

No. 28

Government of the Republic of Zambia, Lockheed Hercules 382B, 9J-RCY,  
and Zambian Air Cargoes Ltd., Lockheed Hercules 382B, 9J-RBX,  
accident at Ndola Airport, Zambia, on 11 April 1968. Report  
dated 24 July 1968, released by the Department of  
Civil Aviation, Zambia

1. - Investigation1.1 History of the flight

The aircraft departed from Cambridge, England, about mid-morning on 9 April 1968, and landed at Benina, where a night stop was made. The flight was continued on 10 April, with landings at Entebbe and Lusaka, where government-owned cargo was unloaded. On 11 April, the aircraft was due to be ferried to its normal base at Ndola, but the Air Turbine Motor (A.T.M) was found to be unserviceable. As the fault could not be ascertained and spares were not available, external power was used for initial engine start and all pre-taxi and taxi checks were carried out satisfactorily. On reaching the take-off holding point, reverse thrust checks were carried out and on returning to ground idle on No. 2 engine, the nacelle overheat light came on. On pulling the fire shut-off handle on No. 2 engine, the overheat light went out immediately. The Flight Engineer carried out a visual inspection of the engine and reported that there were no visible signs of fire. It was assumed that the overheat warning had been due to the tail wind and reverse thrust check, a possible occurrence under the prevailing conditions. A dry motorover was carried out to reduce Turbine Inlet Temperature (T.I.T) and a re-start made. All indications were normal and a further reverse thrust check was carried out on engines 2 and 3. All readings were normal. The normal checks were carried out, engine run-up and pre-take-off checks made and the Captain briefed the crew regarding emergency in flight procedures. The take-off was completed and the flight to Ndola was without incident and, except for the A.T.M., all systems functioned normally.

On approaching Ndola, the "field approach checks" and the "pre-landing check" were carried out. According to the statement of the Flight Engineer, all systems were normal. A normal landing was made, using reverse thrust on all four engines. Towards the end of the taxi run, the First Officer advised the Captain that: "Now we have no A.T.M".

The Captain gave orders to cut engines 1 and 4 when on the perimeter track and the aircraft proceeded on engines 2 and 3. On reaching the parking area, a right turn was commenced to enter the area. Shortly after this point, both co-pilot and engineer claim to have advised the Captain that No. 2 engine nacelle overheat warning light was on. The Captain momentarily considered whether the warning was genuine or spurious, decided to accept that it was genuine and called for No. 2 "Fire T. Handle" to be pulled on No. 2 engine was then shut down.

When No. 2 engine was shut down, the aircraft was being marshalled and was commencing a turn to the left and approaching a parked Hercules aircraft, 9J-RBX, approximately 100 ft ahead. It was the intention that aircraft 9J-RCY be parked alongside 9J-RBX.

Aircraft 9J-RCY was approaching the port side of 9J-RBX at an angle of about 45°, and was in the final turn to park alongside 9J-RBX when steering and brake pressures became exhausted.

The nose wheel castored, this being seen by the ground crew around 9J-RBX, and 9J-RCY straightened up and collided with the port wing of 9J-RBX, No. 3 engine propeller cutting through some 12 ft of the wing. Fire broke out immediately.

### 1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Non-fatal			
None	4		

### 1.3 Damage to aircraft

At impact, the outer fuel tank of 9J-RBX was cut open and an immediate conflagration resulted. Burning fuel was sprayed over the top of the fuselage of 9J-RCY and the flames were concentrated from the nose to the centre section and burning through the skin, spreading to the interior of the flight deck and forward section of the cargo compartment, causing virtually total destruction of the forward section of the fuselage. Owing to the slope of the concrete hard standing, burning fuel flowed under the forward fuselage of 9J-RBX, causing total destruction of that area and the fire spread to the cargo compartment, in which empty fuel drums were loaded. Some of these drums exploded. Both aircraft were considered a total loss, due to the extent of the damage and the distance from a suitable repair base.

