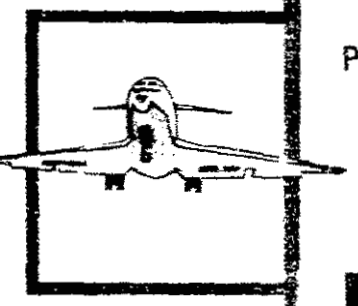

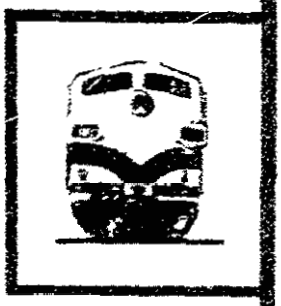

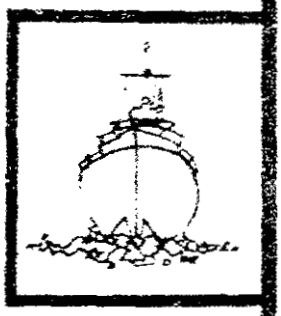

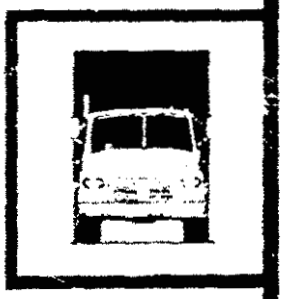

PB83-910405

NATIONAL TRANSPORTATION SAFEN BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

A. E. STALEY MANUFACTURING COMPANY, INC.
CANADAIR CHALLENGER CL-600, N805C
HAILEY, IDAHO
JANUARY 3, 1983

NTSB/AAR-83/05

UNITED STATES GOVERNMENT

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15. Supplementary Notes

16. Abstract About 0910 mountain standard time on January 3, 1983, a Cenadair Challenger CL-600, N805C, operated by the &E. Staley Xanufacturing Company: Inc., Deeatur. Illinois, crashed into a mountain about 2.2 nautical miles north of Friedman Memorial Airport, Hailey, Idaho (Sun Valley Airport). At the time, the airplane was proceeding to land at the airport.

Shortly before the accident, N805C had completed an instrument flight rules (IFR) flight from Decatur to Sun Valley Airport and had deseended in visual flight rules (VFR) flight conditions. The weather at the airport was overcast, ceilings were reported io have been between 800 and 1,500 feet overcast, and the visibility was 10 miles. The base of the clouds were below the tops of the surrounding mountains. N805C missed the airport, flew to the north over the town of Hailey, and into an area of lowering ceilings and worsening visibility. After passing the airpor;, the pilot attempted to climb above the mountains. The airplane was destroyed during the impact, and the pilot and the copilot, the only persons on board, were killed in the crash.

The National Transportation Safety Board determines that the probable cause of the accident was the flightcrew's failure to adhere to the recommended visual arrival procedures for the Sun Valley Airport ana its failure to execute timely terrain avoidance actions. The reasons for the flightcrew's failures could not be established conclusively. Contributing to the accident were meteorological conditions and the obscuration of terrain features and landmarks by snow that made navigation by visual references and terrain avoidance difficult.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: September 7, 1983

A.E. STALEY MANUFACTURING COMPANY, INC.
CANADAIR CHALLENGER CL-600, N805C
HAILEY, IDAHO
JANUARY 3, 1983

SYNOPSIS

About 0910 mountain standard time on January 3, 1983, N805C, a Canadair Challenger CL-600, owned and operated by the A.E. Staley Manufacturing Company, Inc., Decatur, Illinois, crashed into a mountain about 22 nmi north of the Friedman Memorial Airport, Hailey, Idahc (Sun Valley Airport). At the time, the airplane was proceeding to land at the airport.

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1. FACTUAL INFORMATION

1.1 History of the Flight

At 0613 m.s.t. 1/ on January 3, 1983, N805C, a Canadair Challenger owned and operated by the A.E. Staley Company departed Deeatur, Illinois, was on an IFR RNAV 2/ flight plan to Friedman Memorial Airport, Hailey, Idaho. The route of flight was

1/ All times herein unless otherwise noted are mountain standard time based on the 24-hour clock.
2/ IFR - Instrument Flight Rules; RNXV - Area Navigation, a method of navigation that permits airplane operation on any desired course within coverage of a station.

via Capitol, Illinois, VORTAC; 3/ Omaha, Nebraska, VORTAC; Scotts Bluff, Nebraska, VORTAC; Riverton, Wyoming, VORTAC; Idaho Falls, Idaho, VORTAC; direct 43° 31' north latitude, 114° 17' west longitude. 4/

The en route portion of the flight was uneventful, and about 35 nmi east of the Idaho Falls VORTAC, N805C was cleared by the Salt Lake City, Utah, Air Route Traffic Control Center (ARTCC), to descend from FL 390 5/ to FL 220. N805C descended to FL 220, and the flightcrew then requested a descent to 17.000 feet. 6/ About 35 nmi east of Sun Valley Airport after being cleared, N805C descended to 17,000 feet. About 0901, N805C's flightcrew cancelled their IFR flight plan and, shortly thereafter, changed the transponder from 1311, the assigned discrete code, 7/ to 1200, the VFR 8/ code. At 0901:07, the DART 9/ radar data showed a 1311 beacon code at 17,000 feet about 11 nmi east of the Sun Valley Airport. At 0901:37, the DART radar data showed a 1200 VFR transponder beacon code with no altitude readout about 2 nmi west of the 1311 beacon code that was recorded at 0901:07.

At 0904:10, DART radar data recorded a 1200 code target at 13,500 feet almost directly over the Sun Valley Airport. According to an employee of the airport's fixed base operator, N805C's flightcrew called on the airport's UNICOM 10/ frequency and requested a landing advisory and asked if a food order had been placed. The flightcrew then stated that there would "be a quick-turn," and placed a fuel request. This was the last transmission heard from N805C. The employee said that she provided the latest altimeter setting to N805C, and "since we did not have the cloud conditions in the area, I was glad when other pilots were able to give reports as they saw things from the air."

The flightcrew of Cessna Citation, N13BT, which had landed at Sun Valley about 0903, also heard N805C report "over the field." According to N13BT's pilot, N805C reported over the field "sometime during our final approach or landing." According to the pilot, the weather at the airport when he landed "was 800 (feet) overcast with 10 miles visibility. The tops of the overcast or fog bank was about 6,800 (feet) m.s.l." He said that the overcast was "solid northwest up the valley. Visibility appeared lower (to the) northwest."

3/ VORTAC - Very High Frequency Omni Directional and Tactical Air Navigation facility providing both range and bearing information.

4/ The geographical coordinates of Friedman Memorial Airport, hereinafter called Sun Valley Airport.

5/ FL 390 - A level of constant atmospheric pressure related to a reference datum of 29.92 inHg. Each is stated in three digits that represent hundreds of feet; e.g. FL 390 represents a barometric altimeter indication of 39,000 feet.

6/ All altitudes herein unless otherwise noted are altitudes above mean sea level (m.s.l.)

7/ All four-digit transponder codes whose last two digits are other than 00 are discrete codes assigned to the airplane by the ATC computer; all four-digit transponder codes whose last two digit are 00 are classified as non-discrete codes.

8/ VFR - Visual Flight Rules. Pursuant to 14 CFR 91.105, no person may operate an aircraft under VPR at 1,200 feet or *less* above the surface (regardless of m.s.l. altitude) within controlled airspace when the flight visibility is less than 3 statute miles and at a distance less than 500 feet below the clouds. Under VFR, outside of controlled airspace, the flight visibility cannot be less than 1 statute mile, and the aircraft must be operated "clear of clouds." Sun Valley Airport is located outside controlled airspace.

9/ DART - Data Analysis Reduction Tool.

10/ UNICOM - Nongovernment air/ground radio communications facility which may provide airport advisory information at certain airports. [Paragraph 158(a), Airman's Information Manual (AIM)]. The Sun-Valley UNICOM did not record, nor was it required to record or log the time of radio communications.

About 0908, Trans Western Flight **1301,** a Convair 580, landed at Sun Valley Airporr. Flight **1301** had descended through a hole in the overcast abou' 15 nmi southwest of Bellevue, Idaho, which is about **3** nmi southeast of the Sun Valley Airport. The first officer said that he gave position reports to the Sun Valley **UNICOM** when the flight was **15** nmi from the airport, 10 nmi from the airport, over Bellevue turning on final approach for runway **31,** and **1** mile from the runway. The first officer said that he could see the VASI 11/ lights for runway **31** during the landing approach. The captain and the first officer said that they neither sew N805C nor heard radio transmissions from N805C.

About 0900, a man, who was driving his truck north on the highway between Bellevue and Hailey, Idaho, saw a twin engine, cream colored jet, break through the clouds when he was about 2.5 miles north of Bellevue. He saw that the landing gear was down but he did not see any lights on the airplane. When the airplane appeared, "it was about 300 to 500 yards from the west hills adjacent to the airport and about 1,000 feet from the valley floor." The airpiane was in a noseup attitude. The witness said that after the airplane descended below the clouds "and (the pilot) saw how close to the hills he was, he then started a sharp right turn." The airplane disappeared from his view into "low hanging clouds" over the northwest side of the hangar at the airport.

Between 0900 end 0930, another man, who was in the yard of his home in northeast Hailey, **saw** a jet eirplane east cf his home. The airplane was "white or silver with a blue tint." (N805C was painted white with blue and gold stripes along the length of the fuselage and tops of the wings.) The airolane was below the clouds, and he had "a goad view of the airplane for about 10 to 15 seconds." He said that the airplane had a high noseup attitude and "the wings were rocking up and down about 20°." The witness said that the clouds obscured all but the lower peaks of ?he mountains to the east and that after he lost sight of the airplane he thought it was "odd that the aircraft was under the cloud cover."

Shortly after 0900, a woman who was located in *an* apartment in southeast Haiiey, heard a jet airplane fly over "in a northerly direction." She thought that this was "odd because jets don't go over us heading north from the airport. The engines sounded very loud. ..."

