CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: July 15, 1954 Released: July 19, 1954

PAN AMERICAN WORLD AIRWAYS, INC. - BETWEEN HONOLULU, T. H., AND WAKE ISLAND, DECEMBER 6, 1953

The Accident

The No. 4 engine and propeller of N 90947, a Pan American World Airways Boeing 377, tore from the aircraft after little warning at 1236,1/ December 6, 1953. The flight was about halfway to Wake Island from Honolulu, T. H., cruising at its assigned altitude of 10,000 feet. Control was regained after losing considerable altitude and the flight diverted to Johnston Island. None of the 35 passengers and seven crew members was injured.

History of the Flight

Flight One/05 departed San Francisco International Airport at 2048, December 5, 1953, on a scheduled flight to Tokyo. The first intermediate stop was to be Honolulu, and the second Wake Island.

The flight arrived Honolulu at 0613, December 6. No malfunctions of the aircraft were experienced between San Francisco and Honolulu. Except for routine servicing and inspections during the stop at Honolulu, no work was needed. Flight crews were changed.

The flight departed Honolulu International Airport at 0847 under an approved IFR-type flight plan but in Visual Flight Rules weather. There were 35 passengers and a crew consisting of Captain E. G. Kelley, First Officer L. B. Newby, Second Officer F. M. Kelley, Flight Engineer W. J. Foster, Purser M. J. Finney, Stewardess P. Lux and Steward E. E. Moore. Gross weight of the aircraft at takeoff was 139,440 pounds (maximum allowable 144,900 pounds). The load was properly distributed with relation to center of gravity limits.

The flight was routine until 1235, three hours and forty-eight minutes after departure, when the crew felt an unusual vibration. At the time, the flight was in clear weather and smooth air. The vibration built up rapidly and within a minute culminated in an explosive noise and violent jolt. The aircraft went out of control in a right descending turn accompanied by violent buffeting. The flight was at 20.4° North Latitude and 174.4° West Longitude, almost exactly halfway between Honolulu and Wake. The nearest land was Johnston Island, about 350 nautical miles to the southeast.

Captain Kelley had left the cockpit sometime earlier. First Officer Newby who was occupying the right seat noted the vibration. He immediately

1/ All times referred to herein are Greenwich Civil Time and based on the 24-hour clock.

ordered all propeller spinners checked, disconnected the automatic pilot, and flew the aircraft manually. Control surface boosters were not turned on after the automatic pilot was disconnected. The flight engineer and second officer (who was navigating) checked from B compartment, forward of the cabin, but did not observe any of the engines running roughly or propeller spinners wobbling. The flight engineer returned to his station and attempted to detect the trouble; none of the engine instruments showed abnormal readings and he was unable to isolate the source of the vibration.

At the first sign of abnormal operation the captain hurried back to the cockpit. As he reoccupied the left seat, he glanced over his shoulder at the flight engineer's panel to see if he could detect the trouble. No. 4 engine and propeller fell away at that moment; simultaneously, violent buffeting began.

The steward had come forward to report unusual vibration in the galley and saw a flash of fire as No. 4 engine left; he and the second officer called to the flight engineer that No. 4 was gone.

The buffeting continued during the diving turn to the right. The master fire warning light came on and the fire warning bell sounded; there was no further evidence of fire thereafter, so CO_2 was not used. Power was reduced on the left engines. Full left aileron and rudder tabs were rolled in. Wing flaps were extended about 15 degrees to reduce buffeting, but were found ineffective; they were therefore retracted. The combined efforts of both pilots were used to apply full left aileron and rudder, but the right wing would not come up. At this time, ditching appeared imminent.

In an effort to raise the right wing and bring the aircraft under control, the captain ordered fuel dumped from No. 4 tank. The aircraft continued to lose altitude while 2,500 pounds of fuel were dumped, and control was eventually regained. Altitude was temporarily stabilized at 3,700 feet, then the aircraft again settled slowly until the power and air speed combination was found which would arrest descent and still permit control with the least buffeting. Heading was controllable within 20 degrees at 145 knots indicated air speed and descent was checked at 2,300 feet.

