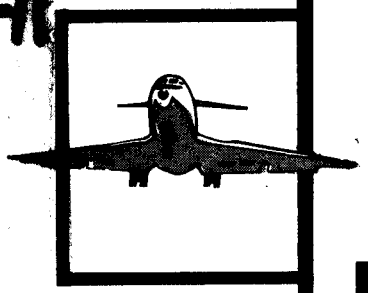

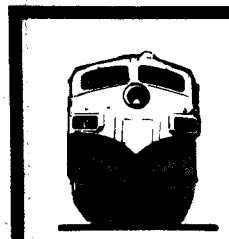

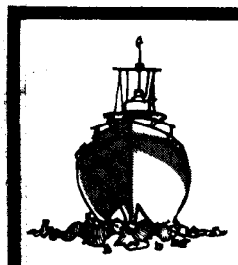

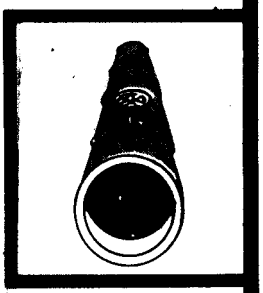

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

TRANSAMERICA AIRLINES, INC.,
LOCKHEED L-188, N859U
SALT LAKE CITY, UTAH
NOVEMBER 18, 1979

NTSB-AAR-80-11

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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15. Supplementary Notes

16. Abstract

At 0456 mountain standard time on November 18, 1979, Transamerica Airlines' Logair Flight 3N18, a Lockheed L-188C Electra, departed Hill Air Force Base, Ogden, Utah, with three crewmembers and 27,552 lbs of cargo, on an instrument flight rules (IFR) flight to Nellis Air Force Base, Nevada. After departure from Hill AFB, and while climbing from 12,000 to 13,000 feet, the flight indicated to Salt Lake departure control that they had lost all electrical power, the flight requested no-gyro vectors to visual flight conditions and clearance for an immediate descent to a lower altitude. During the descent, the aircraft attained a high airspeed and high rate of descent and disintegrated in flight. The three crewmembers were killed, and the aircraft was destroyed. The wreckage was dispersed along a path about 1 1/2 miles long on an abandoned airport about 4 nmi south of the Salt Lake City International Airport.

The National Transportation Safety Board determines that the probable cause of this accident was a progressive failure in the aircraft's electrical system leading to the disabling or erratic performance of some critical flight instruments and flight instrument lighting while the flight was operating in night instrument meteorological conditions. As a result of these conditions, the flightcrew could not resolve the instrumentation anomalies to determine proper aircraft attitude reference, and became disoriented and lost control of the aircraft. The crew's efforts to regain control of the aircraft imposed aerodynamic loads which exceeded design limits of the aircraft and caused it to break up in flight.

17. Key Words	18. Distribution Statement
Electrical system, night instrument meteorological conditions, priority bus A, horizon flight director, gyrosyn compass indicator, pictorial deviation indicator, integral lights, spatial disorientation, electrical bus lockout.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

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CONTENTS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopte: August 26,1980

TRANSAMERICA AIRLINES, INC.
LOCKHEED L-188, N859U
SALT LAKE CITY, UTAH
NOVEMBER 18,1979

SYNOPSIS

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1. FACTUAL INFORMATION

1.1 History of the Flight

About 0432, 1/ the crew of Transamerica Airlines Logair Flight 3N18 called Hill Air Force Base (AFB) ground control on frequency 126.2 MHz, advised that they were starting engines, and requested instrument flight rules (IFR) clearance to

1/ All times herein are mountain standard, based on the 24-hour clock.

Nellis Air Force Base, Nevada. The flight was cleared to takeoff on runway 14. The tower advised the flight, "We have light rime icing from nine thousand to flight over the entire local flying area." The crew acknowledged the advisory.

At 0442, the Hill AFB ground controller cleared the flight as follows:

> "Cleared to Nellis as filed; after departure, turn right heading one six zero, proceed direct Salt Lake, direct Mormon Mesa and then direct Nellis. 'Maintain flight level two zero zero. Contact Salt Lake departure on one two six point eight, squawk one one zero zero."

The ground controller told the crew that the local weather was estimated 2,500 ft broken, 6,000 ft overcast; visibility 15 miles; winds 180° at 10 kns, and the altimeter was 29.86 inHg. The flight acknowledged these communications.

Shortly thereafter, at 0445, the tower controller advised the crew that the flight was cleared for takeoff and amended the clearance to maintain 11,000 ft; the crew acknowledged.

Shortly after takeoff, the flight advised Salt Lake City departure control that it was airborne and was leaving 5,600 ft, climbing to 11,000 ft. Salt Lake City departure requested the flight to select transponder code 5101. Salt Lake City departure then requested the flight to delete the 11,000-ft restriction and cleared the flight to climb to flight level 200; the crew acknowledged the transmission. Shortly thereafter, Salt Lake City departure cleared the flight to proceed direct to the Salt Lake City VOR and to resume its own navigation on course. About 0451:29, when the aircraft was near the Salt Lake City VOR, the departure controller requested the flight to select transponder code 1100. The flight acknowledged the transmission.

Conversations between the Salt Lake City departure and center controllers disclosed that they had observed the secondary radar return of the aircraft, with its transponder code on 1100. According to the departure controller, the aircraft flew almost directly over the Salt Lake City VOR. At 0452:43 the flight reported that it was out of 11,000 ft. The controller then asked the flight to turn left to a heading of 160°. The flight acknowledged the heading. At 0453:34, the cockpit voice recorder (CVR) recorded sounds of a power interruption. Two seconds later, the captain said, "lost everything." The captain and first officer then discussed the loss of an electrical bus, after which the first officer said ". . .I don't have any heading reference at all" and the captain indicated that he also had no heading reference.

At 0453:42, Salt Lake City departure called the flight and advised it to resume its own navigation on course and to report its altitude. When there was no response from the crew, Salt Lake departure control called again at 0453:53, and again, there was no response from the crew. Both of the controller's transmissions were recorded on the aircraft's CVR. About 0454, the captain asked the first officer if he had a flashlight. The first officer replied, "yeah I got a flashlight."

At 0454:10, the first officer said, "Ah, we're boost out too." At 0454:15, the captain said, "yeah give us the boost," and the second officer said, "you got it." At 0454:19, the captain said, "no, get the boost off," followed by "go needle, ball, airspeed."

The departure controller stated that when he saw the aircraft's target about 1 mile south of Salt Lake City International Airport, he was no longer receiving a secondary radar return from the flight and that the automated radar terminal service tag for the aircraft displayed a "coast mode." About 0454:22, the departure controller called the flight; the first officer transmitted 4 seconds later that all electrical power on the aircraft had been lost. At 0454:33, the flight stated that a deviation from its heading and a descent were needed.

At 0454:43, the flight reported descending through 12,000 ft. About the same time, the second officer made a statement that sounded like ". . . we've still got B." Five seconds later, the controller advised the flight to maintain 11,000 ft for terrain clearance and to continue in a right turn, At 0454:58, the flight indicated that it would need heading information from departure control. According to the CVR, at 0455:05, the first officer said, "no, you're in a right turn," and the captain responded, "you help me, help me, help me fly the airplane." The first officer replied, "okay," and at 0455:17 he said "300 on the heading."

About 0455:34, the controller advised the flight to descend at the pilot's discretion and to maintain 8,000 ft. The flight replied, "Okay, what we need is some VFR weather, point us toward some VFR weather if at all possible." At 0455:43, the captain said "okay help me, I'm climbing."

At 0455:44, the controller said, "I'll take you north of Salt Lake, and I'should be able to get you down to about 6,000 to get you parallel to the airport. For the present time, maintain 8,000 for terrain. . . ." The last communication from the flight to the controller was at 0455:58 when the crew transmitted, "Descending.. .." At 0455:59, sounds of the aircraft breaking apart were recorded on the CVR, and 3 seconds later the recording stopped.

About 0456, the Salt Lake City tower controller observed a glow in the sky through the tower cab windows, heard an explosion, and saw two fireballs descend out of the overcast to the southwest. The aircraft crashed on an abandoned airport, about 4 nmi south of Salt Lake City International Airport.

The accident occurred about 0456 during hours of darkness; the coordinates of the crash site are 40° 43'43" N, 112° 00'49" W.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	3	0	0
Serious	0	0	0
Minor/None	0	0	0

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

None.

1.5 Personnel Information

All flight personnel were currently certificated and qualified for flight in accordance with current Federal regulations. (See appendix B.)

1.6 Aircraft Information

Logair Flight 3N18, a Lockheed Electra (L-188), N859U, was owned and operated by Transamerica Airlines, Inc., and was powered by four Detroit Diesel-Allison 501-Dl3 turboprop powerplants. (See Appendix C).

