AIRCRAFT ACCIDENT REPORT 3/96

ACCIDENTS INVESTIGATION DIVISION

Civil Aviation Department
Hong Kong

Report on the accident to
Lockheed Hercules L100-30 382G PK-PLV
at Hong Kong International Airport
on 23 September 1994

October 1996
The Right Honourable Christopher Patten  
Governor of Hong Kong  
Government House  
Hong Kong

Sir,

In accordance with regulation 10(6) of the Hong Kong Civil Aviation (Investigation of Accidents) Regulations I have the honour to submit the report by Mr. H.C. Kwan, an Inspector of Accidents, on the circumstances of the accident to Lockheed Hercules L100-30 382G, Registration PK-PLV, which occurred in Hong Kong on 23 September 1994.

Yours faithfully,

R.A. Siegel  
Director of Civil Aviation
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAIB</td>
<td>Air Accidents Investigation Branch (of the United Kingdom Department of Transport)</td>
</tr>
<tr>
<td>AFM</td>
<td>Airplane Flight Manual</td>
</tr>
<tr>
<td>agl</td>
<td>Above ground level</td>
</tr>
<tr>
<td>amsl</td>
<td>Above mean sea level</td>
</tr>
<tr>
<td>AOM</td>
<td>Airplane Operating Manual</td>
</tr>
<tr>
<td>APP</td>
<td>Approach Control</td>
</tr>
<tr>
<td>ATC</td>
<td>Air Traffic Control</td>
</tr>
<tr>
<td>ATIS</td>
<td>Automatic Terminal Information Service</td>
</tr>
<tr>
<td>CDC</td>
<td>Clearance Delivery Controller</td>
</tr>
<tr>
<td>cm</td>
<td>Centimetre</td>
</tr>
<tr>
<td>C of A</td>
<td>Certificate of Airworthiness</td>
</tr>
<tr>
<td>CVR</td>
<td>Cockpit Voice Recorder</td>
</tr>
<tr>
<td>ELT</td>
<td>Emergency Locator Transmitter</td>
</tr>
<tr>
<td>FCU</td>
<td>Fuel Control Unit</td>
</tr>
<tr>
<td>FDR</td>
<td>Flight Data Recorder</td>
</tr>
<tr>
<td>GMC</td>
<td>Ground Movements Controller</td>
</tr>
<tr>
<td>G(s)</td>
<td>Acceleration due to gravitational pull (1G = 9.81 m per second per second)</td>
</tr>
<tr>
<td>hPa</td>
<td>Hectopascal(s)</td>
</tr>
<tr>
<td>hr</td>
<td>Hour(s)</td>
</tr>
<tr>
<td>KCAS</td>
<td>Calibrated Airspeed in knots</td>
</tr>
<tr>
<td>KIAS</td>
<td>Indicated Airspeed in knots</td>
</tr>
<tr>
<td>Km</td>
<td>Kilometres</td>
</tr>
<tr>
<td>kt</td>
<td>Knots (nautical miles per hour)</td>
</tr>
<tr>
<td>lbf</td>
<td>Pound force</td>
</tr>
<tr>
<td>m</td>
<td>Metre</td>
</tr>
<tr>
<td>MAC</td>
<td>Mean aerodynamic chord</td>
</tr>
<tr>
<td>MHz</td>
<td>MegaHertz</td>
</tr>
<tr>
<td>OM</td>
<td>Pelita Air Service Basic Operations Manual</td>
</tr>
<tr>
<td>PAS</td>
<td>Pelita Air Service</td>
</tr>
<tr>
<td>QNH</td>
<td>Pressure setting at which a barometric altimeter reads airport elevation when on the ground at that airport</td>
</tr>
<tr>
<td>RPM</td>
<td>Revolutions per minute</td>
</tr>
<tr>
<td>RTF</td>
<td>Radiotelephony</td>
</tr>
<tr>
<td>SMO</td>
<td>Survey and Mapping Office of the Lands Department, Hong Kong</td>
</tr>
<tr>
<td>TAF</td>
<td>Terminal Area Forecast</td>
</tr>
<tr>
<td>TIT</td>
<td>Turbine Inlet Temperature</td>
</tr>
<tr>
<td>TSN</td>
<td>Time since new</td>
</tr>
<tr>
<td>TSO</td>
<td>Time since overhaul</td>
</tr>
<tr>
<td>UTC</td>
<td>Co-ordinated Universal Time</td>
</tr>
<tr>
<td>$V_1$</td>
<td>Decision speed</td>
</tr>
<tr>
<td>$V_2$</td>
<td>Take-off safety speed</td>
</tr>
<tr>
<td>$V_r$</td>
<td>Rotation speed on take-off</td>
</tr>
</tbody>
</table>
SYNOPSIS

The aircraft had arrived in Hong Kong on 21 September 1994 from Jakarta with an operating crew of six plus an additional positioning crew of six. The two crews had subsequently in turn operated flights from Hong Kong to Hanoi and return on 22 and 23 September 1994. After returning to Hong Kong from Hanoi on 23 September, the aircraft was refuelled and the incoming crew was replaced by the crew who had rested throughout that day in Hong Kong. The incoming crew members remained on board to position back to Jakarta.

At 1115 hrs the aircraft lined up on Runway 13 at Hong Kong International Airport for take-off on the positioning flight back to Jakarta. The initial stages of the take-off run were normal but immediately upon becoming airborne the aircraft yawed and banked to the right. The pilot took corrective action but was unable to control the aircraft which continued to turn right. As the aircraft departed from the runway and headed towards the harbour the right main gear briefly contacted the grass area adjacent to the runway. The aircraft continued flying at a very
low altitude and in a right turn until it crashed into Kowloon Bay approximately 500 metres off-shore. Seven survivors were picked up by the rescue services but one died before arrival at the hospital. The remaining five occupants were found drowned inside the aircraft.

The following causal factors were identified:

(i) The No. 4 propeller entered the ground handling or Beta range shortly after the aircraft became airborne.

(ii) The crew were unable to retain control of the aircraft following this occurrence.

Nine Safety Recommendations are made.

1. FACTUAL INFORMATION

1.1 History of the flight

The aircraft and the operating and positioning crews were deployed from their home base in Jakarta, Indonesia, to Hong Kong on 21 September 1994 to carry out a contract for Heavy Lift Cargo Airlines. The contract involved making one return trip from Hong Kong to Hanoi on 22 September and another on 23 September to transport Vietnamese illegal immigrants in Hong Kong back to Vietnam. The crew involved in the accident flight had operated the return trip on 22 September and had rested on 23 September while the other crew operated the flight to Hanoi earlier that day. When PK-PLV arrived back in Hong Kong at 0935 hrs on 23 September 1994, the operating crew were relieved by the rested crew for the flight back to Jakarta. The Commander who took over was verbally informed by his predecessor that there were no problems with the aircraft. The ground mechanic fully checked the aircraft and had it refuelled to give a total of 45,000 lbs fuel on board.
With both crews back on board, the Commander started the engines at 1031 hrs. The start was normal and at 1049 hrs he used reverse thrust to back out from Bay 78 to position on the taxiway. The Commander then taxied to the holding point at A1, for a take-off on Runway 13. The time taken to reach the holding point was approximately 18 minutes. This was partly due to the pilot's unfamiliarity with the taxy route and partly to a delay of some six minutes to give way to another aircraft. A map of the airport showing the taxy route taken is at Appendix 1. During the ground movement, the Commander completed the normal taxy and before take-off checks. He also gave a take-off briefing to his crew. After a delay of 2½ minutes at the holding point, he was cleared by Air Traffic Control (ATC) to line up on the runway behind landing traffic and wait. PK-PLV was subsequently cleared for take-off at 1114 hrs, 2 minutes after the traffic had landed. At that time it was already dark with a visibility of 9 Km. There was light rain and the runway was wet. The surface wind was 090°/12 kt. The Commander in the left seat was the handling pilot and both the First Officer and Flight Engineer occupied their normal seats. Also in the cockpit were 4 other personnel. The Captain of the positioning crew was in the observer's seat and the positioning First Officer, another positioning crew member and the Senior Purser/Air Loadmaster were seated on the bunk at the rear of the cockpit. The other five personnel occupied seats in the passenger compartment. The layout of the aircraft and the locations of the personnel are shown in Appendix 2. Not all the surviving occupants of the aircraft were wearing seat belts at the time of the accident. The only survivors in the cockpit were the Commander and the two positioning crew members who were seated on the bunk.

After the aircraft lined up on the runway the Commander held the aircraft on the wheel brakes while setting 5,000 in-lbs of torque on all 4 engines. As this power figure was achieved he made a check of the engine instruments before releasing the brakes and applying full power. To the occupants of the aircraft the take-off seemed normal, although two external observers commented that
the acceleration seemed slightly slow for a Hercules. When the First Officer called "70 kt", the Commander moved his left hand from the steering tiller to the control column. The First Officer made the normal take-off calls of "\( V_1 \)", "\( V_R \)" and "\( V_2 \)". The Commander rotated the aircraft at \( V_R \) and, after the First Officer had announced "positive rate", he called for "gear up". He saw the First Officer reach for, and move the gear lever. Then he heard "a high pitched noise" from his right and found that he was applying left aileron because the aircraft was banking right. Looking at the engine instruments, he noted that No. 4 RPM was indicating higher than normal and that No. 4 Turbine Inlet Temperature (TIT) was reducing slowly. The commander recalled his airspeed at that time to be about 122 or 123 kt and he was by then applying left rudder and full left aileron. The aircraft kept turning right and started buffeting. The Commander tried bringing No. 1 throttle back a little to stop the turn but this action had no apparent effect. He then called "Take action for No. 4", but there was no confirmation that any remedial action was attempted by any of the other flight crew members.

As the aircraft continued on its right turn at very low altitude its right main gear briefly contacted the grass strip adjacent to the runway. It finally impacted the water 500 metres off-shore in Kowloon Bay on a southerly heading, with some right bank and in a nose low attitude. As the aircraft gradually submerged, 2 life rafts came to the surface and were utilised by the 7 occupants who had managed to escape. Of these 7 survivors 1 died before arrival at hospital. The remaining 5 occupants were later found drowned.

1.2 Injuries to persons

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Crew</th>
<th>Positioning crew</th>
<th>Passengers</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>3</td>
<td>3</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>Serious</td>
<td>2</td>
<td>2</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>Minor/None</td>
<td>1</td>
<td>1</td>
<td>N/A</td>
<td>0</td>
</tr>
</tbody>
</table>
1.3 Damage to aircraft
The aircraft was destroyed.

1.4 Other damage
None.

1.5 Personnel information

1.5.1 Flight crew qualifications

**Commander**
- Licence: Male, aged 40 years
- Licence: Airline Transport Pilot’s Licence
- Aircraft ratings: Hercules, DHC-7 and BAe-146
- Medical certificate: Valid to 19 October 1994
- Instrument rating: Renewed 31 August 1994
- Last base check: 31 August 1994
- Last line check: 25 March 1994
- Flying experience:
  - Total all types: 11,781 hours
  - Total on Hercules: 3,949 hours
  - Duty time: 1 hour 45 minutes prior to the time of the accident
  - Rest period prior to duty: 23 hours 30 minutes

**First Officer**
- Licence: Male, aged 42 years
- Licence: Airline Transport Pilot’s Licence
- Aircraft ratings: Hercules and CASA-212
- Medical certificate: Valid to 11 October 1994
  - Limitation - Correcting glasses required while exercising the privilege of this certificate
Instrument rating : Renewed 29 June 1994
Last base check : 29 June 1994
Last line check : 29 July 1994
Flying experience:
Total all Types : 9,064 hours
Total on Hercules : 2,570 hours
Duty time : 1 hour 45 minutes prior to the time of the accident
Rest period prior to duty : 23 hours 30 minutes

Flight Engineer : Male, aged 58 years
Licence : Flight Engineer's Licence
Aircraft ratings : Hercules and C-160
Medical certificate : Valid to 24 July 1995
Limitation -
Correcting glasses required while exercising the privilege of this certificate
Instrument rating : Not applicable
Last base check : 10 November 1993
Last line check : 11 March 1994
Flying experience:
Total all Types : 18,630 hours
Total on Hercules : 5,599 hours
Duty time : 1 hour 45 minutes prior to the time of the accident
Rest period prior to duty : 23 hours 30 minutes

1.5.2 Flight crew training
The Pelita Air Service (PAS) crews use a company in Singapore for Hercules Simulator training and all flight crew attend a 3 day refresher course each year. The course appears comprehensive with one day being dedicated to normal and emergency operations at Hong Kong.
The training records of the 3 operating flight crew members provided by PAS revealed that:

(a) The Commander had attended the refresher course from 29 to 31 August 1994. Amongst many other aspects, he was exposed to various propeller malfunctions and his report indicates that he worked hard and produced a consistently high standard.

(b) The First Officer attended the course from 27 to 29 June 1994 and was exposed to a wide range of emergencies including some propeller malfunctions. His report was poor and included a comment that he needed to review emergency procedures. On return to PAS, he was given unspecified remedial training.

(c) The Flight Engineer attended the course from 8 to 10 November 1993 and was also exposed to a variety of emergencies including some propeller malfunctions. His report reflected a good performance during normal operations but a weak knowledge of emergency procedures. On return to PAS, he was also given unspecified remedial training.

1.5.3 Senior Purser

The Senior Purser carried out the duties of Air Loadmaster for the flight and had completed the load sheet for the Commander.

1.6 Aircraft information

1.6.1 Aircraft Particulars

<table>
<thead>
<tr>
<th>Type</th>
<th>Lockheed L100-30 382G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructor's number</td>
<td>4826</td>
</tr>
<tr>
<td>Date of Manufacture</td>
<td>9 August 1979</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Certificate of Registration</th>
<th>No. 986 valid until 8 August 1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certificate of Airworthiness</td>
<td>Cargo Category No. 986 valid until 24 October 1994</td>
</tr>
<tr>
<td>Total airframe hours</td>
<td>15,223 hours</td>
</tr>
<tr>
<td>Engines</td>
<td>4 Allison 501D-22A turboprops</td>
</tr>
<tr>
<td>Maximum take-off weight</td>
<td>155,000 lb</td>
</tr>
<tr>
<td>Estimated weight at time of accident</td>
<td>123,835 lb</td>
</tr>
<tr>
<td>Estimated fuel remaining at time of accident</td>
<td>44,200 lb</td>
</tr>
<tr>
<td>$V_1$ for take-off</td>
<td>107 kt as determined by the crew</td>
</tr>
<tr>
<td>$V_R$ for take-off</td>
<td>110 kt as determined by the crew</td>
</tr>
<tr>
<td>$V_2$ for take-off</td>
<td>120 kt as determined by the crew</td>
</tr>
<tr>
<td>Estimated centre of gravity at time of accident</td>
<td>24.8% MAC (within the C of G limits)</td>
</tr>
</tbody>
</table>

1.6.2 General description

The Lockheed Hercules is a land-based long range aeroplane. It is a high-winged monoplane of all-metal construction powered by four constant speed turbo-prop engines, each driving a four-bladed propeller.

The semi-monocoque fuselage is divided into a flight station and a rear compartment. The flight deck is arranged for a crew of three, i.e. pilot, co-pilot, and flight engineer plus an observer's seat for check pilots. Both the flight deck and the rear compartment can be pressurised to maintain a pressure equivalent to pressure at 8,000 feet altitude at an aircraft altitude of 32,000 feet. For the accident flight PK-PLV was in 03 Passenger configuration. This gave a passenger seating capacity of 128 (Appendix 3).

The tricycle landing gear has dual nose wheels and two wheels in
tandem on each main gear. The nose gear folds forward and the main
gears retract vertically into fuselage fairings.

1.6.3 Engine Fuel Control Unit (FCU)

The engine fuel control unit is a hydromechanical device which,
amongst other functions, provides engine overspeed protection by means
of a governor and overspeed protection system. Within flight range of
operation the engine speed in revolutions per minute (RPM) is governed
at 100 percent by the constant speed system of the propeller.

If due to a malfunction or improper adjustment the RPM increased to
over approximately 105 percent in the flight range or approximately 103
percent in the ground range, the overspeed protection system would
reduce the amount of fuel scheduled to the engine to the minimum flow
setting, thus providing overspeed protection. This flow setting is
equivalent to the flight idle setting at 100 percent RPM during the
normal operation of the engine, and would normally produce a Turbine
Inlet Temperature (TIT) of around 530°C when conditions had
stabilised. However, if the overspeed were caused by the propeller
driving the engine, the RPM after the fuel reduction would still be
determined by the propeller, but a transient TIT of 460°C could be seen
as a result of the fuel reduction.

1.6.4 Propellers

The propeller is a Hamilton Standard 54H60-117, variable pitch, full
feathering, reversing propeller with a 13' 6" diameter. In flight
regimes, the propeller in conjunction with the control maintains the
engine at a constant speed of 100 percent (1020 RPM) by varying the
propeller pitch (blade angle) to maintain an on speed, 100 percent
condition. The propeller blade angle can be positioned by throttle
movements for ground handling and reversing. The propeller can be feathered in flight for engine shutdown to minimise drag.

The two major components of the propeller are the propeller assembly and the control. The propeller assembly includes the barrel assembly, four blade assemblies, the pitch lock regulator, and the dome assembly. The barrel assembly retains the propeller blades and pitch lock regulator. The dome assembly is the pitch change mechanism and contains the low pitch stop.

The control consists of two components, the valve housing, and pump housing assemblies. The control is a non-rotating assembly located on the rear barrel half extension between the propeller assembly and the engine gear box. The pump housing contains the oil reservoir and pumps to supply the valve housing with the proper hydraulic pressure to vary the propeller blade angles. The valve housing contains a servo governor and several additional valves that route the pressure to increase or decrease blade angle based on an input from the cockpit.

The engine compressor and reduction gearbox are capable of absorbing a large amount of power and the negative thrust that can be generated is enormous when the engine is not producing power and the propeller attempts to drive the engine as the result of a malfunction.

A revolving propeller has a combination of aerodynamic and centrifugal twisting moments acting on the blades, attempting to twist them to an angle in the Beta range, somewhere near flat pitch. If, for any reason, the propeller hydraulic system is not able to resist this moment, some form of protective or corrective action is required. To provide this protection several safety features have been incorporated. These are:

Low Pitch Stop
Negative Torque Signal System
Pitch Lock Regulator
Safety Coupling

Information on the various features derived mainly from Lockheed briefing material made available to customers is given below:

1.6.4.1 **Low Pitch Stop**

The Low Pitch Stop is a hydraulic, as well as mechanical, latch mechanism designed into the propeller to prevent operation below a pre-selected minimum blade angle during flight. However, it will allow the latches to retract, and the propeller to operate at lower blade angles when the aeroplane is on the ground.

This mechanism consists of three latch type levers supported by a wedge that must be retracted to allow the levers to collapse inward, which in turn, permits the pitch change mechanism to enter the ground handling or Beta range.

This device and its relationship with the fuel control unit affects the basic handling characteristics of the aircraft by providing negative thrust at touchdown speeds. Normally, the wedges are only retracted on the ground by the pilot moving the throttle levers over the Flight Idle Gate into the Beta range. However, the wedges can be retracted in flight by inadvertent movement of the throttle levers aft of the Flight Idle Gate, or by improper manipulation of a throttle lever in the event of a throttle cable failure.
1.6.4.2 Negative Torque Signal System

The Negative Torque Signal System is a "drag reducer" designed to minimise the drag that is generated when the propeller attempts to drive the engine to a nominal level of -1,260 inch-pounds of torque.

When the negative torque reaches a level of -1,260 ± 600 inch-pounds, a plunger in the engine reduction gear box extends and, through mechanical linkages, positions the propeller feather valve in the valve housing toward the feather position. This action results in propeller oil being routed to the front side of the propeller dome piston causing it to move rearward. This movement increases the blade angle. The increase in propeller blade angle increases its air load, thereby reversing the power flow and causing the engine to again drive the propeller, thus relieving the negative torque condition.

If the negative torque conditions remain stable, the propeller blades will cycle about an angle that produces a nominal -1,260 in-lb of torque. The higher the true air speed, the higher the blade angles will be and at high airs speeds they will approach the feather blade angle.

1.6.4.3 Pitch Lock Regulator

This is a hydro-mechanical device that is designed to prevent excessive decreases of blade angles in the event that propeller governing ability is lost. It consists of two sets of ratchet teeth which are spring loaded to the engaged position and
held disengaged by propeller oil pressure. Engagement of the ratchet teeth - propeller pitchlock - occurs anytime the propeller oil pressure in the Pitch Lock Regulator chamber is not greater than the spring force that is attempting to engage the ratchet teeth. There is no advantage in having this safety feature operational at high blade angles or near the Low Pitch Stop. Therefore, the ratchet teeth are mechanically held disengaged at blade angles lower than 25° and higher than approximately 55°.

Loss of propeller oil pressure in the Pitch Lock Regulator chamber occurs in one of two ways: first, if the RPM reaches approximately 103.5 percent, the flyweights in the Pitch Lock Regulator actuates the valve and dumps the pressure from the chamber. The second way is from loss of propeller oil.

After the Pitch Lock ratchet teeth are engaged, the propeller blade angle is prevented from decreasing any further. A pitchlocked propeller operated in accordance with the Airplane Flight Manual Emergency Procedures will continue to produce thrust at 96 to 98 percent RPM until it is shut down before landing.

1.6.4.4 Safety Coupling

This safety device is an engine component and should be thought of as a "drag limiter". It is a one-way link in the power transmission from the engine to the propeller. It is physically located between the engine reduction gear box and the torque shaft. It transmits positive power, that is power from the engine to the propeller. This is accomplished with a set of helical splines that are spring loaded to the engaged
position. As long as there is a positive power flow the splines remain engaged. However, should the propeller attempt to drive the engine, the helical splines tend to disengage. A reverse power flow level of a maximum of 1,315 negative horsepower (6,000 in-lb of torque) will overcome the spring force holding the helical splines engaged and cause decoupling.

1.6.5 Beta System

The power plant system includes a Beta, or ground operation system. In this mode of operation there is a direct relationship between the throttle position and the blade angle. The governor pilot valve is used as a simple metering valve: retard the throttle and the blade angle decreases; advance the throttle and the blade angle increases. On the throttle quadrant, the Beta range is from just below the Flight Idle gate to maximum Reverse. In this range of throttle movement, fuel is mechanically scheduled to the engine for continued operation with the selected blade angle.

Beta range is for ground operation only. Moving the propeller into Beta range in flight will cause wing lift loss and extremely high drag, resulting in dramatic loss of aircraft control.

Once the throttle is placed above Flight Idle position, the propeller should maintain 100 percent RPM as engine power increases. If for any reason the blade angle does not govern above Flight Idle, a proper interpretation of the indications is essential. Misinterpretation can be disastrous.
Throttle Cable system

The original throttle control cables were constructed of carbon steel wires formed into seven strands; each comprising a centre wire and six outer wires. The strands were formed into a cable, itself comprising a centre 'heart strand' and six outer strands wrapped round the heart strand. This construction is identified as '7 x 7 carbon steel'. Some parts of the cable run which are not required to pass over pulleys are sheathed in an aluminium sleeve to limit the amount of cable stretch due to tension and to make the thermal coefficient of expansion closer to that of the aluminium airframe.

