CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: June 23, 1953 Released: June 26, 1953

PAN AMERICAN WORLD AIRWAYS, INC., - NEAR CAROLINA, BRAZIL, APRIL 29, 1952

The Accident

At approximately 0740 GMT 1/, April 29, 1952, a Pan American World Airways' Boeing 377 aircraft, N 1039V, being operated as Flight 202 between Buenos Aires, Argentina, and New York, New York, crashed in the dense Brazilian jungle about 887 nautical miles north-northwest of Rio de Janeiro, Brazil, its last point of departure. All 50 persons aboard, consisting of 41 passengers and a crew of nine, lost their lives, and the aircraft was completely demolished

History of the Flight

Flight 202 originated at Buenos Aires, destination New York, with en route stops scheduled at Montevideo, Uruguay; Rio de Janeiro, Brazil, and Port of Spain, Trinidad. The flight of April 28, 1952, departed the Buenos Aires ramp at 1826, returning at 1834 for maintenance, and at 1848 again left the ramp, becoming airborne at 1852 After a scheduled stop at Montevideo the flight arrived at Rio de Janeiro at 0105, April 29, 1952 Here a routine crew change was effected, and at 0217 the flight departed with a new crew consisting of Captain Albert Grossarth, First Officer L A Penn, Jr , Navigator John T Powell, Flight Engineer Paul L Stilphen, Radio Operator Leroy R Holtzclaw, Stewards Anthony L Urda, Anthony Nasco, and Julio Hansen, and Stewardess Patricia Monaghan.

The aircraft was cleared for an off-airways direct route from Rio de Janeiro to Port of Spain, to cruise from Rio to Barreiras check point at 12,500 feet altitude, from there to Santarem at 14,500 feet, and from Santarem to Port of Spain at 18,500 feet The estimated flight time at standard cruise was 10 hours and 30 minutes, with a fuel requirement of 7,296 gallons The estimated flight time on long-range cruise was 11 hours and seven minutes The actual fuel aboard at departure was 7,400 gallons The take-off weight was approximately 3,550 pounds below the maximum allowable weight.

1/ All times referred to herein are Greenwich Mean and based on the 24-hour clock. All times referred to after arrival at Rio de Janeiro may be converted to local time by subtracting three hours

On departing the ramp the aircraft was observed to taxi to Runway 32 and stop on the taxi strip headed southwesterly, where the engines were heard to run up without any noticeable malfunctioning. From this position, at 0230, the flight advised that it was returning to the ramp for maintenance. However, the aircraft was observed shortly thereafter to taxi southeastward to the runway's end, turn to a northeasterly heading where it remained for approximately 10 minutes, following which it turned northwest and took off.

A message from the flight at 0306 advised that its take-off time was 0243, estimating abeam of Palmira, Brazil, at 0326. It next reported abeam of Palmira at 0325, estimating abeam of Bello Horizonte, Brazil, at 0354. It reported abeam of Bello Horizonte at 0357 and estimated abeam of Montes Claros, Brazil, at 0444. At 0448 the Porto Alegre, Brazil radio station relayed a message to Rio stating that the flight reported abeam of Montes Claros at 0445, estimating abeam of Barreiras, Brazil, at 0610. All messages stated the flight was flying under VFR conditions, off airways, at 12,500 feet altitude.

At 0616 the Cayenne, French Guiana, radio station relayed to Belem, Brazil, hence to the Rio station, a message from the flight, reporting abeam of Barreiras at 0615, flying at 14,500 feet under VFR conditions and estimating abeam of Carolina, Brazil, at 0745. This was the last known message from the flight.

When the flight failed to report at its Carolina check point or arrive at Port of Spain, its next scheduled stop, a missing-aircraft procedure was immediately initiated. On May 1, 1952, the wrecked aircraft was spotted from the air and plotted by the United States Air Force Search and Rescue Unit as latitude 9° 45' 36" south, longitude 50° 47' 18" west. This position placed the wreckage approximately on course 282 nautical miles, northnorthwest of the Barreiras abeam check point, 36 nautical miles southsoutheast of the Carolina abeam check point, and approximately 887 nautical miles rrom Rio, the point of departure.

The forecasts and verbal briefing furnished the crew prior to departure indicated a partly cloudy to cloudy condition from Rio de Janeiro to six degrees south latitude, consisting of two layers, one at about 2600 feet and the other at 14,800 feet. From this point to the northern border of Brazil, scattered cumulo-nimbus with showers were expected and cloudy thence to Trinidad. Winds aloft at cruising level were expected to be westerly about 25 knots from Rio to Montes Claros, then northerly about 18 knots to six degrees south and northeasterly 8-18 knots to Trinidad. Moderate turbulence was expected north of six degrees south

Investigation

The Civil Aeronautics Board was notified at 1800, May 1, 1952, that the wreckage had been located in a dense jungle in Para State, Brazil. Upon receipt of notification, a Civil Aeronautics Board investigator was dispatched

immediately to Belem, Brazil, to act as the accredited United States representative He was also authorized to act as investigator-in-charge to whatever extent the Brazilian Government permitted the Board's participation in the investigation of the accident The investigator arrived at Belem on May 3, 1952, and immediately contacted the U S Consul where it was learned that the Brazilian Government's investigation of the accident was being conducted by Brigadeiro Rodrigues Coelho, First Air Zone Commander, Forcas Aereas Brasaileiras (FAB) The CAB status in the investigation could not be determined at this time

The investigator was briefed concerning the air search operation which had been conducted by Flight C, First Air Rescue Squadron, USAF, Ramey Air Force Base, Puerto Rico. Aerial photographs taken during this operation indicated that the wreckage was scattered over approximately a one-mile area which was divided into two segments. one containing large sections of the aircraft believed to be the fuselage and the right wing, and the other containing the left wing and numerous smaller pieces When it was determined there were no survivors and that an attempt to reach the scene of the accident by parachute teams would be impracticable because of the dense jungle, the USAF Air Search Unit returned to its base Observations made by all air search and survey parties indicated that the only practical way to reach the scene would be to plan an expedition using a land plane airlift from Belem to an airstrip at Araguacema, 523 miles south of Belem From this point an amphibian airlift could be used to Lago Grande, a point 85 miles south of Araguacema on the Araguaia River With a base camp established at Lago Grande, a foot trail could then be cut from Lago Grande to the wreckage, a distance of approximately 35 miles, 26 miles of which were through dense jungle This plan was chosen because the Araguacema airstrip was the closest land plane landing area to the wreckage, and Lago Grande, a village of four mud huts, was located at a point on this river which was capable of accommodating large amphibian aircraft at this season The village of Lago Grande is located in a jungle area bordering the Araguaia River This river has a 60-70 foot rise during the rainy season, which makes the use of the PBY amphibian possible

Brigadeiro Rodrigues Coelho was unable to attend a meeting of interested parties arranged for the following day, May 4, at which time tentative plans for the proposed expedition to the scene of the accident were to be discussed It had been hoped that since the investigating group were there by the pleasure of the Brazilian government, the Brigadeiro would at that time clarify the status of the group and make known to them the extent of the Board's participation in the investigation There were present at this meeting, representatives of the Civil Aeronautics Board, Civil Aeronautics Administration, Pan American World Airways, United States Air Force, Panair do Brasil and Pratt and Whitney Aircraft Division The use of a helicopter as a means of transporting personnel to the scene of the accident was discussed It was agreed that its use was practicable, providing safe operating clearings were prepared both at the Lago Grande base camp and in the vicinity of the wreckage It was further agreed that it was necessary to improve the Araguacema landing strip to accommodate a transport aircraft,

which could deliver to that point a dismantled helicopter From here a helicopter could proceed to the Lago Grande base camp, which was within its fuel range.

It was learned through the United States Consul that the Brigadeiro had assigned Major Carlos Miranda Correa, of the FAB, to handle the investigation for the Brazilian Government, and at a meeting with Major Correa at the United States Consulate on May 6 the CAB representative was invited to participate in the investigation in accordance with the International Civil Aviation Organization (ICAO) agreement.

The plan of action discussed at the May 4 meeting was agreed upon, which was predicated upon the cutting of a jungle trail, using natives led by Pan American employees who were familiar with the jungle, from the Lago Grande base to the scene of the accident

A request was then forwarded to Washington to obtain the services of a USAF helicopter, with crew, and an aircraft to transport the helicopter, together with the necessary jungle survival equipment, to the Araguacema landing strip.

On May 7 the Brazilian Boundary Commission and the Indian Protective Agencies were visited to obtain information on the conditions to be expected in the jungle and the equipment needed During this discussion officials of these agencies stated that friendly Carajai and Tapirape Indians would be found in the Lago Grande area but that the wreckage was located in an area known to be occupied by hostile Ciapos Indian tribes. They further advised that any party going into this area should be well-armed, should not attempt any contact with the Ciapos tribe; should remain in a group and not become isolated; should fire upon Indians if they were encountered; should equip themselves with suitable clothing to protect against jungle briars, thorns, and vines; and that protection should be provided against wild boars, black leopards, jaguars, and snakes of the boa constrictor and viper species. They further stated that the area surrounding the wreckage had never been explored and, as far as known, there was no habitation west of the Araguaia River

On May 8 Major Correa accepted the services of the three CAB personnel present, two of whom had just arrived, as chairman of working groups to be set up to establish proper division of work and responsibility Major Correa then named members of the structures, powerplant, and investigating groups, realizing that some re-arranging of the groups might become necessary depending upon conditions met It was further agreed that the technical personnel would remain in Belem until the helicopter arrived and the base camp at Lago Grande was ready

The base camp was established at Lago Grande and arrangements made to clear the approach path to the Araguacema landing strip to permit the USAF transport aircraft to deliver the helicopter While this was being accomplished, a message was received at Belem from the Lago Grande base camp stating that, while flying over the wreckage area, the crew of a supply flight observed parachutes in the tops of trees and the presence of persons in a

partial clearing located about four air miles from the main wreckage The following day Brazilian newspapers reported that the parachutists dropped into the clearing were a group of civilians backed by Ademar de Barros, former Governor of Sao Paulo State It was later learned that after the clearing was sufficiently enlarged, Linos de Matos, a leader of the group and deputy to the former Governor, had been transported to the clearing in a Brazilian two-place helicopter

On May 11 a USAF C-82 Packet aircraft arrived at Belem, carrying the helicopter, a Sikorsky Model S-51 In addition to its flight crew, it also carried a C-82 mechanic, two helicopter mechanics, a five-man jungle team, and eight jungle survival kits Additional jungle equipment and a doctor with medical supplies were furnished by PAWA.

