File No. 1-0150

CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: June 27, 1957 Released: July 1, 1957

TRANS WORLD AIRLINES, INC., MARTIN 404, N 40404,
LAS VEGAS, NEVADA, NOVEMBER 15, 1956

The Accident

At 1504,[1/] November 15, 1956, Trans World Airlines Flight 163, a Martin 404, crashed at McCarran Field, Las Vegas, Nevada. The accident occurred during an attempted single-engine go-around. The captain and hostess and 14 of the 35 passengers received minor injuries. There was no fire; however, the aircraft was damaged beyond repair.

History of the Flight

Trans World Airlines Flight 163 is a regularly scheduled domestic operation between Kansas City, Missouri, and Los Angeles, California, with intermediate stops at Topeka and Wichita, Kansas; Amarillo, Texas; Santa Fe and Albuquerque, New Mexico; and Las Vegas, Nevada. A scheduled crew change is made at Albuquerque. There, on November 15, 1956, Captain Arthur G. deFabry, First Officer James P. Rapattoni, and Hostess Anne J. Zeman boarded Flight 163 as its crew to complete the remaining segments. The flight was routine to Las Vegas where it landed at 1440.

During the short ground time at Las Vegas the aircraft was serviced and the crew performed routine duties for continuation of the flight to Los Angeles. There was no apparent need for maintenance on the aircraft and none was performed.

An Instrument Flight Rules flight plan was prepared and filed because of instrument weather conditions over the latter portion of the flight segment to Los Angeles. Weather conditions at Las Vegas, however, were clear.

At 1449 Captain deFabry, seated in the captain's position, taxied N 40404 from the Las Vegas terminal to runup position beside runway 7 where the required pretakeoff checks were accomplished. The aircraft and equipment responded normally. The flight was issued an instrument clearance by Air Route Traffic Control. At this time, according to the company load manifest, the gross weight of the aircraft was 41,801 pounds, well under the maximum allowable for takeoff, 43,650 pounds. The load was properly distributed with respect to the center of gravity limitations of the aircraft.

1/ All times herein are Pacific standard and based on the 24-hour clock.

With Captain deFabry operating the aircraft, Flight 163 took off at 1456. The takeoff was routine and was followed by a climbing left turn to gain altitude and establish a southwesterly course toward Los Angeles. At 1501, when over the northern perimeter of the city, First Officer Rapattoni radioed the Las Vegas tower stating the flight was returning to the airport, engine out.

The Las Vegas tower controllers immediately notified all other traffic to remain clear and alerted emergency equipment. Flight 163 was cleared to land, any runway, and informed that the wind was calm. Captain deFabry elected to use runway 7 and First Officer Rapattoni notified the tower. Emergency equipment was then dispatched into position on the taxiway parallel to that runway.

N 40404 was soon observed on a wide base leg for runway 7 and as it turned onto the final approach. Position and altitude of the flight seemed normal. As the aircraft drew closer its extended gear could be seen and its left propeller was clearly visible, stopped and feathered.

As the aircraft passed over the runway threshold its alignment, position, and altitude seemed good; however, to nearly all observers excessive speed was apparent. The aircraft floated a considerable distance down the runway before touching it. It then bounced several times, after which an application of power was heard, obviously in an attempt to go around. The Martin climbed, veered to the left, and its left wing gradually lowered. It seemed to "struggle" to continue flight and its airspeed decreased visibly. Seconds later the aircraft struck the ground, left wing low, just inside the airport boundary.

Weather conditions at the time of the accident were clear, visibility 65 miles, and the wind was calm. A large cloud of dust, raised by the accident, hung over the scene and gradually lifted nearly vertically in evidence of the calm wind.

Investigation

One witness, who was operating an emergency vehicle on the taxiway parallel to runway 7 when the accident occurred, reached the scene within a few seconds. He said that passengers began to evacuate the aircraft approximately 30 seconds after his arrival and that all the occupants were out in less than two minutes. Nearly all concerned said the evacuation was orderly and that it was carried out under competent direction and supervision of the crew members, using the forward loading door and emergency window exits 4-A, 4-D, and 8-A.

