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CIVIL AERONAUTICS BOARD

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AIRCRAFT ACCIDENT REPORT

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IMPERIAL AIRLINES, INC., LOCKHEED CONSTELLATION L-049,
N 2737A, BYRD FIELD, RICHMOND, VIRGINIA,
NOVEMBER 8, 1961

SYNOPSIS

On November 8, 1961, at 2124 e.s.t., an Imperial Airlines, Lockheed L-049, crashed and burned during an attempted landing at Byrd Field, Richmond, Virginia. Seventy-four passengers and three flight crew members died as a result of carbon monoxide poisoning. Two members of the flight crew escaped from the burning wreckage. The aircraft was totally destroyed.

The flight was en route from Baltimore, Maryland, to Columbia, South Carolina, when in the vicinity of Richmond the crew as a result of fuel mismanagement allowed the Nos. 3 and 4 engines to run the No. 4 fuel tank dry. When they were unable to restart the two engines, they feathered the propellers and elected to land at Richmond. As the flight approached the airport for its intended landing on runway , Captain Greenlee, who was acting as copilot, without warning to the captain in command, turned the aircraft to attempt a landing on runway 02 and put the landing gear selector in the down position. When the landing gear did not extend due to crew mismanagement of the hydraulic system, a go-around was attempted with only the Nos. 1 and 2 engines operating. During the go-around, which was poorly executed, the No. 1 engine failed as a result of overboosting. With only one engine remaining in operation it was impossible to maintain flight. The crew also misjudged the aircraft flightpath, overshot the extended centerline of runway 33 and crashed one-half mile to the left of the final approach path and one mile from the runway threshold.

The Board determines the probable cause of this accident was the lack of command coordination and decision, lack of judgment, and lack of knowledge of the equipment resulting in loss of power in three engines creating an emergency situation which the crew could not handle.

Investigation

Imperial Airlines Flight 201/8 was scheduled as a common carriage flight to transport newly inducted members of the U. S. Army to Columbia, South Carolina, for training. The aircraft, a Lockheed L-049, N 2737A, was to depart Columbia, South Carolina, enplane passengers at Newark, New Jersey, Wilkes Barre, Pennsylvania, and Baltimore, Maryland, and transport them to Columbia.

In preparing for the flight several aircraft discrepancies required maintenance. The aircraft was serviced to 3,180 gallons of fuel and the necessary flight

papers prepared. The crew consisted of Captain Ronald H. Conway, Captain James A. Greenlee, Flight Engineer William F. Poythress, Student Flight Engineer Peter E. Clark, and Stewardess Linda Johns. Captain Conway testified at the public hearing that although Captain Greenlee was the senior captain, it was agreed between them that Conway could command this flight and Greenlee would act as copilot.

At 1514[1] e.s.t., after changing the flight plan from IFR to VFR,[2] the flight departed Columbia for Newark to pick up the first of its passengers. Flight Engineer Poythress testified at the hearing that as the aircraft broke ground, he noticed a drop on the No. 3 fuel pressure gauge. Poythress then said he inquired of the trainee Clark, who was occupying the Flight Engineer's station, "What are you going to do?" Clark replied "I am going to go to 3 and 4 crossfeed to assure positive pressure on the right side." Poythress said the crossfeeds were opened and the pressure drop did not occur again. He also stated that the captain was not informed of the drop in fuel pressure or that the crossfeeds were opened. Poythress testified that the crossfeeds were closed when the aircraft reached cruise altitude of 9,500 feet.

The remainder of the flight segment was routine, landing at Newark at 1737. Twenty-six passengers were boarded during the 45-minute layover. Neither service nor maintenance was performed during the stop and according to the surviving crew members the aircraft had 2,300 gallons of fuel remaining.

At 1822 the flight departed Newark for Wilkes Barre, Pennsylvania, on a VFR flight plan to cruise at 4,500 feet. At the public hearing, Flight Engineer Poythress stated that he opened the Nos. 3 and 4 crossfeed valves prior to takeoff to keep from having the drop in fuel pressure which occurred out of Columbia. A fifteen-minute passenger stop was scheduled at Wilkes Barre, and the aircraft was on the ground about 16 minutes while 31 additional passengers were boarded. During this stop engines Nos. 1 and 2 were shut down and Nos. 3 and 4 were kept operating.

The flight then departed for Baltimore at 1912, VFR at an altitude of 4,500 feet. The calculated takeoff weight was 82,176 lbs. Maximum allowable takeoff weight for N2737A was 98,000 lbs. Mr. Poythress again, according to his testimony, opened the Nos. 3 and 4 crossfeeds for the takeoff.

The flight then landed at Baltimore and again only engines Nos. 1 and 2 were shut down while 16 additional passengers were boarded. The aircraft then left the gate and proceeded to the run-up area. However, it was recalled to the terminal to pick up one additional passenger. After this additional delay, takeoff was made at 2030. As Mr. Poythress testified later, in anticipation of a drop in fuel pressure he again opened the Nos. 3 and 4 crossfeeds.

About 2035, Greenlee contacted Washington area radio and filed a flight plan: direct to Columbia, South Carolina, at 4,500 feet VFR, true airspeed 218 knots, estimated time en route 2-hours 10 minutes with 5-hours 30 minutes fuel on board; 74 passengers and crew of five.