Throttle cables run between the throttle and the associated coordinator; the main cable circuit runs in a closed loop from points below the throttle quadrant and adjacent to the engine wing mounting. Both the outward and return cable runs are tensioned by a cable tension regulator which consists of a set of pulleys whose axes are able to move against spring tension. The cable tension regulator is primarily provided to take account of thermal expansion and contraction and maintains a tension of between 35-55 lbf. A properly maintained throttle cable tension regulator will instantaneously expand a maximum of 0.375 inches in the event of a cable failure with the rest of the expansion occurring over a minimum period of two minutes. If the dampener in the tension regulator has not been maintained properly, the regulator can instantaneously expand more than 0.375 inches, up to full expansion.

1.6.6.1 Effects of Throttle Cable Failure

In the event of cable failure the release of cable tension may cause:
(a) The throttle lever becoming partially or completely jammed.

(b) Throttle lever movement not producing a corresponding power change, or even producing a power change in the opposite sense to throttle lever movement.

(c) An uncommanded propeller blade angle movement, in either direction.

Mechanical interference between throttle and condition lever cables may also be experienced and may produce unscheduled propeller or engine conditions.

A throttle cable failure on its own may cause the propeller to enter the Beta range.

1.6.6.2 Cable Defect History

The original carbon steel cables were found to be susceptible to defects, particularly on cables passing round pulleys. A Lockheed summary of the history of the throttle control cables states that:

'A review of the files has revealed that fraying in the areas near the pulleys in the "horse collar" and FS245 were the prevalent problem in the 7 x 7 Carbon Steel control cables. A list that was compiled in late 1974 listed 18 incidents in which engine control cables had broken. There have been other failures since this list was compiled, however I was not able to find reports of such. These incidents resulted in the following series of changes being made:
(i) The pulleys at the problem areas were changed from aluminium (MS20219A3) to phenolic (MS20219-3). The intent of this change was to minimise the wear of the cable due to contact with the side of the pulley. This change was made at aircraft serial 4459 in late 1970. [Note: PK-PLV was serial 4826].

(ii) Larger diameter pulleys, 2.312 versus 1.438 inches, were installed at the problem areas. This change was the result of cyclic testing which showed a significant increase in the fatigue life of the cable. This change was made at aircraft serial 4645 in mid 1975. Service Bulletin 382-185/82-370 was written to offer retrofit of this change. [Note: PK-PLV was serial 4826].

(iii) As a result of extensive life comparison tests of various different materials and construction, 7 x 19 CRES (Corrosion Resistant) stainless steel control cables were substituted for the 7 x 7 Carbon Steel control cables. These tests showed that the 7 x 19 CRES cables have a significantly longer fatigue life than the 7 x 7 Carbon Steel. This change was made at aircraft serial 4900 in 1981 as a product improvement. The 7 x 19 CRES cables became the preferred spares to the 7 x 7 Carbon Steel. All Hercules owner/operators were notified of these changes by a letter which included a cross-reference list of the new and old cables. The details of this change was also published in a Service Information Letter at the 1981 Hercules Operators' Conference.
(iv) Throttle and Condition Cable Replacement Kit, 3403328, was developed and offered to all Hercules owner/operators in 1987. This kit was intended for retrofit purposes only.

(v) Due to reports from various operators concerning excessive wear of the 7 x 19 CRES cables in the area of fairleads and fireseals, more testing was conducted, resulting in a material change for the fairleads and fireseals. These tests showed that the main cause of wear was vibration emanating from the propellers. This change was made at aircraft serial 5211 in 1989 as a product improvement. Service Bulletin 382-76-11/82-632 offered this change to Hercules owner/operators.

However, the number of operators that retrofitted their aircraft with 7 x 19 stainless steel cables is not known.

A comparison of 7 x 19 and 7 x 7 cables is shown in Appendix 4.

1.6.6.3 Throttle Cable Lifting Policy and Maintenance Requirements

The Lockheed policy on engine throttle control cable life is that they are 'on condition'. Under the 1.382G Series Progressive Inspection Programme SMP515-C-55 the cables are to be checked at 3,400 hour or 3 year intervals irrespective of the type of cable, although different inspection methods are detailed in Work Card SP-77 for the two types of cables that may be used.
Owing to the lack of evidence to the contrary it can only be assumed that the 7 x 7 carbon steel cables found on PK-PLV were the original cables, which would have flown for 15,223 hours. Maintenance records provided by PAS showed that a one time visual inspection (called for by SB 382-76-10) in accordance with Work Card SP-77 was performed on 25 May 1987 at 9,757 aircraft hours with satisfactory results. However, the periodic checks required by the L382G Series Progressive Inspection Programme SMP515-C-55 had not been carried out.

1.7 Meteorological information

1.7.1 General

A routine weather bulletin issued by the Royal Observatory, Hong Kong at 0910 hours on 23 September showed that the area was under the influence of a northeast monsoon. There was also a report of a severe tropical storm over the western Pacific, centred about 870 km westnorthwest of Guam and forecast to be slow moving. A few isolated squally thunderstorms were forecast for the evening and rain patches overnight. Winds were forecast to be moderate from the east.

1.7.2 Terminal Area Forecast (TAF)

The 24 hour TAF issued to the crew covered the period from 0600 hrs on 23 September to 0600 hrs on 24 September. It gave a wind of 090°/10 kt, visibility of greater than 10 km, scattered cloud at 1,500 and 2,000 feet above ground level (agl) and broken cloud at 8,000 feet agl; temporarily from 0600 to 1000 hrs the wind would be 140°/10 kt; temporarily from 1500 to 0300 hrs the wind would be 030°/10 kt,
visibility would be 4,000 metres in rain and cloud would be scattered at 800 and 1,400 feet agl and broken at 3,000 feet agl.

1.7.3 The Automatic Terminal Information Service (ATIS)

The ATIS broadcast was continuous and updated each time a weather report was received from the Airport Meteorological Office (half-hourly or special report). Additionally, if there was any significant change to the contents, a new broadcast was made. Each broadcast had an identification letter. The Manual of Air Traffic Control required Air Traffic Controllers to ensure that pilots acknowledged receipt of the current ATIS broadcast on initial contact. The acknowledgement was recorded by entering the ATIS message identification letter on the appropriate flight progress strip. Subsequent changes should likewise have been made known to aircraft and recorded.

When the crew checked in with Hong Kong Clearance Delivery Control, they were advised that Information Victor was current. This advice was not acknowledged by the crew despite a requirement published in the Hong Kong Aeronautical Information Publication for pilots to acknowledge the ATIS broadcast identification letter on first contact with the appropriate ATC unit. Information Victor, issued at 1003 hrs, gave a surface wind of 090°/10 kt, visibility of 10 km, no significant weather, cloud scattered at 1,200 and 2,000 feet, temperature 28° C and QNH 1010 hPa. Information Victor was superseded at 1038 by Information Whiskey and at 1105 by Information X-ray which reported the runway wet, surface wind 090°/10 kt, visibility 9 km in rain, cloud scattered at 1,000 and 1,800 feet, temperature 27° C and QNH 1011 hPa. Although these changes had no bearing on the accident, the crew should have been in receipt of the current information identification letter prior to take-off. Perusal of the Air Traffic Control (ATC) transcript reveals that ATC had not asked the crew for
confirmation that they had received Information Victor, did not inform
the crew of the change to Information Whiskey and X-ray, and did not
pass the current QNH to the crew.

1.7.4 Anemometry

Surface wind strength and direction was measured by 3 distant reading
cup anemometers installed at the Airport. The southeast (SE)
anemometer was located about 510 metres northnorthwest (NNW) of
Runway 31 threshold and was at a height of 12 metres above the
runway. The northwest (NW) anemometer was located about 130
metres south of the Runway 13 threshold and was at a height of 10
metres above the runway. The Mid-Runway anemometer was located
about 480 metres southsoutheast (SSE) of the Aerodrome Reference
Point (ARP) and was at a height of 11 metres above the runway. Each
anemometer recorded the present wind, 2 minutes mean wind and 10
minutes mean wind and this information was displayed in ATC Tower
on a digital display. Additionally, the crosswind and headwind
components were calculated, recorded and displayed. The strongest
wind noted over the previous 10 minutes was also recorded and
displayed. The wind passed by ATC to aircraft on approach or about
to depart was normally taken from the SE anemometer. However, the
readings from the NW and Mid-Runway anemometers were also passed
if these were significantly different. At the time of the accident the
Mid-Runway anemometer was unserviceable.

1.8 Aids to navigation

Not applicable to the accident.
1.9 Communications

At 1029 hrs PK-PLV using callsign Heavy Lift 01 (HLA 01) initiated radio communication with Hong Kong Ground Control on 121.6 MHz. The crew were advised to contact Clearance Delivery on 124.65 MHz and were given their ATC clearance on that frequency. They then called ground control again for start, push-back and taxi clearances. At 1111 hrs, as HLA 01 reached the holding point at A1 (see map at Appendix 1), the crew were advised to contact Hong Kong Tower on 118.7 MHz. This frequency was maintained until the aircraft crashed at 1115 hrs. Continuous speech recording equipment was in operation on all three frequencies used, and a satisfactory transcript of communication between the accident aircraft and ATC was obtained.

The tape recordings showed that radiotelephony (RTF) conversations were conducted entirely in English and no difficulties in transmission or reception were evident. There was evidence of some unfamiliarity with the taxiway and apron layout on the part of the crew of HLA 01 but this was resolved by the ATC Ground Movements Controller. Just prior to impact there was an involuntary transmission lasting 2 seconds from the aircraft. This transmission was analysed by the United Kingdom Air Accidents Investigation Branch (UKAAIB) in an attempt to establish engine noises but no relevant information could be extracted.

1.10 Aerodrome information

1.10.1 General

The single runway aligned 135°/315°M at Hong Kong International Airport (Appendix 1) is situated on a promontory of reclaimed land which is 242.3 metres wide and protrudes into Kowloon Bay. The elevation of the runway is 15 feet amsl and the runway has no
longitudinal slope. A full length parallel taxiway runs along the eastern edge of the promontory and is separated from the runway by a grass area approximately 69 metres wide. On the western side of the runway is another grass area bounded on its western edge by a road and a sea wall level with the road; the distance from the centreline of the runway to the edge of the sea wall is approximately 110 metres. Operational services at the airport, as well as the rescue and fire fighting services, are provided by departments of the Hong Kong Government.

Runway 13 was the runway in use at the time of the accident. It has the following physical characteristics:

| Direction | : 135°M |
| Length | : 3,331.5 metres |
| Width | : 61 metres |
| Take-off run available | : 3,331.5 metres |
| Take-off distance available | : 3,444.5 metres |
| Accelerate-stop distance available | : 3,331.5 metres |
| Surface | : The first 150 metres and the last 91 metres are concrete; the rest is asphalt. The entire length is grooved. |

1.10.2 Lighting aids

The lighting on Runway 13 consists of lead-in, threshold, centreline, wing-bars, runway edge and end lights. All of the lighting was on at the time of the accident. The lighting had been subject to the twice daily serviceability checks and was last checked at 0735 hrs on the day of the accident when all lights except for one low-intensity edge light were reported to be serviceable.
1.11 Flight recorders

1.11.1 General

The Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR) were removed undamaged from the aircraft tail section after it was recovered from Kowloon Bay. They were immersed in fresh water and despatched to the Flight Data Recorder Section of the UKAAIB at Farnborough for readout.

1.11.2 Cockpit Voice Recorder

The aircraft was fitted with a Fairchild A100 CVR configured to the area microphone standard. From the audio information on the tape, the CVR appeared to have been working only intermittently and the accident flight was not recorded. No useful information could therefore be obtained from the CVR.

1.11.3 Flight Data Recorder

The aircraft was fitted with a LAS 109 scratch foil recorder. The following five parameters were recorded:

a. Airspeed
b. Altitude
c. Magnetic heading
d. Normal Acceleration
e. Incremental time

The foil medium had been used previously before being refitted to the aircraft, so there was old FDR information recorded on the foil. Nevertheless, useful data were retrieved which showed a maximum
airspeed achieved of approximately 133 kt, an initial heading on the runway of approximately 135° and a right turn onto the final heading of approximately 176°. Altitude resolution below 100ft was not possible and no height information was retrieved. Normal acceleration was functioning and did not show any impact. A graphical presentation of this data is included in Appendix 5.

1.12 Wreckage and impact information

1.12.1 Ground marks

A 65 metre wide grass strip, running parallel to the right hand side of Runway 13 was found to contain a ground mark 41 cm. wide and approximately 100m long. The ground mark was a continuous track starting at about 45m from the edge of the runway and curving to the right in a direction similar to that taken by the aircraft terminating at the extreme edge of the runway promontory. The location of this ground mark is shown in Appendix 6. Numerous ground marks caused by fire trucks and other vehicles during the rescue operation were also found on the grass strip. These vehicular ground marks were parallel tracks much narrower in width than the ground mark described above and they started from and terminated at the edges of the grass strips.

1.12.2 Aircraft wreckage recovery

The aircraft wreckage was located in Kowloon Bay at a depth of approximately 16 metres and was declared a marine hazard. Its position is shown in Appendix 6. The main salvage operations employing a crane and divers began on 25 September and ceased on the evening of 30 September, having cleared the marine hazard and recovered the occupants and most of the fuselage including the cockpit, wings and tail section. The recovery was impeded by poor underwater visibility
throughout the operation. During the recovery the wing was lifted with
the engines but without the propellers attached. However, as it was
lifted clear of the water the engines detached and fell back into the
water. Three engines (including No. 4) and three propellers (but not
No. 4) were later recovered.

A sonar search for the missing engine and the No. 4 propeller was then
conducted and within two days both were recovered.

Initial reports by the divers employed in rescue duties before the
wreckage recovery began indicated that the aircraft had initially come
to rest inverted on the sea bed at an angle of 45° to the horizontal but
with the wings parallel with the sea bed; the final heading of the aircraft
was approximately northeasterly. The tail section had broken off and
was located some 50 yards from the main fuselage. However, reports
made by salvage divers on the next day indicated that the fuselage was
upright and apparently facing east (see also last paragraph of section
1.16.2). The starboard wing appeared to be intact. The port wing tip
appeared to be detached. There was severe damage to the fuselage and
undercarriage. The position of the undercarriage indicated that it was
in transit when it hit the water. Since the undercarriage was operated
by screw jacks, which were not reversible, the position would not have
changed during impact or recovery. The manufacturer advised that the
time taken for the undercarriage of a Hercules to be fully retracted after
the gear lever had been selected was 19 seconds maximum with an
average of 11-12 seconds. Hence with a ground speed of 120 kts, the
aircraft would have flown a maximum distance of about 1200m before
the undercarriage was fully retracted.

Considerable additional damage to the aircraft was incurred during the
recovery. The recovered wreckage comprised the following sections:
Flight deck.
Tail section.
The wings, with the outer sections, including the ailerons, separated.
Broken pieces of the rear section fuselage.
All four engines.
All four propellers, less blades 1 and 3 on No. 1 propeller.

Sketches showing the main parts of the fuselage recovered together with some photographs of those parts are at Appendix 7. Sections of the fuselage roof and of the rear compartment hold flooring remained missing. The synchrophaser had been displaced from its mounting and was not recovered. However, its authority was limited to only +/- 2 percent of propeller range.

1.12.3 Engine instruments and controls

The engine instrument panel contained eight instruments for each engine (see diagram in Appendix 8). Three of these instruments were of a type which retained the last reading when electrical power was interrupted. The readings recorded were:

<table>
<thead>
<tr>
<th>No. 1 engine</th>
<th>No. 2 engine</th>
<th>No. 3 engine</th>
<th>No. 4 engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque (in-lbs)</td>
<td>6,600</td>
<td>3,250</td>
<td>4,050</td>
</tr>
<tr>
<td>Turbine Inlet Temp. (°C)</td>
<td>640</td>
<td>655</td>
<td>665</td>
</tr>
<tr>
<td>Engine oil pressure (psi)</td>
<td>40</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Gearbox oil pressure (psi)</td>
<td>150</td>
<td>150</td>
<td>200</td>
</tr>
</tbody>
</table>

* The maximum allowable engine and gearbox oil pressures are 60 psi and 250 psi respectively. The abnormally high engine oil pressure could not be achieved mechanically and is probably the result of an electrical abnormality during break up.
The fire handles were found to be in their normal stowed position. The condition levers and Nos. 2 and 4 throttle levers were in the fully forward position; No. 3 throttle lever was approximately 2" back from the fully forward position and No. 1 throttle lever was approximately 1" ahead of flight idle position. However, these lever positions may not be the same as those at impact because of possible disturbance caused by the impact, escape attempts and during recovery of the aircraft.

1.12.4 Other observations

1.12.4.1 Altimeters

Altimeter settings:

Captain 29.92 in (equivalent to 1013.2 hPa)
First Officer 29.93 in (equivalent to 1013.5 hPa)

1.12.4.2 Transponder

The transponder setting was 5327.

1.12.5 Propellers

All four propeller assemblies were recovered and found to have separated from their engines at the aft end of the reduction gearbox. Apart from No. 1 propeller which had blades 1 and 3 missing due to impact with the water, all the other propeller assemblies had all 4 blades attached. The propellers were returned to the manufacturer for strip examination.
1.12.6 Engines

All four engines were recovered generally intact and the suspect No. 4 engine was returned to the manufacturer for strip examination.

1.12.7 Flying controls

1.12.7.1 Flaps

The flaps were found to be in the 50 percent position. The right inboard flap section had been damaged and the aerofoil section had been displaced. However, the left and right hand inboard screwjack positions were symmetrical.

1.12.7.2 Trims

The following trim tab positions were found:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aileron</td>
<td>4.5°</td>
</tr>
<tr>
<td>Elevator</td>
<td>3.3°</td>
</tr>
<tr>
<td>Rudder</td>
<td>1°</td>
</tr>
<tr>
<td></td>
<td>up</td>
</tr>
<tr>
<td></td>
<td>down</td>
</tr>
<tr>
<td></td>
<td>left</td>
</tr>
</tbody>
</table>

1.13 Medical and pathological information

The Commander who was the only surviving operating flight crew member was fit to fly. He showed no evidence of any medical condition which might have contributed to the accident.

Post Mortem examinations were carried out on all the deceased personnel. Although there was evidence of bruising on all of them, the cause of death in each case was drowning. None had any pre-existing medical condition which might have influenced the accident.
1.14 Fire

There was no fire.

1.15 Survival aspects

1.15.1 Doors and exits

The aircraft was provided with 3 doors and 6 emergency exits.

1.15.1.1 Flight Deck

a. A crew door is installed to the rear of the flight deck section on the left side of the aircraft. The crew door was still in position, the jettison handle was in the closed position and wirelocked with thin mild steel wire and the internal/external operating handle was in the shut position.

b. One top emergency exit is provided, this hatch was missing and the jettison handle was in the open position.

c. Two hinged windows are fitted to the flight deck, the left hand hinged window was open (inwards), and the right hand window was closed.

1.15.1.2 Rear Passenger Compartment

a. Two aft entry doors are provided, one located on either side of the fuselage to the rear of the landing gear
fairing. The left hand aft entry door was in place and locked; the right hand aft entry door was missing, as were the rear vertical and bottom members of its surrounding frame.

b. One side emergency door is located on the right wall of the rear compartment. This was missing although the release handle was in the shut position and wirelocked with stainless steel wire. Tests carried out on the wire showed that forces of between 54 and 59 lbf. were required to break it (Appendix 9).

c. Two top emergency exit hatches are provided. The forward top emergency hatch was missing, and the rear top emergency hatch was in place in the locked position.

1.15.2 Flotation Equipment

1.15.2.1 Liferafts

The flight plan stated the carriage of 4 liferafts capable of carrying 150 persons. In fact the aircraft had 4 liferaft compartments, each containing a type F-2B 20-man inflatable liferaft with a survival kit. Therefore the total capacity of the liferafts was 80 persons. No emergency radios were found in the survival kits after recovery. All 4 rafts had been manufactured in April 1993 and installed on 1 October 1993; they were scheduled for an annual functional test and inspection on 1 October 1994.

Installed liferafts may be ejected from their compartments
and automatically inflated by operation of the liferaft release system. Each liferaft is secured to the aircraft by a rope to preclude the possibility of the liferaft drifting from the aircraft after inflation. None of the survivors reported deploying the liferafts, but initially at least 2 liferafts were available to the survivors on the surface. All 4 liferafts were subsequently recovered.

1.15.2.2 Lifejackets

The operator stated that a total of 135 lifejackets had been provided on the aircraft. However, only 2 valises containing 43 lifejackets were recovered. The others were presumed lost.

1.15.2.3 Others

The operator stated that individual flotation devices in the form of flotation cushions were fitted. Although no seat cushions were recovered a passenger on the previous flight confirmed that these cushions were fitted and, indeed, the design of the passenger seat make them difficult to use without a seat cushion.

1.15.3 Emergency Locator Transmitter

The emergency locator transmitter (ELT) is an omnidirectional radio frequency transmitter that emits a clear signal on the international distress frequencies of 121.5 and 243 MHz. The ELT can be armed by a control switch operated by the co-pilot, or by a switch on the transmitter, and will activate if a force of 5 Gs is encountered. Alternatively, the transmitter can be manually activated by placing the
control switch on the transmitter to ON or selecting the co-pilot's ELT remote switch to ON. An ELT antenna is mounted on the top fuselage forward of the fin. An alternative portable antenna is also provided.

Both the co-pilot's remote control switch, and the switch on the transmitter, were found in the ARM position. The ELT was due for servicing on 1 Feb 95. A search of the tape recording of the distress frequency 121.5 MHz at the time of the accident revealed three short bursts of transmission at 10, 11 and 20 seconds after 11:16 hrs.

1.15.4 Seats and seat belts

The aircraft was configured with 128 passenger seats in the rear passenger compartment and Lockheed confirmed that the rear compartment was fitted with canvas seats which were designed and manufactured originally for use by the United States Air Force on their C130 aircraft. They were installed on PK-PLV, at customer request, by Lockheed at Marietta in August 1979.

Seat belts, rated at 1500 lbs., recovered from the rear compartment were in good condition and were dated after aircraft delivery. Labelling on the belts indicate conformity with FAA-TSO-C221 standards.

1.15.5 Fire Protection

The requirement of the Indonesian Regulatory Authority is one fire extinguisher in the flight deck and two in the passenger compartment. A CO₂ extinguisher was recovered from the flight deck together with one from the passenger compartment. These extinguishers are considered suitable for their purpose. However, as there was no fire this had no bearing on the survivability of the accident.
At 1115 hrs, the Airport Fire Contingent was alerted of the accident by the Air Traffic Control Tower through the activation of the crash alarm. Although there were initial difficulties by ATC staff in providing the exact location of the crash and in communicating with the rescue units, the airport fire rescue launch, a catamaran, callsign "Thunderbird" was immediately despatched from its berth adjacent to the Sub-fire Station located near the southeastern end of the runway promontory in the general direction of the crash location. The position of the crash site was subsequently passed to the Thunderbird en-route.

The Thunderbird was the first rescue vessel to arrive on scene reaching the wreckage at 1124 hrs. The aircraft was mostly submerged with the tail section still above the water surface and some survivors were sighted. However, due to the proximity of the wreckage, the Thunderbird could not get close to the survivors. Instead, an inflatable life-raft was launched and this was boarded by the survivors. The wreckage continued to sink and was fully submerged within a few minutes of the arrival of the rescue catamaran.

