File No. 1-0038

CIVIL AERONAUTICS BOARD

AIRCRAFT ACCIDENT REPORT

ADOPTED: January 6, 1960 **RELEASED:** January 10, 1960

AMERICAN AIRLINES, INC., LOCKHEED ELECTRA, N 6101A,
IN THE EAST RIVER, LA GUARDIA AIRPORT, NEW YORK,
FEBRUARY 3, 1959

SYNOPSIS

At approximately 2356 e. s. t., on February 3, 1959, an American Airlines Lockheed Electra aircraft crashed into the East River while attempting an instrument approach to runway 22 at La Guardia Airport.

There were 73 persons on board, including one infant. The captain and one stewardess were killed; the first officer, flight engineer, and the remaining stewardess survived. Of the 68 passengers, 5 survived. To date 63 bodies have been recovered including the bodies of the captain and one stewardess; two others are still missing.

The Board believes that a premature descent below landing minimums was the result of preoccupation of the crew on particular aspects of the aircraft and its environment to the neglect of essential flight instrument references for attitude and height above the approach surface. Contributing factors were found to be: limited experience of the crew with the aircraft type, faulty approach technique in which the autopilot was used in the heading mode to or almost to the surface, erroneous setting of the captain's altimeter, marginal weather in the approach area, possible misinterpretation of altimeter and rate of descent indicator, and sensory illusion with respect to height and attitude resulting from visual reference to the few lights existing in the approach area.

As a result of this accident, the Federal Aviation Agency, on February 8, 1959, as a precautionary measure, raised Electra landing minimums. Upon the installation of the conventional three-pointer altimeter, the restrictions were lifted.

The Board has recommended to the Federal Aviation Agency that autopilot approach criteria and limitations applicable to all air carriers should be established, taking into account the particular autopilot used, the aircraft involved, and the approach facilities utilized. The Board has also recommended to the FAA that all air carriers should establish simulator training programs prior to putting into service aircraft which require the acquisition and application of significantly different operational techniques; and that all large turbine-engine aircraft used in air transportation be equipped with a flight recorder.

USCOMM-DC-25241

INVESTIGATION

The Flight

Flight 320 of February 3, 1959, was scheduled to depart Chicago Midway Airport at 2100[1]. It was loaded, dispatched, and operated to the New York area routinely in accordance with the applicable company and Civil Air Regulations. An instrument flight plan was filed with the company and clearance was approved by Air Route Traffic Control. The aircraft was off the ground at 2154 and estimated one hour and forty-two minutes en route to New York. Communications with the company and Air Route Traffic Control were routine.

At 2327:55, approximately one and one-half hours after departure, Flight 320 made its first transmission to La Guardia approach control. After contact was established, the flight reported it was at 9,000 feet approaching Somerset (Pennsylvania) intersection.

At 2328:43, Flight 320 reported over the Somerset intersection. At 2333:39, Flight 320 reported northeast bound on Amber 7 Airway and was identified by La Guardia radar. At 2334:03, Flight 320 was issued the 2331 La Guardia weather as follows: "measured four hundred overcast; a mile and a quarter visibility; light rain and fog; the visibility south and to the northwest reported at two miles; wind is southwest at three, altimeter is dropping; it is now two nine seven eight." The latest La Guardia weather was given to Flight 320 on two other occasions, at 2328:10 and at 2344:39.

During the period 2339:01 to 2349:35, Flight 320 was given heading and altitude changes to increase its separation from a preceding DC-3, and was vectored to the back course of the ILS while descending from 8,000 to 1,500 feet. The following message was transmitted to Flight 320 at 2344:39, "Roger, now the latest La Guardia weather, out at thirty-eight past the hour, the time is forty-four past the hour; it's measured four hundred overcast; two miles visibility, light rain and fog; altimeter two-nine-nine-seven. Correction, the altimeter is two-nine-seven-seven, two-nine-seven-seven, La Guardia altimeter." At 2345:43, Flight 320 was advised that another aircraft had previously missed its approach.

At 2352:23, Flight 320 reported to approach control that it had passed New Rochelle and approach control requested the flight to contact the La Guardia tower on 118.7 mcs. for a straight-in approach to runway 22[2]. At 2353:00, the flight reported to La Guardia tower as having passed New Rochelle. At 2354:37, Flight 320

1/ All times herein are eastern standard based on the 24-hour clock, shown in hours, minutes, and seconds.

2/ Initial approach procedure prescribed an altitude of 1,500 feet asl 10 miles northeast of New Rochelle inbound for runway 22, to pass New Rochelle at minimum of 1,000 feet afl, descend to a minimum of 800 afl over the La Guardia range station, and continue descent to 400 feet afl altitude. If contact is established at this point, a landing may be effected. (Day and night company minimums for runway 22 are 400 feet and one mile.)

(asl - above sea level; afl - above field level)

reported over the La Guardia range which is 2.8 nautical miles from the threshold of runway 22, and 4.8 nautical miles from New Rochelle. At 2354:40 it was cleared to continue its approach to runway 22, and was requested to stand by for further clearance. At 2355:20, Flight 320 was cleared to land straight in on runway 22, wind south-southwest 8 knots. At 2355:27, the flight acknowledged by saying "320." There was no further message from the flight.

The crash occurred approximately seven seconds following the final message. Most of the wreckage was found submerged within a 200-foot radius circle, the center of which was located approximately 4,891 feet short of the threshold and 610 feet to the right of the extended centerline of runway 22.

According to the testimony of the crew, the takeoff and climb from Chicago was routine. The autopilot was initially engaged sometime during climb-out in the manual mode position. Since it did not operate correctly in this position it was switched to heading mode3/ which operated satisfactorily and was used throughout the entire trip. The flight was on and off instruments at a cruising altitude of 21,000 feet. The pitot heaters were on during the entire flight.

Some ice was encountered during descent approaching the New York area. However, it was of short duration, so the captain elected not to use the wing heaters. After passing Newark Intersection, a thirty-degree error was reported by the first officer on his RMDI (radio magnetic direction indicator). However, radar vectoring and magnetic compass indications revealed the captain's RMDI was operating satisfactorily.

The aircraft was flown in the New York area at an airspeed of 175 knots or less with approach flaps. The "before landing" checklist was accomplished prior to intercepting the localizer course inbound except for landing flaps, heaters, landing lights, and autopilot which are accomplished later in the landing approach. The landing gear was extended at New Rochelle and the airspeed from New Rochelle inbound was approximately 140 knots.

The first officer stated that during the approach to La Guardia, the ILS switch was in the back course position; sensitivity switch "not desensitized," and a reciprocal heading of the front course localizer of 44 degrees was set up in the course deviation indicator window. The ADF selectors were in ADF position, the autopilot was in the heading mode, steering needle mode selector knob was in the deviation position, both VHF navigational receivers were on the La Guardia ILS, the captain's ADF was tuned to the compass locator at the middle marker (La Guardia), the first officer's to New Rochelle compass locator and, after passing that point, retuned to the La Guardia range.

The surviving flight crew members testified that during the approach, the captain was flying the aircraft by the autopilot; the first officer was handling the communications and assisted the captain; the flight engineer was handling the throttles and maintaining approximately 140 knots on the captain's airspeed indicator.

3/ Heading mode is a position on the autopilot control panel that allows the autopilot to receive heading information from the captain's course deviation indicator only. If a new heading is desired, the captain need only reset the heading rotating the heading knob. The autopilot will turn the airplane to and maintain this new heading.

The first officer stated he received his altimeter setting from company radio and the three crew members corss-checked the altimeters when the item was called for on the landing checklist. The flight engineer recalls the first officer resetting his altimeter after receiving a transmission from La Guardia tower. The setting was 29.77. The altimeters were cross-checked again by the first officer when passing the La Guardia range inbound at an altitude of 900 feet. Both altimeters indicated approximately the same.

The first officer stated that after passing the range station the captain momentarily increased the rate of descent to approximately 600-800 feet per minute and then decreased it to about the normal rate of 200 to 300 feet a minute. The flight engineer also noted the captain actuate the autopilot pitch trim wheel in the "down" direction just prior to impact. The airspeed was maintained in the range of 135 to 145 knots on the captain's instrument. There was very little throttle movement by the flight engineer; the horsepower ranged from 900 to 1,200. The first officer stated that at 600 feet on his altimeter he called out 600 and an airspeed of 135 knots. He glanced out his right side window, saw some red lights just a little below the level of the cockpit and before he could look back to his instruments to call out "500 feet," they struck the water.

