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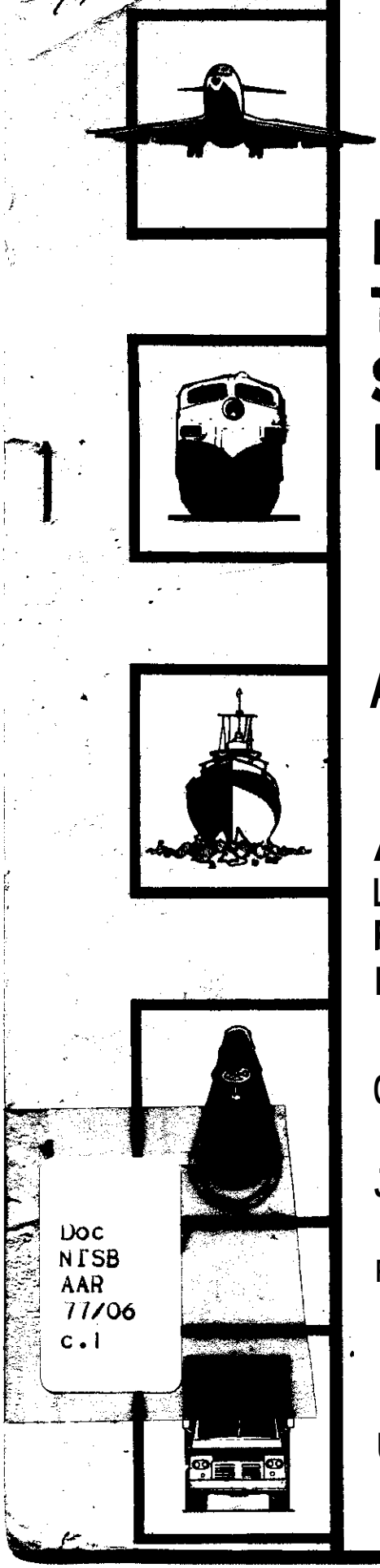

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

AR MANILA, INCORPORATED,
LOCKHEED L-188A
REPUBLIC OF THE
PHILIPPINES REGISTRY RP-C1061

GUAM, MARIANAS ISLANDS

JUNE 4, 1976

REPORT NUMBER: NTSB-AAR-77-6

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16. Abstract At 1447:48 Greenwich mean time on June 4, 1976, Air Manila Flight 702 crashed while attempting to takeoff from runway 6L at the Agana Naval Air Station, Guam.

When the aircraft lifted off the 10,015-foot runway, the No. 3 propeller feathered. The aircraft Climbed to between 75 and 100 feet, flew level for 1,600 feet, and then struck gradually rising terrain in a tail-low attitude 4,300 feet beyond the end of the runway. The aircraft dragged along the brow of the hill, dropped off a 13-foot embankment, crashed through a chain link perimeter fence of Agana NAS, slid across a highway, struck a moving automobile and burst into flames. The aircraft came to rest in a vacant area that was surrounded by six houses. The driver of the automobile, 12 crewmembers, and 33 passengers aboard the aircraft were killed. A woman and her young son, who were standing outside their residence just south of the impact site, were seriously injured by the intense heat and flying debris when the aircraft's fuel exploded.

The National Transportation Safety Board determines that the probable cause of this accident was the loss of climb capability after the crew retracted the flaps at too low an altitude to clear the rising terrain. The flaps were retracted after the No. 3 propeller feathered as the aircraft lifted off the runway.

Contributing to the accident was the captain's decision to continue the takeoff after an engine failed before reaching the rotation speed.

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SYNOPSIS

At 1447:48 Greenwich mean time on June 4, 1976, Air Manila Flight 702 crashed while attempting to takeoff from runway 6L at the Agana Naval Air Station, Guam.

When the aircraft lifted off the 10,015-foot runway, the No. 3 propeller feathered. The aircraft climbed to between 75 and 100 feet, flew level for 1,600 feet, and then struck gradually rising terrain in a tail-low attitude, 4,300 feet beyond the end of the runway. The aircraft dragged along the brow of the hill, dropped off a 13-foot embankment, crashed through a chain link perimeter fence of Agana NAS, slid across a highway, struck a moving automobile, and burst into flames. The aircraft came to rest in a vacant area that was surrounded by six houses. The driver of the automobile, 12 crewmembers, and 33 passengers, aboard the aircraft were killed. A woman and her young son, who were standing outside their residence just south of the impact site, were seriously injured by the intense heat and flying debris when the aircraft's fuel exploded.

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1. INVESTIGATION

1.1 History of Flight

At 2109 1/ on June 3, 1976, Air Manila, Inc., Flight 702 (a Lockheed Electra L-188A, Philippine registry RP-C1061) departed Wake Island for Manila, Republic of the Philippines. An en route stop was scheduled at Agana Naval Air Station (NAS), Guam, Marianas Islands. Flight 702 was operating as a charter flight to transport personnel and goods between Wake Island and the Philippines. The flight was authorized by the Department of Tourism, Civil Aeronautics Board, Republic of the Phillipines, and the United States Civil Aeronautics Board under Order No. 75-5-6.

Shortly before landing at the Agana NAS, the flightcrew of Flight 702 notified Pan American World Airways 2/ on that company's radio frequency that they were inbound and would require maintenance. They did not mention the type of problem nor notify air traffic control, ARINC-Honolulu, or Agana NAS of any aircraft difficulty. When the aircraft landed at the NAS at 0211 on June 4, the crash alert crew observed that the No. 2 propeller was feathered. The flightcrew taxied the aircraft to the terminal ramp, off-loaded the passengers, taxied the aircraft to the north ramp, and parked it.

