No. 9

American Flyers Airline Corporation, Lockheed Electra L-188C, N 183H, accident near Ardmore Municipal Airport, Oklahoma, U.S.A. on 22 April 1966. Report No. SA-392, File No. 1-0001, released 4 April 1967 by the Civil Aeronautics Board, U.S.A.

1. - Investigation

1.1 History of the flight

The flight was planned as follows: a ferry flight from Ardmore to Lawton, Oklahoma; a Civil Air Movement (CAM) Flight 262/D to McChord AFB, Washington; a ferry flight to Monterey, California; and a CAM Flight 280/D to Columbus, Georgia with a refuelling stop and a crew change at Ardmore, the American Flyers Airline Corporation (AFAX) maintenance base.

The crew in charge of the first part of the flight reported for duty at the Ardmore AFAX operations at 0430 hours Central Standard Time* and took off at 0603 hours. The flight arrived at Lawton at 0639 hours and departed at 0732 hours for McChord AFB where it arrived at 1204 hours. Around 1230 hours one of the pilots received a weather briefing for the route McChord to Monterey and Monterey to Ardmore from the U.S. Air Force weather office.

The weather officer provided the pilot with an outlook for the route from Monterey to Ardmore which indicated that the flight would encounter no significant weather until it reached eastern New Mexico and with the current military weather warning advisory which indicated that en route to Ardmore, the flight would be flying into an area of forecast maximum thunderstorm intensity.

The pilot requested the forecast for Ardmore. Since there was no terminal forecast prepared for Ardmore, the weather officer gave him the Tinker AFB, Oklahoma, the Sheppard AFB, and Perrin AFB, Texas terminal forecasts for conditions at his expected time of arrival at Ardmore.

The flight departed from McChord at 1344 hours and arrived at Monterey at 1535 hours. The total flight time from Ardmore to Monterey was 6 hours and 59 minutes. At Monterey, the only mechanical writeup entered on the flight log was "Auto pilot altitude hold inop." The engineer signed the item off by writing: "OK to continue." The flight plan was a composite VFR/IFR via Jet Airway 110/Jet Airway 76 to Amarillo VOR, direct to Altus VOR, direct to Ardmore VOR, with an estimated en route time of 3 hours 45 minutes. The following weather information was transmitted to the crew: existing weather at Ardmore: 1 100 ft overcast, visibility 4 miles in light rain forecasted to decrease to 3 miles.

The U.S. Navy weather service at Monterey stated that no weather briefing was provided to the flight crew.

---

* All times in this report are Central Standard time unless otherwise indicated.

A flight engineer boarded the aircraft at Monterey and the original engineer returned to Ardmore as a non-revenue passenger. Since there was room for only 93 passengers and five crew members aboard the aircraft, one of the two pilots-in-command returned to Ardmore via commercial air transportation. He stated that, in his opinion, the aircraft and the crew were in excellent condition when he left them.

The flight departed Monterey Peninsula Airport at 1632 hours, climbed to FL 215 and operated under Visual Flight Rules. At 1807 hours it was cleared by the Denver Air Route Traffic Control Centre (ARTCC) direct to Tuba City, then J76 Airway to Las Vegas, direct to Amarillo, direct to Altus, direct to Ardmore at FL 210.

After passing Tuba City, the crew requested and received clearance to deviate south of course because of cloud buildups. At approximately 1839 hours control of the flight was transferred from the Denver to the Albuquerque ARTCC and, at the crew's request, the flight was cleared to descend to and maintain FL 190. At approximately 1905 hours, when approaching Las Vegas, New Mexico, the flight requested and received the Dallas and Ardmore weather from the Flight Service Station (FSS) at Las Vegas. The Ardmore 1857 hours weather was: balloon ceiling, 600 ft overcast, visibility 1¼ miles in light rain showers and fog, temperature 63°F, dewpoint 63°F, wind 110°/6 kt, altimeter setting 30.06 in.

En route to Amarillo the flight was vectored around and between several areas of precipitation echoes by Albuquerque ARTCC.

Shortly after passing the Amarillo VORTAC, at 1942 hours, control of the flight was transferred from the Albuquerque to the Fort Worth ARTCC. At 2003 hours, when approximately 10 miles northwest of Altus VOR, the flight requested a lower altitude and was cleared to descend to and maintain 7 000 ft.

At 2005 hours it requested to proceed direct to Duncan VOR, direct to the Ardmore radio beacon. This routing was approved and the flight reported leaving 17 000 ft. It was then advised of precipitation echoes beginning 15 miles west of the Ardmore VOR.

At approximately 2006 hours the crew contacted the Ardmore FSS, gave their estimated time of arrival as 2028 hours, and requested the current Ardmore weather. The 1957 hours weather observation was then given to the crew as follows: measured ceiling 800 ft overcast; visibility 2 miles in very light rain showers and fog; temperature 63°F; dewpoint 63°F; wind 120°/5 kt; altimeter setting 30.05 in; thunderstorm from 1912 hours to 1920 hours with no wind gust reported.

At 2007, 2008 and 2010 hours the Fort Worth ARTCC controller attempted to contact the flight. Radio contact was re-established on the last attempt, and the crew reported leaving 12 000 ft. The flight was then cleared to descend to 5 000 ft and reported level at that altitude at 2016 hours. Two minutes later it reported 30 miles west of the Ardmore VOR, requested a lower altitude, and was cleared to continue at 5 000 ft to the Ardmore Airport. Radar service was terminated and the crew was advised to contact the Ardmore FSS.

At approximately 2020 hours the crew contacted Ardmore and requested that the lights on runway 08 be turned on. The FSS specialist changed the lights from runway 12 to runway 08 and advised the flight to stand by as he was making a special weather observation. Shortly thereafter, he transmitted: measured ceiling of 700 ft broken clouds; overcast 1 100 ft; visibility 3 miles in very light rain showers and fog; wind 130°/6 kt; altimeter setting 30.06 in.

