National Transportation Safety Board
Aviation Accident Final Report

Location:	EAGLEVILLE, CA	**Accident Number:**	LAX02FA031
Date & Time:	11/21/2001, 1126 PST	**Registration:**	N900RA
Aircraft:	Aero Commander 500S	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	5 Fatal
Flight Conducted Under:	Part 91: General Aviation - Personal		

Analysis

The airplane collided with mountainous terrain during cruise after encountering turbulence and downdrafts associated with mountain wave conditions. According to Federal Aviation Administration (FAA) records, the pilot called the Reno Automated Flight Service Station at 0941 and filed an IFR flight plan, then asked for the winds aloft forecast, which was provided. The pilot did not request any additional weather briefing information for the flight. No other record was found that the pilot obtained additional weather forecast information from any official source associated with the FAA or the National Weather Service. At the time of the pilot's call to the Reno AFSS, several AIRMET weather advisories had been issued hours prior detailing warnings for turbulence and clear icing along the route of flight. The advisories warned of occasional moderate turbulence below 18,000 feet in moderately strong westerly winds especially in the vicinity of mountainous terrain. Clear Air Turbulence (CAT) between 18,000 and 40,000 feet was forecast over the area of the accident site due to jet stream wind shear and mountain wave activity. The pilot departed under visual flight rules (VFR) and picked up his instrument flight rules (IFR) clearance en route and climbed to 14,000 feet. The pilot later asked if he could maintain 12,500 feet. The controller advised him that the minimum IFR altitude on this segment of his route was 14,000 feet, and the pilot cancelled his IFR flight plan. The controller advised the pilot that he had lost radar contact, and instructed the pilot to squawk VFR and the pilot acknowledged the transmission. The last radar target was about 1/2 mile east of Eagle Peak (elevation 9,920 feet) in the Warner Mountains. Rescuers discovered the wreckage near the crest of Eagle Peak on November 23. Investigators found no anomalies with the airframe, engines, or propellers that would have precluded normal operation. The NWS had a full series of AIRMETs current over the proposed route of flight, which included mountain obscuration, turbulence, and icing. Analysis of the weather conditions disclosed a layer between 9,500 and 11,000 feet over the accident site area as having a high likelihood of severe or greater turbulence. A pilot on the same route of flight reported at 1127 that he was in instrument conditions at 11,000 feet, and experiencing light turbulence and light clear icing conditions. He also reported encountering updrafts of 2,000 feet per minute, which was indicative of mountain wave activity. A company pilot was in a second Aero Commander trailing the accident airplane and he reported that at 1147, at a position near the accident site, he encountered a severe downdraft. He applied full climb power, but as the

airplane passed over the accident site position, the airplane continued to lose altitude even at maximum power. At 1159, he was able to gain altitude, and return to his assigned cruising altitude of 14,000 feet. The second Aero Commander was turbocharged, the accident airplane was not. Analysis showed that the topography of the area was critical in this case, given that the accident site was at an elevation of 9,240 feet on the eastern slope of Eagle Peak. The accident airplane's flight track was normal along the airway until immediately downwind of the higher terrain. As the flight approached the lee side of the mountain, it came under the influence of the mountain wave and first encountered an updraft and then a downdraft, which increased in amplitude as the flight progressed towards Eagle Peak. Eagle Peak was the tallest point along the Warner Mountain range and the steep slope of this terrain was significant when the mountain wave action was encountered. Such terrain features have been known to enhance the vertical downdrafts and updrafts associated with the most intense mountain wave turbulence.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: the pilot's encounter with forecast mountain wave conditions, moderate or greater turbulence, and icing, with downdrafts that likely exceeded the climb capability of the airplane, which was encountered at an altitude that precluded recovery. Also causal in the accident was the failure of the pilot to obtain an adequate preflight weather briefing which would have included a series of Airmets that were in effect at the time.