1/ All times herein are eastern standard based on the 24-hour clock.
2/ IFR - Instrument Flight Rules.
VFR - Visual Flight Rules.

Captain Conway testified that he flew the entire flight from the left pilot's seat and that Greenlee was acting as copilot. He also stated that Mr. Clark had acted as flight engineer and had occupied the seat at that station throughout the flight, including the takeoff from Baltimore. Poythress denied this by stating that he, not Clark, had been at the flight engineer's station during takeoff from Baltimore.

Captain Conway testified at the hearing that after departure from Baltimore he proceeded west of Washington, D. C., to avoid the congested area, and to intercept Victor airways 3. He said his usual route for this segment was by way of "Brookville", (presumably he meant Brooke Omni) Flat Rock, Raleigh - Durham, Winston, Chesterfield, and Columbia. Captain Conway said he recalled passing the "Brookville Omni" after reaching flight plan altitude and establishing cruise power. He asked Greenlee to make a notation of this so as to be able to get an accurate groundspeed check on the next log.

Sometime after passing "Brookville", he did not know how long, he said the airplane yawed to the right and the fuel pressure warning lights for engines 3 and 4 came on. At this time, according to Mr. Poythress, he had gotten up and student Flight Engineer Clark was at the panel. Clark shouted to Poythress concerning the fuel pressure warning lights, and Poythress immediately assumed the flight engineer's station. Poythress testified that when he took over the engineer's station the Nos. 3 and 4 fuel pressure warning lights were on and No. 3 engine had stopped rotating. No. 4 engine r.p.m. was surging between 1,500 and 2,000 r.p.m. Conway said he advised Mr. Poythress "you have got a fuel problem " He said he saw Mr. Poythress open all four crossfeed valves and check to see that fuel selectors were positioned for tank to engine feeding. In addition, he said Poythress turned on all four fuel boost pumps and advised he was going to try to start Nos. 3 and 4 engines At this time both Poythress and Conway stated that the fuel gauges were all in a position which indicated fuel. However, they could not recall the exact amount.

A few moments later Captain Conway said he told Poythress to concentrate on one engine. He said "No. 4 appeared to be partially running, so I told him to feather No. 3 engine and concentrate on No. 4 " Poythress testified that he had received these orders from Greenlee. According to Conway, Poythress then said he was unable to restart No. 4 and he was going to try No. 3 and shut down No. 4.

Poythress said that about this time he ordered Clark, the student engineer, to go back to the passenger cabin and open the midship fuel crossfeed valve. Poythress testified that Clark came back to the cockpit and said he would have to have a screwdriver to get at the valve. At that time Greenlee said "don't open that valve. You have good pressure on 1 and 2; leave it there." With that, the crossfeed valve was not opened. Conway testified that he knew nothing of this until after the accident and assumed that the valve had been opened. In the meantime, Poythress attempted to restart engine No. 3. Poythress then told Conway he had tried every procedure he knew and that he did not believe he could get 3 or 4 started, and that they should get the airplane on the ground.

Conway said he was in agreement and turned toward Richmond to land. He said he checked to make sure both Nos. 3 and 4 engines were feathered and the feather-ing checklist was completed. He said he noted that there was no r.p.m. indicated on Nos. 3 and 4 engines; both tachometers were indicating zero. Captain Conway said at this time he retrimmed the aircraft and got a good speed out of it and

that Poythress had reported the temperatures on Nos. 1 and 2 were normal. Conway then said he told Greenlee to advise Richmond tower of the situation and that they were going to land. The stewardess was advised of the engine difficulty and the decision to land at Richmond. She relayed this information to the passengers over the public address system. The crew did not anticipate a crash landing and therefore did not instruct the stewardess to give emergency evacuation instructions.

The first call from N 2737A was recorded at Richmond at 2110. The controller advised the flight that all runways were available and that the wind was north-northwest at 15 knots with gusts to 22 knots. He requested that the flight advise him on base leg for the runway chosen, and asked if standby emergency equipment was desired. Greenlee replied in the affirmative. Conway testified that he asked Greenlee to fly the airplane so he could check over the flight engineer's station.

Conway then advised the Richmond controller when the flight was passing south of the city and that they would use runway 33. He said the aircraft was maintaining altitude and that they had a "healthy airspeed." He said their heading was about 90 degrees and the in-range check had been started, when Greenlee suddenly remarked "let's land on this runway." Simultaneously, Greenlee, who was still flying the aircraft, turned left to runway 02, and lowered the landing gear handle. Conway said he looked down and saw a lighted runway, but thought they were too high and possibly a little too fast to be able to land on it. He said he then looked at the landing gear lights and shouted "the gear is not down." He then said he looked back at the flight engineer's panel and saw Mr. Poythress either putting the hydraulic crossover switch into the emergency position or checking that it was in the emergency position. He said, however, that when he saw the switch it was in the emergency position. Conway then said he reached down and "recycled the landing gear up." Again there was no change in the indicator. About this time it was apparent the landing attempt would have to be abandoned and Conway said both he and Greenlee called for full power on engines Nos. 1 and 2. He said at this time he felt that the airspeed and altitude were still sufficient to make runway 33 but that they would have to make a right turn to the runway.