Ground marks showed that the left wing tip of the aircraft made the initial contact with the ground and this was followed closely by the left engine nacelle and aircraft fuselage. The aircraft then slid on its belly in an upright position for 225 feet along a northeast heading. While sliding, the aircraft turned left around its vertical axis so that when it stopped the aircraft was headed northwest. The final resting place was located about 900 feet north of the centerline of runway 7 measured from a point 200 feet west of the east end of that runway. Airport elevation is 2,171 feet, mean sea level.

The aircraft received unrepairable damage from the ground impacts and the subsequent sliding forces. The fuselage was nearly separated parallel to the fifth row of passenger seats. Elsewhere it was twisted and buckled. The empennage was relatively undamaged.

Both wings of the aircraft were buckled and the right wing was broken chordwise just outboard of its engine nacelle.

The left engine was found turned outboard 40 degrees by forces which bent and broke its engine mounts. The right engine was torn out during initial forces and as the aircraft slid forward on the ground this engine was rolled inward toward the fuselage. It then struck and penetrated the right side of the fuselage floor. This unit was found lodged in the cabin flooring just ahead of passenger seat No. 2.

The main and nose components of the landing gear were found fully retracted. The wing flaps were found in a slightly extended position; however, numerous fractures in the hydraulic lines would have allowed the flaps to move from the position which existed at the instant of impact.

The engines and propellers were removed from the accident scene and shipped under government seal to the company's maintenance facilities at Kansas City. There, under the direction of a Board engine specialist, the components were carefully examined.

The left engine was torn down to determine the reason for its failure. All rocker box covers were removed and the rocker arms checked for clearance. The No. 2 cylinder exhaust valve rocker arm was found to have excessive clearance. Its push rod was then removed and examined. The ball end assembly was found to be loose and the spacer between the push rod and the ball end was broken into several pieces and completely displaced. The end of the push rod was worn, with pieces broken away. The ball end socket was belled out and polished. Evidence indicated, therefore, that the push rod failure occurred where the ball end is press fitted to the push rod. Crew testimony, in addition to the physical evidence, fully supported the push rod failure.

New or reconditioned push rods are installed during engine overhaul. Because the ball ends and rods are purchased separately, whether new or reconditioned, the ball ends are press fitted to the rods as a TWA overhaul operation.

Examination of both propellers and the right engine disclosed no evidence that they were in other than good condition prior to impact. Evidence indicated this engine was capable of delivering its specified power. Further, there was no fault with respect to the antidetonation injection (ADI) system.

Company maintenance records showed the aircraft and its components had been maintained according to company procedures. There was no record of any inflight push rod failure on TWA Martin aircraft prior to the subject accident.

The investigation of this accident included an examination and bench check of the major components of the hydraulic system. The parts were removed from the aircraft and the work was done, under Board supervision, at Kansas City.

Test procedures were set up in advance, using as a guide the manufacturer's acceptance tests for each of the units. This inspection disclosed no significant discrepancies. From examination of the components of the aircraft hydraulic systems it was determined that the hydraulically actuated mechanisms would operate as designed and as directed by cockpit control positioning.

To protect wing and flap structure, the wing flap system of the Martin 404 incorporates a wing flap unloading valve. According to test flight data published by Trans World Airlines and distributed to its pilots, the unloading valve will not permit a flap extension beyond 35 degrees, throttles fully retarded, unless the airspeed of the aircraft is at 120 knots or less. As airspeed is decreased, the flap extension is progressive until full extension, 45 degrees, is reached at or below 104 knots with throttles fully retarded. The approach flap setting is 24 degrees. This amount of extension can be obtained at 120 knots by selecting the approach flap position. Therefore, at this airspeed about 10 degrees more flap extension could be obtained by positioning the cockpit flap control in the full flap detent than in the approach position. Examination of the various components of the flap system indicated the system of N 40404 would operate, prior to impact, according to the data described.

