File No. 1-0019

CIVIL AERONAUTICS BOARD

AIRCRAFT ACCIDENT REPORT

ADOPTED: June 20, 1966 **RELEASED:** June 24, 1966

CONTINENTAL AIR LINES, INC.
B-707-124, N70773
KANSAS CITY MUNICIPAL AIRPORT
KANSAS CITY, MISSOURI
JULY 1, 1965

SUMMARY

Continental Air Lines, Inc., Flight 12, a Boeing 707-124, N70773, crashed at Kansas City Municipal Airport, Kansas City, Missouri, at 0529 c.s.t., July 1, 1965.

Of the 60 passengers and 6 crewmembers aboard, three passengers and two crewmembers received minor injuries. The aircraft received substantial damage although no major fire occurred.

The aircraft made a "firm" landing, in heavy rain, about 1,050 feet past the approach end of runway 18. When the crew's efforts to stop the aircraft were ineffective, and the captain was convinced that they were going off the end of the runway, he used differential power and rudder to cock the aircraft to the left. The aircraft slid off the end of the runway, went through the ILS localizer antenna building, struck a dirt blast mound, slid up over the mound, and came to rest with the nose section in the perimeter road between the blast mound and a river levee.

The passengers and crew evacuated the aircraft without major difficulty.

The Board determines that the probable cause of this accident was hydroplaning of the landing gear wheels that precluded braking effectiveness.

1. INVESTIGATION

1.1 History of Flight

Continental Air Lines, Inc., Flight 12, (CAL Flight 12) was a Boeing 707-124, N70773, scheduled in domestic passenger service from Los Angeles International Airport, California, to O'Hare International Airport, Chicago, Illinois, with an intermediate stop at Kansas City Municipal Airport, Missouri. The flight operated as planned except that the cruising altitude was changed from 29,000 feet to 33,000 feet to avoid weather and to increase passenger comfort.

Following an en route descent, the flight began an ILS approach to runway 18 at Kansas City. After passing the outer marker the flight was cleared to land

straight in on runway 18. They were advised that the approach lights were inoperative but the runway lights would be turned up to full intensity. The wind was reported to be from 070 degrees at 7 knots.

The crew stated that they saw the runway from a point 1.8 nautical miles from the approach end of the runway. There was light rain and light to moderate turbulence at this point. The windshield wipers were turned on, full flaps were lowered, and the approach continued.

The captain stated that touchdown was within 5 knots of the airspeed specified for their gross weight, and between 1,000 and 1,200 feet past the approach end of the runway. The crew said that heavy rain was noted at that point, but neither pilot noticed standing water on the runway.

Immediately after a "firm" touchdown, the nose gear touched down. Brakes were then applied, the spoilers were raised, and reverse thrust was applied to 80 percent. After the aircraft rolled approximately 4,000 feet, reverse thrust was increased to 100 percent. The captain stated that the aircraft appeared to be picking up speed rather than slowing down when the brakes were applied. He also said "about 1,000 feet from the end of the runway I thought that if we went as far as the dike, I wanted the wing to take up the initial shock. I used differential power and rudder to bring the right wing into position." The aircraft went off the end of the runway cocked about 30 degrees to the left, at an estimated 40 knots. The right wing struck the blast mound and the aircraft slid up over the mound and came to rest with the nose section in the perimeter road between the blast mound and a river levee. (See Attachment No. 1.)

The accident occurred at 0529 c.s.t.[1/] at the Kansas City Municipal Airport, Kansas City, Missouri.[2/] Light conditions were described as "gray" in heavy rain under an overcast sky.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Non-fatal	2	3	0
None	4	57	

1.3 Damage to Aircraft

The aircraft received substantial damage in the accident.

1.4 Other Damage

A blast fence protecting the ILS localizer antenna building, the antenna building, and its contents were destroyed. The perimeter fence between the blast mound and the perimeter road was damaged.

1.5 Crew Information

Captain Lee R. Zerba, age 44, was hired by Continental Air Lines, Inc.,

1/ All times herein are central standard based on the 24-hour clock.
2/ Latitude 39° 07' N - Longitude 94° 35' W.

June 4, 1947, after serving six years in the U. S. Army Air Corps. He held airline transport pilot certificate No. 321671 with ratings in DC-3, CV-240/340, CV-440, Viscount 744/745/812, DC-6/7, and Boeing 707/720. He qualified as a B-707 captain June 9, 1964. Captain Zerba had 18,729 hours flying time of which 850 hours were in Boeing 707/720 aircraft. He also had 872 hours of instrument time. In the last 90 days he had flown 190 hours, including 12 hours of instruments and 87 hours of night time. His last line check was accomplished July 5, 1964, and his last proficiency check, including an instrument check, was completed January 19, 1965.

Captain Zerba's Class I physical examination was dated May 25, 1965, with no waivers noted. The captain had flown into the Kansas City Airport 38 times in B-707/720 aircraft since August 2, 1964, and his most recent Kansas City Landing, prior to the accident, was April 13, 1965. He had 24 hours rest before this flight and had been on duty 4:38 hours prior to the accident, including 3:38 hours flying this trip.

First Officer Howard T. Anderson, age 35, was employed by Continental Air Lines, Inc., May 25, 1959, after completing a tour in the USAF during which he flew conventional and jet aircraft. He held commercial pilot certificate No. 1401484 with an instrument rating, and a DC-3 type rating. Mr. Anderson held flight engineer certificate No. 1510377 with type ratings in the B-707 and B-720B. He had a total of 3,178 hours pilot time including 428 hours in B-707/720 and 134 hours of instrument time. He had flown 233 hours in the 90 days preceding the accident including 3 hours of instruments and 73 hours of night time. His class I physical examination dated May 28, 1965, contained no waivers. He had 24 hours rest before this flight and had been on duty 4:38 hours including 3:38 of flying.