A total of 7 survivors were rescued and helped on board the Thunderbird by firemen within 9 minutes. They had all sustained injuries and were transferred to a police launch which had by then arrived on scene and tied alongside the catamaran. They were conveyed by this police launch to the jetty at the western side of the runway promontory and were brought ashore at 1141 hrs. They were given treatment by waiting ambulance staff while awaiting helicopter transport to hospital but one crew member failed to respond to resuscitation efforts. Although a Sikorsky S76 helicopter was standing by on the runway it was initially tasked with the search for the crashed aircraft and was not equipped for stretcher case casualty evacuation.
Subsequently another Sikorsky S76 helicopter had to be readied for the purpose. By that time the police had cleared the road traffic in the vicinity of the airport and had provided an unobstructed route from the airport to the Queen Elizabeth Hospital (QEH), approximately 5.5 Km and 10 minutes drive away. The decision was made to transport the casualties by ambulance instead. In all, four ambulances were used.

ATC was unsuccessful in alerting the duty Port Health Medical Officer at the Airport who should respond to such emergencies and an off-duty Port Health Medical Officer was alerted at home. The duty Port Health Medical Officer was later alerted by the Airport Management Division and due to delay in transportation arrived at the scene after the casualties had left for the QEH by ambulance. It was later revealed at a critique meeting on the rescue operation that the telephone number used by ATC for alerting the duty Port Health Medical Officer was that of the Airport Clinic which was not manned in the evening.

1.16 Tests and research

1.16.1 Propellers

The four propellers were delivered to Hamilton Standard for disassembly and examination. Propeller No. 1 has serial No. N237885, propeller No. 2 serial No. N237765, propeller No. 3 serial No. N237889 and propeller No. 4 serial No. N236010. Representatives from the Investigation Team, the Allison Engine Company and Lockheed witnessed the examination of the No. 4 propeller which was suspect. The report on the examination is at Appendix 10 and the following observations were made:
During disassembly all settings and adjustments such as low pitch stop setting, cam out ring index, barrel half index and dome stops ring index were checked and found to be correct per Hamilton Standard manuals P5059 and P5056 for all four propellers.

Incorrect part markings were noted on propellers serial numbers N237885, N237765, and N236010, i.e. propellers No. 1, No. 2, and No. 4 respectively.

The No. 3 and No. 4 propellers had sustained more substantial damage than the No. 1 and No. 2 propellers.

Blade impact angles for propellers No. 1, No. 2 and No. 3 were found to be at 22° to 23°, i.e. flight idle. However, the blade angle at impact of No. 4 propeller was 14° i.e. within the Beta range.

The No. 4 propeller was found to have been assembled correctly. Component testing performed on the dome, low pitch stop and pitch lock regulator revealed no discrepancies. The valve housing and valves were also examined and tested and found to operate correctly.

1.16.2 No. 4 Engine

The No. 4 engine was bulk stripped and examined by the Allison Engine Co. in the presence of representatives from the investigating team, Hamilton Standard and Lockheed. The Fuel Control Unit was despatched to Allied Signal Aerospace Equipment Systems at Bendix by the Allison Engine Co for examination. In summary disassembly/visual inspection and testing of the Main Fuel Control found no abnormalities other than corrosion damage consistent with salt water submersion and impact during the accident. Nothing was found that would have
prohibited those units from operating normally at the time of the accident.

The report of the findings of the engine and fuel control unit examinations are contained in Appendix 11 and Appendix 12 respectively.

Sediment was found inside the compressor casing in a position which indicated that the engine was approximately horizontal, and the right way up, when the sediment was deposited.

1.16.3 No. 4 Engine Throttle and Condition Control Cables

Those throttle and engine condition cables recovered from the salvaged wreckage and identified as coming from the No. 4 throttle system were:

<table>
<thead>
<tr>
<th>Run</th>
<th>Part Number</th>
<th>State</th>
<th>Length Recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(inches)</td>
</tr>
<tr>
<td>T4A</td>
<td>371931-3</td>
<td>complete</td>
<td>161.08</td>
</tr>
<tr>
<td>T4A</td>
<td>371930-1</td>
<td>complete</td>
<td>236.76</td>
</tr>
<tr>
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<td>371927-4</td>
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<td>115.44</td>
</tr>
<tr>
<td>T4A</td>
<td>371928-55</td>
<td>severed</td>
<td>55</td>
</tr>
<tr>
<td>T4A</td>
<td>370918-4</td>
<td>severed</td>
<td>101</td>
</tr>
<tr>
<td>T4B</td>
<td>3719314</td>
<td>complete</td>
<td>181.20</td>
</tr>
<tr>
<td>T4B</td>
<td>371930-2</td>
<td>complete</td>
<td>205.25</td>
</tr>
<tr>
<td>T4B</td>
<td>371927-8</td>
<td>complete</td>
<td>143.91</td>
</tr>
<tr>
<td>T4B</td>
<td>371928-63</td>
<td>severed</td>
<td>24</td>
</tr>
<tr>
<td>T4B</td>
<td>371918-3</td>
<td>severed</td>
<td>91</td>
</tr>
</tbody>
</table>
This represents approximately 66 percent of the central fuselage circuit for the No. 4 throttle cables, but did not include the cables passing over the pulleys at the base of fuselage station 245. The cables were despatched to the AAIB at Farnborough for examination. The failed wire ends, although rusted, showed necking associated with tension failures. No evidence of fraying or fatigue was seen.

A diagram showing the Hercules engine throttle and condition control cable assemblies is at Appendix 13.

1.16.4 Beta Light Bulbs

The set of four light bulbs from the Beta lights were examined. Continuity checks showed that bulbs numbers 1, 2 and 3 were open circuit. The filament in each case had fractured adjacent to one of the support posts with no signs of filament stretch. The continuity of bulb number 4 was confirmed with the filament showing some signs of looping (Appendix 14). However, examination of the Beta light microswitch in the No. 4 propeller control assembly showed that, at impact, the microswitch had not made contact and in this condition power would not have been applied to the No. 4 Beta light. It is not possible to determine whether the No. 4 Beta light came on when the propeller went into the Beta range shortly after the aircraft became airborne.

1.17 Additional information

1.17.1 No. 4 Engine maintenance history

Engine serial No. CAE 550510 had been fitted to the No. 4 position in PK-PLV on 9 July 90 at 6,493.21 hours time since new (TSN), having
been overhauled by Standard Aero Ltd. At the time of the accident the engine had completed a total of 3,217.07 hours since overhaul and 9,710.28 hours TSN. The engine log book recorded two items of work:

29 Sep 90  Starter Air Turbine replaced.
18 Feb 93  Six fuel nozzles replaced.

The following pilot reported defects were recorded in the aircraft technical log sheets between 1 March 93 and the date of the accident:

<table>
<thead>
<tr>
<th>Date</th>
<th>Worksheet</th>
<th>Defect</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 Sep 94</td>
<td>013494</td>
<td>Eng bleed air sw &quot;ON&quot; = &quot;OFF&quot;</td>
<td>5 fuel nozzles replaced due to interval check.</td>
</tr>
<tr>
<td>29 Jan 94</td>
<td>010465</td>
<td>Eng bleed air off but same with on position</td>
<td>Replaced bleed reg valve.</td>
</tr>
<tr>
<td>5 Jan 94</td>
<td>010458</td>
<td>Eng bleed air sw pos OFF=ON</td>
<td>See delay discrepancy.</td>
</tr>
<tr>
<td>2 Jan 94</td>
<td>010456</td>
<td>Climb setting torque and F/F (fuel flow) same as others, TIT 30°C underread, suspect thermocouples.</td>
<td>Rectified plug.</td>
</tr>
<tr>
<td>26 Dec 93</td>
<td>010452</td>
<td>Climb setting torque and</td>
<td>Calibrated TD amplifier.</td>
</tr>
</tbody>
</table>

1.17.2 No. 4 Propeller maintenance history

Propeller serial No. 236010 was fitted to No. 4 engine on PK-PLV on 6 September 94 at 15,203.52 aircraft hours; it had previously been removed from another Lockheed Hercules aircraft, PK-PLU, on 1 January 94 at a TSN of 10,403.52 hrs and time since overhaul (TSO) of 4,895.52 hours. The log book contained no reference to the reason for removal, nor any actions which might have taken place between 1 January 94 and 6 September 94. The operator reported that the propeller had been removed for a faulty Beta Feed-back shaft which had
been found during maintenance. Although there was no record of any repairs to the faulty shaft, there was no record of any reported defects on this propeller whilst it was fitted to PK-PLV.

1.17.3 Deferred defects

There were no outstanding delay discrepancies or carried forward defects.

1.17.4 Operational Instructions and Documents

The crew were required to operate the aircraft in accordance with the PAS Basic Operations Manual (OM). The manual refers to other documents, including the Airplane Operating Manual (AOM), Airplane Flight Manual (AFM - dated 10 January 1990 up to revision 20), and Flight Crew Check Lists relating to the operations of company aircraft. Crews were also issued with a manual entitled "Hercules Flight Manoeuvres" which was produced by the training department of PAS.

1.17.4.1 PAS Basic Operations Manual

Relevant extracts from the PAS OM are reproduced below:

a. The flight engineer shall be proficient in handling of the aircraft's engines, systems and equipment under all conditions.

b. The flight engineer will monitor during all phases of flight the operation of the engines, systems and equipment.
c. The flight engineer will in case of deviation from normal operation analyse the problem and give the captain the required information.

d. For the other cockpit members the use of the shoulder harness is strongly recommended during normal take-off and landing, but is compulsory during emergency landing. There are 2 exceptions to seat belt rules i.e. flight engineers who have to be able to participate directly in the execution of the flight and persons not participating directly in the execution of the flight but whose presence in the cockpit is required in view of their task in aviation.

e. Cabin crew shall be strapped to their seat during take-off and landing.

f. All passengers shall have their seat belts fastened during taxi, take-off and landing.

g. During take-off, in the case of a malfunction, the captain will decide upon the action to be taken and give the appropriate command when required.

h. The flight engineer is not allowed to stop an engine during take-off without the express command to that effect, unless for certain conditions as indicated in the relevant AOM.

1.17.4.2 Airplane Operating Manual (AOM)

Relevant extracts from the AOM are reproduced below:
a. The flight engineer continuously monitors turbine inlet
temperature indicators, tachometers and torque-meters,
and reports unusual conditions to the pilot.

b. During the take-off run the flight engineer will monitor
all systems and report any malfunctions to the pilot.

c. All crew seats are provided with a conventional seat
safety belt and shoulder harness. Clevis-type
attachment assemblies installed on the back rest of the
crew bunk permit the installation of three extra seat
safety belts at this station.

1.17.4.3 Airplane Flight Manual (AFM)

Relevant extracts from the AFM are reproduced below:

a. If an engine should fail above $V_1$ speed, the take-off should
be continued. The pilot should maintain directional control,
and shut down the engine in accordance with Engine
Shutdown Procedures in section 3.

b. For propeller malfunctions after $V_1$, continue the take-off
and maintain directional control with flight controls and
engine power as necessary. Below 135 KCAS it may be
necessary to reduce power on the opposite engine to help
maintain directional control. Continue to operate engine
unless fire is indicated.

c. Propeller malfunctions during take-off may be difficult to
analyse at this most critical phase. If the engine is shut
down immediately and the propeller fails to feather, it is
possible that higher than normal minimum control speed may
result. When fire is not indicated, it is recommended that
the engine be allowed to run until at least 135 KCAS is
reached.

d. Performance definitions are included as follows:

(i) $V_1$ is the speed at which, after an engine failure having
been promptly recognised, the continued Take-off
Distance Required will not exceed the Take-off
Distance Available, the Continued Take-off Run
Required will not exceed the Take-off Run Available,
and the Accelerate-Stop Distance will not exceed the
Emergency Distance Available.

(ii) $V_2$ is the minimum take-off safety speed. It shall not
be less than 1.15 times the zero thrust stalling speed
with wing flaps in the take-off position, or less than
1.10 times the minimum control speed in the air.

(iii) $V_{MCA}$ (see Note) is the minimum inflight speed at which
an engine can be lost and directional control
maintained using full rudder deflection and not more
than $5^\circ$ of bank.

Note: Throughout the different manuals, the terminology for
minimum inflight control speed varies; for
standardisation purposes in this report, the term $V_{MCA}$
will be used.
Relevant extracts from the PAS Hercules Flight Manoeuvres are reproduced below:

a. Execution of **EMERGENCY** checklist stating memory or immediate action required for a certain emergency or abnormal procedure, should be done by the PNF (pilot not flying). Monitor/confirmation is done by F/E (flight engineer) under standard command of the captain, i.e., "Identify, Take Fire Action" or "Engine No. 4 Fire, Take Action". Do not read the **EMERGENCY** checklist during the critical phase of take-off.

b. During a take-off by the captain, the co-pilot should not touch the rudder pedals.

c. During take-off each pilot should monitor his instrument panel, and the flight engineer will monitor all system and central instrument panel.

d. If, after an emergency arises, it is decided to continue the take-off, the PF (pilot flying) shall pay full attention to fly the aircraft. The PNF shall, subject to captain decision initiate the required emergency procedure.

e. For an engine failure after $V_1$, but before $V_2$: "Positive rate of climb, retract the landing gear and then feather the propeller".
f. For an engine failure after $V_2$: "If flaps have not been retracted, climb at the established air speed not to exceed $V_2 + 10$ and assume the three engine profile when the flaps have been retracted.

1.17.4.5 Pilots and flight engineer’s checklists

Six crew checklists were found in the wreckage after the salvage operation. These were of varying types and differing contents. Furthermore, of the standard company issues, two were dated 1 April 1994 while two others had no date. The following points were noted:

a. The introduction referred to the AOM and the AFM for emergency procedures.

b. There were no "Bold Face" items contained in the checklists. It was also noted that there were no emergency checks detailed for propeller malfunctions or for take-off emergencies.

c. The first three actions required for an engine shutdown were as follows:

(i) Engine Condition Lever: "Feather" (by Copilot).

(ii) Fire Emergency Control Handle: "Pulled" (by Copilot if fire nacelle overheating or visible fluid leak is indicated).
(iii) **Fire Extinguisher Agent:** "Discharged" (by Copilot if fire or nacelle overheat is indicated).

### 1.17.5 Other aircraft manuals

Other aircraft manuals considered pertinent to the circumstances of the accident were subsequently found in the recovered wreckage. These included a manual for the 3-day Hercules Flight Simulator Refresher Course for PAS aircrew held in Singapore by the Asia-Pacific Training and Simulator PTE Ltd, and a Lockheed manual dealing with Low Speed Qualities of the Hercules. Relevant extracts from these manuals are as follows:

#### 1.17.5.1 Refresher Course manual dated 23 and 26 June 1994

- **a.** The manual refers to engine shutdown "Bold Face" items.

- **b.** Exercise 1 included practice on engine failure after take-off for both inboard and outboard engine. It also included a discussion on engine failure after take-off and engine malfunction after take-off.

- **c.** Exercise 2 was carried out at Hong Kong on both Runway 13 and Runway 31. It also included a demonstration of a propeller malfunction.

- **d.** Exercise 3 included a discussion on 3 and 2 engine operation and also had an optional $V_{MCA}$ demonstration.
1.17.5.2 Low Speed Flying Qualities Manual

In the introduction, the manual states that its purpose is to provide additional understanding and not to supersede the AFM. Among other subjects, it includes the following comments on $V_{MCA}$, Stall Speeds and Low Speed Controllability:

a. $V_{MCA}$ is defined as the lowest airspeed at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane with that engine still inoperative and continue straight flight.

b. Asymmetric power produces a lift differential between the left and right wing, thereby inducing a rolling moment on the aircraft. This induced moment is greatest at low airspeeds when an outboard engine fails and the remaining engines are operating at take-off power.

c. Under certain conditions, such as take-off or go-around, it may not be possible to reduce power on the opposite engine following an engine failure. Then the yawing moment must be balanced by the rudder. Aileron control is used to balance out the rolling moment and to maintain a bank angle. Bank angle offsets the side force induced by the rudder.

d. Using 5° favourable bank and favourable sideslip produces significantly lower $V_{MCA}$ speeds than trying to maintain either zero sideslip or wings-level attitudes. All FM $V_{MCA}$ speeds assume 5° of
favourable bank is maintained; it also assumes that full rudder deflection or 180 lbs pedal force is applied.

e. Directional control is most critical with No. 1 engine inoperative and the aircraft at minimum flying weight. The failure of the No. 4 engine produces a situation that is less critical than the failure of the No. 1 engine because of the influence of power on the lateral-directional aerodynamic characteristics of the aircraft. However, roll control requirements are larger with the No. 4 engine failed than with No. 1.

f. $V_{MCA}$ is increased by 20 kt with 5° of adverse bank at minimum flying weight and increases even more as gross weight increases. Note: A diagram in the manual shows an increase of 30 kt with 5° of adverse bank at 124,000 lb which approximates the estimated weight of the aircraft at the time of the accident.

g. "Power-off" stall speeds, which are presented in the FMs, are greater than "Power-on" stall speeds.

h. Stall warning consists of light airframe buffet that increases to moderate or heavy buffet at the stall.

1.17.6 Lockheed Information

During the investigation, Lockheed Aeronautical Systems Company carried out a flight dynamics technical assessment and analysis of various take-off scenarios. This modelling report is included as Appendix 15 and was of significant value to the investigators. The
Company also provided prompt information in response to questions from the Investigation Team. Those considered relevant to the investigation are as follows:

a. There are no circuit breakers or electrical components on Fuselage Station 245 panel that would inhibit engine/prop operation once running.

b. Depending on landing gear extension and compression, with a right wheel on the ground 14-15° bank will result in contact with the ground by the right propellers or wing tip.

c. Fuel tank boost pump failure would not cause a significant power loss on take-off with crossfeeds closed.

d. Confirmation of stalling speeds are as follows:

(i) Power-off stall speed, wings level : 98 KIAS
(ii) Power-off stall speed, 15° bank : 100 KIAS
(iii) Power-off stall speed, 30° bank : 105 KIAS
(iv) Power-off stall speed, 45° bank : 115 KIAS
(v) Power-on stall speed, wings level : 80 KIAS
(vi) Power-on stall speed, 48° bank : 116 KIAS

e. $V_{mca}$ is based on a certain set of circumstances, one of which is the assumption of 5° bank away from the failed engine. It is also split between being in or out of ground effect; in ground effect being at a height approximately equal to half the wing span i.e. 66 feet based on the Hercules wing span of 132 feet. There are significant differences if the wings are level or with 5° of bank towards the failed engine. These speeds are as follows:
(i) Ground effect $V_{MCA}$ $5^\circ$ bank away : 103 KIAS
(ii) Out of ground effect $V_{MCA}$ $5^\circ$ bank away : 105 KIAS
(iii) Ground effect $V_{MCA}$ wings level : 113 KIAS
(iv) Out of ground effect $V_{MCA}$ wings level : 115 KIAS
(v) Ground effect $V_{MCA}$ $5^\circ$ bank towards : 134 KIAS
(vi) Out of ground effect $V_{MCA}$ $5^\circ$ bank towards : 136 KIAS

1.17.7 Airport radar data

Subsequent to the accident, radar recordings were scrutinised to establish what, if any, relevant information on the accident flight was available. These were from two radar sites. One was a COSSOR 990 Secondary Surveillance Radar (SSR) located southeast of the Airport on Mt Parker at 2216.18N 11413.27E. It recorded a single secondary response, based on the aircraft's known transponder setting of 5327, at 11:15.13 hrs. This showed the aircraft close to the runway but the height indication was showing between ground level and 100 feet based on standard pressure setting and the known radar limits. It confirmed the transponder setting, but could not be used for the extraction of any further useful information. The other was a CARDION CMSSR-401 Approach Secondary Surveillance Radar (ASSR) located on top of Beacon Hill to the north west of the Airport at 2221.07N 11410.00E. This radar has an antenna rotation speed of 12 RPM and therefore updates every 5 seconds. A computer print out of the radar recording contained a total of 28 consecutive responses from the 5327 transponder covering the period 11:13.11 hrs to 11:15.23 hrs. The intervals are accurate but the initial time is manually set from a different clock and so the start and end times are not precise.

The responses were plotted by the Hong Kong Government Lands Department Survey and Mapping Office (SMO) using appropriate corrections to compensate for the slant range. Following comparison
with the responses of another aircraft which took-off before HLA 01 and was known to have tracked the runway centre-line, the SMO was able to establish a fixed radar correction. This was then applied to the responses of HLA 01. The results are shown in Appendix 6. These responses are based on known radar characteristics; i.e. the radar discrimination is 115 metres radially and .088° in angular distance. Therefore, to illustrate the possible position of each return an "error box" has been superimposed on each response. There was no height indication on any response indicating that the aircraft was ever above 200 feet based on standard pressure setting and the known radar limits.

This information was correlated with the ground mark and the available FDR information to give the flight path of the aircraft.

1.17.8 Simulator Trial

Following the accumulation of evidence and the receipt of the Lockheed modelling report (Appendix 15), two investigators visited the simulator at Royal Air Force Lyneham for a practical trial to assess the problems associated with No. 4 propeller going into the Beta range. The trial consisted of noting the engine indications following No. 4 propeller going into the Beta range and then watching crew responses to this emergency.

The initial indication was the engine torque decreasing rapidly to a negative level which resulted in the pointer moving through almost 180°; unless the movement was seen, the indications on all 4 torque gauges could then appear to be the same. Shortly afterwards, the RPM increased slowly and then the TIT began to decrease.

Two simulator instructors, who were current and had substantial experience on the Hercules, were then briefed on the possibility of
No. 4 propeller going into the Beta range. Each of them, on multiple occasions, were given this emergency one second after take-off at speeds between 120 and 125 KIAS; the extent of the Beta range was varied and they were asked to use different amounts of rudder. It was found that the aircraft was controllable but the subjective view of both pilots was that the situation was marginal and that pre-warning of the emergency was a significant factor in the successful outcome.

The opportunity was then taken to give operational crews the same emergency but without any pre-warning. All Royal Air Force crews are subjected to monthly simulator exercises and normally experience some sort of take-off emergency on each exercise. The trial was necessarily limited because of the need to create realism but, of the 9 crews examined, 6 were unable to control the aircraft following No. 4 propeller going into the Beta range.

1.18 New investigation techniques

None.
2. ANALYSIS

2.1 General

The crew were qualified to carry out the flight and the aircraft appeared fully serviceable prior to take-off; the weather was well within the capabilities of the crew and the safety speeds had been correctly computed and briefed by the commander. Up to lift-off, the aircraft performance appeared normal, but the commander was aware of a problem shortly after PK-PLV became airborne. No information could be obtained from the CVR and the information obtained from the FDR was limited. Additionally, the only surviving crew member was the commander, and because he was concentrating on attempting to retain control of the aircraft, his information regarding engine instrument indications was understandably limited. Nevertheless, his recollections were of paramount importance to the investigating team. The radar information was also extremely valuable in correlation with the information from the FDR. The direction of the ground mark corresponded very closely to the projected flight path of PK-PLV and would not have been caused by a vehicle or another aircraft. From the characteristics and location of this ground mark, it is believed that it was caused by the starboard undercarriage of PK-PLV.

