CIVIL AERONAUTICS BOARD

AIRCRAFT ACCIDENT REPORT

ADOPTED: October 28, 1959 **RELEASED:** November 3, 1959

PAN AMERICAN WORLD AIRWAYS BOEING 707,
N 712PA OVER THE ATLANTIC BETWEEN LONDON, ENGLAND,
AND GANDER, NEWFOUNDLAND, FEBRUARY 3, 1959

SYNOPSIS

On February 3, 1959, at 2205 G. m. t., Pan American World Airways Flight 115, a Boeing 707, N 712PA, en route from Paris, France, to New York, New York, made an uncontrolled descent of approximately 29,000 feet. Following recovery the aircraft was flown to Gander, Newfoundland, where a safe landing was made. A few of the 119 passengers and 10 crew members on board sustained minor injuries; extensive structural damage to the aircraft resulted.

The aircraft was flying at an altitude of 35,000 feet in smooth air with the autopilot engaged when the captain left the cockpit and entered the main cabin. During his absence the autopilot disengaged and the aircraft smoothly and slowly entered a steep descending spiral. The copilot was not properly monitoring the aircraft's instruments or the progress of the flight and was unaware of the actions of the aircraft until considerable speed had been gained and altitude lost. During the rapid descent the copilot was unable to effect recovery. When the captain became aware of the unusual attitude of the aircraft he returned to the cockpit and with the aid of the other crew members was finally able to regain control of the aircraft. Recovery was made at an altitude of approximately 6,000 feet.

As a part of the investigation of this accident depositions were taken of the crew, personnel of the company, the manufacturer of the aircraft, manufacturers of various components, and the Federal Aviation Agency.

Following the taking of these depositions, the FAA, citing failure to comply with Part 41.62 (Pilots at Controls) of the Civil Air Regulations, levied a civil penalty against the captain. The copilot received a six-months' suspension of his ATR.

Investigation

Pan American Flight 115 of February 3, 1959, was a scheduled flight between Paris, France, and New York, New York, with intermediate stops planned at London, England, and Gander, Newfoundland. The crew consisted of Captain Waldo Lynch, pilot in command; Captain Samuel Peters, copilot; J. Laird, navigator; G. Sinski, flight engineer; A. Leibner and R. Barton, pursers; and T. Clark, J. McCormack, J. Descoteaux, and P. Jones, stewardesses. Both of the captains in the flight crew were supervisory personnel and qualified as pilots in command of B-707 aircraft. The departure from Paris was routine and the trip to London was without incident.

Flight 115 departed London at 1845 1/ with 119 passengers. The flight plan called for an IFR flight to Gander of 4 hours and 58 minutes at maximum cruise thrust. The aircraft was to cruise at an altitude of 28,500 feet to the South Shannon intersection, 29,000 feet to 20 degrees west longitude, and 31,000 feet to Gander. A routine operation was conducted until near 30 degrees west longitude where a frontal condition accompanied by heavy thunderstorms was encountered. Because the flight, flying at its assigned altitude, was passing through the tops of these storms in moderate turbulence and encountering light icing, clearance was obtained from Shannon and Gander OAC (Oceanic Area Control) to climb to and cruise at 35,000 feet. At this altitude the aircraft was on top with all stars visible.

At approximately 2150, Captain Lynch went to the main cabin. Captain Peters remained in the cockpit, seated in the copilot's seat. The aircraft was in maximum cruise configuration flying at Mach 0.82 in smooth air; autopilot was engaged in the manual mode and the altitude hold was on; gross weight was between 190,000 pounds and 195,000 pounds; and outside air temperature was minus 55 degrees centigrade. The aircraft position was 52.5 degrees north latitude 40.5 degrees west longitude.

All other crew members were at their stations and Mr. Mackey, a company dispatcher from Idlewild on an indoctrination trip, was seated in the observer's seat immediately behind the captain in command. Captain Peters said his belt was snug and the seat was so adjusted that he had easy access to the controls.