A fourth witness said that, between 0900 and 0940, she heard a jet airplane overfly her house in northeast Hailey. The woman was in the living room of her house when she heard the airplane and thought tha? "it must be low because of the loudness of the (engine) noise," and that "the sound of the jet did not trail off as they do as they fly farther away from you. The sound stopped less than **30** seconds from the time I first heard it." At the time, the clouds were resting on and hiding the top of the mountains to the east.

About **1030,** the chief pilot of the **A.** E. Stalcy Manufacturing Company, who was to board N805C at Sun Valley, arrived at the airport. Since the airplane was overdue, he instituted inquiries to several nearby airports to determine where the airplane had landed. At 1300, he asked ATC 12/ to make a full communications search. At 1400, after being told that the airplane had not been found, he requested an air search. While waiting for search and rescue teams to arrive, the chief pilot rented an airplane, end about 1700, found the accident site. The impact site, elevation about 6,520 feet. was about **2.2** nmi north of Sun Valley Airport at coordinates 43°32'50" N latitude, 114°17'35" W longitude.

11/ VASI - Visual Approach Slope Indicator.

12/ ATC-Air Traffic Control.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal	2	0	0	2
Serious	0	0	0	0
Minor	0	0	0	0
None	0	0	0	0
Total	2	0	0	2

1.3 Damage to Airplane

The airplane was destroyed by impact.

1.4 Other Damage

None.

1.5 Personnel Information

The pilot and copilot were qualified in accordance with current Federal regulations. (See appendix B.)

Because pilots employed by the A. E. Staley Manufacturing Company are required to perform collateral activities, the copilot also worked as an airframe and powerplant mechanic. The pilot had worked as a scheduler until he had been relieved of that duty in August 1982 when he began training in the Challenger CL-600. Since another employee had taken over the duties of scheduler, he had not been reassigned to that job or any other secondary responsibility after he completed Challenger CL-600 training.

Flight records showed that during the last 90 days before the accident the pilot and copilot had flown 57 hours and 62 hours, respectively, in the Challenger CL-600. Both pilots were familiar with the Sun Valley Airport. The copilot had flown into the airport numerous times. The pilot had flown into the airport in the CL-600 airplane on December 2 as copilot and on December 26 as the pilot-in-command.

1.6 Airplane Information

The Canadair Challenger CL-600-1A11 is manufactured by Canadair Limited, Montreal, Quebec, Canada. The certification testing of the airplane was conducted by Transport Canada with Federal Aviation Administration (FAA) participation at Mojave, California. The airplane was certified to the requirements of 14 CFR Part 25, and type certificates for the airplane were issued by both Transport Canada and the FAA. The FXA type certificate was issued on October 15, 1981.

Canadair Challenger, N805C, was owned and operated by the A. E. Staley Manufacturing Company, Inc., Decatur, Illinois. (See appendix C.)

On January 3, 1983, N805C left Decatur with about 12,031 lbs. of Jet A fuel. Based on an estimated zero fuel weight (ZFW) of 24,000 lbs., the airplane weighed about 36,034 lbs. at takeoff, and its center of gravity (c.g.) was about 23.7 percent M.A.C. 13/ According to the Airplane Flight Manual (AFM), at 36,034 lbs., the airplane's forward and aft c.g. limits were 12 percent and 31 percent M.A.C., respectively, and the maximum allowable takeoff weight was 40,100 lbs.

13/ Mean aerodynamic chord.

Based on an estimated en route fuel burn off of about **7,131** lbs, the airplane's weight and c.g. for landing at Sun Valley Airport was about **28,903** lbs. and **24.9** percent M.A.C. According to the AFM, at **28,903** lbs. the airplane's forward and aft c.g. limits were 12 percent to **32.1** percent M.A.C., respectively, and the maximum allowable landing weight was **36,000** lbs. The evidence showed that N805C was below the maximum allowable takeoff and landing gross weights and within the maximum allowable c.g. limits at takeoff and at the time of intended landing.

1.6.1 RNAV Equipment

N805C was equipped with a Collins LRN-85 Long Range Navigation System which had been installed by the Tracor Corporation, Goleta, California. The LRN-85 uses sisals from eight worldwide Omega beacons and from very low frequency (VLF) communication transmitters to provide navigational information to the flightcrew. On or about October 15, **1982, an** FAA test flight was conducted to obtain a Supplemental Type Certificate (STC) for the LRN-85 installation on N805C. According to the **FAA** test engineer, the test fixes along the route of flight showed that the system, as installed in N805C, had shown an along track error of 3.1 nmi and an across track error of 2.7 nmi on a 95 percent probability basis. These results exceeded the accuracy limits contained in Advisory Circular (AC) 90-45 and the STC for the LRN-85 installation on N805C was withheld.

The installation of the LRN-85 in N805C permitted selection of the course data derived from the VLF Omega signals to be displayed on both the pilot's and copilot's Horizontal Situation Indicators (HSI). When this mode was selected, appropriate indicator lights would be illuminated.

The manufacturer's Pilot's Guide states that the LRN-85 is a "long range navigation system" which under normal signal conditions, has "an average error of less than **2** nautical miles. Only 5 percent of the time will an error of more than 4 nautical miles be observed."

N805C was not equipped with, nor was it required by FAA regulations to be equipped with, a Ground Proximity Warning System (GPWS) and an Emergency Locator Transmitter (ELT).

1.7 Meteorological Information

On January **3,** 1983, the 0800 surface weather map prepared by the National Weather Service (NWS) showed a slow moving cold front over southeastern Idaho about **110** nmi south of Sun Valley Airport. The airport area was under the influence of high pressure behind **a** cold front.

The NWS's Rocky Mountain Area Forecast, issued at 0440 on January **3, 1983,** and valid until 1700 January **3, 1983,** contained the following pertinent weather information:

> Flight precautions:
> IFR—Idaho and Montana
> Icing—Idaho, Montana, Wyoming, Colorado, and Arizona
> Turbulence—Idaho, Montana, Wyoming, Colorado, and Arizona
> Mountain Obscuration—Idaho and Montana

The Area Forecast also contained the following pertinent data:

> Southern Idaho — southwestern Montana. Clouds 7,000 feet broken, layers to above 20,000 feet, visibility occasionally 5 miles in light snow showers especially in higher terrain. Valley visibility occasionally 3 to 5 miles in fog and smoke.

Burley, Idaho, 60 nmi south of Sun Valley Airport, was the closest station to the airport for which a terminal forecast was available The Burley terminal forecast issued at 0240, January 3, 1983, and valid from 0300 January 3 to 0300 January 4, 1983, read as follows

> Partial obscuration, ceiling 5,000 feet broken, 9,000 feet overcast, visibility 5 miles in fog and smoke Slight chance of partial obscuration, ceiling 3,500 feet overcast, visibiity 3 miles in light snow showers, fog, and smoke.

No NWS weather station is located at Sun Valley Airport Airport weather observations which support the operations of Trans Western Airlines are taken by employees of the airline who are certified weather observers The only weather observation which was pertinent to the time of the accident was taken at 0936 and read as follows:

> Scattered clouds at 1,000 feet; broken clouds at 3,000 feet; broken clouds at 9,000 feet; visibility—20 miles; temperature—20° F; wind--340° at 4 knots; altimeter setting—30.20 inHg; total sky cover—.8.

Statements from ground witnesses and pilots who either took off or landed at Sun Valley Airport concerning the weather conditions at the airport about the time of the accident indicated that the clouds obscured the mountains to the east and west of the airport. There was a layered overcast above the airport, and the estimated height of the ceiling at the airport ranged from 800 to 1,500 feet. Ground witnesses said that the clouds were thicker and the cloud bases appeared lower to the north of the airport; and that the visibility was 3 to 4 miles A few witnesses said that the clouds were lifting to the south of the airport and that the visibility south of the airport was 10 miles or more. One witness said that you could see vertically through the overcast.

The pilots interviewed estimated that the overcast layer was about 500 to 1,000 feet thick. They said there were "holes" in the overcast about 10 to 15 nmi southwest of Bellevue Several of the pilots said they were able to descend through the holes and to proceed to and then land at the airport while maintaining prescribed VFR minima.

On January 3, no weather observations had been taken before N805C contacted the Sun Valley UNICOM. Since cloud and visibility data were not available, the current altimeter setting was the only information provided the flightcrew by the Sun Valley UNICOM. However, at 0901, when N805C cancelled its IFR flight plan, the flightcrew requested Sun Valley weather from the Salt Lake ARTCC controller. Because there was no NWS weather station at the airport, the information was not available; however, the controller relayed a recent pilot report (PIREP) to N805C which said that the "(cloud) bases were at seven thousand feet at the Kinze Intersection." (Kinze Intersection is 27 nmi south of the Sun Valley Airport. It is located at the intersection of

the 066° redial of *e Mountain Home, Idaho, VORTAC and the 349° radial of the Twin Falls, Idaho, VORTAC.) In addition, the pilot of a Piper Cherokee, N57J, flying near the Sun Valley Airport, told N805C that he could see down the valley and that there were (cloud) layers and a hole over Magic. (Magic Reservoir, about 15 nmi south of Sun Valley Airport.) The pilot of Trans Western Flight 177 also told N805C that there was a thin cloud layer between 6,200 and 6,800 fee: south of Me Sun Valley Airport and that the visibility was 7 miles.

1.8 Aids to Navigation

So: applicable.

19 Communications

mere were no known communications difficulties.

1.10 Aerodrome Information

Sun Valley Airport (Friedman Memorial Airport), elevation 5,315 feet, is located ebout one-half mile southeast of Hailey in Wood River Valley. The airport does not have an operating control tower. The landing area consists of one runway -- 13-31 -- which is 6.600 feet long and 100 feet wide, is asphalt surfaced, ad is equipped with VAS lights. On December 17, 1982, the airport was certificated under 14 CFR 139.

Runway 13-31 is aligned essentially with the floor of ?be valley which is oriented southeast-northwest. Beginning a? the airport and proceeding northwest, the floor of the valley ranges in width from I mile to 1.25 miles. The east and west sides of the valley rise over 1,000 fee: in elevation within 05 mile from the valley floor. (See appendix D.)

