No. 52

Aerovías Sud Americana, Curtiss C-46-F, N-10425, crashed 3.3 miles northwest of La Aurora Airport, Guatemala City, Guatemala on 6 November 1957. Report released by the Director General of Civil Aviation, Guatemala.

Circumstances

The aircraft took off from Runway 01 at La Aurora Airport at 1118 hours local time on a scheduled cargo flight to St. Petersburg, Florida via Belice, British Honduras. It carried a crew of two and no passengers. The flight was cleared on a visual flight rules flight plan and the take-off gross weight was 44 995 lbs including 575 gallons of fuel. At 1125 hours the flight advised La Aurora Airport Control Tower that it was returning for an engine check and was cleared for an approach to Runway 19 at that airport. At approximately 1135 hours the aircraft was seen to crash at a point 5 029 ft above sea level in a residential area, 3.3 miles northwest of La Aurora Airport, fatally injuring one adult and one child. Three other persons on the ground and the two crew members were seriously injured. The aircraft was demolished by impact and subsequent fire.

Investigation and Evidence

The investigation was carried out by order of the Director of Civil Aviation, and, in accordance with ICAO's Annex 13, an accredited representative and adviser from the State of Registry participated in the inquiry proceedings.

The crew gave the following information on the flight:

The engine runup prior to take-off and the take-off were normal at take-off power, which was reduced to maximum except take-off power at an altitude of 300 feet. METO power was reduced to climb power at an altitude of approximately 1 000 feet during the climb on a 05° magnetic heading and at an airspeed of approximately 120 knots.

The climb was normal until 1125 hours at which time the left engine oil temperature was discovered to have reached 102 °C with the oil pressure simultaneously discovered to have lowered to 50 lbs with left engine back firing and roughness approximately 30 seconds later. At this point the aircraft had reached an altitude of 8 000 feet above sea level and approximately 3 000 ft above the terrain of La Aurora Airport (4 928 ft above sea level). As the captain turned the aircraft back toward La Aurora Airport he reduced left engine power to 1800 rpm and 30 inches of manifold pressure. The co-pilot requested a landing clearance on Runway 19 and notified them that the left engine was failing.

The reduction of power did not eliminate the back firing, and several minutes later the engine instruments indicated no power on the left engine. The left engine's propeller was then feathered. Single engine airspeed of 110 to 115 knots was established with METO power on the right engine.

A loss of altitude was immediately noticed and right engine power was increased to take-off power very shortly thereafter as the captain opened the right engine cowl flaps to approximately three eighths open position, the cylinder head temperature not exceeding 230 °C.

The loss of altitude continued and the captain, as a precautionary measure, diverted slightly westward away from the city, flying under the direct flight path to the airport and toward an open field. At this time the aircraft was at an altitude of 1 000 feet above the terrain and too low to turn and fly to the emergency airport somewhat to the left of the flight path.

The descent continued in a southwestward direction to an altitude of 200 ft above the terrain. Power was reduced on the right engine for a landing, but a wide gully then became visible and some children playing in that area prevented an immediate landing that was, by this time, inevitable.

The wing flaps were then extended in preparation for landing just beyond the gully, between a number of high knolls, but a group of children became visible in that area, and it was decided to turn left in an attempt to land on an adjacent highway extending southward in order to avoid a row of residences just beyond and parallel to the highway. A laundry truck parked on the Colonia Centro America Street then became visible and persons on the ground appeared to be running toward the highway, and a landing between the highway and the row of houses was attempted. Power line wires and then trees appeared in the flight path, and the aircraft crashed through them to the ground.

The wreckage was found scattered about over a highway intersection from which point the approach path was traced rearward to a point 2 300 ft north of the wreckage to a panel truck parked on the highway headed north, the top of which was concaved in a front to rear direction.

The two upper wires of a power line located 1 000 ft south of the truck were found to have been carried away at a point approximately 50 ft above the elevation of the panel truck. Four hundred feet south of that point the tops of a row of trees, approximately 25 ft below the elevation of the upper power line wires, were broken off approximately 20 ft above the ground over a total east to west distance of 87 ft.

A 60-ft length of 1/2" diameter copper power line wire was found on the ground 80 ft south of the broken trees, and 60 ft further south, the tops of another row of trees were also broken off 20 ft above the ground over an east to west distance of 50 ft.

A group of trees located approximately 60 ft south of this point was progressively broken off at a sharp angle toward the ground, and just south of this point a long and wide furrow was found in the soft earth of a garden.

From this point to the highway low bushes and plants were flattened in a southward direction as far as the debris of a small residence bordering the highway which was occupied at the time of the accident.

All the fuselage forward of the entrance door position was completely consumed by fire, and no pertinent evidence was obtained in that area. The tail assembly was damaged. The elevator trim tab was found set in full nose up position, and the rudder tab in neutral.