Pan Am maintenance personnel offered their services: however, the two Air Manila mechanics, who were a part of the regular flightcrew, declined the offer. Ground witnesses, including Pan Am maintenance personnel, saw the Air Manila mechanics open a 10-inch by 15-inch access panel on the inboard side of the No. 2 engine (directly behind the No. 2 propeller). They looked inside and remarked, "It's dry." The mechanics then got a 5-gallon can marked "CAL-TEX" from the aircraft and transferred fluid from it to a 1-gallon service can. They transferred fluid to the service can twice: however, the witnesses did not know the amount of fluid that was transferred each time.

According to the witnesses, one mechanic then went to the cockpit and cycled the No. 2 propeller out of and back into the feather position. He cycled the propeller several times, after which, the mechanic closed the access panel. The witnesses saw no other outside maintenance accomplished on the aircraft. A Pan Am maintenance man, who boarded the aircraft just before the engines were started, saw the Air Manila mechanics replace the carpet in the vicinity of the aft galley. The mechanics gave no reason for doing so.

1/ All times are Greenwich mean time, unless otherwise noted.

2/ Pan Am provided contract ground and cabin services, weather information, and interstation ground communication for Air Manila.

While the mechanics were working near the No. 2 engine, the aircraft was refueled. Shortly after the work was completed, the passengers boarded and the flightcrew started all four engines without difficulty. The flightcrew taxied the aircraft to the end of runway 6L, made a right turn onto the runway, and executed a rolling takeoff.

Witnesses stated that the aircraft lifted off the 10,015-foot runway between 6,600 and 8,000 feet down the runway. Most of these witnesses placed the actual liftoff near the 7,500-foot point on the runway. All witnesses described the attitude of the aircraft at liftoff as normal and most of the witnesses stated that the No. 3 propeller feathered during, or just after, liftoff. One witness, located abeam of the 6,000-foot mark from the approach end of the runway, stated that the flaps were in the takeoff position when the aircraft passed his position. He also stated that he heard a definite change in the sound of the propellers. The sound he described was that produced by a reduction from high rpm to low rpm and then back to high rpm. (This witness was a qualified Navy P-3 crewmember.) The witnesses estimated that the aircraft climbed to between 75 and 100 feet while yawing to the right; it then rotated to a nose-high attitude, appeared to become laterally unstable, and struck the rising terrain in a tail-low attitude. Impact was about 4,300 feet beyond the end of the runway.

The aft portion of the aircraft fuselage dragged along the ground for 220 feet in a right wing down attitude, after which the aircraft slid off the brow of a 13-foot embankment, crashed through the chain link perimeter fence at Agana NAS, crossed a highway, and burst into flames. The aircraft came to rest in an open area between residential areas, about 4,900 feet beyond the end of runway 6L.

As the aircraft slid across the highway, it struck an automobile on the highway; the driver of the car was killed. A woman and her son, who were standing outside their residence just south of the impact site, were seriously burned by the heat of the burning fuel and were seriously injured by flying debris.

The accident occurred at latitude 13° 29.5' N and longitude 144° 49' E, and at an elevation of about 390 feet m.s.l. The accident occurred during daylight hours at 0447:48.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	12	33	1
Serious	0	0	2
Minor/None	0	0	

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

An automobile was destroyed and one residence was damaged. One-hundred and twenty feet of chain link fence was damaged, and numerous gouges were made in the paved surface of the highway.

1.5 Crew Information

The crew of Flight 702 was certificated and trained in accordance with the existing Philippine C.A.A. Regulations. (See Appendix B.)

1.6 Aircraft Information

This aircraft was manufactured in 1958 and registered to Eastern Airlines as N5502. The aircraft was sold to Air Manila on November **30,** 1971, and registered by the Republic of the Philippines as RP-C1061.

The last certificate of airworthiness was issued by the Republic **of** the Philippines, Civil Aeronautics Administration, **on** May **10,** 1976, and was valid until June 11, 1976.

A review of the maintenance records of RP-C1061 indicated that the aircraft inspections and maintenance requirements had been performed at the required times and all applicable airworthiness directives had been complied with. The transponder, which was required equipment, was listed **on** the deferred maintenance list as inoperable.

The records revealed the following maintenance log discrepancies and the corrective actions taken for the four flights which preceded the aircraft's departure from Manila **on** June 3, 1976, for the series of flights that culminated in the accident:

Date	Discrepancy	Corrective Action
May 24, 1976	**"1.** No. 3 engine **no** NTS 3/ light."	"Found open wire of light capsule and reconnected--operational check **OK."**
May 26, 1976	"1. No. 3 engine torque meter fluctuating by **500** HP."	"Cleaned cannon-plug engine torquemeter shaft, swapped HP indicator No. 3 and No. *4* and replaced No. 3 inducer valve due to stucked-up (sic) to open ground run-up check **OK."**

3/ Negative Torque system.

Date	Discrepancy	Corrective Action
May 31, 1976	"1. No. 3 HP fluctuating in climb and cruise."	"Calibrated phase detector cal A and B and cleaned 5th, 10th and 14th bleed valves, ground run-up check OK.
June 2, 1976	"1. See performance data	"Noted and calibrated HP"
	"2. No. 3 engine HP still fluctuating and No. 3 F/F."	"Found loose contacts of torquemeter cannon plug, cleaned and secured. Ground run-up, check noted engine reading OK."

The Safety Board could not determine if discrepancies had been found and logged before the aircraft departed Wake Island, because the aircraft's maintenance log was destroyed in the accident; there was no requirement that copies of completed log pages be removed and forwarded to Air Manila. Consequently, all maintenance records completed after the aircraft departed Manila were destroyed.