Findings

Occurrence #1: IN FLIGHT ENCOUNTER WITH WEATHER
Phase of Operation: CRUISE

Findings
1. (C) WEATHER CONDITION - MOUNTAIN WAVE
2. (C) WEATHER CONDITION - TURBULENCE,TERRAIN INDUCED
3. (C) WEATHER CONDITION - ICING CONDITIONS
4. (C) PREFLIGHT BRIEFING SERVICE - NOT USED - PILOT IN COMMAND

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings
5. WEATHER CONDITION - DOWNDRAFT
6. AIRCRAFT PERFORMANCE,CLIMB CAPABILITY - EXCEEDED
7. TERRAIN CONDITION - MOUNTAINOUS/HILLY

Factual Information

HISTORY OF FLIGHT

On November 21, 2001, at 1126 Pacific standard time (PST), an Aero Commander 500S, N900RA, collided with terrain near Eagleville, California. Commander Northwest Limited was operating the airplane under the provisions of 14 CFR Part 91. The airline transport pilot licensed pilot, a commercial rated pilot passenger, and three passengers sustained fatal injuries; the airplane was destroyed. The personal cross-country flight departed Reno, Nevada, at 1037, en route to Wenatchee, Washington. Visual meteorological conditions prevailed at the nearest reporting station, which was 24 miles away. An instrument flight rules (IFR) flight plan had been filed. The approximate global positioning system (GPS) coordinates of the primary wreckage were 41 degrees 17.69 minutes north latitude and 120 degrees 11.936 minutes west longitude.

According to Federal Aviation Administration (FAA) records, the pilot called the Reno Automated Flight Service Station at 0941. The records show that the pilot filed an IFR flight plan, then asked for the winds aloft forecast. The specialist provided the winds aloft information. The pilot did not request any additional weather briefing information for the flight. No other record was found that the pilot obtained additional weather forecast information from any official source associated with the FAA or the National Weather Service. At the time of the pilot's call to the Reno AFSS, several AIRMET weather advisories had been issued hours prior detailing warnings for turbulence along the route of flight. The advisories warned of occasional moderate turbulence below 18,000 feet in moderately strong westerly winds especially in the vicinity of mountainous terrain. Clear Air Turbulence (CAT) between 18,000 and 40,000 feet was forecast over the area of the accident site due to jet stream wind shear and mountain wave activity. Complete details of the weather forecasts and conditions can be found in the Meteorological Information Section of this report.

A transcript of recorded radio transmission indicated that the pilot informed clearance delivery that he would depart under visual flight rules (VFR) and pickup his IFR clearance en route. At 1044, the pilot requested his IFR clearance from Reno Departure Control. Departure control cleared him to his destination via radar vectors Lakeview (LKV) VORTAC (very high frequency omni-directional radio range, tactical air navigation) as filed. They then cleared him via the V165 airway as filed, and the pilot acknowledged the clearance.

At 1051, the pilot checked in with Oakland Air Route Traffic Control Center (ARTCC) climbing through 12,000 feet to 14,000 feet. The controller instructed the pilot to fly a heading of 350 degrees to intercept V165.

At 1054, the pilot asked if he could maintain 12,500 feet. The controller advised him that the minimum IFR altitude on V165 was 14,000 feet, and the pilot cancelled his IFR flight. The controller said that he could provide flight following, but would lose radar contact in 20 miles. At 1059, the controller advised the pilot that he had lost radar contact, and instructed the pilot to squawk VFR and approved a frequency change; the pilot acknowledged the transmission.

Recorded radar data depicted a target operating along V165 at a mode C reported altitude of 10,500 feet. Between 1112 and 1126, the data indicated a series of up and down oscillations of 100 to 200 feet, which increased in frequency as the target approached the Warner Mountain Range. At 1124:58, the target made a slight change in course to the northwest and began

descending.

The last target occurred at 1126:22, at 41 degrees 17 minutes 09 seconds north latitude and 120 degrees 11 minutes 41 seconds west longitude. This was about 1/2 mile east of Eagle Peak (elevation 9,920 feet). Rescuers discovered the wreckage near the crest of Eagle Peak on November 23. A team recovered the wreckage on July 23, 2002.

PERSONNEL INFORMATION

A review of FAA airman records revealed that the pilot held an airline transport pilot certificate with an airplane multiengine land rating. He held a commercial pilot certificate with ratings for single engine land, single engine sea, and glider aero tow. He held a certified flight instructor certificate with ratings for airplane single engine and multiengine land, instrument airplane, and glider. The operator estimated that the pilot's total flight time was 20,000 hours.

The pilot held a ground instructor certificate with ratings for advanced and instrument. He held an airframe and powerplant mechanic certificate.

The pilot held a second-class medical certificate issued on February 23, 2001. It had the limitations that the pilot must wear corrective lenses and possess glasses for near and interim vision.

AIRCRAFT INFORMATION

The airplane was an Aero Commander 500S, serial number 3070. The operator reported a total airframe time of 8,101 hours. The last annual inspection occurred on September 30, 2001.