Second Officer[3/] Harold E. Cameron, age 28, was employed by Continental Air Lines, Inc., March 8, 1965, after completing a tour as a naval aviator. He had 1,163 hours of pilot time and 73 hours of second officer time. He had a Class I physical examination January 15, 1965, with no waivers noted. He qualified as a second officer May 27, 1965. Mr. Cameron held commercial pilot certificate No. 1611337, with an instrument rating, and flight engineer certificate No. 1635444. He had 24 hours rest before this flight and had been on duty 4:38 hours including 3:38 of flying time.

The cabin attendants, a male Director of Passenger Service and three stewardesses, were regularly employed by Continental Air Lines, Inc., and their emergency training status was current at the time of the accident.

1.6 Aircraft Information

Boeing 707-124, N70773 was manufactured April 19, 1959, with serial No. 17609. The aircraft had flown 21:26 hours when purchased by Continental Air Lines, Inc., on April 19, 1959. The aircraft was maintained by Continental under a continuous overhaul program. The aircraft had a total time of 25,263 hours at the time of the accident.

N70773 was powered by four Pratt and Whitney, model JT3C-6 engines with times as shown.:

3/ Second Officers perform duties as Flight Engineers.

Engine No.	Total Time (TT)	Time Since Overhaul (TSO)
1	15,820	226
2	15,827	230
3	14,078	58
4	18,192	2,450

Main landing gear brake data were:

Position	Date Installed	No. of Landings
No. 1 aft	6/20/65	89
No. 1 fwd.	6/6/65	233
No. 2 aft	6/20/65	89
No. 2 fwd.	6/20/65	89
No. 3 aft	6/26/65	42
No. 3 fwd.	6/20/65	89
No. 4 aft	6/24/65	56
No. 4 fwd.	6/20/65	89

The main landing gear tires were size 46x16, 20 ply, 200 miles per hour:

Position	Installed	Times Recapped	Landings
No. 1 fwd.	6/20/65	New	89
No. 1 aft	6/10/65	5	92
No. 2 fwd.	6/26/65	5	42
No. 2 aft	6/26/65	4	44
No. 3 fwd.	6/25/65	8	51
No. 3 aft	6/19/65	4	103
No. 4 fwd.	6/20/65	6	89
No. 4 aft	6/30/65	4	1

A review of the aircraft maintenance records showed that all overhauls and inspections of major components of N70773 had been accomplished in accordance with applicable company and FAA approved directives. These records revealed no evidence of any deficiencies, trends, or indication of incipient failure or malfunction of the aircraft or its systems.

The weight and balance was within prescribed limits during the approach and landing at Kansas City.

The aircraft was fueled with Jet A turbine engine fuel.

1.7 Meteorological Information

The crew of CAL Flight 12 was briefed in Los Angeles, by a company meteorologist, to expect little or no en route weather or turbulence until reaching eastern Kansas when thunderstorm activity was to be encountered. The meteorologist forecast the arrival of thunderstorm activity in the Kansas City area beginning at 0300 with 2,000 feet obscured, visibility three miles, moderate thunderstorm, hail, and wind gusts to 40 knots. He later advised the crew of a thunderstorm occurring at Topeka, Kansas.

The U. S. Weather Bureau regional forecast issued by the Kansas City office at 2350 June 30, 1965, and valid from 0000 June 30, 1965, to 0000 July 1, 1965, read in part:

Significant weather. Scattered showers and thunderstorms along east slope Rockies, Montana, Wyoming and eastward into Nebraska, Kansas spreading eastward to about western Iowa, western Missouri by morning . . . .

The aviation area forecast issued at 0045, July 1, 1965, valid 0100-1300 was in part as follows:

. . . In eastern Kansas patches ceiling 8,000-12,000 feet broken variable to scattered and elsewhere in Missouri and Iowa clear to 30,000 feet thin overcast.

The aviation terminal forecast for Kansas City issued at 2245 June 30, 1965, for the period 2300-1100 was in part:

0200 (July 1) - 0600 30,000 feet thin scattered, visibility 5 miles, haze.

An amended forecast issued at 0245 July 1, 1965, valid 0245-1100 was in part:

"Kansas City 0245-0800, 8,000 scattered, 30,000 thin broken, visibility 5 miles, haze, smoke, wind 120° 10 knots, occasional ceiling 1,500 feet broken 3,000 feet overcast, visibility 3 miles, thunderstorms, light rain showers, haze, smoke, after 0330."

The last recorded weather observation taken at Kansas City before the accident was at 0455 and reported an indefinite ceiling 700 feet, sky obscured, visibility 2 miles, thunderstorms, heavy rain showers, haze and smoke, wind 020 degrees, 8 knots. Thunderstorms were reported south to overhead moving east, with frequent lightning in clouds and cloud to cloud all quadrants.

An observation taken 2 minutes after the accident reported a measured ceiling of 700 feet broken, 1,500 overcast, visibility 2 miles, thunderstorms, heavy rain showers, haze and smoke, wind 060 degrees, 9 knots. Thunderstorms were reported in all quadrants moving east with lightning in clouds and cloud to cloud. The wind direction was variable.

Thunderstorms began at Kansas City at 0317 and ended at 0608. Rain began as very light showers at 0344 and became light rain showers at 0434. From 0439 to 0535 rain fell continuously as moderate or heavy rain showers. During the period 0515 to 0530 0.28 inches of rain fell.[4/]

The captain of a jet transport that landed about four minutes before the accident said that the weather was better than reported but the rain increased in intensity during his landing rollout.

Ground witnesses at various positions around the airport observed Flight 12 during the landing and rollout. Many of them commented about the large amounts of water on the runway and thrown into the air by the wheels and the application of reverse thrust of the flight. Some witnesses stated that the aircraft was obscured from their sight in the spray.

The captain of Flight 12 testified that he encountered light rain on the landing approach and that the rain increased after landing. He also testified that

4/ The USWB Manual of Surface Observations defines heavy rainfall as a rate of fall of more than 0.30 inches in 1 hour or more than 0.03 inches in 6 minutes.

from his observation of the aircraft weather radar he thought the thunderstorm cells he saw were dissipating. He did not recall seeing any lightning during the approach or landing.