The outboard area of the left wing centre section lay in approximately its original position in relation to the aircraft with its fuel tank areas and the area originally adjacent to the fuselage consumed by fire. The wing had torn off just outboard and adjacent to the attach angle.

The left landing gear lay fully retracted in its proper position and severely damaged by fire.

The left engine, with nacelle, was found 20 ft forward of the original position on the centre section and lay in an upright attitude but with its thrust axis at a 90° leftward angle to that position.

The left propeller was found in the fully feathered position with two blades that were in contact with the ground distorted 60° upward in symmetrical curves. The third blade was intact.

Removal of the propeller dome revealed that the securing nut was tight but that the lock ring was missing.

The lower engine nacelle area, including the cowl flaps, was consumed by fire, and the lower front and rear cylinders with ignition leads were fire damaged.

The engine rear section was intact except for a partially melted carburettor and a large hole melted through the left lower blower case. The blower control was midway between high and low blower, the mixture was in emergency rich and the throttle was open, but all control rods were broken off under strains from various directions.

No evidence was found in the parts of the aircraft or controls of structural failure, malfunctioning or fire prior to impact.

The weather at the time of the accident, as indicated by the Guatemalan Government's La Aurora Airport observation of 1130 hours, was ceiling unlimited, scattered clouds, visibility 25 miles, wind north 15 knots, temperature 20.5 °C, dew point 13.5 °C, altimeter setting 1024.7 millibars, 30.24 inches, barometer 854.50 millibars, 25.23 inches.

Removal of the main oil screen from the left engine revealed no excessive metal debris, but the screen was heavily contaminated with sludge and carbon and had collapsed. An excessive amount of carbon and sludge was also found in the screen cover.

Removal of the nose section revealed failure of the crankshaft.

The failure pattern began just forward of the front main bearing and passed forward for 3.5 inches between the cam drive gear splines to a sharp point, then angled away from the direction of rotation and rearward in a spiral pattern around the crankshaft to meet its starting point. The metal at the failure adjacent to the sharp point, normally under the front secondary counterbalance, appeared fatigued. A dark area of discolouration was found on the surface of the failed metal, approximately under the cam drive gear position.

The front cam reduction drive gear was broken into four sections, and the sections were found lying in the bottom of the nose case. The face of the gear was blued with heat over approximately 110° of its arc with the rear half of the teeth over this area ground away. The metal in the failure point at the right end of this heat discoloured area, viewed looking rearward, appeared fatigued adjacent to the spline at which failure began.

Approximately one third of the metal area at the rear part of this failure point appeared highly polished, and its forward part was heavily battered. The spline adjacent to this point on the gear was also heavily battered at the right side, viewed rearward.

Examination of the crankshaft splines, originally under the failed cam drive gear, revealed two deep gouges which matched the battered metal at the failure point referred to and the battered gear spline adjacent to it.

The upper intermediate cam drive gear was distorted rearward over approximately half of its area with its face rotationally interference marked and the teeth spalled. The adjacent main bearing face was also scored. The upper intermediate cam drive gear was intact.

The left distributor drive gear failed through the metal adjacent to each lightening hole, but the gear was undistorted and unmarked.

The bearing on which the counterbalance operates was heavily scored, excessively worn out of round to a maximum of approximately .04 of an inch and split open on one side. Its drive gear was broken into four pieces.

All of the components forward of this point were intact, and all parts within the nose sections appeared well lubricated.

The master cylinder was removed from each row of cylinders and all parts within each power section appeared normal in all respects and well lubricated. The cylinders, pistons and valve mechanism of these cylinders appeared normal in all respects.

No evidence of fatigue or defective metal was found in any part of the engine examined with the exception of the fatigued cam drive gear.

The clearance between the front main bearing and the crankshaft was measured to be .022 of an inch.

Due to its extremely fire damaged condition the right engine was not disassembled.

The captain had accumulated a total of 10 729 hrs 43 mins of flying time of which 3 808 hrs 58 mins were as co-pilot on C-46 aircraft and 2 525 hrs 20 mins were as pilot-in-command. He had passed a six months' equipment and instrument competency check on 14 July 1957.

The co-pilot had a total of 3 213 hrs 30 mins flying time to his credit of which 310 hrs were as co-pilot and 400 hrs were as pilot on C-46 aircraft. He had also passed a six months' co-pilot equipment and instrument route check on 5 October 1957.

No evidence of inadequate crew training or crew qualifications was found.

The aircraft was found to have been properly loaded with respect to gross weight and centre of gravity at the time of the accident, as specified by the State of Registry. The gross weight at take-off was 5 lbs under the 45 000 lbs allowable for take-off on the runway involved.

