80-7

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

NEVADA AIRLINES, INC.
MARTIN 404, N40438,
TUSAYAN, ARIZONA

NOVEHBER 16, 1979

NTSB-AAR-80-7

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UNITED STATES GOVERNMENT

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The National Transportation Safety Board determines that the probable cause of the accident was the unwanted autofeather of the left propeller just after takeoff and an encounter with turbulence and downdrafts--a combination which exceeded the aircraft's singleengine climb capability which had been degraded by the high density-altitude and a turn to avoid an obstacle in the flightpath. Also, the available climb margin was reduced by the rising terrain along the flightpath The cause(s) for the unwanted autofeather of the left propeller could not be determined

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WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: May 28,1980

NEVADA AIRLINES, INC.
MARTIN 404, N40438
TUSAYAN, ARIZONA
NOVEMBER 16,1979

SYNOPSIS

About 1452 m.s.t., on November 16, 1979, Nevada Airlines, Inc., Flight 2504 crashed into a clearing in a heavily wooded area about 1.5 mi north of the departure end of runway 3 at Grand Canyon National Park Airport, Tusayan, Arizona. The aircraft crashed shortly after takeoff from runway 3. Of the 44 persons aboard, 10 were injured seriously. The aircraft was damaged substantially during the crash sequence and was destroyed by ground fire.

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1. FACTUAL INFORMATION

1.1 History of the Flight

On November 16, 1979, Nevada Airlines, Inc., Flight 2504, a Martin 404 (N40438), was a chartered flight from Las Vegas, Nevada, to Grand Canyon National Park Airport, Tusayan, Arizona, and return. About 0935 1/ Flight 2504 departed Las Vegas to carry a French tour group to the Grand Canyon for a sight–seeing tour. There were 41 passengers and a crew of 3 aboard for the roundtrip. The crew and passengers reported that the trip from Las Vegas to Tusayan was routine. After a scenic flight over the Grand Canyon, a landing was made at Tusayan after about 1 hr 10 min of flight time. No fuel, oil, or antidetonate (ADI) fluid was taken on, and no baggage was placed aboard at Tusayan. Takeoff for the return flight was started at 1450 from runway 3. The copilot was to make the takeoff from the right seat. The weather was clear, visibility unlimited, and winds were from 040° at 15 kns.

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

The crew stated that all pretakeoff checklist items were completed and that the takeoff roll was normal. The captain said that he checked the engine instruments at V_2 speed, takeoff safety speed, as the aircraft was rotated for takeoff and "everything was normal." He said he raised the landing gear and, almost immediately thereafter, sensed a loss of power from the left engine. He said he took control of the aircraft from the copilot and noticed that the left engine autofeather light was illuminated and the feather button depressed. About 1451:20, the tower local controller stated, ". . . do you want to come back?" The captain-said he told the copilot to advise the tower that the flight had lost an engine and was returning to the airport. At 1451:50, the copilot told the tower, ". . . we're (sic) lost an engine and we want to come back around." The local controller cleared the aircraft as requested. There was no reply from Flight 2504.

The captain stated that he noticed a 200-fpm rate of climb when the aircraft reached the departure end of the runway. He said that after passing the runway the aircraft encountered a downdraft and turbulence which overcame the singleengine climb performance of the aircraft. He said that, as the engine failure emergency checklist was being accomplished, he made a slight left turn to avoid a radio tower along the flightpath. The copilot stated that the aircraft passed to the left of and below the top of the tower; the top of the tower is 6,739 ft, 2/ about 100 ft above the ground.

Even though she was aware of an engine problem, the flight attendant stated that she was not aware that an engine had failed. She said she was not warned by the cockpit crew about the impending crash.

The passengers recalled hearing no unusual noises during the takeoff; however, several of them saw the left propeller stop shortly after the aircraft left the ground. Several passengers stated that, once the aircraft was airborne and after the left engine had failed, they experienced a "rocking" movement of the aircraft. One passenger, a pilot who was seated at the front of the cabin, said he was aware that the left propeller had been feathered and that, immediately thereafter, the aircraft began to descend. None of the passengers interviewed, were aware that the aircraft was going to crash until they heard the noise of a tree strike. They said there was no warning given by the crew.

Several witnesses on the ground stated that they saw the aircraft flying low with the left propeller stationary. Some reported that the landing gear was up. No witnesses reported smoke, fire, or any other problems with the aircraft before impact.

The airport tower personnel stated that they saw the left propeller stop when the aircraft was abeam of their position in the tower and slightly below the top of the tower. The tower is located about 6,000 ft from the beginning of Flight 2504's takeoff roll. Tower personnel stated that the aircraft never climbed over 100 ft above the ground level. They said the aircraft banked slightly to the left and descended into the trees. They activated the crash notification circuit when they realized an accident was inevitable.

2/ All altitudes are mean sea level unless otherwise indicated.

The captain stated that he "was making it except for the downdrafts," and he noticed that the airspeed had decreased to 105 kns; V_2 was about 101.5 kns. He said that when he saw that the temperature of the right engine cylinder head was rising rapidly toward the maximum limit, he reduced the manifold pressure about 2 inHg to avoid engine failure. However, he said the inability of the aircraft to climb and the proximity of the terrain required that he return the right engine to full power and select a forced-landing area.

The captain stated that, since terrain surrounding the airport was heavily wooded, he headed for the clear area north of the field. He said that when he realized that he would not clear two tall trees before reaching the clear area, he lowered the nose slightly and "flew through the trees." The cockpit struck one of the trees, shattering the captain's windshield.

The captain said the aircraft lost about 20 kns of airspeed when it struck the trees and the aircraft began to roll to the left; minimum control speed with the left engine inoperative was about 91 kns. He further reduced the power on the right engine, rolled the wings level, and rotated the aircraft so that it would strike the ground in a nose-high altitude. Both pilots said they hit the ground three times, with each impact becoming progressively more severe.

The aircraft came to rest about 850 ft beyond the point where the first trees were struck. The crashpath was oriented on a heading of 355°, and the fuselage came to rest on a heading of 070°. A fire broke out on the right side of the aircraft as it slid to a stop. The fire originated near the cockpit, which had twisted to the left about 120°.

The accident occurred during the hours of daylight at latitude 35° 58' 30" N and longitude 112° 07' 30" W. The wreckage was located 15 miles from the departure end of runway 3 and on a bearing of 012' magnetic.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	3	7	0
Minor/None	0	34	0

1.3 Damage to Aircraft

The aircraft was damaged substantially during impact with the trees and during the ground slide. A severe ground fire destroyed the fuselage area and part of the right wing.

1.4 Other Damage

None

1.5 Personnel Information

The pilots were qualified and certificated for the flight, and they had received the training required by current regulations. The flight attendant was qualified and trained in accordance with current regulations. (See appendix B.)

On November 14, 1979, the captain traveled to Oakland, California, to fly the accident aircraft from Oakland to Las Vegas. At 1100 on November 15, 1979, he went to the airport to see if the aircraft was ready for flight. Since a new left engine was being installed on the aircraft, the aircraft was not ready for flight, and he returned to his hotel. At 1600, he returned to the airport and flew the aircraft to Las Vegas, arriving in Las Vegas at 2155. The captain had about 8 hrs of rest time during the night before the accident.

The copilot flew on November 14 and 15 and went off duty at 1700 on November 15. He went to bed at 2200 the evening before the accident.

1.6 Aircraft Information

N40438 was certificated and equipped in accordance with current regulations. (See appendix C.) When the aircraft took off from Grand Canyon National Park, there were about 2,660 lbs of 100/130 octane aviation fuel aboard. There was no cargo or baggage aboard, except carryon baggage. About 6.0 gallons of ADI fluid were available for use during takeoff.

The aircraft's maximum allowable takeoff gross weight was 44,000 lbs; however, the operations specifications for Nevada Airlines limited allowable gross weight for takeoff from Grand Canyon National Park Airport to 40,500 lbs. The center of gravity (c.g.) limits for the aircraft were from 13.5 to 37.5 percent mean aerodynamic chord.

The aircraft's weight and balance for takeoff at Grand Canyon National Park Airport was computed after the accident by using average winter weights for the occupants -- 170 lbs each. The gross weight was computed to have been 39,326 lbs for takeoff. The weight and balance form, prepared by the crew before takeoff, showed a gross weight of 39,498 lbs and a c.g. of 33 percent.

Aircraft single-engine performance was computed using the following data:

Estimated takeoff weight	39,326 lbs
Runway length	8,999 ft
Altimeter setting/temperature	30.27 inHg/56° F
Density altitude	7,500 ft
Surface wind	040°/15 kn
Left propeller	Feathered
ADI	On

Based upon these data, the following were computed:

Maximum allowable takeoff weight	39,700 lbs
Rate of climb 3/	310 fpm
V_1 - Critical-engine-failure speed	100 kns
V_2 - Takeoff safety speed	101.5 kns
Best single-engine climb speed	115 kns

To compute these data, takeoff power was assumed on the operating engine. If the power on the operating engine was reduced to maximum continuous power, the rate of climb would have decreased to about 220 fpm.