According to testimony of the controllers, just prior to the time the airplane started its right turn, a transmission was received in the tower, "Tower get everybody off. We're losing another one here and we can't get our gear down." Conway said he then took over the controls and started the right turn. He said he lost sight of the runway and again turned the controls over to Greenlee who was in a better position to see the runway out of the right side of the aircraft.

At this time the student engineer, Clark, was requested to assist with the landing gear in the event it would have to be pumped down. A continuous right turn was made until Captain Conway could see the runway again when Mr. Poythress stated again that they were losing engine No. 1. Captain Conway said that he got back on the controls again with Greenlee and the turn was continued. Mr. Poythress announced again that there was a continuing decrease in power on No. 1 engine. Conway testified that somewhere in this turn, again without his knowledge, the landing gear handle was placed in the down position and that he recalled Clark assisting to pump the gear down with the hydraulic hand pump. He said during the final approach he remembered seeing two green lights indicating two of the three landing gears were down.

Conway said the aircraft was slightly to the left of the extended runway centerline on final approach when the airspeed began to decay rapidly. He said he realized they would not make the runway and pulled back on the control column. His last recollection of airspeed just as the aircraft stalled into the trees was that it indicated between 90 and 95 knots.

Conway said the aircraft decelerated rapidly when it hit the trees but that the impact was "cushioned". He realized immediately that the airplane was on fire and got out of his seat.

Mr. Poythress opened the door to the airplane cabin and the cockpit immediately filled with dense smoke. Then as Mr. Poythress opened the crew exit door on the right side of the cockpit, Captain Conway said he opened the pilot's sliding window and exited from the airplane. He said as he left the aircraft Mr. Poythress and Greenlee were at the crew exit door presumably preparing to jump. He said that after clearing the aircraft it was completely engulfed in flames and he did not think it possible that anyone else could have gotten out of the aircraft.

Investigation of the wreckage pattern area, which was approximately 250 feet long, indicated that the aircraft was in a right bank of approximately 10 degrees when it first contacted trees, 50 feet above the ground. The aircraft then passed through a clear area about 100 feet in length, then into a section of larger trees which brought the aircraft to a stop in approximately 100 feet. The angle of descent from the first contact with trees to ground impact was about 10 degrees. From all indications, the aircraft struck the ground in a level longitudinal attitude. The final heading of the fuselage was 14 degrees magnetic although the wreckage path was along magnetic north.

Both wing tips, a portion of the right aileron, and the right empennage were severed in the first group of trees; and the wings were cut into several sections at and following ground impact. The aft fuselage, center vertical fin, and the left empennage suffered only light impact damage.

The entire fuselage forward of Fuselage Station 1037 and the major part of the left wing were destroyed by fire. With the exception of the portion attached to the fuselage, outboard of wing station 90, the right wing was only slightly damaged by fire. This damage was confined to approximately two feet of the leading edge of the separated wing section containing the No. 4 fuel tank.

There was no evidence of fire at any point along the wreckage path prior to where the fuselage came to rest. The nose gear was in the retracted position, but the uplock was in the "release" or "open" position. The two main landing gears were down but, due to destruction of the locking system, no determination could be made as to whether the locks were engaged. The landing gear selector handle in the cockpit was in the down position. The wing flaps were in the "up" position. There was no evidence to indicate a failure of the primary or secondary flight controls.

Except for the seat structures, the fire which occurred after impact had completely destroyed the entire cabin area. All the seats except two of the more forward were found in the normal position and had not been dislodged by impact. Only one of the seat belt buckles found showed indication of being fastened during the fire. The grouping of bodies in the passenger cabin indicated that many of

the passengers had left their seats after impact and had attempted to evacuate the aircraft. The student engineer, Clark, apparently had gone to the cabin immediately before the crash to assist as a cabin attendant. Both Clark and the stewardess were found in the cabin with the passengers. The largest group of bodies was found near the main cabin entrance door, which either had been jammed by the ground impact or by trees and debris which were piled up against the fuselage. There was no evidence to indicate that attempts had been made to use any of the emergency over-the-wing window exits. The charred remains of what appeared to be the emergency escape slide retaining bar were found lying across the bottom of the main cabin door opening. No positive evidence of impact injuries to the passengers was found. The cause of death in all cases was established as suffocation caused by carbon monoxide poisoning.

All four engines, with propellers in place, separated from their nacelles at the firewall upon ground impact. The ensuing ground fire resulted in complete disintegration of the rear accessory, supercharger housings and rear-mounted accessories. Numerous cylinder heads of engines 1, 3, and 4 had been burned away. No. 2 engine suffered light fire damage in comparison to the other engines. Only the rear-mounted accessories on this engine were heat damaged. Examination of the engines after disassembly revealed complete internal failure of No. 1 engine prior to the crash due to failure of the master rod and bearing followed by complete disintegration of the connecting rods. There was no evidence of in-service failures or malfunctions of engines 2, 3, and 4. No evidence was found of any inflight fire on any of the engines.

Examination of the four propellers revealed that each assembly remained on its engine at impact. There was adequate lubrication of the reduction gear assemblies up to the time of ground impact and no evidence of operating distress was found. Blade angle and prop governor r.p.m. settings at initial impact were found as follows: No. 1 was on the low-pitch stop at 17 degrees and 2600 r.p.m.; No. 2, 28 degrees and 2563 r.p.m.; No. 3 and No. 4 were fully feathered.

