File No. 1-0018

CIVIL AERONAUTICS BOARD

AIRCRAFT ACCIDENT REPORT

ADOPTED: September 17, 1963 **RELEASED:** September 19, 1963

AMERICAN AIRLINES, INC., LOCKHEED ELECTRA, L-188, N 6102A,
MCGHEE-TYSON AIRPORT, KNOXVILLE, TENNESSEE,
AUGUST 6, 1962

SYNOPSIS

On August 6, 1962, at 1731 e.s.t., Flight 414, an American Airlines, Inc., Lockheed Electra, N 6102A, crashed during a landing on runway 4L at McGhee-Tyson Airport, Knoxville, Tennessee. Sixty-seven passengers and five crew members were on board the aircraft. All escaped injury except one passenger who suffered a minor injury. The aircraft was substantially damaged.

During the landing made by the captain in an area of thunderstorm activity and heavy rain showers, the aircraft skidded to the right off the runway. It struck a newly constructed taxiway the surface of which was approximately 17 inches above ground level, causing failure of the right main landing gear. The right wing became separated from the aircraft. The remainder of the aircraft continued to deviate to the right off the side of the runway for a short distance and came to rest 3,010 feet from the approach end of the runway on a heading of 200 degrees magnetic.

The Board determines that the probable cause of this accident was the loss of directional control as a result of the improper technique employed in a cross-wind landing in adverse weather conditions.

Investigation

American Airlines Flight 414, a Lockheed Electra, N 6102A, originated at Dallas, Texas, with its destination New York, New York. Intermediate stops were scheduled at Little Rock, Arkansas; Memphis and Knoxville, Tennessee, and Washington, D. C. The crew consisted of Captain Victor E. James, First Officer Dennis P. Allmond, Flight Engineer William A. Adams, Stewardesses Sharon I. Sheldon, and Nancy L. Root.

Prior to departure from Dallas, Texas, the flight crew was furnished company weather forecasts. These forecasts indicated scattered thunderstorms over Tennessee from 1400 to 0200, and broken clouds at 4,000 feet; high broken clouds; scattered thunderstorms and light rain showers at McGhee-Tyson Airport from 1400 to 2200. The U. S. Weather Bureau forecast for Knoxville indicated scattered thunderstorms from 1530 to 2200 with a broken ceiling of 3,000 feet, and conditions lowering briefly in the thunderstorms and heavy rain showers to ceiling 800 feet; sky obscured and visibility 1 mile.

The aircraft was loaded within allowable weight and center of gravity limits when it departed Memphis at 1530. There were 67 passengers on board. The flight was cleared by Air Route Traffic Control to the Knoxville Airport and was routine to the vicinity of Knoxville.

At 1723, while nearing Knoxville, American 414 contacted Approach Control and was given the following weather report: "Estimated ceiling 3,000 broken; 12,000 broken cirrus; visibility two zero; thunderstorm. Thunderstorm north moving east-northeast. Public reports 3/4 inch hail 15 miles northwest of Knoxville." Approach Control then vectored the aircraft to the ILS[1/] final approach course to runway 4L. A "Notice to Airmen" indicated that the glide slope of the ILS was inoperative at that time.

Four miles southwest of the outer marker Flight 414 reported the airport "in sight." The Knoxville Tower local controller acknowledged receipt of this information and then transmitted the following message: "American 414 have you in sight, cleared to land, runway four left, wind is north-northwest 20, gusts to 28." The flight acknowledged the transmission and the only additional information requested was the altimeter setting which was provided. When American 414 was approximately 1/2 mile from touchdown, the local controller transmitted the following message: "Gusts now to 35." This message was not addressed to American 414 nor was there an acknowledgement from the flight.

