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SECURITY INFORMATION

REPORT OF STRUCTURES AND AERODYNAMICS GROUP

1. The first point of impact of the aircraft with the ground occurred at a distance of approximately 1000 feet beyond the actual end of runway 030 and approximately 2400 feet to the left. At this point, there were clear gouges in the earth extending in a westerly direction. There were five of these gouges and the total distance from the first to the last measured approximately 80 feet. At the end of the last gouge is a deep tear drop shaped hole. To the right of this hole were five slashes in the earth made by the blades of a propeller perpendicular to the longitudual axis. The distance between these gouges measured approximately 47". Further along the ground path was a second hole similar in shape and appearance to the first hole but minus the propeller imprints. Just beyond this second hole was a much larger one than either the first two. The wreckage distribution was very intense from this last hole to the end of the wreckage pattern.

2. The largest piece of wreckage was the aft end of the fuselage and empennage. This piece of the aircraft came to rest with the longitudinal axis approximately parrallel to the runway but heading backward in the reverse direction. All the engines were broken loose and were located in the immediate vicinity of the empennage section. Intense fire damage to the aircraft was such that much of the aircraft was melted down. The fire originated at approximately the first tear drop hole and continued thru-out the remainder of the wreckage. The most intense fire damgage was in the vicinity of the cockpit and forward fuselage area. Very little was left of this part of the aircraft. The general shape of wreckage distribution resembled a horn with the narrow end at the first point of impact. Analysis of the impact marks on the ground and the general wreckage distribution resulted in the evaluation that the aircraft contacted the ground left wing low in an angle of bank of approximately 25°. The longitudinal axis was approximately 90° to the take off runway. This attitude was derived at by orienting the built up portion of the outer left wing section and tip with the first gouges in the ground. It became apparent that the gouges were made by the wing tip and under side of the wing flap fairing as the aircraft was in a skidding turn. The resistance of the ground to the motion of the aircraft slowly turned it such that engine #1 made the first tear drop hole, engine #2 the second and the nose the third. The aircraft then continued in an arc on the ground finally coming to rest in the position as indicated by the empennage fuselage section.

3. Inspection of various parts of wreckage revealed that the main landing gear and nose gear were in the retracted position. This conclusion was evident due to the fact that the nose gear actuating extension cylinder was out and bent meaning gear was retracted. Each actuating cylinder on the main gear was retracted which is the position for gear retracted.

4. An examination of the wing flap system disclosed the following condition: The five (5) wing flap drive screws mounted on each wing of the airplane and progressively driven by a hydraulic driven winch near the fuselage centerline were found in varied positions. The screws on the left wing varied from approximately two

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approximately two degrees flaps down at the center screw to approximately 20 degrees on the extreme inboard and outboard screws. This is explained by the progressive failure of the left wing at several points, which in turn failed one cable or the other of each closed circuit allowing the remaining cable to rotate the screws in one direction or the other. The right wing drive screws indicate a reasonable consistant indication of approximately five degrees flaps down. The flap drive winch was found broken loose from its drive motor and brake assembly. An examination of the winch arm that would actuate its limit valve showed a zero flap condition and was verified by the cable wraps on the drum. Once again this could have been pulled in this position as the cables failed during the airframe disintegration. It is pointed out that this system was equipped with synchronizing cables from each outboard flap screw drive to the fuselage centerline which prevents a "split flap" operation.

5. The hydraulic flap drive motor and brake assembly previously mentioned were examined and no evidence of a malfunction was found. Broken hydraulic lines were still attached to the unit.

6. The flap operating handle, normally mounted on the right side of the flight compartment pedestal, was recovered from the burned debris and found to be in the "Flap Up" position. It is pointed out that the handle is spring loaded and may be raised and dropped into any of the three notches provided, "Flap Up" "Neutral"and "Flap; Down". It is necessary to make a two position positive movement to move the handle from the position in which it has been placed. It is improbable the handle could have moved as a result of the airframe disintegration.

7. Considering the foregoing it is concluded that the wing flap system was operative prior to the impact, the flaps were being raised at the time of impact and were stopped at the approximate five degree position by the impact.

8. Examination was made of the elevator and rudder controls and locking mechanism in the empennage. The empennage and controls were in good condition and easily accessible for inspection. The surface control locks were found in an intermediate position between locked and unlocked. A study was made as to the position of these locks prior to impact and to account for the intermediate position.