The main oil screens, except that of No. 2 engine, were consumed by ground fire. The No. 2 screen and sump were free of any foreign material.

All engine fuel injection nozzles were removed and examined for presence of foreign matter. The majority of the nozzles of all 4 engines contained foreign material in small amounts, some of it black and nonmagnetic, whereas other material was magnetic and reddish-brown in color. Ferrous material was also found in the passages of the No. 2 fuel injection pumps, master control, and the No. 2 booster pump.

The entire fuel system was extensively damaged as a result of ground impact and fire. The left wing fuel tank area was completely consumed. The outboard portion of the No. 3 fuel tank was free of any fire damage and, as stated before, the No. 4 tank had very little fire damage.

The cable operated fuel tank shutoff valves for Nos. 1, 2, and 3 were closed. The position of the valve for No. 4 tank could not be determined. The electrically operated emergency fuel shutoff valves were found in the open position. Only the No. 2 crossfeed valve was recovered and it was jammed in the 3/4-closed position. The position of all cable operated valves is unreliable due to valve control cable movement at impact. The position of the midship crossfeed shutoff valve could not be determined.

All of the fuel boost pumps were destroyed by fire except No. 2; however, inspection of the remaining steel parts to these pumps revealed no evidence of rotor or shaft failures prior to impact. The entire No. 2 boost pump unit was intact. The pump motor brushes were in place, but one brush was not of the proper type for the motor assembly. At the public hearing Poythress testified that this brush had been manufactured from an electrical brush obtained from Imperial's Chief Flight Engineer, John Mayfield.

Fuel filters for engines 1 and 2 were not recovered due to fire. Fire damage to Nos. 3 and 4 Purolator filters was in evidence but there was a brown discoloration of the cartridge bowl and the filter element of these two cartridge filters. Magnetic inspection also revealed the presence of foreign material in the cartridge filters. The No. 3, C-5 fuel filter was free of any contamination.

A functional check of No. 2 engine-driven hydraulic pump revealed that the pump produced normal pressure and normal output. This is a positive indication that hydraulic pressure was available to the primary system. The selector valve on the hydraulic hand pump was in the aft position for emergency gear operation. The nose gear emergency extension isolation valve was in the full open position. The hydraulic crossover valve was in the fully closed position. This valve, when opened, permits pressure from the primary system to be utilized to operate the entire secondary system including the landing gear and flaps. No evidence of malfunction or damage, other than from ground fire, was found in this valve and its electric motor.

During the investigation the possibility of fuel contamination as a causative factor was thoroughly explored. Fuel injection reciprocating engines are among the most susceptible to fuel contamination. The fuel injection pump plungers on these engines, because of their extremely close tolerances, would be expected to bind or stick upon introduction of any large amount of foreign matter. When any such binding occurs, the tappet faces would be battered by the wobble plate. There was no evidence of any such battering. This type of malfunction would most likely result in slight engine roughness initially, increasing in magnitude, followed by fluctuation of engine power and engine surging over a considerable period of time.

It was found that N 2737A had been serviced with 1,832 gallons of fuel prior to departure from Columbia, South Carolina. Captain Greenlee had instructed that both inboard tanks were to be filled and the outboard tanks were to be fueled to 800 gallons each. Two refueling trucks were utilized to accomplish the refueling. Both of the trucks were examined and samples of fuel were taken for analysis. It was found that the truck which had serviced the Nos. 3 and 4 fuel tanks did have considerable contamination, sufficient to be classed gross contamination. The filter assembly from the truck was disassembled and found to contain large amounts of rust deposits. In addition, it was found that two of the 20 elements in the filter were not properly seated and were allowing some unfiltered fuel to pass.

Refueling records revealed that a number of airplanes, including N 86532, a Lockheed L-049 also owned by Imperial, had been serviced from the contaminated truck. All of these airplanes were checked. Although significant contamination was found in one of them, there had been no operating difficulties attributable to fuel contamination. The substantial contamination found in the fuel sumps of the one aircraft was mostly of a different nature than that found at the Columbia airport fueling facilities.

For a considerable period of time prior to this accident, the Federal Aviation Agency conducted many extensive inspections of Imperial's operations and maintenance practices and procedures. Many discrepancies were found in the company's methods of keeping its records. Numerous errors were found in computations of overhaul time periods for airplane component parts. It was found in many cases that crews were not reporting aircraft discrepancies on the flight logs. Many of these matters were brought to the attention of the carrier. It was found that the carrier did correct those specific items pointed out by the FAA. However, it was also stated by an FAA witness that the company corrective action was slow and confined only to those areas mentioned specifically.

An inspection of Imperial's operations and maintenance practices and facilities was conducted by the Board following this accident. This investigation revealed that company manuals were not kept current and, in some instances, were not initialed as approved by FAA. Company policies were not accurately reflected in the manuals and in some cases required procedures set out in them were not being followed.

Several instances were found where aircraft inspection periods were exceeded or where the records of the inspection were missing. In several instances it was found that an aircraft had been operated for a considerable period of time, as much as 70 hours, with no writeups whatsoever. Then on the final flight immediately before a periodic inspection as many as 40 or 50 discrepancies would be noted.