The final approach was made in light rain, and light to moderate turbulence was encountered below 300 feet. Heavy rain was visible on the west edge of the airport. At or shortly before touchdown, the wind gusts increased in intensity, the left wing of the aircraft came up slightly, and the right main gear made contact with the runway 223 feet beyond the threshold. The aircraft then skipped three or four times to a point approximately 1,000 feet farther down the runway. At this point all wheels were on the runway, and full left aileron, left rudder, and forward elevator control pressures were applied. The flaps were left fully extended. The aircraft was then engulfed in heavy rain and wind gusts estimated by a witness to be 40-50 knots. When the strong gusts struck, the aircraft moved to the right as indicated by the tire marks on the runway. Full reverse thrust was then applied, but when the rate of movement to the right increased, the power levers were advanced toward the flight idle position, which reduced the reverse thrust. The aircraft continued its forward and rightward movement until the right main gear left the runway approximately 2,000 feet from the runway threshold. The aircraft traversed an additional 462 feet where it struck the edge of a taxiway which was under construction, at a point approximately 21 feet from the edge of the runway. On contact with the taxiway, the right main landing gear failed and the remaining stub gouged the concrete as it crossed the taxiway surface. When this landing gear separated, Nos. 3 and 4 propellers struck the taxiway leaving slash marks on its surface. The right wing began tearing free and subsequently was separated from the fuselage.

After the aircraft crossed the taxiway the nosewheel skidded off the edge of the taxiway into an area which had not been back-filled. The nose landing gear then broke off. The captain then issued a command to pull all emergency handles. The flight engineer responded by pulling the shutdown handles and shutting off the electrical power switches. The aircraft, minus the right wing,

1/ Instrument Landing System.

continued its forward and right movement finally coming to a stop in an upright position on a heading of 200 degrees magnetic with the nose resting 125 feet to the right of the runway and 3,010 feet from the approach end of the runway. Even though fuel spilled in the crash path and leaked from the left wing, there was no fire in or near the fuselage or left wing section. Fire however, did develop on the ground immediately aft of the separated wing. The fire was promptly extinguished by personnel of the Tennessee Air National Guard and the Knoxville City Fire Department.

When the aircraft slid to a stop the cabin attendants and a passenger opened the lounge emergency exit, the galley exit, and the left overwing exit. The captain went to the cabin and opened the right forward emergency exit. The first officer deplaned through the copilot's side window. All the passengers left the aircraft in approximately 3 minutes using all the exits except the main cabin door and the right overwing exit. One passenger received minor injuries when she jumped from the galley door against the stewardess's advice.

The aircraft and its powerplants sustained major damage. Damage to the fuselage varied from minor indentations and skin wrinkling to punctures and gouges. Both sides of the fuselage were penetrated by pieces of propellers. A section of propeller 12" x 8" was found in the forward cabin compartment. Another piece 8" long x 6" wide was found protruding 4 inches through the floor into the cabin interior. One blade had penetrated the cabin interior aft of the lavatory in front of the first passenger seat. The right wing front spar severed at the fuselage in an aft and slightly upward direction.

A detailed examination of the aircraft's structure and systems indicated no evidence of failures prior to impact. The examination did reveal that the wing flaps were fully extended and the landing gear was down and locked at impact.

The inspection of the powerplants revealed that they had been capable of normal operation. These facts were further substantiated by the flight crew who stated that the operation of the aircraft and powerplants was normal with the exception of the No. 1 Beta light, which came on late. The No. 1 propeller was checked completely and operated normally except that the Beta light switch adjustment was found to be set for actuation at a propeller blade pitch approximately two degrees lower than normal.

Runway 4L is 9,000 feet long and 150 feet wide. Its magnetic heading is 045 degrees and the runway slopes upward on a one-degree grade for a distance of 5,500 feet. The pavement is concrete with a crowned cross section and transverse slopes of 1-1/2 degrees to each side from the centerline. The elevation of the threshold is 923.3 feet m.s.l. Due to an intervening hill, only the touchdown area of the approach end of runway 4L is visible from the control tower. The only parts of the aircraft visible to the tower in the area where the aircraft came to rest were the rudder and vertical fin.