On the morning of May 12 the C-82 Packet departed Belem for the Araguacema airstrip, followed by a Pan American C-46 carrying the helicopter crew, jungle team, mechanics, and CAA-CAB personnel. Upon arrival at Araguacema the C-46 passengers continued on to Lago Grande in a Panair do Brasil Airways' PBY amphibian, returning to Araguacema the same day after inspecting the helicopter clearing there and flying over the wreckage to select a possible helicopter site nearby

Every effort was made to expedite assembly of the helicopter on its arrival at Araguacema to enable this expedition to reach the scene as quickly as possible, it being felt that unknown persons in the wreckage area might disturb or destroy valuable evidence The Brazilian authorities were unable to furnish any information concerning these persons other than that contained in the newspapers.

The advance party which had arrived at Lago Grande to set up the base camp had prepared a canvas-covered shelter, had rented one of the mud huts and converted it into a storeroom, first-aid station, radio station, and kitchen, and had cleared a landing area approximately 200 feet in diameter in the adjacent jungle for the use of the helicopter

On May 13 the assembly of the helicopter was completed, and it was flown to the Lago Grande base, arriving late that afternoon.

In addition to preparing the base camp and helicopter landing area at Lago Grande, two alternating ground parties, including numerous newsmen and led by Pan American employees familiar with the jungle, had cut a path from Lago Grande to within approximately 10 miles of the wreckage. These ground parties were guided through the jungle by the crew of the PBY aircraft, who upon observing smoke bomb signals, made daily food drops and noted compass courses to the wreckage on tags attached to the drop sacks Along the 16 miles of trail cut toward the wreckage, only two widely separated water holes were found, at which points camps were constructed

Since the ground parties were still approximately 10 miles away from the wreckage, a conference was held in Lago Grande, attended by representatives

of all interested parties, which included the two helicopter pilots and Lieutenant Ferreira representing Major Correa, to expedite the movement of the investigating groups to the scene It was decided that the use of the helicopter from the Lago Grande clearing to the one utilized by the parachutists would best accomplish this purpose. From this point, working groups could be moved quickly by helicopter to the proposed clearing near the wreckage, a distance of approximately four miles

A factor also considered at this time was the establishment of Brazilian Government security over the wreckage to prevent its possible disturbance For this reason Lieutenant Ferreira and a representative of Pan American were the first to be flown into the clearing. On subsequent flights Major Correa, a Para State Police officer, and an FAB medical officer were transported to the clearing to complete the Brazilian Government representation, and by May 15 all members of the powerplant and structures groups and an operations observer had been transported to the clearing

The previously mentioned PBY amphibian, and later an FAB PBY amphibian brought to Lago Grande for the use of Major Correa, alternated in providing air surveillance over the helicopter and in dropping food supplies Radio communication from the Lago Grande camp was maintained with the helicopter, the amphibian, and the advance camp now established at the parachutists' clearing.

During the seven helicopter flights required to transport the total party of 14 to the clearing, a Brazilian Bell helicopter and two light planes, operating from a high point in the marsh area approximately seven miles from Lago Grande, could be seen from time to time flying over the clearing

On May 15, following the seventh and last trip necessary to bring all personnel into the clearing, the helicopter developed serious vibration in the tail area Inspection revealed that the entire tail cone had become distorted, probably the result of unloading operations at Araguacema without the aid of lifting lugs, and the forward bearing of the tail rotor drive was overheating badly This difficulty was beyond correction by the mechanics under the existing conditions, and the USAF was unable to furnish the replacement of the tail cone at that time, neither was it in a position to furnish a substitute helicopter to continue the operations.

At about this time one of the alternate groups cutting the trail from Lago Grande to the wreckage was ordered to return to Lago Grande, and the remaining group was instructed to discontinue cutting the trail and proceed to the wreckage singly in the most expeditious manner possible. This action presented a new problem, since it did not permit the trail to the wreckage to be completed and, therefore, in the event it was necessary for the investigating group to walk out through the jungle they had no way of locating that portion of the trail which had been finished and the very necessary water holes along its route.

The pilots, after evaluating the situation, pointed out that possibly the helicopter, before the bearing failed completely, could make the seven trips into the clearing necessary to evacuate the group of 14 when they were ready to return, but it would, except in an emergency, be necessary to restrict its operation to that purpose only. This situation was made known to the group at the parachutists' clearing by means of portable radio equipment operated by Mr Scott Magness, a Civil Aeronautics Administration Aviation Safety Advisor

With the problems now confronting the investigating group, it was decided to continue as much of the investigation as possible under the circumstances, using the clearing, where an adequate water supply was available, as a base, having in mind the possibility of establishing another camp at the wreckage providing an adequate water supply could be found in the immediate area From the base camp the aircraft wreckage lay to the northwest over the rocky and rugged Tomanacu Mountain Range, a distance of about four air miles

On the afternoon of the 15th a representative group of all interested parties, each carrying a canteen of water and a small supply of USAF "C" rations, left camp in an attempt to reach the scene of the accident A very circuitous route led the party over such rough and rugged terrain that at times the use of guide ropes was necessary to make any progress All but eight of the official party were defeated by the terrain and tropical heat, and returned to the base camp Those who returned included the FAB medical officer, who suffered a heart attack, and the Para State Police official, who was seriously injured by a fall.

By the time these members turned back, it was evident that the trip would be overnight en route and there was a possibility of water shortage They were, therefore, instructed to notify the base camp at Lago Grande by radio that the PBY crew, which accomplished daily food drops to the group, should look for smoke bomb signals at the wreckage which would indicate the need for an emergency helicopter flight to lower water to the group, as water could not be successfully dropped from the PBY

It later developed that the distance between the base camp and the wreckage by the shortest practical route was approximately seven miles An overnight camp was established on the trail, and on the following day, May 16, the investigating party was met on the trail by six members of the parachutists' group, including their leader, Linos de Matos This group, now out of water, joined the official party

The official investigating group which finally reached the main wreckage area on May 16 was now reduced to eight persons - two representing the Brazilian Government, two, Pan American World Airways, one, Civil Aeronautics Board, one, Flight Engineers International Association; one, Air Line Pilots Association, and one, United Aircraft Service Corporation.

It had been determined by aerial observations made by the First Air-Sea Rescue Squadron, Albrook Field, Panama, and by photographs prepared by the

Strategic Air Command, Ramey Field, Puerto Rico, that portions of the wrecked aircraft lay in four separate areas of the jungle. Upon arrival of the investigating party at the area containing the main wreckage, it was apparent that other persons had preceded them, as was evidenced by disturbance noted in portions of the wreckage On May 17, 1952, this already-enlarged party was joined by the ground party, which had been instructed to abandon cutting the trail from Lago Grande to the wreckage and had proceeded singly to the scene This group of approximately 25 persons, including numerous newspapermen, were also out of water. During the first night spent at the wreckage, the water in the canteens of some of the official group disappeared.

This area contained what remained of the aircraft fuselage from the cockpit aft to the pressure bulkhead, the right wing, Nos. 3 and 4 engines together with their respective propellers, and the aircraft's landing gear It was deemed impracticable at the time to attempt to reach the other wreckage areas due to the lack of trails through the jungle and to the absence of supplies, communications, and protections On the following day, May 17, emergency smoke bomb signals were sent up indicating the need of water, which signals were observed by the PBY crew.

With the emergency helicopter flight now necessary, it was decided that this trip would be the first of the seven evacuation trips required and the helicopter would be diverted over the wreckage area to lower water cans while enroute from Lago Grande to the parachutists' clearing Lowering the water cans to the main wreckage, however, proved to be only partially successful due to the 100-115 foot high trees and the unstable air, and it was considered too dangerous for further attempts

It was necessary at this time to divert the efforts of some of the investigating party to the burying of bodies, gathering of personal effects, and making positive identification of the aircraft This phase of the work was accomplished under the supervision of Major C M Correa, FAB, and Mr. H W. Toomey, PAWA, Latin American Division The first task of the investigating group was to locate and identify as many of the larger pieces of wreckage in the area as possible, in order that a record of their distribution and condition could be made for future reference

OBSERVATIONS AT THE SCENE

The wreckage was located at an altitude of approximately 1300 feet on the side of the Tomanacu Mountain Range and was found lying in an inverted position on an approximate heading of 90 degrees.

The wreckage area consisted of a large burned-out hole in the jungle approximately 100 feet in diameter Indications were that this portion of the aircraft had made a nearly vertical descent while in a horizontal attitude; this was evidenced by the condition of the surrounding trees, all of which had been damaged from directly overhead. One such tree approximately

four inches in diameter had vertically pierced No. 4 engine cowling.