At approximately 2026 hours the FSS specialist requested the position of the flight and was advised that it was over the Ardmore radio beacon inbound. Surface wind information and altimeter setting were given to the flight.

Approximately two minutes later, the FSS specialist observed the lights of an aircraft north of the airport moving in an easterly direction. Moments later, at 2029 hours, the crew requested the lights to be changed to runway 12. He actuated the selector switch, checked that the lights were operating and returned to his normal position in the facility. At 2030 hours he looked out his east window and observed a fire ball some distance northeast of the airport. As no answers were received to his attempts to contact the flight he alerted the fire station and advised that he thought the flight had crashed northeast of the airport.

The site of the accident was located $1\frac{1}{2}$ miles northeast of the airport, the coordinates of the wreckage site being 96°58'55"N - 34°19'46"W, and the elevation being approximately 963 ft.

Witnesses located along the route of flight stated that the aircraft passed approximately one mile to the north of the Ardmore beacon, then followed a path to a point approximately $1\frac{3}{4}$ to 2 miles north of the approach end of runway 08 at an altitude which was estimated as being approximately 1 160 ft (see Figure 9-1).

Interviews with the surviving passengers revealed that they had little or no recollection of the accident. Most of them were asleep at the time of impact. One survivor did recall a turn to the left before the impact, and another testified that following a series of turns the aircraft turned sharply to the left and the engine sounds increased markedly just before impact. None of the survivors recalled the aircraft nosing over, diving, or feeling any negative "g".

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	5	78*	
Non-fatal		15	
None			

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

There was property damage to livestock and trees in the wreckage area.

* One non-revenue passenger included (flight engineer).

1.5 Crew information

The pilot-in-command, aged 59, held an airline transport pilot's certificate with type ratings in the DC-3, DC-4 and L-188. He had completed proficiency and line checks on 4 February and 26 September 1965 respectively. His first-class medical certificate, dated 22 February 1966, specified that he must wear glasses while flying. He had flown a total of 16 247 hours, including 1 247 hours on L-188 aircraft. He had flown 60 hours during the 90 days prior to the accident, including 8 hours on instruments and 12 hours by night, and 18 hours during the 30 days prior to the accident, including 2 hours by night. His duty time on the day of the accident had been 16 hours, including 7 hours 25 minutes of flight time.

The co-pilot, aged 49, held an airline transport pilot's certificate with type rating in DC-3 and commercial privileges for airplane single and multi-engine land and sea. His last en route inspection was conducted on 9 February 1966. His first-class medical certificate, dated 1 March 1966, specified that he must possess glasses for near vision. He had flown a total of 12 355 hours including 1 155 hours on L-188 aircraft. He had flown 225 hours during the 90 days prior to the accident including 23 hours on instruments and 47 hours by night, and 75 hours during the 30 days prior to the accident including 2 hours on instruments and 16 hours by night. His duty time on the day of the accident had been 16 hours including 7 hours 25 minutes of flight time.

The flight engineer held a flight engineer's certificate as well as an airframe and powerplant certificate. He had been designated by the Federal Aviation Agency as a flight engineer check airman on L-188 equipment as of 22 March 1966. His second-class medical certificate was dated 21 September 1965, with no limitations. He had flown a total of 4 378 hours including 2 546 hours on L-188 aircraft. He had flown 230 hours during the 90 days prior to the accident and 55 hours during the 30 days prior to the accident. His duty time on the day of the accident had been 5 hours and 30 minutes.

Also aboard were two stewardesses who had recently received recurrent emergency training.

1.6 Aircraft information

The aircraft had flown a total of 4 019 hours since new and its last 300 hour inspection (P) as well as its last service check (75 hours inspection) and daily inspection were completed at Ardmore on the day of the accident. The aircraft then flew 10 hours 49 minutes prior to the accident.

An examination of the flight log revealed that one of the two compressors providing cabin pressurization was disconnected during the flight from Monterey to Ardmore because of a low oil pressure indication, however, this would not have affected normal aircraft operation.

The weight and balance form prepared by the crew showed a take-off weight of 110 125 lb, which was less than the permissible maximum of 160 000 lb, and a landing weight of 92 625 lb also under the permissible maximum of 95 650 lb. The centre of gravity was computed to be within limits both at take-off and at the time of the accident.

1.7 Meteorological information

Meteorological information relevant to the weather existing in the Ardmore area was as follows:

The 2100 hours surface weather chart showed a warm front extending southwestward from southwestern Kentucky to near San Antonio, Texas, and a trough extending southwest from northwestern Illinois to near Wichita Falls, Texas.

The 2043 hours Ardmore local weather observation was in part as follows: measured 700 ft overcast, visibility 2 miles in light rain showers and fog, temperature 63°F, dewpoint 63°F, wind 120°/7 kt, altimeter setting 30.07 in.

The 2043 hours Fort Worth radar weather observation was in part as follows: broken area of echoes containing light rain showers and thunderstorms producing light rain showers, decreasing slowly in intensity, area bounded by: 297° 78 miles from the antenna, 088° 139 miles, 065° 179 miles, 120° 13 miles, moving from 220° at 30 kt, top of detectable moisture 20 000 ft amsl.

The 2045 hours Oklahoma City radar weather observation was in part as follows: broken area of echoes containing light rain showers and thunderstorms producing moderate rain showers, increasing in intensity, area bounded by 060° 125 miles from the antenna, 085° 125 miles, 160° 100 miles, 188° 90 miles, 115° 50 miles, moving from 260° at 20 kt, top of detectable moisture 25 000 ft amsl includes a solid line of echoes containing thunderstorms producing moderate rain showers located from 115° 50 miles from the antenna to 188° 90 miles, 12 miles wide, top of detectable moisture 35 000 ft amsl.

A radar scope photograph made by the National Severe Storms Laboratory at Norman, Oklahoma, about the time of the accident showed an isolated echo, containing heavy rain showers and probably a thunderstorm, centring between the Ardmore Radio Beacon and the airport. The diameter of the echo was approximately 4 NM, and it was moving northeastward at about 35 kt.