### 1.4 Other damage

Aircraft 9J-RBX had empty fuel drums on board and these suffered some damage, whilst 9J-RCY carried a small cargo which suffered varying degrees of damage.

### 1.5 Crew information

Captain:	Leslie Victor Worsdell.
Age:	51 years.
Licence:	British CPL. No. 9449, valid at time of accident. This licence was validated for the flight in question by cable from D.C.A., Zambia.
Experience:	9 000 hr.P.l. 140 hrs. on type.
First Officer:	Geoffrey John Bolton.
Age:	44 years.
Licence:	Zambia CPL. No. 100.
Experience:	8 000 hrs. 800 hrs. on type

Flight Engineer: Anthony Brian Hoare-Pearson.  
Age: 27 years.  
He did not hold a Flight Engineer's licence but, due to his training and experience, was authorised by Zambia D.C.A. to fulfil the duties of Flight Engineer for the trip in question.

#### 1.6 Aircraft information

Lockheed Hercules 382B, 9J-RCY, Serial Number 4109, manufactured by Lockheed Aircraft Corporation, Georgia, was manufactured on 12 August 1966. It was maintained in accordance with the manufacturer's recommendations SMP 515, which was approved by the D.C.A., Zambia.

In June 1967, the aircraft was damaged by fire at Dar-es-Salaam. Temporary repairs were carried out on site by Marshall of Cambridge Ltd., who then flew the aircraft to the United Kingdom for permanent repairs. The aircraft was on its delivery flight back to Ndola when the current accident occurred. Total hours flown up to the time of the accident: 2339:39.

Lockheed Hercules 382B, 9J-RBX, serial number 4137, manufactured by Lockheed Aircraft Corporation, Georgia, on 29 March 1966. It was maintained in accordance with the manufacturer's recommendations SMP 515, which was approved by the D.C.A., Zambia. Total hours flown: 4704:35.

#### 1.7 Meteorological information

An observation was recorded immediately after the incident at 15.19Z. A surface wind of direction 110° and speed of 06 knots was noted. Visibility was 50 km with no variation of visibility. It was partly cloudy with a QNH of 1 016 mb. The screen temperature, dry bulb, was 25° C, wet bulb, 18° C.

#### 1.8 Aids to navigation

Not being used.

#### 1.9 Communications

Transmission between the aircraft and the tower had been concluded. The voice recorder was operating only on the flight deck intercommunication system and this tape has been utilised to assess the approximate time/distance between occurrences following the shut-down of No. 2 engine.

#### 1.10 Aerodrome and ground facilities

The aircraft was under marshaller's directions immediately prior to loss of hydraulic pressure.

#### 1.11 Flight recorders

Aircraft 9J-RCY was equipped with a flight recorder. The recorder was used during two test flights carried out at Marshall's, Cambridge, but was not switched on during any of the flight legs from Cambridge to Ndola. The reason given by the Captain for this omission was that the flight was made using the R.A.F. Hercules Flight Reference

Cards (AP 101B-0701-14A) and the flight recorder is not mentioned on these cards. Had the flight recorder been used, it might have been possible to verify positively that electrical power was still available after No. 2 engine had been shut down, as the operation of the recorder is dependent on electrical power.

#### 1.12 Wreckage

After completion of the investigation, the wreckage of both aircraft was removed from the parking area to an adjacent site.

#### 1.13 Fire

On impact, the rotating No. 3 propeller churned through the port wing and into the outer fuel tank. The escaping fuel was atomised by this action and ignition could have been caused by any of the following:

- (a) A discharge of built-up static in 9J-RCY when contact was made with 9J-RBX;
- (b) A short circuit caused when the 9J-RCY propeller churned through the wing of 9J-RBX and associated wiring, assuming that power was 'ON' in 9J-RBX; it could not be ascertained from any witness whether or not the mains in 9J-RBX were alive.
- (c) A possible spark caused by metallic contact during the collision.
- (d) Atomised fuel being ignited by No. 3 engine exhaust.