1.8 Aids to Navigation

The Kansas City Municipal Airport is equipped with an ILS, PAR, and a VOR for use during instrument approaches. The PAR was not used during the approach of Flight 12 because one of the associated radar scopes was being calibrated. Subsequent to the accident a flight check of the operational navigational equipment revealed no discrepancies.

1.9 Communications

The flight was in continuous radio contact with the appropriate air traffic control agencies and company radio. At no time were the remarks of the 0455 weather report pertaining to the thunderstorm activity around the airport transmitted to the crew of CAL 12.[5/] Additionally the crew was not advised that the PAR was not being used to monitor their approach or that they would not be provided with radar advisories during their approach.[6/]

The Continental Air Lines, Inc., assistant manager of customer service who was on duty at the time of the accident testified that while he was aware of the company requirement for a runway inspection he did not make one. The Company's Operations Manual requires that "Customer Service Manager shall maintain a close watch over conditions of the airport, particularly under conditions outlined below, and shall promptly advise Flight Control in full as follows with reference to conditions." Among the conditions listed is "water percent (of runway) covered - amount of runway covered heavy precipitation." Furthermore, when heavy snow or precipitation occurs an inspection of the runway shall be arranged before the arrival of company aircraft. The assistant manager of customer services said that Flight Control called him regarding the arrival of Flight 12 and at that time he reported that the rain had increased to "moderate" intensity. While he was talking to Flight Control he saw Flight 12 rolling down the runway and terminated the conversation. He had been on duty approximately 30 minutes at that time. He further testified that prior to that time the rain had been "light."

1.10 Aerodrome and Ground Facilities

Runway 18 at Kansas City Municipal Airport is the principal instrument runway. It is 7,000 feet long, 150 feet wide and has an effective gradient of 0.229. The runway is concrete with a bituminous overlay where the other runways on the airport cross 18-36. (See Attachment No. II.) Approach lights are installed for use but were inoperative during Flight 12's approach and landing. The runway

5/ FAA ATS Handbook "Communication Procedures" AT P 7300.1B subsection 230 states in part ". . . Announce remarks included in weather reports when of interest to pilots. . . ."

6/ Subsection 346 of AT P 7110.1B requires that whenever weather is below basic VFR minimum PAR equipment will be used to monitor approaches under the condition that existed, and the aircraft is to be advised of the frequency on which advisories may be received or, if not monitored, the fact that advisories cannot be given.

is equipped with high intensity runway lighting which was operational, in use, and on the brightest setting at the time of the accident. The surface texture of the runway was measured at the touchdown area and several other points along the runway. In the touchdown area the texture was slightly smoother than a float finish concrete surface used as a guide. The bituminous overlay was slightly rougher than float finish concrete used as a guide and was also rougher than textured concrete. The condition of the runway was reported to be good on the current Federal Aviation Facilities Record (FAA Form 29A) for this airport.

1.11 Flight Recorder

A Lockheed model 109C Flight Recorder, S/N 522, was installed in the aft area of the left main landing gear wheel well. There was no evidence of mechanical damage to the recorder; however, there was some mechanical damage to the recording tape. This damage did not interfere with the readout procedure.

The readout indicated that the aircraft touched down at approximately 137 knots indicated airspeed. The airspeed data after touchdown was not corrected for errors due to static source location, ground effect, and other factors which affect the indicated values.

1.12 Wreckage

Runway 18 was examined following the accident to establish the touchdown point, the track of the aircraft, and to recover any components of the aircraft that might have been detached during the landing roll. No aircraft components were found on the runway.

At a point 1,050 feet south of the threshold of runway 18, clear, double, white scrub marks were found, on the right side of the runway centerline. These tracks were continuous, varying only in intensity, and terminated at the wreckage area. No marks were found on the left side of the runway until a single white mark appeared 6,200 feet past the runway threshold. At this same location, the right-hand marks changed from double to triple marks and indicated a turn towards the centerline of the runway. At the 6,300-foot point, the left hand track changed to triple tracks. Narrower white scrub marks appeared about halfway between the two sets of triple white marks 6,600 feet down the runway. These marks also followed the left turn shown by the triple tracks. Tracks continued through the dirt terminating at the position of the three landing gears in the wreckage area.

All the major aircraft components were in the main wreckage area.

The main fuselage was broken into three sections which were still partially attached by portions of skin, cable, and portions of through structure. Major fractures occurred at fuselage stations (FS) 600 and 1060.7/ Portions of the bottom fuselage were crushed and torn. The wings were intact and remained attached to the fuselage. The horizontal and vertical tail surfaces were generally undamaged. The elevators and rudder were attached and operational.

7/ Fuselage stations are measured in inches back from a datum point 130 inches in front of the nose of the aircraft.

The leading edge flaps on both wings were fully extended and had received minor damage. The ailerons were attached and operable as were the spoilers, which were found in the down position. The trailing edge flaps were attached, damaged, and the jackscrews were fully extended.

There was no evidence of flight control cable or system malfunction before impact.

The wheel brakes and anti-skid systems of N70773 were given functional tests and no discrepancies were found.

Examination of the tires from the nose and main landing gears showed that 30 percent or more tread depth remained on them. There was evidence of rubber reversion8/ on all the tires as indicated:

Tire	No. of Reversion Points
L Nose	1 (360°)
R Nose	1 (360°)
#1 FWD	5 or 6
#1 AFT	6
#2 FWD	6
#2 AFT	1 almost 360°
#3 FWD	4
#3 AFT	3
#4 FWD	3
#4 AFT	5 or 6

Two tires were flat after the accident. One had a cut in the sidewall but the other was in good condition with no cuts present. Tire pressures on the other main landing gears tires ranged from 104 to 132 p.s.i. Tire pressure should have been 125 ± 5 p.s.i. No evidence of preimpact failure or discrepancy in the tires, brakes, or anti-skid systems was found.

The No. 1 engine was still attached to the strut but the other three engines had separated from the struts, with portions of the struts still attached to the wing. Examination of the engines and crew testimony revealed no evidence of pre-accident failure or malfunction.

The landing lights were in the fully extended position and undamaged.