The nearest winds aloft observations were taken at Oklahoma City and Fort Worth at 1800 hours and were in part as follows:

	Height (in ft amsl)	Direction (in degrees true)	Velocity (in knots)
Fort Worth	1 000	160°	18
	2 000	170°	27
	3 000	180°	34
Oklahoma City	2 000	010°	11
	3 000	050°	8

At approximately 2006 hours while descending to 7 000 ft, the flight was informed by Fort Worth ARTCC controller that there was a small line of cell activity beginning fifteen miles west of Ardmore and running northeast from that position. This was acknowledged by the flight.

At 2016 hours while the flight was en route from Amarillo to Ardmore and in a descent to 5 000 ft, it was provided with the following weather data by the Fort Worth ARTCC controller:

"Ardmore weather measured eight hundred overcast, two miles, light rain and fog, winds one two zero degrees at five knots. I have what appears to be a line running northeast and southwest twenty miles west of Ardmore running on a line about fifty miles long."

This was also acknowledged by the flight.

Several witnesses located northwest of the Ardmore Radio Beacon described light, and in one instance, heavy rain showers near the time of the accident. One witness, located between the radio beacon and the airport, described the aircraft as "lower than most" aeroplanes that pass his home. The noise of the aircraft, which he described as that of an "Electra", brought him outside his home but he could not see it. After he returned to his house, he heard a loud clap of thunder and heavy rain began to fall. Witnesses located at or near the Ardmore Municipal Airport described light rain prior to the aircraft passing, followed immediately by heavy rain showers after the aircraft passed low over their location. They described a ragged cloud base to the north.

1.8 Aids to navigation

The Ardmore Municipal Airport had a designated control zone, and there were three published instrument approach procedures prescribed for the facility, namely an ADF, a VOR and a VOR/DME approach. Ground certification checks of the VOR, the TACAN/DME, the Low Frequency Radio Beacon, the associated monitor equipment for NAVAIDS, and the VHF communications (FSS Frequencies) were begun at 2130 hours on the night of the accident. All facilities were found to be operating within established tolerances.

The FAA approved instrument procedure for a straight-in ADF approach to the Ardmore Municipal Airport, with a transition from the Duncan VOR, is via a magnetic track of 088° to the Ardmore Radio Beacon. The minimum altitude between Duncan and Ardmore is 2 600 ft and the minimum crossing altitude at the Ardmore Radio Beacon is 2 300 ft. The magnetic track from the radio beacon to the runway is 076°. The missed approach procedure requires a climb to 2 700 ft on a course of 076° magnetic within 20 miles of the airport. The weather minima applicable to this type of aircraft, at night, for a straight-in approach to runway 08 were ceiling 600 ft and visibility 1 mile. Circling minima at night were 600 ft (i.e. 1 362 ft amsl) and $1\frac{1}{2}$ miles. There were no radar services associated with the Ardmore Municipal Airport.

1.9 Communications

Air-ground communications were routine except for the failure of the crew to respond to calls from the Fort Worth ARTCC on frequency 133.9 mcs that should have been guarded while the flight was under the Centre's control. A period of 2 minutes and 25 seconds elapsed before communications were re-established between the Centre and the co-pilot who was then obtaining weather information from the Ardmore FSS specialist on frequency 126.7 mcs.

1.10 Aerodrome and ground facilities

The Ardmore Municipal Airport had no functioning control tower. However, the FSS was located on the airport, and provided landing information. The airport was equipped

with two lighted runways for use at night and two other unlighted runways. The airport was also equipped with a green and white rotating beacon and blue taxiway lights. The rotating beacon and runway lights on runway 08/26 and 12/30 were operational and in use on the night of the accident. Runway 08/26 was equipped with low-intensity 30 watt lights and runway 12/30 with high-intensity 200 watt lights.

When the crew requested the lights on runway 08 at 2020 hours, the FSS specialist changed the lights from runway 12, the runway which the existing wind favoured. At 2029 hours the crew requested the lights to be changed to runway 12. The FSS specialist immediately switched off the lights on runway 08 and turned on the lights on runway 12. In each instance, the lights of the appropriate runway were observed to be lit.

1.11 Flight recorder

The aircraft was equipped with a LAS 109C flight data recorder. The recorder assembly was recovered intact at the accident scene, but an examination revealed that the engaging tangs of the pawl assembly were loose in the recorder housing. As a result the recorder foil had only advanced a minute amount and was not advancing prior to or at the time of impact and no recording was available for the last flight.

The operating procedure for the flight recorder required it to operate continuously from the instant the aircraft commenced the take-off roll until it had completed the landing roll. The AFAX procedures required the flight engineer to check the operation of the recorder on each leg by listening to the test tone signal through the interphone system. In the event of an in-flight failure of the recorder, the aircraft may continue only to the next stop where repairs or replacements can be made.

1.12 Wreckage

The aircraft crashed in the foothills of the Arbuckle Mountains approximately $1\frac{1}{2}$ miles northeast of the Ardmore Municipal Airport. The first evidence of impact was a mark on a tree at an elevation of 963 ft. The aircraft struck the ground just below the crest of a hill, proceeded over the top of the hill and slid down a slight grade for a distance of about 800 ft. The wreckage was scattered along a line approximately 150° magnetic and all the major components of the aircraft were recovered in the wreckage area including all of the flight controls, trim tabs and landing flaps. No evidence of any pre-impact malfunction of the flight controls was found.

Measurements of the landing flap screwjacks revealed that the flaps were 78 per cent extended at impact. All three landing gears separated from the aircraft, the actuating cylinders were in positions corresponding to a gear down at impact.

No evidence of pre-impact overtemperature or other operational distress was found during the examination of the engines and propellers.

1.13 Fire

The first evidence of fire was found in the area of the No. 3 engine ground impact crater, which was located 82 ft from the initial impact. Three other areas of ground fire damage were evident farther along the wreckage distribution area.

Fire fighting equipment and personnel from the Ardmore Municipal Airport extinguished whatever fires remained following the moderate rain showers which began immediately after the accident occurred.