Captain deFabry and First Officer Rapattoni testified that the malfunctioning of the left engine began shortly after takeoff when the flight was climbing over the northern perimeter of Las Vegas. The engine difficulty was in the form of an appreciable power loss, backfiring, and engine roughness. Attempts to correct the trouble were unsuccessful and when heavy and visible vibration began, Captain deFabry, fearing for the safety of the flight, feathered the left propeller taking that engine out of operation. The feathering was prompt and the propeller rotation stopped. The crew established single-engine operation, notified the McCarran tower of the emergency, and turned toward the airport. The pilots stated the flight entered the traffic pattern on a left base leg and made a long final approach to runway 7. The landing gear was lowered and approach flaps were extended during the final approach. Airspeed was 120-125 knots. With respect to the runway, the pilots stated the alignment, position, and altitude of the aircraft seemed good.

Captain deFabry said that power was reduced on the right engine and that the flight crossed the threshold at a normal height, or slightly above. At this time the airspeed indicator showed 115-120 knots. The captain testified that this airspeed was excessive and that 95-100 knots would be normal at the threshold. He added that at this time he had not called for full flaps because he thought they would not extend appreciably beyond the approach position until the airspeed had reduced to about 105 knots. The captain said, however, that when First Officer Rapattoni asked if he wanted full flaps he answered in the affirmative. First Officer Rapattoni immediately positioned the flap control to the full flap detent. Asked if he thought the captain had overlooked them the first officer stated, "Well, he was pretty busy and that was the reason for my statement, I wanted to be sure, I thought if he didn't know it that I would call it to his attention." He said that full flaps were normally extended prior to the threshold.

The pilots stated the aircraft did not seem to decelerate and according to most eyewitnesses it floated down the runway a few feet above it. According to tire marks found on the 6,499-foot runway, the initial touchdown occurred 2,749 feet beyond the approach end. Captain deFabry said this touchdown was the result of an attempt to force the aircraft on but that it bounced back into the air. He again attempted to force the aircraft on the runway but again it bounced off. Another attempt followed. Several eyewitnesses described the series of bounces as the porpoising type.

Captain deFabry said that after the last bounce the aircraft was still airborne and its airspeed was 100-105 knots. At this point he was firmly convinced that he should go around and believed the aircraft could do it. He called for takeoff power on the operating engine and up gear. He noted the first officer's prompt compliance. Flaps were retracted to the takeoff position, 12 degrees.

Eyewitnesses positioned close to the runway were unable to estimate accurately the distance consumed by the flight during the series of bounces. Most were occupied watching the aircraft itself rather than this specific detail. Most said they were extremely concerned for the safety of the flight because of the obviously excessive speed. These witnesses, who were aeronautically qualified, stated it was apparent that the pilot was attempting to put the aircraft on the runway but was unsuccessful. Witnesses said that when power was applied the aircraft was then in the air a few feet above the runway surface.

The pilots said that as the flaps raised the aircraft settled and airspeed decreased. The aircraft then immediately veered to the left and its left wing lowered. Observing a house ahead and convinced ground contact was imminent, Captain deFabry pulled off the power of the operating engine and partially leveled the airplane before it struck the ground.

Captain deFabry testified that at the time he decided to discontinue the landing and execute the go-around he was firmly convinced the performance of the Martin 404 on single-engine would enable him to do so. He stated he believed that such go-around was possible provided the airspeed of the aircraft was appreciably above minimum control speed. He stated that the airspeed, when he initiated the go-around, was 100-105 knots and the minimum control speed of the aircraft in the existing configuration was 91 knots. The captain further stated that his impression was obviously in error because as the flaps retracted it was necessary to raise the nose to prevent settling into the ground, and airspeed was sacrificed to the extent that continued flight became impossible.

The captain was questioned about his training with respect to the Martin 404 single-engine performance capabilities. He said that prior to the accident his training included familiarization with various single-engine situations; however, this training did not stress single-engine balked landing or go-around with various aircraft configurations and speeds. Captain deFabry added that subsequent to the accident he had received a refresher training course which included the Martin 404 single-engine performance capability in the balked

landing situation. The captain indicated that from this he learned that the performance he had expected at the time of the accident was beyond the performance capability of the aircraft.

