310 degrees to join the "three twenty." About 1 minute later, Departure instructed them to contact Honolulu Center on frequency 124.1.

At 2013:17, Honolulu Center briefed the crew on the Molokai weather. It was: wind 060 degrees at 8 knots; visibility 10 miles; sky clear; temperature 23 degrees (Celsius); and dew point 18 degrees. This brief also informed the crew to expect a visual approach to Molokai Airport. The mode C reported altitude was 6,000 feet.

During the next 6 minutes of the CVR recording, the crew discussed bookkeeping issues and an

instrument problem. The captain remarked "it really didn't grab it right?" Later the sound of tapping was heard followed by the comment "it's doin' it again." The captain then said it was "holding it or it's giving good directions, the autopilot just isn't uh, capturing it."

About 2020, the copilot noted they were about 10 miles out from Molokai. The captain replied they would be taken around to runway 05 and they would probably pass over the airport before being let down. He also commented that he was not watching where they were going. At 2020:53, the copilot asked for and received clearance to descend to 5,000 feet. The copilot remarked they would probably be let down once they were on the other side of the airport. The captain asked if they were past the airport. During several verbal exchanges trying to clarify their position, the copilot instructed the captain to stay on his heading.

At 2021:45, the airplane was at a mode C reported altitude of 5,000 feet when Honolulu Center pointed the airport out at 11 to 12 o'clock and 3 miles. The copilot responded they were looking, and he told the captain they were still going to the VOR. The captain agreed then asked "7 miles out, to what?" The copilot replied from the VOR and the airport was about 3 miles this side of it. The captain asked what they passed over. The copilot responded he was on "FMS and it switches *** course guidance."

About 2022:37, the copilot told the captain that they should be right over the airport. The copilot said they could ask for the approach, since there were still clouds below them. The crew decided to ask for an instrument approach. At 2023:23, the copilot reported the field was not in sight and requested the VOR Alpha approach.

The crew initiated the instrument approach. The copilot directed the captain to proceed outbound on the 254-degree radial. During the next minute, the copilot advised the captain that the desired course was a radial, not a heading.

The captain asked the copilot if the tower was closed and pilot controlled lighting was available. He asked for the frequency and the copilot responded "eighteen seven." The copilot added that he still saw clouds below them and told the pilot to watch his radial. At 2024:19, the CVR group heard sounds similar to 7 microphone clicks. Then the captain remarked, "now there it is."

As the flight continued on the instrument approach, the copilot briefed parts of the approach. About 2024:59, the captain informed the copilot to just direct him around because the briefing was confusing him. The airplane was at a mode C reported altitude of 4,600 feet.

The copilot instructed the pilot to fly 300 degrees for 1 minute for the procedure turn. The captain asked if they could go down to 2,500 feet, and the copilot responded affirmatively. The captain directed the copilot to set the flaps to 10 degrees and the copilot complied. The captain asked for the inbound course, and the copilot responded it would be the opposite of 254 degrees. When the captain asked if 300 degrees was the right heading, the copilot said no, they were doing the procedure turn. The captain remarked he had to make a left turn and they were coming around. The copilot responded that they were turning back around to, "one nineteen, one twenty." Then the captain said, "oop, not too far. Coming the other way. There you go."

The captain said they were out of 2,500 feet and asked the copilot for the field elevation and was informed 400 feet. The copilot said the radial was alive and they could descend to 2,200 feet inbound to the VOR. The captain requested some clicks to see where the runway was. The CVR group heard two series of sounds similar to 7 microphone clicks beginning at 2027:28. The airplane was at a mode C reported altitude of 2,500 feet.

At 2027:33, Honolulu Center terminated radar service and approved a change to advisory frequency. The airplane was at a mode C reported altitude of 2,400 feet. About 30 seconds later, the CVR group heard another series of 7 clicks. Then the copilot remarked "radial on your side there. Watch your radial."

The captain stated they were 6 miles from the runway. The copilot responded they were 6 miles from the VOR and then they could go down to 1,000 feet. The pilot said, "that's another thousand feet." The copilot said they were 10 miles from the airport, and reported that he selected flaps 20. He said the missed approach was a climbing left turn to a 360-degree heading.

The captain said, "this wasn't supposed to be difficult," then chuckled. He still didn't see the runway and asked the copilot to verify the frequency for the pilot controlled lighting. The copilot advised him they did not have the proper frequency; he said they should be on 125.7. About 2029:47, the CVR group heard 7 sounds similar to microphone clicks. The airplane was at a mode C reported altitude of 2,200 feet. A few seconds later the copilot said he had the runway in sight and, "you have * you're right here." About 2030:12, the airplane was at a mode C reported altitude of 2,100 feet. Safety Board software determined this position was 1.3 nm on a magnetic bearing of 251 degrees from the VORTAC, and 5.3 nm and 232 degrees from the airport.