1.13 Fire

The only evidence of fire was the burning and sooting of the insulation below the baggage compartment floor line at FS 1160 and sooting of the rear oxygen bottle in that area. The No. 3 engine was located in this area under the fuselage.

The Fire Department foamed this area for about three minutes. A short time later, because it was still smoking, another application of foam was attempted. Because of obstructions, this application was ineffectual and an opening was cut in the fuselage. At this time the passenger breathing oxygen supply discharged into the area but did not create any problems.

Dry powder extinguisher agent was sprayed on the engines that were smoking although no flames were observed.

8/ Rubber reversion is a condition where the rubber of a tire takes the appearance of its original uncured state, and is sticky and tacky, due to a heat generated by friction between the tire foot print and a wet runway surface.

1.14 Survival Aspects

Although the accident occurred on the airport, rescue agencies had difficulty in finding the aircraft due to the heavy rain and dim light conditions that existed.

Two passengers and two crewmembers were reported to be injured at the time of the accident and one passenger was admitted to the hospital several days after the accident for a reported back injury. One passenger received a sprained wrist and bruised cheek and the other suffered scraped legs. The latter man was released from the hospital after several days rest. Both of these passengers were sitting in the area behind the wing where the fuselage fractured near FS 1040.

One hostess got up from her seat shortly after touchdown and received bruises on the head, arms, and legs when she was thrown to the floor. The second officer suffered a back injury when compressive forces were applied to his back during the final impact.

The aircraft occupants stated the first impact, when the aircraft slid into the side of the blast mound, was not severe. The second impact, described as severe by passengers, occurred when the aircraft fell into the road between the blast mound and the dike. The captain, however, compared the second impact to the jar received when an automobile tire hits a curb. During the first impact a stewardess who was seated in the lounge was thrown from her seat even though she reported her seat belt was fastened. She was not injured. All other persons aboard the aircraft remained in their seats throughout the crash.

There are 10 exits available in this aircraft for emergency evacuation. Two passenger entry doors, one forward and one aft; two galley service doors, one forward and one aft; four overwing emergency exits, two on each side; and two cockpit sliding windows, one on each side.

The flight deck crew were unable to open the door into the cabin and left the aircraft through the right-hand cockpit sliding window. The passengers and the cabin attendants left the aircraft through the forward galley service door, the forward overwing exit windows, and the aft passenger exit door. The evacuation was not timed but cabin attendants estimated that it took from 1.5-2.5 minutes to clear the cabin.

The door from the cockpit to the cabin could not be opened nor could the knob be turned. The Director of Personnel Services attempted to open the forward passenger entry door but was only able to move it six to eight inches due to interior obstruction and buckling of the floor. No attempt was made, by the crew, to open the forward galley door because the TV set from the lounge area had fallen over toward the door during the initial impact. This door opened easily during the investigation and one passenger reported that he left the aircraft through that door.

No attempt was made to open the two aft overwing exit windows despite the fact that a passenger was sitting beside the one on the right side. Both forward overwing exits were opened and used to escape from the aircraft. In addition to the 10 persons sitting in the compartment over the wing, a number of

passengers from the aft section of the aircraft as well as three from the lounge, forward of the wing, used the overwing exits to escape.

The remainder of the passengers and cabin attendants left the aircraft through the aft passenger entrance door. The aft galley door was operable but the hostess decided to open the aft passenger door. A passenger had to assist in opening the door because it was on the high side of the fuselage and had to be pushed up as well as out, and the hostess was not strong enough to do it by herself. The floor level was 5 feet above the ground so the hostess extended the inflatable slide. More than 31 people left the aircraft through this door. (See Attachment No. III.)

A number of persons went back into the cabin at different times to verify that no one had remained inside the aircraft, and assist in the removal of a passenger trapped in his seat. This passenger, sitting in the window seat near FS 1040, was pinned to his seat by the seat row ahead of him. The Director of Personnel Services finally released him by tearing seat backs from the seats of the row ahead after several passengers had failed in attempts to free him.

The consensus of passengers was that there were no lights on in the cabin; however, the first officer went to the cabin as soon as he left the cockpit and reported the lights were on.

During the investigation an examination of the 11 battery powered lights used to mark aircraft exits, when aircraft power is not available, revealed that one light was switched off and the others were "on." All the batteries were checked and found to be completely discharged.

One passenger reported that either his seat belt or its attachment failed, and there were seats reported to have come "partially loose." One passenger required assistance from other passengers to unfasten his seat belt.

1.15 Tests and Research

At the request of the Board, the aircraft manufacturer calculated the stopping distance required, from touchdown, for a B-707 under the conditions[9/] that existed at Kansas City during the landing of Flight 12. Considering a braking coefficient of "0", touchdown airspeed 135 knots, maximum braking, spoilers, and reverse thrust, the landing rollout would have been 7,100 feet. At 160 knots it would have been 8,800 feet. By increasing the braking coefficient to .15 the rollout distance would have been 3,800 feet at 135 knots and 4,500 feet at 160 knots. On a dry runway with a braking coefficient of .35 these distances are further reduced to 2,300 feet and 3,000 feet respectively. An additional calculation was made for a braking coefficient of .05 which indicated that the rollout distance would be 6,600 feet with a 135-knot touchdown airspeed.

A national Aeronautics and Space Agency aerospace technologist participated in the investigation and testified in the deposition proceedings. He testified that there are three known types of hydroplaning. Dynamic hydroplaning which

9/ Airport altitude 758 feet m.s.l., temperature 70°F., runway gradient -.0012 percent, wind - 4.5 knots, gross weight 165,200 pounds.

occurs when there is standing water on the runway surface, viscous hydroplaning which occurs when the runway surface is damp, and reverted rubber hydroplaning. (See footnote 8.)

Dynamic hydroplaning occurs when a tenth or more of an inch of water on the runway acts to lift the tire off the runway and the tire is supported by a water film. Viscous hydroplaning occurs due to the viscous properties of the fluid, water or slush. In this case a very thin film of fluid, a thousandth of an inch or so, cannot be penetrated by the tire, and the tire rolls on top of the film. This can occur at much lower speeds than dynamic hydroplaning but requires a smooth or smooth acting surface. Reverted rubber hydroplaning requires a prolonged locked wheel skid, reverted rubber, and a wet runway surface. The witness theorized that reverted rubber acts as a seal between the tire and the runway and delays water exit from the tire footprint area. The water heats and is converted to steam and the steam supports the tire off the pavement. He believed that all three types of hydroplaning occurred during the landing roll of Flight 12.