The aircraft's basic operating weight was 56,000 lbs; there were 27,500 lbs of payload and 16,000 lbs of jet-A fuel on board at takeoff. Takeoff gross weight was 99,500 lbs and the c.g. was 28.3 percent mean aerodynamic chord. The maximum allowable takeoff weight was 116,000 lbs. The No. 3 generator control unit (GCU) and an ammeter were replaced by Transamerica maintenance personnel at Hill AFB before the flight departed on November 18, 1979, because of a flight log comment regarding the ammeter indication on No. 3 generator on the incoming flight. There were no records to indicate that a functional check of the GCU was performed by maintenance personnel before the aircraft departed.

1.7 Meteorological Information

The crew of the Logair flight was briefed on the en route and terminal weather at all stops by the Hill AFB weather office. A Department of Defense Form 175-1 "Flight weather briefing" was completed and furnished to the crew.

Salt Lake International Airport observations at 0453 were: Clouds--2,000-ft scattered, measured 3,200-ft broken, 7,500-ft overcast; visibility--10 miles in light rainshowers; temperature--41° F; dewpoint--38° F; wind--180° at 7 knots; altimeter setting--29.87 inHg. Remarks were: ceiling ragged and lowering, precipitation heavy to southeast.

A Salt Lake City International Airport special observation at 0505 indicated: Clouds--2,000-ft scattered, measured 2,800-ft broken 5,500-ft overcast; visibility--10 miles in light rain; wind--180° at 5 knots; altimeter setting--29.88 inHg. Remarks were: ceiling ragged, precipitation heavier to southeast.

A report from a pilot of a corporate jet aircraft who was flying at or near the altitude of N859U about the time of the accident indicated that some icing conditions existed.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

The controller at Hill AFB stated that when the flight first began to taxi the tower received garbled and weak transmissions. Because the flight's radio transmission was barely distinguishable, the controller advised the crew of the poor transmissions. Later, however, after the aircraft was taxied from the freight loading area, the crew asked the tower controller if the transmissions were being received. The tower controller advised, "a lot better," and gave the flight its departure clearance. Controller personnel in Salt Lake departure control reported no difficulties with the quality of air to ground communications while they were in contact with the flight.

1.10 Aerodrome Information

Not applicable.

1.11 Flight Recorders

The aircraft was equipped with a Fairchild model A-100 cockpit voice recorder, serial No. 1488. The tape was in good condition and was transcribed at the Safety Board's Laboratory in Washington, D.C. (See appendix D.)

The aircraft was equipped with a Fairchild model 5424 flight data recorder (FDR), serial No. 5653. The recorder was recovered from the wreckage and was brought to the Safety Board's Laboratory, where it was read out.

The readout was started at a point where the aircraft was turning onto runway 14 at Hill AFB for takeoff and continued to the end of recorded traces--a total of 9 min. 38.4 sec. To convert pressure altitude to mean sea level, altitude information was based on the elevation of the approach end of runway 14, at Hill AFB—4,782 ft. No other corrections Were made to any parameter.

The final portion of the aircraft FDR foil tape was damaged. This damage created difficulties in the readout of the final heading, altitude, and normal acceleration traces. Between 0454:11 and 0454:46, the FDR heading trace was erratic, similar to the erratic heading variations which appeared during the takeoff roll and the previous landing. These variations are considered to be an instrument malfunction or a loose electrical connection to the FDR since the aircraft was incapable of producing the indicated turn rates as high as 120 deg/sec turn rate.

The FDR information, pertinent meteorological data, and air traffic control information were used to compute the aircraft's probable flight profile. The pertinent portion of the flight profile includes the final 4 1/2 minutes of flight and also includes selected CVR transmissions. (See appendix E.) The profile terminates close to the time of breakup as indicated by such a sound on the CVR.

Electrical power interruption, indicated by a negative spike on the FDR's g-trace, and a 1-second loss of power to the CVR, occurred at 0453:34, at an altitude of 11,800 ft, and about 6 1/2 minutes after liftoff. The aircraft had passed the Salt Lake City International Airport and was on a magnetic heading of 162°. It ,then entered a right turn and continued to climb.

1.12 Wreckage and Impact Information

The aircraft wreckage was scattered along a north-south path about 1 1/2 miles long. The right inboard wing was found in the southwestern part of the wreckage area. It had separated from the wing's center section and had sustained fire damage. The bottom wing planks were intact at impact; however, the top planks had been destroyed by fire. The flap had been destroyed by fire. The jackscrew measured 28 3/4 ins. between the trunnion pivots. The outboard wing had separated in flight. It was not damaged by fire. Its tip had separated from the leading edge and was found nearby. Some wing planks had fragmented. There was evidence of upward bending at the inboard end.

The inboard and center sections of the left wing were found in the main wreckage area which was about 400 ft from the southern end of the wreckage path. The inboard section was damaged by fire, and the flap had been destroyed by fire. Its jackscrew measured 20 ins. between pivot points. The outboard wing section had separated in flight and was not damaged by fire. Some planks had fragmented. There was evidence of downbending at the inboard overload separation of the outboard wing.

The vertical fin, the upper portion of the rudder, most of the left horizontal stabilizer, and 3 ft of the right horizontal stabilizer remained together. There was no fire damage.

The right outboard horizontal stabilizer was located 1,000 ft northeast of the empennage. It was not damaged by fire. A 6-ft x 3-ft portion of the inboard upper skin had separated. The inboard separations were bent downward. A 3-ft to 4-ft section of the left horizontal stabilizer was' found near the right outboard horizontal stabilizer; it was not damaged by fire.

Pieces of elevators and the lower rudder were recovered northwest of the empennage; they were not damaged by fire. There was evidence of overtravel at the hinges of the elevator upper surfaces. A piece of right outboard elevator was found at the north end of the wreckage pattern. All control surfaces recovered had separated due to overload.

The nose, cockpit, and cargo floor portions of the fuselage were within the main wreckage area. The fuselage had hit the ground inverted at a near 30° nosedown attitude. Portions aft of the flight engineer's panel were damaged heavily by fire. Several large sections of skin had been stripped off the bulkheads in flight and came to rest north of the main wreckage. These sections were not burned. The pressure bulkhead and the lower aft fuselage had separated in flight and were found with no fire damage in the main wreckage distribution area. The

upper aft fuselage failures were typical tension-type failures, while the lower failures were compression-type failures. The tailcone had separated and was found near the wing leading edges. It was not damaged by fire.

The left main landing gear was located in the main wreckage area. The gear and its attachments to the nacelle had been damaged heavily by fire; the tires were destroyed. The right gear was located about 20 ft west of the right inboard wing. The gear had separated from the oleo strut below the nut which holds the piston in the cylinder; it was not damaged by fire. The nose gear strut and the gear doors were found in the main wreckage and showed only slight evidence of fire.

All engine and propeller components were recovered at the accident site. The No. **1** engine was located some distance away from the main wreckage. The examination of engines and propellers disclosed no evidence of preimpact distress or malfunctions.

The power feederlines from the No. 2 generator to the nacelle firewall showed heavy fire damage, especially on the neutral, or ground, feederline. These units were recovered from an area in the center of the ground fire. Solidified, molten aluminum was found throughout. The No. 2 generator ground feeder was found free of its attachment to the generator. The lug which attaches the feeder to the generator was still attached to the terminal board. The other two generators were found attached to the No. **3** and **No. 4** engines. There was no evidence of electrical malfunction **or** distress on these units.

The majority of the cockpit instruments were destroyed beyond recognition. The captain's horizon flight director was recovered, it indicated an inverted, 30° nosedown attitude.

The directional gyros were not recovered. One turbine inlet temperature gauge indicated a value in the normal range **for** an operating engine. A control boost "OFF" warning light contained a hot-fractured filament.

The aileron and elevator flight control boost units were recovered; one unit was some distance away from the main wreckage and the other unit was near the main wreckage. They were both in a mechanical de-boost position. The units contained hydraulic fluid. Three electrically driven hydraulic pumps were recovered in the main wreckage area. Two pumps were damaged by fire and heat, one pump was undamaged.

1.13 Medical and Pathological Information

Postmortem and toxicological examinations of the flightcrew disclosed no preexisting medical problems or other abnormal conditions.

1.14 Fire

The aircraft was subjected to some ground fire.

1.15 Survival Aspects

The accident was not survivable because impact forces exceeded the limits of human tolerance.

1.16 Tests and Research

1.16.1 The Electrical System

The Allison turboprop engines operate at a constant speed for all flight regimes (13,820 ± rpm). The generator speed is, therefore, constant and produces power at 400 Hz, which eliminates the need for conventional constant-speed drives. Three generators are installed, one each on engine Nos. 2, 3, and 4. The aircraft was not equipped, nor was it required to be equipped, with a generator on the No. 1 engine. Generator No. 4 has a two-speed gearbox that permits it to be driven at 400 Hz at the normal in-flight engine rpm and at low-speed ground idle.

Primary electrical power is supplied by the three engine-driven, 60KVA, 3-phase, 400-cycle generators. The generators are not paralleled. A grounded neutral system is provided which gives phase-to-ground voltage of 115 volts. Power transfer relays are electrically and mechanically interlocked to prevent more than one generator from being connected to any one bus at the same time.