At approximately 2200 the navigator posted a change in heading requiring a left turn of about 20 degrees. Captain Peters complied, using the turn knob of the autopilot in so doing. He said that he observed the new heading on his RMI (radio magnetic indicator) for several seconds and that the autopilot was holding the heading in a normal manner. He then began to work on the "How Goes It" curve attached to a clipboard resting on his lap, which necessitated computations being made as to time, distance, cruising speed, and fuel consumption, some parts of which are computed by the navigator. During this time his headset was positioned on both ears as he was waiting to copy the 2205 Gander weather broadcast, and he said he did not observe the forward instrument panel during this time.

The first indications he had that the flight was not proceeding normally was when he felt the aircraft buffet. This was immediately followed by a feeling that positive acceleration forces were building up rapidly. The buffeting increased in intensity and his instrument panel lights went out. Quickly he looked at the captain's instrument panel which remained lighted and saw that the captain's artificial horizon had tumbled and consequently was of no use to him. He then glanced up and saw the stars moving rapidly counterclockwise, indicating that the aircraft was in a nosedown right spiral about to roll over on its back. At this point he grabbed the control wheel, pushed the autopilot release button, and attempted to stop the roll by applying left aileron and rudder, but by this time he was virtually immobilized physically by the pressures created during the maneuver. Various system-warning and fire-warning lights were being activated intermittently and the Mach warning bell was heard.

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

At this time Captain Lynch with considerable difficulty returned to his seat. As he passed the flight engineer, Mr. Sinski reminded him that the power was still at cruise thrust. The captain pulled the power levers to idle position and pulled himself into his seat, which had been moved fully rearward when he left it. His normal seat position when flying is full forward, rudder pedals in the full aft position. Mr. Mackey and Mr. Laird, the navigator, had changed seats and the captain asked Mr. Laird, who was now immediately behind him, to hold him in his seat. Everyone in the cockpit was seriously affected by the G forces which made it difficult or impossible to move properly their heads, hands, or feet. Captain Lynch said that his head was bent over and his feet seemed pinned to the floor.

A quick glance at his instruments showed the airspeed needle in the vacant area to the right near the zero mark, and the altimeter passing through 17,000 feet with the needle turning at a teriffic rate. He could not see the Mach meter because it was hidden by the control wheel and he could not lift his head. The artificial horizon was of no use to him because it had tumbled, and the turn and bankindicator was full to the right with the ball positioned slightly to the left of center. He quickly glanced at Copilot Peters and seeing him struggling with the controls shouted, "I have command." The stabilizer was in the full nosedown position and his electric trim button failed to function. Visual reference was impossible because they were in a cloud. Mr. Laird somehow managed to fasten the captain's safety belt and while this was being done Captain Lynch rolled the wings level and the G forces were relieved. The flight engineer, now able to move, immediately pulled the circuit breaker which deactivated the stabilizer system and then straddled the console and began rolling both stabilizer wheels toward the up position by hand. As they passed through 8,000 feet Captain Lynch pulled the yoke back with a steady pull. At 6,000 feet there was a terrific violent pounding or buffeting which lasted a couple of seconds and then the aircraft ceased to descend and began a fairly steep climb. At 9,000 feet the wings were level and the aircraft was in a moderate climb. About this time the captain asked Flight Engineer Sinski to roll the stabilizer a bit forward and with the aircraft responding reasonably well to control demands he realized he had once again regained positive control. He then moved the horizon switch to the No. 2 position, selecting the No. 2 vertical gyro, and his artificial horizon responded normally; however, when returned to the No. 1 position his horizon registered normal pitch movements, but depicted a steep bank. Captain Lynch noticed that the stabilizer cutout switch was in the on position and that the Mach trim switch was in the off position. After determining their position the flight immediately advised Gander OAC of the difficulty and a cruise altitude of 31,000 feet was obtained for the remainder of the trip.

During the climb some of the passengers felt the need for oxygen and it was administered by means of the portable bottles and the cabin's regular oxygen system. The cabin pressurization system functioned in a normal manner throughout the entire event. When 31,000 feet was attained, a long-range cruise configuration was set up with a speed of Mach 0.79 and the aircraft was manually flown to Gander without further incident.