Accordingly, this analysis attempts to define:

a. when a problem first arose,
b. what the problem was,
c. whether the aircraft remained controllable and the accident could have been averted, and
d. other aspects which, although not having any direct bearing on the accident, were considered pertinent to the aircraft's operation and the survivability of the occupants.
2.2 Take-off Run

Radar information indicates that PK-PLV started its take-off run from the normal position on Runway 13 (as shown at Appendix 6). This was confirmed by statements from the commander and the ATC Tower Air Movements Controller. The commander also stated that prior to brake release the engines were indicating normally when set to 5,000 in-lb torque. Although there were two ground observers who considered the take-off to be slightly slow, correlation of the stated take-off speeds and FDR and radar information indicated that PK-PLV was performing in accordance with the aircraft specification up to the point of lift-off. Furthermore, the commander and other surviving personnel considered that the take-off was normal. Finally, the Lockheed flight dynamics technical assessment and analysis (reproduced in Appendix 15) confirmed that the ground roll derived from the radar data was consistent with all 4 engines operating normally and at full power.

2.3 Initial Problem

The commander stated that he had the first indication of a problem shortly after he saw the first officer reach for and move the gear handle. He became aware of a high pitched noise from his right and then realised that he was applying left aileron because the aircraft was banking to the right. Although incorrect aircraft configuration or a flight control malfunction was unlikely the possibility was considered.

The flap setting for take-off was 50 percent and the likelihood of asymmetric flap was discounted because of the normal take-off and rotation experienced by the commander, and the physical position of the flaps found after aircraft wreckage recovery.

However, it was not possible for the integrity of the control systems to be fully checked because of the incomplete salvage. Nevertheless, there were other
indications that the problem was not initiated by control difficulties. The commander heard the high pitched noise from his right and one of the positioning crew (a flight engineer) in the passenger compartment also heard an unusual noise but could not tell the location. Furthermore, as the commander was trying to retain control of the aircraft he looked at the engine instruments and noted some abnormalities with No. 4 engine; the RPM was higher than normal and the TIT was slightly low and reducing slowly. These observations led to the conclusion that the initial problem was with the No. 4 power plant.

2.4 Wreckage Evaluation

Although a large proportion of the wreckage was recovered, certain significant items, such as the complete powerplant control system, was missing and not available for examination. Additionally, the severe secondary damage sustained during the salvage operation resulted in further loss of information.

The throttle lever angles discovered in the cockpit after recovery could not be relied upon to give pre-impact conditions; not only had the engines torn away from their mountings and control linkages, but the crew's attempts to escape could have altered the control positions. This is illustrated by the fact that although the flap levers were found in the UP position, the flaps were physically at the 50 percent position.

Propellers numbers 1, 2 and 3 were found to have struck the water with their blade angles at flight idle. However, the number 4 propeller blade angle was in the Beta range at 14°, and its Beta switch cam was in contact with, but not operating, the Beta switch. In this condition the Beta light would not have illuminated. The TIT gauges examined showed readings of 640°, 655°, 665° and 460°C respectively.

These symptoms could be accounted for by an overspeed of No. 4 propeller, which would also produce a characteristic noise similar to that heard by the
commander. A propeller entering the Beta range during take-off would overspeed as its blade angle become progressively finer. The engine torque would quickly reduce and become negative as the propeller started to drive the engine. Then, as the RPM increased to approximately 105 percent, the overspeed governor would reduce the engine fuel flow, via the Fuel Control Unit, to the minimum flow figure in an attempt to control the overspeed. This would be consistent with an increasing RPM and a reducing TIT.

The logical conclusion to be derived from the Commander’s evidence of: No. 4 engine temperature decaying; No. 4 engine RPM rising; and the noise from his right hand side, coupled with the propeller blade angles and the turbine inlet temperature gauge readings noted after recovery is that the number 4 power plant was acting in a markedly different way from the other three, and that this was happening with the aircraft exhibiting an undemanded right roll. The Commander was unable to recollect the torque reading but, as discussed in §1.17.8, the torque could have already reduced to a negative value and it would have been difficult, with just a glance, to note any discrepancy.

It is therefore reasonable to relate these events and deduce that the initial problem originated with No. 4 engine or propeller which resulted in an asymmetric thrust condition and high drag.

2.5 Possible causes of high drag on number 4 engine/propeller

Within the flight range, a change of engine power would normally cause the propeller blade angle to alter to maintain 100 percent RPM. High drag can result from propeller blade angles which are inappropriate for the existing conditions of engine power and airspeed. This can be caused by a problem associated with either the propeller or the engine.
2.5.1 Engine or Fuel System Failure

A fuel system deficiency or a basic engine failure were then considered. Whilst these problems could have caused a propeller to overspeed if uncorrected, they could not cause the propeller to enter the Beta range in the absence of defects in the safety features incorporated in the propeller control mechanisms. Examination of the No. 4 propeller revealed all safety mechanisms were serviceable. Similarly, no basic defects were found within the rotating assemblies of No. 4 engine during strip; neither was there any faults found with the Bendix Fuel Control Unit on strip examination.

2.5.2 Propeller in Beta range

The strip examination showed that the No. 4 propeller had entered the Beta range before impact, the only possible causes for this are as follows:

a. Propeller goes into Beta range because of internal propeller problem.

b. Propeller is put into Beta range by crew.

c. Propeller was in the Beta range during the take-off roll.

d. Propeller commanded into Beta range by other than crew action.

2.5.2.1 Internal Propeller Problem

The propeller in-flight range, in which the propeller acts to maintain a constant speed, extends down to a blade
angle of approximately 23°. Below this angle the propeller is in the Beta range, in which the propeller blade pitch is directly controllable by the throttle. The propeller control mechanism contains a low pitch stop and a pitchlock mechanism designed to prevent the propeller inadvertently entering the Beta range. The low pitch stop is designed to prevent operation below a pre-selected minimum blade angle during flight. The operation of the low pitch stop may be bypassed by movement of the throttle levers aft of the Flight Idle Gate, or by improper manipulation of the throttle lever in the event of a throttle cable failure (or an equivalent input to the engine co-ordinator caused by a failure within the throttle cable system). The pitch lock mechanism is designed to prevent excessive decreases of blade angles in the event that the propeller governing ability is lost. However this safety feature is not operational near the Low Pitch Stop where the ratchet teeth are mechanically held disengaged at blade angles lower than 25°.

The examination of the No. 4 propeller showed that all safety features were serviceable. It follows from this fact that the propeller could not have entered the Beta range without an external command.

2.5.2.2 Propeller put into Beta range by flight crew

At the time the problem arose, the commander was handling the aircraft and was not touching the throttle levers. The flight engineer was in his normal seat and would normally have no need to touch or even guard the throttles. The commander, when interviewed, made no
comment about the flight engineer moving any controls. The only possibility would have been for the first officer to have inadvertently caught the No. 4 throttle lever, perhaps with his arm/sleeve as he brought his hand back after selecting the gear up. This was considered because of the commander's statement that he was aware of abnormalities at the time the gear was being selected up. However, to move the throttle into the Beta range requires a positive movement out of detent and moreover, the throttle levers are to the left of the condition levers and thereby partially protected by them (See Appendix 16 for relative location of the levers). Trials and discussion with a Royal Air Force Hercules Squadron indicated that this possibility would be highly unlikely. Furthermore had that been the case the first officer would have felt it and would undoubtedly have been alerted to it when the Captain called "Take action for No. 4".

2.5.2.3 Propeller was in the Beta range during the take-off roll

This is ruled out as performance calculations by Lockheed show that the aircraft would have become uncontrollable during the ground run if the number 4 propeller had been in the Beta range during the take-off roll.

2.5.2.4 Propeller commanded into Beta range by other than crew action

The only possibility left from those quoted above is that the propeller was commanded into Beta range by other than crew action.
Research revealed that mechanical interference between throttle and condition lever cables could produce unscheduled propeller or engine conditions. However, it is considered that this would not produce an undemanded entry into the Beta range unless there was a failure in the throttle cable system between a throttle lever and the engine. Such a failure within the cable system could include either a pulley failure or a cable failure.

A failure within the cable system between a throttle lever and the engine co-ordinator may involve one of the following conditions:

a. The throttle lever becoming partially or completely jammed.

b. Throttle lever movement not producing a corresponding power change, or even producing a power change in the opposite sense.

c. An uncommanded propeller blade angle movement, in either direction. In this situation the propeller could go into the Beta range. Given no throttle movement by the pilot, two failures must occur for the propeller to enter the Beta range, one on the 'increase power' cable and one in the cable tension regulator dampener.

There is no evidence of any improper throttle movement by the pilot. Examination of the throttle cables recovered were inconclusive. The cables recovered did not comprise a complete set, but represented approximately 66 percent
of the central fuselage circuit only. Furthermore, not all other components of the cable system including the cable tension regulators were recovered. It is therefore possible that a fault lay in the missing (and therefore unexamined) portion of the cable system. Lockheed L382G Series Progressive Inspection Programme SMP515-C-55, Work Card SP-125 outlines required testing for the tension regulators to be performed every 3,600 hours or 3 years. An inspection programme for PK-PLV scheduled at 12,600 aircraft hours dated 13 December 1990 included Work Card SP-125. However, maintenance records provided by PAS showed no record of Work Card SP-125 having been performed on PK-PLV. The inspection sign off sheet for the last major inspection at 12,600 aircraft hours which was carried out between 18 February 1991 and 26 September 1991 did not include Work Card SP-125.

The result of the wreckage evaluation was consistent with the commander's statement and reinforced the investigators' opinion that the cause of the accident was that the No. 4 propeller entered the Beta range. The most likely reason for this event was a No. 4 throttle cable system failure without associated throttle movement.

2.6 Lockheed Modelling

Following the initial investigation and wreckage examination, it was apparent that a malfunction affecting the No. 4 propeller sometime after PK-PLV became airborne was the initiating event which caused the accident. As stated in §2.2, the performance of the aircraft during the ground roll was consistent with all four engines developing full power. This performance evaluation was carried
out by Lockheed Aeronautical Systems Company following a meeting involving Accident Investigators and representatives from Lockheed, Allison Engine Company and Hamilton Standard. The Lockheed Flight Dynamics Division were asked to confirm that a malfunction of No. 4 engine/propeller could result in the flight path described by PK-PLV. They were also asked to calculate the most probable point at which the failure could have occurred. Finally, they were asked to advise on when, and if, the crew could have recovered the situation. Relevant parts of the Lockheed report included at Appendix 15 are discussed below. It should be noted that the Lockheed modelling assumed that the runway was at sea level whereas the actual runway elevation is 15 feet amsl. This would result in an impact point slightly further from the runway than shown in the modelling.

The modelling confirmed that there was no problem during the ground roll. The most likely scenario is that one second after lift-off, the No. 4 engine experienced a decrease in power output to somewhere between flight idle and maximum reverse. In the model the pilot is assumed to have applied full aileron but only partial rudder. This is based on the statements made by the commander shortly after the accident. Obviously, the precise moment of failure and the pilot’s inputs might not have been reproduced with complete accuracy; however, the modelling is sufficiently close to available radar and FDR information and the impact point to enable a reasonable assumption to be made that the most likely scenario postulated in the model is highly probable. The modelling results also included a comment that, if full rudder was applied, control of the aircraft could be maintained.

### 2.7 Aircraft Trajectory

From the FDR and radar data, the only information available on the altitude of the aircraft was that it did not climb above 100 feet. However, by correlating the Commander’s statement with the ground mark, it is evident that the aircraft was positively airborne when the First Officer announced "positive rate". The
aircraft then banked to the right and started to lose height. While the aircraft was about half-way across the grass strip, the retracting starboard undercarriage made brief contact with the surface. The aircraft remained at low altitude until impact with water. The Lockheed modelling also found that the aircraft would achieve a maximum height of only 15 feet before hitting the water.

2.8 Crew Actions

The lack of information from the CVR, the First Officer and the Flight Engineer makes it impossible to be certain about the actions of the crew members, particularly those that did not survive the accident. However, the commander provided information which was corroborated by the wreckage evaluation and the Lockheed modelling. Based on the most likely initiating event leading to the accident, the following questions need to be addressed:

a. What were the indications available to the crew and could they have realistically identified the problem?

b. Was the aircraft controllable?

c. What actions could the crew have taken to rectify the situation?

2.8.1 Indications of malfunction

During take-off, the handling pilot was concentrating on control of the aircraft. The duties of the First Officer, as the non-handling pilot, and the Flight Engineer are defined in the Company Manuals. Their primary responsibility is to monitor the aircraft instruments and to bring any discrepancies to the commander’s attention. In practice the First Officer would be concentrating on the flying instruments and the Flight Engineer would be concentrating on the engine instruments.
Unfortunately, the non-survival of the First Officer and the Flight Engineer means that their evidence is not available. The Commander stated that the first indication of a problem was when he heard a high pitched noise from his right and that he was aware of applying left control column because the aircraft was banking right. He then looked at and noted the anomalies on the RPM and TIT gauges. There was no doubt in his mind that there was a problem with No. 4 engine, but he could not identify the precise problem. The Commander made no comment about the torque but by that stage the No. 4 engine torque would have already decreased to a steady but negative state.

The investigators then examined relevant documents to ascertain what, if any, advice was available to crews in the event of a throttle cable failure resulting in a propeller going into the Beta range. The PAS manuals make no mention of throttle control cable failures. Furthermore, the Lockheed Flight Manual held by PAS was not amended up to date and also made no mention of that type of failure. Therefore, in the absence of any advice, it would be unreasonable for the crew to be criticised for failing to recognise the precise nature of the propeller problem.

2.8.2 Aircraft controllability

The Lockheed modelling considered that control could have been maintained but that full rudder was required. There is no doubt that the application of rudder should be the prime reaction for any asymmetric problem and there is some question about how much and when the commander applied the rudder. However, in the PK-PLV accident, there were certain complicating factors. The problem arose at a very critical time when the First Officer had just selected gear up and was probably monitoring the gear indications. This effectively took him out of the loop for a few vital seconds. Additionally, one of the unknown
factors is the speed at which the propeller moved into the Beta range. Discussions with a Hercules engineering authority in the United Kingdom indicate that a throttle cable system break could result in an almost instantaneous movement of the propeller into Beta range. The result could be thrust decreasing very rapidly from a maximum of plus 8,500 lbs to approximately minus 10,000 lbs. As stated in a Lockheed briefing document, moving the propeller into Beta range in flight would cause wing lift loss and extremely high drag, resulting in dramatic loss of control. There is thus some confliction between the Lockheed documents about whether control could be maintained. Furthermore, the simulator trial with the cooperation of the Royal Air Force (discussed in §1.17.8) showed a 66 percent probability of losing control. In summary, although there was a theoretical possibility of retaining control, the timing and the nature of the problem meant that to maintain control would be extremely difficult.

2.8.3 Possible corrective action

The only actions open to the crew was to reduce the asymmetric thrust by reducing the thrust on No. 1 engine or by feathering the No. 4 propeller. The Commander did retard No. 1 throttle a little but he was not aware of any recognisable benefit and had then instructed his other crew members to 'Take action for No. 4'. While not a recognised Company instruction, it was a reasonable command to give bearing in mind the commander's overriding need to try and maintain control and his understandable lack of knowledge of the exact problem. The company procedures are that the non-handling pilot should carry out any necessary actions following the commander's orders and the flight engineer is responsible for monitoring and confirming those actions. Furthermore, the Lockheed Flight Manual held by PAS advised the crew to continue to operate the engine unless a fire was indicated and to accelerate to 135 kt. The PAS Training Manual required the gear to be
retracted and then for the propellers to be feathered while banking 5° towards the live engines and to use full rudder. Even if the crew had retarded the No. 1 throttle to flight idle, the adverse drag from No. 4 engine would still result in a significant asymmetric condition while drastically reducing the climb capability.

The only solution was to eliminate the adverse drag from the No. 4 engine by feathering the No. 4 propeller. However, during the course of the investigation the investigators became aware that the throttle cables are in close proximity to the condition lever cables and there is the possibility that a throttle cable break could cause interference with the condition lever cable. If that happened a subsequent movement of the condition lever could have an undesired effect on the propeller. The most sensible action would be to feather the propeller by the use of the Fire Emergency Control Handle. This is the procedure detailed in the Royal Air Force manuals in the event of a suspected throttle cable malfunction. There is no way of knowing what action, if any, was taken by the First Officer or the Flight Engineer to try and contain the situation. With the lack of information available in the PAS manuals and the Lockheed FM held it is not surprising that the condition was not recognised or rectified. Wreckage investigation showed that Nos. 1, 2 and 3 engines were at flight idle at impact and is an indication that the throttles were brought back prior to impact. This could have been a reaction by a crew member when it was realised that a crash was inevitable. Bearing in mind the lack of information available to the crew about a cable malfunction, it is difficult to even surmise what actions the First Officer or Flight Engineer could have taken.

A propeller malfunction immediately after take-off is acknowledged as critical on the Hercules. As previously discussed, it is difficult to diagnose and to react correctly. As also discussed in §1.17.6, the basic
$V_{mca}$ figures of 103 to 105 kt, in and out of ground effect respectively, are based on 5° bank away from the failed engine. If the wings are level, approximately 10 kt should be added to the basic figure. With 5° bank towards the failed engine, then approximately 30 kt should be added to the basic figure and this would result in a $V_{mca}$ of 134 to 136 kt. FDR and Radar information indicate that PK-PLV achieved approximately 125 kt as the aircraft left the side of the runway and reached a maximum of 133 kt in the last 10 seconds of flight. From the Commander's statements and other eye witnesses' reports the bank angle of the aircraft, shortly after take-off, was noticeable and probably greater than 5° towards the right. With No. 4 propeller moving into the Beta range, the drag and resulting $V_{mca}$ would be higher than stated above. Therefore, with the malfunction occurring at low speed and at low altitude, the situation was irrecoverable once the aircraft reached 5° of bank towards the malfunctioning power plant.

In summary, the crew were faced with an extreme emergency at a critical time of flight. While the Commander's failure to immediately apply full rudder degraded his chances of keeping control of the aircraft, the timing of the malfunction left him with little chance of containing the situation. Once the aircraft had banked towards the No. 4 engine, recovery was impossible without the benefit of height.

2.9 Other Aspects

2.9.1 Certificate of Airworthiness (C of A)

A C of A recovered from the aircraft designated the aircraft in the cargo category, whereas PK-PLV was in a passenger configuration and had been used as passenger transport at least for two days prior to the accident. A further valid C of A certifying the aircraft for spraying only was also recovered. Although the issuing authority stated that the
aircraft was approved and certified properly for the international carriage of passengers, no C of A in the passenger category was recovered from the wreckage.

2.9.2 Company manuals/checklists

Various anomalies were noted within the company manuals and checklists. For example, as stated in §1.17.5.1, the simulator training refers to "Bold Face Items" but there is no indication of any in the checklists. The checklists found within the cockpit were of different types and with different contents but contained no procedures for propeller malfunctions. Additionally, the PAS Operations Manual states that: "The flight engineer is not allowed to stop an engine during take-off without the express command to that effect, unless for certain conditions as indicated in the relevant AOM"; however, the AOM contains no such information. Finally, the PAS copies of the Lockheed FM and OMs do not contain the latest amendments. It would be appropriate for PAS to critically review their company manuals and checklists to ensure that they are consistent, accurate and current.

2.9.3 Liferafts

As stated in §1.15.2.1, there were 4 liferafts on board giving a total capacity of 80. However, the flight plan referred to a liferaft capacity of 150 persons and the aircraft was in a 128 passenger configuration. Although there was insufficient liferaft capacity for the declared passenger fit, under the State of Registry's Civil Aviation Safety Regulations Section 42.2.2, life rafts in sufficient numbers to carry all persons on board are only required on flights over water that are more than 120 minutes flying time at normal cruising speed away from land. It would be appropriate to point out that the four passenger flights undertaken between Hong Kong and Hanoi prior to the accident flight
did not involve flying over water more than 120 minutes flying time at normal cruising speed away from land.

2.9.4 Seat belts

The operating crew were correctly strapped in to their seats but other surviving personnel in both the cockpit and passenger cabin have admitted to not wearing any seat belts. Although the Commander is responsible for ensuring that seat belts are worn by all of those on board his aircraft, the fact that everyone was a crew member places some responsibility on them for their own safety. It is not possible to establish the survivability with, or without, seat belts in this accident but the use of seat belts is acknowledged to play a major factor in survivability in any accident. The restraint provided by seat belts helps to minimize injuries during any sudden or violent aircraft manoeuvres, and reduce the chance of disorientation once the aircraft has come to rest in an accident. It would be appropriate for PAS to re-emphasise the importance of seat belts to their crews.

During the investigation, some passengers from the previous flight were interviewed and they were unanimous in stating that a passenger briefing was given and that the fastening of seat belts rule was enforced.

2.9.5 Wire locking of Emergency Exits

Steel wire was used as a "tell-tale" on the two emergency exit jettison handles that were found in the closed position to indicate whether the emergency exit has been tampered with. The wire normally used in this type of application is copper wire with a very low breaking strain. The use of steel wire could prevent the opening of the exit in the event of an emergency. Although post-accident tests showed that in this case the use of steel wire would not prevent the opening of the exit in the event
of an emergency (see Appendix 9), it is recommended that PAS conduct a review of all their aircraft to replace any steel locking wire used in situations where copper "tell-tale" wire should have been specified.

2.9.6 Emergency Lighting

Emergency lighting is provided by portable battery operated units located throughout the aircraft. These units have three-position ON, OFF, ARM switches. Five units were recovered from the wreckage and all five were found to have their switches in the OFF position. Since non-operation of emergency lighting could impede escape from a crashed aircraft PAS should provide appropriate instructions for arming the lights to crews.

2.9.7 Air Traffic Services

As noted in §1.7.3, the crew of PK-PLV never acknowledged the ATIS message identification letter notified by ATC on first contact and ATC did not take any steps to obtain an acknowledgement. Furthermore, the crew were never informed of subsequent changes to the ATIS prior to take-off. Although the difference between the current QNH and the setting found on the altimeters following the wreckage recovery was small and not relevant to this accident doubt exists as to whether the crew had received and set the correct QNH which, under different circumstances, might have an adverse effect on flight safety. Hong Kong ATC has subsequently reminded their controllers to ensure that crews have the current ATIS.
2.9.8 Lockheed Flight Manual

As discussed in §2.8.3, the Royal Air Force manual relating to the Hercules discusses the possible effects of a throttle cable failure on the condition lever cable and emphasises the dangers of subsequently moving the condition lever but the Lockheed FM held by PAS did not include any reference to a throttle cable failure. One of the more recent Lockheed FMs (FM 382T-50F) which was not issued to PAS includes a warning about throttle cable failure. It advises crews to shut the engine down in accordance with the Engine Shutdown Procedure and the first action in the shut down procedure is to pull the condition lever to feather. To avoid the possibility of any undesired effects on the propeller it would be prudent for Lockheed to review their advice to operators of the Hercules in the handling of a suspected throttle cable failure.

2.9.9 Maintenance

The known failures associated with the carbon steel 7 x 7 cables in the United Kingdom have, in the main, been caused by corrosion of the heart strand cable in the vicinity of fuselage station 245. Such failures were not evident on the surface of the cable, and were therefore not likely to be found by the inspection detailed in SP-77.