1.14 Survival aspects

Most of the passenger seats separated from the aircraft and tumbled out onto the ground during the last 150 ft of aircraft travel. Eighteen passengers survived the accident: ten were found in the last 150 ft of the wreckage area, six were found in a group approximately 50 yards south of the wreckage area, and two walked out of the accident area.

Of the eighteen survivors, three later succumbed to the injuries they received in the accident.

All of the fatalities resulted from injuries sustained during the crash. Toxicological specimens from 63 passengers were sent to the Armed Forces Institute of Pathology for a carbon monoxide determination. Of these specimens only 12 cases showed evidence of carboxyhemoglobin in excess of 10 per cent with the maximum being 45 per cent.

1.15 Tests and research

On 4 May 1966, a series of flights were conducted with an L-188 to attempt to establish an accurate flight path with the assistance of witnesses who either saw or heard the aircraft on 22 April 1966. Five flights were made during daylight hours and two were conducted after dark. All flights were conducted during clear weather, and at an indicated airspeed of 160 kt.

In general, all flights began from an altitude of 2 300 ft at a point one mile north of the Ardmore Radio Beacon and descended to an altitude of approximately 1 160 ft in the area of the wreckage site.

The consensus of the witnesses was that the noise of the test aircraft was never as loud as that of Flight 280/D on 22 April 1966, and that most of the test flights were conducted at too high an altitude. Witnesses agreed that the probable route of flight was over a point one mile north of the Ardmore Beacon, then on a magnetic heading of approximately 071° until at a point approximately one mile north of the Ardmore Municipal Airport, where a turn to the right was begun (see Figure 9-1).

1.16 Medical investigation

Autopsies were performed on the three flight crew members and the causes of death were determined as follows: Pilot-in-command, either multiple injuries or coronary artery arteriosclerosis; Co-pilot, injuries; Flight Engineer, injuries. In view of the findings as to the cause of death of the pilot-in-command, an investigation was made into his medical history.

The autopsy protocol of the pilot-in-command stated he had severe arteriosclerosis with calcification and brittleness of the coronary arteries. Microscopic examination of the heart revealed microscopic foci of fibrocytes with brown pigment laden macrophages and a few lymphocytes. There were also areas of bands of pink acellular scar tissue and mild focal perivascular fatty infiltration. The myocardium for the most part was free of scarring and no fresh infarcts were demonstrable. There was a fracture of the right ulna (large bone of the forearm), a fracture of the left lateral epicondyle

(outer elbow), and a fracture of the left index and ring fingers. Additionally, there were fractures of the skull, both legs, multiple rib fractures and internal injuries.

Post-mortem examination of the co-pilot revealed amongst other injuries, a comminuted fracture of the right humerus; a comminuted fracture of the right ulnar and radial bones, proximal third; fractures of the metacarpal head of the thumb of the right hand; a compound comminuted fracture of the left thumb; and a fracture dislocation through the medial epicondyle.

Autopsies of the other crew members revealed traumatic injuries consistent with severe decelerative forces experienced during the accident. There was no evidence of pre-existing diseases which would have rendered them incapable of performing their duties.

The pathologist who performed the autopsy testified that his examination of the pilot-in-command's heart revealed "severe and very vast coronary arteriosclerosis which, because of the severity, precluded cutting or sectioning at the scene" (of the autopsy). He described arteriosclerosis of the coronary arteries as a disease process which causes narrowing of the lumens through which the blood flows, and slows and precludes the carrying of a full volume of blood which carries the oxygen to the heart. The gross impression of severe coronary artery arteriosclerosis was confirmed by microscopic examination. He stated that he believed the arteriosclerosis was of long duration and involved all of the major branches of the coronary circulation. In some cases the lumens through which the blood should flow were so small that it was necessary to use a microscope to see them.

He described the arteries as being calcified which meant to him that the disease was of long duration, in excess of a couple of years. He described coronary insufficiency as a condition where an insufficient volume of oxygen-bearing blood is supplied to the heart muscle to maintain it under various situations. This demand is increased when the heart has additional activity to perform. In his opinion, the arteriosclerosis found in the pilot-in-command's heart was sufficiently advanced to result in coronary insufficiency. He also stated that it was possible to have a coronary insufficiency without a demonstrable thrombus or a hemorrhage in the plaque. Thrombosis was described as a plugging or clogging of the lumen with a clot, while a plaque hemorrhage occurs around the lumen into the arteriosclerotic process in the arterial wall. The hemorrhage enlarges the plaque and occludes the lumen so as to compromise the blood flow through the area. Both can result in an occlusion. He stated that angina pain prior to the accident cannot be established by pathological findings. He did not list a single cause of death for the pilot-in-command as he could have died from either heart disease or traumatic injuries. When asked to compare the pilot-in-command's heart condition with conditions of persons whose cause of death was designated as an acute coronary insufficiency, he stated that in the absence of other injuries or other findings he would feel that the pilot-in-command's death was due to coronary insufficiency.

The doctor described the fractures of the hands and arms of the two pilots and noted that the difference appeared to be that the co-pilot suffered fractures of both thumbs while those of the pilot-in-command were not broken but two fingers were. He was unable to express an opinion as to whether the pilot-in-command was relaxed at the time of impact or the co-pilot may have had control of the aircraft, based on the injuries each suffered in the crash.

Another pathologist, who had participated in autopsies of many aircraft accident victims, testified that there was without doubt coronary insufficiency present in the pilot-in-command's heart. He further testified that his review of the pilot-in-command's medical records showed that they reflected all the symptoms of coronary insufficiency and the findings of the autopsy reinforced his opinion. He stated that it would

not be possible to detect angina by pathological means. He also testified that if the traumatic injuries suffered by the pilot-in-command had not been present, his death would have been attributed unequivocally to coronary arteriosclerosis and stated that the probability of a patient with such a degree of arteriosclerosis having a coronary insufficiency and sudden death was quite high. He testified that, given the circumstances under which the pilot-in-command had been operating and his physical condition, it was medically probable that he could have suffered anginal pains and that there was a reasonable medical probability that he may have experienced sudden death from coronary artery disease prior to impact.