Electrical loads are assigned to buses based on their priority. Systems not necessary for safe flight and certain redundant items are supplied from bus B. Systems not necessary for safe flight but considered highly desirable, plus certain redundant items and most flight station equipment are supplied from bus A. Both bus A and bus B can be powered from two of the three generators.

Systems considered essential for continued safe flight are supplied by the essential a.c. bus and can be powered by any one of the three generators. If all generators fail, equipment critical for immediate descent and landing is automatically powered from the inverter bus which is powered from the battery and emergency inverter. The L-188 Electra "abbreviated emergency procedures" checklist does not incorporate procedures for electrical system failures because of the automatic features of the system. The Electra operating manual, however, does contain trouble-shooting charts with recommended in-flight procedures for certain electrical system discrepancies. The discrepancies listed in these charts do not include the symptoms discussed by the flightcrew on the CVR of the accident aircraft.

The L-188 has an automatic transfer system which controls the power flow from the generators to the buses as described below:

(a) Normal operation (three generators required)
generator No. 2 supplies bus B,
generator No. 3 supplies bus A,
essential a.c. bus is supplied from bus A, and
generator No. 4 is a spinning reserve.

(b) If generator **No. 2** fails:
generator **No. 4** supplies bus B,
generator **No. 3** supplies bus **A,**
essential a.c. bus is supplied from bus **A,** and
generator **No. 2** is off-loaded.

(c) If generator No. **3** fails:
generator No. **2** supplies bus B,
generator No. **4** supplies bus **A,**
essential a.c. bus is supplied from bus **A,** and
generator No. **3** is off-loaded.

(d) If both generator **Nos. 2** and **3** fail:
generator **No. 4** supplies bus **A,**
essential **a.c.** bus is supplied from bus **A,**
bus B is dead, and
generator Nos. **2** and **3** are off-loaded:

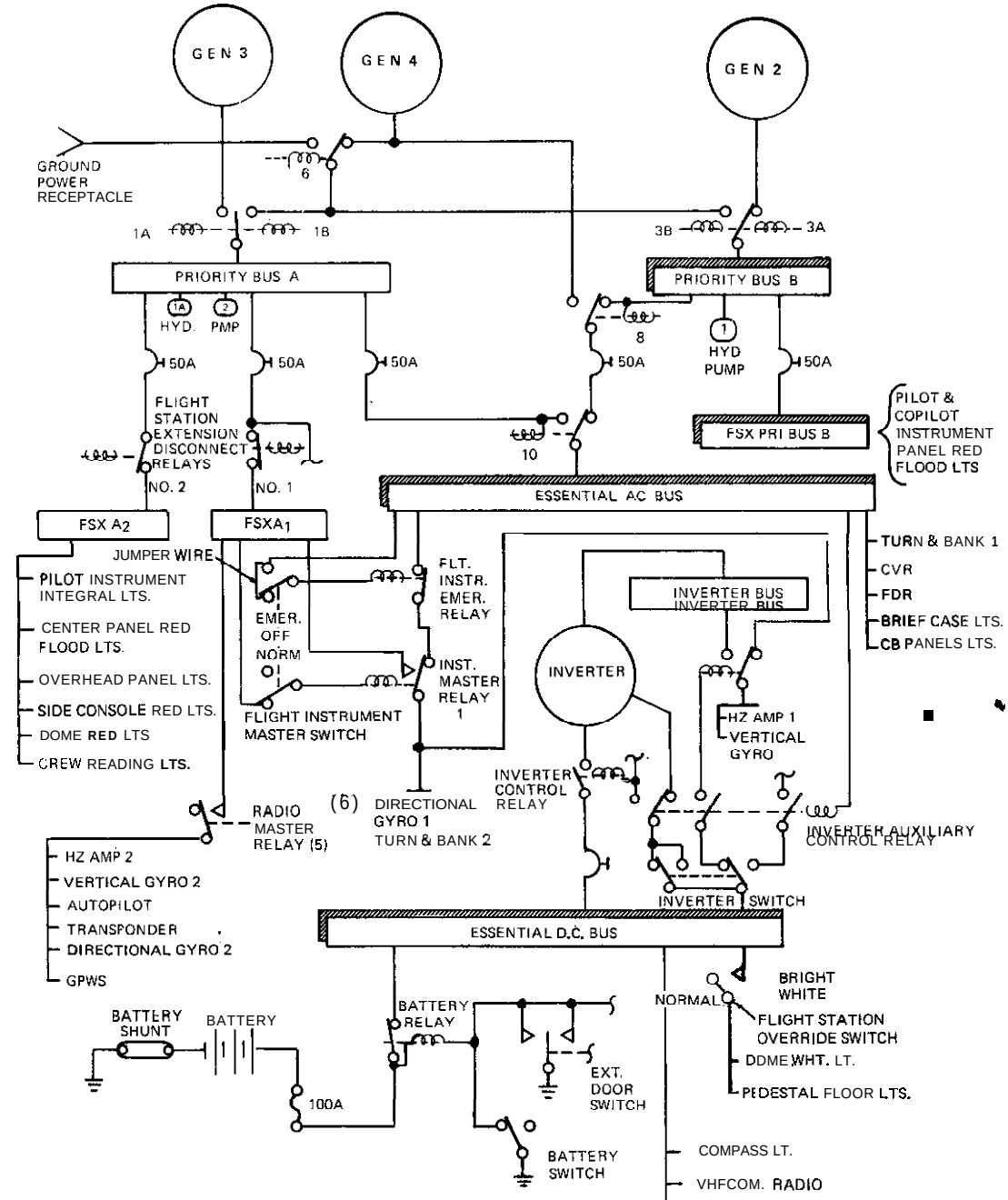
(e) If generator **No. 3** fails and a bus **A** lockout occurs:
generator No. **2** supplies bus B,
essential a.c. bus **is** supplied from bus B,
generator **No. 3** is off-loaded,
generator **No. 4** is a spinning reserve available to bus B and/or essential a.c. bus, and
bus **A** is dead and locked out from transfer.

Using available data, a simple schematic was drawn depicting the pertinent electrical system configuration of N859U at the time of the accident. (See figure **1.)** Because of the many changes made to this system throughout the life of the airplane, it is possible that some differences existed between the system as depicted on the diagram and the actual electrical system on the accident aircraft. Tests of the systems and components of sister ships of the accident aircraft were performed to identify some of the differences.

Ground tests of the **L-188** weather radar system, using conditions of decaying voltage showed that radar scope brightness, target position **or** range varied and sweep stopped completely at 95 volts.

Data received from the manufacturer of the **HZ-4** Flight Director System, and the **VOR** units also indicates that erratic and unpredictable displays can be expected when electrical supply does not meet specified voltage and frequency requirements.

During the investigation of a previous occurrence involving momentary loss of control of a Boeing **707-321C** aircraft using the same type of flight director instrument, the Board found that within seven seconds of an electrical power failure the instrument displayed a bank to the left of about 20° causing the pilot to make corrections for the false indication and placing the aircraft in a right wing down/diving attitude. This characteristic of the **HZ-4** unit was not generally known to flightcrews and existed in such units bearing serial numbers below **3000.** The serial number of the unit installed on the captain's side of N859U was **1870-D.**



NOTES:
1. FSX = Flight station extension
2. Shadowed barer indicate burrer considered energized prior to break-up of aircraft
3. Generator #3 considered failed and priority bur A locked out.
4. Switch and relay contacts shown in post lockout position.
5. Gang bar not activated 151
6. Provides FDR heading data (6)

Figure 1. — Schematic of Electrical System, L-188, N859U

1.16.2 Ground Tests *on* Transamerica L-188's

To develop a better understanding of the interrelationship of the various flight instruments, warning flags, and electrical power transfer systems on Transamerica's L-188's, tests were conducted on two sister-ships, N854U and N860U, at Miami, Florida, on January 24 and 25, 1980. During the tests, the entire electrical system was tested with engines operating, and the numerous flight station instruments and displays were observed. With the loss of power to the priority A bus, the copilot's horizon flight director, gyrosyn compass indicator, and pictorial deviation indicator were inoperative with power failure flags visible. The copilot's turn-and-bank indicator remained operative but flight instrument integral lighting was lost. The pilot's horizon flight director, gyrosyn compass indicator, pictorial deviation indicator, and turn-and-bank indicator remained operative. However, with a flight director function selected, a flight director warning flag was displayed and the steering bars were centered in the pilot's horizon flight director. The pilot's pictorial deviation card and command bars were inoperative, and a VOR-inoperative flag was displayed. A VOR-inoperative flag was also displayed on the pilot's gyrosyn compass indicator and the integral lighting in the pilot's flight instruments was lost. With four exceptions, the preliminary schematic is believed to have reflected the configuration of the sister ships' electrical systems. The exceptions were: (1) vertical gyro 1 and directional gyro 1 were connected through the flight instrument emergency relay and instrument master relay No. 1 rather than directly to the essential a.c. bus, (2) the instrument master switch had a jumper wire which energized the flight instrument emergency relay in either the "NORM" or "EMERG" position, (3) the instrument panel emergency white lights were connected directly to the essential d.c. bus, bypassing the flight station lighting override switch, and (4) the turn-and-bank 1 on N859U was connected directly to the essential a.c. bus rather than to the inverter bus.