Then the CVR group heard a sound similar to a decrease in engine rpm. The captain said the landing gear was going down. Then he said the flaps were going to full down. He later added that the landing lights were out.

At 2030:51, the copilot reported to Honolulu Center that they had the airport in sight and cancelled their IFR clearance. The airplane was at a mode C reported altitude of 1,800 feet. Safety Board software determined this position was 0.6 nm on a magnetic bearing of 175 degrees from the VORTAC, and 4.3 nm and 239 degrees from the airport. About 10 seconds later, the copilot broadcast to Molokai traffic that they were inbound to runway 05.

The captain said he was going down a little bit. At 2031:24, the airplane was at a mode C reported altitude of 1,300 feet. Safety Board software determined this position was 1.2 nm on a magnetic bearing of 111 degrees from the VORTAC, and 3.3 nm and 232 degrees from the airport. At this time the captain said, "oop." The copilot said, "that's the clouds." The captain queried, "let's have that again. That's the clouds, huh? Oh." Three seconds later, the captain said, "ooh, wadoyou..." and the CVR recording ended 1 second later.

The airplane obliquely impacted the side of a mountain ridge about 100 feet from the crest of a 1,400-foot ridge.

1.1.1 Statements of Witnesses

A security guard at the airport heard the crew report their intention to land, and then the runway lights illuminated. She saw two blinking lights on the hills west of the airport. She saw the white blinking light of an airplane left of the right light. She normally observes airplanes on the right side of this light and not far away. This airplane was still far away and appeared low over the mountains. She said it was a very clear night and she could see the outline of the mountains. The airplane turned toward her left. She thought this was to align with the runway, but this was farther away from the airport than normal. She stopped watching and went to open a gate. She was out of her vehicle when another person drove up and told her they saw the lights disappear, and then they saw a fireball. She said there were no clouds.

Security guards patrolled the ranch grounds on which the accident occurred. Several of them noted the airplane passed lower than normal over the ridgelines they were on. They also stated it was a clear night.

1.2 INJURIES TO PERSONS

Both flight crewmembers and all four passengers sustained fatal injuries in the collision sequence and post crash fire.

1.3 DAMAGE TO AIRPLANE

The impact and post crash fire destroyed the airplane.

1.4 PERSONNEL INFORMATION

1.4.1 The Captain

The IIC reviewed FAA airman records. The captain held an airline transport pilot certificate with an airplane multiengine land rating. He held a commercial pilot certificate with a rating for airplane single engine land. He held airline transport pilot type ratings in the following airplanes: CE-500, G-S2, HE-25, L-12329, LR-Jet, and N-265. He also held a flight instructor certificate with ratings for single and multiengine land. He held a first-class medical certificate, issued on March 22, 2000, with the restriction that he must wear corrective lenses and possess glasses for near and interim vision. The operator listed the captain's total flight time as 12,775 hours, and he had logged 70 hours in the last 90 days. He had 1,370 hours in this make and model.

The IIC interviewed the chief pilot for the copilot's employer, for whom the captain had also previously worked. The chief pilot flew from Boulder to Argentina with the captain. He reported that they experienced no difficulties with the airplane on the trip to Argentina. He said the captain did not like to use a challenge-response approach to checklists. When they arrived in Argentina at dusk, they encountered unexpected weather. He said it was mountainous terrain, and he took it upon himself to brief the approach. The captain told him to direct the captain through the approach. This pilot had also flown to Molokai with the captain on a previous occasion, and the captain had warned him prior to their arrival about terrain southwest of the airport.

The captain completed the Flight Safety International (FSI) recurrent training course in the Sabreliner between May 24 and May 26, 1999. It included ground instruction on systems, performance, crew resource management (CRM), and flight training in a simulator. During the period March 6 to March 8, 2000, he completed the FSI Citation II Pilot Recurrent Course. The training included ground instruction and three flights (6.0 hours) in a flight simulator. A review of the FSI simulator instructor's remarks revealed a comment that CRM was one of the pilot's weak areas. During the third simulator session, the instructor noted that the pilot needed additional training on landings from an ILS (instrument landing system). FSI instructors reviewed the weak areas and provided additional training as required.