Training personnel at Kansas City, the principal training center for Trans World Airlines, stated that flight tests simulating the configuration of the Martin 404 in the accident showed it was necessary to sacrifice about 300 feet of altitude while retracting the flaps to the takeoff position. They stated that on single-engine the flap retraction is necessary in order to allow the aircraft to accelerate. It was stated that following the accident a demonstration of this loss of altitude was given to key operations pilot personnal for dissemination to line captains and the demonstration was added to the company training program. Further, it is stressed during training that when full flaps are extended at an altitude below 300 feet during a single-engine approach the aircraft is committed to a landing. Training personnel said that although a balked landing procedure was in preparation it had not as yet been made a part of the Trans World Flight Operations Manual. A company instructor-pilot testified that perhaps the company pilot training had not stressed the single-engine balked landing situation enough prior to the Las Vegas accident. He added that this was probably because the program intended to teach the pilots to make the single-engine approach and landing without overshooting. He stated this proficiency and ability was expected of a line captain and that in all of the transitions he had given in the Martin 404 over a period of several years he had never seen an overshoot on a simulated single-engine.

Analysis

Examination of the No. 2 cylinder exhaust valve push rod showed conclusively that the failure of this rod was the cause of the left engine failure which occurred shortly after takeoff. The examination further showed the failure occurred where the ball end is press fitted to the rod and that the failure was most likely the result of an improper fit made by the Trans World overhaul department.

This failure caused the exhaust valve to remain closed, thereby trapping exhaust gases under pressure which would normally be dissipated through the exhaust port. Therefore, when the intake valve opened these exhaust gases entered the induction system of the engine causing loss of power, backfiring, and engine roughness. The Board is of the opinion that these conditions would be of such severity that the pilots, as in this instance, would be expected to take the engine out of operation by feathering its propeller. It is recognized that thereafter the pilots operated the aircraft under the stress and demands of an emergency situation. Under this situation the aircraft was handled properly during the downwind leg and until the flight was positioned on the final approach for landing on runway 7.

Captain deFabry stated that on the final approach the airspeed was about 120 knots. It is not unusual to maintain a higher than normal approach speed under such conditions. However, this speed must be dissipated at a point when the landing is assured and in time to preclude overshooting. The Board believes

Captain deFabry did not properly judge this position. As a result he continued with excessive speed beyond a reasonable position for a safe landing. Contributing to his misjudgment Captain deFabry erroneously believed that with 115-120 knots he could not get additional flaps beyond the approach extension. Although only about 10 degrees more extension could have been obtained, this difference and its cumulative effect may well have been the difference between the overshoot and a safe landing. Notwithstanding the testimony of Captain deFabry to the contrary, the Board does not discount the possibility that he forgot to call for the full flap position until First Officer Rapattoni reminded him.

Following a series of attempts to force the aircraft on the runway, Captain deFabry believed he would be unable to stop the aircraft in the remaining runway and decided to go around. Because the distance consumed during the bounces is unknown, the Board is unable to determine whether or not the aircraft could have been stopped and considers such a determination speculative.

When Captain deFabry decided to go around he believed the performance of the Martin 404 on single-engine would enable him to do so. He thought that 10-15 knots above the minimum control airspeed was sufficient although the aircraft was on one engine, it was in a decelerating condition, and the landing gear and approximately 45 degrees of flaps were extended. All of these conditions existed with no altitude to sacrifice. Based on these factors, the Board is of the opinion that the captain's belief was unreasonable.

The Board concludes that the training program of the company with respect to the single-engine balked landing situation was inadequate prior to the accident. This was reflected in the captain's decision and the Board believes this was in a substantial degree responsible for the decision. It is felt that the type of situation which confronted Captain deFabry should have been foreseen by the company and the performance capabilities of the aircraft in such a situation fully covered as a training subject.