On arrival at Gander the aircraft was carefully examined and it was determined that although it had sustained extensive structural damage it could, with minor repairs, be flown safely to the Boeing plant at Seattle, Washington, for final repair.

Another B-707 was ferried to Gander to transport the passengers to New York. All passengers and crew continued the flight to its planned destination.

The damage consisted mainly of buckles in the lower surface skin of the right and left horizontal stabilizers and buckles in the center section web and upper surface doubler, and both wing panels were damaged including shear wrinkles in the rear spar webs and damage to the outboard ailerons and aileron control rods. The wing-to-fuselage fairings were damaged and a three-foot section of the right fairing separated in flight. Both wing panels suffered a small amount of permanent set. All four wing-to-strut fairing sections of the engine nacelle struts were buckled. Nos. 2 and 3 nacelle shear bolts partially failed in shear and the fitting holes of all front spar-to-wing bushings were elongated.

Stabilizer Trim

During the early part of the descent the stabilizer pitch trim which varies the angle of incidence of the adjustable horizontal stabilizer was seen by the flight engineer to move toward a nosedown position. When Captain Lynch returned to the cockpit the stabilizer trim was in the full nosedown position. The horizontal stabilizer may be varied electrically by means of an electric trim button on the upper outboard side of the pilot's control wheels. The autopilot disengage switch is located on both pilots' control wheels immediately below the trim control switch. Copilot Peters testified that during the descent he did not touch the electric stabilizer trim switch but that he remembered pushing the autopilot release button. He also said that the speed brake was not used at any time.

Because of the nature of this accident, certain systems and components of the aircraft were definitely suspect; these were the autopilot, Mach trim systems and their warning systems. As a part of the Board's investigation comprehensive tests of these systems were made at the Boeing Airplane Company plant near Seattle, Washington, under the direction of a CAB investigator.

Autopilot

The PB-20D autopilot provides sensitive automatic, coordinated control of the aircraft. It incorporates all the necessary switches, including mode selector switches, for normal autopilot operation; in addition the system includes a comparator unit. Basically, the comparator is a second autopilot computer that monitors response of the autopilot. By keeping autopilot signals under constant observance it monitors against step command (hardover) signals or gradual error condition buildup (slowovers) and automatically disengages the autopilot in response to such signals. The system is designed to be sensitive with respect to autopilot disengagements in the interest of safety and passenger comfort.

On several previous flights of B-707 aircraft there have been disengagements of the autopilot without the existence of a mechanical failure and after which the system functioned normally when the autopilot was reengaged. One such disengagement occurred on the immediately preceding flight of the subject aircraft. On this occasion the warning light failed to come on and the crew became aware of the disengagement by observing a 20-degree right-wing-low attitude on the horizon indicator. Before recovery was effected approximately 600 feet in altitude was lost. The warning light was checked by the crew immediately after the occurrence and it did not light.

Functional tests of the autopilot system subsequent to the accident showed it to be operable in a normal manner with the following exceptions:

1. In several instances the autopilot disengage warning light did not function properly after disengagement of the autopilot.

2. The pitch trim potentiometer did not recenter after autopilot disengagement. The mechanical centering of this potentiometer is necessary for the autopilot upon reengagement to have available full noseup or nosedown trim.

The principal components of the autopilot were bench checked. These also functioned in a normal manner with the following exceptions:

1. When testing the amplifier-computor it was found that the operation of relay K-14 was erratic. Two of the contacts within this relay serve the autopilot disengage warning light circuit. Detailed inspection of this unit disclosed a considerable misalignment of its internal structure, suggestive of the type of damage which might be expected if the relay had been dropped. The damage found resulted in certain of the contact pressures being below standard. In all other respects the relay appeared to be normal. Testing of the vertical gyro transmitter disclosed that the rate switch was inoperative.

2. The vertical gyro transmitter is an electrically driven gyro that provides the vertical reference for the automatic pilot. Incorporated in the assembly is a rate-of-turn control consisting of a hermetically sealed rate gyro and switch. At preset turn rates the switch turns off the vertical gyro erection system, thereby preventing erection of the vertical gyro to a dynamic vertical during turns. Examination revealed that the rate gyro motor windings were open. A crack was also noted in the glass dash-pot tubing. Subsequent to the examining group's inspection, Boeing engineering personnel observed that the rate switch would occasionally stick when closed manually.