Local noise abatement procedures require turbojet engined airplanes to use runway 31 for landing and runway 13 for takeoff. The procedures recommend arrivals for runway 31 to fly toward :he airport an the east side of the valley at 7,000 feet until the pilot is ready to start his landing approach. The procedures also recommend ihat the pilots fly cver the eastern edge of Bellevue io intercept the final approach path to runway 31. !See appendix D.)

The airport does no: have a published instrument approach procedure. Since Sun Valley Airport is located outside controlled airspace, landing traffic Operating under 14 CFR 91 must heve I mile of visibility and remain clear of clouds. Traffic operating under 14 CFR 121 or 14 CFR 135 must have either 3 miles of visibility and a 1,000-foot ceiling, or the minimum ceiling and visibility in applicable company operations specifications, whichever is higher.

According to the chief pilot of the A.E. Staley Manufacturing Company, company pilots had been instructed to fly south toward Magic Reservoir if they were unable to establish visual contact with the Sun Valley Airport on initial arrival over the field. The chief pilot stated that, "If for some reason then, they didn't make contact (with the ground) as they swung south over the Magic Resevoir. ..." they were to contact Salt Lake City ARTCC, get a clearance to descend to 7,000 feet at Reap's Intersection, then descend to 7.000 fee: a: the intersection, and "if they were in (ground) contact, then they would proceed visual to Friedman (Airport)."

Paragraphs 157, 158, end 222 of the Airman's Information Manuai (AIM) recommend that landing pilots maintain a listening watch on the UNICOM frequency from 10 miles to landing. The AIM advises pilots to contact the UKICOM for traffic advisories and wind and runway information, and warns pilots that "TRAFFIC CONTROL IS NOT EXERCISED." The A. E. Staley Company's chief pilot stated that all company pilots are directed to comply with the UNICOM procedures contained in the AIM.

At the time of the accident, the floor and the east and west sides of the valley were covered with snow. According to one pilot who had landed at the airport at 0908, January 3, 1983, "terrain definition was adequate, although it was 'white on white' due to recent snowfall. During our approach the airport was clearly in view; however, the runway was difficult to distinguish due to snow cover. The VASI for runway 31 was visible during our final approach."

1.11 Flight Recorders

The airplane was not equipped with nor was it required by FAA regulations to be equipped with either a cockpit voice or a flight data recorder.

1.12 Wreckage and impact Information

N805C crashed into tht southeast side of Red Devil Mountain. The elevation of the initial impact site was about 6,500 feet and about 2.2 nmi north (magnetic bearing 346°) of the Sun Valley Airport. The airplane's impact heading was about 015° M; its pitch attitude and bank angle were about 5° to 10° noseup, and 5° left-wing-down, respectively. in addition, scratches on the bottom of the forward fuselage were aligned parallel to the centerline of the fuselage and Showed that the airplane was not yawed just before impact.

The airplane struck just below the crest of a slight ridge, slid along the ground about 55 feet to the crest of the ridge, end then became airborne again. During the impact sequence, the airplane broke into eight major segments -- the forward fuselage, center fuselage, near fuselage and left engine, right engine, empennage, right wing, left inner wing, and left outer wing. Except for the right wing and left outer wing section, the remainder of the wreckage became airborne again as it crossed the crest of the ridge, traveled about 500 feet in the air on a heading of about 040° M, struck the ground, and then slid an additional 100 to 200 feet down the mountain slope. The separated right wing and left outer wing sections tumbled down the mountain slope at right angles to the path taken by :he majority of the wreckage and came to rest about 1,000 feet to the right of the initial impact point. Examination of the wreckage revealed no evidence of pre-impact structural failure, in-flight fire, or explosion.

1.12.1 Fuselage and Empennage

The cockpit, forward fuselage, and the forward pressure bulkhead above the cockpit floor were crushed extensively. The center fuselage rearward to fuselage station (FS) 599 wes distorted and crushed. The skin and some structure along its bottom were scaped off and the wing was detached.

The fear fuselage from FS 559 to the aft pressure bulk head, including the left engine, came to rest about 620 feet from the initial impact point. The right engine and mount had separated from the fuselage. This section of the fuselage was crushed and distorted; however, the aft pressure bulkhead had only minor damage.

The empennage including the vertical and horizontal stabilizers, rudder, and elevators, had separated from the fuselage and came to rest adjacent to the rear fuselage. The empennage was reletively intact; however, the structure was distorted severely at the point where it separated from the rear fuselage.

The horizontal stabilizer was undamaged and the length of the electro-mechanical jackscrew was measured; the measured length corresponded to en angle of about 5° leading edge down, or airplane noseup trim.

1.12.2 Wings and Trailing Edge Flaps

The right wing, outboard of wing station (WS) 45 was intact and relatively undamaged. This section included the inner and outer flap sections and hinges, the aileron, and the flight spoilers. The leading edge had been crushed downward and the flight spoilers were retracted.

The left wing, outboard of WS 148, including its aileron and flight spoilers, was intact. The flight spoilers were retracted. The wing tip and leading edge had been crushed. Both inboard flap hinges and the inner and center hinges for the outboard flap section were broken off. The outer flap hinge was twisted and the fairing had broken off. Both flap sections had separated from the wing.

The center wing section from right WS 45 to left WS 148 had separated from the right and left wings and :he fuselage. The wing section had broken apart and was damaged severely by impact forces.

An inboard and an outboard flap section are installed on each wing of the CL-600. Each flap section is operated by two jackscrews actuators. The maximum flap extension is 45° which corresponds to an outboard and inboard jackscrew actuator extension of 9 1/4 and 5 1/4 inches, respectively.

The right wing was recovered with all inboard and outboard flap surfaces, fairings, and jackscrew actuators intact. The extension of both inboard and outboard jackscrews were 9 1/4 inch and 5 1/4 inch, respectively. The flap asymmetry detection and brake unit was intact and attached both mechanically and electrically at the outboard end of the flap drive system. The unit was removed from the wing, tested functionally, and performed satisfactorily.

The inboard and outboard flap surfaces had separated from the left wing and only one jackscrew actuator -- the outboard flap outer actuator -- remained attached to the wing; the jackscrew actuator was extended 5 1/4 inches.

The left wing flap asymmetry detection and brake unit was intact and attached mechanically and electrically at the outboard end of the flap drive system. The unit was removed from the wing, tested functionally, and performed satisfactorily.

The general area in the cockpit which contained the flap selector mechanism was crushed and distorted and had been pushed downward, forward, and to the left. The flap selector handle was in the up position. The top third of the flap selector handle was broken off and the release spring was missing. The left side of the gate plate was attached to the selector, but the right side was not. The flap lever, box, switches, and gears were distorted, but intact. The inside of the flap lever slot at the 45° position was damaged slightly.

The pitch and roll control disconnect handles, which are located adjacent to the flap selector handle, were examined and were in the control connected position.

1.12.3 Landing Gear

The nose gear and the left main and right main landing gears were recovered. Examination of gears showed that all three were extended and locked in the down position. The landing gear handle was in the gear down position.

1.12.4 Powerplants

Both engines were found in the main wreckage area. The left engine was still attached to a section of the rear fuselage; the right engine had separated from its mounts. Both engines were taken to the AVCO Lycoming facility, Stratford, Connecticut, where they were disassembled and examined under the supervision of Safety Board investigators. The damage to both engines indicated that they were probably operating at high fan speeds at impact. There was no evidence of any preimpact malfunction.

1.12.5 Cockpit Documentation

The cockpit area was damaged extensively. Although every instrument, annunciator light, circuit breaker, switch, and control component that could be recovered in an identifiable condirion were documented, the inventory described herein has been limited to those instruments, switches, control components, and lights which were relevant to the facts and circumstances of the accident.

Airspeed/Mach Indicators: The pilot's airspeed needle was missing and the mach indication was frozen at 0.26 mach. The signals to the pilot's instrument were received from the electrically driven air data computer. The copilot's airspeed needle was frozen at 205 KIAS and the mach indication was frozen at 0.29 mach. This instrument was driven by the airplane's pitot-static system. The pilot's and copilot's mach meter readings convert to 155 KIAS and 170 KIAS, respectively.

Altimeters: The pilot's altimeter was frozen at 6,540 feet. Barometric settings were 1022 millibars and 30.16 inHg. Except for the barometric setting -- 1021 millibars and 30.15 inHg -- the copilot's altimeter had been damaged too severely to retrieve reliable altitude information. The pilot's altimeter received its input from the air data computer; the pitot-static system supplied the copilot's altimeter.

Horizontal Situation Indicators (HSI): The pilot's HSI showed the following: the heading pointer was set on 004° M; the selected course for the course deviation indicator (CDI) was set on 164°; the CDI steering bar was one dot right; and the bearing pointer was set on 172° M. The copilot's HSI showed the following: the heading pointer was set on 000°; the CDI course selection was set on 168°; the CDI steering bar was deflected full scale to the right; and the bearing pointer was set on 172° M. The heading bugs on both HSI's were not recovered.

Radio Magnetic Indicators (RMI): The pilot's and copilot's RMI were both selected to the VOR Dosition. The heading on the pilot's RMI was set 006° M, and the No. 2 bearing pointer was set on 075° M, but the needle was bent and free to move; the No. 1 bearing needle was missing. The "off" flag was showing. The heading on the copilot's RMI was 003°. The No. 1 bearing pointer was missing, and the No. 2 bearing pointer was in the parked position. The "off" flag was in view.

Attitude Direction Indicators (ADI): The captain's ADI box was crushed. The bank and pitch angle indications were 5° to 10° right-wing-down and 0°, respectively. The copilot's ADI box was crushed. The bank and pitch angles were 5° to 10° right-wing-down and 0°, respectively. The "off" flags were not in view on either ADI.

1.13 Medical and Pathological Information

Both pilots sustained fatal injuries during the crash. The pathological examination of the copilot disclosed no abnormal conditions and the toxicological tests were negative for alcohol, drugs, and carbon monoxide.