1.7 Meteorological Information

The Grand Canyon National Park Airport is served by a Limited Aviation Weather Reporting Station (LAWRS). Surface observations are taken at the airport by Federal Aviation Administration (FAA) employees who are certified by the National Weather Service (NWS).

Surface observations taken at the airport before and immediately after the accident were, in part, as follows:

1345 record: Clear; visibility — 50 mi; temperature -- 56° F; wind -- 040° at 11 kns; altimeter setting -- 30.27 inHg.

1453: Clear; visibility -- 50 mi; temperature -- 56° F; wind -- 040° at 15 kns; altimeter setting -- 30.26 inHg.

Upper wind observations taken at Winslow, Arizona, on November 16, 1979, were, in part, as follows:

Height ft	Direction degrees	Speed kns
0421		
4,879	320	3
5,828	102	4
6,738	100	12
7,737	097	16
8,693	091	14
9,654	085	12

3/ The single-engine rate of climb is based on an airspeed of 115 kn; however, the computations showed that, if the aircraft climbed at V_2 speed, the rate of climb would have been the same.

1615

4,879	360	2
5,856	—	—
6,833	—	—
7,789	—	—
8,694	—	—
9,493	136	9

The area forecast issued by the NWS, valid from 0600 on November 16 to midnight on November 17, called for clear to scattered cirrus clouds at or above 20,000 ft. There was no forecast for turbulence or updrafts and downdrafts in northern Arizona at the time of the accident.

Several Nevada Airlines pilots and other pilots at Grand Canyon National Park Airport stated that there is usually light to moderate turbulence and updrafts and downdrafts at low levels in the vicinity of the airport, especially when northerly or northeasterly surface winds are present.

1.8 Aids to Navigation

Not applicable

1.9 Communications

No communications difficulties were reported.

1.10 Aerodrome Information

The airport is certificated by the FAA under the provisions of 14 CPR 139. Field elevation is 6,606 ft. An FAA control tower was in operation at the time of the accident. The rim of the Grand Canyon is located about 7 mi to the north and about 6 mi to the northeast of the airport. The terrain beyond the departure end of runway 3 is heavily wooded with tall pine trees and slopes upward gradually at an angle of about 2.68° to just above 7,000 ft at the rim of the canyon. It then drops nearly vertical to less than 3,000 ft at the bottom of the canyon. A radio tower is located about 3,500 ft beyond the departure end of runway 3, slightly to the left of the runway's extended centerline. Runway 3 at the Grand Canyon National Park Airport is hard surfaced and is 8,999 ft long and 150 ft wide. The runway has a 0.6-percent uphill gradient.

1.11 Flight Recorders

The aircraft was not equipped, nor was it required to be equipped, with a cockpit voice recorder or a flight data recorder.

1.12 Wreckage and Impact Information

The aircraft first struck the top of two trees at an elevation of about 6,731 ft while on a heading of 355°. Several broken and cut branches were found on the ground below the trees. The aircraft descended on a heading of 355° until the lower aft fuselage struck the ground at an elevation of 6,680 ft, 420 ft beyond the trees. The aircraft then slid along the ground and came to rest 434 ft beyond the first ground impact point. The aircraft came to rest oriented on a heading of 070° and at an elevation of 6,700 ft. The wreckage was confined to an area 434 ft long and 134 ft wide.

The first aircraft part found along the wreckage path was the aft fuselage access door, which had been installed on the bottom aft portion of the fuselage. The remainder of the wreckage path contained gouges in the earth, uprooted and broken trees, propeller slashes, and various aircraft components. (See appendix D.) The terrain over which the aircraft slid was a relatively level clear area with scattered small trees, stumps, and rocks.

Portions of the fuselage had been disturbed during rescue activities; however, pieces of the wreckage were generally in their relative positions as the aircraft had come to rest. The cockpit section was separated partially from the fuselage and was twisted to the left nearly 120°. The remainder of the fuselage was upright. The entire fuselage had been damaged across the bottom by impact. The empennage assembly was intact and remained attached to the fuselage. The left wing was partially attached to the fuselage and had been damaged by fire and impact. The right wing was attached to the fuselage. Most of the top of the right wing had been consumed by fire.

The upper fuselage and fuselage sidewalls above the passenger windows had been consumed by fire. The entire cabin area, including most of the floor, had sustained extreme fire damage. The main entry door on the forward left side of the fuselage and the aft fuselage passenger ramp separated from the fuselage during the ground slide.

All flight control surfaces and trim tabs were found in place and had been damaged by impact and fire. The variable horizontal stabilizer actuator for the wing flap interconnect system was measured between the rear spar bumper and the base of the rubber bumper fitting. It measured 2 7/8 ins. This measurement was crosschecked on a similar aircraft and was found to correspond to a 12.5° flap position, the correct setting for takeoff.

The left wing outboard flap and slat assembly was intact and attached to the wing. The assembly hinges were bent and had been burned. The hydraulic actuator was extended 4.75 ins. The left wing inboard flap and slat assembly was only partially attached to the wing. The assembly had sustained impact and fire damage. The actuator extension measured 4.75 ins.

The right wing inboard flap and slat assembly was attached to the wing and had been consumed by fire. The actuator had been badly burned. The actuator extension measured 5.5 ins. The right outboard flap and slat assembly was attached to the wing, and had been virtually consumed by fire. The flap actuator was within the debris of the burned flap assembly and was found fully extended. Flap actuator measurements on a similar aircraft with the flaps extended to the 12.5° takeoff position were 4.0, 4.0, 4.25 and 4.0 ins., respectively.

The rudder trim tab was measured at 0.5 in. left deflection, which equates to a 3° right rudder setting. The continuity of all flight control cables and mechanisms was established. All failures and jammings were caused by impact.

The nose gear was found retracted, but unlocked; the locking mechanism had been severely damaged by impact. Both main gears were in the retracted and locked position.

The cockpit-to-cabin door was locked and inoperable because of deformation of the surrounding structure. The cockpit interior was virtually intact with only minor aft deflection of the rudder pedal area and an 8-in. aft displacement of the captain's instrument panel.

1.13 Medical and Pathological Information

There was no evidence of preexisting or incapacitating medical problems which affected the cockpit crew performance.

The captain sustained a multiple compound fracture of his right leg. He also sustained multiple lacerations and contusions. The first officer sustained a compression fracture of the T-12 vertebrae, a broken left ankle, a scalp laceration, three broken ribs, and multiple contusions and abrasions. The flight attendant suffered a severe back strain and multiple contusions and abrasions.

Two passengers sustained compression fractures of the L-1 and L-5 vertebra. Five passengers sustained various contusions, lacerations, abrasions, and stress-related conditions requiring hospitalization; thus, these injuries were classified as "serious." The remainder of the passengers either were treated and released, or were not injured.

1.14 Fire

According to the crew and passengers, fire erupted immediately after the aircraft stopped. There was evidence of sooting and burned foliage back along the crashpath The fire first began on the right side of the fuselage near the forward wing root area. It then propagated along the right wing and eventually into the cabin area and to the left wing.

Although the exact ignition source was not determined, broken electrical wiring, the hot right engine, and friction are possible sources. The fire was fed initially by fuel from the ruptured right wing tank.

The airport fire department, which was located about 21 mi from the crash site, was notified about 1453, and units arrived on scene about 1501. The Grand Canyon National Park Service was notified of the accident at 1454. The Park Service's fire engine was on scene about 1511. Six firefighters and three volunteers responded from the airport, and seven Park Service firefighters responded, three of which were certified emergency medical technicians. Additionally, three firefighters from a private fire and security firm responded. The fire was extinguished about 1531.

1.15 Survival Aspects

The longitudinal stopping distance was 437 ft, of which 434 ft was ground slide and 3 ft was fuselage longitudinal crushing. The fuselage belly was crushed upward about 1 ft in the aft cabin area. The terrain in the ground slide rose slightly about 2.68°, with a depression near'the initial impact point. Although the captain stated that the airspeed dropped from about 105 kns to about 85 kns after striking the trees, the exact forward speed at impact is unknown, and the vertical velocity at impact is unknown.

Both cockpit crewmembers said that they were aware of fire just outside the cockpit after the aircraft came to rest. The copilot opened his side window, which was now overhead, and climbed out. The captain pulled himself up toward the same window where the copilot was able to pull him out by the arms. The copilot then dragged the captain away from the aircraft, assisted by a passerby. The copilot then went back along the left side of the aircraft and assisted passengers evacuating through the aft emergency window exits.

The flight attendant, who was seated in an aft-facing jumpseat at the rear of the cabin, stated that she was aware of an engine problem and turned to her left to face forward to reassure passengers. She said she felt something suddenly strike her right side, and she was knocked forward from her seat into the aisle. When the aircraft came to rest, she was entangled in loose cabin seats. After a passenger freed her from the seats, she opened the rear-most aft left emergency window exit. The right side exits were not used because of fire. She said that two seats were burning in the forward cabin as she exited. Once outside the aircraft, the flight attendant assisted injured passengers and kept them away from the aircraft.