In at least one case it was found that a flight was made without correcting a discrepancy affecting the aircraft's airworthiness. In some cases repairs were made to airworthiness items but were not signed off or did not indicate that the work had been conducted, supervised, or inspected by a certificated mechanic. An additional intensified safety inspection by FAA of Imperial Airlines started on September 19, 1961, and was in progress at the time of the accident, but had not yet been completed.

At the public hearing, considerable testimony was taken concerning Imperial's operations procedures, training methods, and maintenance practices. This information and the data collected during the investigation have been carefully examined and analyzed and the Board's conclusions are set out below.

Analysis and Conclusions

The testimony of Imperial's Chief Flight Engineer, John Mayfield, is both contradictory and vague concerning the maintenance work done on N 2737A prior to its departure. First he testified that he personally had obtained from another airline two electrical brushes for installation in the Nos. 2 and 3 fuel boost pumps. He said that one of the brushes had to be cut down to fit. The other brush he said was an approved type for this unit. He later testified that this second brush "appeared" to be of a suitable type. After hearing testimony which denied that he had been given two brushes, Mayfield again changed his testimony and said he had gotten the second brush from Mr. Clark.

It will be recalled that the No. 2 boost pump was recovered and found to be fitted with a brush of improper type. This confirms testimony by Mr. Poythress that he had manufactured the brush. It is also believed that this brush was the only brush obtained. It is believed that either no repair was made to the No. 3

boost pump or that only temporary repair was effected so as not to delay the flight. This is further confirmed by the fact that Mayfield had ordered a fuel boost pump to be shipped to Columbia from Miami. At the hearing, again, Mayfield testified that this fuel boost pump had been ordered as a spare for the airplane "fly away" kit. It is significant that a spare boost pump was not normally carried and that spare boost pumps were not ordered for the other two Imperial aircraft.

The momentary fluctuation of fuel pressure on the takeoff from Columbia on the No. 3 engine is symptomatic of a boost pump failure. Such failure would not cause the engine to stop because the engine-driven fuel pump will continue to supply sufficient fuel to the engine. When this fluctuation occurred the student engineer opened both No. 3 and No. 4 crossfeeds. In this configuration fuel from the No. 4 tank would be supplied to the crossfeed manifold under pressure by the No. 4 boost pump. Even though the No. 3 fuel tank selector valve remained open, no fuel could flow from the tank. The higher pressure in the crossfeed manifold supplied by the No. 4 boost pump would hold closed a check valve between the manifold and the No. 3 fuel tank. Thus engines Nos. 3 and 4 would both be operating on fuel exclusively from the No. 4 tank provided the No. 4 boost pump remains operating.

The testimony of Mr. Poythress indicates that on each takeoff the crossfeeds were left opened in anticipation of a fluctuation in fuel pressure similar to that experienced out of Columbia. He further stated very positively that the fuel system was returned to the normal tank to engine configuration after reaching their cruising altitude. It is the Board's opinion that the greater part of the flight was conducted with the crossfeeds open and the boost pumps on. Such opinion is based upon an analysis of the conduct of the entire flight and also the testimony of the various witnesses.

The Board, in its investigation, noted several company practices which were not in compliance with Civil Air Regulations. First, making non-standard repairs affecting the airworthiness of the aircraft. Second, operating an aircraft wherein repairs were made which were not in accordance with Civil Air Regulations. Third, operating an aircraft in excess of the required maintenance inspection periods. Fourth, not reporting inflight discrepancies on aircraft flight logs and others. These and other actions describe a pattern of practice which indicates the type of sub-standard operation which Imperial conducted.

In an attempt to visualize what degree of contamination might mean to an engine, the amount of foreign matter found in four representative samples of fuel taken at Columbia was converted to pounds per engine per hour of cruise operation. These were (1) .002 (2) .002 (3) .004 and (4) .03 lbs/hr/eng. The amount of contaminant found in each of the two fuel filters recovered from Nos. 3 and 4 engines amounted to only about one-third of the amount that would be contained in one hour of fuel flow per engine according to the concentrations indicated by (2) and (4) above. It is believed that the samples of fuel tested were of considerably higher contamination concentration than the fuel which actually went into the airplane's fuel system. In view of the Board's findings it is felt that the amount of contamination was not sufficient to cause a complete loss of fuel pressure as reported. It is not likely that following several hours of normal operation, contamination would, either by restricting the flow or causing malfunction of a component, without warning and simultaneously, cause the loss of fuel pressure in two separate fuel systems. It also

should be noted that none of the other aircraft serviced at Columbia, including Imperial's other aircraft, reported any trouble whatsoever from fuel contamination.

Using the same engine powers and rates of fuel consumption as outlined in the carrier's operating manual relative to flight planning, and operating engines 3 and 4 on crossfeed from the No. 4 tank the majority of the flight, it was calculated that 800 gallons of fuel in the No. 4 tank would have been exhausted approximately at the time which the crew indicated the loss of power occurred.

The indications of operating difficulties described by the crew, namely a sudden yaw to the right and sudden loss of fuel pressure on Nos. 3 and 4 engines simultaneously, are also indicative of fuel exhaustion or starvation. Engine surging soon followed by complete power loss such as occurred here would also be expected.