The airplane had a Textron Lycoming IO-540-E1B5 engine, serial number L-8632-48, installed on the left side. Time since overhaul on the engine at the annual inspection was 1,197 hours.

The airplane had a Textron Lycoming IO-540-E1B5 engine, serial number L-6421-48, installed on the right side. Time since overhaul on the engine at the annual inspection was 1,197 hours.

METEOROLOGICAL CONDITIONS

A National Transporation Safety Board staff meteorologist prepared a factual report, and a summary of the report follows. All directions are referenced to true north and distances are in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles. The IIC converted all time to PST.

The report included a topographical map, which showed the accident site on the eastern slope of the Warner Mountain Range.

Surface Observations

Alturas (KAAT), California, which was the nearest reporting station, was 24 miles west-northwest of the accident site at an elevation of 4,374 feet. It had an Automated Surface Observation System (ASOS). An aviation routine weather report (METAR) for Alturus was issued at 1055. It stated: auto; skies 3,400 feet overcast; visibility 10 miles; winds from 190 degrees at 12 knots; temperature 8 degrees Celsius (C); dew point 4 degrees C; altimeter 29.90 inches of mercury. The remarks section noted that the thunderstorm sensor was inoperative.

A METAR for Alturus at 1155 stated: auto; skies 3,400 feet overcast; visibility 10 miles in light rain; winds from 220 degrees at 6 knots; temperature 7 degrees Celsius (C); dew point 5

degrees C; altimeter 29.88 inches of mercury. The remarks section noted less than 0.01 inch of precipitation since the last observation, and that the thunderstorm sensor was inoperative.

Surface Analysis Chart

The National Weather Service (NWS) Surface Analysis Chart issued for 1000 on November 21, 2001, depicted a low pressure system over Idaho with a dissipating cold front to the south of the accident site. This system turned into a warm front and connected with an occluded frontal system with a low pressure system with a central pressure of 988 millibars (mb) off the Pacific coast. Across central and northern California, two high pressure systems with central pressures of 1019 mb and 1020 mb were on either side of the dissipating cold front, with one high pressure system located immediately to the south-southwest of the accident site. The isobars depicted an increasing gradient off the Pacific Northwest coast, but no significant pressure gradient over northern California at the surface.

Weather Depiction Chart

The NWS Weather Depiction Chart issued for 1100 depicted the dissipating cold front to the south of the accident site. It depicted a large area, which included the accident site, of marginal visual flight rule (MVFR) conditions over central and northern California, and southern Oregon. Station models in northern California closest to the accident site depicted the MVFR conditions with continuous light to moderate rain with overcast ceilings from 1,600 to 3,000 feet. Two isolated areas of IFR conditions were also depicted across western and central California, to the west and south of the accident site.

Radar Summary Chart

The NWS Radar Summary Chart for 1115 depicted a large area of echoes over central and northern California, western Nevada, Oregon, and western Washington. It depicted echo intensity in the vicinity of the accident site as very light to light rain, with echo tops to the west ranging from 22,000 to 24,000 feet. One of the closest radar sites used in northern California, however, was not available. The closest cell motion was over Oregon and indicated movement to the east-southeast at 51 knots.

Constant Pressure Charts

The NWS constant pressure charts for 700 mb depicted a low pressure system off the Washington and Oregon coast with an associated trough of low pressure extending eastward and southward from the low. A high pressure system was also depicted further to the south of the low in the Pacific Ocean approximately 28 degrees north latitude and 132 degrees west longitude. Between these two systems, the compressed contour lines over northern California and Oregon indicated a steep pressure gradient, with the strongest gradients off the Pacific Northwest coast. The orientation of the contour lines indicated westerly winds over Oregon, northern California, and Nevada. The zero degree isotherm was out of phase with the contour lines and was to the west of the accident site. The 700 mb best approximated the conditions of the last known altitude of the accident airplane at 10,500 feet, and indicated a westerly wind with temperatures below freezing.

The station model for Reno on the 700 mb chart indicated a height of 3,032 meters (9,948 feet), with a west-southwest wind at 40 knots, a temperature of -1 degree C, and a temperature-dew point spread of 0 degrees C, indicating saturated conditions or clouds at that level. The pressure tendency indicated a height fall of 40 meters (120 feet) during the last 12 hours. The

station model for Medford, Oregon, indicated a west wind at 70 knots, a temperature of 0 degrees C, and a temperature-dew point spread of 2 degrees C. The height of the 700 mb surface was at 2,944 meters (9,659 feet), with a height fall of 60 meters (200 feet) over the last 12 hours. The conditions at Medford were directly upwind from the accident site and an indication of the wind flow over the Warner Mountain Range.