The first officer had been able to transmit a "Mayday" shortly after the engine and propeller tore out. A little later, before descent was arrested, he reported their position to Honolulu and advised the purser over interphone to prepare the passengers for a water landing. Steps had already been taken by the cabin attendants, in accordance with company emergency procedures, to assist passengers in preparation for ditching.

From time to time, Honolulu was advised of progress in coping with the emergency. At 1245 the flight advised Honolulu they were attempting to reach Johnston Island.

The Search and Rescue organization was immediately alerted after the "Mayday." Two aircraft were dispatched from Honolulu and an Air Force aircraft left Johnston Island. Interception was made at 1418 by the Air Force aircraft approximately 140 miles northwest of Johnston Island. Surface craft in the vicinity of Johnston Island were alerted as the flight approached.

The Flight was able to maintain 2,300 feet to Johnston Island and landed

at 1532, two hours and 56 minutes after the engine and propeller fell free.

Investigation

Weather was not a factor in this accident. The forecast was for clear weather throughout, with scattered cumulus along the course well below flight level. The crew stated that no adverse weather was encountered, and turbulence was light.

Since there was a malfunction in the No. 4 power package, followed very quickly by failure which caused the engine and propeller to rip out, the investigation was centered on ascertaining the nature of the malfunction and reason for the failure.

Investigation by the Board and testimony given by engineers from Pan American, Boeing Airplane Company, and Hamilton Standard Propeller Division disclosed that loss of the engine and propeller could have been caused by (1) failure of the engine mount, (2) sudden stoppage or seizure of the engine, (3) an unbalanced or otherwise defective propeller, or (4) a combination of these. Since the engine and propeller fell in deep water and could not be recovered, there was no opportunity to examine them.

During investigation of the first possibility above, it was found in examination of the No. 4 engine mount that the top portion of the engine mount ring was missing. Laboratory examination of the remainder of the ring, an attach fitting, and a portion of a buckled support tube did not reveal any evidence of fatigue failure. This study showed that all fractures apparently had been caused by loads in excess of the design strength. From examination of these pertinent parts and the engine mount in general, it appeared that separation of the engine from the aircraft was downward and to the right.

Loss of No. 4 engine exposed to the air stream the large flat plate area of the fire wall to which the oil cooler remained attached. This created drag and buffeting of such proportions that control could not be regained until dumping of fuel from the No. 4 wing tank made it possible to raise the wing.

The fuselage skin on the right side above the lounge door was damaged by a piece of engine cowling. The skin was abraded, with a slight amount of buckling. There was a triangular tear approximately eight square inches in area at Station 806, just forward of the window above the door. Three circumferential members and three stringers in this area were damaged, but there was no structural failure. There were two small tears in the top skin of the right wing at Stations 213 and 219; the tears were 1-1/4 and 2-3/4 inches long.

Regarding the second possibility -- that of sudden engine stoppage or seizure -- investigation disclosed that there have been no known cases of this type aircraft in which an engine has torn from an aircraft, even at high r.p.m., as a result of sudden stoppage.

Investigation of the third possibility, that of propeller failure, revealed that the engine mount on this aircraft showed several points of similarity with another mount from which No. 1 engine was wrenched out in

flight. In this comparative case, a B-377 of another carrier over Glenview, Illinois, on January 25, 1950, the engine and propeller were recovered and it was found that a propeller blade failure had occurred, causing the engine to fall free. In another case, a Pan American B-377 landed at New York International Airport on March 29, 1951, after unusual vibration was experienced in flight. After landing the No. 1 engine was found drooped in the nacelle and No. 1 propeller had lost 12-1/2 inches of one blade. There have been two other B-377 cases in which the engine and propeller were not recovered for study, but their engine mounts showed points of similarity with the mount in the Glenview incident.

Pan American officials stated that the hollow blade steel propeller, which has been installed on all B-377's, has given good service and their maintenance and inspection procedures have followed practices recommended by the manufacturer. From time to time, the propeller manufacturer and the carrier have felt it desirable to adopt more exacting inspection and blade rework procedures. Following this accident, in cooperation with Hamilton Standard, Pan American instituted more stringent procedures for operation, inspection, and maintenance of the hollow blade steel propellers installed on its B-377 aircraft.