The adoption of the stainless steel control cables appears to offer two advantages: longer life, and the change of mode of failure from corrosion and fatigue to wear on the outside of the cable from pulleys and fairleads. Thus early signs of failure can be more easily detected by the presence of broken or worn wires on the outside of the cables. Lockheed should consider making it mandatory for stainless steel control cables to be used.
It is recommended that PAS review their engine and condition control cable maintenance policy for any other Lockheed Hercules aircraft they may have, and consider retrofitting stainless steel control cables in place of carbon steel cables. PAS should also ensure compliance with the L382G Series Progressive Inspection Programme SMP515-C-55.
3. CONCLUSIONS

3.1 Findings

3.1.1 The aircraft commander was properly licensed and qualified to command the flight.

3.1.2 The remaining flight crew were properly licensed and qualified to carry out their duties.

3.1.3 The commander was in the left seat and was the handling pilot.

3.1.4 The aircraft was correctly loaded and there were sufficient fuel reserves on board.

3.1.5 The aircraft carried a C of A in the cargo category despite the State of Registry having stated that the aircraft had been certified and approved for passenger carriage. It was in a passenger configuration and had been operating as passenger transport prior to the accident flight.

3.1.6 The aircraft was equipped with insufficient liferafts to accommodate the maximum number of crew and passengers that could be carried. On the accident flight and the two preceding flights the carriage of liferafts was not required under the relevant Indonesian Regulation.

3.1.7 Not all personnel were wearing seat belts.

3.1.8 Steel instead of copper wire was used as a "tell-tale" on two emergency exit jettison handles.
3.1.9 All five units of emergency lights recovered were found to have their switches in the OFF position.

3.1.10 Hong Kong Air Traffic Control did not advise the crew of PK-PLV of changes in the ATIS nor ensure that the crew had the correct QNH.

3.1.11 The telephone number for the Port Health Medical Officer listed in the emergency alerting list was inappropriate.

3.1.12 Various anomalies existed in the PAS manuals and checklists.

3.1.13 The Lockheed Operations Manual and Flight Manual provided for PK-PLV by Pelita Air Service were not amended up to date.

3.1.14 The No. 4 propeller of PK-PLV entered the Beta range shortly after the aircraft becoming airborne.

3.1.15 The most probable cause of the No. 4 propeller going into the Beta range was a failure within the No. 4 throttle cable system.

3.1.16 A ground mark found on the grass strip was believed to be caused by the starboard undercarriage of PK-PLV.

3.1.17 Aircraft control could have been maintained following the emergency but the nature of the problem required an immediate and positive response. In practice, it is unlikely that a crew would be successful in retaining control given the relatively low speed and low altitude of the aircraft at the time of the occurrence.

3.1.18 The crew of PK-PLV were unable to retain control of the aircraft following the emergency.
3.1.19 The Hercules Manuals produced by Pelita Air Service for the Investigation Team did not contain information about throttle cable failures.

3.1.20 Recent Lockheed Flight Manuals contain a procedure in the event of a throttle cable failure which may not be appropriate for all situations.

3.1.21 The cables fitted to PK-PLV were the original 7 x 7 carbon steel cables which had flown in excess of 15,000 hours.

3.1.22 Maintenance records provided by Pelita Air Service showed that a one time visual check of the engine throttle control cables called for by SB 382-76-10 was performed on 25 May 1987 at 9,757 aircraft hours with satisfactory results, but the periodic checks required by the L382G Series Progressive Inspection Programme SMP-515-C-55 had not been carried out.

3.1.23 Maintenance records provided by Pelita Air Service showed no record of the periodic testing required for cable tension regulators by the L382G Series Progressive Inspection Programme SMP-515-C-55 having been carried out.

3.2 Causal factors

The following causal factors were identified:

3.2.1 The No. 4 propeller entered the Beta range shortly after the aircraft became airborne.

3.2.2 The crew were unable to retain control of the aircraft following this occurrence.
4. SAFETY RECOMMENDATIONS

It is recommended that:

4.1 Pelita Air Service conduct a review of their aircraft and replace any steel wire found being used where copper "tell-tale" wire is specified.
   (Note: Pelita Air Service has advised that this recommendation has been implemented.)

4.2 Pelita Air Service critically review their company manuals and checklists to ensure that they are consistent, accurate and current.
   (Note: Pelita Air Service has advised that this recommendation has been implemented.)

4.3 Pelita Air Service re-emphasise the importance of wearing seat belts to their crews.

4.4 Pelita Air Service review their engine and condition control cable maintenance policy for any other Lockheed Hercules aircraft they may have, and consider retrofitting 7 x 19 CRES control cables with immediate effect.
   (Note: Pelita Air Service has advised that this recommendation has been implemented.)

4.5 Pelita Air Service review their maintenance management procedures to ensure compliance with the inspection frequency required for engine control cables and cable tension regulators by SMP 515-C-55.

4.6 Pelita Air Service issue appropriate instructions to crews for the arming of emergency lights.
   (Note: Pelita Air Service has advised that this recommendation has been implemented.)
4.7 Hong Kong Air Traffic Management ensure that the information contained in the emergency alerting list is appropriate and up to date.
(Note: Hong Kong Air Traffic Management has taken action to have the list amended.)

4.8 Lockheed Martin Aeronautical Systems review their advice to operators of the Hercules aircraft in dealing with a suspected throttle control cable failure.
(Note: Lockheed Martin Aeronautical Systems has commented that it has reviewed the flight manual emergency procedures for throttle cable failure and has drafted a change to give the crew the option of using only the fire handle to shut down the engine after suspected cable failure.)

4.9 Lockheed Martin Aeronautical Systems consider issuing an Alert Service Bulletin recommending change to stainless steel cables for all throttle and condition control cables.
(Note: Lockheed Martin Aeronautical Systems has commented that although the 7 x 19 cables are the preferred replacement, properly maintained and inspected 7 x 7 cables are acceptable if the operator chooses to use them.)

These recommendations are addressed to the regulatory authority of the State having responsibility for the matters with which the recommendation is concerned. It is for that authority to decide whether and what action is taken.
(The invaluable contribution by the following organisations acknowledged :-

The United Kingdom Air Accidents Investigation Branch
The Royal Air Force
Lockheed Martin Aeronautical Systems
Hamilton Standard
Allison Engine Company
Allied Signal Aerospace)

H.C. KWAN
Inspector of Accidents
Accidents Investigation Division
Civil Aviation Department
Hong Kong
is gratefully

Appendices
GENERAL LOCATION OF CREW WITH INDICATION OF FATALITY/DEGREE OF INJURY SUSTAINED

1. Commander - minor
2. First Officer - fatal
3. Flight Engineer - fatal
4. Positioning Crew Member (Captain) - fatal
5. Positioning Crew Member (Engineer) - serious
6. Positioning Crew Member (First Officer) - serious
7. Senior Purser - fatal
8. Positioning Crew Member (Engineer) - fatal
9. Positioning Crew Member (Cabin Attendant) - minor
10. Positioning Crew Member (Captain) - fatal
11. Cabin Attendant - serious
12. Cabin Attendant - serious
128 PASSENGER CONFIGURATION

TRIM STATION
Appendix 4

Comparison of 7 X 19 and 7 X 7 Cables

7 X 19 CABLE

20 OR MORE WIRES OVER 180° OF STRAND

MAGNIFIED VIEW SHOWING SECTION OF 7 X 19 AND 7 X 7 CABLE LYING ADJACENT FOR COMPARISON

7 X 7 CABLE

11 OR LESS WIRES OVER 180° OF STRAND

TYP CROSS SECTION OF 7 X 19 CABLE

WIRE

OUTER STRAND

A

TYP CROSS SECTION OF 7 X 7 CABLE

WIRE

OUTER STRAND

B
LEGEND:

- RADAR POINT & PROBABLE AREA OF AIRCRAFT
- GAZETTED POSITION OF BUOY
- REPORTED WRECKAGE POSITION IN THE SEA

PLAN OF THE SURVEY OF AIRCRAFT CRASH RK-PLV ON 23/9/94

PREPARED BY: GEODETIC SECTION
SURVEY & MAPPING OFFICE
Fuselage sides recovered

Right Side View
Wing and Horizontal Tailplanes recovered

Plan View
Wreckage - Aircraft Wing Section
Wreckage - Aircraft Mid Section
Wreckage - No. 1 Propeller Assembly

Wreckage - No. 2 Propeller Assembly

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engine instrument panel

1. propeller beta range light
2. torquemeter
3. engine inlet air duct anti-icing on light
4. tachometer
5. turbine inlet temperature
6. fuel flow
7. oil temperature
8. low oil pressure warning light
9. oil pressure
10. prop low oil quantity master warning light
11. oil quantity
12. oil cooler flap position
13. engine low oil quantity warning light

note

airplanes 4875 and up.
Appendix 9

Hong Kong Aircraft Engineering Company Limited
Calibration and Metrology Centre
Test Report

LOCK WIRE

Customer: CIVIL AVIATION DEPARTMENT Date: 01 DEC 1994

Test Condition: Ambient Temperature: 23 ± 2 °C, R.H.: 50 ± 10 %

Test equipment used:
(1) Tensile machine model HTC
(2) Load Cell S/N: 4424

Method:

Break down test of the lock wire was carried out in CALMET by applying tensile force at the ends of the wire during test. One end of the wire was tied on the Load Cell, the other end was tied on the bottom platform of the tensile machine.

Measurement:

(1) The temperature during calibration was 23 ± 2 °C.
(2) During test, the applied tensile force was increased with one lbf interval.

Result:

Test 1: The lock wire was broken at 54 lbf.
Test 2: The remains portion was tested again and the break down force was measured at 59 lbf.

Uncertainty of measurement: ± 0.35 lbf.

Equipment used for calibration have been calibrated by our laboratory standard instruments which are traceable to National Standard through:

NANAS Certificate No.: TO8585.

Worked By: [Signature]
Supervisor: [Signature]
Date Check: 01 DEC 1994
Approved by: [Signature]
AIRCRAFT ACCIDENT REPORT

Prepared by Mr. Kirk Chamberlain
Hamilton Standard Accident Investigation Team

Registered Owner: PT Pelita Air Service
Operator: Pelita Air Service
Aircraft Type: Lockheed Hercules L100-30 G382
Nationality: Indonesian
Registration: PK-PLV
Place of Accident: Hong Kong International Airport
Date and Time: 23 September 1994 at 1115 hours
1.0 MISHAP SUMMARY:

Hamilton Standard received notification from the Lockheed Safety Office of a mishap at the Hong Kong International Airport involving a chartered Indonesian Lockheed Hercules L100-30 owned by Pelitia Air Service. The aircraft on take-off from runway 13 at Hong Kong International Airport was observed to bank to the right shortly after take-off. The aircraft continued in a low altitude right bank until impacting the water in Kowloon bay in a nose low, right wing low attitude. The aircraft rotated about the right wing and sank to a depth of approximately 16 meters. The wreckage was declared a marine hazard and a salvage operation was conducted from September 25 through September 30 which resulted in the recovery of most of the fuselage including the cockpit, wings, and tail section. Three engines including number 4 were recovered along with three propellers (but not including number 4). A sonar search located the missing engine and propeller within two days and they were recovered. The aircraft had twelve persons on board with 6 fatalities. The pilot was one of the survivors.

2.0 PROPELLER DESCRIPTION:

The propeller is a Hamilton Standard 54H60-117, variable pitch, full feathering, reversing propeller with a 13'6" diameter. In flight regimes, the propeller in conjunction with the control maintains the engine at a constant speed of 100% (1020 RPM) by varying the propeller pitch (blade angle) to maintain an on speed, 100% condition. When operating in the beta range (ground range), the propeller blade angle can be positioned by throttle movements for ground handling and reversing. The propeller can be feathered in flight for engine shutdown to minimize drag.

The two major components of the propeller are the propeller assembly and the control. The propeller assembly includes the barrel assembly, four blade assemblies, the pitch lock regulator, and the dome assembly containing the low pitch stop. The barrel assembly retains the propeller blades and pitch lock regulator. The dome assembly is the pitch change mechanism and contains the low pitch stop.

The control consists of two components, the valve housing, and pump housing assemblies. The control is a non-rotating assembly and is located on the rear barrel half extension between the propeller assembly and engine gear box. The pump housing contains the oil reservoir and pumps that supply the valve housing with the proper hydraulic pressure to vary the propeller blade angles. The valve housing contains a servo governor and several additional valves that route the pressure to increase or decrease blade angle based on an input from the cockpit.
3.0 OBJECTIVE:

The disassembly and examination of the four propeller assemblies was conducted to determine the propeller blade angles at the time of impact. The force of ground or water impact on the blades leaves two parallel witness marks on the shim plate located between the propeller blade shank and barrel stub arm. Since the position of the shim plate is fixed in relation to the blade, there is a direct correlation to determine the blade angle at impact. The blade angle at impact is determined by placing a protractor over the shim plate and aligning the dowel pin holes. A line is established parallel to the witness marks running directly through the center of the protractor and then the angle is directly read off the protractor.

4.0 DISASSEMBLY SITE AND ATTENDEES:

The four propellers were delivered to Hamilton Support System, East Windsor, Connecticut on October 18, 1994, for disassembly and examination. Propeller #1, S/N N237885, propeller #2, S/N N237765 and propeller #3, S/N N237889 were disassembled by Hamilton Standard personnel on November 2nd, 3rd, and 4th respectively.

Witnesses During Disassembly:

Kirk Chamberlain       Hamilton Standard
Peter Hryniewicz       Hamilton Standard
Tony Mauro             Hamilton Standard
Tom Ottone             Hamilton Standard

Propeller #4, S/N N236010, was disassembled and examined by Hamilton Standard personnel on November 7, 1994. In attendance for the disassembly were representatives from the Department of Transport - Air Accidents Investigation Branch, Lockheed, and Allison Engine Company.

Witnesses During Disassembly:

Stuart Culling         Senior Inspector of Accidents - Department of Transport
William Mitchell       Lockheed
Jim Shand              Lockheed
Scott Scheurich        Allison Engine Company
Kirk Chamberlain       Hamilton Standard
Peter Hryniewicz       Hamilton Standard
Tony Mauro             Hamilton Standard
Photographs were taken prior to and during disassembly and examination of all four propellers. Data from the propeller disassembly and examination is attached in appendix #1.

5.0 PROPELLER DISASSEMBLY AND EXAMINATION

5.1 PROPELLER NO. 1: LH OUTBOARD S/N N237885

A. Initial Observation of Propeller

The propeller was received with the front spinner, rear spinner and afterbody attached. The nose cone area of the front spinner was crushed and delaminated. The number 2 and 4 blades were intact and bent forward. The number 2 blade was missing 4 inches of the blade tip at the L.E. (leading edge) crossing diagonally to the T.E. (trailing edge) where 8 inches were missing. Sections of foam were missing from the L.E. and T.E. foam faring on the number 2 blade. The number 4 blade was intact. Both blades were cut off at approximately the 36 inch station for shipment. The number 1 and 3 blades were broken off at the barrel and not recovered. Blade impact sequence could not be determined. The pump housing and valve housing were still assembled and the control was intact on the rear barrel half extension. The propeller shaft and front gear box including the bull gear was still attached to the propeller. Corrosion was present on the outside surfaces from the propeller being submerged in salt water. The propeller log books were examined and no discrepancies were noted except that there were no entries in the log book regarding the 1200 hour dome piston reseal as noted in U.S. Air Force Technical Order 1C-130A-6.

B. Observations During Disassembly

The front spinner and afterbody were removed. The propeller low pitch stop assembly was removed and an oil sample taken. The oil was medium brown in color with no sludge or metal contamination present. The valve housing filters were examined with some contamination present. The low pitch stop setting and pitch lock cam out settings was checked and both were verified as correct per Hamilton Standard manuals P5059 and P5056. The dome assembly was removed and the stop ring measured and found to be at an angle of 23°. The blade angles based on the segment gear position for blades 1, 2, 3, and 4 were 25°, 25°, 25°, and 28° respectively. The propeller hub nut was removed and the propeller was separated from
the propeller shaft. The propeller control (pump housing and valve housing) was removed from the rear barrel half extension. The valve housing back up cam was checked and a blade angle of 24° was indicated. The rear spinner was removed and the barrel was placed on a build up post for removal of the front barrel half. Significant damage to the roller bearings, beveled and flat thrust washers was found from impact. Sheared blade bushing pins and/or screws were found on all four blades. The shim plates at the base of each blade were removed and examined to determine the blade angles at impact. The shim plate blade angles for blades 1, 2, 3, and 4 were all measured at 22°.

C. Findings

Both blades exhibited bending and damage consistent with impacting a soft surface. The dome stop ring indicated a final blade angle of 23° with segment blade gear angles of 25° and 28°. Because the dome piston and blades can move from the impact loads of the other blades, the shim plate angle is the most accurate. A blade angle of 22° is equivalent to a throttle setting of 34°, flight idle.

5.2 PROPELLER NO. 2: LH INBOARD S/N N237765

A. Initial Observation of Propeller

The propeller was received with the front spinner, rear spinner and afterbody attached. The nose cone area of the front spinner was crushed and delaminated. All four propeller blades were intact and bent backward with no tip damage. Leading edge damage was limited to blade number 2 with two gouges between the 66 and 70 inch stations. Blades number 2 and 3 were missing sections of the L.E. and T.E. foam fairing. Blades number 1 and 2 were rotated with the T.E. at approximately the 10 o'clock position. The blade impact sequence could not be determined. All four blades were cut off at approximately the 36 inch station for shipment. The pump housing and valve housing were still assembled and the control was intact on the rear barrel half extension. The propeller shaft and front gear box including the bull gear was still attached to the propeller. Corrosion was present on the outside surfaces from the propeller being submerged in salt water. Propeller records where examined and no discrepancies were noted except that there were no entries in the log book regarding the 1,200 hour dome piston reseal as noted in U.S. Air Force Technical Order 1C-130A-6 and Hamilton Standard's recommendation.

B. Observations During Disassembly
The front spinner and afterbody were removed. The propeller low pitch stop assembly was removed and an oil sample taken. The oil was a clear red color with no sludge or metal contamination present. The valve housing filters were examined with some contamination present. The low pitch stop setting and pitch lock cam out setting was checked and both were verified as correct per Hamilton Standard Manuals P5059 and P5056. The low pitch stop was not identified with a part number or serial number. In addition, it had a lever support sleeve repair which should have been identified with "SK91359" immediately following the sleeve part number. The dome assembly was removed and the stop ring measured and found to be at an angle of 22.5°. The blade angles based on the segment gear position for blades 1, 2, 3, and 4 were 25°, 26°, 26°, and 26° respectively. The propeller hub nut was removed and the propeller was separated from the propeller shaft. The propeller control (pump housing and valve housing) was removed from the rear barrel half extension. The valve housing back up cam was checked and a blade angle of 22° was indicated. The rear spinner was removed and the barrel was placed on a build up post for removal of the front barrel half. Significant damage to the roller bearings, beveled and flat thrust washers was found from impact. Sheared blade bushing pins and/or screws were found on all four blades. Blade S/N 839899 was found in the number 3 blade position. Blade S/N 839898 was found in the number 4 blade position. According to the propeller log book S/N 839898 should have been in the number 3 blade position and S/N 839899 should have been in the number 4 blade position. The shim plates at the base of each blade were removed and examined to determine the blade angles at impact. The shim plate blade angle for blades 1, 2, 3, and 4 were 22.5°, 21°, 22°, and 22.5° respectively.

C. Findings

All four blades exhibited bending and damage consistent with impacting a soft surface. The dome stop ring indicated a final blade angle of 22.5° with segment blade gear angles of 25° and 26°. Because the dome piston and blades can move from the impact loads of the other blades, the shim plate angle is the most accurate. A blade angle of 22° is equivalent to a throttle setting of 34°, flight idle.

5.3 PROPELLER NO. 3: RH INBOARD S/N N237889

A. Initial Observation of Propeller
The propeller was received with the front spinner, rear spinner and afterbody attached. The nose cone area of the front spinner was crushed and delaminated to a greater extent than propellers number 1 and 2. The number 1 blade was approximately in feather and bent towards the camber side with L.E. foam fairing damage. The number 2 blade was bent towards the face side and was missing a section of the blade tip and the trailing edge of the fairing. The number 3 blade was bent towards the face side and was missing 1-2 inches of the blade tip. The L.E. and T.E. foam fairing was cracked. The number 4 blade was bent to the face side, with 6-8 inches of the tip missing and had a 2 inch gouge in the leading edge at approximately the 40 inch station. The blade impact sequence could not be determined. All four blades were cut off at approximately the 36 inch station for shipment. The pump housing and valve housing were still assembled and the control was intact on the rear barrel half extension. The propeller shaft and front gear box including the bull gear was still attached to the propeller. Corrosion was present on the outside surfaces from the propeller being submerged in salt water. Propeller records were examined and no discrepancies were noted except that there were no entries in the log book regarding the 1200 hour dome piston reseal as noted in U.S. Air Force Technical Order 1C-130A-6 and Hamilton Standard's recommendation.

B. Observations During Disassembly

The front spinner and afterbody were removed. The propeller low pitch stop assembly was removed and an oil sample taken. The oil was a clear red color with no sludge or metal contamination in the oil or valve housing filters as defined by Hamilton Standard Manual P5059. The low pitch stop setting and pitch lock cam out setting was checked and both were verified as correct per Hamilton Standard Manuals P5059 and P5056. The low pitch stop was identified with P/N 740311-1 instead of P/N 774474-1 which was the correct configuration of the low pitch stop in this propeller with the two piece teflon slipper seal installed. The dome assembly was removed and the stop ring measured and found to be at an angle of 22°. The blade angles based on the segment gear position for all four blades was 26°. The propeller hub nut was removed and the propeller was separated from the propeller shaft. The propeller control (pump housing and valve housing) was removed from the rear barrel half extension. The valve housing back up cam was checked and a blade angle of 23.5° was indicated. The rear spinner was removed and the barrel was placed on a build up post for removal of the front barrel half. Significant damage to the roller bearings, beveled and flat thrust washers was found from impact. Sheared blade bushing pins and/or screws were found on all blades. The shim plates at the base of each blade were removed and examined to determine the blade angles at impact. The shim plate blade angle
for blades 1, 2, 3, and 4 were 22.5°, 22.5°, 23°, and 23° respectively.

C. Findings

All four blades exhibited bending and damage consistent with impacting a soft surface. The dome stop ring indicated a final blade angle of 22° with all four segment blade gear angles at 26°. Because the dome piston and blades can move from the impact loads of the other blades, the shim plate angle is the most accurate. A blade angle of 23° is equivalent to a throttle setting of 34°, flight idle.

5.4 PROPELLER NO. 4: RH OUTBOARD S/N N236010

A. Initial Observation of Propeller

The propeller was received with the front spinner, rear spinner and afterbody attached. The nose cone area of the front spinner was crushed and delaminated. Damage to the nose cone area was greater than the other 3 propellers. The bottom afterbody was broken away and attached by only two screws. All four blade tips were intact.