During the investigation, the first surviving crew member to be interviewed prior to the public hearing was Flight Engineer Warren E. Cook. Mr. Cook first stated the captain's drum altimeter read, "between zero and the 100-foot mark on the drum" when the aircraft struck the water, and subsequently, during the same interview, clarified this statement, after being reminded that the drum reads in thousands of feet, to state the aircraft struck the water when the hand of the altimeter was on about 500 feet as far as he could recall. Flight Engineer Cook had approximately 8,700 flying hours, 81:29 hours of which were in Lockheed Electra aircraft, all of which were equipped with drum-type altimeters. He also had approximately 190 private pilot hours in small aircraft.

Later, the flight engineer testified that as he glanced out the captain's side window at about 600 feet on the captain's altimeter, he observed 3 or 4 white lights and thought the aircraft was unusually low. He immediately looked at the captain's altimeter and it was indicating a little above 500 feet when the accident occurred.

Both flight crew members stated that visual contact was never established through the forward windshield. The windshield wipers were off, the landing light retracted and off, flaps in approach position, and the autopilot was still engaged.4/ No warning lights were observed, the aircraft and engines operated normally, and there was no indication of a stall, pitch, yaw, or abrupt maneuver.

Witnesses

The surviving stewardess and four passengers stated that prior to the crash the seat belt sign and no smoking sign were "on." The stewardess had made the

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4/ American Airlines Electra Operating Manual, Section 3, Page 34, states that: "The before landing check should be made after reporting in range. On instrument approaches, it should be completed prior to crossing range or radio fix on initial approach, or prior to leaving a holding point for final approach." The final item of the before-landing checklist is "auto-pilot-off." FAA has not issued any policy directives with respect to the use of autopilots in various types of instrument approaches.

routine before-landing check and found that the passengers had complied with the instructions. The feeling of the survivors in the rear of the aircraft was as if a normal descent was being made for a landing.

Upon striking the water, a crash impact light was observed inside the cabin. However, one of the passengers advised that he was unable to read the instructions for opening the emergency door. The stewardess advised the passenger to pull in on the door and it opened.

The crew of Northeast Airlines DC-3, Flight 383, which preceded Flight 320 by about 2 minutes, stated that they crossed New Rochelle at an altitude of 1,500 feet. A straight-in approach to runway 22 was executed crossing the range at 800 feet and then descending to 400 feet. After 10 to 15 seconds at 400 feet, the full length of the runway became visible to them and a normal descent was started and landing effected.

One ground witness in a car on the approach to Whitestone Bridge described his observations of a large aircraft crossing the highway at about 2353, at an estimated altitude of about 100 feet. He saw the whole belly and the lights on the aircraft and he stated that the markings on the aircraft were red and black. He was unable to determine whether the landing gear was down but did state that the aircraft was in a slightly nosedown attitude.

A member of the crew of the tug H. Thomas Teti, stated he saw the aircraft when it was about five to six hundred feet horizontally from the tug and about 12 feet above the water. According to the captain of the tug, the Teti was proceeding southwesterly in the channel on radar toward the approach end of runway 22. It was approximately 4,100 feet from the end of runway 22, and about 850 feet to the left of the centerline extended of runway 22. A crew member saw the aircraft crash and at the time he didn't notice any lights on it. He said that it contacted the water at an angle of about 5 degrees nosedown.

Weather

At the time of the accident, a low pressure center was located near Cape Hatteras and a trough extended northward from this center into the New York City area. Forecasts had underestimated the rapidity of the northward surge of warm air along the Atlantic coastal area in association with the shallow low pressure trough described above. This surge of warm air was reflected in lowered ceilings and visibilities and in the winds aloft observation at Idlewild (2/4/59, 0100 e.s.t.) which read in part as follows: Surface - southerly 6 knots; 1,000 feet - 190 degrees 31 knots; 8,000 feet - 190 degrees 50 knots; 3,000 feet - 200 degrees 60 knots.

The latest weather observation at La Guardia prior to the crash was taken at 2352. At this time, the ceiling was a measured 400 feet (variable), the sky was overcast; visibility 2 miles in light rain and fog; temperature 37; dewpoint 35; wind south-southwest 6 knots; and the altimeter setting was 29.76. In remarks associated with the above observation, the ceiling was indicated as 400 variable to 300 feet and the pressure was indicated as falling rapidly.

The crew of NEA, DC-3, landing at La Guardia two minutes prior to the accident, verified the ceiling and visibility values given in the above observation.

Some members of the tug crew near the crash site and certain ground witnesses described very restricted visibility conditions above the surface of the river and over the land areas north of the river.

The last altimeter settings for La Guardia given to the crew of Flight 320 by company radio about one hour prior to the crash were 29.85 and plus 90, whereas at the time of the crash the altimeter setting was 29.75.

Other aircraft approaching La Guardia shortly before and after the accident did not report icing difficulties. The rapid influx of warm air aloft was causing a temperature inversion of increasing proportions.

Airport and Facilities

Investigation revealed that all required airport, boundary, and runway lights at La Guardia were on.

Subsequent to the accident and in accordance with standard procedures, the FAA conducted an immediate ground check of all navigation facilities serving La Guardia. The following day these facilities were also flight checked and found to be functioning normally. The crew of the NEA DC-3, which preceded Flight 320 on the backcourse ILS, reported that all facilities were operating normally.

Aircraft Structure

More than 90 percent of the primary structural components of the aircraft and the majority of the systems components (hydraulic, pneumatic, air-conditioning, electrical, etc.) were recovered.

The lower surfaces of N 6101A showed a general distribution of water impact damage which was somewhat more severe on the right than on the left side. Water impact broke all three landing gears rearward and tore off the landing gear doors and wing flaps. The landing gear shock strut pistons, with their wheel assemblies attached, broke away, floated, and were recovered separately. The lower forward fuselage belly was completely destroyed by the water impact and very little of it was recovered.

The fuselage shell above the floorline was broken into four general sections; the cockpit, the forward passenger cabin, the center passenger cabin, and the aft passenger cabin with the tail cone and vertical tail surfaces still attached. The left and right sides of the forward and center cabin areas were torn apart either by the impact or during recovery. The entire cabin floor was broken up into small pieces except in the extreme aft end where it was torn partially loose and buckled upward in the center. All seats were broken out of their structural attachments except in the extreme aft end of the cabin. The horizontal tail surfaces on both sides of the aircraft were broken off upward just outboard of the fuselage. The elevators remained attached to the stabilizers.

The wings were broken into four main sections. These were the two outer panels with the ailerons and outboard nacelles attached, and the two inboard nacelles with their integral wing structure and broken main landing gears. The leading edge of the right wing outboard of number 4 engine received severe water impact damage and the wing tip was torn completely off. In contrast, the left wing outer panel only had a small area of water impact damage near the aft edge of the lower surface of the wing tip.

The wing structure between the nacelles on each side and inboard through the fuselage was completely shattered and was recovered in small pieces.

At the impact the landing gear was extended, the flaps were in approximately the approach position, and the right landing light was retracted. The left landing light was not recovered.

Crash Injury

The Board has conducted an investigation of the crash injury aspects of this accident, the results of which will be the subject of a subsequent Board report.

Powerplants and Propellers

The comparatively lengthy submersion in the East River resulted in corrosion and contamination throughout the engines, propellers, and accessories. Nevertheless, accurate determination of the condition of the parts and components prior to impact was readily accomplished.

Surviving crew members testified that all powerplants were functioning normally until the moment of impact. Detailed examination of the engines and propellers following disassembly confirmed this testimony. Engine and propeller oil systems were free of significant contaminants. There was no preimpact damage, foreign object damage, or evidence of over-temperature. Examination of detailed parts, including bearings, accessory drives, oil pumps, and components of the reduction gear assemblies, did not show any to have failed during engine operation.

Propeller blade angles were relatively uniform and averaged approximately 36 degrees. This blade angle when related to power is consistent with power readings obtained from the recovered aircraft instruments, and the crew's testimony concerning horsepower being used during the approach.

Flight Instruments

All recovered instrument and instrument system components had been submerged in salt water for periods of time ranging from about ninety-four hours to twelve days. They were corroded, and many suffered from impact damage. All were inoperative with the following exceptions: The captain's horizon direction indicator, the two directional gyros, the autopilot control panel, the two static selectors, the three-axis trim indicator, the two fluxgate transmitters, and the clock on the captain's instrument panel, which was still operating at time of recovery.

The two instantaneous vertical speed indicator instrument casings were still attached to their respective panels and relatively intact, but the instrument mechanisms were missing and were not recovered. Only one instrument face was recovered.