The aircraft flight manual single engine climb curve for the type of aircraft involved indicated a climb of 70 feet per minute at 8 000 ft, 110 FPM at 7 000 ft 160 FPM at 6 000 ft and 180 FPM at 5 000 ft, under 15 °C standard temperature conditions, with a gross weight of 45 000 lbs and with the left propeller feathered and the right engine delivering maximum except take-off power. A reduction of approximately 10% in performance was indicated at the 18.5 °C temperature involved.

The left engine high oil temperature and low oil pressure with engine back firing and roughness followed by complete power failure and feathering of the propeller in flight probably resulted from fatigue failure of the engine's crankshaft since no other cause properly considers all factors involved.

The failure probably resulted from crankshaft overstressing due to malfunctioning of the front secondary counterbalance. Excessive and out of round wear of its bearing probably caused the counterbalance to accentuate the second order vibrations resulting from the eccentric mass of the front master rod rather than to eliminate them in the manner for which it is designed, the excessive main bearing wear possibly aggravating the condition.

The crankshaft failure probably began as a fracture at the fatigue point under the counterbalance and progressed to the front cam drive gear spline. This spline drives many units through the front cam drive gear, and expansion of the fractured crankshaft probably fractured this heavily loaded and somewhat fatigued gear.

Partial failure of the gear probably resulted in its becoming blue with heat due to the friction of out of line operation; this heat indication being the only source found for the high oil temperature instrument reading and the crankshaft fracture being the only source found for the low oil pressure instrument reading, as no other failure occurred that could have released such a quantity of oil.

The failed ignition distributor gear, driven by this cam drive gear, probably failed at this time resulting in one set of spark plugs firing out of cylinder sequence, resulting in back firing.

Engine power, reduced by back firing, probably continued until the cam drive gear failed completely as found, which eliminated the magneto, also driven by this gear, and the engine power was no longer developed.

The crankshaft fracture meanwhile probably progressed to complete failure, but the crankshaft continued to rotate due to the cam type shape of the failure pattern until the propeller was feathered, the polished metal at the failure points substantiating this subsequent rotation.

Since the oil provided for featherings in the oil supply tank is delivered to the propeller forward of the crankshaft failure point, it was possible to feather the propeller after the failure. Since the aircraft performance figures indicate that the aircraft should have maintained altitude on the remaining engine and considering that no evidence of extended landing gear, wing flap or excessively extended cowl flap was found to produce excessive drag, it appears that there is some other reason that it did not maintain altitude. The right engine instruments did not indicate loss of power, but the severity of the aircraft and right engine fire damage at impact was such that pertinent evidence may have been lost, and the cause of the failure to maintain altitude was, therefore, not determined.

Probable Cause

Inability of the aircraft to maintain single engine flight for reasons undetermined after failure of the other engine.

The following information from a preliminary report on the crankshaft by the National Bureau of Standards, has been added at the request of the Civil Aeronautics Board, Washington:

"The crankshaft contained a large fatigue fracture that originated in the splined section in one of the spline fillets. The fatigue crack had penetrated through the crankshaft wall and progressed in both directions from the origin, initially following a spiral path at an angle of about 45° to the axis of the shaft and then turning into a plane perpendicular to the shaft axis. The fatigue crack attained a total length of about 600 degrees before the final overload fracture occurred. This was a longitudinal break, about 2-1/2 inches long, between two loops of the spiral crack.

The fillet where the fatigue crack started was poorly contoured and contained deep tool marks that evidently had contributed to the cause of the failure. In one fillet near the fracture origin the rough machining had produced an effective radius of about 0.005 inch. The drawing did not specify a minimum radius for the splines. It permitted a maximum radius of 0.015 inch.

In the vicinity of the fracture the average hardness of the steel was 421 Vickers or about 43 Rockwell C. This indicates a tensile strength of about 200,000 psi. The drawing did not specify hardness or tensile strength except on case hardened surfaces, calling instead for 'Core Property P.W.A. No. 7,' which presumably refers to a Pratt and Whitney heat treatment.

The chemical composition of the crankshaft steel complied with the material specification in so far as specified elements were concerned. The steel contained appreciable amounts of molybdenum, chromium and copper, which were not specified, but the presence of these elements in the amounts found would not be expected to reduce the fatigue strength of the shaft.

A small fatigue fracture that formed a part of a complete longitudinal break was found in the counterbalance bearing. This fracture apparently occurred because of unusually high loads imposed by the progression of the fatigue crack in the crankshaft.

The hardness specified in the drawing for the counterbalance bearing was 34 to 38 Rockwell C. Vickers tests showed that the hardness in the part as submitted ranged from 279 to 354 Vickers or from about 27 to 36 Rockwell C. However, the bearing showed evidence of overheating, which probably reduced the hardness in some areas.

Chemical and spectrographic analyses showed that the composition of the counterbalance bearing material complied with the specification."

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