The fire was extremely fierce. The Ndola Airport Rescue and Fire Service were on the site within sixty seconds, followed some six minutes later by two appliances from the Ndola City Fire Brigade. According to reports from eye witnesses, the fire crews, believing persons to be on board, displayed extreme courage with lack of thought for personal safety, in their efforts to effect a rescue. When the fire was extinguished after 41 minutes fire fighting, the fact that the wings of both aircraft were virtually untouched and still contained some 21 000 lbs of fuel, indicates the efficiency of the operation.

#### 1.14 Survival aspects

Although the exterior of the flight deck was enveloped in flames, the crew escaped unhurt through the port side crew door.

#### 1.15 Tests and research

The utility hydraulic system is pressurised by two hydraulic pumps operated by Nos. 1 and 2 engines. Either of the pumps is capable of operating the system independently of the other. The system supplies pressure for operation of the landing gear, brakes and nose wheel steering.

The auxiliary system, consisting of an electrically driven hydraulic pump, provides emergency pressure for the brakes, but not for the nose wheel steering.

The F.A.A. approved Flight Manual, Document SMP 514, contains amongst the emergency procedures, one "Caution" notice which reads: "Nose wheel steering and anti-skid are not operative after loss of utility system pressure".

The certificate of airworthiness of aircraft 9J-RCY, which was valid at the time of the accident, stated that the aircraft was considered to be airworthy when maintained and operated in accordance with the Air Navigation Regulations and the pertinent Flight Manual, Document serial number Lockheed Publication S.M.P. 514.

The delivery flight, carrying cargo for the Zambian Government, was operated by Messrs. Marshall of Cambridge, who provided the Captain and Flight Engineer and who, by agreement, used as First Officer, the services of a Zambian Air Cargoes Ltd. First Officer, who was returning to Zambia from leave.

Throughout the flight from the United Kingdom, aircraft 9J-RCY was operated in accordance with Flight Reference Cards prepared by the United Kingdom Ministry of Technology in collaboration with R.A.F. Handling Squadron. The Captain, when questioned on the use of these cards, stated that R.A.F. check list was used because no other was available, but this had been checked against the original. As an R.A.F. approved test pilot for the type of aircraft, the Captain was familiar with the R.A.F. Flight Reference Cards.

Whilst in the main these Flight Manuals are similar, certain differences do exist.

The R.A.F. "Pre-Landing Check" No. 5 reads: "Auxiliary Hydraulic Pump - ON, pressure up - OFF".

The S.M.P. 514 "Before Landing Check", No. 6, reads: "Auxiliary Hydraulic Pump - ON", and no further mention of the auxiliary hydraulic pump appears in the checks until "Engine shutdown" Check, No. 3, which reads: "Auxiliary Hydraulic Pump - OFF". However, it has been ascertained that Zambian Air Cargoes crews do not follow this procedure and merely select Auxiliary System ON and once pressure has built up, the system is switched OFF again.

The actual sequence of the pre-landing check on the flight in question is vague due to voice recorder external interruptions at the crucial moments.

The following cabled information was received from the United States of America:

"The U.S.A.F. before landing check list (U.S.A.F. Technical Order 1C-13E of March 16th, 1966) states that the hydraulic pump should be turned on until emergency brake pressure is within limits. There is no requirement to leave the pump on during a normal landing. However, the auxiliary pump must be turned on if any malfunction in the utility system is noted.

"The U.S.A.F. also informs and the F.A.A. confirms that, if hydraulic pressure is raised to maximum during the approach to land and then shut off and if, after landing and taxiing, the emergency system has not been used, there will be sufficient pressure for one full brake application which, at normal taxi speed, would be sufficient to stop the aircraft".

The Chief Pilot of Zambian Air Cargoes also supports the above and states that the delay between switching 'ON' the auxiliary pump and obtaining full emergency brake pressure is usually one or two seconds and, at a maximum, four seconds.