Evidently, a maintenance problem made necessary the shutdown of the No. 2 engine en route from Wake Island to Guam. The problem that required this action was indicated to have been in the propeller system because of the Air Manila mechanics answer, "prop, but it's okay now," to an inquiry made by one of Pan Am's maintenance personnel about "any maintenance problems?"

No weight and balance forms were required to have been filed before the aircraft departed Guam. A reconstruction of the weight and its distribution within the aircraft showed that the aircraft weighed about 111,600 lbs. at the time of takeoff. The maximum certificated gross weight for takeoff was 113,000 lbs. and the maximum gross weight for landing was 95,650 lbs. For runway 6L at Agana NAS, the aircraft was weight-limited to 85,000 lbs. for a no-flap takeoff.

The aircraft had been serviced at Wake Island with 3,220 gals. (approximately 21,000 lbs) of JP-4 fuel. The flight plan from Wake Island to Guam required 19,930 lbs of fuel. The aircraft was fueled to capacity at Guam with 3,528 gals. (approximately 23,800 lbs) of Jet A-1 (kerosene).

JP-4 and Jet A-1 fuel are compatible when mixed; the fuel load was calculated to have been approximately 27 percent JP-4 and 73 percent Jet A-1 at takeoff. The flashpoint of the mixture is about 30° F.

1.7 Meteorological Information

The surface weather observations for June 4, 1976, at Agana NAS were in part:

> 0459 --- 1,800 feet scattered, 28,000 feet scattered, visibility--7 miles, temperature--87° F, dewpoint--72° F, wind--120°8 kns, altimeter setting--29.82 inches, cumulonimbus north and east, moving west, wind--080' variable to 150" aircraft mishap at 0449.

The terminal forecast for Agana NAS for 0000 through 2400 on June 4, 1976, was:

> Wind--030' 10 kns, visibility--10 kilometers or more, 3/8 of the sky covered by cumulus clouds with bases at 1,500 feet, 6/8 of the sky covered by cirrus clouds with bases at 30,000 feet, no ceiling, occasional rain showers, gradually becoming clear by 0800-1000, wind direction variable and wind speed 5 kns.

The 0000 winds aloft observation for June 4, 1976, at Taguac, Guam, were (in part):

Altitude (Ft. m.s.l.)	Direction (True)	Speed (Kns)
1,000	055°	8
2,000	060°	8
3,000	050°	8
4,000	050	8

1.8 Aids to Navigation

Not involved.

1.9 Communications

There were no problems with communications.

1.10 Aerodrome and Ground Facilities

Agana Naval Air Station has parallel runways, 6L/24R and 6R/24L. Runway 6L/24R is 10,015 feet long and 150 feet wide, and had an asphalt/concrete surface. Runway 6R/24L is 8,000 feet long and 150 feet wide, and had an asphalt/concrete surface.

Agana NAS is used by both military and civilian aircraft. The airport and ground facilities were not involved in the accident.

1.11 Flight Recorders

RP-C1061 was equipped with a Fairchild A-100 cockpit voice recorder (CVR), serial No. 771, and a Sundstrand Model FA-542, flight data recorder (FDR), serial no. 2635.

The CVR was heavily damaged by fire and impact. The tape contained no usable information, only low-level "thumps," barely above the ambient tape noise level, such as would be noted on a tape which had been erased by a bulk eraser. The bulk tape eraser was not the type usually used in the CVR, but was the type used in a maintenance shop or by a manufacturer to prepare a new tape for insertion into a recorder.

The FDR was partially destroyed by fire. The recording medium magazine was removed; although the foil medium was not damaged, it was coated with heavy black deposits of an undetermined origin.

After the foil was cleaned, examination disclosed that side No. 1 was being used for recording; however, this side of the foil was being used for the fifth time which made it difficult to read. Side No. 2 of the foil had never been used.

The parameter traces were defined by use of the encoding symbols and could be measured. All parameters, except for airspeed, were recorded normally. Examination of the airspeed trace showed a slight positive increase during the takeoff run followed by a decrease to a value below zero. Examination of the recordings of previous flights indicated that this discrepancy had existed for the last 1,000 hours of aircraft operation.

The altitude trace indicated that the aircraft gained about 100 feet during the 22 seconds after liftoff. The trace then indicated a sharp decrease in the rate of climb, which resulted in a zero rate over the next 8 seconds. The indicated total altitude gained from point of liftoff was 109 feet.

The maintenance records revealed that the FDR had not been overhauled since Air Manila, Inc., took possession of the aircraft in November 1971. The aircraft had flown 6,394 hours since that date.

1.12 Wreckage and Impact Information

The elevation of the runway at the approximate liftoff point was 274 feet m.s.l. The elevation of the brow of the hill where the aircraft hit the terrain was 390 feet m.s.l. The rising slope of the terrain from the end of the runway to the brow of the hill averages 2.19 percent.

The first ground impact mark was about *4,300* feet past the departure end of runway 6L at an elevation of *390* feet m.s.l. This mark, apparently made by the lower aft section of the fuselage, continued for about *197* feet where a gouge mark from one blade of the **No.** *3* propeller and slash marks from the **No.** *4* propeller were found. The wreckage came to a stop about *4,900* feet past the end of the runway and was oriented **on** a heading of *063°* magnetic and was **75** feet left of the extended runway centerline.

Most ***of*** the aircraft fuselage was consumed by fire. **Nos. 1,** 2, and *4* engines, with propellers detached, and the empennage were separated from the main structure. All flight controls and major components of the aircraft were accounted for. The landing gear was up and locked and the landing flaps were retracted.