An examination of the runway showed that the first continuous tire marks were made by the right main landing gear and indicated a slight curve to the right of the runway centerline. At the point of nosewheel touchdown this curve had increased slightly, the nosewheel touchdown marks were 4 feet 4 inches to the left of its normal track with respect to the main landing gear. The three tire marks continued in this spacing for a distance of 308 feet at which point the lateral

movement increased to the right and then continued in a straight line for a distance of 160 feet. The tire marks then resumed a slight curve to the right as the nosewheel tire marks gradually approached and joined the left wheel tire marks. With the exception of the initial touchdown marks, which were black, the remaining tire marks were light or whitish in color.

American Airlines' Electra Operations Manual dealing with the subjects of flap retraction after touchdown and crosswind landing states as follows:

"Flap Retraction After Touch-down: If heavy water collection on runway, retract flaps immediately after touch-down."

"Crosswind Landings - Keep wings near level, maintaining runway alignment during approach mainly by crabbing. Remove the crab just prior to runway contact, to avoid side load stresses on the gear. Avoid holding the aircraft off during flare; low angles of attack during landing provide positive lateral control.

"26 knots is the maximum crosswind component authorized on a dry runway. When landing on wet runways of normal runway surface characteristics, 20 knots is generally considered to be the maximum acceptable crosswind component. This 20 knot maximum crosswind component would also apply to runways with obstructions immediately adjacent to, or in the threshold of, the runway. On slippery, snow- or ice-covered runways, where braking for similar types of aircraft is reported to be poor, a crosswind component of 10 knots is considered about the maximum acceptable; it follows, then, in the interest of conservative operation, landing under such conditions with crosswind components in excess of 10 knots is not recommended. After touchdown, continue to control the airplane in all axes while decelerating to taxi speed or until nosewheel steering and wheel braking becomes effective. Use asymmetrical reverse thrust as necessary to aid in maintaining desired heading during deceleration; however, delay application of reverse thrust until sufficient traction is available to overcome inadvertent asymmetrical reverse thrust caused by throttle rigging or sluggish governor operation."

In discussing the approach and landing, the captain said: "We landed approximately 800 feet from the end of the runway slightly to the right of the centerline. We experienced some up and down drafts and light rain on the approach, and heavy rain and strong crosswinds from the left as we touched down. We touched down at approximately 120 knots but I did not observe this speed too carefully. Number 1 Beta light was slow coming on and this pulled us to the right when we reversed. We went off the runway to the right approximately 1,200 feet after touching down and paralleled it until we hit the taxi strip. I did not see any large buildup or large cells in any direction visually or by radar and encountered only light turbulence in descent while going through scattered to broken clouds. On intercepting the ILS outside the outer marker, the complete field was in sight with light rain falling on the field and rain showers northwest of the field. I turned the windshield wipers partially on encountering the light rain as I did not anticipate any heavy rain. The last wind I remember receiving was north 20-28."

The first officer stated in part: "A normal approach was made in airspeed a little on the high side. There was heavy rain on the west edge of the field, light rain on the runway, but the visibility was good. I called out airspeed

and altitude throughout the approach. Three hundred feet on down there was light to moderate turbulence. Touchdown was approximately 800 feet from the threshold. After touchdown the left wing came up slightly and the aircraft got light on the right gear, possible the right wheels left the ground for a short distance. After all wheels were on the ground full left aileron and full forward elevator were applied to hold the airplane on the ground. Immediately on contact with the ground we started to drift to the right."

An eyewitness who observed the final approach of American 444 from a position 3/4 of a mile south of the accident site, stated in part: "I first noticed the aircraft making what seemed to me a normal approach on runway 4L. Extremely high winds and rain had already reached my position before the aircraft landed and was blowing from the north-northwest. It seemed to be raining very hard at the runway before the plane touched down - so hard in fact, that rain between me and the runway tended to limit visibility so far as minute details are concerned."

In commenting on the approach and landing an Air Force Reserve jet pilot riding as a passenger on Flight 444 stated in part: "The flight was normal until approximately 10 seconds before touchdown, at which time it became obvious that there was violent crosswinds affecting the aircraft. Additional power was applied by the pilot just prior to initial touchdown. A moderate bounce was made on first ground contact; however, vertical descent was overcome to make a fairly smooth final ground contact. It was obvious that the pilot did not have lateral control of the craft."