Because of the uncertainty of the effect of a defective neutral ground circuit on generator operation, a special test was performed on sistership N860U. The purpose of the ground wire from generator neutral stud "T-0" is to provide a ground path for single-phase loads back to the "WYE"-connected three-phase generator. For three-phase balanced loads, such as motors for pumps and fans, the ground is unnecessary. However, for single-phase loads, such as lights, instruments,, and phase-to-ground feeder faults, the ground is necessary to provide a low-impedance path back to the generator neutral.

Before testing, the ground wire was removed and tied back from generator No. 2's neutral stud "T-0." The No. 2 engine was started with generator No. 2 switched off, and with generator No. 3 powering priority bus A and the essential a.c. bus, generator No. 2's switch was placed in the "TEST" position, which produced excitation and 117-volt a.c. output at no load. When switched "ON", generator No. 2 picked up priority bus B normally because the loads were all balanced three-phase loads. Priority bus A failure was simulated in an attempt to duplicate suspected conditions in the accident aircraft. The essential a.c. bus immediately transferred from the dead bus A to bus B; the latter continued under power from generator No. 2. There were no abnormal indications.

Additional tests were conducted on N8540 to determine the amount of increase in the control wheel forces with all hydraulic pumps in the "OFF" position. After switching all pumps "OFF" 51 seconds elapsed before aileron control became stiff.

1.16.3 Tests of Generator Control Units

Generator control unit S/N 5331264 had been removed from the accident aircraft just before its last flight. It had been installed in the No. 3 generator position and, according to maintenance personnel, had been removed as a precautionary measure. The maintenance was performed because of a complaint regarding the ammeter for the No. 3 generator, which was reading zero on the preceding flight. Examination of moisture spots on the inner surface of the unit's cover revealed a hot spot on one side of the micarta mounting board around a diode. There was evidence of excessive heat in a solder connection that was covered with a plastic sleeve, and several connections appeared poorly soldered. Spots of splattered solder were noted on the surface of the mounting plate and on wires. The unit was later tested at the manufacturer's facility. The tests disclosed no discrepancies. The unit was then subjected to a magnetic field of about 1.24 kilogauss. No effect was noticed on the operation of the unit.

In order to obtain a sample of the quality of overhauled generator control units, three units from Transamerica's spare parts stock were tested. Two units, S/N 52704198 and S/N 5260511, were tested because they had been removed from aircraft for maintenance reasons. One unit had a broken resistor; the other unit performed normally. A unit removed from stock, S/N 5329304, was tested and was found to function within specifications.

1.17 Other Information

1.17.1 Integrated Flight Instrument System

The L-188 is equipped with an integrated flight instrument system which is displayed on the pilot's and copilot's flight instrument panels. The integrated system consists of three instruments on each panel--the horizon flight director (HFD), the pictorial deviation indicator (PDI), and the gyrosyn compass indicator. (GCI).

The HFD receives and assimilates gyro and navigation radio signals. Attitude indications are received from the vertical gyro and navigational radio information may be introduced through the HFD computer. The attitude sphere shows the attitude of the aircraft as related to the horizontal axes of flight.

The PDI presents all navigation radio beam and VOR radial deviation information and the aircraft's heading relative to the selected course.

The pilot's GCI receives heading signals from the No. 1 compass system (directional gyro 1) and the copilot's GCI receive signals from the No. 2 compass system (directional gyro 2). A switch arrangement is provided so that both

indicators can be switched to either the No. 1 or the No. 2 directional gyro in case one of the gyros is inoperative. The aircraft's magnetic heading is shown on the face of the instrument and the desired heading can be manually set. Two radio navigation pointers are provided for VOR and ADF bearing information. A VOR-ADF selector switch is provided to select the desired function.

The pilot's flight instruments and the center panel instruments are normally lighted by integral lights which are powered by the priority A bus. Secondary lighting is provided by red flood lights connected to the priority B bus or by emergency white lights connected to the essential d.c. bus. The red flood lights are controlled by a switch/rheostat on the lighting control panel which is located above the pilot's station. The emergency white lights, including pedestal floor lights and a white dome light, are normally controlled by the flight station override switch, a 3-position switch located on the same panel. This switch must be in the "bright white" position to energize the emergency white lights. On N859U, the instrument panel emergency white lights were controlled by a separate switch.

1.17.2 Standby Attitude Indicating System

An independently powered standby attitude indicating system, designed to provide attitude indications on large turbojet aircraft in the event of major failures of electrical systems, is not required on large turboprop aircraft and was not installed on the accident aircraft.

2. ANALYSIS

The aircraft and flightcrew were properly certificated. There was no evidence that adverse medical or physiological factors affected the flightcrew's performance. According to CVR comments and air traffic control communications, the first officer was flying the aircraft during takeoff and the first portion of the flight.

The evidence clearly indicates that an electrical system malfunction developed shortly after the flight departed Hill Air Force Base. It is not clear; how the malfunction was first manifested to the crew. The flightcrew was having difficulty with the radar displays on both radar units. There were also remarks on the CVR regarding the captain's VOR indications. The captain concluded at that time that his VOR was not reliable but that the first officer's "appeared" to be right. Because the radar and the first officer's VOR are powered by priority bus A, the Board believes that these difficulties were not coincidental but rather were the first manifestations of a progressively decaying voltage condition and an indication of an insidious onset of the major electrical problems that followed. The Board is also inclined to believe that the erratic behavior of the radar and VOR during the early phase of the flight probably created a state of mind among the flightcrew which made it extremely difficult, if not impossible, for them to rely on flight instrument displays after a bus failure occurred. Unexplained deviations in the aircraft's heading from a point shortly after liftoff until electrical power transfer from bus A to bus B took place further suggests the existence of a decaying voltage condition which resulted in unreliable attitude and heading information on the first officer's flight instruments.

The departure controller stated that he lost the secondary radar return from the aircraft shortly after the flight passed over the Salt Lake City Airport. According to the flight profile, the captain commented "lost everything" about the same time. Therefore, the Safety Board concludes that a definite electrical malfunction occurred at 0453:34, when electrical power to the CVR was interrupted. Correlation of CVR, FDR, and air traffic control information disclosed that the interruption was of about 1 second duration with regard to the essential a.c. bus, because both the FDR and CVR continued to function from this bus without further interruption until the aircraft came apart in flight.

CVR conversations after 0453:36 indicate the flightcrew recognized the loss of an electrical bus but were uncertain as to which bus was lost. Based on the Board's analysis of crew comments and of the electrical systems, it was concluded that the inoperative system was priority bus A, including both flight station extensions A_1 and A_2. The first officer stated that he had no heading reference, and the captain apparently lost the integral lights on his flight instruments when he asked for a flashlight. Thirty-four seconds after the captain commented "lost everything," the first officer commented, "ah we're boost out too."

Since it is normal operating procedure to shut off one hydraulic pump after takeoff, the Safety Board concludes that after takeoff the flightcrew shut off the No. 1 pump which, when coupled with the loss of the No. 2 pump on priority bus A, would have eliminated the hydraulic boost for the flight controls. Ground tests disclosed that about 51 seconds elapsed between the loss of hydraulic boost and flight control stiffening. Therefore, since the time would be less under the aerodynamic loads encountered in flight, the Safety Board concludes that all electrical power to priority bus A was lost.

The design of the L-188's automatic transfer system provides for, in the event of a failure of the No. 3 generator, that priority bus A be automatically powered by the No. 4 generator. However, if priority bus A is locked out by the under voltage protection circuitry within the No. 3 generator's control unit, the bus is completely inoperative and the essential a.c. bus is transferred to priority bus B which is powered by generator No. 2. Consequently, since the aircraft's transponder and integral instrument lights and the copilot's gyrosyn compass indicator remained inoperative, the Safety Board concludes that priority bus A was locked out by a system malfunction.

Tests showed that a disconnected ground wire on the No. 2 generator such as was found on the accident aircraft had no effect on the operation of either priority bus A or priority bus B, or on the transfer of the essential a.c. bus to bus B when bus A was failed. Additionally, there was no evidence of malfunction or distress in the Nos. 3 and 4 generators. Further, since a malfunction in either of these generators should have produced a trip light which would have been plainly visible to the crew, and since there was no mention on the CVR of a trip light, the malfunction apparently involved a fault on the priority A bus which prevented either the No. 3 or No. 4 generator from providing power to the bus. Accordingly, all equipment powered by the bus would have been inoperative. Because of the postaccident condition of the control components of the electrical system, the reason or reasons for the fault on the priority A bus could not be determined.