The flight attendant was unable to communicate with the passengers because she could not speak French and they knew little English. The company had hired an interpreter to accompany the tour group; however, she was seated near the front of the passenger cabin and had exited the aircraft soon after it had stopped. Electronic means of communication, such as the intercom or a bullhorn, were rendered useless when electrical power on the aircraft was lost.

The passengers stated that the evacuation was orderly and without panic. They said that most of the seats had broken loose from the floor during the ground impact. The passengers estimated that the evacuation was completed in 3 to 4 min. They said the fire became more intense once they were outside the aircraft.

All crewmember and passenger seatbelts were the fabric-to-metal, pull-through-buckle type. . There were no shoulder harnesses installed in the cockpit. The pilots' seatbelts were fastened during the accident and were found undamaged.

The flight attendant's seat was mounted in a baggage area separate from the main passenger cabin and on the back left side of the rear cabin bulkhead. (See figure 1.) The seat was not damaged. The seatbelt was found unfastened and undamaged after the accident. The fabric had not been abraded when the knurled bar slipped.

All of the passenger seat units, except unit 5A/B, had sustained some type of impact damage and failure. The damage and failures ranged from bending of legs and seat frames to complete separation of floor and wall attachments. The passenger seats had been burned in varying degrees of severity. Many seatbelts had been charred and burned.

A Park Service medical vehicle arrived about 1458, and a local ambulance service dispatched two ambulances to the scene. The Park Service's medical unit was also supported by seven additional units. Ten volunteer emergency medical technicians and two Park Service paramedics responded. The Park Service began transporting the injured to the Grand Canyon National Park Service Clinic at 1522. After all occupants were transported to the clinic for treatment and observation, several persons, who required hospitalization, were transported by ambulance to Flagstaff, Arizona. The captain was flown by helicopter to Flagstaff.

1.16 Tests and Research

Powerplants

The engines were transported to Burbank, California, for detailed examination at GO Transportation, Inc., a repair facility for Pratt & Whitney R-2800 engines.

The right engine was partially disassembled; however, examination of the engine components revealed no evidence of preimpact malfunction or failure. The examination showed that the engine was capable of normal and full power operation before damaged during the crash sequence.

The left engine fireseal and external plumbing were removed. All spark plugs were removed and examined. There were five types of spark plugs installed in the engine; all were approved types listed on the most recent type of certificate data sheet. The porcelain tips were dark; some were oily, and several were lightly covered with soft, black soot. However, all electrodes were undamaged, and there was no fouling or bridged gaps.

All accessories were removed from the rear accessory case. The commutator (aft) ends of both the starter and generator were damaged by impact.

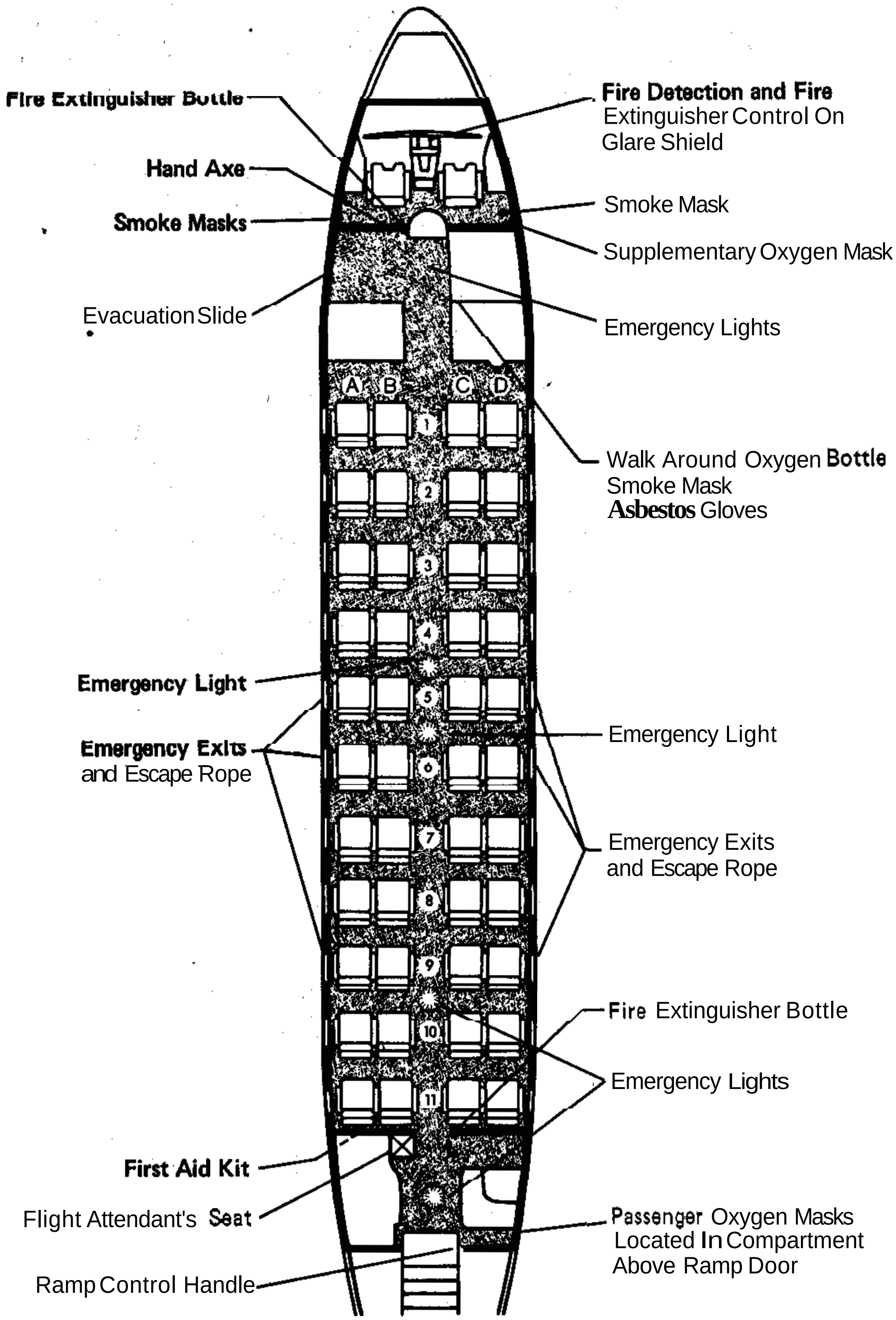

Figure 1.—Floor Plan and Location of Emergency Equipment of the Martin 404.

The rotors, windings, and drive splines were not damaged. The hydraulic pump was destroyed. The aluminum outer housing on the fuel pump was cracked and distorted. The pump rotor was seized by the distorted case. There was no foreign material in the pump, and the rotor and vanes were undamaged and in good condition. The fuel pump drive coupling was separated in the shear section. The Safety Board's metallurgical laboratory determined that the failure was typical of torsional overload and that the failure occurred from rotation in a direction opposite to that of normal drive rotation. At the accident site, the powerplant investigation group had rotated the engine opposite the normal direction of rotation by means of the propeller, which accounts for the failure.

The ADI fluid regulator was intact and appeared undamaged. When removed it contained water, and both water and gasoline were found in the water passage of the accessory housing between the regulator and the fuel-feed valve. However, when the regulator was examined before the bench test, impact damage was noted on the inlet fitting, the derichment valve outlet, and the pressure adjusting assembly. It was bench tested satisfactorily after the damaged parts were replaced.

The blower shift control was removed and found to be in the "low blower" position. Cylinders Nos. 3, 5, 10, 14, and 18 were removed. They were all in good condition with no scoring, rust, or evidence of internal failure. All combustion chambers were clean with no buildup. All valves and valve seats were in good condition. The pistons were all in good condition, lightly darkened on the tops, and with no buildup evident. All piston rings were free and in good condition. The pistons were not scuffed or scored, and there was no burning or deterioration of the top lands.

There was no evidence of internal failure of the left engine. The crankshaft and all connecting rods were intact and undamaged. All other cylinders and pistons were examined through the crankcase, and no discrepancies were found.

The accessory drive gearbox and drives were not damaged. All drives rotated normally when the crankshaft was rotated. The supercharger impeller also rotated freely and was clean and undamaged. The blower case was undamaged, and the interior induction box surfaces were clean.

The reduction gear case was intact and undamaged. Both ignition distributors and the magneto remained mounted on the reduction gearbox. They were undamaged, in good condition, and rotated freely. The reduction gearbox was removed The planetary assembly, propeller shaft, and thrust bearing were in good condition, and all internal surfaces of the gearbox, including gears, were wet with oil. All torque meter pistons were free and moved easily in their chambers. The torquemeter oil passages were unobstructed, and all were wet with oil. The torquemeter ring gear was free to move in the case.