The powerplants were examined at the scene and at Agana NAS. Selected components were taken to the manufacturer's facility for further examination.

Examination revealed that the **Nos. 1,** 2, and *4* engines had been producing power before impact. There was **no** evidence of any condition that would have reduced their power output below an acceptable level.

The **No.** 3 propeller appeared to be in the feathered position in the wreckage. Teardown of the propeller assembly confirmed this observation.

The **No.** *3* engine's fuel control was damaged extensively **by** fire and impact, and it could not be tested for operating capability or fuel-metering control. However, examination of the components of the unit did not reveal any failures or discrepancies that would have prevented its operation before impact. **In** summary, the investigation disclosed **no** evidence of any condition that would have prevented the **No.** *3* engine from operating properly before the accident.

Because of fire damage, the **No.** *3* thrust-sensitive signal (TSS) could not be checked. The TSS provides the means for initiating autofeathering of the propeller.

1.13 .Medical and Pathological Information

The medical records of the flightcrew disclosed **no** evidence of preexisting diseases or other conditions which might have impaired their ability to perform their flight duties.

Post-mortem examinations of the flightcrew disclosed **no** evidence of incapacitating disease. Toxicological analyses for drugs and alcohol were negative. Levels of carbon monoxide (CO) of **18.1,** 26.6 and **11.5** percent were found in blood samples from the captain, first officer, and flight engineer, respectively.

The captain and first officer received fractures of both lower legs and the captain incurred a large laceration to his forehead. The flight engineer sustained a crushing injury to the chest. The three flightcrew members were severely burned, and the captain and flight engineer had deposits of black soot in the tracheae. The captain and first officer died from suffocation by smoke inhalation and shock from severe burns. The flight engineer died from impact injuries.

The other nine crewmembers were burned severely. Seven of them also had severe traumatic impact injuries to the head, chest, and extremities. Three of the nine crewmembers had deposits of black soot in the tracheae, and they died from suffocation by smoke inhalation and shock from severe burns. The other six died from impact injuries. Their blood samples contained levels of CO which ranged from 4.1 to 21.8 percent.

Twenty-three of the passengers died from suffocation by smoke inhalation and shock from severe burns. The other 10 passengers died from various, severe impact injuries. All but one of the passengers was burned severely. The passengers' blood samples contained levels of CO which ranged from 1.6 to 40.4 percent; nine of them showed levels of above 20 percent.

1.14 Fire

There was no evidence of fire before impact.

Shortly after the aircraft touched down, but before it began to slide over the crest of the hill, the left wing was damaged and fuel spilled onto the side of the hill, The ground was charred on the north side of the path created by the left wing before the aircraft struck the airport perimeter fence and before it crossed the highway. Soot deposits on rocks and the pattern of the burned area on the hill indicated that the spilled fuel ignited on or near the highway and that the fire propagated up the hill.

After the aircraft crossed the road and struck an automobile, a severe ground fire erupted along the entire crash path. The damaged automobile and the main portion of the aircraft wreckage erupted into an intense fire. Witnesses reported two or three explosions within seconds after the burning aircraft came to rest.

Personnel of the crash/fire/rescue units from Agana NAS, who were stationed near the midpoint of the runway, witnessed the takeoff and difficulties the aircraft was having and were responding before the aircraft hit the ground. The initial alarm was sounded at 0450 and the first Agana NAS unit was at the scene within 3 minutes. The standby alert unit was on scene at 0455 and the backup alert unit was on scene at 0459. The first firefighting agent was applied at 0454.

Units of the Guam Department of Public Service (DPS) were notified of the accident at 0451, and the units which responded were on the scene about 0459; they began to fight the fire immediately.

Twenty-two firefighters from Agana NAS responded with six pieces of equipment. They used about 43,000 gals. of water and 500 gals. of aqueous film-forming foam. About 41 DPS firefighters responded with 11 pieces of equipment; they hauled water from nearby hydrants and applied it to the fire.

Crash/fire/rescue personnel encountered one significant difficulty--the lock on the gate in the airport perimeter fence, immediately adjacent to the accident, had been changed and keys had not been provided to the Agana NAS fire department. Consequently, its response was delayed until the chain could be cut with bolt cutters.

1.15 Survival Aspects

The decelerative forces in this accident were within human tolerance; however, the aircraft's structure was damaged extensively during the ground slide. Some occupiable areas of the aircraft were crushed and many of the occupants' seats came loose during the accident. The seat structures which were not destroyed by fire were severely bent, and their legs and attachment fittings had failed.

1.16 Tests and Research

Not applicable

1.17 Additional Information

1.17.1 Company Policy

The policy established by company procedures that are based on good operating practice obligates the captain to discontinue the takeoff if an engine fails before reaching V_1 speed. If the speed is above V_1, the takeoff should be carried through; however, the captain may elect to stop if excess runway is known to exist.

1.17.2 -Aircraft Performance Data

The aircraft manufacturer provided performance data for the Electra Model 188A so that takeoff acceleration and climb profile of Flight 702 could be analyzed. The takeoff safety speed (V_2) [4/] for takeoff flap configuration and the existing conditions was determined to have been 123 knots equivalent airspeed (KEAS).

4/ In this case the critical engine failure speed (V_1) and the takeoff safety speed (V_2) are the same. Operating procedures established the rotation speed (V_R) at V_2 - 5 kns.