The post mcrtem examination of the pilot's cardiovascular system contained the following observation: "The coronary arteries arise normally, follow the usual distribution and are widely patent, except for the left anterior descending which reveals grade IV with 70–80 percent occlusion by atheromatous plaque. There is diffuse grade II atherosclerosis except as noted above. No evidence of thrombosis is present." The pathological examination also contained the following: "Note: Although the change in the left anterior descending coronary artery is severe, a conclusion as to whether *this* is related to the accident or not is not possible. The absence of pathology to suggest that this could have been, *in* fact, responsible for the accident does not preclude its being responsible. However, as indicated, a definitive conclusion either way is not possible."

The bodies of the pilots were found about **650** feet from the initial impact point and in the wreckage area which conteined the cockpit section and pilot seats, the aft fuselage and left engine, and the empennage. Both bodies had separated from their respective seats during the impact and subsequent airplane breakup. The post–mortem report stated "Ordinarily in cases involving this degree of force, tnere are injuries upon the body which suggest ihe presence of seat belt and, or, shoulder harness. Injuries of this type were no? identified."

The pilot's shoulder harness and lap belt assembly were recovered; the copilot's shoulder harness and lap belt assembly were not found. The recovered portion of the pilot's seat belt and the lap belt assembly were Sent to the manufacturer's laboratory for examination. The examination showed, in part, the following:

> The buckle and belt assembly had been subjected to considerable loading sufficient to bend the buckle ettachment fittings. Loading is also evident through brinelling of the buckle fitting and lock dog face and abrasive witness mark on (the) webbing at (the) adjuster reeve.
>
> There is also evidence on the buckle load plate in the area where the lap belt fitting plugs into the bockle. This substantiates the bending of the lap belt fitting as the narks match up identically.

The laboratory report concluded "it appears the lap belt assembly had functioned for its intended purpose until **loads** great enough to bend the attachment fittings caused the buckle to unlatch. The attachment fitting is heat treated carbon steel, Rockwel! 'C' **42,** or approximately 190,000 psi."

1.14 Fire

There was no fire.

1.15 Survival Aspects

The accident was not survivable because impact forces exceeded human tolerances.

1.16 Tests and Research

Since the airplane was not equipped with flight recorders, a major effort was made to retrieve all available airplane system components at the accident site. After the snow coves had melted, several trips were again made to the accident site to locate, identify, and retrieve additional components. The components were taken to various laboratories and maintenance facilities and were subjected to functional and other type of test procedures to determine the operating condition of key airplane systems before and at the moment of impact. All tests were conducted under the supervision of Safety Board personnel.

1.16.1 Flight Control System

The hydraulic power control units (PCU) which operate the rudder, elevator, and ailerons were tested functionally at the manufacturer's facility. The tests were performed on test stands using clean test stand fluid and under no-load conditions. All but the lower rudder PCU, operated satisfactorily. When the lower rudder PCU was deflected at maximum rate to full deflection, the PCU deflected to the targeted position: however, intermittently, the speed of the deflection was only one-third of its design maximum rate.

The autopilot and yaw damper actuators were tested at the manufacturer's facility. These tests of the autopilot actuators and servos did not disclose any indication of a preimpact malfunction or any conclusive indication as to whether the autopilot was engaged when the airplane crashed. In addition, all data obtained from the actuators indicate that the yaw dampers were engaged and operating normally.

The light bulbs in the autopilot control circuits were examined microscopically to determine which bulbs were lit at impact. (Distortion and or elongation of a bulb's filament may indicate that the bulbs was lit at impact: however, the lack of elongation is not conclusive of whether the bulbs were lit or not.) The results were conflicting. The bulb filaments in the Couple 1 and Soft Ride switch/lights were elongated indicating the autopilot may have been engaged; however, the filaments in the bulb of the autopilot engage switch/light filaments were not elongated.

The light bulbs from the VLF Omega indicator lights were also examined. It was determined that the lights labeled HSI SEL/VLF for both the pilot's and copilot's HSI were illuminated. The light labeled DATA NAV VLF was also illuminated at impact.

1.16.2 Flap System

The cockpit flap position indicator and portions of the flap selector mechanism were examined microscopically. The flap handle mechanism and the area surrounding it were severely crushed and distorted by the impact. No useful information was determined from the microscopic examination of the cockpit flap position indicator.

1.16.3 Hydraulic System

Two of the three electric hydraulic pumps suffered relatively minor damage, and evidence of rotation at impact could not be determined. Pump 3B was damaged significantly at impact, and the damage showed that the pump was operating at impact.

Examination of the No. 1 and No. 2 hydraulic systems' accumulators and the piston position of the No. 3 accumulator (the No. 3 accumulator was almost destroyed during the accident) showed that the pressures in all three systems had been normal at impact.

Hydraulic fluid samples taken from the reservoir, filters, and power control units operated by the systems were contaminated to higher than normal levels; rubber and other seal materials were the major contaminant. Despite the contamination level, there was no evidence of system failure during the flight. After the accident, the power control units were tested. Except for the lower rudder power control unit, the functional tests showed that all the power control units operated normally.

The primary flight controls were fully powered from all three hydraulic systems. Mechanical deflections of the pilot's controls were conveyed via push-pull rods, quadrants, and cabies to power control units. Examination of the structure and control system components did not reveal any evidence of preimpact failure. The aileron and elevator power control units were functionally tested as noted above and performed satisfactorily.

1.16.4 Electrical System

Electrical power on the CL-600 consists of a.c. electrical power furnished by the engine driven generators and d.c. electrical power furnished by the airplane's battery and transformer rectifier (TR) units. The TR units convert a.c. power from the airplane's generators to d.c. power.

Examinations of the indicator and warning lights on the AC Power Management Panel indicated that the a.c. supply system was functioning properly at impact. In addition, the examination of the No. 35 electric hydraulic pump which is powered from the No. 1 a.c. bus disclosed pronounced scrape marks on the fan and fan housing indicating that the pump was operating and receiving a.c. power at impact.

The examination of the AC Power Management Panel also showed that the bulb filaments in the Auxiliary Power Unit (APU) generator off annunciator light were elongated. This light illuminates when the APU rpm exceeas 95 percent, and the APU generator has not been engaged to the airplane a.c. electrical system.

Examination of the warning lights on the DC Power Management Panel indicated that the No. 1, No. 2, and essential d.c. power buses which were powered by the No. 1, No. 2, and essential TR units had failed. The No. 1, No. 2, and essential TR units which powered the three d.c. buses were recovered and examined. All three TR units were dameged severely. They were inspected and no indications of pre-impact failure were found. The transformer coils did not display any evidence of overheating. When a.c. power was applied to the three TR units, all three units produced d.c. power. All three TR units had rotational scrapes on their cooling fan blades indicating that their integral cooling fans were operating at impact; the cooling fans are operated by the a.c. power to the TR units. In addition, both yaw dampers most probably were engaged at impact. Engagement of these two channels require power from both the essential and No. 2 d.c. buses.

The altitude hold push-button-mode-annunciator light on the Flight Director Autopilot Mode Selector Panel was lit at impact. Because power to this light was supplied by the essential and No. 2 d.c. buses, the evidence confirmed that the No. 2 and the essential d.c. bus were operating at impact.

Tests were conducted to determine the time delays between the occurrence of the TR unit failure and the illumination of the associated d.c. powered annunciator failure lights. A simultaneous failure of all three TR units was simulated by pulling the appropriate circuit breakers (CB). The time delays between the loss of TR unit power

and the illumination of failure lights were measured. The three main d.c. bus off lights illuminated with no measurable delay. Several lights, including tie battery charge, emergency lights on, emergency lights off, and the hydraulic electric pump low pressure light, illuminated when the TR units were failed, but there was measurable delay between the failure of the buses and the illumination of these lights. The delay was longer than the duration of the initial impact sequence.

1.16.5 Engine and Wing Anti-ice Systems

Both engine anti-ice valves were found in the closed position (engine anti-ice off) and thsir pneumatic actuating cylinders were dented and punctured on the sides. According to the AFM, the valves are spring loaded to *the* open position and require electrical power to close end remain closed.

Both the left and right wing anti-icing valves were **found** in the closed (wing anti-ice off) position. These valves are spring loaded to the closed position. They are electrically controlled and pneumatically operated and require electrical power to open and remain open.

Microscopic examination of the wing and engine anti-ice system's controi and indicator light **bulbs** iocated on the anti-ice control panel showed that these bulbs were not lit at impact.

1.17 Other **Information**

1.17.1 **Airplane Performance and Flightcrew Procedures**

Based on the estimated en route fuel burnoff of about 7,215 lbs, the Safety Board concludes that the estimated gross weight of the eirplane at the time of the accident was about 28,785 lbs. Based on this gross weight and with the landing gear down and 45° flaps, the landing approach speed was 126 KIAS. The airplane's stall speed for this weight and configuration was about 96 **KIAS.**

In the event of a missed approach with 45° flaps **and** the landing gear down, the go-around procedure in the Airplane Flight Manual (AFM) required the following:

(1)	Takeoff thrust	Apply
(2)	Flaps	Retract to 20°
(3)	Airplane	Rotate to go-around altitude.
When positive rete of climb established		
(4)	Landing gear	Retract. Climb at minimum. speed of V_2 until safe height is established

The maximum allowable *speed* with 45° flaps was 170 KIAS.

Since the airplane crashed with its landing gear extended and its flaps at 45°, the Safety Board requested the manufacturer to calculate the airplane's climb performance based on the ambient weather and airplane configuration at the time of the accident and with takeoff thrust applied. tinder these conditions and with engine and wing anti-ice applied, the airplane could achieve the following climb gradients: at 126 KIAS —19.8 percent; at **140** KIAS -- **14.5** percent; at **155** KIAS -- 10.4 percent; and at 160 **KIAS** -- 9 percent. With no anti-ice, the resultant climb gradients were: at 126 KIAS -- **22** percent; at 140 KIAS -- 18.8 percent; at 155 KIAS -- 14.8 percent; and at 160 KIAS -- 13 percent.

Canadair performance data also showed that the time required *lo* accelerate from 126 KIAS to 155 KIAS with takeoff thrust applied, 45° flaps, landing gear down, level flight, and with no anti-ice was 9.5 seconds; with wing and engine anti-ice on the acceleration time increased to about 12.5 seconds.