The hollow blade steel propeller, by the nature of its construction, is susceptible to external damage and therefore requires exacting inspection and maintenance.

A nickel-plated hollow steel blade for B-377 aircraft, manufactured by Hamilton Standard, was certificated by the CAA for air carrier operation on September 14, 1953. This blade, while slightly heavier owing to the plating, has shown promise in being considerably less subject to damage by foreign objects such as stones and debris. It is of the same design as the unplated blade, but improvements have been incorporated in it to lessen or eliminate other difficulties, such as corrosion.

Presently, there is no solid-type propeller blade available for B-377 aircraft.

The company, the aircraft, and the crew were currently certificated.

Analysis

As the engine and propeller could not be recovered for study, it was not possible to determine beyond question the cause of malfunction and failure; however, investigation of previous accidents of this type and the evidence in this instance indicate strong possibility of propeller blade failure. This was based on the character and duration of vibration, study of the engine mount, and the probability that engine seizure or engine mount failure could be eliminated as causes.

It has previously been noted that Pan American adopted more stringent requirements following this accident for operation, inspection, and maintenance of the hollow blade steel propellers. In addition to this, the carrier decided to retire the unplated hollow steel blades in favor of replacement with the nickel-plated type, since it was felt that the new blade would give better service. This program of replacement started early in 1954, and the

carrier anticipates that replacement on its B-377 fleet will be accomplished during 1955. In the meantime, the improved procedures relative to the hollow steel blade will remain in effect.

Pan American has also been testing several vibration pickup units, the purpose of which is to give early warning of excessive vibration in a power plant. This permits the flight engineer or pilot to identify the malfunctioning engine or propeller and to take it out of operation by feathering the propeller before serious damage occurs. The results of this testing program have proved promising and the carrier plans early installation of such units on its aircraft. A similar unit to detect unusual amounts of vibration in the power plant is being developed by Hamilton Standard.

The Board wishes to commend the crew for the efficient manner in which they handled a most difficult situation.2/ The immediate transmittal of distress signals, the preparation of passengers for possible ditching, and the dumping of fuel, as needed, were all accomplished with praiseworthy precision.

Findings

On the basis of all available evidence the Board finds that:

1. The carrier, the aircraft, and the crew were currently certificated.

2. The gross takeoff weight of the aircraft upon departure from Honolulu was less than the maximum allowable and the load was properly distributed.

3. Flight One/05 to Wake Island was routine until 1235, three hours and forty-eight minutes after departure from Honolulu, when an unusual vibration was noted.

4. Vibration built up rapidly and within the next minute, No. 4 engine and propeller tore from the aircraft while the flight was at its assigned altitude of 10,000 feet.

5. Control of the aircraft was temporarily lost during a right descending turn, accompanied by violent buffeting.

6. Dumping of fuel from No. 4 tank permitted control to be regained after losing 7,700 feet altitude.

7. The flight diverted to Johnston Island, landing at 1532, two hours and 56 minutes after loss of the engine and propeller.

8. Intercept aircraft were dispatched by the Search and Rescue organization and one escorted the flight into Johnston Island.

2/ Captain E. G. Kelley; First Officer L. B. Newby; Second Officer F. M. Kelley; Flight Engineer W. J. Foster; Purser M. J. Finney; Stewardess P. Lux; and Steward E. E. Moore.

Probable Cause

The Board determines that the probable cause of this accident was a propeller blade failure resulting in an unbalanced condition which tore No. 4 engine from the mount.

By the Civil Aeronautics Board:

/s/ CHAN GURNEY

/s/ HARMAR D. DENNY

/s/ OSWALD RYAN

/s/ JOSH LEE

/s/ JOSEPH P. ADAMS

SUPPLEMENTAL DATA

Investigation and Hearing

The Civil Aeronautics Board was promptly notified of the accident on the morning of December 6, 1953. An investigation was immediately initiated in accordance with the provisions of Section 702 (a)(2) of the Civil Aeronautics Act of 1938, as amended. In lieu of a public hearing, a Special Investigation was ordered and depositions taken at San Francisco, California (January 11-13, 1954), Seattle, Washington (January 18, 1954), Washington, D. C. (February 12, 1954), and Windsor Locks, Connecticut (February 17-18, 1954).