Further observations disclosed extreme disintegration of the aircraft, accompanied by fire which followed impact and had probably continued for many hours. The heat of this fire melted many pieces of the aluminum alloy structure, which resolidified into unrecognizable globules and masses of metal. Many structural parts which retained identifiable shape had their fractured edges melted or burned away, making study of them impossible.

On May 18 all Pan American World Airways personnel were ordered to return to the base camp. Government personnel were advised that if they desired to remain and continue the investigation, daily drops of "C" rations would be provided. However, under the existing conditions and with no water supply available, investigation at the main wreckage was discontinued and the official party returned to the base camp

The evacuation of the official party from the parachutists camp began on the 18th. During the first two evacuation flights, the bearing condition on the helicopter became progressively worse. This, plus the necessity of immediate evacuation of one of the newspapermen stricken with appendicitis and a PAWA employee with an injured foot, made an eighth trip necessary to complete the evacuation. This condition influenced the helicopter pilots to abandon their safety measure of riding together in case of forced landing. This arrangement provided an additional seat for evacuation purposes.

When it became apparent that the United States Air Force helicopter could not long continue the evacuation flights, Mr. de Matos, leader of the Brazilian parachutists group, called to the investigating parties' attention the fact that he and his men would then have no means of leaving the clearing. It was suggested that the Brazilian helicopter, which reportedly had brought de Matos into the clearing, assist in the evacuation This, however, was said to be impracticable, as at this altitude, this machine could not lift a passenger in addition to the pilot. It was therefore decided that the United States Air Force helicopter on return flights, would bring in a power saw and the necessary axes and machetes with which the remaining parachutists and newspapermen could improve the clearing sufficiently to permit the operation of their light plane which was based at a point near Lago Grande. The power saw and small tools necessary to prepare the landing strip were delivered; however, the sixth and last evacuation trip, on May 18, found CAA Advisor Magness and FAB Major Correa still at the clearing.

On May 19, Brigadeiro Coelho and Colonel Proenca, FAB, arrived at Lago Grande with a contingent of FAB enlisted men and took over the base camp as well as the responsibility of evacuating the two remaining members of the investigating group still at the parachutists' clearing. In addition, all Americans were ordered to return to Belem with the assurance that the two group members, upon being brought out of the jungle, would immediately be flown to Belem in the FAB PBY aircraft. On May 21, while waiting the arrival of Mr. Magness and Major Correa, a meeting was held to discuss the possibilities of continuing the on-the-spot investigation. The consensus was that any further investigation at the scene would require a carefully organized and

much better equipped expedition and that such a recommendation would be presented to the Civil Aeronautics Board. There was some question whether further investigation at the scene would be possible since the U. S. Consul advised that the Brigadeiro was opposed to such an undertaking. On May 23, information was received that a Brazilian privately-owned light plane, in landing on the newly prepared landing strip at the parachutists' clearing, had been involved in an accident. On May 24, however, replacement parts were dropped from FAB aircraft, repairs were made after which Major Correa and CAA Advisor Magness, the last men to be evacuated, were flown out arriving at Belem on May 28. The USAF, in the meanwhile, had at the request of the Board photographed the entire wreckage area during a nonstop round-trip flight from Ramey Field, Puerto Rico, and on May 31 all members of the official group were released pending possible reactivation of the investigation at the scene.

The following two and one-half months were spent in obtaining authorization from the Brazilian Government for a second expedition and in the arranging and equipping of this expedition, which was to be composed of men qualified to conduct a thorough technical examination of the wreckage thus far located and to continue thorough air and ground search for missing components.

Brigadeiro Coelho, FAB, having completed his investigation, had released the wreckage to Brigadeiro Raimundo Aboim, Director Aeronautica Civil (DAC), to whom all matters concerning the Board's expedition were now to be referred. In the meanwhile, Brigadeiro Aboim had prepared a landing strip suitable for an airlift near Lago Grande, since the Araguaia River would not accommodate the PBY amphibian operation during the dry season. In addition, to facilitate removal of all bodies and personal effects, a 35-mile jeep trail had been cut through the jungle from the landing strip to the main wreckage. After this had been accomplished, the Civil Aeronautics Board on August 15 received authorization from Brigadeiro Aboim to proceed with its expedition, and on the same day the FAB broke camp at Lago Grande. All their personnel and equipment were removed, with the exception of Lieutenant Bonno, who had been assigned by the First Air Zone, FAB, to act at observer during the Board's investigation, and the radio station with its two operators.

By August 23 the CAB base camp at Lago Grande and the advanced camp near the wreckage had been completed, using a PAWA C-46 aircraft for transportation of personnel, equipment, camp supplies, firearms, and jeeps with trailers from Belem to the Lago Grande airstrip. The personnel of the investigating groups and official observers were selected and furnished all available information concerning wild animals, hostile Indians, insects, and diseases likely to be encountered in the jungle, and of the expected average jungle temperature of 100 degrees during the day and approximately 45 degrees at night.

During the two following days, all observers and members of the power plant and structure investigating groups were transported by jeep and trailer to the advance camp over the 35-mile trail. The jungle through which the

trail passed was actively on fire Although the fire was confined mainly to dead vegetation on the ground and spread in a slow, smouldering manner, it attacked the bases of many old and deteriorating trees with the result that progress along the trail was punctuated by numerous loud reports of large trees crashing to the ground. This slow burning and the falling of trees continued until the beginning of the rainy season The necessity of sawing a way through or hacking a way around newly fallen trees was the major cause of some jeep trips extending from the normal $5\frac{1}{2}$ or 6 hours to as long as $12\frac{1}{2}$ hours. The work of both groups continued daily, from August 24 through September 10, by which time the rainy season was well advanced, making the immediate evacuation of all personnel and equipment necessary During this same period a continuous ground and air search was conducted in an effort to locate missing aircraft components This search consisted of 18 hours 45 minutes of flying time over the area and 3,002 man hours by ground parties working from the advance camp. The result was only partially successful in that the engine and propeller which had been installed in the No. 2 position were not located.

Examination of the Wreckage

The men assigned to the structures and power plant groups began their operations immediately upon their arrival at the scene on August 24 These groups, being fully aware that all work in connection with the examination of the aircraft wreckage would of necessity have to terminate as soon as the rainy season got underway, scheduled examination of components in the order of the importance of the information they expected to obtain. As a result of air and ground search, it was found that parts of the wrecked airplane were scattered over an irregularly shaped jungle area whose major dimension was approximately 4,000 feet 2/

In evaluating the fire damage to the various components, consideration was given to the fact that the wreckage at the main site had received heavy damage from the fire which immediately followed impact, as well as from the application by the Brazilians of flame throwers to the wreckage, for sanitary reasons, following the removal of the bodies and personal effects of the passengers. In addition, a forest fire had swept over the entire wreckage area a short time before the arrival of the investigating group

The parts at the main wreckage site consisted roughly of the fuselage from the nose back to and including the dorsal fin, the complete landing gear, the right wing with Nos 3 and 4 nacelles complete with engines and propellers, that portion of the left wing from the fuselage outward to a point slightly outboard of the No. 2 nacelle, and the No 2 nacelle minus the No 2 engine, engine cowling, and propeller The outboard portion of the left wing was found approximately 2,300 feet from and on a bearing of 318 degrees from the main wreckage, complete with No 1 nacelle, engine,

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2/ See Appendix A

engine cowling, propeller, aileron, and outer portion of the left flap. Examination revealed that this portion of the wing had struck the ground, inboard end first, at an angle approximately 60 degrees from horizontal.

The tail assembly wreckage consisted of the vertical fin, right elevator, horizontal stabilizer from the right tip to approximately the mid span of the left stabilizer, and the aft end of the fuselage. This piece of wreckage was found approximately 2,500 feet from and on a bearing of 50 degrees from the left wing wreckage. At different points close by were found the rudder and approximately the inboard third of the left elevator.

Most of the remaining structural parts of the aircraft were found within an area encompassed by a circle of approximately a 350-foot radius. From the center of this circle, the distance to the tail assembly wreckage was approximately 1,000 feet on a bearing of roughly 340 degrees. These parts included the outer portion of the left horizontal stabilizer, the middle portion of the left elevator, two inboard pieces of the left flap, the right-hand nose wheel well door, and the tip section of the right aileron. (See Chart, Appendix A.)

Since these pieces from different extremeties of the aircraft do not vary too greatly in density, their close grouping indicates that the disintegration of the aircraft's structure occurred in a very short interval of time.

Wing

The wing structure at the main wreckage site was found to be severely disintegrated by the impact force and was extensively consumed by fire following impact. However, from an examination of the debris it was apparent that the basic wing structure was intact from the right wing tip through the center section to the outboard edge of No. 2 nacelle until the fuselage to which it was attached struck the ground.

The most outboard portion of the left front spar lower chord found at the main wreckage site extended from Station 157 to 202. The fracture at the outboard end was a tension failure, which occurred at the second large bolt from the outboard end of the scarf splice in this area. There was some evidence of heat on parts of this section of spar chord which passes through the No. 2 engine nacelle. However, since the evidence indicates application of heat of equal intensity on both fractured and nonfractured surfaces, it is apparent that it resulted from fire following impact with the ground.