At the accident site, the propeller domes for both engines were removed and the stop rings examined to determine the propeller blade angles at impact. Marks on the stop rings indicated that the right propeller blade angle was about 5; the low pitch setting for this installation is 30.5°. The left propeller blade angle was about 90°; the feather blade angle for this installation is 9

At the repair facility, both propeller domes were disassembled and examined. No preexisting damage or discrepancies could be found. Both domes contained sludge deposits in their forward ends, but no foreign metal particles were found.

The left engine magneto was bench checked and found to function normally. No discrepancies were noted in the magneto, the distributors, or the distributor drives. The left engine carburetor was tested at the manufacturer's plant. With the damaged automatic mixture control and accelerator pump blanked off, the carburetor was tested in an airflow chamber. It functioned normally with fuel flow at all test points within 3 percent or less of the test specifications. The fuel derichment valve functioned normally. It produced a fuel flow within 1 percent of the test specification.

The left autofeather switch was removed from the torquemeter pad on the reduction gearbox and was tested on a hydraulic test stand. The switch functioned normally and was within the manufacturer's specifications.

1.17 Other Information

1.17.1 History of the Left Engine

This was the second flight after the left engine had been installed. The engine had been replaced because of an internal bearing failure during a flight to Oakland, California. The overhauled engine had been shipped to Oakland where it was installed on the accident aircraft. The propeller from the failed engine was reinstalled on the overhauled engine. All accessories and wiring harnesses, except distributors, magnetos, and ignition harness, were transferred from the failed engine to the overhauled engine after it was installed. All spark plugs were also transferred.

Nevada Airlines engine-change procedures and checklists require that, after an engine failure, the oil tank, oil lines, and propeller domes be flushed and desludged. The mechanics who changed the engines stated that they did not desludge or clean the propeller domes and did not remove the oil hopper tank to clean it. According to the first officer's flight logsheet, the main oil screen was "serviced," and the oil was changed after the first flight. The mechanic who signed off the corrective action stated that the filter was changed, but the removed filter was not cleaned or checked at that time.

The postaccident engine inspection revealed that the oil system was not contaminated and no foreign metal particles were found anywhere in the engine, except in the main oil screen. The material recovered from the filter was identified by the Safety Board's metallurgical laboratory as aluminums, silver, lead, iron, copper, and nickel.

1.17.2 Automatic Propeller Feathering System

The automatic propeller feathering system starts the propeller feathering cycle soon enough after engine failure to limit propeller drag to that of a feathered propeller. Engine torque pressure--brake mean effective pressure (BMEP)--operating through the high- and low-pressure setting of a piston-type torque pressure switch, is used to determine the need to feather a propeller. This system is designed to insure the optimum in airplane performance and safety during a complete or partial engine failure on takeoff. Optimum performance is accomplished by:

1. Feathering the propeller and stopping the fuel booster pump on the affected engine when the power drops below a preset value for 0.2 second or more.

2. Permitting the propeller to perform in a normal manner during a momentary power loss of less than 0.2 second.

3. Providing a means whereby the, propeller may be unfeathered through the normal propeller control system if power output is restored after automatic feathering has started.

The system must be turned on manually by use of the arming switch on the overhead panel and it must be armed before it becomes operable. Arming of the system is completed automatically when the throttle is advanced to the takeoff position and the torque meter pressure exceeds 75 psi (134 BMEP). The system does not disarm if the pressure drops below the arming value, unless the throttle is retarded or the shielded arming switch is opened. Autofeathering can be overridden manually at any engine speed by pulling the feathering button out to the unfeather position. In normal autofeather operation, if not overridden, the system automatically terminates feathering pump operation after 7 sec. It can be terminated manually by turning the autofeather switch off. Operation of the feather pump is indicatetl by a red warning light in the feathering button, which glows when the pump motor circuit is energized.

When the left propeller autofeather system operates, it will automatically disconnect the cabin supercharger compressor on the right engine. When the autofeathering switch is placed in the "on" position, the autofeathering indicator light in the cockpit glows, the left fuel booster pump relay is grounded, and power is available to a switch on the left throttle. When the left throttle is advanced to the takeoff position, the switch closes and power is available to the torque pressure switch. As the torque pressure reaches 75 psi (134 BMEP), the torque switch closes, the arming relay is locked electrically, and the appropriate "armed" indicator on the cockpit overhead switch panel illuminates. If the torque pressure drops to 32 psi (57 BMEP) or less with the throttle still in the takeoff position, the torque pressure switch will close and energize a 0.2-sec time delay. After the delay, the left propeller will be feathered automatically, and a system will be energized which will prevent autofeather or manual feathering of the other propellers.

1.17.3 Company Maintenance Manual--Propeller Operation

The company maintenance manual describes the propeller feathering operation as follows:

"Push the feathering button in and it will stay in because it energizes its own hold-in coil. When the button is pushed in, it starts the auxiliary pump and the indicator light within the button will glow. The pump sends high pressure oil to the propeller governor. This high pressure oil **flows** to the positioning land and lifts it up, thus positioning the pilot valve to allow the oil to flow to the hub. This oil then acts against the propeller piston and forces the blades to the feathered position. When the blades reach full feather, it is necessary that the feathering button be pulled out manually to the neutral position to terminate the auxiliary pump action and de-energize the feathering button indicator light. The feathering action can be stopped at any time by pulling the feathering button out, allowing the governor to return to the constant speed range."

1.17.4 Single-engine Takeoff Procedures

The company operating manual contained the following:

"Takeoff - Loss of Engine at V_1

The minimum airspeed at which the airplane is controllable with one engine failed and the other engine at takeoff power is 90 knots. For charted performance, the airplane should not be lifted off before V_2. If engine failure occurs at or after V_1 and takeoff is continued, hold the airplane in the center of the runway with rudder, accelerate to V_2 and proceed as follows:

1. Lift off at V_2
2. After positive rate of climb - gear up
2. Check for auto feather and fire
4. Climb to 400 feet at V_2
5. At 400 feet, accelerate to enroute climb speed (115-120 kts). Set METO 4/ power
6. Complete the engine failure checklist.

Leave Maximum power on the good engine until it is safe to reduce power to METO. Normal time limitation for maximum power is 2 minutes. Normally, when circling weather conditions exist, the safest procedure is to circle and land. The captain's judgment will dictate whether circling or making an instrument approach or proceeding to another airport is the safer procedure.

If full METO power is needed but not attained due to fuel flow being above 1360#, mixture may be placed in Auto Lean or manually leaned to 1360# as circumstances require.

To obtain best engine-out performance, use rudder or rudder trim to keep the ball in the center of the turn and slip instrument with wings

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4/ Maximum except takeoff.

level or banked slightly in to the good engine. If airspeed of 120 kts is maintained; normal banked turns can be made in either direction. Avoid banks in excess of 30°.

NOTE: Flaps should be at takeoff for all single engine climbs. Maximum cruising altitude is obtainable only with takeoff flap setting. Single engine climb speed varies with gross weight ranging from 110 knots at 35,000 lbs. to 120 knots at 44,900 lbs."

1.18 New Investigation Techniques

None

2. ANALYSIS;

2.1 General

The flightcrew was properly certificated and qualified in accordance with company and FAA requirements. There were no physiological problems which would have affected their ability to conduct the flight safely.

The aircraft was certificated according to applicable regulations. There was no evidence of preimpact failure, malfunction, or abnormality of the airframe or the powerplants. All of the aircraft's systems functioned normally before impact, except for the autofeather system for the left propeller.

The aircraft was maintained according to applicable regulations, except for the work which was accomplished during the replacement of the left engine. Nevada Airlines engine-change procedures were not followed since the propeller dome was not desludged or cleaned and the oil hopper tank was not cleaned. Metal particles from the failed engine, which were found in the oil filter, could have eventually caused the failure of the overhauled engine.

The aircraft's weight and balance was within specified limits, and its gross weight was near the maximum allowable for takeoff from the Grand Canyon National Park Airport.

2.2 The Left Propeller

The crew statements, the passenger and witness statements, and the physical evidence showed that the left propeller was feathered at impact. The high-pitch stop ring in the left propeller dome was positioned at the feather stop. There was no damage to this dome; therefore, the stop ring position could only be achieved by oil pressure driving the piston and cam in the feather direction. The orientation and direction of propeller marks in the dirt along the wreckage path also confirm that the left propeller was feathered at ground impact. The right propeller blade angle, as determined from the position of the stop ring in the dome, was consistent with the propeller governor setting, as determined from the governor head. These facts confirm crew statements that the left propeller feathered and the right engine and propeller continued to produce power until the aircraft hit the ground.

The crew reported that the left propeller feathered automatically. When properly functioning and armed, the left propeller autofeather system will sense a loss of engine torque output, activate the feather pump, and feather the propeller. The system will also turn off the left fuel boost pumps and actuate the disconnection on the cabin supercharger for the right engine. In this case, evidence indicgted that the supercharger did, in fact, disconnect. Also the crew reported seeing the red light in the left feather button and the BMEP gage indication rapidly decreasing. Therefore, the Safety Board concludes that the autofeather system feathered the left propeller.

In order to determine the cause of the loss of torque, the Safety Board investigated two possibilities--(1) engine or propeller malfunctions or failures, and (2) a malfunction within the autofeather system, itself.