1. Assume the locks were locked prior to impact. It is likely that cutting of cables during disintegration could cause loss of tension in the locking cable. This release of tension and the jarring of disintegration enabled the spring in the locking mechanism to unlock the lock. Investigation revealed that a turnbuckle on the locking cable was jammed against a pulley at fuselage sta. #460. During further disintegration and rearward movement of the empennage, tension was again reapplied by the jamming to pull the mechanism in the intermediate position

A study of the pictures of the empennage before movement of the wreckage to recover bodies shows that the rudder and elevator are in a deflected position very close to neutral. These surfaces may be locked with a 5° tolerance each side of neutral. Since the locks were in the intermediate position, this position further allows more movement away

from neutral into the position as evidenced by the photographs. Another point is that the movements from neutral of the elevator and rudder are approximately equal. This fact is another contribution to the belief that the surfaces were locked prior to impact.

2. Assume the surfaces were unlocked prior to impact. It is reasonable to assume that either one or both of these surfaces would have been deflected thru a wide angle upon impact. This is due to the fact that there is no restraint to movement of the controls and during the decelerations exerted, and also, due to the effect of the velocity and the centrifugal force in turning, they will be rotated far from neutral. However, the surfaces were found in the near neutral position. The control surface lock was found in the intermediate position. Under the assumption of locks being open, in order to bring the elevator and rudder from a large deflection to the position near neutral, it is necessary to pull on the locking cable. The load applied to this cable during disintegration is so sudden that the cable or pulley would break first before this movement could be initiated.

9. The aileron boost motor and pump were recovered from the wreckage and tested. The tests showed the motor operative and no indication of malfunction could be found. The motor brushes showed evidence of no motor or pump operation at the time of the impact. The conclusion is that the pump was not operating either because the pilot's control switch was in the "OFF" position or the aileron surface lock was locked engaging the micro switch and opening the aileron boost circuit at the point.

10. Examinations were made on a number of C-124 aircraft at Larson Air Force Base to determine the operating sequence and functions of the cockpit control surface locking mechanism. Various inadequacies, malfunctions and inconsistencies were noted in this apparatus. In some aircraft just by lifting the handle of the mechanism and allowing it to drop slightly the throttle interlock on the engineers quadrant was rotated out of its locking position which would permit full take-off power to be applied. However, the surface locks, that is, the ailerons, rudder, elevator and rudder tab would still be locked. By downward movement of the handle on different aircraft, the aileron lock would unlock after the throttle lock unlocking and sometimes the elevator and rudder locks would unlock following the throttle unlocking. On other aircraft, it was necessary to push the handle down to almost the full down travel before the ailerons would unlock.

11. There is a cloth curtain that hangs in the compartment doorway which are nearly always open. It is necessary to pull the curtain aside for the operation of the handle. This is noted to draw attention to the fact that the pilot and copilot would have difficulty in observing the control surface lock handle position.

12. On this particular aircraft, SN 50-100 on the fatal flight, testimony showed that the student flight engineer operated the control surface lock for the takeoff. The instruction in the flight operation manual indicates that in order to unlock the surface locks it is only necessary to raise and release the handle. It is possible that the student flight engineer followed the instruction to the letter and just raised the handle to this mechanism. As seen during the inspection of the other C-124 aircraft this could permit unlocking of the

throttles and allow the pilot takeoff power for initiation of takeoff roll yet give a false indication that the surface control locks were released.

13. Information was requested from the Douglas Aircraft Co. as to the flight path of the C-124 provided it took off at full power with 20° flaps and all controls locked. Information received is that the aircraft would take off, start turning and banking to the left, and get into a stall attitude. The same information was requested with the same configuration but with 5° flaps. The path of the aircraft would be approximately similar. These paths agree closely with the flight path of SN 50-100 in that it took off and crashed to the left of the runway in an attitude of falling out of a stall. The reason for the left bank and turn is due to engine torque and slipstream effect generating more lift on the right wing than on the left.

14. The alternate inverter was bench checked and examined with the result that it was not operating at the time of impact. The main inverter was too badly damaged for analysis. However, since the alternate inverter was not running, it is reasonable to assume that the main inverter was in normal operating condition and that the (E-1 normal presentation) gyro-horizon which is operating by the main inverter was functioning. The reason for this evaluation is that if the main inverter were out there would be an automatic engagement of the alternate inverter. A statement in the records of a crewmember listening on the "intercomm" was to the effect that the pilot stated "gyro out". It is quite likely that instead of the gyro being out and indicating an incorrect attitude that the pilot did not believe the instrument was indicating correctly. It is believed the gyro was reading correctly for an unusual attitude of flight.

15. A very intensive search was made in the wreckage area for the cockpit surface lock handle and mechanism. This search was negative. It is very probable that the fire melted down these parts made of aluminum alloy.

16. A review of the maintenance records and UR history pertinent to this aircraft reveal that none of the items recorded are pertinent to the accident.

17. The signatures of the members of the structure and aerodynamics team that participated in thisstudy indicates full agreement and accord with the above statement and the following finding, namely:

> That the preponderance of evidence yields the conclusion that the control surface locks were locked on C-124 serial #50-100 and is the primary cause of this accident.

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