The altimeters installed on the instrument panels of N 6101A were Kollsman, type A-28586-10-001, pressure drum type, having a range of from minus 2,000 feet to 50.000 feet altitude. The heart of this altimeter consists of two matched diaphragms which, in response to changes in atmospheric pressure, expand and contract. This expansion and contraction is transmitted to a pointer by means of a linkage and gear system. The pointer makes one revolution for each 1,000 feet of altitude change, and two concentric drums measure the number of turns of the pointer and accordingly indicate the 1,000-foot flight levels. Provision is made for barometric setting to correlate altitude indication with the prevailing atmospheric pressure in a manner similar to that employed in conventional three-pointer altimeters except that the numerical values of the setting appear in reverse order.

Electra N 6101A had approximately 302 hours of flight time since manufactured during all of which the drum type altimeters installed had operated satisfactorily. Of the 302 hours of flight time, approximately 150 hours had been flown prior to delivery to American Airlines.

Prior to departure of Flight 320 from Chicago, the altimeters were checked by the crew and were reported operating satisfactorily; also, during the flight they appeared to be operating satisfactorily. During letdown on approach to runway 22, both altimeters were reportedly cross-checked at 900 feet and again at 600 feet.

The drum altimeters in N 6101A were calibrated prior to delivery by the manufacturer, Kollsman Instrument Corporation, according to accepted government-industry standards. Examination and testing of these altimeters subsequent to the accident did not reveal any mechanical failures other than those attributable to impact, shock, and immersion in salt water. When the wreckage was recovered, the captain's altimeter read minus one thousand five hundred feet, with a pressure altitude setting of plus 85 feet (barometric setting 29.83). The first officer's altimeter read minus one thousand six hundred and fifty feet, with a barometric setting of 29.79.

Chemical analysis of the contents of the casings of the captain's and the first officer's altimeters disclosed the presence of hydrated aluminum oxide and sea water, with traces of iron and other metallic elements ordinarily found in sea water. No marks were found on the altimeter faces that could have been caused by impact of the pointers. The glass coverings of the faces of the two altimeters were in place and not broken.

Before opening the casings of the altimeters for examination of their internal mechanisms, it was found that the manufacturer's lead seal, which entirely covers the head of one of the screws that secures the casing on the altimeter, was missing from the captain's altimeter. The purpose of this seal is to determine, when an instrument has been returned to the manufacturer with a complaint, for overhauling, or adjustment, whether the altimeter had been opened since its delivery to the purchaser.

Internal inspection of the altimeters revealed considerable corrosion within each of the instruments. A broken link pin was found in the captain's altimeter and a rocking shaft pivot was found broken in the first officer's altimeter. The corrosion was removed to permit a detailed inspection of the moving parts. The broken components were replaced, after which both instruments were checked for mechanical freedom and were found to operate without significant restriction over a range of minus 1,000 feet to 12,000 feet.

Since the diaphragms of both altimeters were overstressed due to submersion, it was impossible to establish a calibration curve which would be representative of the calibration of the altimeter before the crash.

Static Pressure System

Two separate static systems supply barometric pressure to the captain's and first officer's flight instruments, respectively. A third (alternate) static system is also provided as an emergency source of pressure to which either or both sets of flight instruments may be connected by means of static system selectors.

The captain's and the first officer's static selectors were found in normal positions; both were guarded and operable. All connections to the static manifold and from the manifold to the static selectors were proper. The flex-hose assemblies from the static selector valves were properly connected with the aircraft piping.

Simulated icing tests were arranged by the Board and run subsequent to the accident using a B-29 Air Force icing tanker, a test Electra, and a chase Electra for photographic purposes. Flight tests duplicated airplane speeds, configurations, and outside air temperatures, which existed during the final approach of Flight 320 to La Guardia. The tests showed that ice buildup on the fuselage was confined to the forward section and did not approach the area of the static ports, even when the test airplane was yawed drastically. Ground tests on an Electra fuselage section which included the static ports were run to simulate careless washing, splashing of a fluid solvent on a cold fuselage, and a leak in the nose wheel well. These tests did not induce any significant instrument errors. Under the most drastic test, that of a suction induced by twin hemispheres in the vicinity of both static ports on opposite sides of the aircraft, the altimeter error was approximately 175 feet at an airspeed of 135 knots. It is important to note that this venturi effect was man-nade and, so far as is known, is not reproducible naturally.

Maintenance

The maintenance records for American Airlines, N 6101A, were reviewed and it as found that they were complete and showed that the required maintenance had been erformed, that the complaint entries of an airworthiness nature were corrected, and hat they were properly signed off. The aircraft had been flown a total of approxi-ately 302 hours.

Training

Captain DeWitt's Electra ground school training was completed on December 4, 958, at Fort Worth, Texas. The course consisted of 84:30 hours of instruction, of hich 68:30 hours were devoted to aircraft systems and 16 hours to operations and erformance.

An Electra simulator was not available but Captain DeWitt did receive training n a Link trainer equipped with the flight director system similar to that installed n the Electra but not having drum-type altimeters or instantaneous vertical speed ndicators. According to American Airlines' records, Captain DeWitt, during December 958, completed five hours of Link training utilizing the flight director system.

Captain DeWitt's flight training in Electras commenced December 11, 1958. This onsisted of day and night takeoffs and landings, airwork, autopilot operation, mergency procedures, and systems operation. On December 15, 1958, Captain DeWitt ook his first type rating flight check with an FAA inspector after 8:07 hours of ectra training. This check consisted of required maneuvers and navigational pro-ems, holding at a fix, 2-engine out ILS approaches, crosswind takeoffs and landings, d circling approaches simulating 400 feet and one mile visibility. Captain DeWitt iled the portion of the check which required him to perform an ILS approach simu-ting a 200-foot ceiling and one-half mile visibility with engines Nos. 1 and 2 duced to zero thrust. After additional practice, Captain DeWitt on December 16, 58, with a total of 11:59 hours of Electra training, successfully passed his type ting check and an instrument check.

Captain DeWitt had acquired a total of 48:13 hours in Electra aircraft at the time of the accident. After completion of Electra transition training, he also flew approximately 14 hours in DC-6 and DC-7 aircraft before being assigned to electra line operations on January 25, 1959.

The American Airlines Flight Manual requires the ceiling and visibility landing minimums prescribed in the Operations Specifications - Airports, to be increased by 100-feet ceiling and one-half mile visibility whenever the captain in scheduled operation has not served for 100 hours as pilot-in-command on the equipment, or until such time as the captain is certified by his Regional Superintendent of Flying, as qualified to operate at the landing minimums prescribed. The company had check pilots ride with all captains on Electra equipment until they were qualified for lower minimums. The American Airlines Regional Superintendent of Flying authorized the removal of these restrictions on Captain DeWitt January 25, 1959, when he had 12:32 hours of flying the Electra in scheduled operations.

The correct procedure for making a backcourse ILS approach to runway 22 at La Guardia is outlined in the American Airlines Flight Manual carried by the pilots of N 6101A; cross the La Guardia Range at the minimum height of 800 feet (820 above sea level) at 140 knots; when over the center of the La Guardia Range station, commence an immediate descent while maintaining 140 knots; level off at 400 feet, the minimum Electra ceiling for one mile visibility, and increase power to maintain level flight until the landing runway is sighted or the time to execute the missed approach procedure arrives. This is approximately one minute and 15 seconds past La Guardia Range. The ILS approach plate for runway 22 is appended to this report.

Should the pilots establish visual contact with the runway at the 400-foot minimum altitude, they may have to make final directional changes for proper runway alignment, lower flaps to landing position, lower and turn on landing lights, and descend the 400 feet to the runway.

ANALYSIS

Testimony received by the Board indicates that Captain DeWitt had engaged the autopilot after the takeoff climb from Chicago. Since it did not operate correctly in the "manual mode" position, a malfunction which was written in the aircraft logbook, the autopilot was engaged in the "heading mode" position for the remainder of the flight, including the instrument approach.

The only other unusual events of record during the flight and prior to reaching New Rochelle were a drift off course from Amber 7 Airway before reaching the Sparkhill intersection; the discrepancy of 30 degrees in the first officer's RMDI; a right turn short of the localizer centerline just prior to reaching New Rochelle; and a reported slow response by the crew to instructions from La Guardia Approach Control.

Since the flight to New York was uneventful except for the above mentioned incidents, this Analysis will concentrate upon the final segment of the flight path. (See Approximate Flight Path, Appendix B.)