2. ANALYSIS

The airplane was certificated, equipped, and maintained in accordance with Federal regulations and approved procedures. Since the airplane was not equipped with flight or voice recorders, determination of the structural and mechanical integrity of the airplane before the crash had *to* be based exclusively on the examination of the airplane's structure and system components found in the wreckage. This examination included the functional testing of recovered components and microscopic examination of annunciator, warning, and system indicator light bulbs.

The airpiane crashed with the flaps fully extended 45° and with the landing gear down. Since the crash site was about 2.2 nmi beyond the end of the Iending runway, the flightcrew should have had emple time to have reconfigured the eirplane for the go-around, i.e., apply takeoff thrust, raise :he flaps *to* 20°, establish a positive *rate* of climb, and then retract the landing gear. Because the airplane was not in the go-around configuration, the Safety Board attempted to establish wnether the airplane configuration at impect was caused by a preimpact failure or malfunction of an airplane system, an erroneous flightcrew decision, or the flightcrew's failure to implement the go-around procedure in a timely manner.

Since all the wreckege was located at or beyond the initial impact point and close examination of the structural failures and breakup indicated that all failures and breaks were the result of impact or overload, the Safety Board concludes that an inflight structural failure did *not* occur.

The onsite examination and subsequent engine tear down inspection showed that both engines were operating at high thrust settings at impact. Although the Safety Board concludes that the engines did not contribute to the accident, it was not possible to ascertain precisely the engine thrust setting st impact, or when the thrust hed been set to ?he levels evidenced by the impact damage to the engines.

The ianding gear was down and locked, and the landing gear selector handle was found in the down position. During a go-around procedure, the landing gear could not be raised until after the flaps were raised to the 20° position and a positive rate of climb had been established. Therefore, since the flaps were stili extended to 45°, it appears that the landing gear selector handle was properly positioned, and that the flightcrew had initiated a go-around by advancing the thrust levers very shortly before crashing into the mountain.

2.1 Electrical System

The evidence was conclusive that there was no preimpact failure in the a.c. electric generating and distribution system. The examination of the annunciator light bulbs in the AC Power Management Panel did not reveal that any generator was inoperative, or overloeded, or that the No. I or No. 2 main bus off warning lights were illuminated at impact. A similar examination of the Essential AC Power Transfer Panel disclosed that the failure and transfer warning lights Were no: lit, thus, indicating that the essential a.c. bus was powered by the No. 1 a.c. bus.

To further determine that the three main a.c. buses -- No. 1, No. 2, and essential - were functioning at impact, operation of one or more pieces of equipment which were dependent on power supplied from each bus was estabiished. Hydraulic pump No. 3B, yaw damper No. 2, and the No. 1 TR units cooling fen, all of which were powered by the No. 1 a.c bus, were operating at impact. Also, the No. 2 TR unit's cooling fan, which was powered by the No. 2 a.c. bus, was operating at impact. Further, the air data computer, yaw damper No. 1, and the No. 3 TR unit's cooling fan, all of which were powered by the essential a.c. bus, were operating at impact.

Analysis of the bulb filaments showed that the APU generator off light was lit, indicating that the APU was running but that the APU generator, which could have been used to furnish a.c. power to the a.c. buses if the engine driven generators were inoperstive, had not been placed on the line. According to the airplane's normal procedures checklist, the APU is to be started after landing. Kowever, the physical evidence was conclusive that the engine driven generators were powering their respective main a.c. buses at impact. Therefore, the Safety Board concludes that the flightcrew had elected to start the APU generator in preparation for landing. The fact that the APU was up-to-speed and that the APU generator had not been placed on the line further confirms the Safety Board's conclusion that the three main a.c. buses were operating and were being pcwered by the engine driven generators.

The analysis of the DC Power Management Panel's annunciator light bulbs indicated that the No. 1, No. 2, and the essential d.c. buses may have failed before the crash, leaving oniy the battery bus to supply d.c. power. Therefore, additional examinaiions and tests were made to determine if the three main TR units had failed before the initial impact or during ?he impact sequence.

The No. 1, No. 2, and essential Tk units which are located between the cockpit floor and nose of the airplane -- the area which appeared to hove made initial impect with the ground -- were damaged severely. The rotational scrapes on the cooling fan blades and shrouds of each of these three TR units showed that the fans were operating at inpact, and tha: all three TR units were receiving a.c. power at impact. In addition. testing showed that all three units produced d.c. power when a.c. power was applied. Finally, because light bulbs which would illuminate upon TR uni? failure were shown not to have been lit, the Safety Board concludes that the TR units were providing d.c. power to their respective buses and that they failed during the impact sequence.

The evidence showed that both yaw dampers were engaged at impact. Engagement of these channels required power from both the No. 2 and the essential d.c. buses. The No. 1 flight director was engaged a? impact and its computer was powered from the essential d.c. bus. Based on the physical evidence and subsequent testing. the Safety Board concludes that the three main a.c. buses ond the three main d.c. buses and their respective power distribution systems were operating properly at impact.

2.2 Trailing Edge Flaps

All the recovered components of the trailing edge flap system and associated structure were inspected and, where applicable and possible, were subjectzd to functional testing. The inspections did not disclose any preimpact failures that would have prevented the flaps from operating. Those components that were tested -- the power drive unit end potentiometer, left and right flap asymmetry detectors, ana brake units -- operated satisfactorily.

The flaps selector mechanism and flap control unit were recovered and examined. These units were located in areas of the airplane thet had been subjected to Severe impact forces, and the structural breakup in these areas was extensive. The flap selector mechanism was subjected to severe downward and fcrward impact forces. Since the flaps were extended to 45°, the evidence concerning the position of the flap handle at impact - the handle was found in the flaps up position -- was conflicting. While some evidence indicated that the handle was up, the fact that the top of the flap handle containing the release mechanism which permits the pilots to move the flap handle forward past the 20° detent was broken off. and the fact that the handle and selector mechanism were subjected to forward and downwa-d forces also indicated that the direction and severity of the impact forces during the crash sequence probably knocked the flap lever from the 45° position, forward, and into the flap **up** position. Also, it is possible tha: since thrust apparently hed been increased for a go–around maneuver, one of the pilots was in the process of moving the flap selector when impact occurred. However, based solely on the physical evidence, the Safety Board was unable to determine the flaps lever's position at impact.

The Cap control unit receives commands from *the* flap selector unit and signals from the flap speed and asymmetry brakes and then transmits these commands to the power drive unit. The flap control unit was damaged extensively by severe impact forces and could not be tested. The flap control unit and the flap power drive unit are powered by :he No. 1 and No. 2 d.c. buses and the *No.* 1 end No. 2 a.c. buses, respectively. Since the evidence showed that these four buses were powered at impact and that, within minutes before the impact, the flap system had functioned to extend the flaps, without apparent problem, the Safety Board concludes that the trailing edge flap system was opcrationa! at impact. The Safety Board also concludes thet the flap selector handle either was driven to the up position by impact forces, or tha. the flightcrew had just placed it in the up position and the airplane crashed before the **flaps** could move.

23 Hydraulic and Flight Control Systems

The evidence showed that there had been no preimpact failures or malfunction of the hydraulic system or its components. Examination of the light bulbs did not reveal that any low fluid pressure or high fluid temperature warning lights had **been** lit on any af the airplane's three hydraulic systems.

There was no evidence to indicate that either of the two engine driven hydraulic pumps had failed. The firewall shutoff valves were found in the open position.

The hydraulic fluid taken from the hydraulic systems after the crash was contaminated by particles of rubber and other seal materials. However, examination of the hydraulic pumps and microscopic examination of the hydraulic system warning fight bulbs disclosed no evidence of a preflight maifunction or failure of these systems.

The lowest of three **rudder** power control units exhibited an intermittent reduction in its no–load velocity while being cycled. The no–load velocity dropped to about one–third of the required value. The reduction was probably caused **by** the contaminants in the airplane's hydraulic fluid being lodged in the inlet slot to the msin control valve. The Safety Board believes that this condition, by itself, would not cause a rudder control problem. The upper and middle power control units probably would have **been** able to position the rudder to the commanded position. although rhc **speed of** movement would have been reduced. In addition, roll control also would have been available to the flightcrew through the operation of the ailerons.

Blockage of the elevator and aileron power control units, depending on the degree, would manifest itself to the pilot as a control jam. The flight control system incorporates pitch disconnect and roll disconnect mechanisms which are to be used to isolate that half of the control system which has jammed from the other half of the system which is functioning properly. Had the elevator or aileron flight controls evidenced any sign of jamming, the flightcrew probably would have activated the appropriate disconnect mechanism in an attempt to relieve the jam. The evidence showed that the pitch disconnect and roll disconnect mechanisms had not been activated. In addition, the physical evidence at the impact site also showed that the airplane was in controlled flight when it struck the ground. Therefore, the Safety Board concludes from the preponderance of the available evidence that there was no preimpact malfunction of the airplane's primary flight controls.

2.4 Anti-Ice Systems

The position of the engine anti-ice system valves and the examination of the annunicator light bulbs showed that the engine anti-ice system was off at impact. Examination of the wing anti-ice annunciator lights indicated that that system also was off at impact. Since there was no reported icing in the Sun Valley area -- only a thin overcast in the area -- and the descent was to have been made clear of clouds, the Safety Board concludes that the wing anti-ice system was also off at impact. Further, since both anti-ice systems were off, the airplane would have been able to attain maximum available climb performance had it been commanded by the flightcrew.

Because of the facts and circumstances of the accident, the major thrust of the Safety Board's analytical investigation centered upon those airplane systems and components which would have affected the airplane's controllability, navigational capabiiity. and performance capability. However, other airplane systems, which have not been discussed in detail herein, also were subjected to intense examination before they were eliminated as not being pertinent to the crash. Thus, for example, the integrity and resultant performance capabilities of such airplane system as the stall warning, pneumatics and air conditioning, the flight and ground spoilers, and other aural and visual warning system were examined, but the Safety Board found no evidence of preimpact malfunction. All components in a condition wherein testing was possible were subjected to a functionat test, and they operated satisfactorily.