Approximately one-half hour prior to the accident the pilot of an Air Force T-33 flying from Memphis to Knoxville stated that he contacted Knoxville Approach Control and requested a jet penetration and approach to runway 4L. He stated further that, in response to his request for a radar analysis of the storm conditions in the vicinity of Knoxville, he was advised by Approach Control that there was a lead cell 12 nautical miles in diameter northeast of Knoxville which was followed by a second cell 8 nautical miles in diameter; also that the thunderstorm would definitely pass over the airport and should clear the local area by 1735. He also said that when he came over the approach lights he encountered moderate rain; that he landed at approximately 1724 with no difficulty and taxied to the ramp; that immediately after securing the aircraft the rain became torrential with strong winds blowing water through the closed unsealed canopy of his aircraft; and that in approximately one minute there was over an inch of water on the ramp where the aircraft was parked.

This pilot further indicated that he had observed the landing of American 444 which he described as follows:

"As I turned from looking at the water on the ramp to runway 4L I observed a landing aircraft already on the runway but in a slight right-banked attitude. Precipitation had caused a sudden drop in prevailing visibility which from my vantage point could not have been more than 1/4 mile. This obscuring precipitation in conjunction with the increasing bank of the aircraft caused me difficulty in identifying the type of aircraft. The landing aircraft increased its right bank to an estimated 20 degrees whence it gave a slight lurch, the nose dropped and the aircraft began its clockwise swing with an approximately 180-degree change of direction on the southeast side of runway 4L. My passenger and I climbed from the T-33 and ran to the Electra. We were the first persons to arrive not two minutes after the aircraft came to rest."

A flight surgeon riding as a passenger in the T-33 stated that shortly after they had parked their aircraft on the National Guard ramp he was watching a plane land which appeared to be a Lockheed Electra, that a series of events occurred which he listed numerically:

"(1) rain and wind about 20 knots then moderate rain (2) the plane appeared to be landing without incident and seemed to be on the runway (3) sudden gusts of severe wind and rain bringing 1/2 inch water on the runway, rain slanting horizontally to the ramp in sheets with winds estimated to be 40-50 knots (4) looking up saw the plane still on course until gusts seemed to hit it and lift up the left wing, the plane straightened, then the left wing came up again, and it ran off the runway."

Surface weather observations taken at McGhee-Tyson Airport were as follows:

1631 - Special, 3,000 feet scattered, high scattered, visibility 20 miles, thunderstorm, wind southwest 10 knots, thunderstorm north-northwest moving east-northeast, thunderstorm began at 1630.

1658 - Record Special, estimated 3,000 feet broken, 12,000 feet broken, high broken, visibility 20 miles thunderstorm, temperature 89F, dewpoint 71F, wind southwest 12 knots, altimeter setting 29.95 inches. Thunderstorm north moving east-northeast, dark north-northwest to northeast, occasional lightning in clouds, public reported 3/4 inch hail 15 miles northwest of McGhee-Tyson Airport.

1732 - Special, estimated 2,000 feet broken, 4,000 feet overcast, visibility 1 mile, thunderstorm, heavy rain showers, temperature 73F, dewpoint 65F, wind northwest 35 knots, gusts to 40 knots, altimeter setting 29.96 inches, runway 4L runway visibility 1-1/8 miles, thunderstorm overhead moving east-northeast.

The investigation revealed that the 1658 Record Special weather report was transmitted verbatim to Flight 414 by Approach Control with the exception of the wind direction and velocity. The Approach Controller stated:

"The reported winds were not given to the pilot of American 414 in the weather report since the actual winds were previously given to him as read from our own wind instructions in the IFR room."

The wind was given the flight when it was approaching the Sweetwater Intersection at approximately 1723, as north 15.