The A.T.M. was not serviceable at the time 9J-RCY landed at Ndola. When, therefore, No. 2 engine was shut down, it was essential to the maintenance of the hydraulic pressure required for the aircraft brakes, that power be supplied by No. 3 engine generator to operate the auxiliary hydraulic system and that, before utility pressure was lost, the auxiliary hydraulic system be operating and that the emergency brake switch also be selected to the brake select position. The Flight Engineer is confident that no mistake was made when No. 2 engine was shut down and that No. 2 engine generator was switched off and that No. 3 engine generator was left on. Five badly charred switches were found in the ashes of the burnt out flight deck and identified as the switches for the four engine generators and the A.T.M. generator. One of the five switches was in the "ON" position and the other four switches were in the "OFF" position. It was not possible to identify any of the switches with the control of any particular engine or the A.T.M. generator.

None of the crew reported any loss of any electrically operated services and all believe that the electrical mains were alive.

The First Officer claims to have selected the auxiliary pump switch to "ON" and the emergency brake switch to "Brake Select" when he had feathered the propeller of No. 2 engine. Both the Captain and the Flight Engineer claim that the First Officer did not appear to put his hand down to the hydraulic panel until the utility hydraulic pressure was lost, the Flight Engineer stating in his written report: "The First Officer switched to emergency brakes and switched on auxiliary pump". The voice recorder tape reveals that, at the time when No. 2 engine overheat warning was noticed and subsequent to that time, the First Officer was busy explaining to the Captain where the aircraft was to be parked and that momentum would be needed to overcome a rise in the apron and pointing out a guide line on the ground.

The hydraulic panel was salvaged from the ashes, but the switch toggles were the only remaining intact parts. The electrically-operated auxiliary hydraulic pump was found comparatively undamaged and was coupled up to an external power supply and the motor and pump operated satisfactorily.

The hydraulic lines, however, were so damaged by fire that no functional tests could be made.

The brake shuttle valves were found to be in the position for utility hydraulic pressure and this confirms that the auxiliary system pressure had not built up sufficiently to re-position the shuttle valves.

## 2. - Analysis and Conclusions

### 2.1 Analysis

The aircraft was being operated in accordance with R.A.F. Flight Reference Cards.

All systems were reportedly functioning satisfactorily during the pre-landing checks.

It is considered that when No. 2 engine was shut down, No. 2 generator switch was correctly switched OFF and No. 3 generator continued to supply power for the electrical services.

With the shut-down of No. 2 engine, it was inevitable that nose wheel steering would be lost as the utility hydraulic pressure became exhausted. Consequently, any attempt to taxi the aircraft further, apart from into a confined area, was incorrect.

There is no evidence of any pre-collision failure of the auxiliary hydraulic system or emergency brake system.

Collectively, the crew, with only the delivery flight experience of working as a team, appear to have lacked co-ordination and a ready appreciation of the mechanics of the hydraulic systems of the aircraft.

After the decision was taken to shut down No. 2 engine and to continue the taxi-in under power on only one engine, mishandling of the auxiliary hydraulic and emergency brake systems led to the loss of brakes and failure to recover effective braking action.

The last moment reversion back to the already empty utility hydraulic system removed any possibility that the emergency braking would operate in time to stop the aircraft before the collision.

## 2.2 Conclusions

### (a) Findings

The aircraft was correctly documented.

The two pilots were correctly licensed and the flight engineer was authorised to act in that capacity in accordance with the exemption in Section 74(3) of the Air Navigation Regulations.

The aircraft was not being operated in accordance with the requirements of the Certificate of Airworthiness and there was thus a contravention of Section 23(1) of the Air Navigation Regulations. Had permission been requested to operate in accordance with the R.A.F. Flight Reference Cards on the delivery flight, it is probable that, after the cards had been studied and in view of the fact that the Captain was used to operating in accordance with the cards, the necessary action would no doubt have been taken to authorise their use for the one flight.

### (b) Cause or Probable cause(s)

The collision resulted from failure to halt the aircraft when it was decided to shut down No. 2 engine.

A contributory cause was that the crew lacked a ready understanding of the mechanics of the aircraft hydraulic systems.

## 3. - Recommendations

No taxi manoeuvres should be carried out with only one engine operating.

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