The importance of training in this potential accident cause area is reflected by the Board's air carrier statistical data. These show there have been nine accidents since 1946 involving an engine out or engine malfunction during which the pilot attempted to go around after an overshoot. These data also reflect 80 accidents during the same period in which overshoot was a principal causal factor.

The modifications and additions to the training program subsequent to the accident appear to be adequate corrections to the previously inadequate situation.

Findings

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

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

2. The flight was properly dispatched from Las Vegas where clear weather and calm wind conditions existed.

3. The prior segments of the flight, the pretakeoff checks, and the takeoff at Las Vegas were normal.

4. Shortly after takeoff the left engine No. 2 cylinder exhaust valve push rod failed causing backfiring, loss of power, and engine roughness; these conditions necessitated taking the engine out of operation by feathering its propeller.

5. Emergency single-engine operation was established, the McCarran tower was notified, and the flight returned to the airport to land.

6. The base leg and final approach to runway 7 were normal with respect to alignment, position, and altitude.

7. The flight crossed the threshold with excessive airspeed and floated 2,749 feet before touching the runway.

8. A series of bounces occurred as unsuccessful attempts were made by Captain deFabry to force the aircraft on the runway.

9. Believing the aircraft could successfully go around at the speed and in the configuration which existed the captain attempted unsuccessfully to do so.

10. Prior to the accident company pilot training with respect to single-engine performance of the Martin 404 in the balked landing situation was inadequate.

11. Examination showed there was no malfunction of the right engine, landing gear and flap hydraulic systems, or the ADI system.

Probable Cause

The Board determines that the probable cause of this accident was that during an emergency situation the captain failed to reduce speed during the latter portion of a single-engine approach; this excessive speed resulted in an overshoot and an attempted go-around which was beyond the performance capability of the aircraft under existing conditions.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE
/s/ CHAN GURNEY
/s/ HARRAR D. DENNY
/s/ G. JOSEPH MINETTI

Member Louis J. Hector did not take part in the adoption of this report.

SUPPLEMENTAL DATA

Investigation and Depositions

The Civil Aeronautics Board was notified of this accident at approximately 1600, November 15, 1956. An investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. Depositions were taken at Las Vegas, Nevada, on January 17, 1957; Santa Monica, California, on January 21, 1957; and Kansas City, Missouri, on January 23, 1957.

Air Carrier

Trans World Airlines, Inc., a Delaware corporation, is a scheduled air carrier with its principal offices at Kansas City, Missouri. It possesses a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration. These certificates authorize the carrier to transport by air persons, property, and mail over various routes, including the route involved.

Flight Personnel

Captain Arthur G. deFabry, age 40, held a currently effective airman certificate with airline transport rating and an appropriate rating for the Martin 404. Captain deFabry was employed by TWA April 20, 1943. He had a total of 9,431:54 flying hours, of which 639 were in the type equipment involved. His last physical examination was on September 24, 1956. His last Martin landing renewal check was on October 16, 1956.

First Officer James P. Rapattoni, age 33, held a currently effective airman certificate with commercial rating. He was employed by TWA on May 26, 1947. He had a total of 9,926:40 flying hours, of which 105:32 were in the type equipment involved. His last physical examination was on October 30, 1956. His last Martin landing renewal check was on October 5, 1956.

Hostess Anne J. Zeman was employed by the company August 23, 1956. She graduated from hostess training on September 25, 1956. Her last actual emergency evacuation practice was on September 21, 1956.

The Aircraft

N 40404, a Martin 404, manufacturer's serial number 14104, was manufactured in 1951. It had a total of 10,451:55 hours, of which 1,087:02 had been since last base overhaul. It had accumulated 76:24 hours since its last No. 8 inspection. The last station service and line maintenance check was accomplished November 15, 1956, at Kansas City, Missouri. The aircraft was equipped with Pratt and Whitney R2800CB-16 engines and Hamilton Standard propellers, model 43E60-9. The aircraft was currently certificated by the Civil Aeronautics Administration.