The most outboard portion of the left rear spar lower chord found at the main wreckage site extended from Station 90 to Station 224. The fracture at Station 224 was a tension failure with a slight indication of upward bending. The fracture occurred at the third bolt from the inboard end of the scarf splice in this area

The most outboard portion of the left wing lower surface found at the main wreckage site was a section of the lower surface panel from Station 221

inboard approximately half-way to the fuselage The fracturesof the skin and stringers at the outboard end were tension failures The fractures extended from the rear spar at Station 221 directly forward through Stiffener No 3 From this point it extended inboard and forward through the wheel well doubler at approximately Station 200 and Stiffener No 6

The spar rear chords found at the site of the left wing wreckage had been driven into the ground approximately three feet by the impact forces Interference with a boulder and the ground stripped off all of the surrounding structure The impact forces and fire after impact severely disintegrated and melted most of the structure from the inboard end out to Station 510 From this Station to the tip, the panel was intact except for several instances of impact damage One of these was inward deformation of the wing tip directly aft of the position light, which together with its plexiglass former was missing Specimens of white deposits on the skin in this area were removed for laboratory analysis

The sections of spar lower chords which speared into the ground mated with the outboard extremities of the spar chords found at the main wreckage site indicating definitely the spanwise station of the wing separation in flight The inboard portions of these sections of spar chord which were buried in the ground showed no evidence of heat Due to the extreme shattering on impact and the melting which occurred in the fire after impact, no portion of the nose section or upper and lower surfaces just outboard of the wing separation was identified for further study of the separation

Fuselage

The fuselage wreckage consisted of numerous pieces, larger at the fore and aft ends than in the center portion, generally arranged in an inverted position, squashed flat, and with the longitudinal spacing corresponding roughly to the original length Most sections had evidence of moderate to severe burning after impact, much of the metal in the center portion of the fuselage having been melted

An attempt was made to examine the fuselage structure near the plane of the inboard propellers for indications of propeller cuts However, due to the extremely severe disintegration and melting in this part of the fuselage, only two small pieces of structure with portions of the ice striker plates attached were identified There was no indication of propeller cuts on either piece, however, due to the small coverage, the findings are inconclusive The main entry door was found with all bayonets extended and the inside door handle in a horizontal position

Cockpit instruments were so severely shattered that no significant readings could be obtained

The dorsal fin was found at the main wreckage site, severely torn and mangled There was a large trough-shaped depression in the leading edge approximately two feet below the tip The depression was approximately one

foot wide and five inches deep, with the trough running from upper right to lower left and aft A film of oil was noted on the left side of the dorsal fin and on the most rearward portions of the skin from the left side of the fuselage

The only portion of the nose wheel well left door identified was a small fragment attached to a piece of fuselage structure by means of the rear hinge The edges of this fragment were curled inward and the fragment showed no evidence of twisting deformation The right door was found intact with little evidence of distortion, other than that the front bulkhead was forced slightly rearward by impact with the ground

Tail Assembly

An examination of the tail assembly wreckage indicated that the fin and the right elevator were not severely damaged prior to impact with the ground The upper surface of the right stabilizer was noticeably wrinkled A small hole was punched through the upper skin of the right stabilizer and there was a tear in the upper fabric of the right elevator The left side of the fin also was streaked with a film of oil

Examination of the left stabilizer revealed that it had failed in flight along an irregular chordwise line near Station 145 as the result of an excessive upward load A hole was also found in the upper skin surface just forward of the rear spar, beginning at Station 122 and increasing in width to about six inches as it extended outboard This hole had been made by some zinc chromate painted object entering from above However, the skin adjacent to the hole also bore gray smears similar in appearance to paint There were no indications of impact damage anywhere along the stabilizer leading edge, and the lower surface was also covered with a film of oil

The left elevator had separated into several pieces in flight Examination of the inboard and middle pieces indicated upward bending consistent with and apparently resulting from the stabilizer failure The remaining portion of the elevator was not found

The rudder was found approximately 250 feet from the tail assembly wreckage Examination of marks on the vertical fin indicated that the rudder had not separated from the fin until after the tail assembly had separated from the fuselage Streaks of oil film were also observed on the left side of the rudder

Flight Control Systems

Examination of the flight control systems indicated damage consistent with the separation of the left wing and fuselage in flight and with the breakup and burning of the structure following impact with the ground In addition, the control cables running through the fuselage were found to have been hacked, sheared, and chopped into many pieces varying from three to six feet in length subsequent to the accident This condition very likely resulted from the Brazilians finding it necessary to move portions of the

wreckage to facilitate the removal of bodies and personal effects However, no indications were found of control systems' connections having failed in service All four of the wing flap actuating screws were in positions which correspond with flap extension of approximately three to four degrees

Power Plants

This aircraft was powered by four Pratt and Whitney, Model R4360-TSB3G engines equipped with Hamilton Standard Model 24260-43 propellers

No 1 engine was found with the left wing which had separated from the aircraft at a point just outboard of the No 2 engine nacelle It lay among rocks and boulders approximately 10 feet forward of its normal position with respect to the wing

Nos 3 and 4 engines were found with the wreckage of the fuselage and right wing and were lying slightly forward of their normal positions with respect to the wing, which was inverted The ring cowl of the No 4 engine had, in falling, been pierced by a small tree, which when examined was still standing and protruding through the cowl. Since this engine had remained at the approximate point at which it first made contact with the ground, it is evident that the engine in its final descent had little if any horizontal velocity

The nose cases of these three engines were ruptured to the extent that it was possible to examine visually the propeller reduction gear assemblies There was no evidence of gear or bearing failure or of any rotational interference; neither were there any indications of abnormal internal heat

Nos 1 and 4 engines, lying among the boulders, could not be moved without the aid of equipment which was not available, therefore, examination of only approximately two-thirds of their power sections could be made No. 3 engine, however, could be moved, and its entire power section was examined Although the headers, baffles, and intake pipes of all three engines were generally crushed and distorted, no evidence was found indicating either in-flight fire or structural failure Neither was there any indication of power section failure, which would have been evidenced by power case rupture or loss of cylinders.

All three engines suffered major fire damage to a similar degree The entire portions aft of the power case were completely consumed by fire, except for steel parts which were found in the burned rubble immediately beneath the burned-out areas These engines also suffered from fire damage in the power section areas, being most extensive in No 3 engine In each instance, molten metal which had run downward with respect to the final position of the engines, indicated clearly that the fire damage occurred subsequent to impact

The measurements of the cowl flap jack screws converted to cowl flap openings indicated openings varying from 1 25 inches to 2 25 inches Waste gate positions of Nos 3 and 4 engines were found to be approximately 1" to

1½" from the closed position The information with respect to No 1 engine waste gate could not be obtained due to impact damage Examination of all compressors and turbo wheels gave no indication of rotational interference or failure

Propellers

The propellers installed in Nos 1, 3 and 4 positions were found and identified with their respective engines Examination and study of these components, within the limits imposed by the facilities available in the jungle, revealed no evidence of propeller malfunctioning nor any evidence that they were not operable prior to impact with the ground.

No 2 Position Power Plant

Extensive ground and air search[3/] failed to locate the No 2 engine with its mounted accessories or No 2 propeller Examination, therefore, was limited entirely to those portions of No 2 power plant which were recovered. With the exception of the left diagonal of the lower "V" strut assembly, the major portion of the engine mount structure from the ring mount aft to the point of attachment to the wing structure was recovered with the fuselage and right wing wreckage

The ring mount apparently remained attached to the engine. The ring attaches to the engine mount structure at five main points: two near the top of the ring, one at the bottom, and one on each side The failures at these five points were of two types: the forked ends of one bottom and the two top engine mount members separated from the ring mount lugs in a manner typical of a shear failure of the bolts The forked ends were intact, but the bolts were missing The other type failure occurred at the two attach points on each side of the ring At these two points the lugs themselves were torn from the ring mount, taking with them small pieces of the ring These represent the most forward portions of the engine mount recovered The engine mount tubes were broken off at their aft terminal forgings and showed discoloration from exposure to heat The terminal forgings, however, suffered no fire damage or evidence of having been exposed to heat

The aluminum drain pan attached to the forward spar showed no evidence of fire damage

The lower scoop assembly was found by the ground search party apparently 500 feet from the tail group, the nearest major aircraft component Examination of the scoop revealed no evidence of any explosion or damage by either engine or propeller impact A forest fire had burned over this area, resulting in exposure to heat of those parts adjacent to the ground An examination of the air inlet scoop showed evidence of exposure to heat on upper surfaces Areas on the aft face which were protected by folded-over

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3/ See Appendix B.

metal were comparatively clean, and cavities within the scoop were clean other than being coated by a light film of oil The upper rear portion of the scoop which is normally adjacent to the exhaust stack showed no sign of exhaust impingement The entry area of the scoop showed no evidence of fire damage The oil coolers remained in their normal position within the scoop assembly There had been an intense localized fire in their area, in which the molten metal had run or dripped downward with respect to the final inverted position of the scoop

The aluminum shroud which normally covers the exhaust system ball joint was intact, with no fire damage The exhaust "Y" joint, the waste gate section, the ball joint, and the flight hood showed no damage other than impact The waste gate was approximately one inch from the fully closed position

The waste gate motor was found with the No 2 engine mount Its potentiometer was in the extreme clockwise or "Waste gate closed" position.