3. As had been previously observed during the autopilot system checks, the pitch potentiometer failed to recenter when the autopilot was disengaged. The unit was opened and it was observed that travel of the actuating lever was excessive, causing a slight binding of the lever. Subsequent to the group's examination, this assembly was inspected by Eclipse-Pioneer Division personnel at their plant. They reported finding some of the solenoid sealing compound within the solenoid in such a way as to make it sticky.

4. Comparison unit tests indicated that a five-degree pitchup change of attitude as a step was required for disengagement as against the four-degree step change specified. It was also observed that the alarm would occur intermittently at 10 degrees noseup without the step change of pitch attitude normally required for an alarm.

The integrity of the aircraft wiring associated with the autopilot and Mach trim system was checked by making accurate resistance measurements of all circuits. In addition, the wiring in the two control columns, which forms the major part of the autopilot manual disconnect circuit, was removed and given a detailed visual inspection.

These checks disclosed no irregularities in the pertinent aircraft wiring.

Mach Trim System

The Mach trim system on the Boeing 707 is designed to aid in providing longitudinal stability during manual flight at high speeds. This is accomplished by adjusting the position of the movable horizontal stabilizer to counteract the aircraft-nosedown tendency at speeds of Mach 0.84 or above. This nose down tendency at high speeds, or "tuck under" as it is sometimes called, is a flight condition pertinent to all high-speed sweptwing aircraft. Although the B-707 aircraft is designed to be controllable throughout the Mach trim range without the operation of this system, it is however, required by Civil Air Regulations. The Mach trim system was tested and found to be operating in a normal manner. The Mach trim switch is turned on as a part of the after-takeoff checklist; the crew testified that they believed this was done on departure from London.

The Mach warning system serves to alert the crew of the approach of limiting airspeeds. This is done by means of a warning bell. A test of this system indicated that the bell center bolt was loose, thereby producing a buzzing sound rather than the clear ringing sound intended.

Flight Recorder

N 712PA was equipped with a Lockheed Aircraft Service Flight Recorder, model C, which continuously measures and records the aircraft's compass heading, barometric altitude, vertical acceleration, and indicated airspeed. The recorder in this aircraft is mounted in the left main gear wheel well and is connected to the aircraft's electrical power system through a switch on the landing gear scissors; it operates continuously when the aircraft is airborne. The measured parameters are recorded on aluminum foil tape by means of stylii which move transversely across the foil as the foil moves past the stylii at a uniform rate. A time trace is also impressed on the foil to facilitate the analysis of the recorded data. The tape, which winds from one spool to another, is driven by an electric motor through an escapement and gearing. The foil tape on a loaded spool is fastened to the spool by a piece of masking tape in much the same manner as photographic film is attached to its spool. The recorder will continue to operate even after the foil supply has been exhausted but the resistance of the masking tape is generally sufficient to "stall" the spool drive mechanism. When this occurs the various stylii markings are superimposed (or nearly so) upon themselves and it is difficult, if not impossible, to obtain any intelligence from the recorded markings. A 100-foot roll of aluminum tape is used in the recorder and this is sufficient for approximately 150 hours of recorder operating time.

When the recorder on N 712PA was examined after the accident, it was determined that the foil supply had been exhausted at the time of the accident. Records revealed that the recorder, SN #103, had been installed on N 712PA on January 19, 1959, by a PAWA mechanic who had obtained the recorder from the PAWA stockroom at Idlewild. The unit had been stored in the stockroom since its return from Lockheed Aircraft Service following a repair by that organization. The mechanic verified that the tape was in the recorder but he did not, nor would he ordinarily, measure the length of the installed tape. Measurement of the tape after the accident disclosed that instead of the usual 100-foot length the tape was only 51 feet long. Further investigation disclosed that 18 flight segments, covering 71:26 hours, were recorded on the tape from January 21 until the tape was exhausted on a westbound flight on January 27, 1959. From this latter date nine flights, covering 43:18 hours, were made during which intermittent record advance totaling .35 inches

occurred as a result of slippage of the masking tape retaining the foil tape to the spool. The ninth flight was the one involved in the descent maneuver.