2.5 Operational Factors

Because there were no recorders on the airplane and no terminal ATC radar data, there were no recorded data availabie to reconstruct the last portion of N805C's flightpath- The only information concerning the last few minutes of N805C's ilightpath in the vicinity of the Sun Valley Airport was obtained from witnesses. However, becaase the witnesses did not become aware of the accident until the following day, their recollections of the the time factors concerning the airplane's route of flight were not precise.

Examination of light bulb filaments showed the HSI/SEL, VLF, and **DATA NAV VLF** lights were on at impact. "he illuminated HSI/SEL end VLF lights showed that the pilots' HSI's were displaying course data derived from the Omega system when the airplane crashed. Because the **DATA** NAV VLF light was illuminated, Omega navigational information (bearing, range, and course deviation) should have been portrayed in the airplane's HSI displays. Based on the light bulb analysis and the RNAV type flight plan filed by the flightcrew, the Safety Board concludes that the Omega equipment was operating at impact and had been used by the flightcrew during the en route portion of the flight from Decatur to over Sun Valley.

The last radar position recorded for N805C was at 0904:10, and at that time the airplane was at 13,500 feet and almost directly over Sun Valley Airport N805C had reported to the Sun Valley 'UNICOM that it was over the field at 7,000 feet and this position report was overheard by a Cessna Citation pilot. According to the Cessna Citation pilot, he landed at 0903 and heard the position report either shortly before or shortly after he landed. Therefore, the "over the field" report was probably made at, or shortly after, the 0904:10 position was recorded, and the 7,000 feet reported by the flightcrew referred to the airplane's altitude above the airport rather than its m.s.l. altitude.

After reporting their position, the flightcrew of N805C requested a landing advisory, checked the status of their food order, placed their fuel request, and then Stated that there would "be a quick turn" Based on this transmission, the Safety Board concludes that N805C had no mechanical problems known to the flightcrew which would have prevented or delayed its arrival and departure from Sun Valley and that the pilot further intended to descend and land Since the flightcrew had cancelled its IFR flight plan ebout 4 minutes earlier, the descent, approach, and landing would have to have been conducted in visual flight conditions

Based on the weather reports, witness descriptions, and PIREPS, there was an overcast over the airport. Arriving and departing pilots estimated that the ceilings and visibility at the airport ranged from 800 to 1,500 feet, and from 3 to 10 miles, respectively. However, the witnesses indicated that the ceilings became lower and the visibility decreased north of the airport. PIREPS also indicated that the overcast became thinner south of the airport and that there were holes in the overcast south and southwest of the airport in the vicinity of Magic Reservoir. Based on the weather, N805C would have to have descended southwest of the Sun Valley Airport to have cleared the clouds. Since the airplane was sighted south of Hailey and proceeding below the clouds on a northeasterly track toward Hailey, and since the weather described at the airport was not below minimums, the Safety Board concludes that the descent was made clear of clouds and that the flight toward the airport was conducted in accordance with regulatory restrictions for uncontrolled airspace.

Based on the two witnesses' sightings of N805C, the airplane had descended and was below the clouds west of, and abeam of the airport The airplane was within "300 to 500 yards" of the mountains to the west of the airport, and then it turned right and "disappeared" into "low hanging clouds" over the northwest side of the airport N805C was next seen east of Hailey and it was still below the clouds Two witnesses, living in Hailey, heard the airplane fly "over" their homes Both stated that the engine sound was loud.

The initial impact swath was oriented about 015° M. The pilot's and copilot's RMIs read 006° M and 003° M, respectively, when electric power was lost; the headings on the pilot's and copilot's HSIs read 004° M and 000° M, respectively, when electric power was lost. Given the described cloud bases and the witnesses' observations of the airplane, the Safety Board concludes that N805C was flying on a northwesterly heading as it approached Hailey and on a course aligned along the western side of the valley. As N805C approached Hailey, it began a northerly turn, passed to the north of Sun Valley Airport over the southeastern tip of Hailey, then east of Hailey, and toward the crash site. The right turn apparently continued until the airplane reached the impact heading.

Based on the witness statements and the physical evidence, N805C probably was climbing at impact. The calculated elevation of the impact site was 6,520 feet and the pilot's altimeter was reading 6,540 feet when electric power to the air data computer

was lost. Since the Sun Valley Airport was located outside controlled airspace, and since the pilot was flying N805C below 1,200 feet above the ground (AGL), VFR regulations required that he remain clear of clouds and maintain at least 1 mile forward visibility. Given the elevation of the Sun Valley Airport -- 5,315 feet — and given the description of the cloud ceiling by pilots and witnesses, the Safety Board concludes that N805C was within 1,000 feet AGL and probably flew by the airport at or below 6,300 feet. Since the elevation of the impact site was 6,520 feet, the Safety Board concludes that N805C ascended at least 220 feet and possibly more before it crashed.

The pilot's mach meter rending at impact — 0.23 Mach — suggests that N805C's last indicated airspeed was 155 KIAS However, the landing gear was down and the flaps were fully extended to 45°. Since the maximum allowable speed for 45° flaps was 170 RIAS, the pilot obviously decelerated the airplane below 170 KIAS before selecting 45° flaps. The Vref sp d was 126 KIAS; however, the Safety Board does not believe that the pilot would have decelerated to 126 KIAS until he had sighted the runway and was about to begin the final approach descent. He most probably would have flown the airplane at Vref plus 10 to 15 KIAS until he was about to begin the final approach descent. Since the evidence showed that the pilot did not establish N805C on the final approach to the airport, the Safety Board believes that he probably maintained about 135 to 140 KIAS until he abandoned the attempt to land. Based on the pilot's airspeed indicator reading at impact, the Safety Board concludes that in addition to climbing slightly during the final moments of the flight, N805C also accelerated about 15 to 20 KIAS.

Given the eyewitness accounts of the airplane's flight track, the flightcrew's UNICOM radio report, and the request for fuel, food, and a "quick turn," the fact that the flightcrew was in radio contact with the fixed base operator and did not report any airplane difficulties, the fact that the pilot did not (in accordance with company procedures), report either on final approach or his distance from the airfield, and finally the location of the crash site with respect to the airport. the Safety Board concludes that the flightcrew either did not see the Sun Valley Airport, or did not see the airport until it had passed to the northwest of the airport. Further, the Safety Board concludes that the flightcrew was not aware of its precise location as it flew northwestward toward Hailey.

The Safety Board was not able to establish conclusively the reason(s) for the flightcrew's inability to establish its position in accordance with the Sun Valley Airport's visual arrival procedures, or why it was unable to locate the airport. Both pilots had flown into the Sun Valley Airport — the pilot twice in the preceding month and the copilot numerous times. Therefore, the flightcrew (particularly the copilot) should hare been reasonably familiar with the landmarks associated with the visual arrival route.

According to pilots flying into the Sun Valley Airport on January 3 — pilots who were familiar with the area and terrain — terrain and landmark definitions were obscured by snow. According to one pilot, these conditions in combination with the low overcast clouds produced a "white-on-white" situation that made visual navigation difficult. The pilot also stated that he could see the airport while on final approach, however, the runway was covered by snow and was "difficult to distinguish." Consequently, the Safety Board believes that the flightcrew of N805C, when faced with this situation, probably did not definitely establish its position visually as it flew toward the airport. Further, we believe that, as a consequence, the flightcrew might have misidentified the town of Hailey as the town of Bellevue, which is about 4.4 nmi southeast of Hailey and about 2.2 nmi southeast of the approach end of runway 31. Bellevue is the key landmark used by pilots for aligning the airplane with runway 31. (See appendix D.)

The misidentification of Hailey as Bellevue is supported by the airplane's 60° right turn over Hailey followed by shallow wing rocking. If the flightcrew had misidentified Hailey for Bellevue, the right turn would have been appropriate to intercept and then align the airplane with the visual arrival route for runway 31. The wing rocking suggests that the flightcrew was attempting to acquire and identify visual landmarks beneath the airplane. However, under the circumstances, the right turn placed the airplane on a heading toward the lower clouds north of the airport and on a collision course with the cloud-covered mountains north and east of Hailey. The flightcrew apparently recognized their error shortly after completing the right turn and initiated acceleration and a slight climb for terrain avoidance, all of which were too late to avoid the mountain

The Safety Board believes also that the evidence tends to support an inference that the flightcrew of N805C used Gmega navigational information to assist them in locating the airport and that the information was not sufficiently precise because of the limitation of the Omega LRN-85 system. The Omega was operating and supplying navigational data to the HSIs at impact. It had been used to navigate directly from the Idaho Falls VORTAC to the immediate vicinity of the Sun Valley Airport. The selection of 168° in the course selector also suggests that Omega data was used to supplement VOR information during the flight toward Magic Reservoir, the reported location of the breaks in the undercast cloud layer.

Although no posterash range information could be extracted from the Omega equipment because the range information is electrically displayed (light emitting diodes) and is erased with the cessation of electrical power. Both HSI bearing pointers were indicating 172° at impact. This bearing passed slightly north of the airport. possibly 1 or 2 nmi, and suggests that the computed Omega fix was offset to the north of the airport. If the fix had been accurately located at the airport, the flightcrew would have had accurate range information, and there would have been no reason for it to have flown over and to the north of the airport. However, under the circumstances, an error of 1 to 2 nmi in the computed location of the fix — an error that was not recognized by the flightcrew — could have reinforced their probable belief that Hailey was Bellevue and would explain their delay in initiating a climb for terrain avoidance. With the available climb capability, the airplane could have cleared the mountains north of Hailey had the flightcrew not been misled as to their location, either by a mistaken visual reference or erroneous Omega information, or both, and had they initiated the climb for terrain avoidance in a timely manner.

The occluded condition of the pilot's left anterior descending coronary artery indicated that he was susceptible to a coronary attack. Had such an attack occurred during the last moments of the fliht, after the airplane was configured for landing, he might have slumped over the controls and either caused the airplane to crash, or prevented, or delayed the copilot from instituting and executing timely corrective action. The location of the pilots' bodies in the wreckage, coupled with the absence of bruising associated with seat harnesses, suggested that this might have happened, and that that the copilot may have released his and the pilot's harnesses in order to remove the pilot from his seat to either stop or prevent the pilot from interfering with the airplane's controls. However, because the examination of the pilot's seat harness buckle and belt assembly indicated that it was fastened until "loads great enough to bend the attachment fittings caused the buckle to unlatch, the Safety Board concludes that the pilot was strapped in his seat at impact. S i e his body was not bruised, the Board concludes that the impact forces were not of sufficient magnitude to inflict this type of injury. x similar conclusion also can be made concerning the lack of such bruising on the copilot's body.