The following data were either extracted directly or extrapolated from data obtained during flight certification or wind tunnel tests, and were corrected for the airplane's weight, the runway gradient, and the atmospheric conditions that existed at the time of the accident.

a. Takeoff Ground Roll -- Distance from Standing Start

SPEED	CONFIGURATION	4-Engine Power (feet)	3 Engine Power (feet)	3 Engine Power after 2,000 feet of Roll (feet)
Rotation (V_2-5kn) (118 kn)	Takeoff flaps	3,650	6,000	4,850
	No flaps 5/	3,350	5,800	4,350
V_2 (123 kn)	Takeoff flaps	4,050	6,750	5,550
	No flaps	3,675	6,450	5,000
V_2 + 5 kn (128 Kn)	Takeoff flaps	4,500	7,550	6,500
	No flaps	4,050	7,050	5,650

b. Climb Gradient 6/ -- Percent (Height to Distance)

SPEED	Height Above Ground (feet)	CONFIGURATION (3 Engines Operation) Takeoff Flaps, Gear Down (percent)	Takeoff flaps, Gear Up (percent)	No Flaps, Gear Up (percent)
Rotation (V_2-5 kn)	0	5.6	--	--
	50	2.0	3.9	-0.5
	100	1.4	3.3	-1.0
V_2	0	5.6	--	--
	50	2.3	4.2	2.5
	100	1.7	3.8	2.0
V_2+5 kn	0	5.6	--	--
	50	2.5	4.6	4.1
	100	2.0	4.2	3.6

5/ The distances listed for "No flaps" are for the aircraft to attain the speeds shown in this chart. This speed and distance are not accurate for a planned "No Flap" takeoff.

6/ The figures are shown as a function of altitude to include the change in aerodynamic efficiency caused by the loss of ground effect.

The manufacturer's data relating to flap and landing gear retraction times contains the following information:

Landing gear retraction time

at V_2	9.5 seconds
at 190 KIAS	9.7 seconds

Flap retraction time

From	To	At (Kns)	Time (Seconds)
Full extend	Up	170 kn	15.5
Takeoff (78%)	Up	190 kn	12.5

A propeller feathering sequence, either autofeathered or manually initiated, requires 6 seconds.

1.18 New Investigative Techniques

None

2. ANALYSIS

The crew was qualified and properly certificated. There were no physiological or toxicological factors that could have affected the flightcrew's performance before the accident.

Although the Safety Board was unable to determine positively when the CO found in the cockpit crewmembers was ingested, the Board believes these CO levels resulted from exposure to postcrash conditions.

Since decelerative forces were within human tolerances, the accident was partially survivable. Seventeen persons died as a result of the structural damage in occupiable sections of the aircraft. Twenty-eight persons died from the effects of smoke and fire. Even though they survived the impact forces and loss of restraint, they were unable to escape or be rescued before the fire and smoke became lethal.

A mixture of 27 percent JP-4 and 73 percent Jet A kerosene will ignite and propagate much the same as undiluted JP-4. Jet A kerosene is generally considered a safer fuel, provided the impact conditions do not cause misting of the fuel. The extent to which such misting occurs during an impact sequence is often difficult to evaluate.

The crash/fire/rescue response was rapid and adequate; however, the rate of fire propagation precluded possibility of rescue for the survivors. The fire was rapidly extinguished after the fire equipment reached the scene.

The Safety Board could not determine the airworthiness of the aircraft at the time of the accident. The aircraft had landed at Guam with the No. 2 engine shut down and the No. 2 propeller feathered. The maintenance records for the series of flights that had begun on June 3, 1976, were carried onboard the aircraft and any discrepancies, including the reason for shutting down the No. 2 engine, could not be determined. However, since the Air Manila mechanics added fluid to the No. 2 engine/propeller installation through an access panel, the Safety Board assumed that the No. 2 engine shutdown was caused by a loss of oil from the propeller control. This assumption is supported by the fact that the mechanics cycled the propeller in and out of the feathered position after fluid had been added.

The Safety Board believes that the maintenance records of this aircraft reveal a pattern that has a bearing on this accident. Beginning on May 26, 1976, and continuing through the next two flights before the aircraft departed Manila on the series of flights that culminated in the crash, each flightcrew had reported a problem with the No. 3 engine's horsepower output. Although some corrective maintenance was recorded after each noted discrepancy, the only component change had been the replacement of the inducer valve on the No. 3 engine. The horsepower discrepancy continued uncorrected after this component change and on all flights before June 4.

The normal procedure for controlling either an improper turbine inlet temperature or horsepower output would be to place the temperature datum control switch in either the "NULL" or "OFF" position and control the fuel metering of the fuel control by throttle movement. Probably because of the history of this No. 3 engine, this method of thrust-output control was being used by the crew on this series of flights. Because the records were destroyed in the crash, the Safety Board could not determine if there were other problems with the No. 3 engine during the flights from Manila to Guam and from Guam to Wake on June 3, 1976, nor the flight from Wake to Guam on June 4, 1976. However, if the pattern that was established during the last three flights continued, it is highly probable that horsepower was being lost on the No. 3 engine as the aircraft made the takeoff run and reached the critical point 6 seconds before the aircraft lifted off the runway. As a result, the No. 3 engine shut down either when the No. 3 propeller autofeathered or when the crew initiated the manual feather sequence. The Safety Board believes that the engine sounds described by the witness located abeam of the 6,000-fodt point were made by the engine as it was being shut down and as the propeller was spinning down.

Assuming that an engine problem occurred and that the flightcrew was attempting to adjust the controls to remedy this problem, the slow acceleration and the long takeoff roll were not unusual.