The 500 mb Constant Pressure chart for 1800 on November 22, 2001, depicted conditions of the mean atmosphere at approximately 18,000 feet. The trough of low pressure off the western United States continued to be depicted, and it depicted a double high pressure system over the approximate 700 mb positions. The contour lines continued to indicate a tight gradient over the northwestern United States. The station model over Reno indicated a 500 mb height at 5,574 meters (18,287 feet), with a west wind at 65 knots, temperature of -13 degrees C, and a temperature-dew point spread of 0, and a height falls of 20 meters (120 feet) over 12-hour period was also depicted. Medford displayed no wind data.

The 250 mb chart for 1800 depicted conditions at 34,000 feet. Based on the isotachs, the chart depicted a jet stream core of 170 knots off the northern Californian and Oregon coast with westerly winds in excess of 70 knots over the accident site.

Upper Air Data

The model sounding, located approximately 50 miles south of the accident site, for 1000 depicted saturated conditions with below freezing temperatures from approximately 800 mb to 630 mb or from approximately 6,500 feet to 13,000 feet. The freezing level was near 850 mb or approximately 5,000 feet. The wind profile indicated winds from the south-southwest at 10 knots at the surface and veering to the west-northwest with height with increasing wind speeds. The maximum wind was from the west-northwest at 95 knots about 250 mb or 34,000 feet and just below the tropopause. At 700 mb or approximately 10,000 feet, the sounding indicated saturated conditions with the wind from the west at 45 knots and a temperature of -3 degrees C.

The closest standard upper air station was Reno (KREV), located approximately 104 miles south-southeast. The 1600 sounding from KREV indicated a stable, saturated environment from approximately 9,500 feet to 19,000 feet, with the freezing level at 9,000 feet. The wind profile indicated a wind from the southwest at 8 knots at the surface with winds veering to the west through a deep layer with little variation in direction with height through 500 mb or approximately 18,000 feet. The mean wind was from 268 degrees at 52 knots. The observed wind at 10,000 feet or 700 mb, the closest to the last reported altitude of the accident airplane, was from 245 degrees at 45 knots, with a temperature of -0.7 degrees C.

The sounding from Medford, Oregon, immediately upwind from the accident site, indicated westerly winds at 72 knots at 10,000 feet with a temperature of -0.3 degrees C.

Weather Radar Information

The nearest Weather Surveillance Radar 1988, Doppler (WSR-88D) from Washoe County (Reno) located 99 miles south-southeast detected echoes in the 5 to 20 dBZ range or weak to moderate echoes along the route of flight and over the accident site. At this range the radar beam had a width near 10,000 feet.

The National Radar Mosaics at 1100 and 1200 also confirmed a large band of weak to moderate echoes over northern California and western Oregon.

Pilot Reports

A pilot in a light multiengine airplane operating along the same route of flight as the accident airplane reported at 1127 that he was in IMC conditions at 11,000 feet, and experiencing light turbulence and light clear icing conditions. He also reported encountering updrafts of 2,000 feet per minute along the route of flight.

Two other pilot reports were significant. One urgent report indicted severe turbulence at 11,000 feet near Redding (RDD), California, at 1524. This was approximately 150 miles west of the accident site and at the same approximate altitude.

The other significant pilot report was over Bishop (BIH), California, at 1532. This pilot reported only light to occasional moderate chop, but observed stratiform cap clouds obscuring the mountain tops and stretching on the western side and dissipating on the east side. He also reported altocumulus standing lenticular (ASCL) cloud formations. This was also in the vicinity where the GOES-10 water vapor imagery indicated moisture channel darkening.

The majority of other pilot reports over northern California, to the southwest and south of the accident location, reported multiple layers of clouds and instrument meteorological conditions. Turbulence reports varied from none to continuous light to moderate turbulence, and appeared to get more intense with time. Icing reports also varied over the area with several pilots reporting light to moderate icing between 12,000 feet and 16,500 feet. The type of icing varied from rime, mixed, to clear ice.