This witness prepared a calculation of the landing roll of the aircraft based on the crew's testimony, the flight recorder readout, and aircraft data provided by the aircraft manufacturer and the Board. His calculation shows that the aircraft had decelerated to 39 knots when it left the end of the runway. His calculations also indicated that only 11.2 percent of the stopping energy applied to the aircraft was induced by the wheel brakes in this accident. The total stopping energy available from the varied application of reverse thrust was 4.4 percent and the majority of the stopping energy, 84.4 percent, was a combination of aerodynamic drag and rolling resistance in this case. He performed another calculation based on the use of 100 percent reverse thrust to "0" velocity, with all other factors the same, which showed that the aircraft would have stopped after 5,560 feet of roll. However, he testified that this calculation neglected the loss of reverse thrust due to the cross ingestion of exhaust gases and that this loss would practically insure that the airplane could not have stopped on the runway.

As a result of the flight engineer's reported injury, during the final vertical impact, a special study was conducted of his seat. It was determined that the seat does not have a metal bottom as the other crew seats have, but the cushion is held by plastic straps. These straps stretch in service and are within 1/4 inch of the heavy metal column on which the seat is mounted. While no accurate estimate of the vertical loads applied to this aircraft could be made, it was noted that a test load of 8 feet/sec. imposed a peak load of 20 G over 40 milliseconds on a test dummy. This is the range of loading in which ejection seats operate and has been known to cause spinal injuries.

1.16 Water Accumulation

Testimony was taken during the deposition regarding the accumulation of water during periods of heavy rain. Tests in this respect indicate that on a paved surface with a transverse fall of 1 part in 150, a precipitation rate of 3/4 inch per hour left 0.2 inch of water standing on the pavement. In this connection the witness extrapolated the water accumulation on the Kansas City runway, based on the reported rate of rain fall, and estimated that 0.3-0.4 inch of water was standing on portions of the runway at the time Flight 12 landed.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

N70773 had been maintained in an airworthy condition and there was no malfunction of any of the aircraft's structure, systems, or components that contributed to the accident.

The crew was certificated, and qualified in accordance with existing company and Federal Aviation Agency Regulations. The evidence indicates that the instrument approach and landing at Kansas City was conducted in accordance with company operating procedures except that the aircraft weighed more than the company's imposed 160,000 pounds maximum gross landing weight. This excess weight was below the FAA landing weight restriction of 175,000 pounds for B-707 operations into Kansas City.

The crew of Flight 12 was not provided with adequate weather information, by the approach controller, upon which to base a decision to land at Kansas City under the existing runway conditions. By virtue of the controller's failure to advise them that significant weather existed over the airport, the crew had every right to assume that their only concern was a 700-foot ceiling and two miles visibility. This evaluation appeared to be borne out when they found they could see the runway from a point 1.8 nautical miles out, at which time they were clear of the clouds. They also knew that TWA Flight 84, a large four engine jet transport, had landed, without reported difficulty, about four minutes ahead of them. This situation was compounded by the failure of the company representative to perform an inspection of the runway conditions existing at the airport, and report them to Flight Control to be relayed to Flight 12, and also to inform the dispatcher of the heavy precipitation occurring at the airport.

Touchdown at about 137 knots, occurred approximately 1,050 feet past the runway threshold and was solid, with no bounce. This is evidenced by the scrub marks on the runway and the testimony of an aeronautically qualified passenger aboard the aircraft. Spoilers were extended, wheel braking begun, and reverse thrust was initiated immediately after landing. A lack of decelerating forces was noted by the crew and several passengers. Heavy spray was thrown up by the aircraft as it progressed down the runway. Due to excessive cycling of the wheel anti-skid system the captain increased reverse thrust from 80 percent to 100 percent. When it bacame apparent to him that the aircraft would not stop on the runway, the captain cocked the aircraft to the left by advancing the Nos. 3 and 4 engines into forward thrust and the use of left rudder. The aircraft weather-cocked 35 degrees to the left but continued to slide down the runway going off the concrete at about 40 knots.

The Board is unable to accurately determine how much water was standing on the runway; however, it is estimated that the water depth exceeded 0.3 inches at the time of landing. This amount of water is more than enough to induce dynamic hydroplaning. It would have exceeded the average tread depth of all but one of the tires, causing them to react as smooth tires above this aircraft's dynamic hydroplaning speed of approximately 102 knots.

The evidence of rubber reversion on all the tires indicates that there were periods of locked wheel skid where the tread was in contact with moist pavement.

In this case there was probably little braking effect because either the tire was riding on a cushion of steam trapped in the footprint area by the sealing effect of the melted rubber, or on the melted rubber itself which would offer a smooth surface.

The third type of hydroplaning, viscous, takes place when very thin films of water are on smooth, or smooth acting, surface. This could have occurred in the touchdown area of the runway where large amounts of rubber from landing aircraft tires were deposited.

It is the Board's opinion that most if not all of these types of hydroplaning occurred in this case.

Based on the testimony of the witnesses, and statements from the passengers that they felt little or no deceleration after landing, it is probable that the braking coefficient on the runway was less than 0.15. The manufacturer computed that if the braking coefficient were 0.05 it would take 6,700 feet of runway to stop, using full reverse thrust to zero velocity. At landing, the pilot had 5,950 feet of runway remaining. Calculations and testimony by the NASA technologist indicated that, under the conditions of the landing, the airplane could not have been expected to stop on the runway.