He compared the injuries suffered by the pilot-in-command and the co-pilot with particular reference to the injuries they sustained to their upper extremities. He testified that the injuries to the co-pilot's hands and arms were indicative of his hands being on the controls of the aircraft at the time of impact. Such injuries were not found on the pilot-in-command's hands.

An aviation medical examiner, who was also a flight surgeon and cardiovascular specialist, testified that he had reviewed the pilot-in-command's medical record obtained from his personal physician. These records revealed that the first indications of coronary artery disease were reported in December 1947. From that time until 1950 there were many visits, the records of which presented increasing evidence, from a historical standpoint, that he was having difficulty with his heart. From 1950 until 1963 there is no record of any complaints about the patient's heart, but from 1963 until his last visit on 11 April 1966, there was an indication that he was having increasing symptoms that were related to his heart. The symptoms were primarily pain in the chest with radiation down the left arm, apprehension, and increase in heart rate. These symptoms were characterized as those that come from heart disease.

During the periods covered by the medical records reviewed, the pilot-in-command received prescriptions for various medications including aminophyllin, nitroglycerin, and Peritrate. The nitroglycerin was to be taken for relief of pain at first but later the patient was advised to take it prophylactically to preclude the occurrence of pain. From November 1963 on, the physician prescribed a dosage of four Peritrate tablets daily. The prescription records showed that this prescription was filled 26 times during this period.

The records also revealed that from October 1962 until the time of the accident, the pilot-in-command was being treated for diabetes with a prescription of ½ an Orinase tablet daily. The records showed that this treatment apparently controlled the diabetes with only occasional sugar spilling being reported.

During these periods of treatment the pilot-in-command was taking semi-annual FAA Class I flight physicals as a part of his airline pilot transport rating licence requirements. A review of the medical history portion of the application he completed revealed that he always denied having had either heart disease or diabetes. He also denied, in the more recent applications, having consulted a physician or being under medication.

The witness testified that Peritrate is a drug that dilates the arterial system and it is believed that it dilates preferentially and better the coronary vessels than others. He was not aware of this drug being prescribed for anything other than cardiovascular disease.

He testified that nitroglycerin is also a dilator of the arterial system. Preferentially it dilates the coronary arteries and is a very rapid acting medication because it is rapidly absorbed and its effect is also rapidly dissipated. Ordinarily the patient is advised to have the tablets handy at all times and to take them at the first sign

of discomfort. Also, if the patient knows certain activity would produce discomfort and knows under particular circumstances that he must carry out that activity, he might take the tablet prophylactically to prevent difficulty. He also testified that if the taking of Peritrate was discontinued, one might expect the patient would have more difficulty with pain.

He testified that when a patient suffered angina pain he would be handicapped in the performance of whatever he was doing, distracted by the discomfort, and on occasions actually incapacitated. He stated that there was a probability that a person with this type of severe coronary artery disease would suffer sudden death. Such an attack would probably include sudden unconsciousness, possibly within 7 to 12 seconds. This could occur under circumstances that would induce coronary insufficiency. He also testified that, given the circumstances of this flight and the physical condition of the pilot-in-command, it was very likely that he would have experienced angina pains and that the possibility of sudden death would have been high.

A toxicologist testified at the public hearing regarding tests he performed on specimens taken from the pilot-in-command's body. He also testified regarding his tests of two types of pills, a container of paper tape, and a small empty prescription bottle labelled with the pilot-in-command's name, which were recovered after the accident. There were no pills in the bottle, but there was a residue in the bottle which was analysed. He was also supplied with a sample of embalming fluid used in embalming the pilot-in-command's body.*

The body specimens were tested for determination of alcohol, carbon monoxide, acidic, basic, and neutral drugs, cholinesterase inhibitors, and blood sugar. The other materials were tested to determine the active ingredients in them and for identification of the tape.

He reported that there was no ethyl alcohol detected in the blood sample and there was only a trace of carbon monoxide. The embalming fluid contained methyl alcohol, but not ethyl alcohol. No acidic drugs were detected in the blood or liver tissue. Traces of material having the properties of tolbutamide were obtained from the liver tissue but the quantity was insufficient for identification except by chromatograph RF and U V Spectrum. No neutral drugs including nitroglycerin were detected in the blood or liver tissue.

Examination of a "Tabloid" tablet revealed it contained salicylate, phenacetin, caffeine and codeine. The quantity of codeine was equivalent to the amount in a tablet containing one-half grain of codeine. Two other tablets did not contain opium alkaloids, saccharin or atrophine, but did give a positive test for the presence of nitroglycerin. The paper tape was identified as "Glucose Tes-Tape" normally employed for testing for sugar in the urine. The residue in the bottle contained salicylate, phenacetin, caffeine, and codeine.

He identified tolbutamide as an agent which a patient might take to influence the level of blood sugar. He attached no significance to the relatively low blood sugar reading in the pilot-in-command's blood because of the type and number of injuries he suffered.

Testimony taken during a previous aircraft accident investigation** revealed that a heart with evidence of severe coronary arteriosclerosis and advanced coronary arteriosclerotic heart disease is identified by showing large areas of fibrous scarring. This is considered evidence of long-standing previous disease. The scarring is caused by a lack of oxygen supplied to the muscle fibre which causes the muscle to die and be replaced by fibrous scar tissue. The period of time involved would be several months at least.

---

* The pilot-in-command's body was embalmed before the autopsy was performed.

**Flying Tiger Line, L1049A at Burbank, California on 14 December 1962 - SA-369 (See ICAO Digest No. 14 - Volume I, Summary No. 25).

People who suffer from arteriosclerotic heart disease or coronary arteriosclerosis are likely to suffer sudden collapse or death particularly under conditions of either physical or mental stress, such as those encountered by a pilot landing under instrument flight conditions. Literature in aerospace medicine indicates that pilots who are landing or taking-off in aircraft do have higher blood pressure during those periods and pilot stress is also indicated by increased pulse rate, increased respiration, and other symptoms, when compared with straight and level flight. He was unable to describe what action a person suffering such an attack might take but some victims double over forward, some people just grasp their chest and lean over backwards. There is no hard and fast rule.