1.5.2 The Copilot

The copilot held a commercial pilot certificate. He had ratings for airplane single and multiengine land, instrument land, and a type rating in the N-265. He held a certified flight instructor certificate, as well as advanced and instrument ground instructor ratings. A first-class medical was issued on September 9, 1999, with no limitations. His employer certified he

satisfactorily completed a 12/24-month Pilot Proficiency flight test in a Sabreliner in accordance with 14 CFR 61.58 on January 18, 2000. His employer supplied a pilot history report to an insurance company dated September 9, 1999. It indicated a total pilot time of 1,725 hours with 600 hours as pilot-in-command. Total hours and pilot-in-command hours, respectively, were: retractable gear 1,200/300; multiengine 1,200/150; turboprop 85/85; jet 1,100/50; actual instrument 90/90; simulated instrument 60/60; and instructor 200/200. His employer said he flew an additional 93.2 hours between September 9 and December 31, 1999, of which 8.9 hours were pilot-in-command. They said he flew 127 hours in the previous 90 days; 73 hours were in Sabreliners. He flew 45 hours in the previous 30 days; 25 hours were in Sabreliners.

The copilot's employer said their records indicated this crew flew together on three previous occasions, including a roundtrip to Argentina in February. Their total flight time together was about 30 hours.

1.5.3 Human Performance/Duty and Rest Periods

The captain had been in Argentina for 2 weeks. The copilot arrived on May 7, and had a rest period until departure on May 9. The captain told the operator that they planned to depart in the morning hours and the itinerary indicated one stop for a passenger pickup and three stops for fuel. Total flight time from Argentina to Tahiti, as indicated by the flight plans submitted by the operator, would have been almost 10 hours 50 minutes. The flight plan into Tahiti indicated an arrival time of 1619 HST (0219Z). The copilot's dispatcher indicated the flight was to arrive in the early evening hours, and the workday would have been over 14 hours. This would have made the estimated time of departure around 0900 and time of arrival around 2320 Argentine time.

The copilot called his dispatcher about 0800 HST on the day of the accident to inform her of an attempt to change the planned itinerary. He reported that all was well, he was excited about the trip, and he was going to take a walk along the beach. If they successfully changed the itinerary, he said they would depart for Hawaii about 1300.

The airplane arrived in Maui at 1920 HST after the en route stop at Christmas Island. The dataplans indicated the total flight time for the trip from Tahiti to Maui was 6 hours 09 minutes. Upon arrival in Maui, the crew spent about 30 minutes clearing customs. During this time, one of the pilots remarked to a customs officer that it had been a long day. At 2008 HST (0308 Argentine time, May 11, 2000), the flight departed from Maui on an instrument flight rules (IFR) flight plan in night visual meteorological conditions. The accident occurred at 2031 HST (0331 Argentine time, May 11, 2000).

While the trip from Esquel to Tahiti took over 14 hours, an intervening rest period in Tahiti occurred before the flight continued on to Maui and Molokai. Since duty times were not recorded, the exact length of this rest period could not be exactly determined. The IIC assumed the rest period would have begun about 1 hour after arrival in Tahiti to account for postflight activities and transport to the hotel. The IIC assumed the rest period ended 1 1/2 hours prior to departure from Tahiti to account for transport from the hotel to the airport and preflight activities. Based on these assumptions, this rest period would have been about 18 hours in duration.

The accident flight was conducted under 14 CFR Part 91, which does not specify any limitations for crewmember flight time and duty period nor any requirements for crew rest periods. While

no specific regulations governed the crew scheduling for this operation, it was useful to compare the actual crew schedule flown to regulations governing nonscheduled, on-demand commercial flight operations.

Title 14 CFR Part 135, Section 135.267, specifies the flight time limitations and rest requirements for unscheduled one and two pilot crews operating under the rules of that part. When the accident flight departed Maui, the crew had logged 6 hours 09 minutes of flight time earlier that day traveling from Tahiti to Maui. According to the flight plan filed with the Honolulu AFSS, the accident flight was scheduled for about 15 minutes of flight time. This totaled about 6 hours 25 minutes of flight time in the 24-hour period prior to the accident occurrence. This was less than the maximum 10 hours of flight time specified in 14 CFR Part 135 for a crew consisting of two pilots. Traveling from Esquel to Tahiti on May 9, 2000, the crew's flight time exceeded 10 hours and their duty day exceeded 14 hours. However, according to available information, the crew had sufficient time available to have received an intervening rest period of greater than 12 consecutive hours during their layover in Tahiti as would be required if the flights were to be conducted under 14 CFR Part 135.

Although compliant with the regulations of 14 CFR Part 135 regarding flight time and flight crew duty and rest periods, the accident flight crew engaged in transmeridian flight the day prior to the accident. They crossed 7 time zones during a duty day that exceeded 14 hours. Therefore, Safety Board Staff examined in more detail the potential contribution of circadian disruption from transmeridian flight and a long duty day within 72 hours of the accident. Highlights of their findings follow.