Over the Reno area, several air carrier pilots reported low level wind shear and turbulence from the surface to approximately 13,000 feet, and higher clear air turbulence reports after 1100. One of the pilots in an Airbus jet reported moderate turbulence from 5,000 feet to 10,500 feet, with a severe jolt of turbulence at 10,500 feet.

Satellite Data

The Geostationary Operations Environmental Satellite number 10 (GOES-10) from 1030 through 1130 indicated multiple layers of clouds extending over the area. The infrared image at 1130 indicated a large band of clouds obscuring the accident site, which was on the northern edge of a band of cirrus type clouds. A radiative temperature of 233.20 degrees Kelvin or -39.96 degrees C was over the accident site, which corresponded with cloud tops in the range of 30,000 feet.

Area Forecast

The Area Forecast (FA) issued at 0345 was valid until 1600. The forecast began with a warning in the header to see the AIRMET Sierra series for IFR conditions and mountain obscurations over the region. The synoptic section indicated that a weak cold front extended over north-central California, with another Pacific storm system approaching the Washington, Oregon, and northern California coastal areas.

The forecast from 1000 to 1200 for northern California expected overcast ceilings at 8,000 feet msl and tops to 25,000 feet, with light rain and snow developing eastward across the area. The outlook from 1600 to 2200 was for MVFR conditions due to low ceilings and visibilities in rain, snow, and mist.

The conditions over the Sacramento Valley to the west of the accident site were for ceilings overcast at 3,500 feet with tops to 20,000 feet with visibility 3 to 5 miles in light rain and mist.

The outlook was for MVFR conditions due to low ceilings and visibilities in rain and mist.

In-Flight Weather Advisories

The NWS Aviation Weather Center (AWC) located in Kansas, City, Missouri, had a full series of AIRMETs (AIRman's METeorological Information) current over the proposed route of flight, which included mountain obscuration, turbulence, and icing.

The NWS issued AIRMET Sierra update number 5 at 0838 for mountain obscuration. The advisory warned of mountains occasionally obscured in clouds, precipitation, and mist, with conditions continuing beyond 1300 through 1900. This area bordered the accident site.

AIRMET Tango update 3, issued at 0655 and valid until 1300, was also current for turbulence along the route of flight. The advisory covered portions of Washington, Oregon, California, and Nevada, and warned of occasional moderate turbulence below 18,000 feet in moderately strong westerly winds especially in the vicinity of rough terrain. The conditions were expected to continue beyond 1300 through 1900. The accident site was within this area. Another AIRMET warned of moderate turbulence between 18,000 and 40,000 feet over the area due to jet stream wind shear and mountain wave activity.

AIRMET Zulu update 2, issued at 0645 and valid until 1300, was for occasional moderate rime to mixed icing in clouds, and in precipitation between the freezing level and 20,000 feet; it covered portions of Washington, Oregon, California, and Nevada. It identified the freezing level at 6,500 feet over northern California. The advisory was validated by pilot reports across the region.

No other in-flight weather advisories were current for the route of flight and no SIGMET (SIGnificant METeorlogical Information) or Center Weather Advisories were issued.

Rawinsonde Observation (RAOB) Analysis Program

A rawinsonde observation (RAOB) analysis program was also utilized in this investigation to evaluate the potential for clouds, turbulence, icing, and mountain wave activity.

RAOB Cloud Algorithm

The RAOB analysis indicated five potential cloud layers based on the upper air observation. The first overcast layer of clouds had a base at 4,400 feet above ground level (agl) and tops at 11,100 feet with stratocumulus type clouds. It indicated a second layer overcast layer between 13,500 feet with tops at 15,100 feet with altocumulus type clouds. The third broken layer was between 19,000 feet with tops at 22,900 feet. The fourth layer of clouds was identified as a scattered cirrocumulus clouds between 24,500 feet and 29,000 feet, and the fifth was a scattered layer of cirrostratus clouds between 29,600 feet and 34,500 feet.

RAOB Dynamic Turbulence Algorithm

The RAOB program also had a dynamic turbulence or clear air turbulence (CAT) algorithm based on criteria established by the American Meteorological Society (AMS) and the NWS working groups on turbulence. The definitions and categories of turbulence used are defined in the NWS Weather Service Operations Manual (WSOM) and Aeronautical Information Manual (AIM).