The weather at La Guardia Field, the weather known to prevail in the New Rochelle La Guardia area, and the weather reported by the flight immediately preceding Flight 320, make it highly probable that Flight 320 could not have been observed from the ground immediately prior to the range station at an altitude much above 400 feet. That this final descent had been initiated at an altitude less than

the approved minimum of 820 feet asl over the range station is borne out by the observations of the witnesses in the vicinity of the station. A lay or even a skilled aeronautical witness has great difficulty in estimating accurately the height of an aircraft above the ground. This is especially true when the kind and size of the aircraft is not known to the witness and familiar reference points for establishing relative size and height are neither known nor discernible. It is possible, however, to obtain a compelling impression which, while not accurate in every detail, establishes the most significant facts. In this instance the Board is of the opinion that the one known eyewitness to Flight 320 just prior to its passage over the range station actually saw it, that it was flying low, and was headed in the direction of the range station. The Board is of the opinion, however, that his estimate of 100 feet is too low. In fact, to have descended to an altitude below 300 feet and successfully traversed the area without colliding with buildings or other obstacles, many of which are about 200 feet in height along the approach path leading to runway 22, or without having attracted the attention of many other witnesses, is highly improbable. It is believed, therefore, that Flight 320 definitely approached the range station at a height greater than 300 feet and probably higher than 400 feet above the ground.

If that be the case, one must return to the testimony presented by the crew, physical evidence of the wreckage, and the limitations on the possible flight paths of Flight 320 from the range station to the point of impact. All available evidence shows that Flight 320 struck the water in a very shallow descent approximately one minute after passing the range station. Furthermore, the point at which impact occurred was only two miles from the range station. In order to have passed the range station at 900 feet and strike the water where it did, Flight 320 would have had to have experienced an average rate of at least 900 feet per minute throughout its descent. During the engineering flight test of the static pressure system simulating the final approach of Flight 320 to La Guardia, it was observed that to stabilize the airspeed at 135 knots, and the rate of descent at 250 feet per minute, 980 - 1,200 h.p. were required.

Operational flight tests observed by Board personnel were conducted on June 16, 1959, between the range station and the crash site using an American Airlines Lockheed Electra 188, N 6113A, which had a gross weight of 97,192 pounds at takeoff. Atmospheric conditions existing at the time were: surface temperature 63 degrees F; surface wind, northwest at 15 knots; winds at 1,000 feet were from 300 degrees at 16 knots; at 2,000 feet, from 300 degrees at 21 knots. In simulating a 900-foot descent with a constant horsepower of 900 and 1,200, descent rates up to 2,000 - 2,500 feet per minute were reached, with airspeed indications of 175/195 knots observed.

Such indications should normally have been immediately perceptible to the crew. If Flight 320 crossed the range station at approximately 400 feet, a rate of descent of approximately 400 feet per minute would place the aircraft at the approximate impact point. Under conditions of still air such a rate of descent would be compatible with the evidence concerning the horsepower output of the engines during descent and at the time of impact since the brief period during which the aircraft was reported to have reached a rate of descent of 600-800 feet per minute would require a rate of descent in the order of 200-300 feet per minute during the remainder of the descent to the water.

As a result of this accident and in connection with its investigation, the Board arranged extensive tests of the altimeter systems and components of the Electra.

Tests were accomplished on the effect of a possible static leak in the nose wheel well static system components; of rain and icing on the static ports; of a large spoiler ahead of the static ports; and of simulated careless washing and ground splash on the static system. The Electra static system was evaluated in flight by flying through freezing water dumped from an Air Force tanker. The results of these tests indicated ice buildup on the fuselage was confined to the forward section and did not approach the area of the static ports even when the test Electra was yawed drastically. Inflight vibration measurements were obtained from the instrument panel and outer case areas of drum altimeters. Seven drum altimeters were then subjected to these vibrations and exercised repeatedly in a manner approximating the profile of the fatal flight and over a period of more than 500 hours. No sticking, lagging, or other malfunction was noted. In addition, one altimeter was enclosed in a transparent case which permitted examination with a strobe light in a vibration environment similar to that of the Electra instrument panel. Tests were conducted to measure the effect of contamination in the inlet filter screen of drum altimeters by liquids, dry-wing insects, and other contaminants. The effects were measured for a wide range of rates of climb and descent. The greatest error produced was 285 feet too high during a descent at close to sea level. This was caused by completely coating the filter screen with turbo oil.

In addition to the tests arranged by the Board, tests were accomplished by Lockheed Aircraft Corporation on two groups of ten altimeters wherein they were mounted in a test panel and exercised from ground level to 10,000 feet m.s.l. at an average rate of climb and descent of 500 feet per minute. The second group was moved outdoors where it was subjected to the changes in ambient temperature occurring over 24-hour periods.

Similarly, an exhaustive review has been accomplished of all maintenance records, including pilot complaints of all operators, civil and military, utilizing this type altimeter. Prior to and since this accident, several malfunctions of drum altimeters of the type installed on N 6101A have been reported. The more significant malfunctions which have occurred are described below:

On an American Airlines Electra training flight at Fort Worth, on February 7, 1959, one drum altimeter reportedly stuck on three occasions; once at 2,350 feet, and twice at 12,320 feet. Inspection of the internal mechanism at the National Bureau of Standards laboratory disclosed that lint was adhering to the pinion teeth, removal of which permitted the instrument to function satisfactorily. The factory seal had been broken thereby preventing determination of the time lint had been introduced into the instrument.

A drum altimeter installed as a "third" altimeter on American Airlines Electra N 6107A stuck at 1,310 feet on an ILS approach and landing at Detroit, Michigan, on April 3, 1959. During the removal of the instrument from the panel, the sticking ceased and the instrument indications became normal. Examination and TSO tests by Kollsman and the National Bureau of Standards disclosed this altimeter to be in satisfactory operating condition.

Of the twelve other drum-type altimeter malfunctioning reports prior to and since February 3, 1959, five reported sticking above 9,000 feet; one reported sticking (no altitude given); one read 600 feet at any altitude (with the condition reported as being remedied by removing a kink in the connecting hose); one reported lagging and sticking due to sticky stops (no altitude given); two reported barometric pressure knobs difficult to turn because of loss of lubricant, but with no sticking

in altitude readings; one read 1,000 feet off because of being out of calibration; and one was reported as malfunctioning, but except for serial number and date, no information was given. In many instances, information supplied concerning these malfunctions was insufficient to make complete evaluations.

Of the drum-type altimeter malfunctions mentioned above, none of these malfunctions involved more than one of the drum-type altimeters aboard the aircraft. In addition, examination and testing of the altimeters involved in this accident failed to reveal any mechanical failure not attributable to impact shock and immersion in salt water. It should be noted that the failures causing known erroneous indications discussed earlier in this analysis could not have been detected in laboratory examination and test if the altimeters involved had been subjected to impact and submersion as were the altimeters installed on N 6101A.

The Board believes that the destruction of the two instantaneous vertical speed indicator internal mechanisms was caused by impact and submersion of the instrument panels in approximately 20 feet of water.

Following the erroneous altitude indication of a drum altimeter at Detroit, Michigan, April 3, 1959, mentioned above, use of the drum-type instrument as a "third" altimeter was discontinued by all air carriers operating Electras. Since that time, the Board has had no opportunity to observe or make further critical examination of drum altimeters in Electra aircraft even as a "third" or standby instrument. However, the service results of the use of this type of altimeter in other aircraft are being monitored.

On the basis of the available evidence, several possible equipment malfunctions and operational errors have been examined critically with a view to determining the most probable cause of this accident.

Dual Altimeter Failure

As far as could be determined, the two drum-type altimeters were installed in N 6101A at the Lockheed factory. Electra N 6101A had approximately 302 hours of flight time during all of which the altimeters had operated satisfactorily.

According to the testimony of First Officer Hlavacek and Flight Engineer Cook, the altimeter indications appeared normal throughout the approach to approximately 500 feet when the aircraft struck the water. From their testimony it is apparent that any error in the two drum altimeters must have been in the nature of a lag rather than pointer sticking. Both testified to a gradual reduction in altimeter indication during the approach from New Rochelle to the point of impact consistent with descent contemplated in the instrument approach procedure. At no time were they conscious of a prolonged indication of a fixed altitude. To have indicated 500 feet at the moment of impact, the lag in the altimeters must have been approximately 500 feet. None of the altimeter malfunctions known to the Board here have involved similar manifestations.

As required by the Civil Air Regulations, the altimeters installed on the pilot's and copilot's flight instrument panels have separate static sources. The static lines leading to the instruments from normal source are completely independent. Since there exists no common element of the instruments or any of their related static system and sources, an identical and simultaneous malfunction of these instruments and associated systems of the magnitude suggested by the crew testimony would involve such an extreme mathematical improbability that the Board is compelled to reject it.