From all of the foregoing, it is clear to the Board that the loss of power on engines Nos. 3 and 4 was not the result of a malfunction or mechanical failure of the engines. It is equally clear that fuel contamination was not a cause of the engine stoppage. It is the Board's conclusion that fuel exhaustion brought about by improper fuel management caused the stoppage of engines 3 and 4.

The procedures followed by Flight Engineer Poythress in attempting to restart the two engines indicate the lack of knowledge and the inability to diagnose the results of the inoperative fuel boost pump and determine appropriate corrective action. Had the proper procedures been followed, there is no reason why the Nos. 3 and 4 engines could not have been restarted. When the No. 4 fuel tank was run dry, the No 4 fuel tank shutoff valve remained open. The No. 4 fuel boost pump continued to operate pumping air into the crossfeed manifold and thus to both engine fuel supply lines. Since the No. 3 fuel boost pump was inoperative, fuel by gravity and suction of the No. 3 engine-driven fuel pump would have to displace the air in the fuel lines. It is believed that the No. 3 engine would have restarted had the No. 4 fuel boost pump been turned off, and had enough time been allowed to prime the No. 3 engine-driven pump. It is also believed that it would have started had the crossfeed valves been closed.

The engines could also have been restarted by opening the midship crossfeed valve. This valve would have allowed fuel from tanks Nos. 1 and 2 under boost pump pressure to be supplied to engines Nos. 3 and 4.

The first contact with the Richmond tower was made at 2112. At this time Nos. 3 and 4 engines had been feathered and the decision had been made to land at Richmond. According to testimony the crew was experiencing no unusual problems in operating the aircraft on its two remaining engines. In point of fact the aircraft flew satisfactorily for at least eight minutes after this call was made.

The Lockheed L-049 aircraft was designed in accordance with the requirements of Part 4b of the Civil Air Regulations. Among the many capabilities the aircraft must demonstrate for certification is the ability to sustain flight satisfactorily with two engines on the same side inoperative. N 2737A obviously met this criterion.

As the aircraft was proceeding to Byrd Field the decision was made to land on runway 33. The tower was so notified and it must be assumed that both pilots were aware of this intention. It is clear that both captains were issuing orders

and both were attempting to command the flight. Greenlee, although senior with the company, had elected to act as copilot. Yet, during the emergency he issued orders to the other crew members as captain. From all of the testimony the Board concludes that confusion prevailed in the cockpit due to lack of crew coordination and the issuing of conflicting orders. Greenlee's sudden turn to attempt a landing on runway 02 is a clear indication that a division of command and lack of coordination existed. His actuation of the landing gear selector handle was equally rash. Conway testified that when this turn had been made and the gear handle lowered he did not see any indication of the landing gear extending. He then "recycled the landing gear up."

Normally on the L-049 hydraulic power for landing gear actuation is supplied by the Nos. 3 and 4 engine-driven hydraulic pumps. Consequently the loss of engines Nos. 3 and 4 would result in total loss of hydraulic power for this operation. However, N 2737A was equipped with a hydraulic crossover valve (normally operated from the cockpit by a switch) which would permit hydraulic pressure from Nos. 1 and 2 engine-driven pumps (the primary hydraulic system) to be supplied to the landing gear. Imperial's other two Constellations were not equipped with this type of crossover valve.

As noted above, this valve and its motor were recovered and showed no evidence of malfunction. The valve was in the closed position. In addition, the No. 2 hydraulic pump was operable. Based on all this evidence, it is the Board's conclusion that the crew did not open the hydraulic crossover valve. Notwithstanding their testimony, it is further concluded that the crew was unaware that the aircraft was equipped with this valve. Had this valve been opened the landing gear would have extended in 20 to 25 seconds.

When the landing gear did not extend, it became apparent that the landing on runway 02 would have to be abandoned. According to testimony both pilots called for full power on engines Nos. 1 and 2. Apparently Conway took over the flight controls again and started a right turn to runway 33. He then again passed control of the airplane to Greenlee because Greenlee, in the turn to the right, could keep the runway in sight.

From the location of the wreckage it is apparent that the landing pattern was poorly executed. It is believed that when the airplane was on its base leg the bank angle was steepened in an attempt to avoid overshooting the extended centerline of the runway. This increased angle of bank and increased rate of turn bled off airspeed and the aircraft began to sink. To try to arrest the sink rate Greenlee called for ..."all the power you got." By this time the No. 1 engine was destroying itself as a result of the over boosting during the emergency. It failed completely. With only one engine delivering power it was impossible to maintain flight and the aircraft stalled into the trees.

It is apparent that few, if any, traumatic injuries to the occupants were incurred by the impact. The distribution of carbon monoxide levels found in the blood describes a normal biologic curve, with some succumbing at fairly low levels and others attaining 80 percent saturation. This range is to be expected due to variance in individual tolerance, variance in source of blood analyzed, variance in carbon monoxide and oxygen concentration in inspired air, and variance in the cardiorespiratory systems of the individuals.

Certain portions of the cabin were evidently ruptured during impact with the

trees permitting smoke and flame to fill the cabin immediately. The threshold of useful consciousness of occupants exposed to carbon monoxide is a function of the concentration of CO, the rate of consumption of available oxygen by the fire, the physical condition of the subjects, individual tolerance factors and the total exposure time.