The turbo compartment was broken open and the turbo extensively damaged. The upper pressure header of the intercooler was detached The lower header remained in place The inlet face of the intercooler was clean The cooling air exit face was oily, with some soot being evident

In the airplane there are three emergency fluid shut-off valves controlling the engine oil, engine fuel, and hydraulic fluid These valves normally operate simultaneously by a gang-bar from the engineer's station in the cockpit The hydraulic fluid valve was found in the fully closed position The position of the other two valves, one of which was not recovered, could not be determined

Examination of the main left landing gear doors revealed that the rubber bumpers and forward bulkheads of both doors were unburned, and the exterior of the right door was oily along its hinge line

Empennage Anti-Icer Heaters

The empennage anti-icer heaters remained in position in the dorsal fin There was no evidence of fire, soot, or stains within the ducts around the heaters or adjacent structure

Landing Gear

All three landing gears were located in the main wreckage area The nose gear was identified and was still attached to a section of the fuselage The main oleo cylinder was still attached to the fuselage structure The left and right drag strut remained with the nose gear assembly, but both were deformed and twisted away from their supporting structure Both wheels and tires were completely consumed by fire Both steering cylinders were intact but had been subjected to extensive fire damage

The right main gear was found in an inverted position still attached by its fittings to the rear spar This assembly had been subjected to extensive burning as all wheels, tires, and brake lines had been completely melted away The drag link, still attached to the main oleo by the lower universal link, had been deformed by impact and fire The drag struts and retracting mechanism were broken away from the main oleo cylinder and had been severely deformed by impact and fire

The left landing gear was located in the main wreckage area approximately 30 feet from the right main gear The oleo cylinder and piston were completely separated The torsion links had failed at the scissor bolt The drag struts, drag link, and retracting mechanism were separated from their supporting assemblies and had also been severely deformed by impact and fire damage Both wheel and brake assemblies were completely burned Very little of the left rear wing spar was located with this landing gear assembly due to the proximity to the main fire area

All landing gear actuators corresponded to the landing gears' retracted position

Miscellaneous Equipment

In the fuselage area in the vicinity of what would be the center fuel tank location, the emergency landing gear and wing flap motor, emergency hand crank, and a fuel shut-off valve were found All of these components had been extensively burned in the ground fire but remained in their near correct location

One fuel dump valve was located still attached to the right rear wing spar web Examination showed this valve to be in the closed position

The six CO_2 cylinders of the fire extinguisher system were found and identified These cylinders, four of which are normally mounted in the No 3 engine nacelle and two in No 2 nacelle, had their control valves knocked off at the cylinder neck at impact or had been subjected to severe ground fire The impact damage and fire damage to these cylinders was so extensive that it was impossible to determine if any of the cylinders had been discharged prior to impact

Inspection

With respect to N 1039V, the aircraft involved, testimony revealed that nothing was found during the overnight in-transit service performed at Buenos Aires, April 27, 1952, to indicate that the aircraft was not in an airworthy condition when it departed Buenos Aires as Flight 202 on April 28, 1952 Testimony further revealed that as a part of the overnight in-transit service performed at Buenos Aires, each propeller blade was examined with the aid of magnifying glass for cracks or other possible operational damage This particular propeller examination was performed by the supervisor in charge of

night service Following the flight's arrival at Rio de Janeiro, the propellers were again inspected, this time visually, and again nothing was found to indicate an unairworthy condition

Resume of Propeller Testing and Service Difficulties

Examination of the vibration and service information concerning the Hamilton Standard propellers with which Pan American World Airways' Boeing 377's are equipped revealed some interesting and pertinent facts As a background of the subject propeller, a brief review regarding the basis for vibrational approval, and some of the service difficulties subsequently experienced, is found necessary.

The basis for approval was established from a combination of laboratory testing on the subject type of propeller which determined the strength limits for this propeller construction, and from very comprehensive flight and ground testing of the engine-propeller combination, both in the subject aircraft and on the test stand.

The initial test program of these propellers showed only two critical high-stress conditions to exist One occurred during low rpm running on the ground during crosswind operation, which resulted in a placard, still required restricting operation between 1600 and 2,000 rpm under this condition The other condition was felt by the manufacturer to be objectionable, resulting in modification of the propeller design, which corrected the difficulty

The peak of the propeller stresses was found in the neighborhood of 1600 rpm during flight testing These stresses were within the safe limits established for the blade design, consequently, no rpm restrictions were considered necessary With less than two years of service experience, longitudinal cracks were found in a number of blades in the outboard blade section, with cracks originating generally along the bond line between the core and shell portions of the blade, about four inches from the leading or trailing edge and parallel to the edge These cracks were found to be due to the black rubber filler in the blade breaking and allowing the steel shell of the blade to vibrate locally from aerodynamic buffeting At this point the blade design was again altered by using nylon-rubber filler instead of black rubber, the nylon filler being tougher and more resistant to shattering A daily tap test was required, as an interim measure, to locate any internal voids that were occurring in the blades with the black rubber filler

One service failure attributed to a longitudinal blade crack starting from a void in the black rubber filler occurred near Glenview, Illinois, on January 25, 1950. In this instance, the outboard section of the blade flew off, resulting in the engine being torn from the aircraft and requiring an emergency landing at Chicago A portion of the propeller blade skin was found lodged in the aircraft fuselage, resulting in a relatively sudden cabin depressurization This had occurred prior to complete propeller failure On the same day, an identical aircraft coming into Tokyo, Japan,

lost an engine, which fell into the ocean Although the engine and propeller were not recovered, the same type of failure is presumed to have occurred On March 29, 1951, the crew of another Boeing 377 felt a severe shock and vibration while descending for a landing at Idlewild, New York The altitude was approximately 3,000 feet, air speed 160 knots, and engines operating at reduced power No 1 propeller was feathered within seconds of the first shock, and the vibration stopped A normal landing was made approximately six minutes later, with an outboard section of one propeller blade missing and the engine drooping in the nacelle Subsequent examination showed that three of the six mount ring lugs had failed--the remaining three, together with the lines, cables, etc , being all that held the engine on the aircraft. Again, on July 28, 1952, another Boeing 377, while being ferried between Rio and Port of Spain, required a propeller to be feathered due to extreme roughness Examination later revealed that this was caused by a transverse fatigue crack across the midsection of the blade

Detailed inspection of all service blades resulted in the finding of several other blades with smaller cracks progressing A still further detailed inspection, which required all leading edge deicing boots to be removed for closer inspection, revealed an additional blade with a crack existing

Subsequent flight vibration testing of the subject combination after the cracked blades were found was performed on this particular aircraft to determine if anything peculiar was present in this engine installation that was not found during the initial type testing conducted in 1948 The only significant difficulty was in the neighborhood of 1600 rpm, where the vibration stresses had increased about $1\frac{1}{2}$ times the value previously measured Since it developed that about five percent of the total operating time, particularly where longrange cruise was involved, was at this rpm, all aircraft were placarded immediately to avoid any continuous operation in this critical range. As a result, there has been combined with the daily visual inspection of all blades, a very elaborate and detailed inspection to be performed every 50-100 hours on all service blades on the subject combination Such an inspection procedure had been set up prior to the discovery of the more recent blade cracks and has since been revised to include tighter inspection and rework limits, as set up in the Hamilton Standard Propeller Service Bulletins Nos 177 and 193 The ground daily visual inspection is intended to spot any serious or obvious blade difficulties

Electrical System

All electrical equipment, including generators, alternators, actuating motors, switches, relays, and instruments, was extensively damaged by impact and subsequent fire, and much of the equipment, for this reason, was unidentifiable No evidence was found of electrical short circuits having existed in any of the aircraft's wiring

The main power bus, normally located in the ceiling of the lower lounge, was found in that general area of the wreckage This bus consists of three main parts· the main generator bus, the main load bus, and a smaller "L" shaped terminal bus The main generator bus was in one piece, except for a

short portion of one end, which was missing. The entire bus was bent in a long curve toward its terminal face. Six heavy 00 power leads were more or less intact and showed no evidence of electrical shorts having occurred Three limiter lug fusible strips were intact and showed no evidence of electrical overload

Each of the 11 studs in the main generator bus was examined, and all were found tight with the exception of two, one of which was missing In the area of the missing stud, there was found a burned irregular hole, varying from approximately 3/4 of an inch in diameter on the terminal surface to approximately 1½ inches in diameter on the back surface There was also evidence of copper deposits imbedded in the inner surface of this hole All studs showed signs of heating, and all insulation had been burned away from the cables, which remained attached to the bus

Radio and Electronic Equipment

All radio and electronic equipment was completely destroyed by fire with the exception of the radio altimeters, the AM100 modulator, and the RCA record player These last-named items were destroyed by impact

Operations

The operations group confined its efforts to the examination of such items concerning the flight as dispatching, take-off weight, load distribution, refueling, weather, radio facilities, radio contacts, flight documents, and manuals required to be aboard the aircraft No irregularities were noted which would in any way adversely affect the operation and conduct of the flight. Neither was anything found to indicate that the aircraft was not in an airworthy condition upon its departure from Rio de Janeiro

A study of the crew history revealed that Captain Grossarth had been employed by Pan American World Airways since April 18, 1941, and had on August 19, 1946, qualified as Master Pilot on the Latin American Division His total accumulated time as pilot was 8,452 hours, of which 735 hours were in Boeing 377 aircraft His last route check was accomplished January 11, 1952; last equipment and instrument check, March 6, 1952; and emergency equipment check, February 23, 1952

First Officer L A Penn, Jr., had been employed by Pan American World Airways since November 1, 1942 He was assigned as first officer on Boeing 377 equipment November 1, 1950; and his total time as pilot was 9,099 hours, of which 1,134 were in the type equipment involved His last equipment and instrument check was accomplished on November 5, 1951

Mr P L Stilphen became an employee of Pan American World Airways on June 23, 1939, was promoted to flight mechanic on November 1, 1942, and to first flight engineer on Boeing 377 equipment on March 15, 1952

Mr L. R Holtzclaw had been employed by Pan American World Airways

since October 22, 1941, as flight radio officer, and on December 16, 1945, was promoted to senior flight radio officer.

Mr. J T Powell held navigator certificate No 1051697 and pilot air transport rating No 98357 He had been employed by Pan American World Airways since August 2, 1946, as navigator and copilot, and on December 21, 1951, was qualified as first copilot on Boeing 377 equipment.

The aircraft involved was properly certificated, and all members of its crew held such currently effective certificates as their assigned duties required.