Except for a rocking of the wings when the airplane was sighted east of Hailey, the witnesses did not describe any violent or unusual maneuvers- If the pilot had become incapacitated and slumped over the control, the Safety Board believes that the airplane most probably would have struck in a nose down and or wing down attitude that would have been indicative of control input difficulties. The airplane did not crash in this manner. However, it is also possible that the pilot became incapacitated while the airplane was approaching Hailey along the west side of the valley and did not interfere with the controls. The pilot's affliction could have distracted the copilot from his flight and navigational duties during the time he would have sighted the airport and fixed the airplane's position. By the time the coipilot realized what was occurring, the airplane would have been too close to the mountains on the east side of the valley to avoid collision.

The only evidence to support the possibility that the pilot had suffered a coronary attack is the occluded coronary artery. The Safety Board can only point out that the coroner, while not ruling out the possibility that the pilot's heart condition could have been a causal factor, also stated "Although the change in the left coronary artery is severe, a conclusion as to whether this is related to the accident or not is not possible-" In the absence of compelling evidence which would show thai the pilot was, in fact, incapacitated, the Safety Board cannot conclude that he was.

Despite the lack of evidence relating to operational decisions, the Safety Board attempted to reconstruct the airplane's flightpath after the flightcrew reported "over the field." 'he evidence showed that the recommended landing procedures at the Sun Valley Airport called for landing traffic to approach from the southeast along the east side of the valley, fly just east of Bellevue, intercept the final approach path, and land. Airplanes descending through clouds were to follow the same procedures after descending and reaching visual flight conditions. The flightcrew of N805C did nc follow these procedures and approached the airport along the west side of the valley and then failed to see the Sun Valley Airport in time to either land *or* to depart the airport safely. The Safety Board has developed several possible reasons for the flightcrew's failure to find the airport and failure to initiate timely terrain avoidance actions; no single possibility is supported by the evidence to the exclusion of other possibilities. 'herefore, definitive conclusions about the flightcrew's failure to locate the airport in time to complete a successful landing or to complete timely terrain avoidance actions are not possible. 'he Safety Board also believes that the facts and circumstances of this accident further illustrate the hazards associated with low level flying in mountainous terrain particularly when the flight is conducted in marginal visual conditions.

In conclusion, the Safety Board believes that the facts and circumstances of this accident further illustrate the necessity of requiring that flight data (FDR) and cockpit voice recorders (CVR) be installed in rnultiengine, turbine-powered, fired wing airplanes. Recorded flight parameters and 15 minutes of CVR conversation would have provided significant clues as to the cause of the accident and the remedial action required to prevent recurrence. Accordingly, the Safety Board reiterates Safety Recommendations A-82-107 and -109 through -111 on recorders for all multiengine, turbine powered, fixed wing airplanes. These recommendations appear in the Recommendations section of the report.

3. CONCLUSIONS

3.1 Findings

1. Except for the Omega system installation for which an STC had not been issued, the airplane was certificated, equipped, and maintained in

accordance with Federal regulations and procedures. There was no evidence of malfunction or failure of the airplane.

2. The pilot was certificated properly. There was no evidence of any toxicological involvement in the accident. The pilot's post mortem examination disclosed that the left anterior descending coronary artery was 70 to 80 percent occluded, however, the examining pathologist could not determine whether or not the pilot had suffered an incapacitation.

3. The copilot was certificated properly. There was no evidence of preexisting medical or physiological problems that might have affected his performance.

4. A supplemental type certificate for the installation of the Collins VLF/Omega (LRN) RNAV on N805C was withheld because the equipment errors exceeded the accuracy limits set forth in AC 90-45.

5. There are no published instrument approaches for the Sun Valley Airport. The recommended procedures required landing airplanes to approach the airport from the southeast, along the east side of the valley, intercept the final approach path on the east edge of Bellvue, and land.

6. In the event of overcast conditions at the airport, landing airplanes may descend below the overcast southwest of and south of the airport. The descent can be made at either Reaps or Kinzie intersection, or in VFR flight conditions through breaks in the clouds After reaching VFR flight conditions below the clouds, landing airplanes may proceed to the airport and land using the recommended procedures described above.

7. N805C reported over the field and the flightcrew requested weather advisories, and stated their intention to depart Sun Valley as soon as possible after landing. This report was made on UNICOM frequency and was the last transmission received from the flightcrew.

8. The ceiling at the airport ranged from 800 to 1,500 feet, and the reported visibilities ranged from 3 to 10 miles. Ceilings were higher, visibilities were better, and there were breaks in the overcast south of the airport.

9. The ceilings were lower and visibilities were reported to be poor north of the airport and over Heilcy. The cloud bases were below the tops of the mountains on either side of the Wood River Valley.

10. At the airport and proceeding northwest, the Wood River Valley is 1 to 1.25 miles wide and the terrain on both sides of the valley rises over 1,000 feet within 0.5 mile of the valley floor.

11. N805C descended below the overcast southwest of the airport and proceeded northwestward toward airport along the west side of the valley. The flightcrew's reasons for proceeding along the west side of the valley are unknown. At the time, N805C passed abeam the airport its landing gear was down.

12. The flightcrew of N805C did not see the airport in time to either change course and avoid the mountains or to start a climb and clear the mountains. The reasons why the flightcrew did not see the airport could not be established conclusively.

13. N805C climbed about 220 feet or possibly more after passing the airport and before striking the ground.

14. When the airplane hit the ground its landing gear was down, its flaps were at 45°, and the engines were operating at high thrust levels The airplane was in controlled flight at impact

3 3 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the flightcrew's failure to adhere to the recommended visual arrival procedures for the Sun Valley Airport and its failure to execute timely terrain avoidance actions The reasons for the flightcrew's failures could not be established conclusively. Contributing to the accident were meteorological conditions and the obscuration of terrain features and landmarks by snow that made navigation by visual references and terrain avoidance difficult.

4. RECOMMENDATIONS

As a result of its investigation of this accident, tine Safety Board reiterated the following recommendations:

Require that all multiengine, turbine-powered, fixed-wing aircraft certificated to carry six or more passengers manufactured on or after a specified date, in any type of operations not currently required by 14 CFR 121.343, 121.359, and 135.151 to have a cockpit voice recorder and/or a flight data recorder, be prewired to accept a "general aviation" cockpit voice recorder (if also certificated for two-pilot operation) with at least one channel for voice communications transmitted from or received in the aircraft by radio, and one channel for audio signals from a cockpit area microphone, and a "general aviation" flight data recorder to record sufficient data parameters to determine the information in Table I (see appendix D) as a function of time. (Class II, Priority Action) **(A-82-107)**

Require that "general aviation" cockpit voice recorders ion aircraft certificated for two-pilot operation) and flight data recorders be installed when they become commercially available as standard equipment in all multiengine, turbine-powered fixed-wing aircraft and rotorcraft certificated to carry six or more passengers manufactured on or after a specified date, in any type of operation not currently required by 14 CFR 121.343, 121.359, 135.151, and 121.127 to have a cockpit voice recorder and/or a flight data recorder. (Class III, Longer Term Action) **(A-82-1091**

Require that "general aviation" cockpit voice recorders be installed as soon as they are commercially available in all multienginc, turbine-powered aircraft (both airplanes and rotorcraft), which are currently in service, which are certificated to carry six or more passengers and which arc required by their certificate to have two pilots, in any type of operation not currently required by 14 CFR 121.359, 135.151, and 127.127 to have a cockpit voice recorder. The cockpit voice recorders

should have at least one channel reserved for voice communications transmitted from or received in the aircraft by radio, and one channel reserved for audio signals from a cockpit area microphone. (Class II, Priority Action) (A-82-110)

Require that "general aviation" flight data recorders be installed as soon as they are commercially available in all multiengine, turbojet airplanes which are currently in service, which are certificated to carry six or more passengers in any type of operation not currently required by 14 CFR 121.343 to have a flight data recorder. Require recording of sufficient parameters to determine the following information as a function of time (see Table I (see appendix D) for ranges, accuracies, etc.):

altitude
indicated airspeed
magnetic heading
radio transmitter keying
pitch attitude
roll attitude
vertical acceleration
longitudinal acceleration
stabilizer trim position
or pitch control position

(Class III, Longer Term Action) **(A-82-111)**

In addition, the Safety Board recommended that the Federal Aviation Administration:

In conjunction with the appropriate Canadian authwities, conduct a survey of Canadair CL-600 airplanes to determine whether the hydraulic systems of the airplanes characteristically develop high levels of rubber/Teflon particle contamination; if unacceptable levels of contamination are found, determine and correct the cause of the contamination, and require the necessary improvements in the hydraulic filtration systems to prevent contaminants from entering vital components, such as flight control actuators (Class II, Priority Action) (A-83-63)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ G. H. PATRICK BURSLEY
Member

/s/ DONALD D. ENGEN
Member

August 23, 1983

5. APPENDIXES
APPENDIX A
INVESTIGATION AND PUBLIC HEARING

1. Investigation

The National Transportation Safety Board was notified of the accident about 2245 eastern standard time on January 3, 1983, and immediately dispatched an investigation team to the scene from its Washington, D.C., headquarters. Investigative groups were formed for operations, air traffic control, structures, systems, powerplants, and maintenance records.

Parties to the investigation were the Federal Aviation Administration, Canadair, Inc., and AVCO Lycoming, Inc. Also participating in the investigation was an accredited representative from the Aviation Safety Bureau of Transport Canada. The Aviation Safety Bureau made available its laboratory facilities and personnel for the examination and testing of numerous airplane components.