The crew used the rolling takeoff technique, and the aircraft progressed down the runway as the power was advanced. The distance

covered using this technique varies, depending on the rate at which the pilot advances the power. Under normal circumstances with four engines operating, the amount of runway used while adjusting the power in a rolling takeoff would be of little or no consequence since the aircraft would accelerate to the V_R speed of 118 kns in about 4,000 feet. 'In the cockpit, the crew would have ample indication of each engine's output by the horsepower indications and the turbine inlet temperature gauges.

Therefore, a pilot would likely continue the takeoff run while attempting to normalize the No. 3 engine through throttle manipulation with the temperature datum system deactivated. Because of his recent successful takeoffs using this method of controlling the No. 3 engine, this pilot probably expected that this takeoff would also be successful.

However, the Safety Board believes that the uncorrected problem in the No. 3 engine reached a critical stage on this takeoff and that the engine was not producing the required thrust for acceleration from the time the takeoff was begun. The No. 3 engine's output deteriorated to the point that the propeller either autofeathered or was manually feathered just before the aircraft reached the V_R speed of 118 kns. Either method of feathering the propeller and shutting down the engine requires 6 seconds. Since the consensus of the witnesses established that the No. 3 propeller blades stopped at, or immediately after, liftoff, the propeller began its feathering sequence 3 to 6 kns. before the aircraft reached the V_R speed.

The aircraft performance analysis for the conditions that existed at the time of the takeoff shows that a distance of 6,750 feet would have been required for this aircraft to accelerate to the V_2 speed of 123 kns on three engines. The addition of the amount of ground covered by the aircraft while the crew was aligning the aircraft with the runway and adjusting the power for the rolling takeoff to the required 6,750 feet makes the witnesses' observations of a 7,500-foot liftoff point credible and acceptable. The witnesses' observations of the slower-than-normal acceleration of the aircraft supports the conclusion that, although four engines were operating, full power was being developed on only three engines. The captain was either attempting to analyze and correct the problem on the No. 3 engine or he was not using full power on the three good engines while he attempted to normalize the power output of the No. 3 engine.

Witnesses saw the aircraft, with the feathered No. 3 propeller, climb to an altitude of between 75 and 100 feet after which it rotated to an extreme noseup attitude and ceased climbing. Although changes in the airplane's configuration were noted only by one witness, the wreckage examination revealed that both landing gear and flaps were retracted before impact. The observation that the aircraft's attitude changed to nose-high and apparently lost climb performance is understandable if one

considers the effects of altitude, airspeed, and configuration changes on performance. Immediately after takeoff, an aircraft's climb capability is enhanced as the airflow over the aerodynamic surfaces reacts with the ground plane. As an aircraft gains altitude, the efficiency of the aerodynamic surfaces is significantly affected by the loss of ground effect which results in a decrease in the lift-to-drag ratio and a consequent reduction in the airplane climb capability. With or without ground effect, an aircraft's ability to climb depends on the amount of thrust above that required to overcome the aerodynamic drag in level, unaccelerated flight. For any gear/flap configuration, there is an optimum airspeed, usually above the specified V_2 speed, at which the excess thrust is maximum. If an aircraft is at an airspeed less than optimum, the thrust used to overcome drag will be greater and the thrust available for climb will be less. Thus, the achievable climb gradient is reduced. The airplane is said to be in the region of reversed command when a further decrease in airspeed will result in even higher drag. Consequently, with a continued reduction in airspeed, the available thrust may not be sufficient to maintain level flight.

Changes in the aircraft's configuration will affect both the lift and drag forces and have an even more significant affect on its climb capability. While retracting the landing gear will have a positive affect, retracting the flaps can have either a negative or positive affect, depending on the airspeed. If flaps are retracted at an airspeed much below that for the optimum lift-to-drag ratio for the flaps up configuration, the loss of climb capability can be catastrophic. Since, in the new configuration, the aircraft is in a region of speed wherein rotating the nose of the aircraft to a higher pitch attitude in an attempt to maintain a given climb gradient or even level flight will result in a further decrease in climb performance.

The evidence indicates that these performance characteristics were prevalent during this accident. The L-188 performance data, for the conditions existing at the time of the accident, show that the airplane could have achieved a climb gradient of 5.6 percent at ground elevation, at a V_2 speed of 123 KEAS, with three engines operating at takeoff power, flaps extended to the 78 percent takeoff position, and with the landing gear down. When the aircraft reached 50 feet, with other factors remaining constant, it could have achieved a climb gradient of only 2.3 percent, barely above the 2.19 percent terrain gradient beyond the end of the departure runway. Any attempt to increase the climb gradient would have resulted in a loss of airspeed and a reduction in performance. After the gear was retracted, which took about 9 seconds, the climb performance would have increased and a gradient of about 4 percent should have been obtainable. The retraction of flaps, however, would have had a severely negative affect, by reducing the maximum achievable climb gradient to about 2 percent if V_2 speed for takeoff flaps was maintained. If the speed was allowed to decrease only 5 kns., the aircraft would have been unable to maintain level flight.

The Safety Board believes that the aircraft became airborne at an airspeed very close to V_2. With the No. 3 engine inoperative, the gear down, and the flaps extended, the aircraft's ability to out climb the rising terrain was marginal, and it's ability to accelerate to higher airpseeds while outclimbing the terrain was nil. After the landing gear was fully retracted, the aircraft could have continued to climb clear of terrain while accelerating with the flaps in the takeoff position. However, the extreme nose-high attitude and the cessation of climb indicates that the crew acted to retract the flaps before the aircraft was allowed to accelerate. As the flaps were retracting, the aircraft's climb capability, even at a constant airspeed, was reduced. Furthermore, the change in aerodynamic forces as the flaps retracted would have caused the aircraft to pitch to a higher noseup attitude unless the crew exerted forward pressure **on** the control column. Under the critical situation confronting them, the Safety Board believes that the crew would have been reluctant to push the nose down. **In** any event, the **loss** of only a few knots of airspeed was sufficient to place **the** aircraft in a position from which recovery was not possible.