The flight arrived in Tahiti about 1620 local time on May 9, 2000. The IIC could not establish when the flight crew arrived at their sleeping quarters in Tahiti or when they went to sleep.

Resynchronization of circadian rhythms is usually completed more rapidly after a westward flight as compared to an eastward flight of the same magnitude. For example, researchers (Gander, P. H., Myhre, G., Graeber, R. C., Andersen, H. T., & Lauber, J. K. (1985). Crew factors in flight operations: Effects of 9-hour time zone changes on fatigue and the circadian rhythms of sleep/wake and core temperature. NASA Technical Memorandum 88197) examined sleep and wake onset times after both eastward and westward flights resulting in 9-hour time shifts. After the westbound flight, average sleep onset and wake onset times appeared to be fully adapted to local time by the first night's sleep. However, after the eastbound flight, average sleep onset and wake onset times did not fully readjust until after the third night.

Research has demonstrated that sleep episodes during flight crew trips are of shorter duration than either pre- or post-trip sleep episodes at home. For example, researchers (Gander, P. H., Graeber, R. C., Foushee, H. C., Lauber, J. K. & Connell, L. J. (1984). Crew factors in flight operations II: Physiological responses to short-haul air transport operations. NASA Technical Memorandum 108856) found that mean sleep duration among 74 pilots studied was 7.06 hours in the days before their trip, 6.69 hours during their trip, and 7.36 hours in the days after the trip. Research indicated that most pilots were able to successfully manage their rest periods during trips involving transmeridian flight by either sleeping efficiently at selected times or by sleeping less efficiently but staying in bed longer or by napping. Nonetheless, subjective sleep quality typically decreases slightly (Graber, R. C. (1988). Aircrew fatigue and circadian rhythmicity. In (E. L. Wiener & D. C. Nagel, Eds.) Human Factors in Aviation, San Diego: Academic Press).

The accident occurred after sunset in the local area, during the early morning hours in the time zone that the flight crew was still predominantly acclimatized to (0331 Argentine time). The copilot talked to his dispatch office via telephone about 0800 HST (1500 Argentine time) on the day of the accident. It was unknown whether he had taken any additional sleep in the intervening time before the airplane departed Tahiti. If not, he would have been awake for at least 12 hours 30 minutes at the time of the accident. It was unknown when the captain awoke and how long he had been awake when the accident occurred.

Time since awakening is considered to be a primary factor in fatigue-related aviation accidents as accident data indicates significantly higher accident rates when time awake is greater than about 13 hours (National Transportation Safety Board (1994). A review of flightcrew involved major accidents of U.S. air carriers, 1978 through 1990. NTSB SS-94-01. See also, Batelle Memorial Institute, JIL Information Systems (1998). An overview of the scientific literature concerning fatigue, sleep, and the circadian cycle. Prepared for the Office of the Chief Scientific and Technical Advisor for Human Factors, Federal Aviation Administration).

Fatigue and decreased alertness can manifest themselves in performance decrements and errors. Graber [Graber, R. C. (1988). Aircrew fatigue and circadian rhythmicity. In (E. L. Wiener & D. C. Nagel, Eds.) Human Factors in Aviation, San Diego: Academic Press] identified four categories of performance effects attributable to fatigue and sleep loss including: 1) increased reaction time; 2) reduced attention; 3) diminished memory; and 4) withdrawn mood.

1.6 AIRPLANE INFORMATION

1.6.1 General

The airplane was a Sabreliner NA 265-65, serial number 465-5. The operator maintained it in accordance with a computerized aircraft maintenance program. A 150-hour inspection was completed on March 3, 2000, at a total time of 8,053.2 hours. This inspection occurred after a second set of avionics, which included a global positioning system (GPS), air data computer, and altimeter, were installed to make the airplane compliant with the rules governing Reduced Vertical Separation Minimum (RSVM). The operator said the captain was familiar with the system installed and helped determine what system to purchase. The most recent entry was a check of airworthiness directives and service bulletins on April 7, 2000.

1.6.2 Engines

Honeywell TFE-731-3R-1D engines were on the airplane. Each was rated at 3,700 pounds of thrust. Serial number P-83108 was on the on the left side of the airplane. Serial number P-83110 was on the right side. Total time on the left engine was 7,656 hours. Total time on the right engine was 7,409 hours.

1.6.3 Equipment

GROUND PROXIMITY ALERTING

The airplane was not equipped with a ground proximity warning device. Safety Board staff made no determination whether and to what extent various ground proximity warning devices would have provided the crew with information and alerts regarding terrain proximity during their approach to Molokai.