Estimates of the expected elapsed time from impact to loss of mobility of cabin occupants are from as little as 30 seconds to as long as two minutes, under such extreme conditions. It would be expected then, that with known available escape routes, time would have permitted at least a small number of occupants to escape. Possible limiting factors include dense smoke, rising ambient heat, radiation, shock, panic, no preparation for emergency evacuation, and the possibility of jammed or blocked exits.

From a study of all the information available to the Board it is concluded that this flight crew was not capable of performing the function or assuming the responsibility for the job they presumed to do. The Board further concludes that the management personnel of Imperial Airlines should have been aware of the manner in which company operations were being accomplished. It is believed that the substandard maintenance practices of Imperial's employees were condoned by management. The manner in which maintenance and personnel records were kept by the company confirms this conclusion.

The Federal Aviation Agency, which is charged with the responsibility of inspection for compliance with Civil Air Regulations and minimum safety standards by all air carriers, conducted extensive inspections of Imperial's operations and maintenance practices and procedures over a period of almost a year prior to the accident. Numerous improper operational procedures, and maintenance practices were found. It is indicated that Imperial did take some corrective action when specific items were pointed out. However, it is also evident that Imperial's management did not make satisfactory efforts on their own to improve the overall operations and maintenance standards of the company, but only corrected those items which the Federal Aviation Agency pressed.

Probable Cause

The Board determines the probable cause of this accident was the lack of command coordination and decision, lack of judgment, and lack of knowledge of the equipment resulting in loss of power in three engines creating an emergency situation which the crew could not handle.

BY THE CIVIL AERONAUTICS BOARD:

/s/ ALAN S. BOYD
Chairman

/s/ ROBERT T. MURPHY
Vice Chairman

/s/ CHAN GURNEY
Member

/s/ G. JOSEPH MINETTI
Member

/s/ WHITNEY GILLILLAND

SUPPLEMENTARY DATA

Investigation and Hearing

The Civil Aeronautics Board was notified of this accident at 10:00 p. m., on November 8, 1961. Investigators were immediately dispatched to the scene and an investigation was initiated and conducted in accordance with the provisions of Title 702(a)(2) of the Federal Aviation Act of 1958. A public hearing was ordered by the Board and held at the John Marshall Hotel, Richmond, Virginia, on November 21 and 22, 1961. The hearing was continued at the Barcelona Hotel, Miami Beach, Florida, on December 5 and 6, 1961.

Air Carrier

Imperial Airlines, Inc., is a New York corporation with headquarters at Miami Springs, Florida, and holds a temporary certificate of public convenience and necessity. This certificate was reissued from Regina Cargo Airlines, Inc., on June 6, 1960. Regina's change of name to Imperial Airlines, Inc., was approved by the Board on February 2, 1960. As a supplemental carrier, Imperial Airlines, Inc., is authorized to conduct up to ten individually ticketed or individually way-billed flights per month in each direction between any pairs of points within the United States. It is also permitted to conduct domestic charter flights without numerical limitations. Pursuant to an exemption, Imperial Airlines was authorized, until September 30, 1960, to carry transatlantic passenger charters. Imperial also has authority to transport cargo to foreign nations as well as authority to transport both passengers and cargo in overseas transportation. It also possesses a valid air carrier operating certificate issued by the Federal Aviation Agency. At the time of the accident, Imperial Airlines was operating three L-049 Constellations and one C-46 aircraft. As of June 30, 1961, Imperial had a negative net worth of $40,006.92. For the first half of 1961, Imperial had sustained losses of $35,154.90.

Flight Personnel

Captain Ronald H. Conway, age 29, was employed by Imperial Airlines, Inc., in March 1960. He holds a valid airline transport pilot certificate with type ratings for the C-46 and L-049 aircraft. His L-049 rating was issued May 15, 1961. Captain Conway has accumulated 4,433 hours of which 293 hours were in the L-049. His last Class I physical examination was given August 16, 1961, and his proficiency check flight May 15, 1961.

Captain James A. Greenlee, age 45, was employed by Imperial Airlines, Inc., in June 1960. He held a valid ATR certificate with type ratings in the C-46, DC-4, DC-6, DC-7 and L-049. The L-049 rating was issued March 7, 1961. His total flying time as of November 1, 1961, was 17,841 hours of which 352 hours were in the L-049. The date of Captain Greenlee's last physical examination was October 6, 1961.

Flight Engineer William F. Poythress, age 30, was employed by Imperial Airlines for the last two years both as a flight mechanic and a flight engineer. He was issued a flight engineer's certificate in the L-049, September 6, 1961. Mr. Poythress also holds an A&P certificate issued November 20, 1956, and a private pilot certificate issued April 30, 1958. He has flown approximately 200 hours in the L-049.