Although the captain had taken off successfully with the engine problem, he should have been prepared to abort the takeoff and then to have taken that action when the propeller feathering sequence started.

Since he knew that Air Manila had **no** maintenance facility or spare parts at Guam to correct any major engine difficulty, the Safety Board believes that the captain continued the takeoff with the intention of analyzing the problem after the aircraft was airborne and, if there was any way he could get the No. 3 engine to operate, continue to his destination. If the engine could not be restarted, he had the option to return and land.

The Safety Board believes that the captain's failure to abort the takeoff immediately after the propeller feathering sequence was initiated, exposed the aircraft and its passengers to a hazardous situation that the company policy and good operating practices have been designed to prevent. There was adequate runway remaining to have stopped the aircraft by utilizing only the two outboard engines for symmetric reverse and the aircraft's normal braking system.

3. CONCLUSIONS

3.1 Findings

1. The flightcrew members were certificated and qualified in accordance with the Republic **of** the Philippines regulations and requirements.

2. The aircraft was originally certificated and registered by the United States Federal Aviation Administration and recertificated and reregistered under the Republic of the Philippines regulations.

3. The airworthiness of the aircraft could not be determined.

4. The aircraft's transponder, a required item, was known to be inoperable before the flight departed Manila and had not been repaired.

5. The aircraft's fuel load was a mixture of JP-4 and Jet A kerosene. This mixture has a low flashpoint -- about 30°F -- and a hazardous fire propagation characteristic.

6. This accident was partially survivable. Twenty-eight occupants of the aircraft survived the impact loads but were unable to escape or be rescued because of the rapid onset of fire.

7. The aircraft departed Manila with an unresolved problem of low horsepower output in the No. 3 engine.

8. The aircraft arrived in Guam with the No. 2 propeller feathered.

9. The only maintenance performed on the No. 2 engine/propeller installation was the addition of oil.

10. All four engines were observed to start normally and to continue running until the aircraft lifted off the runway.

11. The flaps were extended to the takeoff position before the aircraft started the takeoff.

12. Slow acceleration to attain V_2 speed resulted in an excessive amount of runway being used for takeoff.

13. The No. 3 propeller feathered during liftoff. This action began before the aircraft reached rotation speed.

14. There was adequate runway available to have aborted the takeoff following the initiation of the No. 3 propeller feathering; however, the captain continued the takeoff.

15. The aircraft lifted off the runway at the 7,500-foot point and climbed to about 100 feet.

16. The crew retracted landing gear and flaps before the aircraft reached the apex of the climb.

17. The aircraft was not accelerated to a speed at which a climb could be maintained in a flaps-up configuration.

18. The aircraft rotated to a nose-high attitude at the top of the climb with a resultant loss of airspeed and lateral stability.

19. The aircraft did not climb to an altitude high enough to clear the rising terrain because the wing flaps were retracted prematurely.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the loss of climb capability after the crew retracted the flaps at too low an altitude to clear the rising terrain. The flaps were retracted after the No. 3 propeller feathered as the aircraft lifted off the runway.

Contributing to the accident was the captain's decision to continue the takeoff after an engine failed before reaching rotation speed.

4. SAFETY RECOMMENDATIONS

The Safety Board did not issue any safety recommendations as a result of this accident.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ KAY BAILEY
Acting Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ WILLIAM R. HALEY
Member

September 26, 1977

5. APPENDICES

5.1 APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The National Transportation Safety Board was notified of the accident at 0219 e.d.t., June 4, 1976. Investigators arrived in Guam, Marianas Islands, at 0330 Guam daylight time, June 6, 1976.

The National Transportation Safety Board notified the Republic of the Philippines, the State of Registry, by telephone to the Philippine Embassy, Washington, D.C., at 1400 G.m.t. on June 4, 1976. Additional notification was forwarded to the Philippine Government through the United States Embassy in Manila. The Republic of the Philippines assigned an accredited representative to assist the United States in the investigation.

The National Transportation Safety Board investigated the crash. The Federal Aviation Administration, The Federal Bureau of Investigation, Department of the Navy, Guam Department of Public Safety, Lockheed-California Company, Detroit Diesel Allison Division-General Motors Corporation, and Air Manila, Inc., also assisted in the investigation.

Working groups were established for: operations, which included air traffic control, weather, and witnesses; human factors; powerplants; structures; systems, which included maintenance records; cockpit voice recorder and flight data recorder.

Parties to the investigation were: Air Manila, Inc.; Federal Aviation Administration; Lockheed-California Co. of the Lockheed Aircraft Corp.; and Detroit Diesel Allison Division-General Motors Corp.

2. Hearing

No public hearing was convened by the Safety Board.

5.2 APPENDIX B

FLIGHTCREW TRAINING AND PROFICIENCY

The flightcrew held current aeronautical certificates for the equipment operated and the tasks performed. Air Manila, Inc., send their flight personnel either to school at the contractor's domicile or the contractor sends instructors to the Air Manila facility to perform aircraft training and qualification. In the case of flight deck personnel, aircraft type-rating flight checks are given in the local area. Proficiency demonstrations in the handling of abnormal and emergency conditions of flight are required. Under the procedures of Republic of the Philippines Administrative Orders, aeronautical licenses expire annually and airmen must reapply for appropriate licenses. The proficiency demonstration for requalification may be conducted by a designated check airman, who is a company employee, and the check may be conducted during a regular service flight while passengers are aboard the aircraft. Accordingly, emergency procedures may be discussed but not performed. Flight maneuvers with partial or unbalanced power are not required.