The evidence also substantiates that the essential a.c. bus was powered, apparently by the No. 2 generator through priority bus B, because after the brief loss of power to the CVR and FDR both continued to function. Also, the second officer made a statement that sounded like "we've still got B." With the essential a.c. bus operative, electrical power should have been available to the captain's horizon flight director, gyrosyn compass indicator, and turn-and-bank indicator; also, the first officer's turn-and-bank indicator should have been operative. Moreover, because of the jumper wire between terminals of the flight instrument master switch, the captain's gyrosyn compass indicator and the first officer's turn-and-bank indicator should have been operative even if the instrument master switch was in the normal position. Since FDR heading information is obtained through the No. 1 compass system and the FDR heading trace was continuous, with regard to electrical continuity, the Safety Board concludes that the captain's compass indicator was functional and was providing reliable heading information. Also, the close correlation between the postcrash attitude indications (30° nosedown and inverted) on the captain's horizon flight director and the aircraft's impact attitude indicate that the horizon flight director was functioning properly at impact.

The flight instrument panel red flood lights and emergency white lights should have been available to the captain and first officer through the flight station extension of priority bus B and the essential d.c. bus, respectively. However, the availability of the lights would have depended on the positions of their control switches/rheostats. Apparently, the switches were off, at least initially, because the captain asked for a flashlight. Because the switches/rheostats are on the control panel above the captain's head and because there were no further comments on the CVR about obtaining lighting other than by flashlight, the Safety Board concludes that the red flood lights and emergency white lights probably were not turned on and the captain and first officer were relying on the flashlight for flight instrument panel illumination.

Under the circumstances, following the complete loss of priority bus A, the flightcrew was faced with a confusing situation in a darkened cockpit, while flying at night over mountainous terrain and in instrument meteorological conditions. The first officer's flight instruments, with the exception of the airspeed indicator and turn-and-bank indicator, would have been inoperative with appropriate warning flags indicating this condition.

Further, the captain's horizon flight director and pictorial deviation indicator, although operative, probably would have displayed warnings related to failures of their flight director functions. Similarly, VOR-inoperative flags would have appeared on his pictorial deviation indicator and gyrosyn compass indicator, although the latter's heading function would have remained operative. These displays, coupled with the loss of integral lights in these instruments, probably caused him to believe that his flight instruments were also inoperative or at least unreliable. This is supported by his negative response to the first officer's queries of whether he had any heading reference, by his subsequent command to fly by reference to basic flight instruments ("needle, ball, airspeed"), and his request for directional assistance ("give us gyro headings, we have no gyros").

The captain apparently took control of the aircraft because at 0454:26 the first officer began making the radio transmissions to the departure controller. This is further supported by the first officer's comment at 0455:05, "no you're in a right turn," and by the captain's request for help in flying the aircraft. It is not known whether the captain was asking for assistance because of the loss of hydraulic boost or whether he wanted assistance in interpreting the flight instruments. However, since the first officer had the flashlight and was making the radio transmissions, the captain probably wanted illumination of, and assistance in, interpreting the flight instruments. This is supported by the first officer's comment, "Three zero zero on the heading." Since the FDR heading at that time was about 330° and since a 30° reading error would not be unusual under the existing circumstances, the Safety Board concludes that the first officer was illuminating the captain's instruments with a flashlight and was reading the aircraft's heading from the captain's gyrosyn compass indicator.

The captain obviously became disoriented shortly after the first officer's comment about the aircraft's heading and almost immediately after the departure controller transmitted "...stop turn." About 0455:39, the FDR altitude trace indicates that the aircraft was descending through about 9,700 ft at a rate of about 12,000 ft/min. Simultaneously, the g-trace was about +2.9 g's and the indicated airspeed was at 270 kns and was increasing rapidly. At 0455:43, while still descending rapidly, the captain said, "Okay help me, I'm climbing." This indicates that the captain was totally disoriented and that the aircraft was out of control.

Within the following 10 to 13 seconds, the altitude trace stopped, followed by the airspeed trace, and high g-forces were recorded. At 0455:59, the sounds of aircraft disintegration were recorded on the CVR and 3 seconds later all recording ceased. Extrapolation of the altitude trace indicates that the aircraft broke apart at an altitude of about 7,200 ft, or about 3,000 ft above the ground.

The Safety Board believes that some aspects of this accident merit further discussion. The weight of the evidence indicates that the captain may have made quick judgment regarding the extent of the electrical malfunction ("lost everything") and although he afterwards discussed the loss of a bus, he did not alter his original assessment as indicated by his continued reminders to use basic instrument references. However, as determined in the investigation, even with the loss of bus A, the flight instruments on the captain's instrument panel should have been functional. Thus, the question must be raised as to whether the crew should have been able to diagnose and react properly to the total electrical/flight instrument situation under the given conditions. It is apparent from the comments on the CVR that from the time of the electrical power malfunction, the captain was primarily and continuously occupied in attempting to maintain control of the aircraft. There were only minimal comments concerning the electrical problem. It is, therefore, conceivable that the perplexing and insidious onset of the electrical system malfunction, such as a progressive voltage decay, may have led the flightcrew to doubt the reliability of all of their electrically powered flight instruments. The immediacy of having to make these judgments because of the night instrument meteorological conditions and with the instrument lights suddenly becoming inoperative made their task one of considerable magnitude. In view of

the behavior of the horizon indicator, which would first have indicated a 20° left wingdown attitude, the Board believes that the aircraft was placed in an unwanted right wingdown attitude before the A bus power loss had occurred or that loss was clearly indicated to the flightcrew. Thus, the limited assessments of the electrical problems by the crew as found on the CVR may be due, either fully or in part, to the compounded situation they were facing.

The foregoing discussion of the crew's response to the electrical system problems is based almost entirely upon the information contained on the CVR. Since the crew's verbal comments and cockpit sounds do not provide a complete indication of crew actions and communications, the full extent of their efforts to interpret displayed systems and to diagnose and remedy the problem cannot be determined from the investigation. In light of the incompleteness of the evidence, the Safety Board cannot reach a conclusion as to the extent of the crew's response to the emergency, but can conclude that their efforts did not succeed in coping with the emergency situation in time to avert a complete loss of control. While the Board does not fully understand the apparent lack of active involvement of the flight engineer in some form of definitive observations and corresponding remarks relative to the displays on the electrical control panel during the emergency, it is very likely that some analytical assessment of these displays was being performed by him, but this is not evident on the CVR.

Although not required in civil turboprop transport aircraft by current Federal Aviation Regulations, the Safety Board believes that an independently powered standby attitude indicator is an indispensable instrument under the conditions and circumstances of this accident. With the loss or assumed loss of electrically operated flight instrumentation and cockpit lighting in instrument meteorological conditions, the pilot's main concerns are to keep the aircraft under control and to keep it in level or near level flight while analysis of the electrical problems can be conducted. With an attitude indicator that is independently powered, the pilot can be reasonably confident that it is accurate, reliable, and unaffected by electrical problems. Consequently, he not only has a valuable instrument to rely on for maintaining aircraft control, but he also has an instrument that can be used to assess the performance of the normal flight instruments. The Safety Board believes that this accident probably would have been avoided had an independently powered standby attitude indicator been installed in N859U.

3. CONCLUSIONS

31 Findings

1. The flightcrew was properly certificated and qualified for the flight.

2. The aircraft was properly certificated and was maintained in accordance with existing regulations.

3. An electrical system malfunction occurred while the aircraft was climbing between 12,000 and 13,000 ft; the first officer was flying the aircraft when the malfunction occurred.

4. The flight was operating at night in instrument meteorological conditions when the electrical system malfunction occurred.

5. The difficulties with radar and **VOR** systems immediately after takeoff were the result of a progressive voltage decay in the bus **A** system.

6. The horizon flight director displayed unreliable attitude information before there were clear indications of an electrical system manfunction.

7. The electrical system malfunction involved a lockout of priority bus **A;** following lockout, all equipment powered from this bus was inoperative, including the first officer's horizon director, pictorial deviation indicator, and gyrosyn compass indicator, as well as the integral lights in the pilots' flight instruments.

8. When the malfunction occurred, the essential a.c. bus was transferred from priority bus **A** to priority bus B, which involved a brief interruption of power to the essential a.c. bus.

9. The insidious onset of the electrical system malfunction caused the captain not to rely on flight instrument displays.

10. The captain's horizon flight director, gyrosyn compass indicator, and turn-and-bank indicator were operative at the time of impact. ■

11. Following lockout of priority bus **A,** flight instrument panel lighting was available from emergency white lights and from red flood lights; these lights were not on before the lockout occurred.

12. After the electrical malfunction, the captain took control of the aircraft.

13. The captain became spatially disoriented and lost control of the aircraft.

14. The aircraft's structural design loads and its maximum airspeed were exceeded, and the aircraft broke apart in flight about **3,000** ft above the ground.

15. The aircraft was not equipped, nor was it required to be equipped, with an independently powered standby attitude indicator.

16. Had the aircraft been equipped with an independently powered standby attitude indicator, the accident probably would have been avoided.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was a progressive failure in the aircraft's electrical system leading to the disabling or erratic performance of some critical flight instruments and flight instrument lighting while the flight was operating in night instrument meteorological conditions. As a result of these conditions, the flightcrew could not resolve the instrumentation anomalies to determine proper aircraft attitude reference, and became disoriented and lost control of the aircraft. The crew's efforts to regain control of the aircraft imposed aerodynamic loads which exceeded design limits of the aircraft and caused it to break up in flight.