Analysis

Flight 414 was dispatched according to company procedures; the flight crew and the aircraft were properly certificated; the aircraft landed within allowable weight limits; and there were no significant malfunctions or failures of the engines, the aircraft or its components.

Before American 414 departed Dallas, the crew was furnished the company weather forecast which indicated scattered thunderstorm activity over Tennessee, and at Knoxville Airport.

According to statements of the approach controller, the only information transmitted to Flight 444 during the approach relative to thunderstorm activity was in part as follows: ". . . thunderstorm north moving east-northeast . . ." Based on the above information, the pilot of American 444 may have assumed that all thunderstorm activity was moving away from the airport. However, as the aircraft neared the airport, the location and intensity of such activity should have been apparent to the captain by visual observation. This conclusion is substantiated by the statement of the first officer as well as eyewitnesses who described the intensity of the thunderstorm which was in close proximity to runway 4L.

There is some doubt as to whether the captain received the message "Gusts now to 35." His testimony indicated, however, that he was advised that the wind was 20 knots, gusts to 28.

A north-northwest wind of 20 knots on runway 4L (45 degrees magnetic) would result in an effective crosswind component of approximately 18 knots. American Airlines' Electra Operations Manual indicates that when landing on a wet runway 20 knots is generally considered to be the maximum acceptable crosswind component. Eyewitnesses on the ground indicated that there was a substantial increase in wind velocity and gusts as the thunderstorm approached the airport. Since the initial touchdown of Flight 444 was nearly simultaneous with the arrival of the strong wind and gusts in that immediate vicinity, the Board concludes that the crosswind component encountered on landing in all probability exceeded the value specified by the company manual. While it cannot be expected that a pilot mentally compute the exact crosswind component, he should be able to recognize an area of danger. In this instance he should have been aware that there was a significant crosswind, and that it could be increasing in intensity because of the proximity of the thunderstorm.

The tire marks on the runway indicate that the pilot of Flight 444 landed the aircraft left wing high with the right main landing gear touching down first. The mark made by initial touchdown of the nose landing gear indicates that the aircraft heading was 6 degrees left of the runway heading. The facts show that the pilot did not retract the landing flaps after all three landing gears were on the ground, as required by American Airlines' Operations Manual. Further, the pilot used reverse thrust, in an effort to control the aircraft, before he had established positive traction and control of the aircraft. The failure to retract the flaps and the use of reverse thrust under these conditions are contrary to the requirements of the operations manual.

The light colored or whitish tire marks observed on the runway during the investigation are the type of markings commonly associated with a phenomenon known as aquaplaning. Aquaplaning occurs when the hydrodynamic lift force developed between a tire and a water-covered runway equals or exceeds the down loading of the aircraft on the tires. In this condition a film of fluid exists between the tire and the runway surface, resulting in a loss of ground traction.

Any action by the pilot which would increase the vertical loading on the landing gear would be of value in avoiding aquaplaning. The crew's failure to retract the landing flaps, as required by the company's operations manual for wet runway operation, contributed to this phenomenon.

The application of symmetrical reverse thrust to an aquaplaning aircraft that is in a crabbed attitude to compensate for a crosswind will assist the crosswing in drifting the aircraft.

The pilot stated that the No. 1 Beta light came on late and that the slow reversing of the No. 1 propeller caused the aircraft to veer to the right. The No. 1 propeller was checked completely and operated normally except that the Beta light switch adjustment was found to be set for actuation at a propeller blade pitch approximately two degrees lower than normal. This would cause the light to come on later in relation to the other Beta lights. However, the Beta light is a visual indication only, and would not affect the reversing. Furthermore, the American Airlines' Operations Manual states that reverse thrust will not be initiated until after the Beta lights are on.

Probable Cause

The Board determines that the probable cause of this accident was the loss of directional control as a result of the improper technique employed in a crosswind landing in adverse weather conditions.