As a result of investigations of similar accidents, the Safety Board issued safety recommendations A-92-55, A-95-035, and A-99-036 to the FAA, which recommended some

form of terrain warning capability on turbine-powered airplanes.

In response to these safety recommendations, the FAA issued its final rule on March 23, 2000, requiring that all U.S. registered, turbine-powered airplanes configured with six or more passenger seats be equipped with a terrain awareness and warning system (TAWS). The final rule requires that new production airplanes be equipped with TAWS by March 29, 2002, and existing airplanes by March 29, 2005.

This airplane had a seating configuration for eight passengers. Consequently, the owner/operator would have been required to comply with the FAA rule mandating the installation of TAWS by March 29, 2005.

1.6.4 Weight and Balance

The operator provided the IIC with passenger weights and an estimated weight of baggage. The IIC used the dataplan to Maui to estimate 4,000 pounds of fuel remaining upon landing there. The manufacturer's representative used information in the airplane's logbooks to establish the airplane's base line center of gravity range and weight. Using this information, the manufacturer's representative estimated that the airplane operated within the manufacturer's suggested limits throughout the takeoff and accident.

1.7 METEOROLOGICAL CONDITIONS

A routine aviation weather report (METAR) for Molokai was issued at 2054 HST. It stated: skies clear; visibility 10 miles; winds from 050 degrees at 14 knots; temperature 73 degrees Fahrenheit; dew point 67 degrees; and altimeter 30.13 inHg.

Safety Board software determined that sunset occurred at 1900, civil twilight occurred at 1924, and there was 55 percent illumination of the moon.

1.8 AIDS TO NAVIGATION

A statement from the Hawaii Department of Transportation confirmed the airport's operational status. All airfield lighting was operational. All obstruction lights at Waihee Hill and Waihuna Hill, 2 miles southwest of the airport, were operational.

The FAA International Flight Inspection Office (IFIO) reported on the status of the VORTAC. The IFIO completes a flight checked of the VORTAC every 570 days (18 months). The Molokai VORTAC was inspected on June 15, 1999. All systems were satisfactory. Additional ground self-tests are done quarterly. The VORTAC completed satisfactory ground tests on March 22, 2000, and May 11, 2000.

1.9 COMMUNICATIONS

The crew filed an IFR flight plan with Honolulu AFSS while on the ground in Maui on frequency 123.6. Departure Control established contact on frequency 120.2. Departure turned control over to Honolulu Center on frequency 124.1. The pilot reported the airport in sight on the common traffic advisory frequency (CTAF) of 125.7.

1.10 AIRPORT INFORMATION

1.10.1 Airport

The US Chart Supplement Pacific Airport/Facility Directory (A/FD) indicated the field elevation was 454 feet. Runway 05 was 4,494 feet long and 100 feet wide. The runway surface

was composed of asphalt.

The communications section stated that the air traffic control tower ceased operations at 1830 HST. Pilot controlled lighting was available on the CTAF of 125.7. The A/FD legend noted that seven clicks of the microphone would illuminate the runway lights to their maximum intensity.

The radio aids to navigation section noted that the airport was on a magnetic bearing of 066 degrees at 4.1 nm from the VORTAC. The remarks section indicated that runway 05 was equipped with a precision approach path indicator (PAPI) with a 3.0-degree glideslope angle. However, the PAPI was not authorized for use beyond 1.8 nm beyond the landing threshold due to rapidly rising terrain, and it was not operational at night.

1.10.2 Approach Information

The company provided the crew with Jeppesen airway charts and instrument approach procedure (IAP) charts. The planform view of the IAP chart contained a boxed note, which said pilot controlled lighting was available. The chart indicated that the Molokai tower did not operate continuously.

The IAP chart depicted the procedure turn. It specified an outbound course of 254 degrees from the VOR. It depicted a right turn to a heading of 299 degrees to enter the procedure turn and a minimum altitude during the procedure turn of 2,500 feet. It depicted a descent to 2,200 feet when the flight was established on the inbound course (074 degrees) back to the VOR.

The VOR/GPS-A approach to Molokai was a nonprecision approach. It contained multiple step-down fixes based on VORTAC station passage and distance measuring equipment (DME) fixes. The approach also required a heading change upon passage of the Molokai (MKK) VORTAC. The step-downs continued to a minimum descent altitude (MDA), illustrated on the chart, which was determined by the category of the airplane. This airplane had DME installed, and the manufacturer's representative stated it was in category C.