The RAOB turbulence algorithm related the vertical wind shear to the turbulence category, and utilized the Richardson Number (Ri) to correlate the turbulence probability. The program

determined that the KREV 1800 sounding had a high probability of light to moderate intensity turbulence below 16,000 feet. There was one significant layer of turbulence in the extreme category at 9,938 feet. It also noted high altitude turbulence between 34,000 and 41,000 feet in the moderate to severe category. The KREV sounding identified the layer where the accident airplane was operating, between 9,500 and 11,000 feet, as having a vertical wind shear of 29.2 knots per 1,000 feet, which is typically correlated with severe-to-extreme turbulence. The algorithm had a probability of turbulence of 100 percent given the vertical wind shear and Ri of 0.1 for the layer. Above 11,000 feet, the turbulence intensity and probability decreased, and at 14,000 feet had only a 56 percent probability of light turbulence. The most intense layer of potential turbulence was between 9,455 feet and 11,008 feet agl.

RAOB Mountain Wave Algorithm

Mountain waves develop as air flows over a mountain in a stable stratified atmosphere. Since buoyancy is the restoring force, mountain waves can also be called gravity waves. Mountain waves can propagate both horizontally and vertically because there is no sharp density boundary in the atmosphere, and depending on environmental conditions, the waves may refract. In particular, horizontal waves may be refracted vertically. This may lead to a streamline slope becoming zero (vertical) or even negative (overturning). When this happens the wave becomes unstable and breaks. Breaking waves are sometimes called malignant as opposed to nonbreaking benign waves.

The RAOB program determines the existence of mountain waves and categorizes the turbulence intensities based on information on lee waves based on research with application algorithms. The critical factor in these waves calculations is the Lyra-Scorer parameter (LSp), which is a function of atmospheric stability and vertical shear. Mountain waves (or lee waves) can occur if the LSp decreases with height. When the RAOB program finds a region where LSp decreases with height, mountain parameters are then used to determine wave characteristics.

The RAOB program for 1800 from KREV with added details of the local terrain of the accident site indicated favorable conditions for mountain wave activity. The KREV sounding identified the predominate wave at 9,938 feet, with a wavelength of 5.65 miles from crest to crest and a maximum vertical velocity of 3,591 feet per minute (fpm). The conditions also correlated with those associated with a breaking wave and probable severe turbulence. The 1800 sounding also indicated turbulence at higher altitudes between 15,000 and 20,000 feet and between 29,000 and 34,000 feet, with the potential of light-to-moderate and moderate-to-severe turbulence, respectively. Both the mountain wave and dynamic turbulence algorithms identified the layer between 9,500 and 11,000 feet as having a high likelihood of severe or greater turbulence.

NWS Mountain Wave Diagnostic Program (MWAVE)

The NWS AWC has an experimental mountain wave diagnostic program called MWAVE, which is being run daily for operational evaluation, before becoming approved as a standard NWS product. The Safety Board specialist requested the MWAVE model archive data for the period to evaluate the products available. MWAVE is designed to identify areas where there is a high probability of breaking mountain wave activity, which is correlated with significant turbulence events. The important parameters in the MWAVE product are the vertical profiles of wind speed (U), and the stability or temperature changes with height (N), and the height of the mountain range (h) over which the air is flowing. A detailed description of the MWAVE

diagnostic program follows the attachments to the factual report. A mountain wave may exist with strong up-and downdrafts, but be classified as non-breaking and not depicted by MWAVE. The MWAVE program evaluates and predicts strong breaking waves, which are considered the more dangerous events with severe turbulence.

The maps of MWAVE are composites of breaking pressure drag in the layers typically 1,000 to 2,000 feet thick, and combine the amount of wave energy and the likelihood of wave breaking. The chart for northern California depicted significant breaking mountain waves over the Sierra Nevada Range south of Reno, over southeast California, and over the Coastal Range and Cascades near Redding. They did not identify any significant layers in the vicinity of the accident site.

Topography

The accident site was at an elevation of 9,240 feet on the eastern slope of Eagle Peak and only 0.3 miles northeast of the 9,892-foot peak. Eagle Peak was the tallest point along the Warner Mountain range, which runs north to south across northeastern California and southern Oregon. The steep slope of the Warner mountains to the Surprise Valley located to the east, could be significant when encountering mountain wave action. Such terrain features have been known to enhance the vertical downdrafts and updrafts associated with the most intense mountain wave turbulence.

WRECKAGE AND IMPACT INFORMATION

Rescuers reported that the airplane came to rest about 200 feet below the crest of a saddle in a ridgeline. They recovered two victims on November 9, 2001, before snow buried the airplane. They were unable to recover more victims until June 2002, and recovered the last victim during the wreckage recovery in July 2002.