Air Carrier

Pan American World Airways, Inc., is a New York corporation with its main offices in New York, New York. Headquarters for the Pacific-Alaska Division are at San Francisco International Airport. The corporation operates as an air carrier under a certificate of public convenience and necessity and an air carrier operating certificate issued pursuant to the Civil Aeronautics Act of 1938, as amended. These certificates authorize the carrier to engage in air transportation between various points in the United States and foreign countries.

Flight Personnel

Captain Elmer G. Kelley, age 34, was employed by Pan American World Airways as a pilot in 1941. He held a valid airman certificate with an air transport rating and type rating for several aircraft, including the B-377. Captain Kelley had a total of 6,763 flying hours at the time of landing at Johnston Island, of which 534 were in B-377 equipment. He received his latest route check on June 12, 1953, an emergency equipment recheck on October 13, 1953, and his last CAA physical examination on November 30, 1953.

First Officer Luther B. Newby, age 39, was employed by Pan American World Airways on January 11, 1942. He had served as a captain for six of his 12 years with Pan American and as a first officer in the Pacific-Alaska Division since 1948, because of pilot seniority requirements. Mr. Newby possessed a valid airman certificate with an air transport rating and a type rating for B-377 aircraft. At the time of landing at Johnston Island, he had 11,564 flying hours, of which 3,180 were acquired on B-377 aircraft. His latest physical examination was given on August 17, 1953, and his latest emergency equipment recheck on August 14, 1953.

Second Officer Frank M. Kelley, age 33, was employed by Pan American World Airways in 1945. He held a valid airman certificate with an air transport rating and a flight navigator's certificate. Mr. Kelley had accumulated 1,066 hours, of which 285 were on B-377 aircraft, at the time of the Johnston Island landing. His last CAA physical examination was given on April 28, 1953, and latest emergency equipment recheck on November 18, 1953.

Flight Engineer William J. Foster, age 42, was employed by Pan American World Airways in 1934 and had served as a flight engineer since 1936. He held a valid flight engineer certificate and had accumulated 4,224 hours in B-377 aircraft. He received his last CAA physical examination on November 25, 1953, and his latest emergency equipment recheck on May 1, 1953.

Purser Margaret J. Finney was employed by Pan American World Airways in April 1946. She received her latest emergency equipment recheck prior to the accident on July 28, 1953.

Stewardess Patricia Lux received an emergency equipment recheck on June 17, 1953.

Steward Eugene E. Moore was employed by Pan American World Airways in 1951, and received his latest emergency equipment recheck on June 23, 1953.

The crew departed San Francisco at 2047, December 4, 1953, and arrived at Honolulu at 0619, December 5. After a rest period of 26 hours, they departed on Flight One/05 at 0847, December 6.

The Aircraft

N 90947, a Boeing 377, serial number 15963, was owned and operated by Pan American World Airways and was currently certificated by the Civil Aeronautics Administration. At the time it landed at Johnston Island, it had almost 10,023 hours, of which nearly 872 hours had been acquired since its last periodic (No. 5) service. It was equipped with Pratt and Whitney Wasp Major B-6 engines and Hamilton Standard 24260-43 propellers. When No. 4 engine left the aircraft, it had a total of 6,760 hours, of which 615 hours had been accumulated since overhaul.

No. 4 propeller had three Hamilton Standard 2J17F3-8W and one 2J17H3-8W blades. An F-3 (short cuff) blade was replaced at Pan American's propeller overhaul shop, San Francisco, on September 17, 1953, with the H-3 (long cuff) blade, which had been reworked by the manufacturer. The replacement blade had about 2,400 hours and the other three about 6,800 hours when the change was made; the propeller was balanced before installation on the aircraft.