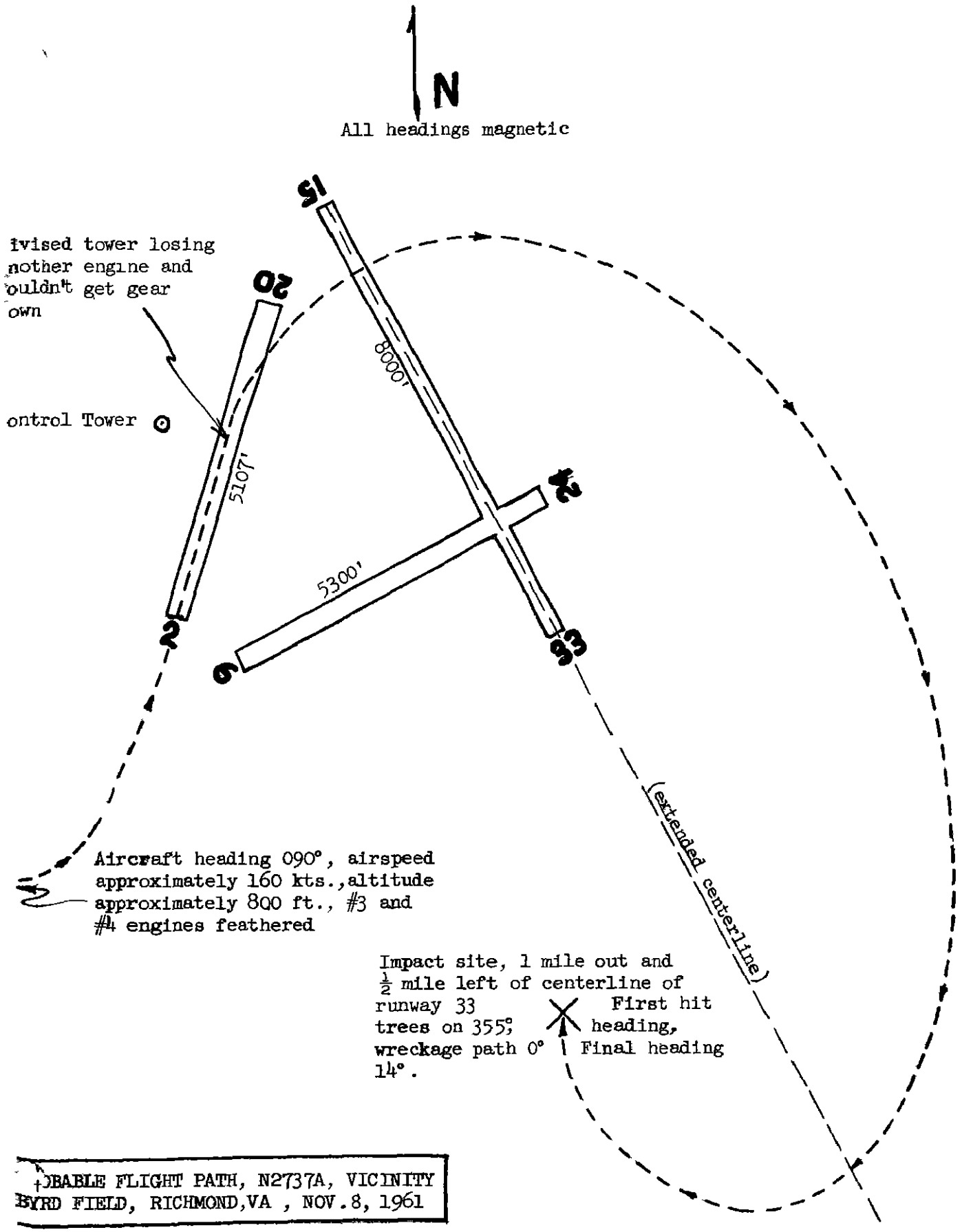
The other two members of the crew were Student Flight Engineer Peter E. Clark and Stewardess Linda Johns.

The Aircraft

The aircraft, a Lockheed Constellation model L-049, U. S. Registry N 2737A, was owned by the Miami Aircraft and Engine Sales Company, Miami Springs, Florida, and was leased to Imperial Airlines, Inc., on an exclusive-use basis. The aircraft was manufactured on April 30, 1946, with manufacturer's serial No. 1976. Originally owned by Capital Airlines, it was later purchased by Miami Aircraft and Engine Sales, and placed in service by Imperial Airlines, Inc., on May 2, 1961, with 32,001 hours on the airframe. The total time on the aircraft as of October 31, 1961, was 32,589 hours.

The last major overhaul was a 12,000-hour accomplished by Capital Airlines; completed June 30, 1958. The time on the airframe at the completion of overhaul was 28,290 hours. The last service accomplished by Imperial Airlines was a 600-hour check. The time since this check was 47 hours to the date of the entry of the last available flight log dated October 31. The last available preflight entry was dated October 31, at Columbia, South Carolina, signed by John Mayfield, and accepted by Captain Conway. The aircraft was reported to have been operated on November 2, 3, 6, 7, and 8 but the records of these flights have not been made available.

The Constellation was equipped with Wright 745-18BA-3 engines and Hamilton Standard 33E60 propellers. As of October 31, 1961, engine times since overhaul were as follows: Engine No. 1 - 1,164:30; Engine No. 2 - 47:22; Engine No. 3 - 1,360:02; Engine No. 4 - 47:22.



OBABLE FLIGHT PATH, N2737A, VICINITY
BYRD FIELD, RICHMOND, VA , NOV. 8, 1961