A heart specialist testified in the previous investigation that it was possible for a person to have severe coronary artery disease and yet have a normal electrocardiogram. It would be possible for a patient to have this type of heart disease and an examining physician would not be able to detect it without the patient's co-operation. He also testified that coronary artery insufficiency may manifest itself by heart pain (angina pectoris) or may lead to certain conduction disturbances known as arrhythmias and may also lead to heart failure (myocardial infarction). Myocardial infarction may be manifested by pain, sudden shock or collapse, sudden episodes of loss of consciousness, palpitation or extreme shortness of breath.

He also testified that the best test to diagnose coronary heart disease was a history of angina pectoris with or without corroborative evidence of an electrocardiogram. The actual establishment of heart pain is one of the most important tools in such diagnosis.

A pathologist also testified in the previous investigation that in the absence of evidence of acute ischemia he was not in a position to state with certainty that the changes present caused pilot incapacitation. Persons with this degree of coronary arteriosclerosis are known to be subject to sudden death or incapacitation from acute coronary insufficiency. Any conclusion of pilot incapacitation must be based on gross and microscopic findings and a careful consideration of other corroborative evidence of the facts, conditions, and circumstances surrounding the accident.

2. - Analysis and Conclusions

2.1 Analysis

The maintenance discrepancies regarding the flight recorder discovered during the course of this investigation did not contribute to the cause of this accident. There was a lack of knowledge on the part of the company inspection and maintenance department with respect to the operation, servicing, and maintaining of the flight recorder. There was no training or course of instruction relative to the servicing of the flight recorder within the aircraft. Subsequent to the accident, these deficiencies were corrected.

The condition of the torquemeter pickups, the compressor sections and the turbine assemblies indicated that the four engines were rotating and developing power at impact.

All structural components were intact and capable of normal operation prior to initial impact. The landing gear was fully extended, and the flaps were extended 78 per cent, indicating the crew had the aircraft in an approach configuration, with the intention of landing at Ardmore.

The crew had more than a casual interest in obtaining current weather conditions at Ardmore, as evidenced by their many contacts en route. At the time of the accident,

an inverted trough extended from northeast to southwest, just a few miles west of the Ardmore Municipal Airport. Radar weather observations and photographs showed a line of thunderstorms and moderate rain showers which are considered to have been associated with the trough.

Although the ceiling and surface visibility conditions at the airport were officially reported above approved circling landing minima, at the accident site, the ceiling could have been on the order of 100-200 ft sky obscured with ¼ to ½ mile visibility in the very light rain showers and fog. The winds aloft at 1 000 and 2 000 ft amsl, were 140° to 150°, 18/20 kt, and 160° to 170°, 28/30 kt respectively. For several hours Ardmore had been reporting weather conditions which were very close to instrument approach minima for the airport, and the crew became aware of this fact early in the flight.

Except for the brief communications discrepancy, flight operations during the en route descent to the Ardmore Radio Beacon were routine. At 2026 hours Ardmore Radio requested the flight's position and was advised they were over the beacon inbound. According to ground witnesses who observed or heard the original flight and watched and/or listened to the fly-bys, the aircraft passed approximately one mile north of the beacon and turned to the northeast establishing a magnetic track of approximately 071°.

Under the provisions of the approach clearance issued to the flight, selection of the approach procedure to be utilized was left entirely to the pilot. The pilot's choice was an ADF approach, since he requested clearance to the Ardmore Radio Beacon shortly after having initiated en route descent. Before reaching the beacon the crew asked the FSS for lights on runway 08 and minutes later reported inbound over the Radio Beacon.

The probable reason for the pilot's decision to execute the ADF approach was that this procedure was the only one that authorized a straight-in approach and it provided the lowest weather minima at Ardmore.

Utilizing ARTCC data, witness information, and simulated flight test data, the approximate flight of the aircraft was reconstructed. The significant factors revealed were: the track over the ground placed the aircraft approximately one mile north of the Ardmore Radio Beacon at the time of passage; the track from the beacon to the airport placed the aircraft about 1¾ to 2 miles north of runway 08, in an east-northeasterly direction; and the aircraft's altitude varied from 1 200 ft to 963 ft during the last minute and 15 seconds of flight.

There are several possible reasons for the aircraft passing one mile north of the Ardmore Radio Beacon, instead of over it. The first was that the crew failed to correct for wind drift and allowed the aircraft to drift to the north. The second was that the ADF was malfunctioning; however, this could have been monitored with the use of the Ardmore VOR and DME backup, both of which were tuned to their respective frequencies and were operating satisfactorily. The third and most probable reason was that the crew, using airborne radar, was circumnavigating radar echo activity 12 to 15 miles west of the beacon as well as an isolated radar echo near the beacon.

The aircraft's altitude at station passage should have been not less than 2 300 ft. The magnetic track from the Ardmore beacon to runway 08 was 076°. The aircraft was observed by a witness 1½ miles northwest of the airport at an altitude of approximately 1 160 ft and it was calculated that the magnetic track of the aircraft after station passage was approximately 071°. The average wind from station passage to this witness location was 170°/27 kt. This would have introduced a drift of 10° to the left, therefore the aircraft would have been flying on a magnetic heading of 081°.

The magnetic heading of 081° is 5° farther right than the approach bearing of 076°. It can be assumed that the crew turned to 081° in an attempt to correct for the one mile north deviation in order to intercept the 076° bearing. However, because the winds were stronger than they anticipated, approximately 10° of left drift was encountered and the approximate magnetic track of the aircraft became 071°.

The aircraft's descent angle, just prior to impact, was determined to be approximately 7.2° and the calculated wing attitude was approximately 10° right-wing down at impact. Using this angle of descent and an airspeed of approximately 150 kt at time of impact, the aircraft would have had an average descent rate of 1 950 ft/min.