Since the engine had been overhauled and installed recently, the Safety Board was concerned that something in the overhaul procedure or in the installation process induced a loss of torque and the autofeather. The large amount of metal fragments in the engine oil filter came from the oil tank and was deposited there after the failure of the previous engine. This source is highly likely, because a bearing had failed in the previous engine and the maintenance crew who changed the engines stated they did not flush the oil tank as required by company procedures. In addition, tests indicated that the metal fragments were the type used in the bearings, and no evidence of a bearing failure was found in the overhauled engine. The material might have passed through the lubrication system and lodged in the torquemeter oil passages, which could have caused a false low torque pressure signal and the autofeather. However, no foreign material or loose metal was found anywhere in the engine, and no mechanical failure or evidence of combustion distress was found.

The Safety Board also examined the possibility of an interruption of fuel flow to the engine. No discrepancies were found in the carburetor or water regulator to indicate that either might have caused a fuel flow interruption. The crew stated that water-methanol continued to flow to the right engine; and in the absence of evidence to the contrary, the Safety Board assumed that it also continued to the left engine and did not contribute to a loss of torque. The failure of the fuel pump drive coupling would also cause fuel flow to be interrupted and result in an autofeather. However, there was no evidence of pump interference or rotor damage which could have caused the coupling failure. The rotor was seized and could not rotate because of the distorted pump housing. However, the housing had suffered severe impact damage, probably as the engine fell from the nacelle. The coupling fracture was induced by investigators when they rotated the propeller in a direction opposite the normal rotation.

Therefore, the Safety Board concludes that there was no interruption of fuel flow to the engine to bring about the loss of torque and autofeather. In addition, since engine ignition system components were in serviceable condition, there were no discrepancies in the propeller, and, the torque pressure switch functioned normally, the Safety Board concludes that the **loss** of torque and autofeather was not the result of a malfunction of the engine or the propeller.

The fact that an autofeather occurred is evidence that the feather pump operated normally to drive the propeller pitch cams and blades to the feather position. The source of power to the feather pump is the 28 volt d.c. nacelle bus through the feather pump relay which is "closed' by a feather signal. Because of destroyed components and wiring, the autofeather electrical system could not be completely' checked; the autofeather control box, which contains seven relays including a timer relay, was destroyed by ground fire. Operation of the feather pump relay would have required a signal either from the autofeather control box **or** from an outside energy source through an electrical short of some kind. The feather pump relay could not have been powered by a signal from the reversing control box, because the pilot valve of the propeller governor, which also receives its signals from the reversing control box, was positioned to the feather position. Even if the autofeather control box had been recovered, it is doubtful that all possible mechanical and electrical failure modes of operation of the relays could have been isolated electrically to pinpoint the exact location of the signals which energized the pump. However, all of the evidence indicates that the system was armed. The switch was found in the armed position. The before-takeoff checklist requires the system to be armed, and the crew reported seeing the armed indicator light illuminate when they turned on the autofeather system during the checklist.

If the autofeather system is armed and the ADI system is turned on after the engines were producing takeoff power, which is contrary to company procedures and contrary to good standard operating practices, the rapid ingestion of ADI fluid into the carburetor fuel-derichment valve could cause a momentary loss of torque, which could result in a propeller autofeather.

The flightcrew stated that they followed standard procedures and turned the ADI system on before the engines were brought to takeoff power. The ADI fluid is available to both engines at the same time and would affect them similarly; there were no indications of problems with the right engine. The captain stated that he was required to reduce power on the right engine shortly after takeoff because of a rising cylinder head temperature, which would indicate that ADI fluid may have no longer been available to that engine. **For** the amount of ADI fluid which was available for use--about **6** gallons--to be completely consumed by this point in the flight, the ADI system would have had to be turned on before the takeoff roll was started and the system would have had to be energized when the throttles were advanced for takeoff. Therefore, the Safety Board concludes that there was no rapid ingestion of ADI fluid **or** a malfunction within the autofeather system, itself, to cause the loss of torque and autofeather.

In summary, after examining and discounting these possibilities, the Safety Board can only conclude that an unwanted autofeather of the left propeller occurred just after the flight lifted off the runway. The Board cannot determine the reason(s) for the autofeather.

2.3 Aircraft Performance

According to the performance data computed after the accident, the single-engine rate of climb which the aircraft should have attained was 310 fpm with takeoff power on the good engine and 220 fpm with maximum continuous power on that engine. These climb rates take into account the fact that the density altitude was about 900 ft above the field elevation.

Additionally, the rising terrain north of the airport had an effect on the accident. The terrain rose 400 ft in the 6 mi between the end of runway 3 and the rim of Grand Canyon. The aircraft was traveling over this terrain about 2 mi/min. Therefore, the terrain under the aircraft was rising at an effective rate of about 133 fpm, which eliminated part of the climb margin available to the captain.

The investigation revealed that the flightcrew complied with the in-flight engineout emergency procedures. However, the accepted single-engine climb technique is to fly wings-level. If a turn is required, the aircraft should be banked slightly toward the operative engine. If these procedures are not followed, singleengine climb performance will be degraded. In this case, the slight left turn was necessary to clear the radio tower which was in the flightpath because of the reduced climb rate. In addition, the only relatively clear area'on which the aircraft might be crash landed was to the left of the aircraft's flightpath.

2.4 Meteorological Aspects

Since aircraft performance and flightcrew actions should have been adequate to allow for a climb to a safe altitude and a return to the airport for landing, the Safety Board looked into a possible meteorological influence on this accident.

Rough terrain extends to the north and east of the accident site. Mountains to the north slope upward to above 7,000 ft and then downward below 3,000 ft to the Colorado River. Winds fro'm a northerly direction will usually flow upward on the windward side of the mountain to above 7,000 ft and then descend on the leeward side. On the windward side of the mountains, the air flow will usually follow the slope of the terrain. Under certain conditions of atmospheric stability, as the air reaches the peak of the mountains it will descend following the slope of the terrain on the leeward side. In most cases, the wind speed of the descending air is equal to that of the ascending air.

Two methods were used to calculate the effect this wind pattern would have had on the accident aircraft. First, by using a logarithmic wind profile, the wind speed at both 3,000 and 7,000 ft was estimated. An average of these two values--20 kns--was calculated as the wind speed likely acting on the windward slope. The wind direction was assumed as 040'. The slope of the windward terrain was calculated using the Las Vegas Sectional Aeronautical Chart. The terrain was assumed to rise from 3,000 to 7,000 ft over a horizontal distance of 1.5 nmi, yielding a slope of about 24°. The slope on the leeward side was assumed to be equal to the slope on the windward side. A wind speed of 20 kns from a direction and of 040' would yield a wind speed on the windward slope of 824 fpm in an upward direction (updraft). Air that reaches the top of the slope would likely begin to descend. The descending air follows the slope of the leeward side. Since the slope of the leeward side is assumed to be equal to that of the windward side, and the descending air has an assumed speed of 20 kns, the downdraft would also be 824 fpm.

The second method used to calculate the effects of the wind pattern assumed that the upper temperature profile at Winslow, Arizona, was representative of the temperatures aloft in the Grand Canyon area. Given this temperature profile, a parcel of air would be lifted along the windward slope from 3,000 ft to 7,000 ft. At 7,000 ft, the parcel of air would be colder and therefore denser than its environment and would sink on the leeward side of the mountains. The speed of this downdraft was estimated to be 700 fpm.

Turbulence could also have had an effect on the flight. Although an in-flight weather advisory for turbulence was not in effect, the increase in wind speed from 15 kns at the surface to 35 kns above 7,000 ft could produce light to moderate turbulence below 1,000 ft a.g.l. in the accident area.

The Safety Board concludes from the evidence that turbulence with downdrafts between 700 to 800 fpm existed in the area to the north and east of runway 3 at the time of the accident. The turbulence and downdrafts of this magnitude would have exceeded the aircraft's single-engine climb capability of, at best, 310 fpm.

In summary, the Safety Board believes that the single-engine climb performance capability of the aircraft was sufficient after the autofeather to have effected a safe climb and an eventual emergency landing. However, the expected single-engine climb capability, which already had been degraded by the high density altitude and a turn to avoid an obstacle in the flightpath, was exceeded by the effects of the turbulence and the downdrafts. Also, the climb margin was reduced by the rising terrain off the end of the runway.

2.5 Survival aspects

Since, according to the captain, the airspeed dropped to 85 kns after the aircraft struck the trees, the aircraft's velocity at ground impact was assumed to be about 80 kns. The flightpath angle was 7° from the point of impact with the tree to initial ground contact. The aircraft hit terrain which sloped upward 2.68°. However, the empennage first struck the edge of a depression which sloped downward an estimated 4°. Assuming that, during the initial ground impact, velocity parallel to the face of the hill did not change and assuming that there was no rotational acceleration, the initial impact was purely vertical as the aircraft rotated about the empennage out of its nosehigh pitch attitude and impacted the down slopping terrain. The estimated vertical peak g load on the aircraft's longitudinal axis was calculated at 1.5g, assuming a normal triangular pulse shape.