Analysis

A. INTRODUCTION

In analyzing the factual data obtained during the investigation, it is necessary to fully consider the pertinent circumstances under which this accident occurred These circumstances are as follows:

1. Cruising flight on a magnetic heading of 343° at an altitude of 14,500 feet MSL (approximately 13,000 feet above the ground) was planned over the area where the wreckage was found.

2 The weather conditions in the general area at the time of the accident were such that violent turbulence of the air appears unlikely However, due to the long distances between stations which report weather in the general area of the crash, no positive statement can be made that a storm did or did not exist in the area of the crash An analysis of the weather conditions in that area indicates that no storms were occurring at the time and place of the accident and that the air was generally smooth Apparently the winds aloft in that part of Brazil at the time of the accident were generally light and from a northerly to northeasterly direction.

3 The last message received from N 1039V was a routine position report No radio message was received indicating any in-flight difficulties or impending disaster. With the reported unsatisfactory radio reception due to meteorological interference in the accident area, together with the scarcity of aeronautical radio stations, it is entirely possible that an emergency message could have been transmitted without its ever having been received, or not understood if received due to the language difficulties in that part of the world.

4 The type of propeller blade with which this aircraft was equipped is subject to fatigue failure as the result of comparatively minor blade damage.

5 Since No 2 engine and propeller were not recovered, they could not be examined to determine the cause of their separation from the aircraft However, it can be concluded from examination of No 2 engine mount, which remained with the aircraft, that separation resulted from the application of forces beyond that for which it was designed Similar separations of engines from B-377 aircraft in flight, due to excessive loads being applied to the engine mount, are known In all cases where the engine and propeller were recovered, examination disclosed that the separation resulted from a propeller blade failure and the resulting destructive load due to the propeller unbalance

6 The distribution of the wreckage indicates that the structural disintegration, with the possible exception of No 2 engine mount separation, occurred in a very short interval of time and at a moderately high altitude

These circumstances, in general, indicate the probability of an emergency occurring with little or no warning, which required the full attention of the flight crew. Considering the density of the jungle vegetation in the crash area, the failure to find the No. 2 engine and propeller does not preclude the possibility that they are in the area covered by both ground and air search If so, the time interval between their separation from the airplane and the final disintegration of the structure was extremely short

During the early part of the investigation, particular significance was attached to the burned electrical bus bar, located in the lower lounge, as being a possible contributing factor to this accident. The theory was that upon the discovery of severe arcing of the bus bar, as an emergency measure all DC electrical current was shut off, thereby initiating a series of events which eventually resulted in No 2 engine and propeller being torn from the aircraft Examination of the wreckage, however, revealed two very pertinent facts, both of which clearly indicate that the DC electrical current was still available throughout the aircraft when this occurred

1 As a part of the emergency procedure initiated in the event of the loss of an engine in flight, the fuel, oil, and hydraulic fluid shut-off valves of the particular powerplant involved are closed simultaneously by the actuation of a gang bar from the flight deck. These shut-off valves are electrically operated Although the positions of the fuel and oil valves were not determined, the hydraulic fluid valve was found in the fully closed position

2 The No. 2 engine waste gate motor, which remained with the aircraft, was found in the "waste gate closed" position Separation of the engine from the aircraft would have unbalanced the motor control, causing the waste gate motor to move from its normal cruising waste gate position to either the fully open or fully closed position In either case, electrical current must have been available for the motor's operation

For the above reasons, it appears most unlikely that the DC current was shut off at any time for any reason or that the heavy arcing at the bus bar occurred before disintegration of the aircraft began

B. PROBABLE SEQUENCE OF FAILURE

The significance of the wreckage distribution, together with other factual information revealed by detailed examination of the wreckage, throws additional light on the sequence of failure and subsequent disintegration.

1. Numerous parts of the structure were covered with a film of engine oil. The areas covered by oil include the left side of the vertical fin and dorsal fin, the rudder, the normally exposed portions of the upper surface of the left flap in the area aft of the No. 2 nacelle, the most rearward portions of the fuselage left skin found at the main wreckage site, and the left stabilizer Since these pieces of wreckage were found at widely scattered points, as shown on the wreckage distribution chart, it is apparent that there was an abnormally large quantity of engine oil discharged from the No 2 nacelle area before any of these parts separated from the airplane This, considered in conjunction with the determination that No. 2 engine mount probably failed due to high unbalance of forces, indicates the probability that the oil was discharged from the severed oil lines between engine and tank when the No. 2 engine separated from the airplane. Since extremely violent maneuvers or high gust loads would be more critical for the outboard engine mounts than for Nos. 2 and 3, it appears that the emergency resulting in disintegration was caused by a failure in either the No 2 engine or propeller rather than an emergency causing high accelerations resulting in the loss of the No 2 engine.

2. A trough-shaped depression in the leading edge of the dorsal fin appears to have been caused by impact with a relatively lightweight object which had a flat surface approximately four inches in width and was moving rearward and slightly to the right A piece of cowling from the No. 2 engine appears to be the most likely object to have caused this damage.

3. A small hole was punched through the upper skin of the right stabilizer, and a tear in the upper fabric of the right elevator appeared to have been caused by impact with an unidentified small object of light weight moving rearward to the right and downward This evidence merely indicates the probable separation of objects from the airplane prior to the fuselage separation

4. With reference to the hole in the upper skin of the left horizontal stabilizer just forward of the rear spar at Station 122, it is apparent that most of this damage was

caused by the inboard end of the rear spar upper cap outboard of Station 130 after the upper cap had failed. However, in addition to zinc chromate deposits on the exterior surface of the skin, which were rubbed off the rear spar, there were also some gray smears similar to paint Analysis of these smears disclosed that they were cellulose acetate butyrate dope It is possible that the gray smudge was caused by elevator fabric being carried into the hole by the fractured spar end

5 The tail section of the airplane did not bear any evidence of impact in flight from a large or heavy piece of the airplane In addition, the separated pieces of the left inboard flap bore no evidence of impact with the tail end of the airplane, other than cable marks diagonally across the top skin of one of the pieces It therefore appears doubtful that the left wing and pieces of flap passed rearward of the tail section prior to the fuselage separation

6. All flap actuator screws were found with the nuts at 13 to 14 threads from the retracted position, which corresponds to a few degrees' flap extension This is not normal for cruising flight It suggests the probability of an attempt by the crew of N 1039V to stop tail buffeting, which could be caused by disturbed airflow over the No 2 nacelle minus its engine Although at least one B-377 is known to have lost an engine without severe buffeting, differences in the distortion of the cowling and the amount that hung on to the nacelle could very easily be the determining factor as to whether or not buffeting occurs in a particular case

Considering further the wreckage distribution, it is significant to note again the close grouping of parts from various extremities of the airplane; namely, the outboard section of the right aileron, the center third of the left elevator, the right-hand nose wheel well door, the inboard sections of the left flap, and the outer half of the left stabilizer. These pieces were found within an area encompassed by a circle of approximately 350 feet radius As these pieces are fairly uniform in density, it is apparent that all separated from the airplane in a very short interval of time It is significant, then, that the bearing from the center of this circle to the tail section wreckage was approximately 340 degrees or practically identical to the intended track of the airplane over this area The winds aloft were probably light from a northerly to northeasterly direction; therefore, they would have comparatively little effect on the relative paths of these pieces of wreckage in falling to the ground from high altitudes Since the left flap obviously broke up as a result of the left wing failure and the pieces of flap came to rest near pieces of the left elevator and stabilizer, it is apparent that there was practically no time interval between the wing failure and the tail separation

The location in which the No. 2 engine scoop was found fits in with this reasoning as to the flight path of the airplane when disintegration occurred, since the path of the scoop shown on the wreckage distribution chart appears

to have resulted from the dense piece of wreckage having first struck a rock, from which it ricocheted along the ground on a bearing of 200 degrees However, the location in which the intercooler installation parts of the No. 2 engine were found is approximately 1,000 feet east of where one would expect to find them if they separated from the airplane while it was making a track of 343 degrees The location of the left wing and the main wreckage relative to the other pieces is not inconsistent, since these two parts consisted largely of unstable lifting surfaces which could modify their path of descent from fairly high altitude to a very great extent In addition, the engines could have produced thrust during all or part of the descent, further affecting the path of descent.

Considering all of the above evidence and reasoning, it appears that the emergency originated either in the No 2 propeller or engine It appears that very shortly after this, the left wing failed

Almost simultaneously and as a result of violent pitching of the aircraft during the wing separation, entire tail group broke from the fuselage in a downward direction at a point just aft of the dorsal fin, probably before the left wing proceeded that far rearward.

C. POSSIBLE CAUSES OF STRUCTURAL DISINTEGRATION

The probable sequence of failure indicates to some extent the probable cause of the structural disintegration However, as it does not give clear-cut proof, it is necessary to consider other possible causes of structural disintegration. Since the weather does not appear to have had any bearing on the accident and since continued cruising flight over the area of the accident was intended, numerous possible causes of structural disintegration are eliminated without further analysis The remaining possibilities are analyzed in the following sections on the basis of available information:

1 Explosion

Due to the apparent suddenness of the disintegration, the theory of an explosion causing the accident gained some credence However, examination of the wreckage disclosed no evidence of distortion of a nature which would be caused by an explosion in the airplane Although the central portion of the fuselage was completely destroyed by impact and subsequent fire, a number of components, which are normally located in this section, still remained in their relative positions However, the fire damage could have obliterated possible evidence of an explosion Nevertheless, it appears that any explosion in this part of the airplane which would have been severe enough to cause the accident should have caused the fuselage to separate at either the front spar station or the rear spar station This did not occur, and no evidence was found to support the explosion theory

2 Sabotage

Examination of the wreckage disclosed no evidence of sabotage However, due to the extreme destruction in the central portion of the airplane, evidence of many types could have been obliterated. Nevertheless, the type of sabotage most likely to cause a very sudden disintegration, namely, a bomb exploding, is extremely unlikely as discussed above.