2. Public Hearing

A public hearing was not convened and depositions were not taken

APPENDIX B
PERSONNEL INFORMATION

Henry Edward Cook

Henry E. Cook, 58, the pilot-in-command was employed by the A. E. Staley Company on August 6, 1966. He held Airline Transport Certificate No. 147797 with an airplane multi-engine land rating and commercial privileges in airplane single engine land. tie was type rated in the McDonnell Douglas DC-3, Falcon 10 and 20, Cessna Citation C-500, and the Canadair Challenger CL-600. He also held CFI Flight Instructor Certificate No. 147797. His last first class medical certificate was issued December 8, 1982, and he was required to "wear corrective lenses while exercising the privileges of his airman certificate." On August 12, 1964, Mr. Cook had been issued a Statement of Demonstrated Ability for defective vision in both eyes (20/200 corrected to 20/20).

Mr. Cook qualified as pilot-in-command of the Canadair Challenger CL-600 on October 5, 1982. His last three pilot proficiency examinations were completed satisfactorily in the Falcon DA-10, DA-20, and Cessna Citation. All three examinations were completed on February 15, 1982. Mr. Cook has flown 19,242 hours, 59 of which were in the Challenger CL-600. During the last 90 days, 30 days, and 24 hours he has flown 117 hours 29 hours, and 3 hours, respectively- Mr. Cook had been off duty in excess of 24 hours before reporting for the flight about 0513, January 3, 1983. At the time of the accident, Mr. Cook had been on duty about 4 hours, 3 of which were flight time.

Mr. Cook had flown into Sun Valley Airport on December 2 and 26, 1982. Both flights had been in the CL-600 airplane; on December 2, Mr. Cook flew as copilot, and on December 26 he was the pilot-in-command.

In 1964, while on active duty with the United State Air Force (USAF), Mr. Cook's medical records showed that he had been removed from flight status by the USAF Central Aeromedical Review Board. The removal was based on a history of syncope (fainting). A fainting episode was reported on Mr. Cook's Application for Airman's Medical Certificate (FAA Form 1064) on July 1964 as follows: "Fainted during medicai examination 8 March 1964, approx. 30 sec. duration." Subsequently, Mr. Cook's complete medical record was reviewed and, on July 28, 1964, the FAA Regional Flight Surgeon issued a second class medical certificate. There were no further recurrences of fainting, and his subsequent medical examination were otherwise unremarkable.

Chester S. Wesolek

Chester Wesolek, 57, the copiiot on the flight, was employed by the A. E. Staley Company in August 2, 1959. He held Airline Transport Certificate No. 238843 with an airplane multiengine land rating and commercial privileges in airplane engine land and sea. He was type rated in the McDonneil Douglas DC-3. His iast first class medical certificate was issued July 15, 1982, and he was required to "have available glasses for near vision.

Mr. Wesolek has been under treatment for hypertension since 1962. Mr. Wesolek has complied with FAA requirements concerning flying while undergoing treatment to controi hypertension and his first class rnedicai certificates reflected this fact.

Mr. Wesolek qualified as a copilot—n the CL-600 on October 5, **1982.** His last three pilot proficiency examination were completed successfully *in* the Falcon **DA-10** on July **31, 1982;** in the Falcon **DA-20** on May 5, **1982;** and in a Swearingen Merlin 4C on January 5, **1982.** Mr. Wesolek had flown about 15,000 hours, **67** of which were in the Challenger CL-600. During the last **90** days, **30** days, and **24** hours he had flown 127 hours, 47 hours, and 3 hours, respectively. He had been off duty in excess of **24** hours before reporting for duty about **0513** on January **3, 1983.** **At** the time of the accident, he had been on duty about 4 hours, **3** of which were flight time.

Mr. Wesolek had made numerous flights into the Sun Valley **Airport** before the accident flight.

APPENDIX C
AIRPLANE INFORMATION

Canadair CL-600-1A11, Challenger N805C

The airplane? manufacturer's serial No. 1037, was delivered to the A.E. Staley Company on January 25, 1982. It was then delivered to TRACOR Aviation Inc., Santa Barbara, California, for installation of additional customer option avionics. TRACOR completed the avionics installation and returned the airplane io the A.E. Staley Company in September 1982. The airplane has Seen operated continuously by the company since that time.

A review of the airplane flight logs and maintenance records showed that although compliance with some Airworthiness Directives (AD) had no: been documented properly, all applicable AD's had been complied with, and that ail checks and inspections were completed within their specified time limits. The records review showed that ?he airplane nnd been maintained in accordance with company procedures and FAA rules and regulations and disclosed no discrepancies that could have affected adversely the performance of the airplane or any of its components.

The airplane was powered by two AVCO Lycoming AFL-502-L2 engines. The engine's rated thrust at takeoff is 7,500 lbs.

The following is pertinent statistical data:

Airplane

Tota! Airplane Time	-	203.5 hours
Total Airframe Cycles	-	86
Last inspection	-	12/20/82

Powerplants

Engine	No. 1	No. 2
Serial Number	LFO 3078	LFO 3079
Dated Installed	Sew	Sew
Time Since Installtion	203.5 hours	203.5 nrs.
Cycles Since Installation	90	90

APPENDIX D

IMPACT SITE

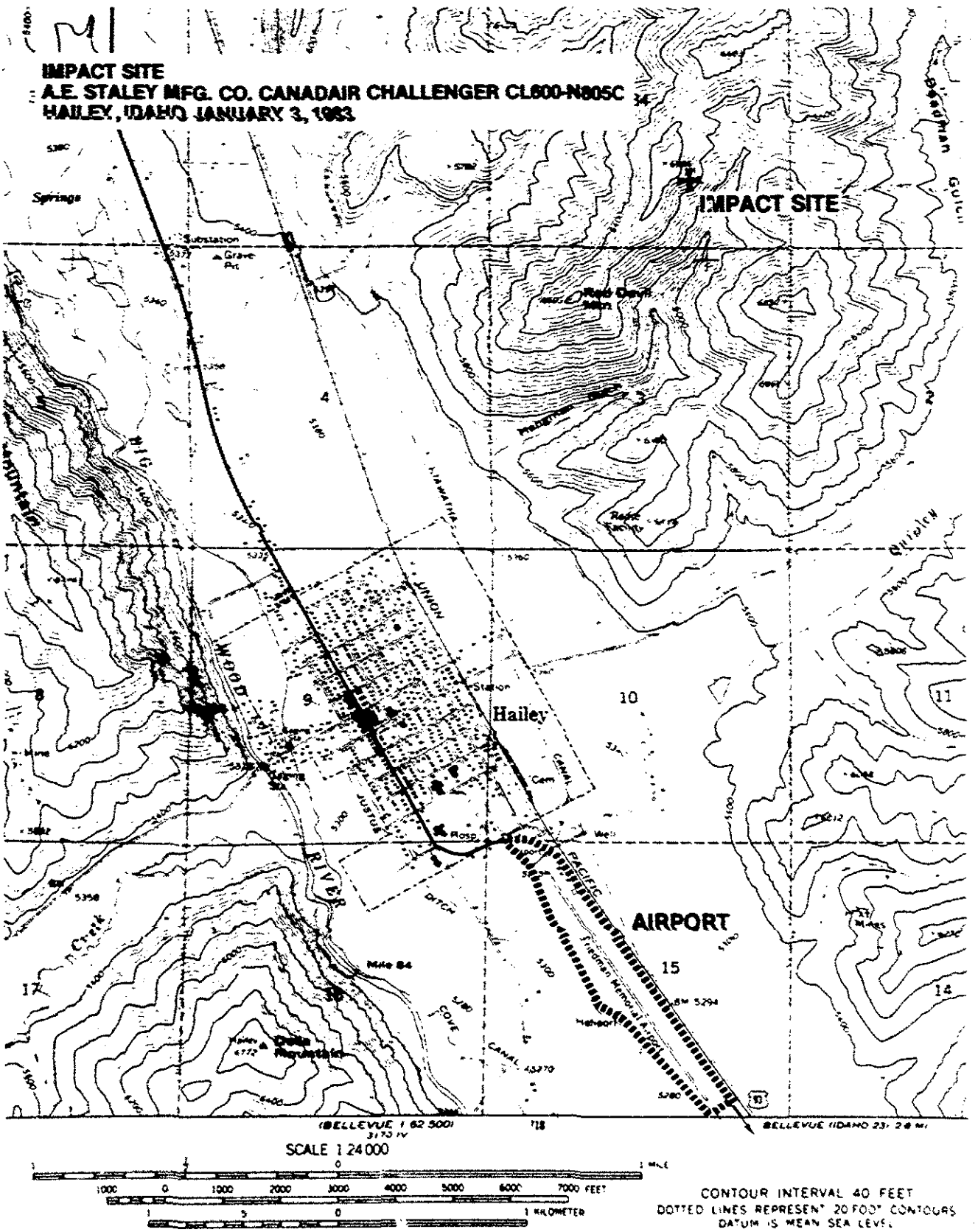

TABLE I

PARAMETER LIST (FIXED WING AIRCRAFT)

PARAMETERS	RANGE	INSTALLED SYSTEM 1/ MINIMUM ACCURACY (TO RECOVERED DATA)	SAMPLING INTERVAL (PER SECOND)
Relative Time (from recorder on prior to takeoff)	8 hrs. minimum	±0.125% per hour	1
Indicated Airspeed	V_{SO} to V_D (KIAS)	+5% or +10 kts., whichever is greater. Resolution 2 kts. below 175 KIAS	1
Altitude	-1,000 ft. to max cert. alt. of A/C	+100 to +700 ft. (see Table I, TSO C51-a)	1
Magnetic Heading	360°	±5°	1
Vertical Acceleration	-3g to +6g	±0.2g in addition to ±0.3g maximum datum error	4 (or 1 per second where peaks ref. to 1g are recorded)
Longitudinal Acceleration	±1.0g	±0.05g in addition to max. datum error of ±0.1g	2
Pitch Attitude	100% of usable range	±2°	1
Roll Attitude	±60° or 100% of usable range, whichever is greater	±2°	1
Stabilizer Trim Position	Full range	±3% unless higher accuracy uniquely required	1
OR Pitch Control Position	Full range	±3% unless higher accuracy uniquely required	1

1/ When data sources are aircraft instruments (except altimeters) of acceptable quality to fly the aircraft, the recording system excluding these sensors (but including all other characteristics of the recording system) shall contribute no more than half the values in this column.