This vertical inertia load then would have been transmitted to the aircraft when the fuselage was fully on the ground at a point estimated to be 100 ft from initial ground contact. Immediately, the aircraft began a 334-ft ground slide into a 2.68° incline. During this final impact, vertical and horizontal stopping distances, including airframe crushing and sliding distances, were 1ft and 337 ft, respectively. Thus, the .resultant.peak g loads along the horizontal and vertical axis of the aircraft were 2.54g and 7.41g, respectively, assuming the same triangular pulse shape.

These loads would produce the type of disruption documented within the cabin. Most seats were torn from their attachments **or** loosely attached to the airframe. Many seats exhibited small fractures at the welds between the seat pan frames and legs. Some seat legs had bent.

The Martin 404 was certified under the Civil Air Regulation Part 4b which only required seat structure in transport aircraft to be capable **of** withstanding ultimate inertia loads under emergency landing conditions of 6g's forward, 4.5g's downward, and 1.5g's sideward. **No** additional safety factor for belt and seat attachments was required. The magnitude of the inertia loads during the accident was estimated to be 7.41 g's downward and 2.54 g's forward. The 7.41 g's is well above the 4.5-g design ultimate inertia load of this equipment.

The severe injuries sustained by the two flight crewmembers were the result of impact. The compound fractures to the captain's right leg were sustained when the aircraft struck a tree which crushed the nose of the aircraft, shattered his front windshield, and displaced the rudder pedals and instrument panel aft. Additionally, head and extremity lacerations and contusions were the result of secondary impacts with surrounding cockpit structure. The lack of a shoulder harness left the captain's upper torso free to pitch forward and strike the instrument panel. The types of injuries received by the captain were consistent with the fact that he had assumed control of the aircraft immediately after the left engine feathered and his hands and feet were on the flight controls.

The first officer sustained his injuries in much the same manner as the captain. However, the compression fracture to the T12 vertebrae most likely resulted from a mispositioned spinal column **or** lapbelt, **or** both. Since he was no longer flying the aircraft, he was not in a brace position and sustained serious upper torso, head, and extremity injuries.

The flight attendant, unaware of the impending crash, sustained her injuries when she was knocked out of her jumpseat and into the aisle. Evidence indicated that she was struck either by the lavatory **door** ***or*** an aisle **floor** hatch aft of her jumpseat; both of these items were dislodged and thrown forward during impact.

The flight attendant had to be wearing her lapbelt loosely in order to turn sideways in the jumpseat. However, for her to be knocked out of the seat and the lapbelt, she would have had to have been wearing the lapbelt extremely loose, **or** the lapbelt was not fastened properly. A loose lapbelt **or** one inadvertently released during a side turn could permit slippage; however, this would have been evidenced by abrasions on the lapbelt fabric. The flight attendant's lapbelt showed no abrasions.

Two passengers sustained severe injuries. One passenger was in the front row, seat 10; the other could not recall his location. Both passengers sustained compression fractures of the lumbar region of the spinal column. The occupant of seat 10 said that he realized the aircraft was about to crash and braced himself by placing his feet up on the bulkhead 'directly in front of him. Therefore, his compression fractures were probably caused by misalignment of the spinal column since the loading was predominantly vertical. The injuries to the other six passengers were a result of secondary impacts with seats and other parts of the aircraft interior when they were thrown forward during the impact sequence.

The potential consequences of the seat failures as they relate to the emergency evacuation and postcrash fire hazard are significant. Many of the seats that came to rest in the aisle inhibited the flow of passengers to available emergency exits. Passengers were forced to crawl over the jumbled mass of seats. Fortunately, the fire on the right side of the aircraft propagated slowly, and firefighters were quick to arrive on scene. Had the fire spread more rapidly and the evacuation been less efficient, many more persons would have been injured.

3. CONCLUSIONS

3.1 Findings

1. The flightcrew and the flight attendant were properly certificated and qualified.

2. The aircraft was properly certificated.

3. The aircraft was maintained properly except for the use of incorrect engine-change procedures during recent maintenance activities.

4. Except for the unwanted autofeather of the left propeller, there was no evidence of a preimpact failure or malfunction of the aircraft's structure, powerplants, flight controls, or systems.

5. The left propeller autofeathered just after liftoff.

6. The copilot was making the takeoff, but the captain took control after the left propeller autofeathered.

7. The aircraft did not climb above 200 ft a.g.l.

8. The maximum airspeed was 105 kns.

9. The maximum climb performance capability of the aircraft on one engine at takeoff power was 310 fpm at an indicated airspeed of 115 kns.

10. The autofeather system. functioned normally to provide correct cockpit indications and to disconnect the cabin supercharger on the right engine.

11. Metal fragments from the previous left engine failure were trapped by the main oil filter.

12. The torquemeter oil passages were not blocked.

13. All engine accessories functioned properly before the autofeather.

14. The cause(s) of the left propeller autofeather could not be determined.

15. The aircraft's single-engine climb capability was degraded by the high density altitude and the turn to avoid an obstacle in the flightpath.

16. The climb margin available to' the aircraft was reduced by the rising terrain along the flightpath.

17. Downdrafts between 700 to 800 fpm were probably present in the area of the accident.

18. Light to moderate turbulence probably existed below 1,000 ft a.g.l. at the time and place of the accident.

19. Moderate turbulence was not forecast for northern Arizona by either an in-flight weather advisory or the area forecast.

20. The single-engine climb performance of the aircraft was not sufficient to overcome the turbulence and downdrafts encountered just after takeoff.

21. The accident was survivable.

22. No shoulder harnesses were installed on the flight deck.

23. The flightcrew restraint systems consisted of a fabric-to-metal lapbelt only.

24. The severe injuries to the flight crewmembers were a result of impact associated with the collapse of cockpit structure and secondary impacts with the control column and instrument panel.

25. The flight attendant was injured when she was struck by an errant object and knocked out of her seat.

26. The flight attendant, unaware of the impending impact, was improperly positioned and ineffectively restrained in her jumpseat.

27. The two serious passenger injuries were a result of the relatively high vertical impact loads.

28. The other five passengers were injured by secondary impacts with interior structure.

29. Longitudinal peak crash loads were estimated to be 2.54g. Vertical peak crash loads were estimated to be 7.41g.

30. The estimated crash loads were within the limits of human tolerance for a well restrained occupant.

31. The structural integrity of the aircraft's livable volume was not substantially compromised.

32. A postcrash fuel-fed fire erupted immediately after impact.

33. An emergency evacuation of all 41 passengers was executed through 3 emergency exits.

34. The evacuation was hampered by loose seats and other debris in the aisle.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the unwanted autofeather of the left propeller just after takeoff and an encounter with turbulence and downdrafts--a combination which exceeded the aircraft's singleengine climb capability which had been degraded by the high density-altitude and a turn to avoid an obstacle in the flightpath. Also, the available climb margin was reduced by the rising terrain along the flightpath. The cause(s) for the unwanted autofeather of the left propeller could not be determined.

4. SAFETY RECOMMENDATIONS

None

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PATRICIA A. GOLDMAN
Member

/s/ G.H. PATRICK BURSLEY
Member

May 28,1980

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The Safety Board was notified of the accident about 1715 e.s.t., on November 16, 1979. An investigation team from Washington, D.C. was dispatched immediately 'to the scene. Working groups were established for operations, systems, structures, powerplants, human factors, witnesses, and maintenance records.

Participants in the onscene investigation included representatives of the FAA, Nevada Airlines, Inc., the Arizona Department of Transportation, and the American Association of Airport Executives.

Public Hearing

No public hearing was held in conjuction with this accident.

APPENDIX B

PERSONNEL INFORMATION

Captain William Raymond Blewett

Captain William R. Blewett, 52, holds Airline Transport Pilot Certificate No. 1459589 for airplane single- and multi-engine land. He is type rated in the Martin 202, the Martin 404, and the Douglas DC-3. He also holds commercial pilot privileges for airplane single- and multi-engine sea and aero-tow privileges for gliders. He has a first-class medical certificate dated May 30, 1979, with no limitations.

Captain Blewett's most recent proficiency check was administered on May 29, 1979, in the Martin 404. At the time of the accident, he had accumulated about 13,000 total flight-hours, 1,500 hours of which were in the Martin 404.

First Officer James Newton Swain

First Officer James N. Swain, 59, holds Commercial Pilot Certificate No. 361148 for airplane single- and multi-engine land with instrument privileges. He has a second-class medical certificate dated October 26, 1979, with the limitation that "Holder shall wear correcting glasses for near and distant vision while exercising the privileges of his airman certificate."

First Officer Swain's most recent proficiency check was administered in the Martin 404 on August 31, 1979. At the time of the accident, he had accumulated about 9,600 total flight-hours, 100 hours of which were in the Martin 404.