3 Fatigue Failure of the Airframe

Any fatigue failure likely to be a direct cause of sudden disintegration should occur in one of the heavy load carrying members, such as the wing spar caps Careful examination of the wing spar caps in the area where the left wing separated disclosed no evidence of fatigue cracking Only indications of extremely high tensile stresses were in evidence These indications point to upward failure of the wing due to excessive aerodynamic loads

Numerous other fractures throughout the structure were examined for evidence of fatigue cracking, without any being found. It can, therefore, be concluded that fatigue failure of a structural member of the airframe was not the direct cause of the disintegration

One theory which has been advanced as a possible cause was loss of the left nose wheel well door which then collided with the No 2 propeller, resulting in unbalanced forces which tore the engine from the aircraft The loss of a nose wheel well door could result from fatigue failure of one of the attachments However, the only portion of the left nose wheel well door identified was a small fragment attached to a piece of fuselage structure by means of the rear hinge The edges of this remaining door fragment were all curled inward, and the door structure immediately adjacent to the hinge showed no evidence of twisting deformation. If the front hinge had failed in flight due to fatigue or any other cause, allowing the front end of the door to drop down and to cause enough drag to tear the door off, the skin forward of the rear hinge should be curled outward and the structure adjacent to the rear hinge should show twisting deformation. It appears probable, therefore, that the left nose wheel well door did not twist off in flight and strike the No. 2 propeller

4 Fire in Flight Weakening Structure

Numerous indications of fire as a result of impact with the ground and burning due to the jungle fire months after the

accident were found. Although it is possible that some of this fire damage could have obliterated any evidence of damage due to fire in flight, a sufficient number of the pieces of wreckage which separated from the airplane in flight were found with either no fire damage at all or only minor damage resulting from jungle fire. Examination of the wreckage disclosed no evidence of fire in flight, consequently, the disintegration of the aircraft did not occur as a result of weakening of the structure from this source.

5. Hard-Over Signal from Autopilot

The autopilot was so completely destroyed in the ground impact and the subsequent fire that no information could be obtained from examination of it However, the establishment of limiting torques intended to prevent the application of loads in excess of the structural strength was included in the type certification of the Boeing 377. Therefore, structural disintegration due to excessive loads caused by a hard-over signal from the autopilot appears highly improbable.

6. Malfunctioning of Rudder Boost System

Excessive loads due to malfunctioning of the rudder boost system are possible However, the rudder boost system on the Boeing 377 is normally used only for take-off and landing Examination of the Geneva-loc type shut-off valve in the rudder boost panel disclosed that it was in the closed, or boost off, position. Since this type of valve is secure against actuation except by the normal electrical motivation, it is evident that the disintegration was not due to excessive loads resulting from malfunction of the rudder boost system

7. Collision with Foreign Object

As pointed out previously, little evidence of impact damage in flight was found What was found appears to have been the result of the initial disintegration rather than its cause. The possibility of a piece of propeller blade piercing the fuselage has been considered As pointed out under investigation, evidence of such damage was not found. However, due to the severe melting of the fuselage in the region of the inboard propellers, most of the fuselage skin could not be identified However, even if a piece of propeller did slash through the fuselage, it would not necessarily result in disintegration If disintegration did occur due to weakening of the fuselage structure in this area, the fuselage should have parted at this point, which it did not. If a piece of propeller blade slashed control cables, the airplane could become uncontrollable and develop

excessive loads, causing disintegration. However, the manner in which the primary control cables failed indicates they were intact until the structure started breaking up It, therefore, appears improbable that structural disintegration was the result of the control cables being severed by a piece of propeller blade

Another possibility to be considered is a bird strike on the windshield No evidence of this was found on the recovered portions of the windshield or frames. Due to the cruising altitude of 14,500 feet MSL, it is improbable that any bird would be flying at that altitude. However, even if a bird strike did occur, it is unlikely that it would incapacitate both the pilot and the copilot It, therefore, appears highly improbable that the structural disintegration resulted from collision with a bird

8 Buffeting and/or Flutter

No indication of flutter, as such, prior to disintegration was found by examination of the wreckage, although particular attention was paid to the condition of control surface hinges and balance weights for indications of looseness and working. As pointed out in Item B (6), above, the finding of the nuts on the flap actuator screws in a position corresponding to a few degrees' flap extension strongly suggests an attempt on the part of the crew to stop buffeting. The slight extension of the flaps also suggests the possibility that disintegration occurred before the flaps were extended as far as the crew may have intended.

Examination of the tail assembly wreckage disclosed evidence of the application of very high loads in both the up and down directions, as would result from buffeting Examination of the break in the left stabilizer indicated further that after partial failures had occurred in the spars and shell, the outer portion of the stabilizer oscillated up and down through several cycles before separating from the inner portion Buffeting is the most likely cause of such oscillation. The more severe indications of buffeting on the left stabilizer than on the right stabilizer fit in with the No 2 nacelle being the source of the disturbed airflow. As a result, it appears probable that severe buffeting, set up by the No 2 nacelle after the engine separated from the airplane, was more severe on the left stabilizer than on the right and caused a partial failure of the left stabilizer at about its mid-span while only causing wrinkling of the upper skin of the right stabilizer While the outer portion of the left stabilizer was still hanging on and oscillating up and down, it may have disturbed the hinge line in such a manner as to snap the elevators upward, causing a very high down load on the horizontal tail surfaces sufficient

to cause a great increase in lift on the wing and upward failure of the left wing. The nose down pitching acceleration of the airplane when the wing failed, combined with the already high down load on the tail, would then be likely to cause the tail assembly to fail downward.

Another possible cause of buffeting, one which caused an alarming emergency for three to five minutes on Boeing 377, N 1027V, between Galeao Airport, Rio de Janeiro, and Port of Spain on April 10, 1951, should be considered. Distortion and weakening of the left door of the nose wheel well, by interference with the nose wheel during retraction, resulted in a gap at its leading edge when the door was in the closed position. At cruising speed the discontinuity at the leading edge of the door apparently was sufficient to cause the forward part of the door to snap down into the wind stream and cause sufficient turbulence to create violent buffeting

Comparison of this case with the known facts relative to N 1039V does not permit a positive finding relative to the left nose wheel well door on the basis of the physical evidence, since most of the left door was never identified However, a distorted nose wheel well door does not appear to be a likely cause of the disintegration of N 1039V, for the reason that the accident occurred hours after the airplane reached cruising altitude and speed. If a distorted door had been the cause, it should have caused buffeting as the airplane was approaching cruising or very soon after it reached cruising speed. Examination of the nose wheel well right door eliminated it as a probable cause of buffeting, since it bore no distortion that would be likely to cause buffeting. Distortion at the front end was obviously from impact with the ground The only other distortion was caused by the door being blown off the airplane by excessive air loads acting on the door to the right while the door was in the open position. Experience with a military model of aircraft similar in design in many respects to the Boeing 377 which has disintegrated in flight, indicates that when the left wing fails, the right nose wheel well door can be expected to tear off in this manner in the violent left slip that results from the wing failure

Still another instance of severe buffeting has been reported involving the Boeing 377 while on a night training flight in which third pilots were making qualifying take-offs and landings at Idlewild, New York. In this instance, while operating at an altitude of 1200 feet with No 1 engine windmilling as a result of oil difficulties and inability to feather the propeller, the engineer, to put out a suspected engine fire, opened the engines' cowl flaps to their maximum instead of the normal 2½" opening prescribed. This cowl flap setting, in combination

with the windmilling propeller, created such severe buffeting and vibration of the aircraft that only with great difficulty was the pilot able to hold the left wing up or maintain directional control The engineer, upon realizing that the difficulty was caused by the cowl flap position, closed them and the buffeting and vibration stopped immediately However, during this period the aircraft's altitude had dropped to 500 feet and was maintained only by the use of full rated power on the remaining engines

No evidence was found to indicate cowl flaps were in any way involved in the accident under discussion. However, this incident clearly shows the serious buffeting effect which may be induced on this model aircraft by any abnormal air flow such as undoubtedly existed following the loss of No. 2 engine

Additional experience in several accidents to the same military model which involved extremely violent maneuvers due to several causes brings to light a striking similarity in the failures on N 1039V These include failure of the stabilizer at about the mid-span, failure of the aileron at the outmost hinge, loss of wing gap seals, damage to the wing between the inboard and outboard nacelles, and, as mentioned above, loss of nose wheel well doors in violent slips.

Findings

1 The carrier, the aircraft, and the crew were properly certificated

2 The flight was operating under VFR conditions, and weather is not considered a contributing factor

3 The flight was routine to the abeam Barreiras check point, where it reported at an altitude of 14,500 feet

4 The No 2 engine and propeller separated from the aircraft in flight.

5. The aircraft, for reasons undetermined, became uncontrollable following the separation of No 2 engine and propeller, resulting in the loss of the left wing and the tail assembly

6 There was no evidence of fire in flight

Probable Cause

The Board determines that the probable cause of this accident was the separation of the No 2 engine and propeller from the aircraft due

to highly unbalanced forces, followed by uncontrollability and disintegration of the aircraft for reasons undetermined.

BY THE CIVIL AERONAUTICS BOARD:

/s/ HARMAR D. DENNY

/s/ JOSH LEE

/s/ JOSEPH P. ADAMS

/s/ CHAN GURNEY

Oswald Ryan, Chairman, did not participate in the adoption of this report.