In rejecting the possibility of dual and simultaneous altimeter error the Board must, as a consequence, reject portions of the testimony of one or both flight crew members. Considering that the flight crew members received physical injuries and that they were also under great emotional stress, such questioning of their testimony has a rational basis. Under such circumstances, the Board has frequently found that the recollection, particularly of events immediately preceding an accident, is very difficult and often erroneous. Furthermore, we are mindful of the natural human tendency to assume conformance with standard operating procedures to fill in the voids or hazy areas of one's memory. On the basis of other evidence before us, the Board is compelled to reject this testimony to the extent that it would require dual and simultaneous failure of the altimeters in the order of a 500-foot lag.

Single Altimeter failure

The possibility of a single altimeter failure obviously avoids most of the stumbling blocks which compelled the Board to abandon further consideration of a double altimeter error. The absence of need for the acceptance of compounded mathematical probabilities of such extremely low order of itself facilitates this judgment. However, if we assume failure of First Officer Hlavacek's altimeter only, we are met with so many operational imponderables as to make rationalization impossible. So far as this accident is concerned, any single altimeter failure must have involved the captain's altimeter since it is clear that the captain was at the controls of the aircraft during the approach. The Board cannot conclude, however, that a single altimeter failure occurred.

Although First Officer Hlavacek had testified concerning his observation of altimeter indications down to an altitude of 600 feet, he had no recollection of a lower altitude indication. It was his impression that the impact occurred shortly following his 600-foot observation; however, the Board believes that his subsequent judgment of this time interval may be incorrect. While approaching an altitude of 500 feet it would have been expected that, in addition to monitoring the instrument panel, Mr. Hlavacek would be scanning the approach area for lights and handling radio communications. Considering the sparseness of lights on the approach over the East River, there could well have been greater concentration or attention than is usual since it is always difficult at night to judge attitude and altitude over the water.5/ While the aircraft was in instrument conditions, it is also not at all unlikely that the copilot was giving careful attention to the captain's efforts to maintain the localizer path, especially in view of the apparent difficulties being experienced by the captain in maintaining a precise course. Although preoccupation with this or any of the several elements of a new cockpit environment could reasonably explain the failure of Mr. Hlavacek to follow the procedure required in the Operations Manual with respect to monitoring and calling out altitude and airspeed below 600 feet, the Board believes it more likely that he was anticipating breaking out beneath the overcast and, thereafter, having seen lights on the ground or water, was focusing particularly on visual identification of the airport and was no longer monitoring the flight instruments.

At and prior to reaching 600 feet, the flight crew members are clear as to their testimony of cross-checking altimeters. If any portion of the testimony of the flight crew members is to be regarded sufficiently reliable for the purpose of

5/ See the Board's accident investigation reports on the following: Northeast Airlines, nr. La Guardia Airport, New York, January 14, 1952; Western Airlines, San Francisco Bay, California, April 20, 1953; American Airlines, nr. Springfield, Missouri, March 20, 1955.

this analysis, it must relate to the earlier portion of the approach. Therefore, with respect to the possibility that the captain's altimeter had failed, we are of the view that such a failure did not occur before reaching 600 feet. Although the Board has reviewed all available records concerning instrument failure, none appear to be of the nature and magnitude of that suggested here. As has already been indicated, no evidence of instrument failure was discovered in the examination of the wreckage.

The sole evidence of a malfunction of the captain's altimeter is Flight Engineer Cook's testimony. His observation of the captain's altimeter, after some clarification of its facial presentation, was 500 feet at impact. This was after the first officer had called out 600 feet. He made the observation intuitively after a momentary glimpse of lights through the captain's side window which alerted him to the fact that they were extremely low.

To substantiate further a single failure on the captain's altimeter, we must assume a premature descent and discount First Officer Hlavacek's testimony that he called out 900 feet over the La Guardia Range Station. This is necessary in order to rationalize approximately a 300-foot per minute descent as testified to by him.

The captain's altimeter was set at 29.83. The actual pressure at the time of the accident was 29.75, and La Guardia tower was reporting a setting of 29.77. This error in setting of the captain's altimeter would account for 80 feet of erroneous altimeter indication. Since an additional minus 30 to 45 feet of error due to static air correction must be made to the captain's altimeter, one can readily rationalize an accumulative error in which the altimeter indicated from 110 to 125 feet higher than the actual altitude near sea level.

A premature descent is substantiated by the eyewitnesses to Flight 320 just prior to and after its passage over the La Guardia Range Station. As stated earlier, the Board believes Flight 320 approached the range station at a height greater than 300 feet and probably not much higher than 400 feet above the ground because of the prevailing ceiling at the time.

Misreading the Altimeter

Because of the novel presentation components of the altimeter, serious consideration has been given the possibility that the pilot misread the altitude indication and thereby permitted or caused the aircraft to deviate vertically from the desired flight path. While some incidents have been reported in which a pilot had misread the 1,000-foot scale on the small drum, no such error could conceivably be involved here. The altitude presentation below 1,000 feet is accomplished by a pointer the indications and appearance of which are, for all practical purposes, identical to those used by the crew in other aircraft types and the interpretation of which calls for no new or different evaluations on the part of the pilot.

The reversed sensing of the altimeter setting numerals has already been mentioned. While an erroneous setting might result from this condition, the possible order of error would be very small indeed. Unlike the primary instrument flight reference which is frequently "generalized" by approximate positions of pointers or indicators, the altimeter setting scale must be read in order to permit any substantial correction to be made. Furthermore, the altimeter setting positions which were found in the altimeters installed in this airplane are very reliable indications of the settings existing at the time of the accident. The

Board does not believe that the 80-foot error resulting from the setting of the captain's instrument is chargeable to misreading of the instrument.

One other peculiarity of this instrument, however, has raised some question as to susceptibility of misinterpretation. On the right side of the instrument face a cutout is provided through which may be seen the drum which indicates 1,000-foot levels. On both sides of this cutout there has been printed a luminous triangular shaped index against which the 1,000-foot calibrations are read. In a darkened cockpit, the index which appears on the left side of the drum assembly cutout has at times been mistaken for the small 1,000-foot pointer which is installed on the older altimeters. Such an error would leave the impression that a small hand was indicating an altitude of 2,500 feet. This fact had been brought to the attention of the company prior to the accident and it had been agreed that the left index should be removed in order to prevent such a confusion; one of the company's fleet of six Electras had had this index removed at the time of the accident. The altimeters installed in the aircraft all contained indices on both sides of the cutout.

The Board is of the opinion that confusion is also possible in mistaking the right index for the 100-foot pointer. Although this may appear remote because of the distinctiveness of shape of the 1,000-foot altitude index as compared with the 100-foot pointer, these distinctions lose most of their significance at night, especially where hurried references to flight instruments are required in critical flight situations. If, in a hurried glance, the right index were to be mistaken for the large 100-foot pointer, the pilot would have the impression of being at 250 feet when, in fact, the aircraft might be considerably below this altitude.

As a part of the Electra training program, the company gave special attention to the need for training in the Bendix Flight Director System which was installed in the Electra and was otherwise new to the line pilots. The ground trainer in which the captain received approximately five hours of initial training on the Bendix Flight Director System had installed the conventional three-pointer altimeter and not the drum-type altimeter which was actually installed in the Electra.

Misreading the Vertical Speed Indicator

The instantaneous vertical speed indicator installed in the Electra does not possess the lag typical of older instruments which rely solely upon a calibrated flow from the diaphragm for the initial indication of climb or descent. In this regard it can be stated that this type vertical speed indicator possesses characteristics which are definitely superior to those of older types. In at least one respect, however, the difference in presentation must be regarded as significant so far as this accident is concerned. This instrument installed in the Electra is calibrated in such a manner that a given displacement of the needle represents a rate of climb or descent almost three times as great as that shown on former designs. For instance, were the needle of the older instrument displaced 90 degrees downward from its normally horizontal position, it would signify a rate of descent of approximately 750 feet per minute. This same relative position in the case of the Electra instrument would signify a rate of descent of approximately 2,300 feet per minute.

In this connection, it should be understood that a proficient instrument pilot typically accomplishes more than 100 visual fixations per minute while flying solely by instruments during a maneuver such as an instrument approach. Any one fixation upon a flight instrument for the purpose of establishing a particular condition of flight such as airspeed, altitude, or rate of descent is generally a small fraction of one second. For the experienced pilot, therefore, it is common to rely

upon approximate pointer position rather than consciously to read the numerical indications associated with each pointer position. Such a tendency is, of course, heightened at night when precise reading of instruments is more difficult even with optimum instrument lighting. Accordingly, there is a strong suggestion that a pilot with limited exposure to this particular instrument might be led to accept an excessive rate of descent because of a general appearance of instrument indication being within a range normal for an instrument approach when using the older instrument.