All four blades were bent starting at approximately the 42 inch station to the tip with the number 1 blade exhibiting the most tip curl of the four blades. The number 1 and 4 blades were facing camber side forward while the number 2 blade was trailing edge forward and the number 3 blade was approximately in feather. All four blades were stenciled (identified) as A7111E-2 blades on the foam faring camber side. All four blades had a dimple in the blade tip and a patch on the foam faring face side. Based on this observation and the propeller log book entries, the blades should have been stenciled (identified) as A7111D-2 blades. The blade impact sequence could not be determined. All four blades were cut off at approximately the 36 inch station for shipment. The pump housing and valve housing were still assembled and the control was intact on the rear barrel half extension. The propeller shaft and front gear box including the bull gear were still attached to the propeller. Corrosion was present on the outside surfaces from the propeller being submerged in salt water. Propeller records were examined and it was noted that there were no entries in the log book regarding the 1200 hour dome piston reseal as noted in U.S. Air Force Technical Order 1C-130A-6. The 1800-2200 hour inspection required for the pitch lock regulator extension sleeve per 54H60 Service Bulletin number 73 and U.S. Air Force Technical Order 1C-130A-6 was not recorded in the log book. In addition, the propeller was removed from the aircraft, position number 2 on January 1, 1994. No reason for the removal was noted in the
propeller log book. The propeller was later installed on the same aircraft in position 4 on September 6, 1994. The propeller at time of installation was 105 hours from a 5,000 hour Time Between Overhaul (T.B.O.) inspection.

B. Observations During Disassembly

The front spinner and afterbody were removed. The propeller low pitch stop assembly could not be removed until the dome nut was loosened to relieve oil pressure that was contained behind the dome piston. An oil sample was taken. The oil was clear red in color with no sludge or metal contamination found in the oil or valve housing filters as defined by Hamilton Standard manual P5059. The low pitch stop setting and pitch lock cam out setting were checked and verified as correct per Hamilton Standard Manuals P5059 and P5056. The dome assembly was removed and the stop ring measured and found to be at an angle of 16° degrees. The blade angles based on the segment gear position for blades 1, 2, 3, and 4 were 18°, 19°, 18°, and 18° respectively. The propeller hub nut was removed and the propeller was separated from the propeller shaft. The propeller control (pump housing and valve housing) was removed from the rear barrel half extension. The valve housing back up cam was checked and a blade angle of 15° was indicated. The rear spinner was removed and the barrel was placed on a build up post for removal of the front barrel half. Significant damage to the roller bearings, beveled and flat thrust washers was found from impact. Sheared blade bushing pins and/or screws were found on all blades. The shim plates at the base of each blade were removed and examined to determine the blade angle at impact. The shim plate blade angle for blades 1, 2, 3, and 4 were 14°, 13°, 14°, and 14° respectively.

C. COMPONENT TESTING:

Dome Assembly

The dome assembly was reassembled along with the barrel and pitch lock regulator. Seven performance tests were performed including internal leakage test. All test where within specification except for the pressure required to unfeather the propeller was 145 PSI instead of the required 200 PSI. This is explained by the worn stop ring and feather latches which require less hydraulic pressure to come out of the feather latches.

Pitch Lock Regulator
The pitch lock regulator's engagement speed, disengagement speed and leakage was tested with all results within Hamilton Standard's specification limits. The 1800 - 2200 hour inspection per Service Bulletin number 73 to detect potential looseness of the extension sleeve was performed. The torque requirement of 100-130 pound-feet was checked and was found to be at 130 pound-feet.

Low Pitch Stop

The low pitch servo valve setting and test was performed with only minor deviations from Hamilton Standards specification requirements was noted. These results were consistent with a high time propeller.

Valve Housing

The valve housing was removed from the pump housing and partially disassembled. The speed set assembly, alpha and beta shafts were disassembled with no discrepancies noted. The beta switch cam on the beta shaft was in contact, but had not activated the beta switch. The beta switch may be activated from a blade angle of +14° to +16°. A continuity check was performed on the beta switch and it was found that the switch was operating correctly. Six valves, the backup valve, selector valve, standby valve, low pressure relief valve, pump check valve, and high pressure valve were removed from the valve housing for individual component testing. All six valves were installed with the correct seals and they were moist and tacky. All six valves were tested with no discrepancies noted.

The valve housing servo governor was examined. The inner sleeve remained in place. Based on examination of the window timing between the inner and outer sleeves of the governor, the governor was calling for decrease pitch (decrease blade angle). There was no governor bearing failure as based on visual examination of the governor and bearings. As a comparison for this governor, the governor from valve housing S/N 13043, aircraft position number 3, was examined. This governor was also calling for decrease pitch.

D. Findings

All four blades exhibited bending and damage consistent with impacting a soft surface. The dome stop ring indicated a final blade angle of 16° with all four segment blade gear angles of 16° and 19°. Because the dome piston and blades can move from the impact loads of the other blades, the shim plate angle is the most accurate. A blade angle of 14° indicates a blade angle setting in the ground range (beta range) and a throttle setting between flight
idle and ground idle. Component testing of the individual propeller components found no discrepancies.

6.0 Investigation Summary

- During disassembly all settings and adjustments such as low pitch stop setting, cam out ring index, barrel half index and dome stops ring index were checked and found to be correct per Hamilton Standard Manuals P5059 and P5056 for all four propellers.

- Log book discrepancies were noted with all four propellers. In addition, incorrect part marking was noticed on propellers, S/N N237765, S/N N237889 and S/N N236010.

- The increased level of damage on the number 3 and 4 propellers as compared to propellers 1 and 2 supports the conclusion of a low right wing at impact.

"Blade impact angles for propellers, S/N N237885, S/N N237765, and S/N N237889 were found to be at 22° to 23°, flight idle."

- The blade impact angle for propeller S/N N236010 was 14°. The propeller was assembled correctly. Component testing was performed on the dome, low pitch stop, pitch lock regulator with no discrepancies noted. The valve housing and valves were examined and tested and found to operate correctly.
APPENDIX #1

A. Initial Mishap Data

Date of Mishap: 9/23/94
Aircraft Tail/ Reg. Number: 4826 (Lockheed) PK-PLV (Indonesian)
Time of Mishap: 7:00 pm
Aircraft Operation: Passenger - Capacity 128
Weather: Wet Runway - Surface Wind 090/12kt
Persons On Board: 12
Fatalities: 6
Ownership Organization: Pelita Air Services
Site/Field Altitude: Hong Kong International Airport/15ft
Temperature: 27 degrees Celsius
Impact Angle: Nose Low, Right Wing Low
Terrain: Water
Airspeed: 120-123 Knots

B. Log Book Data

<table>
<thead>
<tr>
<th>Propeller S/N</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
</tr>
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<tbody>
<tr>
<td>S/N N237885</td>
<td>N237765</td>
<td>N237889</td>
<td>N236010</td>
<td></td>
</tr>
<tr>
<td>Blade S/N #1</td>
<td>840430</td>
<td>839896</td>
<td>840446</td>
<td>832868</td>
</tr>
<tr>
<td>#2</td>
<td>840431</td>
<td>839897</td>
<td>840447</td>
<td>832869</td>
</tr>
<tr>
<td>#3</td>
<td>840432</td>
<td>839898</td>
<td>840448</td>
<td>832870</td>
</tr>
<tr>
<td>#4</td>
<td>840433</td>
<td>839899</td>
<td>840449</td>
<td>832871</td>
</tr>
</tbody>
</table>

| Date Last Installed: 9/27/90 | 9/08/94 | 12/11/93 | 9/06/94 |
| Date Last Overhaul: 9/27/90 | 4/18/88 | 7/25/89 | 10/24/85 |
| Prop TOT: 7935.40 | 8493.50 | 8222.36 | 10410.30 |
| Prop TSO: 2617.09 | 3934.54 | 3377.05 | 4902.40 |
| Aft TT: 15203.52 | 15203.52 | 15203.52 | 15203.52 |
| Low Pitch Stop P/N: | | | |
| Low Pitch Stop S/N: | | | |
| P. Lock Reg. P/N: | | | 738398-1 |
| P. Lock Reg. S/N: | | | 270 |
| Contl. P/N: 714326-3 | | | |
| Contl. S/N: | | | |
| V.Hsg. P/N: 714325-3 | | | |
| V.Hsg. S/N: 14388 | | | |
| P.Hsg. P/N: 733872-5 | | | |
| P.Hsg. S/N: 23043 | | | |
| Last Maintenance Action: |

S/N N237885 - OHVL Singapore Aerospace 9/27/90
S/N N237765 - Removed For Leak 1-21-94
S/N N237889 - Removed 02/23-24/92 S.B. 125
S/N N236010 - Removed 1/1/94, Reason Unknown

Page A10-12
C. Mishap Propeller Disassembly

Prop Position No. 1  P/N 54H60-117  Prop Assy S/N N237885

1. DOME
   a. Oil Sample  Taken
   b. L.P.S. Depth  1.972
   c. Stop Ring Index  Assembled Correctly
   d. Stop Ring Angle Meas.  23 degrees
   e. Rotating Cam Teeth  No Damage
   f. Shoulder Screws  2 Loose
   g. Rotating Ratchet Teeth  No Damage
   h. Dome/Barrel S/N Match  Yes
   i. L.P.S. S/N  A242

2. BARREL
   a. Barrel Half Serial Match  Yes
   b. Dome Shim Match  Yes
   c. Blade Bore Arm Support  No Damage
   d. Metal Contamination  No
   e. Dry Barrel Condition  No
   f. Beta Feedback Gear  No Damage

3. BLADES  P/N A7111D-2

<table>
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<tr>
<th>#1</th>
<th>#2</th>
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</thead>
</table>
   a. Shank/Log Book Match | Yes | Yes | Yes | Yes |
   b. Beveled Thrust Washer | Broken | Broken | Broken | No Damage |
   c. Roller Bearing | Broken | Broken | Broken | Broken |
   d. Flat Thrust Washer | Broken | Broken | No Damage | No Damage |
   e. Micro ADJ. Ring Index | All Four Assembled Correctly |
   f. Segment Gear Teeth | No Damage | On All Segment Gears |
   g. Segment Gear Angle | 25.0 | 25.0 | 25.0 | 28.0 |
   h. Feedback Gear Teeth | No Damage | -- | -- | -- |
   i. Blade Bushing | Screws And/Or Pins Sheared-All Blades |
   j. Shim Plate Readings | 22.0 | 22.0 | 22.0 | 22.0 |

4. PITCH LOCK REGULATOR  P/N 767999-1  S/N A194
   a. Extension Sleeve | Flex Neck |
   b. Cam-Out Ring Index | Assembled Correctly |
   c. Stationary Ratchet Teeth | No Damage |

5. VALVE HOUSING  P/N 714325-3P4  S/N 14388
   a. BUV Cam Reading | 24 degrees |
   b. Filter Contamination | Some - Require Cleaning or Change |

6. PUMP HOUSING  P/N 733872-5P1  S/N Could Not Read

7. CONTROL  P/N 714326-3P8  S/N 23043
c. **Mishap Propeller Disassembly**

12/20/94

**Prop Position No. 2  P/N 54H60-117  Prop Assy S/N N237765**

1. **DOME**

   a. Oil Sample  Taken
   b. L.P.S. Depth  1.995
   c. Stop Ring Index  Assembled Correctly
   d. Stop Ring Angle Meas.  22.5 degrees
   e. Rotating Cam Teeth  No Damage
   f. Shoulder Screws  Tight
   g. Rotating Ratchet Teeth  No Damage
   h. Dome/Barrel S/N Match  Yes
   i. L.P.S. S/N  Not marked on L.P.S.

2. **BARREL**

   a. Barrel Half Serial Match  Yes
   b. Dome Shim Match  Yes
   c. Blade Bore Arm Support  No Damage
   d. Metal Contamination  No
   e. Dry Barrel Condition  No
   f. Beta Feedback Gear  No Damage

3. **BLADES  P/N A7111D-2**  
   
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<tr>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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</table>

4. **PITCH LOCK REGULATOR  P/N 767999-1 B  S/N A650**

   a. Extension Sleeve  Flex Neck
   b. Cam-Out Ring Index  Assembled Correctly
   c. Stationary Ratchet Teeth  No Damage

5. **VALVE HOUSING  P/N 714325-3P1  S/N 12447**

   a. BUV Cam Reading  22 degrees
   b. Filter Contamination  Some - Require Cleaning or Change

6. **PUMP HOUSING  P/N 733872-5P1  S/N Could Not Read**

7. **CONTROL  P/N 714326-3P8  S/N 23089**
### C. Mishap Propeller Disassembly

**Prop Position No. 3**  
**P/N 54H60-117**  
**Prop Assy S/N N237889**

**1. DOME**

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<tr>
<td>a. Oil Sample</td>
<td>Taken</td>
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<tr>
<td>b. L.P.S. Depth</td>
<td>1.933</td>
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<tr>
<td>c. Stop Ring Index</td>
<td>Assembled Correctly</td>
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<tr>
<td>d. Stop Ring Angle Meas.</td>
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<tr>
<td>e. Rotating Cam Teeth</td>
<td>No Damage</td>
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<tr>
<td>f. Shoulder Screws</td>
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<td>g. Rotating Ratchet Teeth</td>
<td>No Damage</td>
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<td>h. Dome/Barrel S/N Match</td>
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<td>i. L.P.S. S/N</td>
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**2. BARREL**

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<tr>
<td>b. Dome Shim Match</td>
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<tr>
<td>c. Blade Bore Arm Support</td>
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<td>f. Beta Feedback Gear</td>
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**3. BLADES P/N A7111D-2**

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<tr>
<td>a. Shank/Log Book Match</td>
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</tr>
<tr>
<td>b. Beveled Thrust Washer</td>
<td>No Damage On All Four Beveled Washers</td>
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<td>c. Roller Bearing</td>
<td>Crushed Crushed Damaged Crushed</td>
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<td></td>
</tr>
<tr>
<td>d. Flat Thrust Washer</td>
<td>No Damage On All Flat Thrust Washers</td>
<td></td>
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</tr>
<tr>
<td>e. Micro ADJ. Ring Index</td>
<td>All Four Assembled Correctly</td>
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<tr>
<td>f. Segment Gear Teeth</td>
<td>No Damage On All Segment Gears</td>
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<tr>
<td>g. Segment Gear Angle</td>
<td>26.0 26.0 26.0 26.0</td>
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<tr>
<td>h. Feedback Gear Teeth</td>
<td>No Damage -- -- --</td>
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<tr>
<td>i. Blade Bushing</td>
<td>Pins and Screws Sheared Except For #2</td>
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<tr>
<td>j. Shim Plate Readings</td>
<td>22.5 22.5 23.0 23.0</td>
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**4. PITCH LOCK REGULATOR P/N 767999-1 C S/N A672**

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<td>a. Extension Sleeve</td>
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<td>Assembled Correctly</td>
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<tr>
<td>c. Stationary Ratchet Teeth</td>
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**5. VALVE HOUSING P/N 714325-3P1 S/N 13043**

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<tbody>
<tr>
<td>a. BUV Cam Reading</td>
<td>23.5 degrees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>b. Filter Contamination</td>
<td>No - Filter Clean</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**6. PUMP HOUSING P/N 733872-2P8 S/N Could Not Read**

**7. CONTROL P/N 714326-3P4 S/N 21894**
c. **Mishap Propeller Disassembly**  

**Prop Position No. 4**  
**P/N 54H60-117**  
**Prop Assy S/N N236010**

1. **DOME**
   - a. Oil Sample: Taken
   - b. L.P.S. Depth: 1.915
   - c. Stop Ring Index: Assembled Correctly
   - d. Stop Ring Angle Meas.: 16 degrees
   - e. Rotating Cam Teeth: No Damage
   - f. Shoulder Screws: Tight
   - g. Rotating Ratchet Teeth: No Damage
   - h. Dome/Barrel S/N Match: No, Prop S/N Not Stenciled On Dome
   - i. L.P.S. S/N: A159

2. **BARREL**
   - a. Barrel Half Serial Match: Yes
   - b. Dome Shim Match: Yes
   - c. Blade Bore Arm Support: No Damage
   - d. Metal Contamination: Small Metal Fragments Found in Prop
   - e. Dry Barrel Condition: No
   - f. Beta Feedback Gear: No Damage

3. **BLADES**  
   **P/N A7111D-2**

<table>
<thead>
<tr>
<th></th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
</tr>
</thead>
</table>
   a. Shank/Log Book Match: Yes | Yes | Yes | Yes | Yes |
   b. Beveled Thrust Washer: No Damage Except For #2 | No Damage Except For #2 |
   c. Roller Bearing: Crushed | Crushed | Crushed | Crushed | Crushed |
   d. Flat Thrust Washer: No Damage Except For #3 | All Four Assembled Correctly |
   e. Micro ADJ. Ring Index: No Damage | No Damage | No Damage |
   f. Segment Gear Teeth: No Damage On All Segment Gears | No Damage On All Segment Gears |
   g. Segment Gear Angle: 18.0 19.0 18.0 18.0 | 18.0 19.0 18.0 18.0 |
   h. Feedback Gear Teeth: No Damage | No Damage | No Damage | No Damage |
   i. Blade Bushing: All Pins And Screws Sheared, 4 Blades | All Pins And Screws Sheared, 4 Blades |
   j. Shim Plate Readings: 14.0 13.0 14.0 14.0 | 14.0 13.0 14.0 14.0 |

4. **PITCH LOCK REGULATOR**  
   **P/N 733895-1 C**  
   **S/N A640**

   - a. Extension Sleeve: Yes  
   - b. Cam-Out Ring Index: Assembled Correctly
   - c. Stationary Ratchet Teeth: No Damage

5. **VALVE HOUSING**  
   **P/N 714325-3 P1**  
   **S/N 13182**

   - a. BUV Cam Reading: 15.0 Degrees
   - b. Filter Contamination: Moderate - No Metal Fragments

6. **PUMP HOUSING**  
   **P/N 733872-5**  
   **S/N Could Not Read**

7. **CONTROL**  
   **P/N 714326-3**  
   **S/N 21773**
The Analysis and Conclusions from the Report on the Examination of the No. 4 Engine by Allison Engine Company

2.0 Analysis

2.1 General

Engine #4 was sent here to Allison Engine Company, Indianapolis, IN, for analytical teardown and detailed analysis. All four propellers were sent to Hamilton Standard, Windsor Locks, CT, for analytical teardown and analysis. The fuel control was sent to Bendix, Engine Controls Division, South Bend, IN, for analysis.

2.2 Aircraft

Some analysis, and computer simulations were run at Lockheed, Marietta, GA.

2.3 Engine

The engines were installed on PK-PLV as follows:

<table>
<thead>
<tr>
<th>Position</th>
<th>Serial No.</th>
<th>TSN</th>
<th>TSO</th>
<th>TBO</th>
<th>Rem. Hrs.</th>
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<tbody>
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<td>8380</td>
<td>2329</td>
<td>6500</td>
<td>4171</td>
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<tr>
<td>2</td>
<td>550430</td>
<td>10574</td>
<td>1411</td>
<td>6500</td>
<td>5090</td>
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<tr>
<td>3</td>
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<td>9324</td>
<td>2883</td>
<td>5559</td>
<td>2676</td>
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<tr>
<td>4</td>
<td>550510</td>
<td>9710</td>
<td>3217</td>
<td>6500</td>
<td>3286</td>
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2.4 Propellers

<table>
<thead>
<tr>
<th>Position</th>
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<th>TSO</th>
<th>TBO</th>
<th>Rem. Hrs.</th>
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</thead>
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<td>237885</td>
<td>7935</td>
<td>2617</td>
<td>5000</td>
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<tr>
<td>2</td>
<td>237765</td>
<td>8494</td>
<td>3935</td>
<td>5000</td>
<td>1066</td>
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<td>3</td>
<td>237889</td>
<td>8216</td>
<td>3377</td>
<td>5000</td>
<td>1612</td>
</tr>
<tr>
<td>4</td>
<td>236010</td>
<td>10410</td>
<td>4902</td>
<td>5000</td>
<td>98</td>
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</tbody>
</table>

Propeller serial No. 236010 was fitted to No. 4 engine on PK-PLV on 9/6/94 @ 15,203.52 aircraft hours; it had previously been removed from PK-PLV on 1/1/94 at a TSN of 10,403.52 hrs and TSO of 4895.52 hrs. The log book contained no reference to the reason for removal, nor any actions that might have taken place between 1/1/94 and 9/6/94. The operator reported that the propeller had been removed for a faulty Beta Feedback shaft that had been found during maintenance.

There was no record of any pilot reported detects on this propeller while it was on PK-PLV.
2.5 Engine Records & History

Engine No. 4 maintenance history:

Engine serial No. CAE 550510 was sold and shipped to Lockheed on August 29, 1981. It was originally installed on aircraft s/n 4917, position #3 on 10/10/81. The engine was overhauled by Standard Aero Ltd. at a total engine time of 6493.21 hours. It was then returned and fitted to the No. 4 position on PK-PLV on 9/7/90 at 6493.21 hour's time since new (TSN). At the time of the accident the engine had completed a total of 3217.07 hours since overhaul and 9710.28 hours TSN.

Engine #4 consisted of:

<table>
<thead>
<tr>
<th>UNIT</th>
<th>Serial Number</th>
<th>Part Number</th>
<th>TSN</th>
<th>TSO</th>
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<tr>
<td>Power Section</td>
<td>550150</td>
<td>6870232</td>
<td>9710.28</td>
<td>3217.07</td>
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<tr>
<td>Gearbox</td>
<td>650514</td>
<td>6850209</td>
<td>9710.28</td>
<td>3217.07</td>
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<tr>
<td>Torquemeter</td>
<td>A6519</td>
<td>6794101F</td>
<td>9710.28</td>
<td>3217.07</td>
</tr>
<tr>
<td>Turbine</td>
<td>750650</td>
<td>6870237</td>
<td>9710.28</td>
<td>3217.07</td>
</tr>
<tr>
<td>Fuel Control</td>
<td>326322</td>
<td>AP-B3</td>
<td>9710.28</td>
<td>3217.07</td>
</tr>
<tr>
<td>Fuel Pump</td>
<td>PE 10088T</td>
<td>022489-054-03</td>
<td>9710.28</td>
<td>3217.07</td>
</tr>
<tr>
<td>T.D. Valve</td>
<td>15360</td>
<td>3303324</td>
<td>UNK</td>
<td>3217.07</td>
</tr>
<tr>
<td>Coordinator</td>
<td>FFK017</td>
<td>6794215</td>
<td>UNK</td>
<td>3217.07</td>
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<tr>
<td>Accessory Gearbox</td>
<td>AA1930</td>
<td>6859424</td>
<td>UNK</td>
<td>3217.07</td>
</tr>
</tbody>
</table>

The turbine unit consists of:

<table>
<thead>
<tr>
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<th>Serial</th>
<th>Part Number</th>
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<th>Time Limit</th>
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<tbody>
<tr>
<td>Rotor s/n A-12369</td>
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<tr>
<td>1st turbine wheel</td>
<td>KK32946</td>
<td>6875431</td>
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<td>12,000</td>
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<tr>
<td>2nd turbine wheel</td>
<td>KK29115</td>
<td>6845592</td>
<td>9710.28</td>
<td>12,000</td>
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<tr>
<td>3rd turbine wheel</td>
<td>KK23769</td>
<td>6845593</td>
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<td>12,000</td>
</tr>
<tr>
<td>4th turbine wheel</td>
<td>KK23256</td>
<td>6870434</td>
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<td>12,000</td>
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<tr>
<td>1-2 spacer</td>
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<td>6844632</td>
<td>3217.07</td>
<td>-</td>
</tr>
<tr>
<td>2-3 spacer</td>
<td>KK30259</td>
<td>6842683</td>
<td>9710.28</td>
<td>-</td>
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<tr>
<td>3-4 spacer</td>
<td>KK21652</td>
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<td>9710.28</td>
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2.6 Engine Teardown & Analysis

Overall

When the engine was uncrated it was discovered to be generally intact. There was corrosion on exposed surfaces. The interior and exterior had soft silt like mud on it. Figures 1-9 (only Figures 1, 2 and 8 reproduced and attached). The compressor case and gearbox housing exhibited the most damage to corrosion. The front half of the gearbox was still attached to the #4 prop shaft and propeller, located at Hamilton Standard. All accessories and controls were still with the engine.
Gearbox

The front half of the gearbox fractured off due to impact with the water. The remainder of the gearbox unit remained attached to the power section via the torquemeter. The front housing, main drive gear, prop shaft, planet assemblies, ring gear, etc. were with the propeller, and appeared normal and intact, except for the corrosive attack by the salt water.

