UNITED TECHNOLOGIES PRATT&WHITNEY

400 Main Street
East Hartford, Connecticut 06108

July 5, 1989

Mr. R. W. Van Zyl
Director, Aviation Safety
Department of Transport
Republic of South Africa
Forum Building
Struben Street
Pretoria, South Africa 0002

Re: South African Airways Boeing 747-244B "Combi" Registration ZS-SAS Accident in the Indian Ocean Northeast of Mauritius on 28 November 1987.

Dear Mr. Van Zyl:

Powerplant Section of the Accident Report

This powerplant report is based on the examination of photographs taken of the engines on the bottom of the ocean and is not based on actual observations of any engine hardware. This method of investigation limits the extent and depth of the analysis and also effects the accuracy of the determinations.

Conclusions:

Based on the analysis of the photographic evidence available of the engines and associated hardware, it is most probable that the engines were not under power and they were attached to the wings of the aircraft at the time of impact. The evidence also indicates that the wings of the aircraft were perpendicular to the surface of the water at the time of impact with the right wing down with no significant forward or aft velocity.

Summary of Findings:

- The engine mounts and support structure that could be identified in the photographs indicates that the engines were attached to the wings at the time of impact.

- The impact damage to the three engines and the one inlet cowl was consistently from the right side. The fourth engine was not located, therefore the damage to this engine could not be evaluated.

- The condition of the visible blades and vanes in the compressor sections of the three engines and visible sections of the separated low pressure turbine sections indicate that there was no significant engine rotation when impact occurred.

Details of examination:

All of the photographs were reviewed in Johannesburg, South Africa on April 27 and 28, 1989, and it was determined that three of the four engines, two engine tail plugs, and only one engine inlet cowl were located. The positions the engines occupied on the aircraft could not be determined and which engines the tail plugs and inlet cowl came from was also unknown. The photographs of the engine hardware were forwarded to Pratt & Whitney in East Hartford, Connecticut for analysis, and the following is the result of that effort.

The engine inlet cowl (photographs 10/J 163 T124, 10/J 170 T124) was in the shape of the letter "D" and it was determined that the impact to the cowl had occurred on the right side of the cowl. The center of the impact (the flat side of the cowl) was at about the 3:30 o'clock location (viewed from rear) and was in a radial direction with no evidence of any significant fore or aft component.

The determination that only three engines were located was based on the observation that only the front sections of three engines were photographed. In addition to these three major engine sections, there were also other engine components located. It could not be determined whether these components were from one of the three engines identified or could have been components of the fourth engine.

The damage to all of the engine hardware was consistent and indicated that there was no significant rotation of any of the engines at the time of impact. Where the location of the impact could be determined, it was established that all of the impacts occurred on the right side of the engines and was centered about the 3:00 o'clock location.

The first engine located (photographs 1/A 13 T4, 10/J 79 T4, and 9/I 16 T89) was lying on the ocean floor with the aft portion of the engine buried. The engine aft of the high pressure compressor cannot be seen, therefore, the condition or location of the turbine sections could not be determined. It was determined that the undamaged fan blades are on the left side of the engine and that the fractured and missing fan blades are on the right side of the engine. It was observed that the majority of the fan blades on the left side of the engine are straight and relatively undamaged. Based on previous accident investigations, these findings indicate that this engine impacted on the right side and there was no significant engine fan rotation at the time of impact. The separation of all of the engine cowling, all of the engine fan cases and duct hardware, and the fracture and liberation of the outer portion of the intermediate case indicates that the engine was traveling at high velocity when impact occurred, and the impact appears to have been in a radial direction with no significant fore or aft velocity. The determination of no fore

or aft velocity is also supported by the observation of the straight fan blades. If there had been a significant fore or aft velocity component the fan blades would have been bent fore or aft. This lack of any significant fore or aft velocity component at the time of impact was also observed on the other two engines.

The second engine located (photographs 3/C 76 T26, and 3/C 80 T26) was lying flat on the ocean floor with about half of the engine buried. The exact location of the straight fan blades could not be determined but from the evidence that was available in the photographs those blades are on the left side of the engine, therefore the impact to this engine was also from the right side. The view of the aft section of the engine (photograph 3/C 80 T26) shows that everything aft of the high pressure turbine is missing. The first and second stage high pressure turbine blades have either fractured airfoils or the blades are missing from the disk and there are no 2nd stage turbine vanes visible. The lack of extensive damage to the trailing edges of the 1st stage turbine vanes, that would be expected if the 1st stage blades fractured at high rotor speed, indicates that there was no significant rotation of the turbine when the blade airfoils were fractured.

The third engine located (photographs 3/C 86 T27, and 11/K 217 T113 was lying aft end down and buried. Very little of the engine aft of the intermediate case can be seen therefore the analysis is based on the condition of the fan section. It was determined that the broken and missing fan blades were centered about the 3:00 o'clock location which indicates that this engine was also impacted on the right side. The fan containment case can be seen aft of the fan rotor which indicates a small forward velocity component of the engine during impact. The rest of the damage to the engine is mostly radial which further supports the determination that the forward velocity component was very small. The visible fan blades also indicate that there was no significant rotation during impact.

Although other engine components were photographed it could not be determined from which engine these components had been liberated. Two engine tail plugs were located and both showed damage from a radial impact. Due to the symmetry of the tail plug, the location of the radial impact could not be determined (photographs 8/H 102 T71 and 10/J 247 T).

The entire low pressure turbine case with blades and vanes installed was found lying aft end down (photograph 1/A 17 T5). The case was impacted on one side in the photograph but the clock location relative to the engine could not be determined. All of the third stage turbine blades were fractured at the point of impact but the remainder of the third stage blades are not fractured which again indicates no significant rotation at the time of impact.

The inner portion of an engine turbine exhaust case and the sixth stage disk and blades were located (photograph 11/K 219 T113). The damage to the turbine exhaust case struts and the sixth stage turbine blades is consistent with a radial impact load. The observation that in one area all of the blades are fractured and in the other area they are undamaged further supports that there was no significant engine rotation at the time impact occurred.

A section of fan case pieces was located (photograph 10/J 250 T138). The upper most case in the photograph indicates that the fan containment case was separated in a forward direction. This means that there was a small aft velocity component of the engine at impact. The rest of the damage to the fan cases indicate that the major impact force was in a radial direction.

One engine fan containment case was found separated from the engine (photograph 11/K 178 T). This case shows that the fan blades had rubbed the case lightly on the engine horizontal centerline which is the normal rub location which indicates that there was nothing abnormal while the engine was operating at power prior to impact.

Pratt & Whitney appreciated the opportunity to participate in the accident investigation. We are willing to provide further assistance in the clarification of our observations and analysis if necessary.

Sincerely,

UNITED TECHNOLOGIES CORPORATION
P&W Commercial Engine Business

Robert E North

Robert E. North
Airworthiness
Product Integrity

REN/89001

cc: Mr. Brian Richardson