The final approach fix (FAF) was over the MKK VORTAC. At the FAF, the IAP chart depicted a left turn to 070 degrees. The crew was to maintain this course until the missed approach point. At the FAF, the crew could initiate a descent to 1,800 feet until 1 nm from the VOR. At this point, descent could continue down to 1,580 feet until 2 nm from the VOR. At 2 nm, descent could continue to an MDA of 1,080 feet (Category C). This altitude was to be maintained until the missed approach point 3.8 nm from the VOR.

An airport diagram followed the IAP chart. A boxed note on the airport diagram stated, "Mountains located 2.8 NM from threshold Rwy 5 approximately 1,280' high on extended centerline." This chart instructed the crew to activate medium intensity runway lighting on frequency 125.7.

1.11 COCKPIT VOICE RECORDER

The IIC removed a CVR from its mounting position in the empennage. It was a Fairchild model A-100A, serial number 2054. The exterior of the CVR was charred and physically damaged. The IIC shipped the unit to the Safety Board's audio laboratory in the Vehicle Recorders Division. The CVR had a Dulane underwater locator beacon installed on it; however, one end melted and it was unusable. The interior circuit boards were burned and partially melted. The interior of the memory module and the tape sustained no apparent heat or impact damage. The recording consisted of three channels of good quality audio

information. The recording started as the crew was starting the engines prior to departing Maui and continued uninterrupted until the accident.

1.12 WRECKAGE AND IMPACT INFORMATION

The principal impact crater (PIC) was about 13 feet long and 7 feet wide in soft dirt. It was approximately 100 feet below the crest of a 25-degree upslope in sparsely vegetated, hilly terrain. The first identified point of contact was a ground scar. This ground scar was approximately 20 feet long and 1 foot wide. It was perpendicular to the debris field, and led to a tree stump that was 3 feet high. This stump was bent over and scraped in the direction of the debris path. A brushy tree approximately 20 feet tall was lying over the stump. Its broken trunk was uphill in the direction of the debris path. Its crown was lying back over the stump.

Two flap track fairings bracketed the stump. Each was 1 foot away from the stump. The remaining two flap track fairings were near the beginning of the PIC. The debris path led up the slope along a magnetic bearing of 070 degrees. A charred area began near the end of the PIC and fanned out up the hill. Most of the components were close to the debris path centerline and contained within an area 275 feet long and 110 feet wide. The cabin was about 150 feet from the PIC. The last large piece found was the aft battery. It was 275 feet from the IPC. One main landing gear wheel separated midway up its strut. It was at the base of the hill 153 feet prior to the PIC. It was on the opposite side of a fence from the remaining wreckage. The fence was about 6 feet high. It consisted of two sections of overlapping wire tied together at the midpoint. The only separation of the wire halves was in the vicinity of the wheel.

Major components of the airplane surrounded the cabin area. These components were within an area about 70 feet long and 50 feet wide. Distribution of these components along the debris path began with the empennage and left wing.

The left wing separated and came to rest in a ditch on the left side of the debris path. Its tip pointed downhill. The wing root pointed uphill on a bearing of 070 degrees. The aileron hinges were attached and the bolts were in place. However, the aileron was consumed by fire. The left flap and its actuators separated.

Ten feet right of the left wing was the empennage. It canted about 30 degrees into the air. The vertical stabilizer and rudder fractured about the midpoint. The top halves were lying along side of the bottom halves. The right horizontal stabilizer and elevator were charred. The outboard half of the left horizontal stabilizer and elevator were consumed by fire.

The debris path continued uphill to the right wing and engines. The right wing was left of the debris centerline and pointing opposite the direction of the debris path. The leading edge of the wing exhibited crush damage. The right flap and one actuator separated. The flap was consumed by fire.

The engines were on the centerline of the debris path. They were still attached to the pylon, and this whole assembly was inverted. The left engine was on the right and the right engine was on the left.

The cabin area was consumed by fire.

The cockpit area was a few feet past the cabin. The instrument panel fractured into several pieces. A five-point lap belt with all latches secured was in this section of wreckage. All latches released when the IIC operated the buckle. The entry door was on the left side of this cluster of wreckage.

About 80 feet past the cockpit were the last large pieces of debris. A section of the inboard leading edge of the left wing, a battery, and a battery cover were along the crest of the hill. These pieces were not charred or sooty.

The control wheels were consumed by fire. The bottom ends of the push pull tubes were connected at the lower end and through the cabin floor area. They disintegrated to the touch. The ends of the right and left aileron push pull tubes and cables were accounted for. Fractured push pull tubes separated along an irregular and angular plane. The right aileron cable barrel nut was attached to a fractured pulley. The pulley's fracture surface was irregular. The interconnect cable separated in the middle of the cabin area. The left aileron cable separated in a broom straw pattern.