The crew should not have descended below an altitude of 1 362 ft, unless the aircraft was clear of clouds. It has been determined that the aircraft did descend to approximately 1 160 ft, at which altitude it was observed north of the airport and it crashed at an elevation of 963 ft. A loss of 197 ft (1 160 ft down to 963 ft) at the above-mentioned rate of descent would take approximately 6 seconds. Since the ceiling was reported to be ragged, it is believed the crew descended below 1 362 ft in order to maintain visual flight and remain clear of clouds. The only obstruction within 5 miles of their approach path higher than 1 160 ft was a radio tower located 5 miles north of the beacon, the top of which was 1 579 ft amsl. The highest obstruction in the vicinity of the airport was a tower, 75 ft high, located 2 miles north of the airport atop the Arbuckle Mountains which has an average altitude of 1 000 ft.

Two miles northwest of the airport, the aircraft was sighted by a witness. Ground witnesses indicated that the aircraft continued on a magnetic track of approximately 071° until it was one mile north of the airport boundary. At this time and position, the FSS specialist at Ardmore had the aircraft in sight, and the crew requested a change of lights from runway 08 to runway 12.

Based on the identification of the co-pilot's voice on the radio and common custom and practice in air carrier operations, the Board concluded that the pilot-in-command was flying the aircraft.

The pilot-in-command knew his position when he requested to change the lights and being familiar with the terrain surrounding the airport, he would not have intentionally allowed the aircraft to descend below 1 160 ft amsl, while over the Arbuckle Mountains, even if the visibility was obscured by low clouds or rain.

As to why the aircraft was permitted to descend to 963 ft amsl, the Board ruled out malfunction of the control system, airframe failure, powerplant failure, interference with the crew by unauthorized persons, and altimeter error, since the evidence of the investigation established that none of these factors existed.

It has been established that power was applied and the aircraft was rotated noseup immediately prior to impact. This is confirmed by physical evidence at the scene and by the statements of several surviving passengers. There was no mention of a negative "g" force or pushover in the last few seconds prior to impact by these same survivors. The Board believed that the sharp left turn described by surviving passengers was the motion associated with a pilot rolling out of a turn to the right to regain a level flight attitude rather than a turn to the left from a level flight attitude. With no outside reference on which to base the attitude of the aircraft the passengers would not be able to tell which occurred, but the attitude of the aircraft, right-wing down at impact, indicated that the aircraft was more likely rolling out of a turn to the right than into a turn to the left.

A descent at 1 950 ft/min for the last 6 seconds of flight could have been the result of spatial disorientation, an attempt to maintain visual flight and keep the field in sight, or pilot incapacitation.

Spatial disorientation might conceivably have occurred while the pilot-in-command was trying to keep the airport in sight. He may have assumed that the aircraft was in a climbing manoeuvre and reacted by a definite pushover of the yoke. This would have introduced a negative "g" force which would have been felt by passengers. None of the surviving passengers felt a negative "g" force of this magnitude during the last few manoeuvres prior to impact and therefore the Board concluded that spatial disorientation did not initiate the accident sequence.

Concerning the attempt to maintain visual flight, it is very doubtful that the pilot-in-command would push the aircraft over in order to keep the field in sight because of the high terrain in the vicinity. Even if this had been done, power addition and rotation would not necessarily have been utilized. It would have been impossible to see the hills or trees at night because of the lack of lighting and the adverse weather conditions. It is concluded that the pilot-in-command would not intentionally descend below 1 160 ft amsl, in order to keep the field in sight on encountering cloud conditions.

The evidence points toward the probability that the pilot-in-command became incapacitated prior to the last 6 seconds of flight and that the aircraft went into an uncontrolled descending right bank. A pathologist who participated in the investigation and who had performed autopsies on over 2 000 air-crash victims stated that the fractured condition of the co-pilot's hands and arms was of such a nature that it indicated he had his hands on the controls at the time of impact. Further, evidence revealed that the pilot-in-command did not have comparative or similar fractures on his hands and arms.

It is probable that the pilot-in-command entered a standard rate turn to the right in preparation for making a downwind leg for landing on runway 30 and that, while turning through a heading of 142°, he collapsed permitting the aircraft to enter a sink rate of 1 950 ft/min.

The co-pilot, who was probably looking through the right window trying to keep the field in sight, may have been warned of the event by the flight engineer, or noticed the change in attitude. His immediate reaction would have been to grasp the control wheel and order more power. It would have taken approximately 3 to 5 seconds for the co-pilot to respond effectively and grasp the controls. An additional 1.5 seconds would have been required for the aircraft to respond and rotate through an attitude of 12°. Since it would take approximately 6 seconds for the aircraft to descend from 1 160 ft to 963 ft, the co-pilot would have been unable to prevent a collision with the ground under these conditions.

The Board, after reviewing all the evidence relating to the pilot-in-command's physical condition and medical history, the environment in which he was operating and the cardiologists' testimony not only in this but in another case, concluded that the pilot-in-command became incapacitated during the final stages of the approach. Whether he slumped over the wheel, rolled slowly into an excessive rate of bank, or fell back in the seat allowing the aircraft to roll slowly into a bank, with no back pressure applied to the controls, was not determined. However, if any of these situations did occur while the co-pilot was attempting to keep the airport or runway in sight, the results would have been very much the same. The time necessary for the co-pilot to see and recognize the problem and take corrective action, coupled with the response time of the aircraft, was more than the time available for recovery, and as a result the aircraft collided with the ground.

Consideration was given to the possibility that downdraft turbulence from a thunderstorm located directly over the accident site caused a rapid loss of altitude and impact with the ground but no evidence was found of a thunderstorm in the area of the accident other than the one reported near the radio beacon, approximately 6 miles from the accident site. Additionally, had the crew been resisting the effects of a downdraft at the time of the accident, the aircraft's attitude would have been nose high rather than nose low as found in this case.