SUPPLEMENTAL DATA

Investigation and Hearing

On April 29, 1952, at approximately 1348, the Civil Aeronautics Board's Miami Branch Office was advised by the Pan American World Airways' Miami office that their Flight 202, which departed Rio de Janeiro at 0217 and due to arrive at Port of Spain, Trinidad, at 1321, had been unreported since 0615. This information was immediately transmitted to the Civil Aeronautics Board, Washington, D. C. An air search was begun at 1445 on the same date, and at 1800, May 1, 1952, the Civil Aeronautics Board was advised that the wrecked aircraft had been located in the remote jungle of Para State, Brazil. An investigation was immediately begun in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board which was held in Miami, Florida, November 10-14, 1952.

Air Carrier

Pan American World Airways, Inc., is a New York corporation, having its main offices at 135 East 42nd Street, New York City. It operates as an air carrier under currently effective Certificate of Public Convenience and Necessity issued by the Board and an Air Carrier Operating Certificate issued by the Civil Aeronautics Administration. These certificates authorize the company to transport by air persons, property, and mail between various points in the United States and those of foreign countries, two of which include Rio de Janeiro and Port of Spain.

Flight Personnel

Captain Albert Grossarth, age 27, held currently effective Airman Certificate No. 70338-41, with an airline transport rating. He had accumulated a total of 8,452 hours as pilot, of which 735 hours were on Boeing 377 aircraft. He had his last route check on January 11, 1952; his last equipment and instrument check on March 6, 1952; and received his last CAA physical examination on March 11, 1952.

First Officer L. A. Penn, Jr., age 34, held currently effective Airman Certificate No. 93702, with airline transport rating. His total time was 9,099 hours, of which 1,134 hours were in Boeing 377 equipment. His last equipment and instrument check was accomplished on November 5, 1951, and his last CAA physical on December 27, 1951.

Flight Engineer P. L. Stilphen, age 37, had been employed by Pan American World Airways since June 23, 1939; was promoted to flight mechanic November 1, 1942; flight engineer November 23, 1945; and flight engineer on Boeing 377 equipment March 15, 1952. His total flight time was 6,991 hours, of which 216 hours were in Boeing 377 equipment. He held Flight Engineer Certificate No. 1019695.

Radio Flight Officer L. R Holtzclaw, age 32, had been employed by Pan American World Airways as radio officer since October 22, 1941 His last CAA physical was accomplished on September 6, 1951, and he held currently effective Flight Radio Operator Certificate No 1017841, issued by the Civil Aeronautics Administration

Navigator J T. Powell, age 34, had been employed by Pan American World Airways since August 2, 1946 In addition to holding current Navigator Certificate No 1051697, he held Airman Certificate No 98357, with airline transport rating. His total flight time was 8,980. His last CAA physical was accomplished on January 10, 1952

The Aircraft

N 1039V, a Boeing 377 aircraft, Serial No. 15939, was manufactured in September 1947 and purchased by Pan American Airways, Inc., on August 27, 1949. During the period between manufacture and delivery to Pan American, this aircraft was used by the Boeing Company as a flight test article in the determination of performance, control, and stability and for functional tests of various pieces of equipment On completion of the flight test program in October 1948, the aircraft was returned to the factory for modification to the CAA approved configuration and to complete the airplane for customer delivery. This work required approximately nine months to accomplish. Upon completion the aircraft was delivered to the customer after $5\frac{1}{2}$ hours of additional routine production and acceptance flight tests

The aircraft was equipped with Pratt & Whitney R-4360 engines and Hamilton Standard Model 24260-43 propeller hubs, with Model 2J17-8W blades The total time of the aircraft was 6,944 hours. On July 8, 1951, the aircraft was given its last No. 5 check, at which time it had 6,424 hours' flight time.

The following shows the total time and positions of the engines and propellers prior to departure from Rio de Janeiro on April 28, 1952:

ENGINE INFORMATION

Position No	Serial Number	Date Installed	Time Since Overhaul	Total Time
1	2001	4/10/52	126·46	3732 23
2	2043	12/12/51	917.46	3824.39
3	522	1/ 6/52	765 18	2685·53
4	1794	1/27/52	616:14	3706:08

PROPELLER INFORMATION

Position No.	Serial Number	Date Installed	Time Since Overhaul	Total Time
1	163252	4/9/52	1281	5041
2	163613	4/12/52	589	4495
3	163117	4/5/52	167	4559
4	163035	12/19/51	866	6449

WRECKAGE DISTRIBUTION CHART
P.A.A. BOEING B-377 N1039V
NEAR CAROLINA, BRAZIL - APRIL 29, 1952

LAT. 9°45'6" SOUTH
LONG. 50°47'3" WEST

SCALE : ONE CENTIMETER = ONE HUNDRED FEET
ALL BEARINGS MAGNETIC

TRACK OF AIRCRAFT

PATH OF SCOOP

#2 ENG. SCOOP

RUDDER

INBOARD SECTION OF L. ELEVATOR

INTERCOOLER INST. PARTS OF #2 ENG.

TAIL ASS'Y

L.H. STABILIZER (OUTER HALF)

NOSE WHEEL DOOR (R.H.)

O'B'D' SECT. AILERON (R.H.)

FLAP

SKATE

L.H. ELEVATOR (CENTER 1/3)

LEFT WING #1

LOOKOUT ROCK 1650'

GAP COVER

MAIN WRECKAGE

WRECKAGE INVERTED

#1

#3

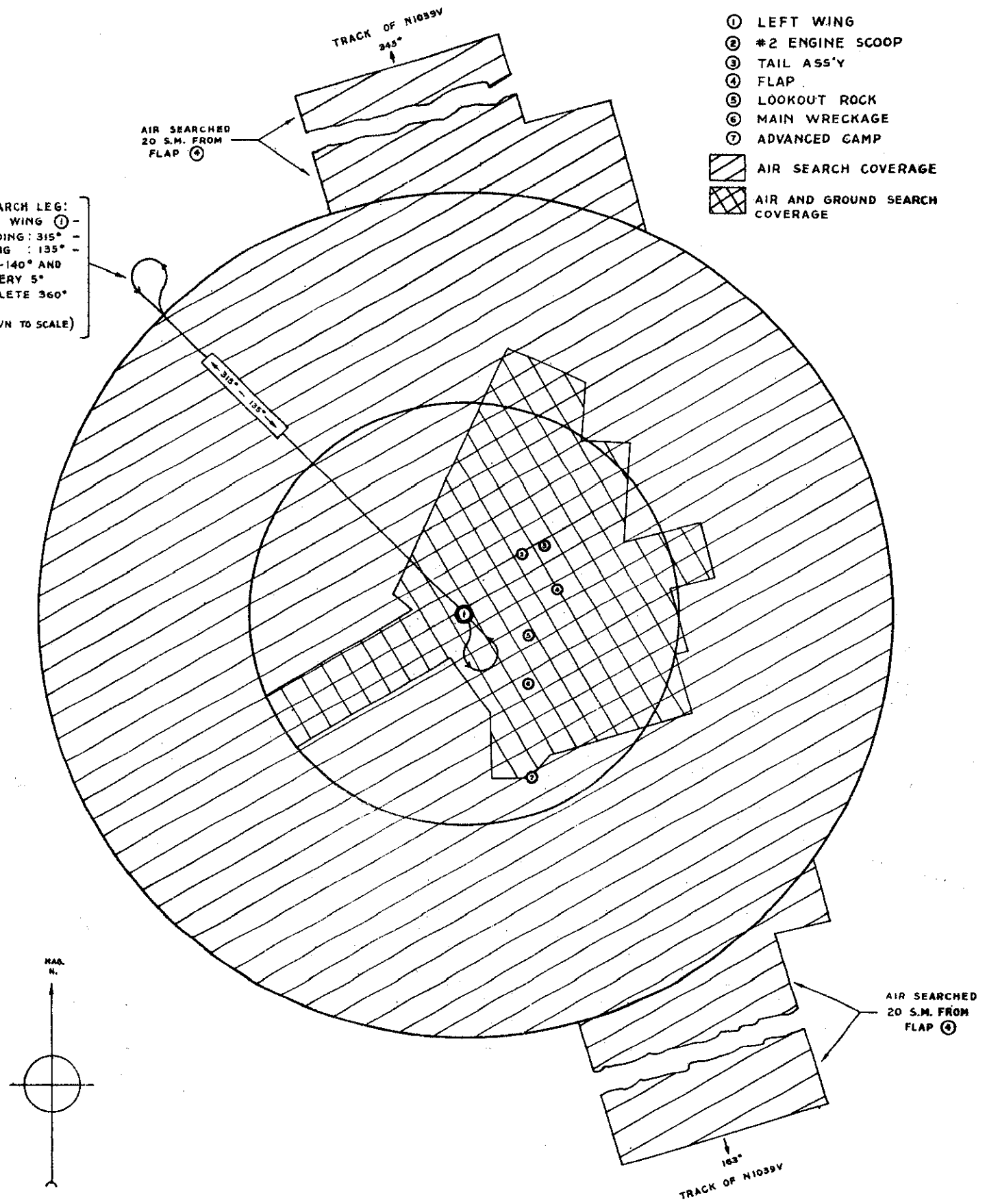
TO LAGE GRANDE AIRSTRIP 21 S.M.

VARIATION 18° W

APPENDIX E

E.D.A. 11665

M.S.



AIR-GROUND SEARCH FOR #2 ENGINE - N1039V

SCALE : 3" = ONE MILE
DIAMETER INNER CIRCLE: TWO MILES
DIAMETER OUTER CIRCLE: FOUR MILES