The flap actuators measured 20.5 inches. The airframe manufacturer's representative determined this was the full extend position. The airframe representative determined the landing gear were in the down position.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

The Maui County Police Department completed autopsies of the pilots. The FAA Toxicology and Accident Research Laboratory performed toxicological testing of specimens of the pilots.

1.13.1 Captain

The results of analysis of the specimens for the captain were negative for volatiles and tested drugs. Tests for carbon monoxide and cyanide were not performed.

1.13.2 Copilot

The results of analysis of the specimens for the copilot were negative for carbon monoxide, volatiles, and tested drugs. A positive reading of 0.41 (ug/ml) of cyanide was detected in the blood.

1.14 FIRE

Fire consumed the majority of the wreckage. Rivulets of a shiny molten metal cascaded down through the debris field. Local fire units responded and extinguished the fire.

1.15 SURVIVAL ASPECTS

1.16 TESTS AND RESEARCH

1.16.1 Engines

The IIC supervised examination of the engines at the Honeywell Product Safety and Integrity Laboratory in Phoenix, Arizona, on June 13 and 14, 2000.

1.16.1.1 Right Engine

Damage was more extensive to the right engine fan rotor than to the left engine fan rotor. Fourteen of 30 first stage fan blades separated from their mounting slots in the right engine's hub. Most of these blades were found in the debris path just prior to the engines. Five of the remaining blades fractured and separated at their root in an irregular and grainy pattern. The 11 remaining blades bent opposite to the direction of rotation. Examiners observed contour rubs on the following components. The rubs covered the approximate arcs listed. Adjacent components exhibited rub marks.

COMPONENT	DEGREES OF RUB ARC

First-stage compressor shroud	360
First-stage compressor stator shroud	360
Second-stage compressor shroud	360
Third-stage compressor shroud	360
Third-stage compressor stator shroud	360
Fourth-stage axial compressor shroud	360
High-pressure (HP) compressor assembly	330
HP turbine shroud	180
First-stage LP turbine shroud	225
Second-stage LP turbine shroud	225
Third-stage LP turbine shroud	135

Metal spray deposits were evident on the suction side of the HP turbine blades, HP turbine nozzle vanes, first-stage LP turbine blades, first-stage LP turbine nozzle vanes, second-stage LP turbine nozzle vanes, and third-stage LP turbine nozzle vanes. Debris was between the vanes of the compressor, in holes in the combustion liner, in the turbine between the rotor blades, and about 1/4 inch thick around the blade tip shrouds. This debris appeared to be a fibrous fabric with a metallic coating.

1.16.1.2 Left Engine

All fan blades were in their mounting slots in the left engine's hub. Nineteen blades displayed leading edges bent opposite the direction of rotation. Examiners observed contour rubs on the following components. The rubs covered the approximate arcs listed. Adjacent components exhibited rub marks.

COMPONENT	DEGREES OF RUB ARCS
Second-stage compressor shroud	360
Third-stage compressor shroud	45
HP turbine shroud	60
First-stage LP turbine shroud	360
Second-stage LP turbine shroud	135
Third-stage LP turbine shroud	180
Fan spinner support	360

Metal spray deposits were evident on the suction side of the HP turbine blades, HP turbine nozzle vanes, first-stage LP turbine rotor, first-stage turbine nozzle vanes, and second-stage LP turbine nozzle.

Black soot coated the internal components of both engines from the compressor to the HP impeller. The power lever angle was 100 degrees for the left engine and 122 degrees for the right engine. The engine manufacturer's representative stated the power lever angle ranged from 20 degrees minimum to 122 degrees maximum. Both exhaust cones collapsed inward.

The examiners did not discover a pre-existing condition that would have precluded normal operation.

1.16.2 Avionics

The IIC sent some of the radio units to a Rockwell Collins facility in Wichita, Kansas, for examination under the supervision of the FAA. Technicians examined two altimeters. One altimeter was set to 29.10 inHg; the other setting could not be determined. They examined two horizontal situation indicators. One had an inbound course of 075 degrees selected and was indicating a heading of 077 degrees. The bearing pointer was indicating 120. They could not determine what frequency was selected. They could not determine the other indicator's heading and selected course. Examination determined the attitude direction indicator (ADI) was not using the flight director command bars. The ADI indicated a slight 3- to 4-degree climb and a 5-degree right bank angle. A rate of turn gyro, model 345A7, exhibited rotational scoring along the midpoint around its entire circumference.