2.2 Conclusions

Findings:

a. The crew was qualified and certificated in accordance with existing company and FAA regulations.

b. The captain was flying the aircraft and the procedures employed by the crew were in keeping with the current company practices except that the crew exceeded the company's imposed maximum landing weight for the conditions at Kansas City. They were, however, well under the FAA maximum gross landing weight restirction of 175,000 pounds for B-707's.

c. Approach Control personnel did not provide the crew with all the available reported weather information.

d. Continental Air Lines, Inc., procedures for inspection and reporting runway conditions were not followed.

e. The crew of Flight 12 knew that TWA Flight 84 had landed about four minutes ahead of them, with no reported difficulties.

f. The final portion of the approach was made under visual flight condition

g. It was raining during the period of the final approach.

h. The crew of Flight 12 had no reason to believe that they would experienc any difficulty during the landing.

i. The evidence and testimony established the aircraft touched down firmly on the runway in the area of the ILS touchdown point.

j. There was approximately 5,950 feet of useable runway remaining after touchdown.

k. There was standing water on the runway from an extended period of heavy rain.

l. All tires, including the nose wheels, exhibited definite evidence of reverted rubber type hydroplaning.

m. Evidence on the runway indicated hydroplaning existed from the point of touchdown to the end of the runway for the right main gear.

n. The coefficient of friction between the tire of the landing gear and the runway surface was less than 0.15 as little or no deceleration forces were felt by the crew or the passengers.

o. At the landing weight and speed of the aircraft at touchdown with the existing runway conditions, more than the remaining useable runway length was necessary to stop the aircraft.

p. The passengers and crew evacuated the aircraft without major difficulty.

Probable Cause

The Board determines that the probable cause of this accident was hydroplaning of the landing gear wheels which precluded braking effectiveness.

RECOMMENDATION

The Board's recommendation to the Federal Aviation Agency and the Administrator's reply to that recommendation is appended as Attachment #4.

BY THE CIVIL AERONAUTICS BOARD:

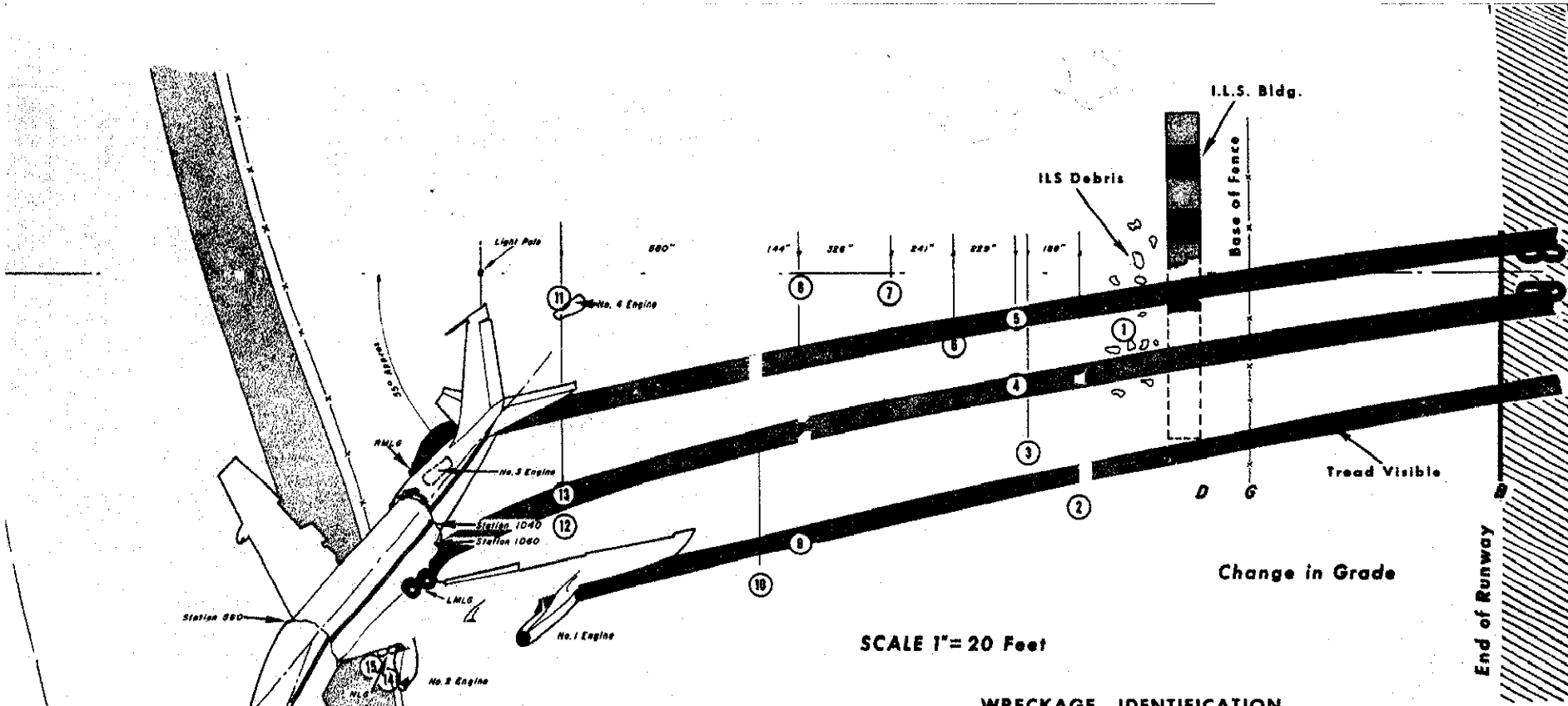
/s/ CHARLES S. MURPHY
Chairman

/s/ ROBERT T. MURPHY
Vice Chairman

/s/ G. JOSEPH MINETTI
Member

/s/ WHITNEY GILLILLAND
Member

/s/ JOHN G. ADAMS
Member



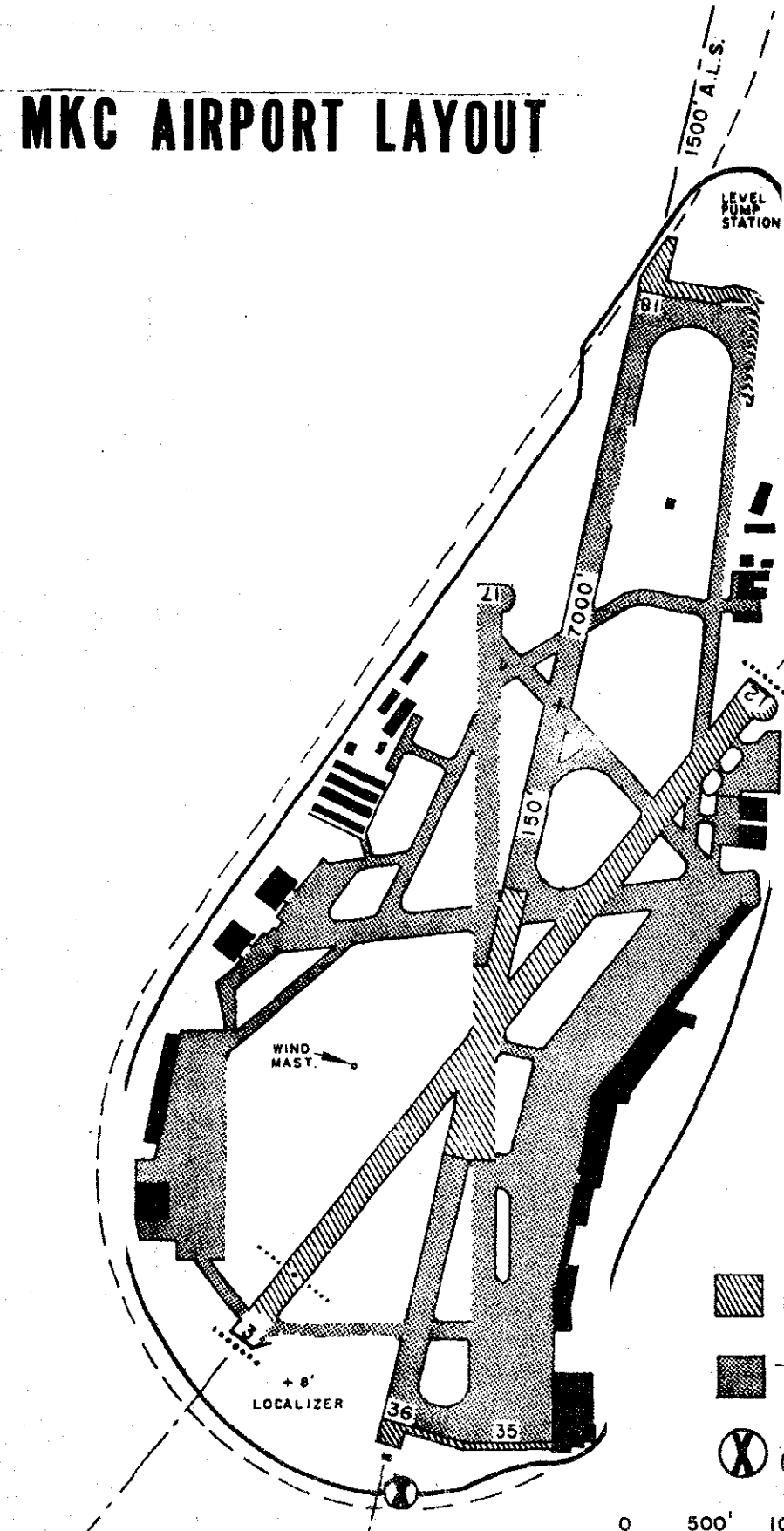
SCALE 1"= 20 Feet

WRECKAGE IDENTIFICATION

No.	Parts
1.	Cowling (S/N 10)
2.	Nose Cowling
3.	Fuselage Skin
4.	N.G. Door
5.	Pylon Fire Wall
6.	M.G. Door
7.	Actuator
8.	Air Starter
9.	N.G. Actuator
10.	Oil Cooler (P/N 10-3237-32)
11.	No. 4 Eng.
12.	T.E. Flap
13.	M.L.G. Door
14.	No. 2 Eng.
15.	N.L. Gear