In an effort to derive as much information on the motions of the aircraft as might be feasible, the tape was returned to Lockheed Aircraft Service, Inc., at Ontario, California, where a detailed microscopic examination of the record was made under the supervision of Board investigative personnel. Although the record was abnormal because of the minute intermittent slippage of the tape, and although it was not always possible to correlate the recorded parameters relative to time, some valuable information was obtained by this examination. The abrupt descent from 35,000 feet to 6-8,000 feet was verified and it was indicated that the airspeed reached by the aircraft was equivalent to a Mach number of 0.95. The heading trace was particularly difficult to interpret because of the poor record but it was indicated that the aircraft had made several turns in the diving, spiral descent. Accelerations representing very high G forces were indicated; however, it is believed that these were too high and were probably influenced by the manner in which this record was made. This flight recorder record was of assistance to the Board investigators and it is unfortunate that owing to tape exhaustion a more reliable record was not obtained.

Analysis

From all of the available evidence it appears that during the captain's absence from the cockpit the autopilot disengaged and the copilot did not detect that the aircraft had entered a steep nosedown right spiral. It is further evident that it entered this maneuver gradually without any abrupt movements. Also, since the accident was during the hours of darkness, the autopilot disengage warning light (a flashing red light) should have been observed by the crew unless it either failed or was almost completely shielded by the dimming cap. The latter appears probable as the cap was found in the full dim position at Gander.

The functional checks conducted on the autopilot system and its components disclosed certain minor discrepancies. These must be evaluated as to what effect, if any, such discrepancies would have on the behavior of the aircraft under the conditions prevailing at the time of the accident.

According to crew testimony, the aircraft was cruising at an altitude of 35,000 feet on Mach 0.82, in straight and level flight; the autopilot was engaged and operating in the manual mode; altitude hold was "on" and the comparison unit was in operation. Under these conditions the pitch trim potentiometer irregularity would remain unnoticed and it would have no tendency to cause the aircraft to depart from the established cruise condition.

The rate switch of the vertical gyro transmitter was inoperative. Specifically, the rate gyro motor was found to have an open winding. The rate switch was, therefore, unable to respond to turns and would have permitted the erection system to remain on at all times. Normally, the rate switch deactivates the erection system during turns to prevent erection of the vertical gyro to a false (dynamic) vertical. However, during the slight turn and subsequent continuation of the straight flight path, this malfunction would not have manifested itself.

Tests of the comparison unit disclosed some irregularities in the pitchup attitude condition. One involved intermittent disengagement at a 10-degree noseup

attitude; however, this attitude is not pertinent to the level attitude of the aircraft in this instance. It was also slightly out of tolerance in response to a step change in pitchup attitude; however, this would have made it less sensitive and therefore less likely to disengage the autopilot in response to a pitchup of the aircraft.

These were the only discrepancies involving components capable through malfunctioning of causing the autopilot to alter the established flight condition or cause autopilot disengagement.

In analyzing the autopilot irregularities found, it is apparent that they were both minor in character and unable to have caused this disengagement. Although such disengagements are by no means common occurrences, some may be expected of an autopilot of this type incorporating a comparison monitor designed to disengage the autopilot quickly should it sense any number of undesirable behaviors or responses. In achieving the desired sensitivity of the monitor system it is conceivable that nuisance disengagements can occur as the result of transitory spurious signals. In this instance, the disengagement also could have been the result of either the accidental operation by the copilot of the stabilizer trim switch or the autopilot disconnect button, both of which are on the control wheel; or by operating the autopilot engage (on-off) switch located on the pedestal.

Functional tests performed on the Mach trim system disclosed that it was capable of normal operation. It must be concluded that it had not been turned on by the crew, otherwise it would have provided increasingly more noseup stabilizer trim action with increase in Mach number.