The training records of flight captain and first officer contained satisfactory grades for: "stability and judgment; command ability; weight and balance check; takeoff roll; rotation and liftoff..." On April 4, 1971, during an en route training flight which was conducted on a Fairchild F-27 charter flight, the captain's flight evaluation report contained the remark: "Pilot undershot runway 06, premature in asking for full flaps." Otherwise, on that flight, the observed standard evaluation gradings were satisfactory.

CREW INFORMATION

Captain Roberto Javaleva

Captain Roberto Javaleva, 46, was employed by Air Manila on September 16, 1964. He held an Airline Transport Pilot's License No. 733, issued by the Civil Aeronautics Administration, Republic of the Philippines. He was type rated in L-188 aircraft and had been classified as a captain in L-188's on December 18, 1971. His license to operate L-188 aircraft was certified valid from March 1, 1976 to August 31, 1976. Captain Javaleva had a current ATR medical certificate issued February 19, 1976, with the limitation that, "Holder shall possess correcting lenses for near vision while exercising the priveleges of his airman certificate."

Captain Javaleva's flight time was as follows:

Total time	10,016	hours
L-188 Captain:	2,422:45	hours
Last 24 hours:	0	hours
Last 30 days :	62:40	hours
Last 90 days :	153:35	hours

First Officer Ernesto Nacion

First Officer Ernesto Nacion, 40, was employed by Air Manila on April 17, 1968. He held an Airline Transport Pilot's License No. 1403 issued by the Civil Aeronautics Administration, Republic of the Philippines. He was typed rated in L-188 aircraft and had been classified as an L-188 reserve captain on March 10, 1975. His license to operate L-188 aircraft was certified valid from January, 1976, to June 30, 1976. First Officer Nicion had a current ATR medical certificate issued December 23, 1975, with no limitation listed.

First Officer Nacion's flight time was as follows:

Total time	8,906:44	hours
L-188 time	2,037:21	hours
Last 24 hours:	0	hours
Last 30 days	58:30	hours
Last 90 days	125:20	hours

Flight Engineer Johnsthan Javaleva

Flight Engineer Johnathan Javaleva, 32, was employed by Air Manila on February 28, 1969. He held a Flight Engineer's License, No. 744, issued by the Civil Aeronautics Administration, Republic of the Philippines. He was qualified as an L-188 Flight Engineer on November 27, 1974, and was certified to operate the L-188 valid from March 1, 1976, to February 29, 1977. He had Flight Engineer medical certificate dated February 11, 1976, with no limitations.

Flight Engineer Javaleva's flight time was as follows:

Total time	5,593:17	hours
L-188	193:25	hours
Last 24 hours	1:05	hours
Last 30 days	64:50	hours
Last 90 days	156:20	hours

Relief Officer Salvador Bello

Relief Officer Salvador Bello, 33, was employed by Air Manila on February 1, 1970. He held an Airline Transport Pilot's License, No. 73A17, Flight Engineer's License, No. 75-14, issued by the Civil Aeronautics Administration, Republic of the Philippines. He was qualified as an L-188 First Officer on September 24, 1974 and was certified to operate L-188's Valid from December 1, 1975, to November 30, 1976. He had an ATR medical certificate dated November 10, 1975, with no limitations.

Relief Officer Bello's flight time was as follows:

Total time	6,051:50	hours
L-188 time	81:18	hours
Last 24 hours	1:05	hours
Last 30 days	64:45	hours
Last 90 days	148:05	hours

Flight Navigator Romeo Almario

Flight Navigator Romeo Almario, 46, was employed by Air Manila in March 31, 1976. He held a Flight Navigator's License, No. 71-2, issued by the Civil Aeronautics Administration, Republic of the Philippines, on January 14, 1976. He held a Flight Navigator's medical certificate dated January 16, 1976, with limitation, "Holder shall possess correcting lenses for near vision while exercising the privileges of his airman certificate." These certificates were a reinstatement of a previous license and he was certificated valid to operate from March 29, 1976, to January 31, 1977.

Flight Navigator Almario's total flight time was not available; however, he had flown 227:15 hours as an observer for the reinstatement and renewal of his Flight Navigator's License and 21:55 hours since March 31, 1976, as an operating navigator.

In addition to the flight deck crewmembers, the crew contained two mechanics, one load master and four cabin personnel. One mechanic was certified as an airframes and powerplant mechanic by the Civil Aeronautics Administration, Republic of the Philippines.

5.3 APPENDIX C

AIRCRAFT INFORMATION

RP-C1061, a Lockheed Electra Model 188A, S/N 1007 was sold to Air Manila by Eastern Airlines on November 30, 1971. As of November 4, 1971, it had 22,895 hours total aircraft time.

The aircraft was equipped with four Allison (GMC) Model 501-D13 turboprop engines. Each engine was equipped with an Aeroproducts Model A6441 propeller.

Engine and Propeller Data

Position	S/N	Time Since Overhaul (hours)	Total Time
No. 1	500905	7440	unknown
No. 2	500787	3879	unknown
No. 3	501063	1084	20,419
No. 4	501092	3975	unknown

Propeller Data

Position	S/N	Time Since Overhaul (hours)	Total Time
No. 1	P1092	829	3,736
No. 2	P 254	1,583	24,499
No. 3	P 081	1,139	23,167
No. 4	P 135	40	unknown