A computation of the times reported over New Rochelle and the La Guardia Range Station indicates that the ground speed of Flight 320 on the approach between these fixes was approximately 129 knots. A computation of the times reported over New Rochelle and the La Guardia Range Station by the five flights preceding Flight 320, and an analysis of the winds aloft reports at Idlewild International Airport and surrounding areas taken at 1900, February 3, and 0100, February 4, indicates that Flight 320 would be making its approach into a mean wind of approximately 25 knots from about 210 degrees. The indicated airspeed between New Rochelle and the La Guardia Range Station appears, therefore, to have been in the order of 150 knots. At this indicated airspeed and at the power settings which the flight crew were using, a rate of descent higher than that necessary for this portion of the approach procedure appears to be likely.

According to the testimony of the flight crew, the aircraft passed over the New Rochelle marker at 1,500 feet. The procedure called for the flight to cross the La Guardia Range Station approximately 4.8 miles southwest at 800 feet. At 140 knots indicated airspeed, this distance would, in a no-wind condition, require approximately 2:03 minutes to traverse. Since the flight had approximately 700 feet to descend between these two fixes, a rate of descent in the order of 350 feet per minute would have sufficed. If the pilot at New Rochelle were to adjust the attitude so as to obtain an apparent 350 feet per minute, based upon his experience with the older vertical speed indicators, he would have realized between 700 and 1,000 feet per minute. The result of an excessive rate of descent would be for the airspeed to increase. The evidence of record shows that the airspeed was in fact higher than the 140 knots, to which the crew testified.

We regard it significant that the ground trainer in which the captain received initial training on the Bendix Flight Director System had installed the conventional vertical speed indicator and not the instrument which was actually installed in the Electra.

The possibility of misreading either the altimeter or the vertical speed indicator could hardly of itself satisfy the Board's search for a probable cause of the accident. There exist far too many other sources of cross-check for the pilot; moreover, the copilot has full facility for monitoring and cross-checking through a completely independent flight instrument panel. Presumably, misinterpretation of one condition of flight should not normally result in gross displacement of aircraft position. However, preoccupation with any one other cockpit problem may set the stage for a dangerous drift from a desired flight path when a certain combination of circumstances exists, particularly when that environment includes any insidious or misleading assurances of a safe flight condition. (See Appendix C.)

Pilot Preoccupation with the Instrument Approach

The Eclipse-Pioneer autopilot, model PB-20E, used by American Airlines on its Electra airplanes is designed to permit completely automatic control of the airplane from initial climb through an ILS approach. Automatic navigation and approach, and automatic altitude and pitch trim control are incorporated in the system. An automatic ILS approach utilizing the PB-20E is possible only where a glide path is suitably paired with a localizer course. Since no glide path is available, an automatic approach could not be made on the backcourse of the La Guardia ILS.

Testimony of the first officer and flight engineer indicates that Captain DeWitt was making a "heading mode" autopilot approach and that the autopilot was still engaged at impact. In this method, the pilot uses the autopilot as an intermediate system to operate the flight controls instead of operating them directly through the control wheel and rudder pedals in the conventional manner. The airplane is steered by selecting a desired heading on the course deviation indicator; the autopilot then directs the airplane to this heading. Captain DeWitt had been using this procedure during the entire flight after the takeoff climb. According to testimony, he was actuating the pitch trim wheel, which is mounted in the autopilot controller on the pedestal to his right and slightly aft, with his right hand and was leaning forward in his seat to reach around the control wheel with his left hand to rotate the CDI cursor just prior to impact. Since no glide slope is available, proper altitude over fixes must be checked solely by reference to the altimeter

The FAA-approved portion of the Electra Airplane Operating Manual contains no limitations as to the type of approach for which the autopilot may be used; nor does it establish any minimum altitude limitations for use of the autopilot. While it is recognized that the autopilot system installed in the Electra is capable of complete automatic control of descent path and direction in an ILS approach, the Electra Airplane Operating Manual specifies that the autopilot must be off before leaving a holding point for final approach.

Although Captain DeWitt had made many actual instrument approaches to La Guardia Airport in other than Electra aircraft, and had made several simulated instrument approaches in the Electra, the Board could find no instance where he had made a previous backcourse ILS approach to La Guardia Airport in an Electra under actual instrument conditions. Records were not available to determine how much previous experience Captain DeWitt had in making simulated or actual instrument approaches in the Electra using the "heading mode" autopilot setting.

Most of the wreckage was found within a 200-foot radius circle, the center of which was located approximately 4,891 feet short of the threshold and 610 feet to the right of the extended centerline of runway 22. It was determined that the horizon director indicator and course deviation indicator would indicate full-scale deflections if any aircraft were approximately 300 feet to the right of the localizer centerline and approximately 5,000 feet from the localizer shack. The lateral displacement of this aircraft from the localizer course is excessive and indicates that the pilot might not have been maintaining proper alignment with the localizer course during the latter portion of the approach.

The captain's and first officer's RMDI's, when removed from the water, read 205 degrees and 219 degrees, respectively. Although the heading indications of the two RMDI's reasonably agree with the instrument approach heading to be flown, neither

reading is necessarily that of the aircraft heading at impact. The effects of impact forces and the exact instant at which each of the compass systems ceased operation are unknown. In addition, the first officer's RMDI was previously found to be in error and the extent to which this malfunction influenced the final reading of that instrument is not known.

Consideration was given to the possibility that the aircraft drifted after initial impact. It was determined that the tides and currents in the channel during and following the accident were such as to have a negligible effect so far as the wreckage location is concerned. Had any drifting of wreckage occurred, it would have been in the direction which would bring it closer to the localizer centerline. The Board believes the aircraft components of substantial mass such as the engines, sank immediately and is of the view that drift after initial impact was negligible.

Captain DeWitt was using the ILS localizer for direction in conjunction with the ADF's to determine precisely the aircraft's position over the navigational fixes. His No. 1 ADF was tuned to the La Guardia compass locator; the No. 2 ADF was tuned to the La Guardia Range. In order for ADF information to be displayed visually on the RMDI, the selector on this instrument must be placed in the ADF position.

Investigation disclosed the selector switch for the captain's No. 1 ADF needle was selected to the ADF position; however, the No. 2 selector was in the VOR position. Under these conditions the single needle would be displaying the position of the La Guardia middle marker which is southwest of the airport and, therefore, would be approximately straight ahead of the flight throughout the final approach to the moment of impact; however, the No. 2 or double needle would be inactive, eliminating its use in displaying the position of the La Guardia Range. Testimony also indicated difficulty in receiving the range station, although station passage was observed by the first officer on his RMDI. The No. 2 ADF control settings were ten kilocycles above the La Guardia range frequency and in the loop position, this suggesting a possible manipulation of the ADF controls to confirm station passage.

Operations Specifications issued to American Airlines on January 23, 1959, require that the ceiling and visibility landing minimums prescribed in the Operations Specifications be increased by 100-foot ceiling and one-half mile visibility whenever the captain in scheduled operation has not served for 100 hours as pilot-in-command on the equipment, or until such time as the captain is certified by his Regional Superintendent of Flying as qualified to operate at the landing minimums prescribed. If these restrictions are to serve any purpose other than to give the appearance of a conservative flight operations policy, the Board questions the wisdom of the company in exempting Captain DeWitt when he had but 12:32 hours of flying the Electra in scheduled operations. This occurred nine days before the accident.

The Board has recommended that the Administrator review existing FAA policy to determine whether the waiver provision contained in the Operations Specifications should be deleted.

Inadequate Operational Technique

Another possibility of accident causation is concerned with adequacy of operational techniques.

Approaching New Rochelle and for the remainder of the instrument approach, the aircraft was flown on autopilot in the heading mode and with the flaps in

approach position. The landing gear was extended while passing over New Rocelle at 1,500 feet and the pilot established a rate of descent which he believed to be in the order of 350 feet per minute. Because of the different calibration of the vertical speed indicator as compared with the instruments used by the captain during almost all of his previous 29,000 flying hours, the actual rate of descent was between 900 to 1,000 feet per minute until checked by Captain DeWitt. The captain's altimeter indicated an altitude approximately 125 feet higher than the actual altitude. Since the captain was utilizing the autopilot, his corrections of altitude and direction were somewhat slower than would normally be expected in a manual approach. Because of the excessive rate of descent, the aircraft descended below the minimum altitude prescribed for station passage. When crossing the La Guardia Range Station, the captain's altimeter indicated approximately 600 feet, which was slightly less than 500 feet above sea level.