The crew reported a change in stabilizer trim to full nosedown. This did not result from a malfunction of the Mach trim system but could have resulted from inadvertent pressure upon the electric stabilizer trim switch located on the control wheel. Although Captain Peters testified that he is quite certain his hand did not touch the switch it remains, after careful consideration, the only logical explanation for the trim system behavior. It is not definitely known what caused Captain Lynch's electric stabilizer switch to not function when he attempted to use it after returning to his seat. It may have been caused by clutch slippage induced by high aerodynamic loads. In any event, it functioned in a normal manner when tested later.

It is evident that PAWA was lax in its inspection of the flight recorder and as a result allowed a shorter than normal tape to be used. This error resulted in the loss of valuable information because of improper recording.

The Board does not condone extended absences from the cockpit by crew members but recognizes that absences of short duration are sometimes necessary. The Board believes that during the absence of either pilot from the cockpit, the remaining pilot should devote his entire attention to flying the aircraft.

Conclusion

The Board concludes therefore that this accident resulted from the inattention of the copilot to the flight instruments during the captain's absence from the cockpit; that during this period the autopilot disengaged for reasons unknown, and that the copilot, unaware of this situation, permitted the aircraft to descend out of control.

As a result of this accident the company took the following corrective action:

1. Issued a directive that one pilot give continuous attention to the attitude and flight of the aircraft during autopilot operation.

2. Reemphasized in pilot training the narrow speed margins between Mach 0.82 and M_{ne} and the brief interval of time it takes the aircraft to accelerate into critical speed ranges.

Probable Cause

The Board determines that the probable cause of this accident was the inattention of the copilot to the progress of the flight, during the absence of the captain from the cockpit, following the involuntary disengagement of the autopilot. Contributing factors were the autopilot disengage warning light in the dim position and the Mach trim switch in the "off" position.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE
Chairman

/s/ HARMAR D. DENNY
Member

/s/ G. JOSEPH MINETTI
Member

Gurney, Vice Chairman, did not take part in the adoption of this report.

SUPPLEMENTAL DATA

Investigation and Depositions

The Civil Aeronautics Board was notified of this accident the morning of February 4, 1959. An investigation was immediately begun in accordance with the provisions of Section 701 (a) (2) of the Federal Aviation Act of 1958. Depositions of pertinent witnesses were taken in New York, New York, March 11 and 12; in Seattle, Washington, April 1; and in Los Angeles, California, April 6 and 7, 1959.

Air Carrier

Pan American World Airways, Inc., is a New York corporation with its main offices in New York, New York. The corporation operates as an air carrier under a certificate of public convenience and necessity issued by the Civil Aeronautics Board, and an air carrier operating certificate issued by the Federal Aviation Agency. These certificates authorize the carrier to engage in air transportation between various points in the United States and foreign countries, including the route involved in this instance.

Flight Personnel

Captain W. Waldo Lynch, age 46, held a valid airman certificate with an airline transport rating and ratings for DC-3, DC-4, DC-6, DC-7, and B-707 aircraft. He had a total of 11,185 flying hours, of which 350 were in B-707 aircraft.

Copilot Samuel Peters, age 49, held a valid airman certificate with an airline transport rating, multiengine land, and aircraft rating on the B-707 aircraft. He had a total of 14,952 flying hours, of which 269 were in B-707 aircraft.

Flight Engineer George Sinski, age 44, held a valid flight engineer certificate. He had approximately 11,012 hours, of which 194 were in B-707 aircraft. He was employed by the company September 23, 1942.

Navigator John Laird, age 41, held a valid flight navigator certificate. He had a total of 1,376 hours, of which 211 were in B-707 aircraft. He was employed by the company May 13, 1946.

Pursers A. Leibner and R. Barton, and Stewardesses T. Clark, J. McCormack, J. Descoteaux, and P. Jones were all properly qualified.

The Aircraft

N 712, a Boeing 707-121, serial number 17591, owned by Pan American World Airways, Inc., had a total of 705 flying hours. At the time of the accident it had accumulated 39 flying hours since the last maintenance phase check. The aircraft was powered by four Pratt and Whitney JT3C6 engines.