2.2 Conclusions

(a) Findings

The crew was properly certificated and qualified for the flight. However, the pilot-in-command had a history of heart trouble extending back 18 years and a history of diabetes extending back 3½ years; if the FAA had been aware of this it would not have issued him a medical certificate. Both pilots had been on duty for 16 hours and aloft 11 hours at the time of the accident; although this was not in excess of the flight time limitations, it contributed to the pilot-in-command's susceptibility to incapacitation.

The aircraft had been properly maintained and serviced with the exception of the flight recorder which was not operating during the last flight. The weight and centre of gravity of the aircraft were within limits both at take-off and at the time of the accident.

The flight was provided with current weather reports and, although thunderstorms in the area may have affected the progress of the flight, they were not in direct causal relationship to the accident.

All structural components were intact and capable of normal operation prior to impact. The powerplants were developing power at impact and were not a factor in the accident.

Radio communications in the terminal area were made by the co-pilot, it was therefore concluded that the pilot-in-command was flying the aircraft. After failing to complete, as intended, a straight-in ADF approach to runway 08, probably because of a thunderstorm in the vicinity of the radio beacon, the pilot-in-command flew north of the airport to land on runway 30. While attempting a right turn he experienced a coronary insufficiency and became unable to control the aircraft which descended rapidly. The low altitude and high rate of descent at the time precluded a safe recovery by the co-pilot.

The Board was concerned by the fact that the pilot-in-command had an established medical history of cardiovascular disease and diabetes mellitus, both of which are disqualifying for the issuance of a first-class medical certificate, and that he deliberately falsified his application for this certificate. It is known that cardiovascular disease and diabetes mellitus could remain undetected during the course of a first-class medical examination and in fact there have been numerous instances where a flight crew member has become incapacitated from cardiovascular disease while at the controls of an air carrier aeroplane orjust subsequent to flight.

The failure of any pilot exercising commercial privileges to disclose his total medical history by falsifying his application for a medical certificate, places in jeopardy not only the lives of the crew members but also the lives of their passengers.

The Board, in conjunction with the FAA, is exploring ways to improve the quality of medical information received from pilots, is attempting to improve the state of the art of medical diagnoses of pilots, and is exploring the possibility of removing legal restraints which prevent physicians from reporting information of importance to the maintenance of aviation safety.

(b) Cause or
Probable cause(s)

The Board determined the probable cause of this accident was the incapacitation, due to a coronary insufficiency, of the pilot-in-command at a critical point during a visual, circling approach being conducted under instrument flight conditions.

ACCIDENT TO LOCKHEED ELECTRA L-188C, N 183H, NEAR ARDMORE MUNICIPAL AIRPORT, OKLAHOMA, U.S.A. ON 22 APRIL 1966

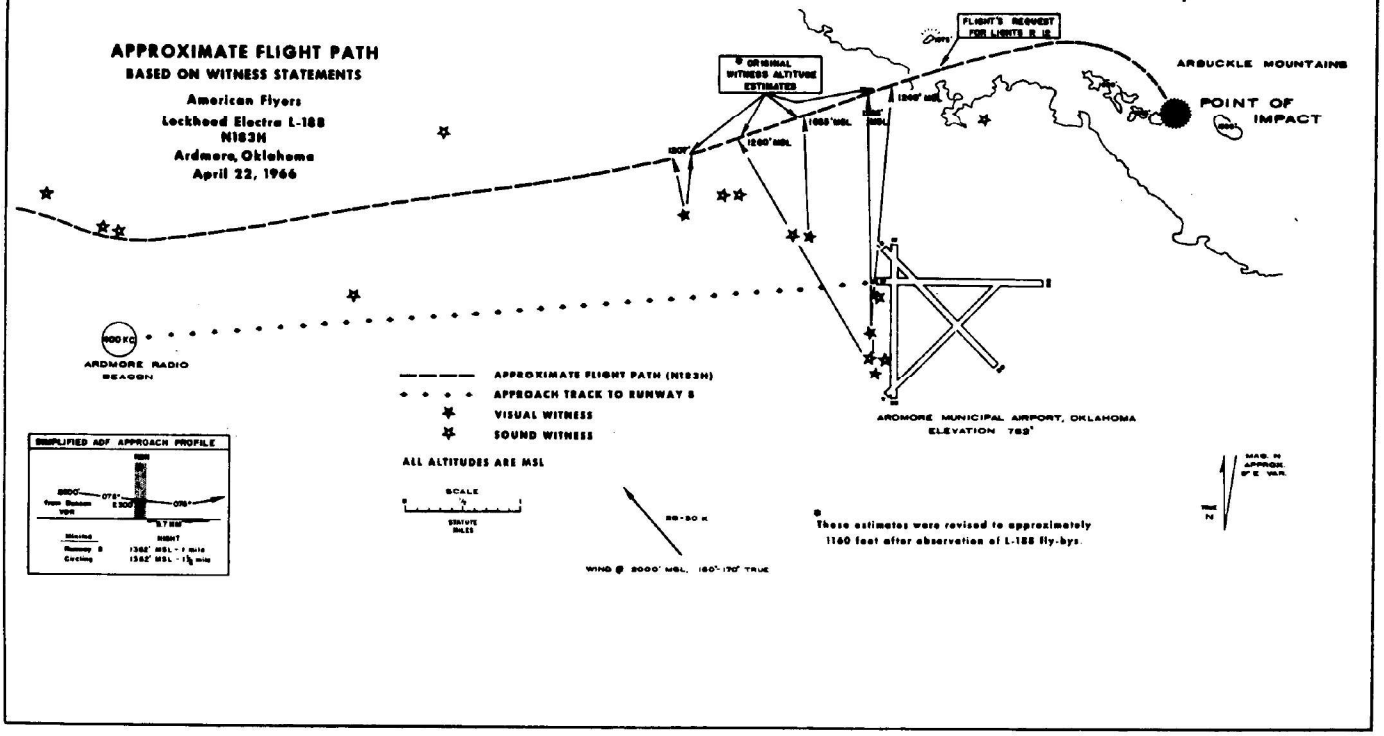

Fig. 9-1