4. SAFETY RECOMMENDATIONS

As a result of this accident, the National Transportation Safety Board on March 13. 1980, recommended that'the Federal Aviation Administration:

> Amend 14 CFR 121.305(j) to extend its application to all large turboprop aircraft to require an additional attitude-indicating instrument which operates from a source of power independent of the normal electrical generating system. (Class 11, Priority Action) (A-80-19)

See Appendix F for the FAA's response to this recommendation and the Safety Board's reply to their response.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

ELWOOD T. DRIVER, Vice Chairman, did not participate. FRANCIS H. McADAMS, Member, filed the following dissent.

Member McADAMS, Dissenting:

In my opinion, in the interest of preventing similar accidents from occurring, the Board should have emphasized that in the event of a partial electrical failure

or interruption, pilots should not assume, as this crew apparently did, that there is a total loss of power. In this case the captain's flight director, gyrosyn compass, and turn and bank indicator were operative, and with such instruments functional the aircraft could have been flown safely. The crew should have adequately analyzed the extent of the power failure and determined which instruments were operative.

/s/ FRANCIS H. McADAMS
Member

August **26,** 1980

5. APPENDIXES

APPENDIX A
INVESTIGATION AND HEARING

Investigation

The National Transportation Safety Board was notified of the accident at 0600 e.s.t. on November 18, 1979, and immediately dispatched an investigation team to the scene. Investigative groups were established for operations, air traffic control, aircraft systems, structures, weather, powerplants, witness, cockpit voice and flight data recorders, and aircraft records.

Parties to the investigation were the Federal Aviation Administration, U.S. Air Force, Transamerica Airlines, Inc., Lockheed Aircraft Corporation, Detroit Diesel Allison Divison of General Motors, and Air Line Pilots Association.

Public Hearing

The National Transportation Safety Board did not hold a public hearing nor were depositions taken during this investigation.

APPENDIX E
PERSONNEL INFORMATION

Captain Marvin H. Dick

Captain Dick, 46, was employed by Transamerica Airlines on May 5, 1972. He held a valid Airline Transport Certificate No. 1415334 with aircraft single and multiengine land ratings. He was type rated in Lockheed L-188, L-382, Curtis Wright C-46 and Armstrong-Witworth 650 aircraft. Captain Dick had a valid first-class medical certificate without limitations issued on June 11, 1979.

His total flying time was reported to be between 15,000 and 20,000 hours with 6,000 hours in L-188 aircraft. The last proficiency check was on September 18, 1979. The last line check was on July 25, 1979.

First Officer Harry H. Gardiner

First Officer Gardiner, 35, was employed by Transamerica Airlines, Inc., on April 30, 1979. He held a valid Airline Transport Certificate No. 2149366, Flight Engineer's Certificate No. 155342331. He was rated for multiengine land, L-188 and CE-500 aircraft, and held a valid first-class medical certificate without limitations, issued on January 30, 1979.

His total flying time was 3,140 hours, with 2,715 hours in L-188 aircraft; last proficiency check was on May 31, 1979.

Second Officer Jack M. Johnston

Second Officer Johnston, 54, was employed by Transamerica Airlines on May 7, 1972. He held aircraft and powerplants Certificate No, 1017744. His total flying time was 14,866 hours, with 8,176 hours in L-188 aircraft.

He held a first-class medical certificate issued on March 14, 1979, with limitation to "wear glasses for near and distant vision." The first-class medical certificate reverted to a second-class certificate after 6 months from the issue date. Only a second-class certificate is required of a second officer.

His last proficiency check was on January 25, 1979; the last line check on May 9, 1979.

APPENDIX C
AIRCRAFT INFORMATION

Lockheed Electra (L-188), N598U

The aircraft S/N 2016 was manufactured on March 29, 1960, and was exported to the Netherlands on April 29, 1960, and kept in service by KLM until May 28, 1968, when the aircraft was imported into United States, and a Certificate of Airworthiness was issued under transport category.

The aircraft was converted into cargo configuration on October 7, 1968, and underwent extensive modifications at Lockheed Aircraft Service Company using Master Drawing List SDR 6708 authorized by supplemental type certificate No. SA1754WE dated July 29, 1968. This cargo modification was performed for Universal Airlines which operated the aircraft until May 4, 1972, when Saturn Airways purchased the aircraft.

The aircraft was registered to Transamerica Airlines on December 1, 1976. All maintenance inspections and component changes had been completed within their specified time limits.

The aircraft had a total of 41,764 operating hours.

The aircraft was powered by 4 Allison 501-D13 engines and Hamilton Standard Model 54H60-125/A7121B-2 propellers. Serial Numbers and operating times were as follows:

Engines	No. 1	No. 2	No. 3	No. 4
Serial No.	501120	501442	500521	501436
Date of Insp.	10/24/79	10/15/79	7/19/79	10/8/79
Time Since Insp.	176 Hrs.	237 Hrs.	723 Hrs.	4,055 hrs.
T.S.O.	2,492 hrs	5,739 hrs	723 hrs	4,055 hrs
Propellers				
Serial No.	214985	216993	214983	215205
Date of Inst.	7/13/77	9/7/79	7/18/79	7/18/79
Time Since Insp.	4,493 hrs	445 hrs	724 hrs	724 hrs
T.S.O.	4,493 hrs	6,135 hrs	724 hrs	3,331 hrs

The aircraft had been maintained in accordance with existing requirements. All applicable Airworthiness Directives had been complied with.

APPENDIX D
TRANSCRIPT OF A PAIRCHILD A-100 COCKPIT VOICE RECORDER SIN 1488, REMOVED FROM THE TRANSAMERICA L-188 WHICH WAS INVOLVED IN AN ACCIDENT AT SALT LAKE CITY ON NOVEMBER 18,1979

LEGEND

CAM	Cockpit area microphone voice or sound source
RDO	Radio transmission from accident aircraft
-1	Voice identified as Captain
-2	Voice identified as First Officer
-3	Voice identified as Flight Engineer
-?	Voice 'unidentified
*	Unintelligible word
#	Nonpertinent word
%	Break in continuity
( )	Questionable text
(( ))	Editorial insertion
---	Pause
TWR	Tower transmission
DEP	Departure control

Note: Times expressed in Greenwich Mean Time

INTRA-COCKPIT

TIME & SOURCE	CONTENT
CAM	((The captain noted that there were no flaps and that the DG rotated and stabilized on 035. the taxiway heading, and that the turn and bank was operational))
1139:00 CAM	((Two power interruptions were noted when engines were dropped to low idle))
CAM-?	Battery switch wasn't on
CM-?	Oh
CAM	((Taxi out was routine))
CAM-1	Everybody ready
CAM-?	•
CAM-1	Go ahead and bring them up
CAM	((Sound of increased RPM))

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
1145:00 TWR	Log Air eight five nine winds are one eight zero, one zero clear for takeoff, I have amendment to your clearance, after departure maintain one one thousand *
RDO-2	Log Air eight five nine cleared for takeoff. after departure maintain one one thousand

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
CAM-?	((Sound similar to final checklist items being read))	TWR	That's correct
CAM-3	Takeoff check complete	1146:00 ROO-2	Ah [redacted] Tower, Log Air eight five nine, ah radio check
		TWR	A lot better on that transmitter
		ROO-2	Ah can you read this transmitter okay?
		1201:00 TWR	Yeah that one's fine
		RW-2	Okay
CAM-2	Let's see sixty knots one eleven one twenty four hundred feet, gear in the well. any abort will be initiated by You, by you		
CAM-?	•		
CAM-?	What was that for? •		
CAM-3	Beta lights are out		
CAM-3	Standard power		
CAM-1	Sixty		
CAM-1	Vee one		
CAM-1	Two	TWR	Roger

INTRA-COCKPIT

TIME & SOURCE	CONTENT
CAM-2	Positive rate, gear up
CAM-2	Meto
CAM-3	Meto
CAM	((Sound of GPWS))
CAM-1	Four hundred feet
CAM-2	Flaps up
CAM-1	Flaps up
CAM-?	•
CAM-1	Climb power

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
TWR	Eight fifty nine. contact departure control
RW-1	Eight fifty nine
1147:44 RW-1	Departure Log Air eight five nine is off [redacted] Field
1147:51 DEP	Log Air eight five nine Salt Lake departure, radar contact. verify altitude leaving, verify climbing to one one thousand
1147:57 RW-1	Leaving fifty six for one one thousand
1147:58 DEP	Yup

INTRA-COCKPIT

TIME & SOURCE	CONTENT
CAM-2	Radar
CAM-2	Don't have anything over here at all, we better ---
1149:25 CAM-2	That's weather there
CAM-?	•
CAM-1	*
1149:50 CAM-1	What scope you on fifty?