The radar altimeter, ALT-55B #5907, part number 622-2855-001, appeared functional. However, an A7J3 connector was severed; a Collin's representative indicated this was known to occur when units were jolted. The technicians noted heavy soot on the pins and some broken connections; therefore, they could not complete all functional tests. However, after they cleaned the pins and overcame intermittent connections, the technicians applied a test signal and noted appropriate readings for various simulated altitudes on the test console.

1.16.3 Black Hole Phenomenon

Chapter 8-1-5 of the Airman's Information Manual discusses illusions in flight. Section 3 discusses factors leading to landing errors, and item (d) discusses the featureless terrain illusion. It notes that an absence of ground features, as when landing over water, darkened areas, and terrain made featureless by snow, can create the illusion that the aircraft is at a higher altitude than it actually is. The pilot who does not recognize this illusion will fly a lower approach.

1.17 ORGANIZATIONAL AND MANAGEMENT INFORMATION

The airplane was a private operation.

1.18 ADDITIONAL INFORMATION

The wreckage was released to the owner's agent. Parties to the investigation were Sabreliner, Honeywell, Executive Aircraft Services, Price Aircraft, and the FAA.

Pilot Information

Certificate:	Airline Transport; Flight Instructor; Commercial	**Age:**	63, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	**Last FAA Medical Exam:**	03/22/2000
Occupational Pilot:		**Last Flight Review or Equivalent:**	03/08/2001
Flight Time:	12775 hours (Total, all aircraft), 1370 hours (Total, this make and model), 9000 hours (Pilot In Command, all aircraft), 70 hours (Last 90 days, all aircraft), 25 hours (Last 30 days, all aircraft), 9 hours (Last 24 hours, all aircraft)		

Co-Pilot Information

Certificate:	Commercial	**Age:**	28, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	09/09/1999
Occupational Pilot:		**Last Flight Review or Equivalent:**	01/18/2000
Flight Time:	1990 hours (Total, all aircraft), 259 hours (Total, this make and model), 630 hours (Pilot In Command, all aircraft), 127 hours (Last 90 days, all aircraft), 45 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Rockwell	**Registration:**	N241H
Model/Series:	NA-265-65 NA 265-65	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	464-5
Landing Gear Type:	Retractable - Tricycle	**Seats:**	10
Date/Type of Last Inspection:	04/01/2001, Continuous Airworthiness	**Certified Max Gross Wt.:**	24000 lbs
Time Since Last Inspection:	6 Hours	**Engines:**	2 Turbo Fan
Airframe Total Time:	7934 Hours as of last inspection	**Engine Manufacturer:**	Garrett
ELT:	Not installed	**Engine Model/Series:**	TFE 731-3R-1D
Registered Owner:	PRICE AIRCRAFT COMPANY, LLC	**Rated Power:**	3700 lbs
Operator:	PRICE AIRCRAFT COMPANY, LLC	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Night
Observation Facility, Elevation:	PHMK, 454 ft msl	**Distance from Accident Site:**	3 Nautical Miles
Observation Time:	1954 HST	**Direction from Accident Site:**	52°
Lowest Cloud Condition:	Clear	**Visibility**	10 Miles
Lowest Ceiling:	None	**Visibility (RVR):**	0 ft
Wind Speed/Gusts:	8 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	60°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	23°C / 18°C
Precipitation and Obscuration:			
Departure Point:	MAUI, HI (OGG)	**Type of Flight Plan Filed:**	IFR
Destination:	KAUNAKAKAI, HI (MKK)	**Type of Clearance:**	VFR
Departure Time:	2008 HST	**Type of Airspace:**	Class G

Airport Information

Airport:	KAUNAKAKAI (MKK)	**Runway Surface Type:**	Asphalt
Airport Elevation:	454 ft	**Runway Surface Condition:**	Dry
Runway Used:	05	**IFR Approach:**	VOR
Runway Length/Width:	4494 ft / 100 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	4 Fatal	**Aircraft Fire:**	On-Ground
Ground Injuries:	N/A	**Aircraft Explosion:**	On-Ground
Total Injuries:	6 Fatal	**Latitude, Longitude:**	21.127222, -157.149722

Administrative Information

Investigator In Charge (IIC):	HOWARD D PLAGENS	**Report Date:**	07/25/2002
Additional Participating Persons:	DAVE RYON; FAA Flight Standards District Office; Honolulu, HI JOHN J MECALO; Sabreliner Corporation; St. Louis, MO DAVE CHAPEL; Honeywell Engines & Systems; Phoenix, AZ JEFF HORNER; PRICE AIRCRAFT LLC; BLOOMFIELD, CO HARRY LITTLETON; EXECUTIVE AIRCRAFT SERVICES; WICHITA, KS		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		