The pinion gear splines, rear pinion bearing, and safety coupling outer member shaft were intact, but severely corroded. Figures 27-30 (only Figures 27 and 30 reproduced and attached). The magnesium gearbox housing exhibited severe corrosive effects from the salt water immersion, see Figures 31-32.

Turbine

The OCC appeared normal in colour. The combustion liners were corroded, but otherwise in fair shape. Figures 68-71 (only Figures 69 and 70 reproduced and attached). All thermocouples were corroded, but otherwise in fair shape. None of the thermocouples exhibited a burned tip or erosion f the tip. There was no sign of overtemperature operation. Figures 80-84 (only Figures 81 and 82 reproduced and attached). The igniters were in rough shape, and exhibited severe tip erosion. Figures 86-88 (only Figure 86 reproduced and attached).

The turbine rotor was caked with bottom silt and mud. Bearings appeared oil wetted. The 1st stage vanes were all corroded. There was only one vane that exhibited a small crack on the Trailing edge. Figure 100. All turbine blades were there. All turbine blades, vanes, wheels, spacers, were corroded, yet showed no signs of distress. The spacer to vane clearances appeared normal, there was no sign of abnormal rub between the spacer knives, and vanes, nor the turbine blade shrouds and blade path tracks.

Compressor

The exterior of the compressor was severely corroded. Bleed valves appeared normal, except for the corrosion. Figures 47-49 (only Figures 48 and 49 reproduced and attached). The compressor vanes and blades were all intact, and none were missing. All blades and vanes were corroded. There was some silt and debris from the bottom of the bay found in the compressor. It was otherwise in fair shape. Figures 50-67 (only Figures 51-54 reproduced and attached).

Torquemeter

The torquemeter exhibited severe corrosion on the entire unit. There was no distress on the rear splines. Figures 36-38 (only Figure 36 reproduced and attached). The torquemeter pick-up was in good condition. The torquemeter pick-up teeth had a permanent off-set. Normally the teeth are aligned, when at rest. Figures 39-40, and Appendix D (only Figure 40 reproduced and attached).

The safety coupling appeared normal there was no indication of ratcheting. Figures 42-45.
Fuel System

All fuel nozzles were corroded on the tip. They did not show any excessive carbon build-up. Figures 74-79 (only Figure 74 reproduced and attached).

The fuel control, TD valve, coordinator, speed switch, speed control, were essentially intact. The coordinator was partially broken off where it mounts on the fuel control. All controls are damaged by corrosion, and not runable, or capable of being functionally tested. The pointer on the coordinator was found at 27°. The pointer on the fuel control was found at 90° and corroded in place. But, this is after being recovered from the bottom of the bay, and being transported to the US from Hong Kong. The fuel control was sent to Bendix, Controls Division, South Bend, IN, for testing and evaluation. (Reproduced and included as a separate Appendix 10).

The a B-nut on the speed sensitive valve was found loose, about 1 flat. Figure 129. This hose is the 14th stage bleed supply line to the speed sensitive valve. At less than 94% (13,000) RPM the valve directs the 14th stage bleed air overboard, and thus the bleed valves remain open. At greater that 94%, the valve directs the 14th stage bleed air to the 5th and 10th stage bleed valves, to close them. The bleed valves are used to unload the compressor for starts and low speed ground idle operation only, and are closed at all times during flight. If this line was sufficiently loose, the engine would never have "up shifted" to high speed ground idle. Or, it wold never have started if the pilot started the engine to high speed ground idle.

All other hoses both air and fuel were tight and in fair shape. There were no indication of air leaks, or fuel leaks.

3.0 Conclusions

3.1 Findings

There was a sudden stoppage between the power section and the reduction gearbox assembly.

The engine was rotating when the aircraft entered the water. But it is impossible to determine at what power setting.

The propeller did not de-couple from the engine.

There was no evidence of any internal or external failure of the power section, reduction gearbox, torquemeter, fuel system, or air control system.

The fuel control tested functionally OK.
1. Engine uncrated at Allison
2. Engine uncrated at Allison
8. Engine uncrated at Allison
27. Splines, pinion gear

30. Rear pinion bearing
31. Corrosion & crack in the rear housing

32. Corrosion in rear housing due to salt water immersion
36. Torquemeter rear splines

40. Torquemeter pick-up teeth
42. Safety coupling, disassembled

43. Safety coupling, inner member & Intermediate member
44. Intermediate member teeth

45. Inner member teeth
48. Bleed valve port 10th

49. Bleed valves, 5th and 10th.
51. Compressor rotor

52. Compressor rotor, stages 4, 5, 6
53. Compressor rotor, stages 1-4

54. Compressor vane 1st stage
69. Combustion section

70. Combustion liners
74. Fuel nozzle
81. Representative thermocouple front

82. Representative thermocouple rear
86. Ignitors
100. Suction side, 1st stage vanes
129. Speed sensitive valve
A. Title

Investigation of ASCA Main Fuel Control (MFC) Model AP-B3, P/L 440970-2, S/N 326322.

B. Purpose

To perform teardown inspection and if possible a functional test of AP-B3 SN 326322, which was installed on Indonesian A/F C-130 A/C which crashed on takeoff from Hong Kong airport.

C. Description of Unit

<table>
<thead>
<tr>
<th>Model</th>
<th>S/N</th>
<th>ASCA P/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP-B3</td>
<td>326322</td>
<td>440970-2</td>
</tr>
</tbody>
</table>

D. Background

Indonesian A/F Lockheed C-130 crashed on takeoff from Hong Kong airport into Hong Kong Harbor.

E. Summary of Results

AP-B3 P/L 440970-2, S/N 326322 obviously was exposed to saltwater. Most external steel parts have heavy corrosion, Ref. F-1 through F-8.

External damage noted was as follows:

Compressor inlet temperature thermostat assembly capillary tube was broken at bellows adjustment nut Ref. F-9. Capillary tube shield kinked near mounting clamp on pressure actuator assembly, Ref. F-10.

Main body cover assembly was cracked at long boss were coordinator mounts, Ref. F-11. The manual cutoff shaft linkage was bent Ref F-12. Manual cutoff shaft bushing was cracked, Ref. F-13.
Lockwire seals have the letters SAL, Ref. F-14.

Drive shaft bearing retainer plate and drive shaft were heavily corroded Ref. F-15. The drive shaft would not rotate so the front body assembly was removed. The drive bearings were corroded, and the fuel seal was seized to the shaft causing the shaft not to rotate, Ref. F-16.

It was determined the cutoff valve was in the open position and that ground idle was in the high speed position. The rear cover assembly was removed and the following was noted:

a. No trace of corrosion internally (Ref. F-17)
b. Speed rack in no speed input position (normal)
c. Compressor inlet pressure (PT2) rack in minimum (Sea Level) position.
d. Speed rack moves smoothly.
e. Compressor inlet pressure (PT2) rack moves smoothly.
f. Metering valve found in the open position.
g. Metering valve moves smoothly.
h. Cams, cam followers and levers move smoothly.

The MFC was reassembled using all original parts except for packings, rear cover assembly, drive bearings, fuel seal. A functional test was performed on the engineering lab flowbench, Ref. F-18.

It was decided that serviceable drive bearings would be installed and an attempt would be made to function the MFC if the pressure actuator bellows could be set during testing.

The pressure actuator assembly was corroded heavily internally, but by removing only the assembly vent plugs and bleeds, flushing of the housing removed enough corrosion to allow proper setting of the pressure actuator bellows.
F. Conclusion:

Run as Received testing and disassembly/visual inspection of the MFC found no abnormalities, with the exception of those noted as corrosion damaged which would be consistent with saltwater submersion and impact during the accident. Nothing mechanically was found that would have prohibited these units from operating normally at the time of the accident.

It is recommended that this report serve as documentation to describe the condition of the subject Main Fuel Control as received by AlliedSignal Controls and Accessories.
<table>
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<tr>
<th>ECD422-AR-69-F1 thru F8</th>
<th>External Corrosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECD422-AR-69-F9</td>
<td>Broken Thermostat Capillary</td>
</tr>
<tr>
<td>ECD422-AR-69-F10</td>
<td>Kinked Capillary Tube Shield</td>
</tr>
<tr>
<td>ECD422-AR-69-F11</td>
<td>Main Body Cover Cracked</td>
</tr>
<tr>
<td>ECD422-AR-69-F12</td>
<td>Manual Cutoff Shaft Linkage Bent</td>
</tr>
<tr>
<td>ECD422-AR-69-F13</td>
<td>Manual Cutoff Shaft Bushing Cracked</td>
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<tr>
<td>ECD422-AR-69-F14</td>
<td>Lockwire Seal</td>
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<td>Drive Bearing/Fuel Seal Corrosion</td>
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<td>Internal View Main Body</td>
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**FINAL TEST SPECIFICATION**

This test specification has been reviewed and all data is within final limits.

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**F-18**
TEST SPECIFICATION  
DATE: 10-JUN-91  
ALLIED-SIGNAL INC., ALLIED-SIGNAL AEROSPACE COMPANY, SEDNIX ENGINE CONTROLS DIV., SOUTH BEND, IN USA  

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1.000 *** THROTTLE STOPS, LEAKAGE AND RELIEF VALVE CHECK ***

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<th>WFT</th>
<th>PT2</th>
<th>PLA</th>
<th>P0</th>
<th>P4</th>
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</table>

.010 Minimum Throttle Stop ---
Reduce PLA to minimum stop
Record throttle angle
Enter the current barometer reading to the nearest .01 in. hg.

<p>| | | | | | | | | | |</p>
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X 9730 | X  BAR |

And the .69 deg F from shaft position reading:
X 1473 | X DPGD

Set the temperature position to the 69 degree depth.

.020 Maximum Throttle Stop ---
Increase PLA to maximum stop
Record throttle angle

.030 Front Body Oil Flow ---

<table>
<thead>
<tr>
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<th>WFT</th>
<th>PLA</th>
<th>P0</th>
<th>P4</th>
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3300 3300 30.00 90.0 100.0 330 |

Fuel temperature

.040 Relief Valve Check ---
P4 set to 700 PSI ± 5 PSI for Tpt 1.040

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3350 0.0270 | X WFM

.050 = = = = = = = = = =

X 320 | 600 WFM
**TEST SPECIFICATION**

**DATE: 18-JUN-81**

**ALLIED-SIGNAL INC., ALLIED-SIGNAL AEROSPACE COMPANY, BENDIX ENGINE CONTROLS DIV., SOUTH BEND, IN USA**

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(010-01-111-049)

**2.000 *** ALTITUDE COMPENSATION *****

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<td>WIN</td>
<td>RCO</td>
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.010 Start the vibrator and leave it running for Paragraph 1

1250 2200 30.000 75.0 270

Set Throttle Angle from 90 degrees set to meet limits at ITP 2.010.
Retain this Throttle Angle for ITP's 2.020 through 2.060.

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.050 Hysteresis (Pt2) ---

| X 50.0 |
| 370 |

.060 Pt2 Rack Step ---

| 3200 6300 2.000 80.0 75.0 120.0 |

.070 44000 44000 |

Turn the vibrator off.
Reset Pt2 to 30 in hg. from 35 in hg.
### 3.000 Acceleration Curve

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Approach NFF directly from previous setpoint for T.P. 3.010.
### 4.000 - GOVERNOR CURVES -

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**4.000 - GOVERNOR CURVES -**

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- Difference from Test Pt. 4.010
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  - 25 |
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- Difference from Test Pt. 4.010
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  - 5.0 |
  - 5.0 |

- Difference from Test Pt. 4.020
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  - 5.0 |
  - 5.0 |

- Difference from Test Pt. 4.030
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  - 5.0 |
  - 5.0 |

- Difference from Test Pt. 4.040
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  - 5.0 |
  - 5.0 |

- Difference from Test Pt. 4.050
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  - 5.0 |
  - 5.0 |

- Difference from Test Pt. 4.060
  - 5.0 |
  - 5.0 |
  - 5.0 |

- Difference from Test Pt. 4.070
  - 5.0 |
  - 5.0 |
  - 5.0 |

**Conditions:**
- WFM: Working Full Mode
- CRPM: Cruise RPM
- MIN: Minimum
- RCD: Receiver Control Display
- MAX: Maximum
- COND: Condition
4.000 *** GOVERNOR CURVES *** (CONT'D)

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<th>PLA</th>
<th>PO</th>
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| ON | ON | ON | SLGR |

| 270 | 275 | 300 | WFM |

| .100 | De-energize Gov. reset solenoid. | | | | | | | | | | | | |

| Set CRPM to 3800 in proper sequence. | | | | | | | | | | | | |

| 5500 | = | 90.0 | 90.0 | = | | | | | | | | | |

| OFF | OFF | OFF | SLGR |

| -40 | 140 | 40 | WFM |

**Difference from Test Pt.: 4.000**
$0.000 \text{ CAN LATCH INDEXING ***}$

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.010 Governor Can Latch ---
Set PLA from 80 degs.
Increase CRPM from 3100 to meet fuel flow (WFM) conditions.

| 3100 | 80.000 | 80.0 | 85.0 | 135 |

Difference from Test Pt. 4.040

.020 Increase CRPM from 2100 to meet fuel flow (WFM) conditions.

| 2100 | 80.000 | 80.0 | 85.0 | 135 |

Difference from Test Pt. 4.040

.030 Governor Reset Response ---
De-energize the governor reset solenoid. Set test conditions for TPY 5.030
Use the non-regulating Boost pressure device to initially establish 180 psig
or greater P4 pressure. Maintain this setting for test points 5.030 and
5.040.

| 5500 | 80.000 | 85.0 | 135.0 |

Energize the solenoid and note the time (in seconds) that P4 pressure
takes to decrease from 180 to 80 psig.

| 180.0 | 80  | 135  | 5.0 |

.040 De-energize the solenoid and note the time (in seconds) that P4 pressure
takes to return to 180 from 80 psig.

| 180.0 | 80  | 135  | 5.0 |

Page A12-14
**TEST SPECIFICATION**

**DATE:** 30-JUN-91

**ALLIED-SIGNAL INC., ALLIED-SIGNAL AEROSPACE COMPANY, BENDIX ENGINE CONTROLS DIV., SOUTH BEND, IN USA**

**MODEL:** AP-B3  **SERIAL NO:** J4623  **(14-19) 12237-02 (20-26)**

**PARTS LIST:** J46976-2  **PAGE CODE:** 0-018-01-115-048

### 6.000 *** PART THROTTLE ***

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**Hysteresis (CRPM) ---**

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**MAX P1-P2 spread between TPs: 3.020, 5.050, 5.080, and 6.100**

**X: 545. X: F1P2**

**0.0 | 6.0 DP12 Calc**

**210 *** Hysteresis (PLA) ---**

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<th>P4</th>
<th>MIN</th>
<th>RCD</th>
<th>MAX</th>
<th>COND</th>
</tr>
</thead>
<tbody>
<tr>
<td>3260</td>
<td></td>
<td>70.0e</td>
<td>285</td>
<td></td>
<td>285</td>
<td>25</td>
<td>WFM</td>
<td></td>
</tr>
</tbody>
</table>

**Difference from Test Pt. 6.000**
CONTROL INSTL-COMPLETE (ENGINE CONTROLS ONLY)

FIGURE 3
CONTROLS INSTL-OUTER WING
FIGURE 4

Page A13-3
HERCULES COMPANY
PARTS CATALOG

CONTROLS INSTL - CENTER WING
FIGURE 5 (SHEET 1)

Page A.13-4
HERCULES LOCKHEED-GEOGRAPH COMPANY

PARTS CATALOG

CONTROLS INSTL - CENTER WING
FIGURE 5 (SHEET 2)

Page A.13-5
Customer: Civil Aviation Department  Date of Test: 9 FEB. 1995

Test Condition: Temperature: 23 ± 2 °C, R.H.: 55 ± 10 %

Test Equipment Used:
1) Metallurgical Microscope Model SMZ-10
2) AVO Meter Model 8

Testing:
A set of 4 filament bulbs were examined under microscope with 30X magnification. Water vapour could be observed on the inside surface of the glass. Photos were taken for reference. Continuity check of the filament was carried out.

Results:

<table>
<thead>
<tr>
<th>Filament No.</th>
<th>Continuity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Open</td>
</tr>
<tr>
<td>2</td>
<td>Open</td>
</tr>
<tr>
<td>3</td>
<td>Open</td>
</tr>
<tr>
<td>4</td>
<td>Closed</td>
</tr>
</tbody>
</table>

By: [Signature]  Date: 9 FEB 1995
No. 1 Engine Beta Light Bulb

No. 2 Engine Beta Light Bulb
Accident Investigation
Lockheed Hercules L100-30
PK-PLV

No. 3 Engine Beta Light Bulb

No. 4 Engine Beta Light Bulb
Flight dynamics technical assessment and analysis provided by Lockheed Aeronautical Systems Company

Flight Conditions

The following flight conditions pertinent to the accident have been supplied by the UK accident investigation board:

- T.O. Gross Weight = 123,835 lbs
- Aircraft Centre of Gravity = 24.8% MAC (estimated)
- Flaps Down 50%
- Sea Level
- OAT = 27°C
- Runway Condition: Wet (light rain had stopped)
- Runway Heading = 135°
- Wind = 090°/10 knots
- Runway Length = 3,392 m = 11,130 ft
- \( V_1 = 107 \text{ knots (as determined by crew) } \)
- \( V_r = 110 \text{ knots (as determined by crew) } \)
- \( V_2 = 120 \text{ knots (as determined by crew) } \)

Powerplant Information

Laboratory inspection of the propellers by Hamilton Standard revealed that the #1, 2, and 3 propellers were at the low pitch stop setting (24° blade angle) at impact. The #4 propeller was at a blade angle between 14° and 16° at impact. The Allison turbines appeared to be in good condition.

Ground Track Analysis

A survey plan of the Hong Kong International Airport with the wreckage position and the aircraft path derived from airport radar data is shown in Figure 1. The radar points were acquired at five second intervals. Table 1 presents values for x-distance from the start of the takeoff and y-distance from the runway centreline which have been scaled from the large survey drawing. Average airspeeds over the five-second time intervals are derived from the data and shown in the table. This would show a constant airspeed for the first 20 seconds, not a very plausible scenario. Figure 2 shows x-distances versus time with the radar accuracy bands included. In an attempt to smooth out and enhance the derived airspeeds, radar points 2, 3, and 4 (as identified in Figure 1) have been adjusted by a factor equal to the accuracy of the radar data. These adjustments and the resulting derived airspeeds are shown in Table 2.

A comparison of the mishap takeoff ground run with a normal takeoff (calculated with the performance methods used for flight manual data at the applicable airport conditions) is shown in Figure 3. The point of liftoff for the Pelita aircraft is assumed to be at the position of the PAPI (Precision Approach Path Indicator), as reported, which occurs between radar points 6 and 7. The adjusted airport radar data show fairly good agreement with the normal takeoff data, as shown in the following table:
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mishap Takeoff</th>
<th>Normal Takeoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to Liftoff</td>
<td>2500 ft</td>
<td>2416 ft</td>
</tr>
<tr>
<td>Elapsed Time to Liftoff</td>
<td>26 sec</td>
<td>25 sec</td>
</tr>
<tr>
<td>Liftoff Speed</td>
<td>Undetermined</td>
<td>114 knots (true)</td>
</tr>
</tbody>
</table>

Predicted takeoff characteristics have also been calculated for a scenario in which engines #1, 2, and 3 are at takeoff power (TIT = 1077°C), but engine #4 is at ground idle from the onset of the takeoff manoeuvre. Takeoff performance for this condition is compared with a normal 4-engine takeoff in Figure 4. Time and distance to liftoff are 52.5 seconds and 5050 feet, respectively. In addition, there is insufficient rudder to maintain directional control of the aircraft. The aircraft would veer sharply to the right off the runway before liftoff was attained. However, the pilot reported that he moved his hand from the nose wheel steering to the column when the copilot called 70 knots, so he must have had control of the aircraft at this point.

The scenario of engine #4 at ground idle throughout the takeoff run does not match the radar data. The overall ground run analysis shows a ground run time history close to normal but leaves uncertain the liftoff speed.

**Airborne Flight Analysis**

Time histories of aircraft responses following engine failures immediately after becoming airborne have been generated using a six-degrees-of-freedom, non-linear, flight simulation computer program. This program does not include landing gear reaction forces, so the effects of engine failure during the takeoff ground roll or inadvertent ground contact after liftoff - e.g. bouncing - cannot be replicated. The aerodynamic data used in the computer program are the same as the data used in C-130 flight simulators. Plots of pertinent parameters - including airspeed, altitude, x and y positions, aircraft attitudes, control inputs, and engine thrust - are shown for each case.

A variety of engine/propeller system failures were considered after liftoff. Thrust levels for these various engine conditions are presented in Figure 5. Feathered and windmilling prop conditions as well as flight idle thrust and maximum reverse thrust are shown. Figure 6 shows the flight manual minimum control speeds. (Air minimum control speed is based on the failure of an outboard engine with the prop windmilling on NTS.) As noted on the figure, published ground minimum control speed was 98 knots and air minimum control speed was 102 knots for the reported conditions.

The following cases simulating various engine failure conditions have been generated. Cases A through C considered a normal liftoff at 115 knots with a failure 3 seconds after liftoff. Case D considered a failure 1 second after liftoff and Case E considered an early liftoff (i.e. low airspeed). Time histories of the aircraft responses are shown in Figures 7 through 10.

Case A: All four engines are at takeoff power, initial airspeed is 115 KEAS, and the aircraft is at a climb angle of 6.4° after liftoff. Three seconds later the #4 engine experiences a failure and its thrust output decreases to a windmilling condition in one second. Control of the aircraft is easily maintained using only 50% of the available aileron and rudder capability. However, if no pilot action is taken, the aircraft will yaw and roll to the right and impact the water 950 feet from the runway centreline. The aircraft will have achieved
a maximum altitude of 215 feet before diving into the water. Time histories of the predicted aircraft responses are shown in Figure 7a through 7e.

Case B: Initial conditions are the same as those for Case A. However, this time the #4 engine fails and thrust decays to flight idle in one second. The flight idle level produces more negative thrust than windmilling at these airspeeds. Therefore, the yawing and rolling moments due to asymmetric power are greater than those for Case A. Control of the aircraft is easily maintained using about 70% of the available aileron and 50% of the rudder capability. However, if no pilot action is taken, the aircraft will yaw and roll to the right and impact the water about 870 feet from the runway centreline. The aircraft will have achieved a maximum altitude of 200 feet before diving into the water. Time histories of the predicted aircraft responses are shown in Figure 8a through 8e.