When passing the range station, the pilot lowered the nose of the aircraft to establish a rate of descent of approximately 250 feet per minute, inasmuch as this rate of descent, if held for 60 seconds, would bring him to an indicated altitude from which a visual landing may easily have been made to runway 22. On passing the range station, he established a descent of from 600-800 feet per minute. Approximately 20 seconds after passing the La Guardia Range Station the aircraft passed through an indicated 400-foot altitude which was slightly less than 300 feet above the water. At this time the flight engineer and first officer observed lights below the overcast. In accordance with American Airlines' Operations Specifications, Flight 320 could descend to a minimum of 350 feet indicated altitude. Approximately 125 feet of calibration and setting error in the captain's drum altimeter would mean the aircraft actually could have descended to 225 feet. Brief visual check on the instrument panel indicated only a very slight descent and it is possible that, expecting to find the 100-foot pointer somewhere in the vicinity of 250 to 300 feet, he mistakenly accepted the indices on either side of the drum when, in fact, the 100-foot pointer was already approaching approximately an indicated 125 feet. The illusion of a safe flight altitude with the limited visual reference available over sparsely lighted areas such as the Rikers Island Channel at night, is not an unknown phenomenon.6/ Furthermore, because of a dike located between the end of runway 22 and the water of the channel, the threshold lights which are slanted at between three and five degrees would not be observed by the crew of Flight 320 unless the aircraft had been at or above the following elevations when at designated distances from runway 22:

Distance	Three-degree Slant	Five-degree-Slant
1/4 mile	79 feet	132 feet
1/2 mile	159 feet	265 feet
3/4 mile	240 feet	400 feet
1 mile	338 feet	530 feet
1-1/4 miles	400 feet	665 feet
1-1/2 miles	478 feet	798 feet
1-3/4 miles	557 feet	929 feet
2 miles	637 feet	1,062 feet

Under these circumstances the descent continued for the few seconds remaining until impact was made by the landing gear and right wing with the water.

6/ See footnote 5, page 14.

The reconstruction of the flight path accomplished in the foregoing paragraphs might well be adjusted for some additional altimeter error not previously indicated or disclosed during the investigation. However, we are of the view that if such an error did in fact exist it need not have been of great magnitude to permit rationalization of the factors involved.

CONCLUSIONS

The Board concludes there is no one factor so outstanding as to be considered as the probable cause of this accident. On the contrary, the Board has found that the accident was an accumulation of several factors or errors, which, together, comprised the safety of the flight.

The Board believes, after exhaustive and detailed investigation, that Flight 320 flew at an average ground speed of 130 knots between New Rochelle and the La Guardia Range Station. Using winds aloft data and time-over-fix data received from aircraft that preceded Flight 320, the Board has determined its indicated airspeed over this area to be approximately 150 knots. The aircraft passed over La Guardia Range Station at a low altitude, possibly as low as 300 feet, but probably not higher than 500 feet. The crew had limited visual reference following the range passage; the first officer and flight engineer observed lights just prior to impact. During the instrument approach, the captain's altimeter was indicating at least 80 feet, and possibly as much as 125 feet above the altitude at which the aircraft was flying owing to calibration and setting errors.

Just prior to impact, the aircraft was in a shallow descent, in approach configuration except for landing flaps and landing light extension, and was maintaining approximately 130 knots groundspeed. Captain DeWitt was flying the aircraft on autopilot "heading mode" during which he was controlling altitude by manipulating the pitch trim wheel with his right hand and controlling direction by rotating the CDI cursor with his left hand. Impact occurred within seconds after the crew received and acknowledged clearance to land. The testimony of the first officer and flight engineer concerning the simultaneous misindication of both drum altimeters could not be substantiated by the evidence of record. The possibility of failure of the captain's altimeter was examined. However, the Board believes there is insufficient evidence available to substantiate this.

The Board believes that even though the accident probably resulted from the captain's neglect of certain essential instrument references, it could have been prevented had the first officer followed prescribed operating procedures, and been fully alert and attentive to all his cockpit duties throughout the approach.

As a result of this accident, the Federal Aviation Agency, on February 8, 1959, as a "precautionary measure," raised Electra minimums. Upon the installation of the conventional three-pointer type sensitive altimeters, the restrictions were lifted.

During this investigation considerable testimony was presented concerning American Airlines' procedures and techniques employed in the operation of autopilots. The Federal Aviation Agency testified that it had not issued any policy directives with respect to the use of autopilots in the various possible types of instrument approaches for an air carrier.

While the Board considers that fully automatic front course ILS approaches using an autopilot coupler may be basically sound, it is the Board's opinion that

autopilot approach criteria and limitations to all air carriers should be established, taking into account the particular autopilot used, the aircraft involved, and the approach facilities utilized. Accordingly, the Board has recommended to the FAA that it initiate a study of air carrier policies, procedures, and techniques for employing an autopilot for instrument approaches and take whatever action appears appropriate.

Service Testing of New Equipment

Although, as indicated in previous sections of this report, the Board does not believe that altimeter malfunctioning was a major factor in this accident, it is convinced that the searching investigation of the altimeters as a result of this accident has disclosed the need for changes in the procedures used to approve such items of equipment and instrumentation.

Units such as the Kollsman drum altimeter, the Eclipse-Pioneer Flight Director System, and the PB-20 autopilot are approved for civil use by the Federal Aviation Agency under the Technical Standard Order System. In obtaining approval for his product under this system, a manufacturer certifies to the FAA that he has complied with all of the specifications and has conducted all of the tests contained in the appropriate TSO. This certification by the manufacturer constitutes FAA approval, and the manufacturer is free to market his product and a prospective purchaser, such as an airline, is then able to install the item in an aircraft without further substantiation of the product. Typically, FAA's TSO program does not require inservice suitability testing of items that are approved, nor does it incorporate specific quality control standards. Furthermore, evidence developed during the Board's investigation and public hearing on this accident indicated that FAA had no overall definitive program for monitoring routine service difficulties on TSO items.

Service testing of novel designs before fleetwise installation is authorized would be very instrumental in uncovering design deficiencies in a product. The incorporation of specific quality control standards in the TSO and/or direct surveillance of the manufacturer's quality control organization by FAA inspectors would insure only high-quality products getting into service. Closer monitoring by the FAA of minor difficulty reports on newer TSO items would detect trends before a serious failure or malfunctioning occurred. These Board views have been conveyed to the FAA.

The Board also believes that the carrier has definite obligations in this area. In view of the novel presentation of the drum altimeters, the Board finds it difficult to understand why American did not at least incorporate this instrument in the Electra cockpit trainer used by the flight crews during their Electra training. Although this would not have been as beneficial as a more extensive preservice test evaluation of this instrument, it would at least have provided the flight crews with some experience on this important safety instrument before they used it in actual scheduled service. Similarly, the new instantaneous vertical speed indicator would have been a desirable instrument to incorporate in the cockpit trainer. In addition, added emphasis should have been placed on the difference between these new instruments and the older types during the crew training program until such time as it was evident that the various crews were experiencing no unusual amount of difficulty in effecting transition to the newer types.

Aircraft Simulator

The Board notes that the carrier introduced an aircraft containing the many novel systems and characteristics of the Electra without having previously established a comprehensive aircraft simulator program. The carrier has not yet procured an approved Electra simulator. Certainly there is little question that the present state of the art and the benefits to be derived from the use of simulators indicate the desirability of utilizing simulators prior to the introduction of the aircraft into air carrier service.

Whether or not any of the many factors which have been discussed in this report are of themselves critically related to this accident, we believe that their accumulative effect is significant - so significant in fact, that the extent to which they appear to compromise the safety of Electra operations must be seriously regarded. We are also of the view that almost all adverse operational aspects of new and substantially different equipment, systems, and procedures, could have been avoided through more comprehensive training in an aircraft simulator.

The Board has on previous occasions indicated its concern over the need for vigorous and comprehensive aircraft simulator programs in air carrier operations. The introduction of the Electra has increased our concern in this respect. Accordingly, we have recommended that the Federal Aviation Agency give immediate consideration to the adoption of a requirement that any air carrier planning to introduce into service an aircraft type containing equipment, systems, or characteristics significantly different from those of predecessor aircraft, shall be required to institute an approved aircraft simulator program the completion of which shall be required before any pilot may be assigned as pilot-in-command in air transportation.