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
1148:03 DEP	Log Air eight five nine squawk five one zero one and ident
1148:42 DEP	Log Air three forty two ---
1148:49 DEP	Log Air eight five nine delete the altitude restriction, climb and maintain flight level two zero zero
1148:53 RDO-1	Five nine is cleared to two zero zero
RDO	((Conversation from Tee Fox))
RDO	((Conversation from Log Air three forty two))

INTRA-COCKPIT

TIME & SOURCE	CONTENT
1149:52 CAM-2	Yeah
1149:55 CAM-1	Don't want to get too far over to the left till we get some altitude *
CAM-1	*
1150:15 CAM-1	Ah something wrong here with our VOR
1150:39 CAM-1	Yours appears to be right, mines gotta be wrong
1150:50 CAM-1	Radars not working for #

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
1149:59 OEP	Log Air eight five nine, proceed direct to the Salt Lake VOR, resume own navigation on course
1150:04 RDO-1	Eight fifty nine
RDO	((Conversation frm Log Air three forty two))
RDO	((Conversation from Log Air three forty two))
RDO	((Conversation from two ninety seven))
RDO	((Conversation from seven TF))

INW

APPENDIX D

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1150:55 CAM-1	My scope isn't (doing) nothing		
CAM-3	•		
1151:02 CAM-1	That's not bad		
1151:09 W-1	Ya see my picture looks like it's on a hundred and fifty all the [illegible] •		
1151:17 CAM-2	Yeah, mine does too		
1151:19 W-2	(N)ah		
1151:20 CAM-2	No it doesn't either •		
		1151:29 DEP	Log Air eight five nine squawk one one zero zero
		1151:37 CAM-1	Eight fifty nine. ah, has your scope picked up weather tonight
1151:44 CAM-1/2	I think we just got on top of that layer		
		1151:45 DEP	Stand by a sec.
1151:49 CAM-1	We got more of it		

INTRA-COCKPIT

TIME a SOURCE	CONTENT
1151:51 CAM-3	Yeah, we a star (in sight)
1151:59 CAM-1	The radar is absolutely worthless
1153:34 CAM	((Sound of power interruption to CVR))

AIR-GROUND COMMUNICATIONS

TIME a SOURCE	CONTENT
RDO	((Conversation from Sabreliner))
RW	((Conversation fom TF))
1152:40 DEP	Okay Log Air eight five nine. say altitude
1152:43 RDO-1	We're out of eleven thousand
1152:45 DEP	Turn left heading to one six zero. eight five nine
1152:47 ROO-1	One six zero
RW	((Conversation from Log Air three forty two))
	%
R W	((Converational fom seven TF))
	%

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1153:36 CAM-1	Lost everything		
1153:39 CAM-1	Ye lost a buss		
1153:40 CAM-2	Lost a buss		
1153:41 CAM-1	Which one		
		1153:42 DEP	log Air eight five nine, resume own navigation on course, say your altitude
CAM-?	Huh		
CAM-?	Huh		
CAM-?	•		
1153:45 CAM-2	I don't have any altimeter. I don't have any heading reference at all		
1153:49 CAM-2	Do YOU		
1153:51 CAM-1	No		
1153:52 CAM-2	Have any heading reference?		
		1153:53 DEP	log Air eight five nine, resume own nav

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
CAM-1	You got a flashlight?		
1154:01 CAM-2	Yeah. I got a flashlight		
		RDO	((Conversation from Sabre TF))
1154:10 CAM-2	Ah, we're boost out to		%
CAM-1	Huh		
1154:13 CAM-2	We're boost out aren't we?		%
1154:15 CAM-1	Yeah give us the boost		
CAM-3	You got it		
1154:19 CAM-1	No, get the boost off		
CAM-?	* (good move)		
CAM-3	(Okay)		
		1154:22 DEP	Log Air five nine Salt Lake
1154:25 CAM-1	Go needle ball airspeed		
		1154:26 RW-2	Roger, eight five nine has lost all electrical power on the aircraft

INTRA-COCKPIT

TIME a SOURCE	CONTENT
1154:30 CAM-1	Okay let's (start)
CAM-1	Request a descent
CAM-1	(Want to) cancel
CAM-3	# we're (still got) "B" #
1154:57 CAM-1	Give us gyro headings, we have no gyros

AIR-GROUND COMMUNICATIONS

TIME a SOURCE	CONTENT
1154:30 DEP	Log Air eight five nine, do you want to land at Salt Lake?
1154:33 RDO-2	Ah we want ah make sure we're on a heading wha- I need deviation from our heading we'll require --- and a descent
1154:40 DEP	All right, you appear to be heading due west now, say your altitude
1154:43 RDO-2	Ah we're heading ah, we're altitude of eleven twelve thousand. now descending through twelve
1154:48 DEP	Maintain one * thousand for terrain Log Air eight five nine and continue in a right turn
1154:53 RDO-2	Okay we ah
RDO	((Keyed microphone))

INTRA-COCKPIT

TIME & SOURCE	CONTENT
CAM-?	1'11 keep an eye on the west
CAM-?	You're in a left turn now
CAM-3	*
1155:05 CAM-2	No you're in a right turn
1155:08 CAM-1	You help ne, help me, help me fly the airplane
CAM-2	Okay
1155:15 CAM-1	What have we got
CAM	((Buildup in airspeed becomes evident))
1155:17 CAM-2	Three zero zero on the heading
1155:18 CAM-1	We need a heading of a ---

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
1154:58 RDO-2	Yeah and we'll need gyro headings the whole way
1155:01 DEP	Roger Log Air eight five nine, do you wish vectors back to Salt Lake?
RDO	((Conversation from Log Air three forty two))
	%

INTRA-COCKPIT		AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
1155:29 CAM-1	Three one zero	1155:24 OEP	Log Air eight five nine stop turn
		1155:26 ROD-2	Eight five nine, roger
		1155:28 DEP	Are you able to maintain your altitude eight five nine?
		1155:31 ROD-2	Eight five nine, we are ah descending, do you want us to maintain altitude?
		1155:34 OEP	You can descend at your discretion maintain eight thousand for terrain Log Air eight five nine
		1155:39 ROD-2	Okay, what we need is some VFR weather, point us towards some VFR weather if at all possible
1155:43 CAM-1	Okay help me, I'm climbing		
CAM-1	Okay	1155:44 DEP	I'll take you

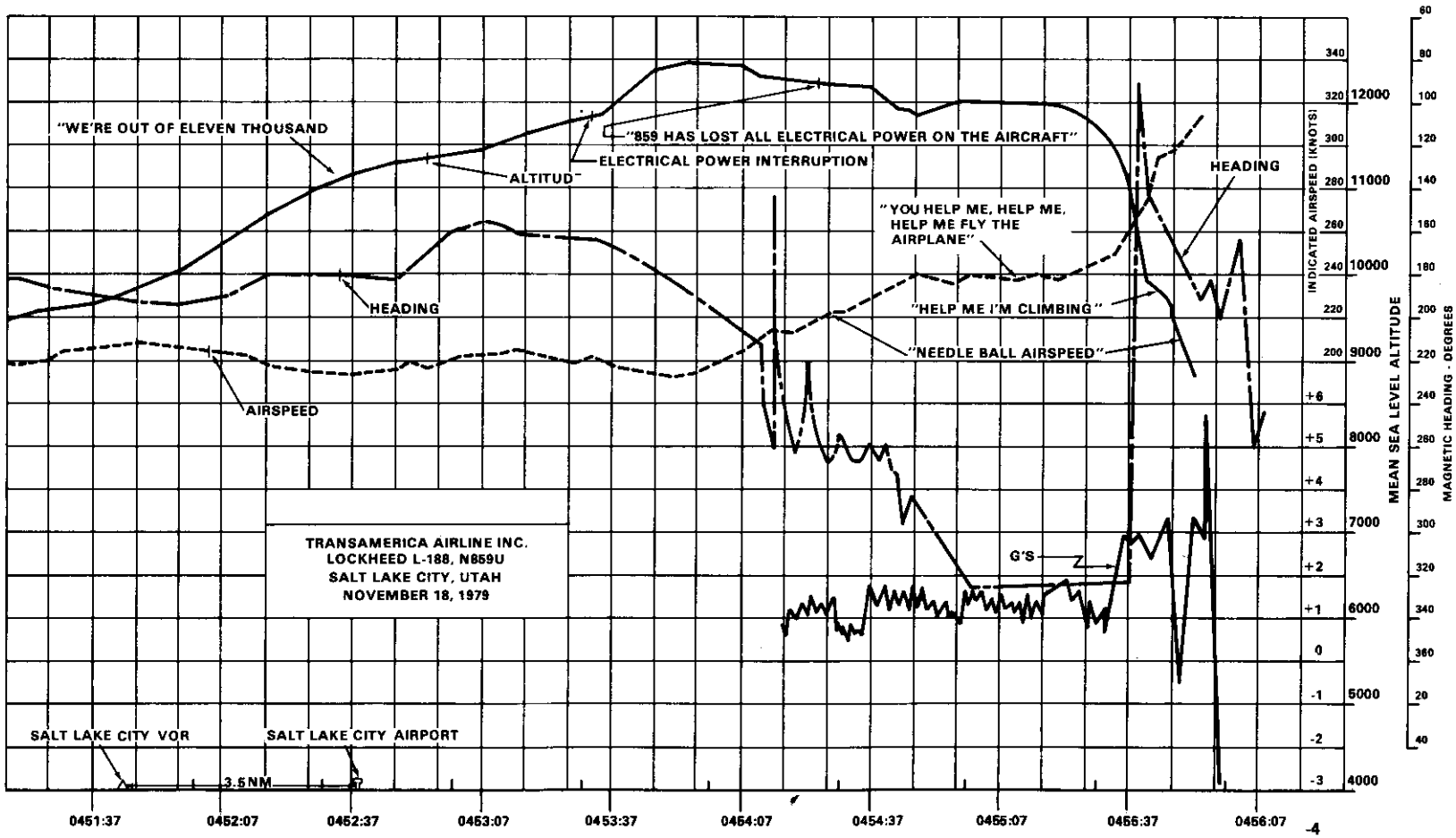
INTRA-COCKPIT

TIME & SOURCE	CONTENT
CAM-1	Help me. Hm, I'm ...
1155:50 CAM-1	Needle ball airspeed
1155:53 CAM-2	I got you in a right turn