The rescuers reported that the airplane came to rest in an upright position with the cabin crumbled under the wings. The fuselage partially separated aft of the wings. The empennage separated and rotated about 20 degrees to the cabin.

MEDICAL AND PATHOLOGICAL INFORMATION

The Modoc County Coroner completed an autopsy. The FAA Toxicology and Accident Research Laboratory performed toxicological testing of specimens of the pilot. They did not perform tests for carbon monoxide or cyanide. The results of analysis of the specimens had no findings for tested drugs. The report contained the following findings for volatiles: 12 (mg/dL, mg/hg) ethanol detected in blood, 10 (mg/dL, mg/hg) ethanol detected in muscle; 17 (mg/dL, mg/hg) acetaldehyde detected in blood.

TESTS AND RESEARCH

Investigators from the Safety Board, Twin Commander, Textron Lycoming, and Hartzell Propellers inspected the wreckage at the Plain Parts, Pleasant Grove, California, on August 20 and 21, 2002, following recovery of the wreckage from the accident site.

The airframe manufacturer's representative reported that all of the airplane's fuel tanks drain to a central tank. Fuel pumps send the fuel through fuel shutoff valves in the center section of the airplane to the engines. The control switches for the shutoff valves are on the cockpit's overhead panel, and are safety wired to the ON position. Investigators found the shutoff valves in the ON position.

The control cables had multiple disconnects. All of the cables exhibited broomstraw type separations. All of the control surface balance weights remained attached the their respective structure.

The engines had been removed during recovery.

Left Engine

Investigators slung the left engine from a hoist, and removed the top spark plugs. The push rods for cylinder number 5 sustained mechanical damage, and investigators removed them. Investigators manually rotated the crankshaft. All valves on the undamaged cylinders moved in sequence, the vacuum pump accessory gears turned freely, and investigators obtained thumb compression on all cylinders. A borescope inspection revealed no mechanical damage on the valves, piston heads, or interior of the cylinders.

Investigators manually rotated the magnetos, and both magnetos produced spark at all posts.

The spark plugs for cylinders 2, 4, and 6 were full of oil. The spark plug electrodes were circular and gray, which corresponded to normal operation according to the Champion Aviation Check-A-Plug AV-27 Chart. All of the plugs contained cylindrical deposits.

The fuel pump gear rotated freely. The fuel manifold valve was not damaged and contained a liquid that smelled like aviation gasoline. The fuel injector nozzles were open.

The wet vacuum pump was secure on its pad, and the gears rotated freely.

The oil suction screen and oil filter were clean.

Left propeller

The spinner dome was crushed on one side and the front. The cap on the front of the spinner dome was missing.

Blade 1 twisted toward the low pitch. Its tip curled aft with chordwise bending. The outer 5 inches of the tip was torn off. It had a 20-degree aft bend at mid-blade. The pitch change knob and counterweight were intact.

Blade 2 bent aft 45 degrees at mid-blade. It exhibited S-bends with fore and aft bending at the tip. It twisted toward low pitch, and had heavy gouges with rotational scoring in the leading edge of the tip area. The cambered side had deep lengthwise scoring from mid-blade to the shank. The pitch change knob fractured; the counterweight was intact.

Blade 3 bent aft 90 degrees, and twisted toward low pitch. It had a sharp aft bend at mid-blade, and bent forward at the tip. The tip was torn and had a piece missing. The tip had rotational scoring. The trailing edge of the cambered side had dents. The pitch change knob and counterweight were intact.

Right Engine

Investigators slung the right engine from a hoist. The crankshaft would not rotate. Investigators used a borescope to inspect the interior of the cylinders and observed rust in the cylinders. They did not observe any mechanical damage.

Investigators removed the spark plugs. None of the plugs sustained mechanical damage. All of the electrodes were circular and gray, which corresponded to normal operation according to the Champion Aviation Check-A-Plug AV-27 Chart. The bottom plugs for cylinders number 2

and 6 contained oil; the engine had been on its left side.

The left magneto was secure on its pad; the right magneto was displaced. Both magnetos produced spark at all posts when manually rotated.

The fuel lines were clear, and the fuel sump was clean. The fuel pump gear turned freely. The fuel manifold valve was not damaged. The screen was clean, and the fuel injector nozzles were open.

The oil suction screen and oil filter were clean.

Right Propeller

The number 2 and 3 hub arms fractured on the rear hub half.