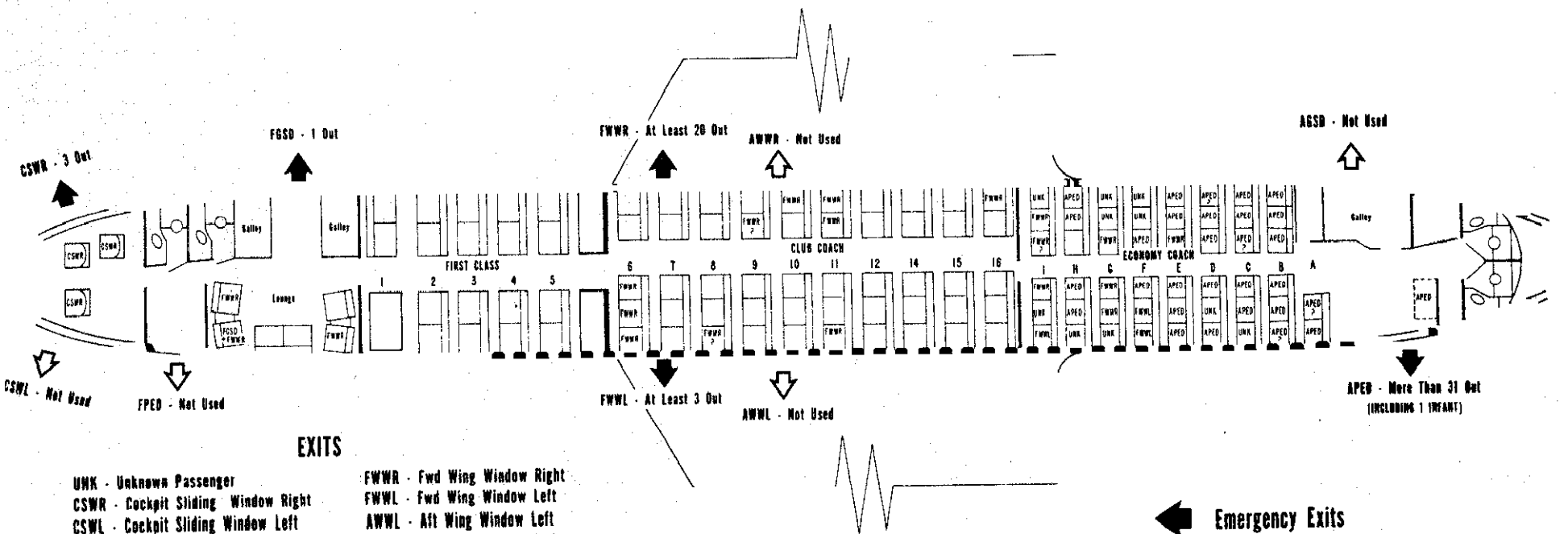
ATTACHMENT 1

MKC AIRPORT LAYOUT



ATTACHMENT II

CONTINENTAL AIR LINES
BOEING 707-124, N70773
JULY 1, 1965
KANSAS CITY, MISSOURI
EVACUATION FLOW CHART



EXITS

UNK - Unknown Passenger
CSWR - Cockpit Sliding Window Right
CSWL - Cockpit Sliding Window Left
FPED - Fwd Pass. Entry Door
APED - Aft Pass. Entry Door
FGSD - Fwd Galley Ser. Door
AGSD - Aft Galley Ser. Door

FWWR - Fwd Wing Window Right
FWWL - Fwd Wing Window Left
AWWL - Aft Wing Window Left
AWWR - Aft Wing Window Right
----- ? Probable Exit Used

Emergency Exits
Emerg. Exits - Not Used

GPO 903-894

COPY

ATTACHMENT NO. 4

CIVIL AERONAUTICS BOARD
WASHINGTON, D. C. 20428

In Reply
Refer to: B-1-90

May 11, 1966

Honorable William F. McKee
Administrator
Federal Aviation Agency
Washington, D. C. 20553

Dear General McKee:

We have noticed that air carrier accidents involving aquaplaning continue to occur with a frequency which suggests the need for further study of this problem and the initiation of additional remedial action.

Your Amendment Number 121-9 to Part 121 of the Federal Aviation Regulations, effective January 15, 1966, has undoubtedly served to alleviate, in part, the operational hazards associated with aquaplaning. Under the terms of this amendment, required runway lengths are increased during conditions conducive to aquaplaning. However, since January 15, 1966, the following turbojet transport category aircraft have been involved in aquaplaning conditions resulting in accidents:

2/27/66 - Delta Air Lines DC-8 - Overshoot at New Orleans, La.
4/1/66 - Allegheny Airlines Convair 580 - Slid off side of snow and slush-covered runway at Bradford, Pa.

In the case of the Continental Airlines Boeing 707 accident at Kansas City on July 1, 1965, it was shown that:

1. The crew was not informed on the characteristics of aquaplaning or its effect on deceleration of the aircraft after landing.

2. The runway length required by the FARs for landing was 6,300 feet while the actual length of the runway was 7,000 feet.

In a study of the Phenomenon of Aircraft Aquaplaning made in 1963, the Bureau of Safety cited 18 accidents and incidents from 1959 through 1962 in which aquaplaning was involved. Since the date of that study, the record shows that under the same regulation the following accidents and incidents have occurred in which aquaplaning

Honorable William F. McKee (2)

was a factor:

1964 -	2/13/64	Hawaiian Airlines CN-440, Hilo, Hawaii - Overshoot - accident
	11/24/64	Delta Air Lines C-46, Baton Rouge, La. - Overshoot - accident
1965 -	7/1/65	Continental Airlines B707, Kansas City, Mo. - Overshoot - accident
	7/5/65	Trans World Airlines B707, Kennedy Int'l Airport - incident

In the summary of the Board's 1963 aquaplaning study is the following statement:

> "Landing techniques to cope with aquaplaning should also be published and all pilots should be indoctrinated concerning this phenomenon."

Since aquaplaning accidents and incidents continue to occur, we believe that the foregoing statement is still valid as a means of further diminishing the recurrence of this kind of accident. We propose that you give consideration to establishing a requirement that air carrier pilots receive instruction during initial and recurrent training in the phenomenon of aquaplaning, the hazards associated with it, and the techniques to use when it is encountered.

In a spot check of current Operations Manuals of three major air carrier training programs, we believe it would also be appropriate to require that the Operations Manuals include detailed information on aquaplaning, what it is, the hazards involved, and how to cope with it.

This problem has been discussed with Mr. James F. Rudolph of your Agency. Representatives of our Bureau of Safety will be available for assistance in connection with this recommendation if so desired.

Sincerely yours,

/s/ Charles S. Murphy
Chairman

C O P Y

FEDERAL AVIATION AGENCY
WASHINGTON, D. C. 20553

May 23, 1966

Dear Mr. Chairman:

We share the concern as expressed in your letter of May 11, 1966, over the problems associated with operating on wet runways, and particularly the perplexing problem of aquaplaning. Although this subject has been covered for sometime in a general sense, we have recently again directed the regions to assure that all air carrier training programs cover the subject of aquaplaning in as definitive a way as the state of the art will permit.

Very frankly, as stated in the preamble to Amendment 121-9, the recent 15 percent increase for wet runway is designed to account for lubricating wetness and not for the more adverse conditions such as aquaplaning or snow and slush. This is an extremely complex problem involving water depth, airplane speed/tire pressure ratios, tire design tread and condition, undercarriage arrangement, runway surface texture, and variations in runway contour which may develop with use.

As you are no doubt aware, research and study have been continuing on this problem since 1960. At present, NASA is actively investigating the possibility of reducing or eliminating aquaplaning by the use of a directed stream of air ahead of the tire. They have just fitted their test equipment with a Boeing 727 type tire which will be the first actual aircraft tire tested. They are also working on the possibility of surface texturing.

We shall, of course, keep the industry fully informed of any important findings or breakthroughs, and will advise you of any significant developments.

Sincerely,

/s/ William F. McKee

WILLIAM F. McKEE
Administrator

Honorable Charles S. Murphy
Chairman, Civil Aeronautics Board
Washington, D. C. 20428