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
RDO	((Aircraft mike keyed))
1155:47 OEP	North of Salt Lake and I should be able to get you down to about six thousand to get you parallel * * * present time maintain eight thousand for terrain Log Air eight five niner
1155:58 RDO-2	Descending
RDO-2	Desc--
1155:59 RDO	((Sound of breakup starts))
RDO	((Restoration of power to recorder))
1156:00 CTR	Log Air three forty two
1156:02 RDO	((Loss of power to recorder))

APPENDIX E
PROBABLE FLIGHT PROFILE



APPENDIX F
FEDERAL AVIATION ADMINSTRATION RESPONSE TO SAFETY RECOMMENDATION A-80-19

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Log 1135

WASHINGTON. D.C. 20591

OFFICE OF THE ADMINISTRATOR

TE-1-30

6/13/80

NSR 2957
MC 80.977

June 11, 1980

The Honorable James B. King
Chairman, National Transportation
Safety Board
800 Independence Avenue, SW.
Washington, D.C. 20594

Dear Mr. Chairman:

This is in response to NTSB Safety Recommendation A-80-19, issued by the Board on March 13, 1980. This recommendation resulted from the Board's investigation of the crash of a Transamerica Airline, L-188, N859U, at 0447 m.s.t. on November 18, 1979. While climbing from 12,000 to 13,000 feet following departure from Hill Air Farce Base, Utah, the crew advised Salt Lake Center that all electrical power had been lost and requested an immediate descent to VFR conditions. During the descent, the aircraft attained a high rate of descent with excessive airspeed and broke up in flight. The Board believes that had N859U had a third attitude-indicating instrument aboard, the crew probably could have avoided the high airspeed and descent rates which contributed to the aircraft breakup.

Accordingly, the Board recommended that the Federal Aviation Administration (FAA):

A-80-19. Amend *14* CFK 121.305(j) to extend its application to all large turboprop aircrait to require an additional attitude-indicating instrument, for bank and pitch, operating from a source of power independent of the normal electrical generating system as is now required on all large turbojet aircraft.

Comment. We do not concur with this recommendation, and it is our belief that a third attitude-indicating instrument should not be required on all large turboprop aircraft due to lack of flight control or electrical problems associated with this type of aircraft.

On June 11, 1969, FAA issued Notice of Proposed Rule Making (NPRM) 69-26. Additional Attitude Instrument in Large Turbojet Airplanes. This notice did not consider requiring a third attitude indicator an turboprop aircraft and the preamble to Amendment 121-57, published in 35 FR 304, January 8, 1970, did not discuss the feasibility of requiring an additional attitude indicator in other than turbojet-powered aircraft (copy enclosed).

NTSB response to Notice 69-26, dated September 10, 1969, concurred with the proposed rule, as written, without further comment or any suggested revisions (copy enclosed).

APPENDIX F

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It is our understanding that the Board has not, as of this date, published an accident report identifying the causal factor for this accident. Accordingly, we are not able to say, positively, what the actual cause was. However. we do not believe that Tranaamerica Airlines' L-188 aircraft experienced a complete electrical power failure due to the fact that the cockpit voice recorder did not reflect a loss of total electrical power. The cockpit voice recorder factual report transcript prepared by NTSB (copy enclosed) states that a preliminary analysis of the power spectrum gave no clues as to the exact nature of the electrical problem mentioned on the radio. The System Group Factual Report of Investigation (copy enclosed) states that no positive evidence of an electrical malfunction vas found during their investigation of this accident.

A review of all L-188 accidents from 1962 to 1979 did not reveal a problem with the aircraft's electrical systems or an accident that was related to a problem vith flight instruments. There is no known case of a total electrical failure in the L-188 aircraft.

In the event of a total electrical power failure, i.e., loss of all engine-driven generators, the pilot's horizon, turn and bank indicators, as well as the white instrument lights, these elements are all automatically powered directly from the battery. This is accomplished without further action from the flightcrew as long as the battery switch is in the "on" position.

We believe it would be prudent for the Board to pursue further investigation in order to clarify and resolve these aforementioned points. Depending upon the findings resulting from this investigation. we believe it would be advisable to again consider what action is appropriate when the final accident report is published.

Sincerely,

Langhorne Bond
Administrator

Enclosures

APPENDIX F

SAFETY BOARD REPLY

AUG 27 1980

Honorable Langhorne Bond
Administrator
Federal Aviation Administration
Washington, D.C. 20591

Dear Mr. Bond:

This is in reference to National Transportation Safety Board Safety Recommendation A-SC-19 and your response dated June 11, 1980. The Safety Board recommended installation of an independently powered Attitude indicating system on large turboprop aircraft. The recommendation was issued during tho Safety Board's Investigation of the Transamerica Airlines L-188, N859U, accident near Salt Lake City, Utah, on November 18, 1973.

While the Safety Board's investigation of the accident hae not pinned down the exact extent. there was evidence of an electricnl system discrepancy of sufficient severity to cause at least partial and/or intermittent malfunctioning of some primary attitude-indicating instruments. The Safety Board believes that, under the existing instrument meteorological conditions end without the aid of flight control boost systems, the crew was not able to determine rapidly which instrument was not functioning normally. This was indicated hv an unidentified person's comment on the cockpit voice recorder: "you're in a left turn now. followed shortly thereafter by the first officer saying, 'no you're in a right turn."

The statement in the System Group Chairman's Factual Report of Investigation that no positive evidence of an electrical malfunction was found," clearly refers only to physical evidence obtainable from the remains of an aircraft which was destroyed and severely burned nfter impact. Other factual data confirm a power interruption. Specifically, evidence of the power interruption is contained in the cockpit voice recorder at 1153:34. and the interruption is corroborated hy the clearly perceptible negative G' spike an the flight data recording.

ROUTING SYMBOL	BAI-4	BAI-4	BAI-2	BAI-1	GC-1	MO-4	MP-2	M-3	M-2
DATE	8/6/80	8/6/80	8/7	8/7	8/8	8/11	8/14	8/18	
INITIAL									

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APPENDIX F

Honorable Langhorne Bond - 2 -

We believe that since a large fleet of aging turboprop aircrnft will remain in operation for some time in which they will often be subjected to various "Supplemental Type Certificate" modifications, they are likely to ba prone to electrical system malfunctions which, in many cases, will be difficult to identify and correct. This was evident during the examination of the history of N359U and sister aircraft. In addition, the Board believes that a passenger in a large turboprop aircrnft should bc afforded the same level of safety as a passenger in a turbojet aircrnft.

While the L-168 electrical system history cited by FAA was encouraging, the Board's recommendation was not intended to be limited to L-188 aircraft only, but to All large turboprop aircraft." In fact, the addition of an independently powered attitude indicating system would be e welcome addition to any aircraft which is certificated to operate under instrument flight rules conditions. Although this is not being recommended, the Roard believes that an FA4 Advisory Circular indicating the increased level of safety provided by such a system would be appropriate.

It is noteworthy that Tranaamerica Airlines Inc., even in the absence of any regulatory requirement, has made a decision to instnll an indnpendently powered attitude indicating system in its L-188 aircraft fleet. This carrier's safety oriented initiative is to be highly commended.

Pending the FAA's further response. Safety Recommendation A-80-19 will bc maintained in en "Open--Unacceptable Action" status.

Sincerely yours.

ORIGINAL SIGNED BY

James B. King
Chairman

HRaza/RKapustin:ps:BAI-4:6/24/80
Revised per MD-2:7/15/80 - 7/16/80:sms - Revised per M-2:7/21/80:sms
Revised per M-3:8/5/80:sms
MC 80-977. Not. 1135, Not. 2881
cc: C(2), V, M-1, 2, 3, MD-1, 2, 4, 5, 6, GC-1, PA-1, AD-46, BAI-1(2), BAI-4, AI-20, AI-30, TE-1

ROUTING SYMBOL	M-1	V	C						
DATE									
INITIALS									

SUBJECT FILE COPY

NTSB Form 1320.24 (3/76)