Blade 1 was twisted toward the low pitch position. It had fore and aft bending on the outer 1/3 of the blade. It had gouges in the leading edge of the tip. The pitch change knob was bent, and the counterweight was intact.

Blade 2 had fore and aft bending on the outer 2/3 of the blade. It had rotational scoring on the leading edge of the cambered side. The pitch change knob fractured; the counterweight was intact.

Blade 3 bent aft 30 degrees, and twisted toward low pitch. The tip was severely twisted and torn. The cambered side exhibited rotational scoring with lengthwise scoring along the trailing edge. The pitch change knob fractured, and the counterweight was intact.

ADDITIONAL INFORMATION

Chief Pilot Statement

Another Aero Commander with the operator's chief pilot aboard departed Reno at 1112, and the chief pilot submitted a written report. He stated that they climbed to 14,000 feet on an IFR flight plan and proceeded on V165 Mustang VORTAC (FMG) to Lakeview. He said that they were in instrument meteorological conditions the entire flight until they were in the state of Washington and began their descent. His airplane was equipped with a global positioning satellite (GPS) system, which provided flight track data.

The chief pilot reported that about 35 minutes into the flight (at 1147), the airplane encountered a severe downdraft. He applied full climb power of 29 inches of manifold pressure and 2,550 rpm (revolutions per minute), but the airplane still lost about 335 feet of altitude. At 1158, he turned west to cross a ridgeline and try and fly out of the downdraft area. His route of flight during the turn to the west took his airplane over N900RA's last radar contact and location of the main wreckage. The airplane continued to lose altitude even at maximum power, and reached its lowest altitude of 13,580 feet at 1159. It then began to gain altitude, and it was able to return to a cruising altitude of 14,000 feet at 1202. He turned back to intercept his original route at 1203.

The chief pilot reported that N900RA was not turbocharged, and had 580 horsepower available. His airplane (N7UP) was turbocharged, and had 800 horsepower available.

The Safety Board IIC released the wreckage to the owner's representative.

Pilot Information

Certificate:	Airline Transport; Flight Instructor	**Age:**	57, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land; Single-engine Sea	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Glider	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 2	**Last FAA Medical Exam:**	02/01/2001
Occupational Pilot:		**Last Flight Review or Equivalent:**	10/01/2001
Flight Time:	20069 hours (Total, all aircraft), 19789 hours (Pilot In Command, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Aero Commander	**Registration:**	N900RA
Model/Series:	500S	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	3070
Landing Gear Type:	Retractable - Tricycle	**Seats:**	7
Date/Type of Last Inspection:	09/01/2001, 100 Hour	**Certified Max Gross Wt.:**	6750 lbs
Time Since Last Inspection:	32 Hours	**Engines:**	2 Reciprocating
Airframe Total Time:	8101 Hours as of last inspection	**Engine Manufacturer:**	Lycoming
ELT:	Installed, not activated	**Engine Model/Series:**	IO-540-E1B5
Registered Owner:	COMMANDER NORTHWEST LTD	**Rated Power:**	290 hp
Operator:	COMMANDER NORTHWEST LTD	**Operating Certificate(s) Held:**	None
Operator Does Business As:		**Operator Designator Code:**	CMMA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	AAT, 4374 ft msl	**Distance from Accident Site:**	24 Nautical Miles
Observation Time:	1055 PST	**Direction from Accident Site:**	295°
Lowest Cloud Condition:	Clear	**Visibility**	10 Miles
Lowest Ceiling:	Overcast / 3400 ft agl	**Visibility (RVR):**	
Wind Speed/Gusts:	12 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	190°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.9 inches Hg	**Temperature/Dew Point:**	8°C / 4°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	RENO, NV (RNO)	**Type of Flight Plan Filed:**	IFR
Destination:	WENATCHEE, WA (EAT)	**Type of Clearance:**	IFR; VFR Flight Following
Departure Time:	1045 PST	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	4 Fatal	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	5 Fatal	**Latitude, Longitude:**	41.285833, -120.194722

Administrative Information

Investigator In Charge (IIC):	HOWARD D PLAGENS	**Report Date:**	03/28/2006
Additional Participating Persons:	Gary Hamlin; Federal Aviation Administration; Reno, NV Mark Platt; Textron Lycoming; Williamsport, PA Geoffrey Pence; Twin Commander; Arlington, WA Tom McCreary; Hartzell Propellers; Piqua, OH		
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/.		