Flight Attendant Judith Kay Morse

Flight Attendant Judith K. Morse was hired by Nevada Airlines in November, 1978. She received "hands-on" emergency training in the Martin 404 on January 25, 1979, and completed the last competency check on March 7, 1979. She held a position within the company as Assistant Chief Flight Attendant.

APPENDIX C

AIRCRAFT INFORMATION

Martin 404, N40438, serial No. 14173, was owned and operated by Nevada Airlines, Inc. At the time of the accident, the aircraft had accumulated 30,451.7 flight-hours. The flight time since the last airframe overhaul was 1,363.0 hours. The overhaul was performed April 12, 1972.

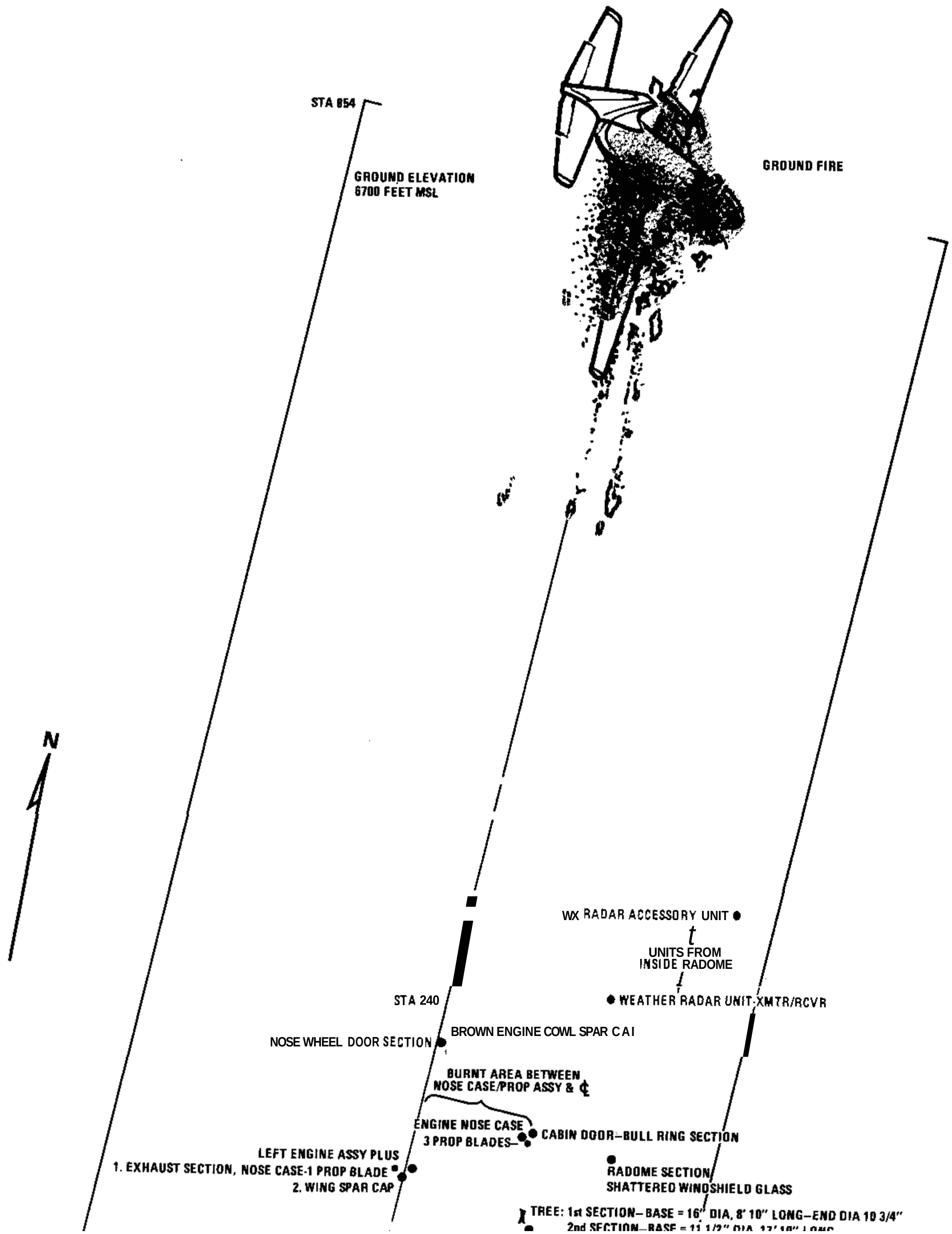
The aircraft was equipped with two Pratt and Whitney, R-2800-CB16 reciprocating engines and two Hamiliton Standard, 43E60 propellers.