BY THE CIVIL AERONAUTICS BOARD:

/s/ ALAN S. BOYD
Chairman

/s/ ROBERT T. MURPHY
Vice Chairman

/s/ CHAN GURNEY
Member

/s/ G. JOSEPH MINETTI
Member

/s/ WHITNEY GILLILLAND
Member

SUPPLEMENTAL DATA

Investigation

The Civil Aeronautics Board was notified of this accident at approximately 1800 on August 6, 1962. Investigators were dispatched immediately to the scene of the accident to conduct an investigation in accordance with the provisions of Title VII of the Federal Aviation Act of 1958, as amended. The investigation was continued until January 1963.

Air Carrier

American Airlines, Inc., a Delaware corporation with general offices at 633 Third Avenue, New York City, New York, operates as an air carrier under currently effective certificates of public convenience and necessity, and an air carrier operating certificate both issued pursuant to the Federal Aviation Act of 1958. These certificates authorize the transportation of persons, property, and mail by air between various points in the United States, Mexico, and Canada, including Knoxville, Tennessee.

Flight Personnel

Captain Victor E. James, age 49, was employed by American Airlines, Inc., on February 15, 1940, and had accumulated a total of 20,634 hours flight time of which 878 hours were in the Lockheed 188. He held a currently effective FAA ATR certificate No. 33959 with numerous ratings, among which was the Lockheed 188 rating. He received his last proficiency check in the Lockheed 188 on January 3, 1962, and his last line check on June 11, 1962. Records indicate that Captain James satisfactorily passed an FAA first-class flight physical on June 19, 1962, with the following medical waiver "corrective lenses for near vision."

First Officer Dennis P. Allmond, age 38, was employed by American Airlines on February 1, 1952, and had accumulated a total of 11,000 hours flight time of which 423 hours were in the Lockheed 188. He held a currently effective FAA multiengine land ATR certificate No. 123863 with Convair 240, 340, and 440 ratings. Mr. Allmond qualified as a first officer in Lockheed 188 on April 9, 1962. He received his last line check on June 16, 1962. Records indicate that First Officer Allmond satisfactorily passed an FAA first-class flight physical on February 20, 1962, without waivers.

Flight Engineer William A. Adams, age 43, was employed by American Airlines on May 24, 1948, and had accumulated a total of 7,526 hours flight time of which 137 hours were in the Lockheed 188. He held a valid FAA flight engineer certificate No. 1256282. Mr. Adams received his last proficiency flight check on May 29, 1962, and his last line check on March 7, 1962. Records indicate that Mr. Adams satisfactorily passed an FAA second-class flight physical on March 7, 1962, without waivers.

Stewardess Nancy L. Root, age 23, was employed by American Airlines on September 12, 1961. She successfully completed emergency procedures review and examination for the Lockheed 188 on November 11, 1961, and passed a supervisory check ride on July 6, 1962.

Stewardess Sharon I. Sheldon, age 22, was employed by American Airlines on September 12, 1961. She successfully completed emergency procedures review and examination for the Lockheed 188 on November 11, 1961, and passed a supervisory check ride on July 6, 1962.

The Aircraft

A Lockheed Electra L-188 manufacturer's serial number 1019 bore a manufacturer's date of December 10, 1958, and was delivered to American Airlines, Inc., on the same date.

The last Periodic inspection (No. 28) was performed on July 11, 1962, when the TST (total ship time) was 6,947 hours. The last trip check was completed in Dallas, Texas, on the day of the accident. The aircraft was equipped with four Allison Model 501D13 engines identified as follows:

Number	Date of Manufacture	Manufacturer's Serial Number	Total Time	Hours Since Overhaul
1	8/22/59	500608	4110	2129
2	7/17/59	501103	3324	336
3	7/10/59	501089	4079	2074
4	12/30/57	500502	2316	337

The records further revealed that the aircraft engines were equipped with four Aero Products propellers, Model A644FN-606 and identified as follows:

Number	Date of Manufacture	Manufacturer's Serial Number	Total Time	Hours Since Overhaul
1	5/19/59	P-435	5470	2851
2	10/20/58	P-161	2309	18
3	9/22/58	P-129	6321	162
4	9/15/59	P-620	2851	2851