Case C: Initial conditions are the same as those for Cases A and B. However, this time the #4 engine fails and thrust decays to maximum reverse in one second. The yawing and rolling moments due to asymmetric power are significantly greater than those for Cases A and B. Control of the aircraft cannot be regained. With full rudder and aileron input the aircraft still yaws and rolls to the right and crashes into the water 600 feet off the runway centreline. If no pilot action is taken, the aircraft will impact the water about 550 feet from the runway centreline. The aircraft will have achieved a maximum altitude of 150 feet before diving into the water. Time histories of the predicted aircraft responses are shown in Figure 9a through 9e.

Case D: All four engines are at takeoff power, initial airspeed is 112 KEAS, and the aircraft is at a climb angle of 1.4° at liftoff. One second later the #4 engine experiences a failure and its thrust output decreases to a level between flight idle (+23° blade angle) and maximum reverse (-6° blade angle). This thrust level was determined via iteration of thrust levels to a condition giving a track that closely matched the radar data. It is estimated that this thrust level corresponds to a blade angle of +19 deg at 100% engine rpm or a +16 deg blade angle at an engine rpm of 123% (i.e. 23% overspeed condition). If full rudder is input, control of the aircraft can be maintained and the climbout continued. Less than full aileron is needed to control the roll. However, if the pilot inputs full aileron to control the roll and applies only partial rudder, then the aircraft will yaw to the right. Sideslip will build up to excessive levels. (Aircraft buffeting on C-130 models is experienced when sideslip angles exceed about 16°.) The excessive sideslip will produce additional rolling moment which cannot be controlled and the aircraft will roll to the right. Impact with the water will occur about 1100 feet from the runway centreline. The aircraft will achieve a maximum altitude of only 15 feet before hitting the water. Time histories of these predicted aircraft responses are shown in Figure 10a through 10e. A comparison of the flight path with the radar points of the actual mishap is presented in Figure 11.

Case E: All four engines are at takeoff power, initial airspeed is 90 KEAS (an airspeed corresponding to the airspeed derived from radar data), and the aircraft is at a climb angle of 1.0° at liftoff. One second later the #4 engine experiences a failure and its thrust output decreases to flight idle level. With full rudder and aileron input the aircraft yaws and rolls rapidly to the right and crashes into the ground 170 feet off the runway centreline. This result would be expected since the airspeed at the time of engine failure is below air minimum control speed (102 knots, as shown in Figure 6).
The survey plan of the Hong Kong International Airport area with the predicted impact points for Cases A through E is presented in Figure 12. Case D (with full aileron input, but only partial rudder) comes very close to the actual wreckage location. The computed flight path for this case is shown and compared to the likely flight path of the Pelita L-100-30.

Results of Flight Dynamics Analyses

Normal engine failures (i.e. failing to windmilling) of an outboard engine at airspeeds above air minimum control speed can be controlled and the climbout successfully completed. Airspeeds of 120-130 knots provide sufficient margin above the minimum control speed (102 knots for this case) so that only partial aileron and rudder control capability is needed to maintain control of flight. At airspeeds from 102-115 knots full rudder input may be required to maintain control of the aircraft until additional airspeed is attained or until power can be reduced on the opposite engine.

However, if the pilot fails to maintain directional control and is more concerned with trying to maintain a wings-level attitude, then sideslip angle can increase rapidly to excessive levels. The high sideslip angles produce additional rolling moment and attempting to maintain a wings-level attitude becomes increasingly difficult. Aircraft buffeting will be felt at sideslip angles greater than 16°-24°.

An engine failure at airspeeds below air minimum control speed cannot be controlled. However, such speeds are less than $V_1$ and the pilot must abort the takeoff. The runway length of 11,130 feet would provide more than sufficient length to easily stop the aircraft.

This analysis also investigated failures which were more severe than the levels used to establish minimum control speeds. These were: failure to flight idle (more critical than windmilling in some speed ranges); failure to maximum reverse; and failures to intermediate conditions.
TABLE 1

FLIGHT PATH CHARACTERISTICS
DERIVED FROM AIRPORT RADAR DATA

<table>
<thead>
<tr>
<th>Point</th>
<th>Time (sec)</th>
<th>X (ft)</th>
<th>Y (ft)</th>
<th>Δ Dist (ft)</th>
<th>Derived Airspeed (kts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>384</td>
<td>45.5</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>382</td>
<td>54</td>
<td>382</td>
<td>45.3</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>764</td>
<td>50</td>
<td>387</td>
<td>45.9</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>1150</td>
<td>25</td>
<td>383</td>
<td>45.4</td>
</tr>
<tr>
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<td>20</td>
<td>1532</td>
<td>21</td>
<td>764</td>
<td>90.5</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>2296</td>
<td>8</td>
<td>767</td>
<td>90.9</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
<td>3061</td>
<td>62</td>
<td>769</td>
<td>91.1</td>
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<tr>
<td>8</td>
<td>35</td>
<td>3825</td>
<td>150</td>
<td>799</td>
<td>94.7</td>
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<tr>
<td>9</td>
<td>40</td>
<td>4568</td>
<td>444</td>
<td>901</td>
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</tr>
<tr>
<td>10</td>
<td>45</td>
<td>5307</td>
<td>959</td>
<td>1084</td>
<td>128.4</td>
</tr>
<tr>
<td>11*</td>
<td>&lt; 50</td>
<td>5494</td>
<td>2027</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \Delta D = \sqrt{(\Delta X)^2 + (\Delta Y)^2} \]

Radar Accuracy: X-Distance ±187 ft

* Denotes wreckage location in water
PLAN OF THE SURVEY OF AIRCRAFT CRASH ON 23/9/94
LOCATION OF POINTS OF IMPACT FOR SIMULATION CASES

LEGEND:
- RADAR POINT & PROBABLE AREA OF AIRCRAFT
- POSITIONS OF PRECISION APPROACH PATH INDICATOR
- GAZETTED POSITION OF BUOY
- POSITION OF C130 IN THE SEA (SUPPLIED BY CAD)

FIGURE 12
AIRPORT RADAR DATA
DISTANCE FROM START OF TAKEOFF

X DISTANCE
(FT)

TIME (SEC)

Radar Accuracy Bounds
○ Radar Data Points

WRECKAGE POSITION

REPORTED LIFTOFF

FIGURE 2
### TABLE 2

**FLIGHT PATH CHARACTERISTICS DERIVED FROM AIRPORT RADAR DATA (ADJUSTED)**

<table>
<thead>
<tr>
<th>Point</th>
<th>Time (sec)</th>
<th>X (ft)</th>
<th>Y (ft)</th>
<th>Adjustment (ft)</th>
<th>Adjusted X (ft)</th>
<th>Δ Distance (ft)</th>
<th>Derived Airspeed (kts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
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<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>195</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>382</td>
<td>54</td>
<td>-187</td>
<td>195</td>
<td>382</td>
<td>45.3</td>
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<td>3</td>
<td>10</td>
<td>764</td>
<td>50</td>
<td>-187</td>
<td>577</td>
<td>386</td>
<td>45.7</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>1150</td>
<td>25</td>
<td>-187</td>
<td>963</td>
<td>386</td>
<td>45.7</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>1532</td>
<td>21</td>
<td>0</td>
<td>1532</td>
<td>569</td>
<td>67.4</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>2296</td>
<td>8</td>
<td>0</td>
<td>2296</td>
<td>764</td>
<td>90.5</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
<td>3061</td>
<td>62</td>
<td>0</td>
<td>3061</td>
<td>765</td>
<td>90.6</td>
</tr>
</tbody>
</table>
TAKEOFF PERFORMANCE
COMPARISON WITH FLIGHT MANUAL PREDICTED DATA

FIGURE 3
PREDICTED TAKEOFF PERFORMANCE

GROSS WEIGHT: 123,835 LB
PRESS ALTITUDE: SEA LEVEL
TEMPERATURE: 27 DEG C

FIGURE 4
ENGINE/PROPELLER THRUST LEVELS

SEA LEVEL

TRUE AIRSPEED (KTS)

THRUST PER ENGINE (LBS)

-16000 -14000 -12000 -10000 -8000 -6000 -4000 -2000 0 2000 4000

FIGURE 5

Page A15-11
MINIMUM CONTROL SPEED
WITH AND WITHOUT PYLON TANKS
50 PERCENT FLAPS  NORMAL BLEED

1077°F C TIIT MAXIMUM

FIGURE 6

4B-44A/(4B-44B blank)

Page A15-12
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=123,835 LBS  INITIAL AIRSPEED=115 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27 °C

○ ENGINE #4 TO WINDMILL THRUST - NO PILOT ACTION
△ ENGINE #4 TO WINDMILL THRUST - PILOT CORRECTIVE ACTION

FIGURE 7a Case A
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50% GW=123,835 LBS INITIAL AIRSPEED=115 KEAS
GEAR DOWN CG=24.8% MAC SEA LEVEL, TEMP=27 ℃

○ ENGINE #4 TO WINDMILL THRUST - NO PILOT ACTION
△ ENGINE #4 TO WINDMILL THRUST - PILOT CORRECTIVE ACTION

---

FIGURE 7b Case A

Page A15-14
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=123,835 LBS  INITIAL AIRSPEED=115 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27 °C

○ ENGINE #4 TO WINDMILL THRUST - NO PILOT ACTION
△ ENGINE #4 TO WINDMILL THRUST - PILOT CORRECTIVE ACTION

Carol A. Meador

FIGURE 7c Case A
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50% GW=123,835 LBS INITIAL AIRSPEED=115 KEAS
GEAR DOWN CG=24.8% MAC SEA LEVEL, TEMP=27°C

○ ENGINE #4 TO WINDMILL THRUST - NO PILOT ACTION
△ ENGINE #4 TO WINDMILL THRUST - PILOT CORRECTIVE ACTION

Figure 7d  Case A
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50% GW=123,835 LBS INITIAL AIRSPEED=115 KEAS
GEAR DOWN CG=24.8% MAC SEA LEVEL TEMP=27 °C

○ ENGINE #4 TO WINDMILL THRUST - NO PILOT ACTION
△ ENGINE #4 TO WINDMILL THRUST - PILOT CORRECTIVE ACTION

![Graph showing Elevator, Rudder, and Total Aileron responses over time.](image)

Figure 7e Case A
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=123,835 LBS  INITIAL AIRSPEED=115 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27 °C

○ ENGINE #4 TO FLIGHT IDLE THRUST - NO PILOT ACTION
△ ENGINE #4 TO FLIGHT IDLE THRUST - PILOT CORRECTIVE ACTION

FIGURE 8a Case B
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=123,835 LBS  INITIAL AIRSPEED=115 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27 °C

ENGINE #4 TO FLIGHT IDLE THRUST - NO PILOT ACTION
ENGINE #4 TO FLIGHT IDLE THRUST - PILOT CORRECTIVE ACTION

ANGLE OF ATTACK (DEG)

LIGHT PATH ANGLE (DEG)

PITCH ATTITUDE (DEG)

TIME (SEC)

FIGURE 8b Case B

Page A15-19
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=122,835 LBS  INITIAL AIRSPEED=115 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27 °C

○ ENGINE #4 TO FLIGHT IDLE THRUST - NO PILOT ACTION
△ ENGINE #4 TO FLIGHT IDLE THRUST - PILOT CORRECTIVE ACTION

![Graph showing predicted aircraft responses with time in seconds on the x-axis and angles on the y-axis, including bank, sideslip, and heading angles.](image-url)
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=123,835 LBS  INITIAL AIRSPEED=115 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27 °C

○ ENGINE #4 TO FLIGHT IDLE THRUST - NO PILOT ACTION
△ ENGINE #4 TO FLIGHT IDLE THRUST - PILOT CORRECTIVE ACTION

TRUE AIRSPEED (KTS)
160.
120.
80.

ENGINE #1 THRUST (LBS)
10.
0.
-10.

ENGINE #4 THRUST (LBS)
10.
0.
-10.

TIME (SEC)
0.  4.  8.  12.  16.  20.  24.

FIGURE 8d Case B

Page A15-21
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=123,835 LBS  INITIAL AIRSPEED=115 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27 °C

ENGINE #4 TO FLIGHT IDLE THRUST - NO PILOT ACTION
ENGINE #4 TO FLIGHT IDLE THRUST - PILOT CORRECTIVE ACTION

ELEVATOR (DEG)

Rudder (DEG)

TOTAL AILERON (DEG)

TIME (SFC)

FIGURE 8e Case B
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=123,835 LBS  INITIAL AIRSPEED=115 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27 °C

○ ENGINE #4 TO MAXIMUM REVERSE THRUST - NO PILOT ACTION
△ ENGINE #4 TO MAXIMUM REVERSE THRUST - PILOT CORRECTIVE ACTION

![Graphs showing aircraft responses](image_url)
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=123,835 LBS  INITIAL AIRSPEED=115 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27 °C

○ ENGINE #4 TO MAXIMUM REVERSE THRUST - NO PILOT ACTION
△ ENGINE #4 TO MAXIMUM REVERSE THRUST - PILOT CORRECTIVE ACTION

FIGURE 9b Case C

Page A15-24
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50% GW=123,835 LBS INITIAL AIRSPEED=115 KEAS
GEAR DOWN CG=24.8% MAC SEA LEVEL, TEMP=27°C

○ ENGINE #4 TO MAXIMUM REVERSE THRUST - NO PILOT ACTION
△ ENGINE #4 TO MAXIMUM REVERSE THRUST - PILOT CORRECTIVE ACTION

![Graphs showing bank angle, sideslip angle, and heading angle over time](image)

FIGURE 9c Case C
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50% GW=123,835 LBS INITIAL AIRSPEED=115 KEAS
GEAR DOWN CG=24.8% MAC SEA LEVEL, TEMP=27 °C

○ ENGINE #4 TO MAXIMUM REVERSE THRUST - NO PILOT ACTION
△ ENGINE #4 TO MAXIMUM REVERSE THRUST - PILOT CORRECTIVE ACTION

FIGURE 9d Case C
PELTIA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50% GW=123,835 LBS INITIAL AIRSPEED=115 KEAS
GEAR DOWN CG=24.8% MAC SEA LEVEL, TEMP=27°C

○ ENGINE #4 TO MAXIMUM REVERSE THRUST - NO PILOT ACTION
△ ENGINE #4 TO MAXIMUM REVERSE THRUST - PILOT CORRECTIVE ACTION

TIME (SEC)

FIGURE 9e Case C

Page 215-27
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50% GW=123,835 LBS INITIAL AIRSPEED=112 KEAS
GEAR DOWN CG=24.8% MAC SEA LEVEL, TEMP=27 °C

ENGINE #4 TO THRUST BETWEEN FLIGHT IDLE AND MAXIMUM REVERSE, BLADE ANGLE = +19 DEG (100% RPM)
○ PILOT INPUT TO MATCH RADAR DATA POINTS
△ PILOT CORRECTIVE ACTION

---

FIGURE 10a Case D

Page A15-28
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%   GW=123,835 LBS   INITIAL AIRSPEED=112 KEAS
GEAR DOWN       CG=24.8% MAC       SEA LEVEL, TEMP=27°C

ENGINE #4 TO THRUST BETWEEN FLIGHT IDLE AND MAXIMUM REVERSE, BLADE ANGLE = +19 DEG (100% RPM)
○ PILOT INPUT TO MATCH RADAR DATA POINTS
△ PILOT CORRECTIVE ACTION

FIGURE 10b Case D
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=123,835 LBS  INITIAL AIRSPEED=112 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27°C

ENGINE #4 TO THRUST BETWEEN FLIGHT IDLE AND MAXIMUM REVERSE, BLADE ANGLE = +19 DEG (100% RPM)
○ PILOT INPUT TO MATCH RADAR DATA POINTS
△ PILOT CORRECTIVE ACTION

![Diagram of aircraft responses over time](image)

**Figure 10c Case D**
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%  GW=123,835 LBS  INITIAL AIRSPEED=112 KEAS
GEAR DOWN  CG=24.8% MAC  SEA LEVEL, TEMP=27 °C

ENGINE #4 TO THRUST BETWEEN FLIGHT IDLE AND MAXIMUM REVERSE, BLADE ANGLE = ±19 DEG (100% RPM)
○ PILOT INPUT TO MATCH RADAR DATA POINTS
△ PILOT CORRECTIVE ACTION

TRUE AIRSPEED (KTS)

ENGINE #1 THRUST (LBS)

ENGINE #4 THRUST (LBS)

TIME (SEC)

FIGURE 10d  Case D
PELITA L-100-30 HONG KONG ACCIDENT
PREDICTED AIRCRAFT RESPONSES

TAKE-OFF CONFIGURATION
FLAPS DOWN 50%   GW=123,835 LBS   INITIAL AIRSPEED=112 KEAS
GEAR DOWN       CG=24.8% MAC     SEA LEVEL, TEMP=27 °C

ENGINE #4 TO THRUST BETWEEN FLIGHT IDLE AND MAXIMUM REVERSE, BLADE ANGLE = +19 DEG (100% RPM)

○ PILOT INPUT TO MATCH RADAR DATA POINTS
△ PILOT CORRECTIVE ACTION

ELEVATOR (DEG)

RUDDER (DEG)

TOTAL AILERON (DEG)

TIME (SEC)

FIGURE 10e Case D

Page A15-32
FIGURE 11
LEGEND:
- Radar point & probable area of aircraft
- Positions of precision approach path indicator
- Gazetted position of buoy
- Position of C130 in the sea (supplied by CAD)

PLAN OF THE SURVEY OF AIRCRAFT CRASH
ON 23/9/94
LOCATION OF POINTS OF IMPACT FOR SIMULATION CASES

FIGURE 12
Diagram showing the Relative Location of the Levers

Flight Station Forward

1. PILOT'S SIDE SHELF
2. PILOT'S SIDE SHELF EXTENSION
3. PILOT'S INSTRUMENT PANEL (Page A16-2)
4. ENGINE INSTRUMENT PANEL
5. OVERHEAD CONTROL PANEL
6. COPILOT'S INSTRUMENT PANEL (Page A16-3)
7. COPILOT'S SIDE SHELF EXTENSION
8. COPILOT'S SIDE SHELF
9. FLIGHT CONTROL PEDESTAL (Page A16-4)
1. PILOT'S INSTRUMENT PANEL
2. ENC INSTRUMENT PANEL
3. COPILOT'S INSTRUMENT PANEL
4. MAGNETIC COMPASS
5. DOOR OPEN WARNING LIGHT
6. ACCELEROMETER
7. CLOCK
8. BEARING DISTANCE HEADING INDICATOR
9. AIRSPEED INDICATOR
10. PITOT HEAT INDICATOR
11. ATTITUDE DIRECTOR INDICATOR
12. PCS MODE ANNUNCIATOR LIGHT PANEL
13. HORIZONTAL SITUATION INDICATOR
14. Vertical Velocity Indicator
15. ALTImETER-ENCODER
16. PCS WARNING OR ADVISORY ANNUNCIATOR LIGHT PANEL
17. NAVIGATION SELECTOR CONTROL AND SMOKE DETECTOR TEST PANEL
18. MASTER FIRE WARNING PANEL
19. CREW DOOR OPEN WARN LIGHT
20. ENGINE LOW OIL QUANTITY WARNING LIGHT
21. CARGO SMOKE INDICATION LIGHT
22. MARKER BEACON CONTROL PANEL
23. WEATHER RADAR INDICATOR
24. ELEVATOR TAB POSITION INDICATOR
25. AILERON TAB POSITION INDICATOR
26. RUDDER TAB POSITION INDICATOR
27. ELECTRONIC FUEL CORRECTION PANEL
28. AIR DIVERTER HANDLE
29. AIRSPEED LIMITATION PLACARD
30. RADIO ALTIMETER

**NOTE:**

⚠️ AIRPLANES MODIFIED BY SB 382-30-4
⚠️ AIRPLANES MODIFIED BY SB 382-52-5
1. CABIN ALTIMETER
2. LOW CABIN AIR PRESSURE WARNING LIGHT
3. WING FLAP POSITION INDICATOR
4. NACELLE OVERHEAT WARNING
5. FREE AIR TEMPERATURE INDICATOR
6. LANDING LIGHTS EXTEND INDICATOR LIGHT
7. AIRSPEED INDICATOR
8. BEARING DISTANCE HEADING INDICATOR
9. ATTITUDE DIRECTOR INDICATOR
10. FCS MODE ANNUNCIATOR LIGHT PANEL
11. HORIZONTAL SITUATION INDICATOR
12. AIR CONDITIONING OVER TEMPERATURE LIGHT
13. VERTICAL VELOCITY INDICATOR
14. PITOT HEAT INDICATOR
15. ALTIMETER
16. FCS WARM OF ADVISORY ANN. LIGHT PANEL
17. MAGNETIC COMPASS
18. NAVIGATION SELECTOR CONTROL PANEL
19. SELECTED NAV SYSTEM OFF LIGHT
20. COMPASS CARD
21. CLOCK
22. EMERGENCY LOCATOR TRANSMITTED ARMING SWITCH
23. AIR DIVERTER HANDLE
24. HYDRAULIC CONTROL PANEL
25. LANDING AND TAXI LIGHTS CONTROL PANEL
26. LANDING GEAR CONTROL PANEL
27. PROP LOW OIL QUANTITY MASTER WARNING LIGHT
1. ENGINE AND PROPELLER WARNING PANEL
2. NO. 2 VHF COMMUNICATION/NAVIGATION CONTROL PANEL
3. NO. 2 C-12 COMPASS CONTROL PANEL
4. NO. 1 C-12 COMPASS CONTROL PANEL
5. COPILOT'S INTERPHONE CONTROL PANEL
6. COPILOT'S INTERPHONE MONITOR PANEL
7. NO. 2 HF COMMUNICATION RADIO (HF-102) CONTROL PANEL
8. ENGINE CONTROL QUADRANT
9. LOW SPEED GROUND IDLE PANEL
10. AUTOPILOT CONTROLLER
11. NO. 2 REMOTE HEADING AND COURSE SELECTOR CONTROL PANEL
12. NO. 2 FLIGHT CONTROL SYSTEM FLIGHT SELECTOR
13. RAMP AND DOOR CONTROL PANEL
14. AUXILIARY INTERPHONE MONITOR PANEL
15. MIKE CORD STOWAGE CONTAINER
16. FLAP CONTROL QUADRANT
17. AUXILIARY INTERPHONE CONTROL PANEL
18. ATC TRANSPONDER CONTROL PANEL
19. NO. 1 FLIGHT CONTROL SYSTEM FLIGHT SELECTOR
20. NO. 1 REMOTE HEADING AND COURSE SELECTOR CONTROL PANEL
21. TRIM TAB CONTROL PANEL
22. FLIGHT CONTROL SYSTEM ANNUNCIATOR TEST PANEL
23. ELEVATION TRIM TAB POWER SELECTOR PANEL
24. FLIGHT RECORDER CONTROL PANEL
25. NO. 1 HF COMMUNICATION RADIO (HF-102) CONTROL PANEL
26. PILOT'S INTERPHONE MONITOR PANEL
27. PILOT'S INTERPHONE CONTROL PANEL
28. COCKPIT VOICE RECORDER CONTROL PANEL
29. DUAL ADF CONTROL PANEL
30. NO. 1 VHF COMMUNICATION/NAVIGATION CONTROL PANEL
HK 363.124 H7 B96 1
Hong Kong. Civil Aviation
Dept. Accidents Investigation
Division.

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