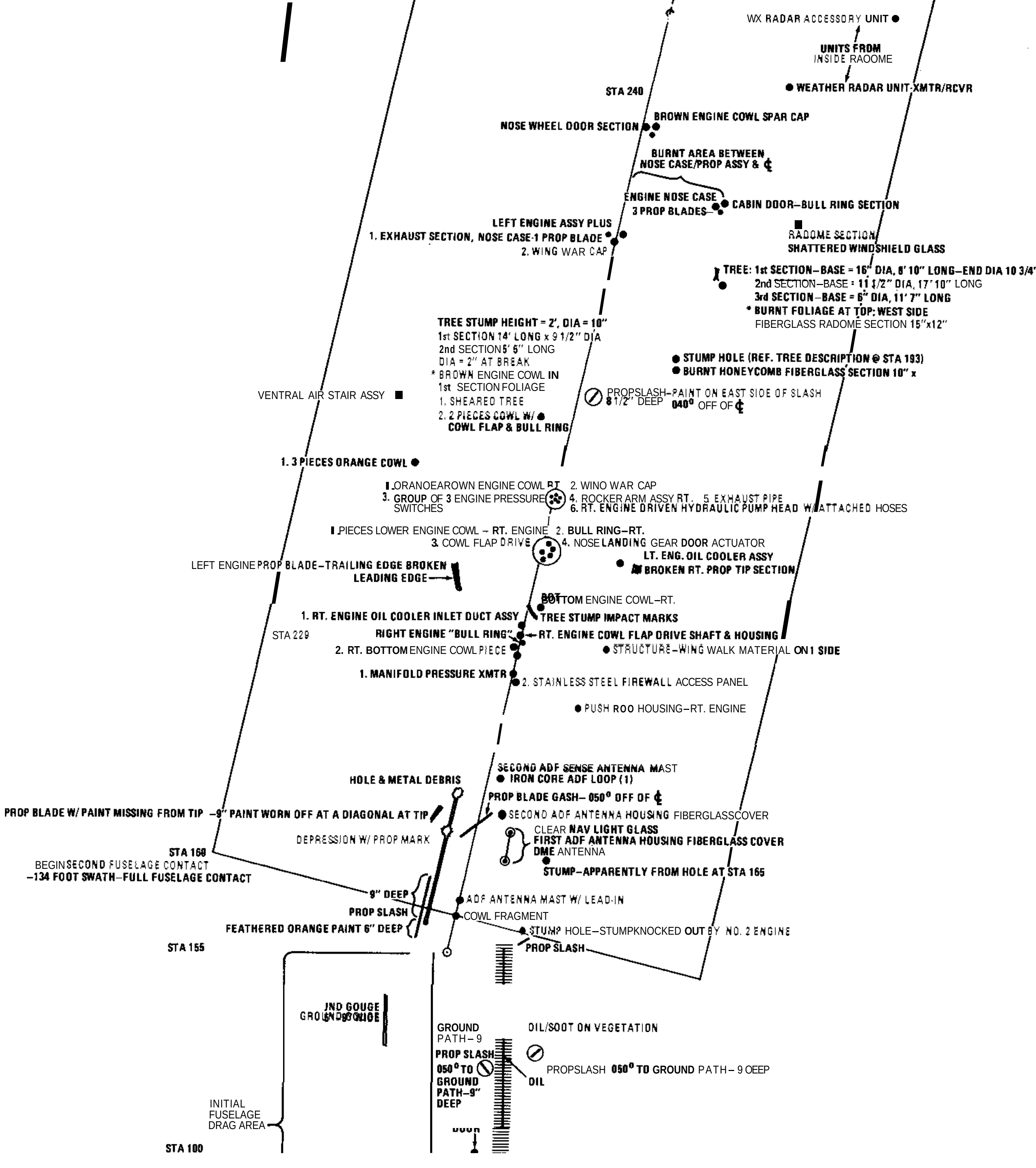
Engine Data

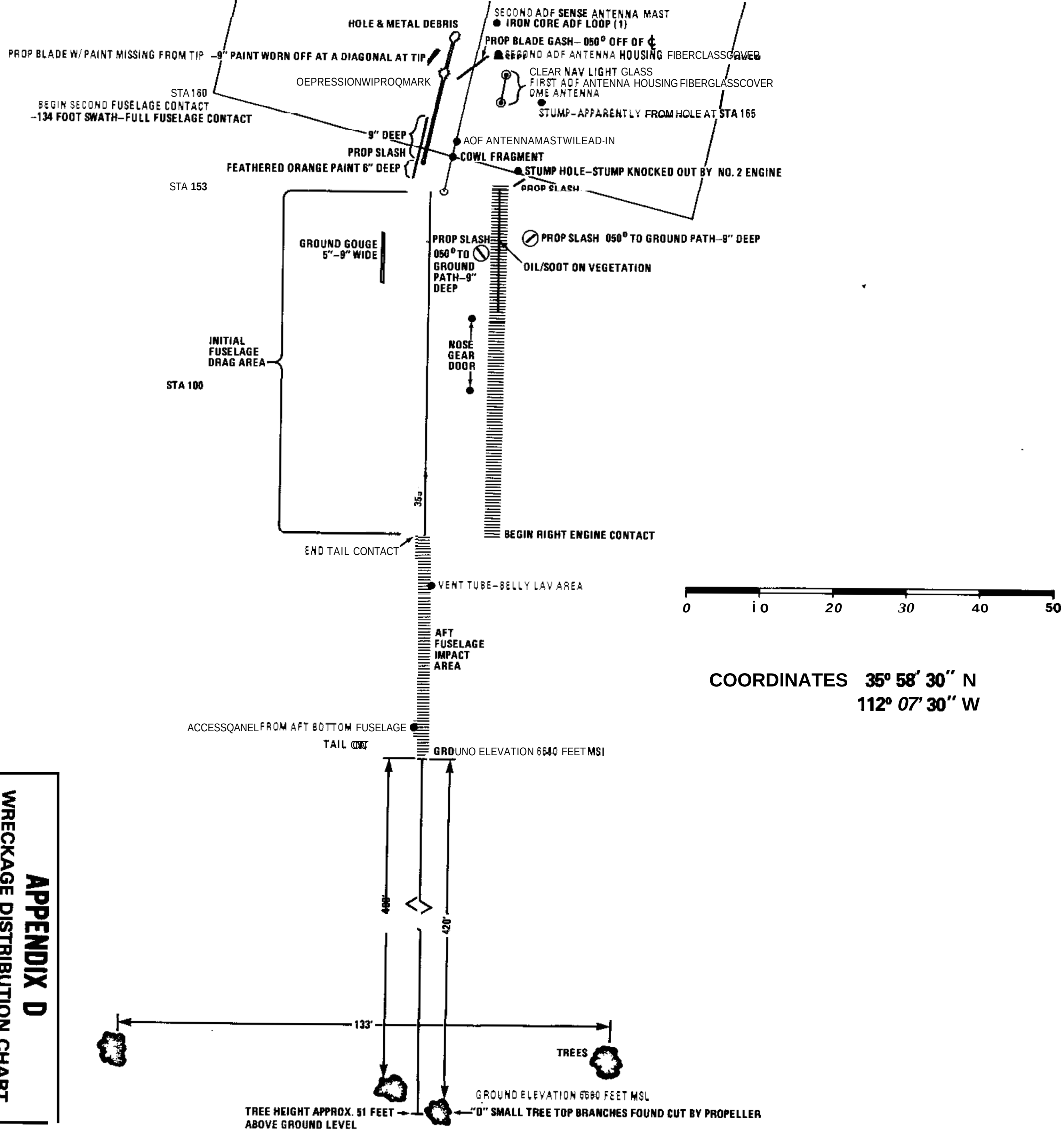
Installed position:	Left	Right
Serial Numbers:	NK-510266	P-35532
Total times (hrs):	Unknown	Unknown
Time since last overhaul (hrs):	7.9	855.9
Date of Installation:	11/15/79	05/17/77

Propeller Data

Installed position:	Left	Right
Serial Numbers(Hub):	BU4193	BU2594
Total time in service (hrs):	1168.7	1171.8
Date of Installation:	11/15/79	12/04/72


STA 854
GROUND ELEVATION
6700 FEET MSL
GROUND FIRE
N
WX RADAR ACCESSORY UNIT
UNITS FROM
INSIDE RADOME
STA 240
WEATHER RADAR UNIT-XMTR/RCVR
BROWN ENGINE COWL SPAR C A I
NOSE WHEEL DOOR SECTION
BURNT AREA BETWEEN
NOSE CASE/PROP ASSY & ℄
ENGINE NOSE CASE
3 PROP BLADES
CABIN DOOR–BULL RING SECTION
LEFT ENGINE ASSY PLUS
1. EXHAUST SECTION, NOSE CASE-1 PROP BLADE
2. WING SPAR CAP
RADOME SECTION
SHATTERED WINDSHIELD GLASS
TREE: 1st SECTION–BASE = 16" DIA, 8' 10" LONG–END DIA 10 3/4"


WX RADAR ACCESSORY UNIT
UNITS FROM INSIDE RAOOME
WEATHER RADAR UNIT-XMTR/RCVR
STA 240
BROWN ENGINE COWL SPAR CAP
NOSE WHEEL DOOR SECTION
BURNT AREA BETWEEN NOSE CASE/PROP ASSY & ¢
ENGINE NOSE CASE
3 PROP BLADES
CABIN DOOR–BULL RING SECTION
LEFT ENGINE ASSY PLUS
1. EXHAUST SECTION, NOSE CASE-1 PROP BLADE
2. WING WAR CAP
RADOME SECTION
SHATTERED WINDSHIELD GLASS
TREE: 1st SECTION–BASE = 16" DIA, 8' 10" LONG–END DIA 10 3/4"
2nd SECTION–BASE = 11 1/2" DIA, 17' 10" LONG
3rd SECTION–BASE = 6" DIA, 11' 7" LONG
* BURNT FOLIAGE AT TOP; WEST SIDE
FIBERGLASS RADOME SECTION 15"x12"
TREE STUMP HEIGHT = 2', DIA = 10"
1st SECTION 14' LONG x 9 1/2" DIA
2nd SECTION 5' 5" LONG
DIA = 2" AT BREAK
* BROWN ENGINE COWL IN 1st SECTION FOLIAGE
1. SHEARED TREE
2. 2 PIECES COWL W/ COWL FLAP & BULL RING
STUMP HOLE (REF. TREE DESCRIPTION @ STA 193)
BURNT HONEYCOMB FIBERGLASS SECTION 10" x
PROPSLASH–PAINT ON EAST SIDE OF SLASH 8 1/2" DEEP 040° OFF OF ¢
VENTRAL AIR STAIR ASSY
1. 3 PIECES ORANGE COWL
1. ORANGE/BROWN ENGINE COWL RT
2. WING WAR CAP
3. GROUP OF 3 ENGINE PRESSURE SWITCHES
4. ROCKER ARM ASSY RT.
5. EXHAUST PIPE
6. RT. ENGINE DRIVEN HYDRAULIC PUMP HEAD W/ATTACHED HOSES
1. PIECES LOWER ENGINE COWL – RT. ENGINE
2. BULL RING–RT.
3. COWL FLAP DRIVE
4. NOSE LANDING GEAR DOOR ACTUATOR
LT. ENG. OIL COOLER ASSY
BROKEN RT. PROP TIP SECTION
LEFT ENGINE PROP BLADE–TRAILING EDGE BROKEN
LEADING EDGE
BOTTOM ENGINE COWL–RT.
TREE STUMP IMPACT MARKS
1. RT. ENGINE OIL COOLER INLET DUCT ASSY
RIGHT ENGINE "BULL RING"
RT. ENGINE COWL FLAP DRIVE SHAFT & HOUSING
STA 229
2. RT. BOTTOM ENGINE COWL PIECE
STRUCTURE–WING WALK MATERIAL ON 1 SIDE
1. MANIFOLD PRESSURE XMTR
2. STAINLESS STEEL FIREWALL ACCESS PANEL
PUSH ROD HOUSING–RT. ENGINE
SECOND ADF SENSE ANTENNA MAST
IRON CORE ADF LOOP (1)
HOLE & METAL DEBRIS
PROP BLADE GASH– 050° OFF OF ¢
PROP BLADE W/ PAINT MISSING FROM TIP –9" PAINT WORN OFF AT A DIAGONAL AT TIP
SECOND ADF ANTENNA HOUSING FIBERGLASS COVER
CLEAR NAV LIGHT GLASS
FIRST ADF ANTENNA HOUSING FIBERGLASS COVER
DME ANTENNA
DEPRESSION W/ PROP MARK
STA 160
BEGIN SECOND FUSELAGE CONTACT
–134 FOOT SWATH–FULL FUSELAGE CONTACT
STUMP–APPARENTLY FROM HOLE AT STA 165
9" DEEP
PROP SLASH
FEATHERED ORANGE PAINT 6" DEEP
ADF ANTENNA MAST W/ LEAD-IN
COWL FRAGMENT
STUMP HOLE–STUMP KNOCKED OUT BY NO. 2 ENGINE
STA 155
PROP SLASH
GROUND GOUGE
GROUND PATH–9
OIL/SOOT ON VEGETATION
PROP SLASH 050° TO GROUND PATH–9" DEEP
OIL
PROPSLASH 050° TO GROUND PATH–9 DEEP
INITIAL FUSELAGE DRAG AREA
STA 100



APPENDIX D
WRECKAGE DISTRIBUTION CHART