Flight Recorder

In 1957 the Civil Aeronautics Board adopted an amendment to the Civil Air Regulations which required the installation of a device on certain aircraft used in air transportation for the purpose of recording continuously during flight, time, airspeed, altitude, vertical acceleration, and heading. This requirement met with considerable opposition in the aviation industry and serious consideration was given by the Board to the question whether the potential value of this device justified the cost of procurement, installation, and maintenance. The Board finally concluded that only the larger turbine-engine aircraft intended for operation in completely new environments would justify the expense of providing flight recorders. To define such aircraft types the Board relied upon a simple criterion - such recorders would be required in aircraft certificated for flight above 25,000 feet. Although the Electra is capable of flight above 25,000 feet, the carrier chose to request certification below 25,000 feet under which limitation it is unnecessary to install flight recorders. The probability that this would be done was known to the Board at the time the regulation was written. However, the Board concluded that the regulation, then promulgated, represented the most demanding requirement which could be justified on the basis of the then existing state of the art.

Clearly, a flight recorder in this aircraft would have enabled us to identify the causal factors involved in this accident with far greater precision than is now possible. The Board is of the view that the quality of flight recording systems which are available to the industry warrants the conclusion that no large aircraft introduced into air carrier service should be without a recorder. Accordingly, the Board is recommending that the FAA initiate action to amend the appropriate regulations to require that all large turbine-engine aircraft used in air transportation be equipped with flight recorders.

PROBABLE CAUSE

The Board determines the probable cause of this accident was premature descent below landing minimums which was the result of preoccupation of the crew on particular aspects of the aircraft and its environment to the neglect of essential flight instrument references for attitude and height above the approach surface.

Contributing factors were:

1. Limited experience of the crew with the aircraft type;

2. Faulty approach technique in which the autopilot was used in the heading mode to or almost to the surface;

3. Erroneous setting of the captain's altimeter;

4. Marginal weather in the approach area;

5. Possible misinterpretation of altimeter and rate of descent indicator; and

6. Sensory illusion with respect to height and attitude resulting from visual reference to the few lights existing in the approach area.

BY THE CIVIL AERONAUTICS BOARD:

/s/ JAMES R. DURFEE
Chairman

/s/ CHAN GURNEY
Vice Chairman

/s/ G. JOSEPH MINETTI
Member

/s/ WHITNEY GILLILLAND
Member

/s/ ALAN S. BOYD
Member

SUPPLEMENTAL DATA

Investigation and Hearing

The Civil Aeronautics Board was notified of the accident on February 4, 1959, soon after occurrence. An investigation was immediately initiated in accordance with the provisions of Title VII of the Federal Aviation Act of 1958. A public hearing was ordered by the Board and was held in New York, New York, March 18, 1959.

Air Carrier

American Airlines, Inc., is a Delaware corporation and maintains its principal offices in New York, New York. The corporation holds a current certificate of public convenience and necessity issued by the Civil Aeronautics Board to engage in the transportation of persons, property, and mail. It also possesses a valid air carrier operating certificate issued by the Federal Aviation Agency, (formerly Civil Aeronautics Administration).

Flight Personnel

Captain Albert Hunt DeWitt, age 59, was employed by American Airlines on June 6, 1929. He held a currently effective airman certificate with airline transport and all other appropriate ratings. He had a total flying time of 28,135 hours, of which 48:13 were in Lockheed Electra aircraft. He satisfactorily passed his last FAA (formerly CAA) physical examination October 16, 1958. His last semi-annual proficiency check was given by one of the company's check pilots December 16, 1958.

First Officer Frank Schopen Hlavacek, age 33, was employed by the company on January 29, 1951. He held a currently effective airman certificate with airline transport rating and Convair 240, 340, and 440 type ratings. He had a total of 10,192 flying hours, of which 36:35 were in Electra aircraft. His last FAA physical examination was satisfactorily passed June 7, 1958.

Flight Engineer Warren Edward Cook, age 36, was employed by the company July 28, 1948. He held a current airman certificate with flight engineer rating. He had a total of 8,700 flying hours, of which 81:29 were in Electra aircraft. His last physical examination was satisfactorily completed November 7, 1958.

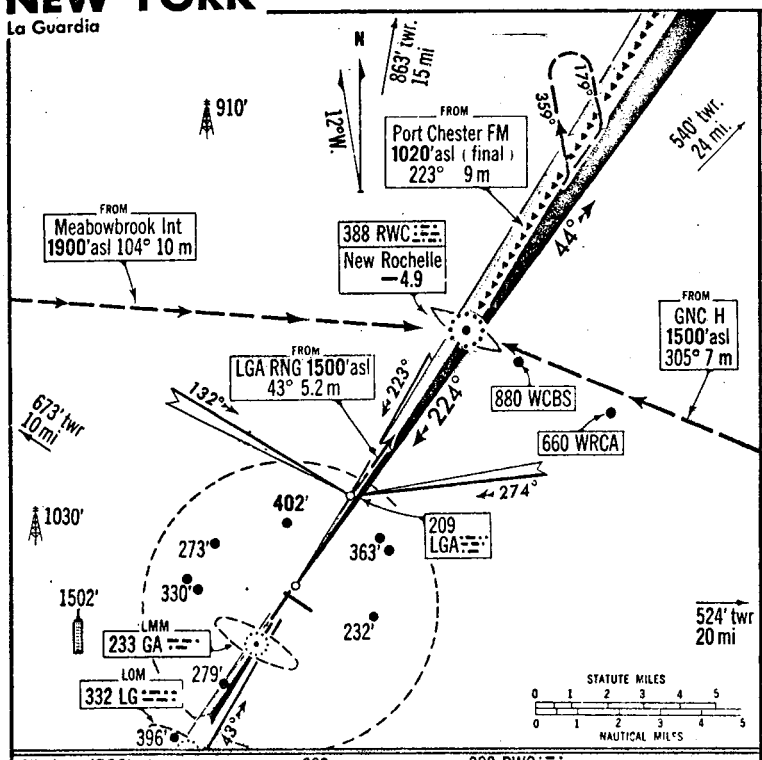
Stewardess Mae Markidis, age 22, was employed by the company May 7, 1957. Stewardess Joan Zeller, age 21, was employed by the company on July 29, 1958.

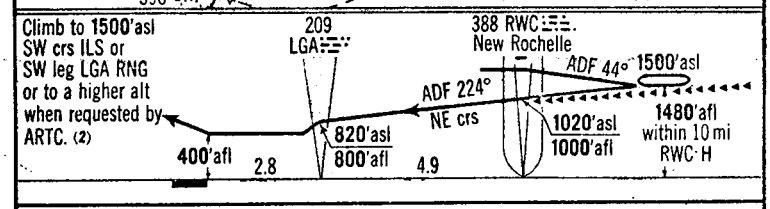
The Aircraft

Electra Aircraft, model L-188, N 6101A, was manufactured November 27, 1958, by Lockheed Aircraft Corporation. The aircraft was equipped with four Allison 501D13 engines. The four propellers, model A6441FN-606, blades 6503368, were manufactured by Aero Products, Allison Division, General Motors Corporation.

NEW YORK
La Guardia

LGA ILS & ADF BACK CRS APCH TO RNY 22





Altitude 20'asl
H 388 RWC
LCZR 109.9 ILGA
Tower 118.7
Gnd Ctl 121.7*
Apch Ctl 119.9
VOT 108.4

All altitudes are above field level unless otherwise indicated

Authorized as: REGULAR PROVISIONAL for
ALTERNATE Washington

CEILING AND VISIBILITY MINIMUMS

	RNWY	SVC	CONVAIR	ELECTRA, DC6's-7's
LANDING Straight-in	22	PSGR & CGO	400-1 (1) SS 500-3/4 500-1 H(1) SS 600-3/4	
Circling	All		600-1	600-1½ SS 800-1
TAKE-OFF	4, 13, 22, 31	PSGR & CGO	300-3/4 (3)(1) 400-3/4 J (1)	100-1/4 K
	All		300-1 (1) SS 400-3/4	200-½
ALTERNATE LANDING	All	PSGR & CGO	600-2 AS 800-1 800-2 H AS 1000-1	

ADF use same procedure and minimums unless otherwise indicated. LGA RNG must be monitored during approach.

H ADF minimums.

J ILS or PAR gnd & airborne equipment must be in normal operation and straight-in apch can be made to Rnwy 4.

(3) Take-off alternate must be specified within 38 miles.

K Psgr svc requirement. Hi intensity rnwy lgts must be on and operating normally.

(1) Sliding scale NA below 3/4 mile.

TIME & MIM RATE OF DESCENT	Kts	Min-Sec	FPM
H to pullout if ground contact is not established at authorized mim	120	3-50	200
	130	3-34	

SPECIAL NOTES

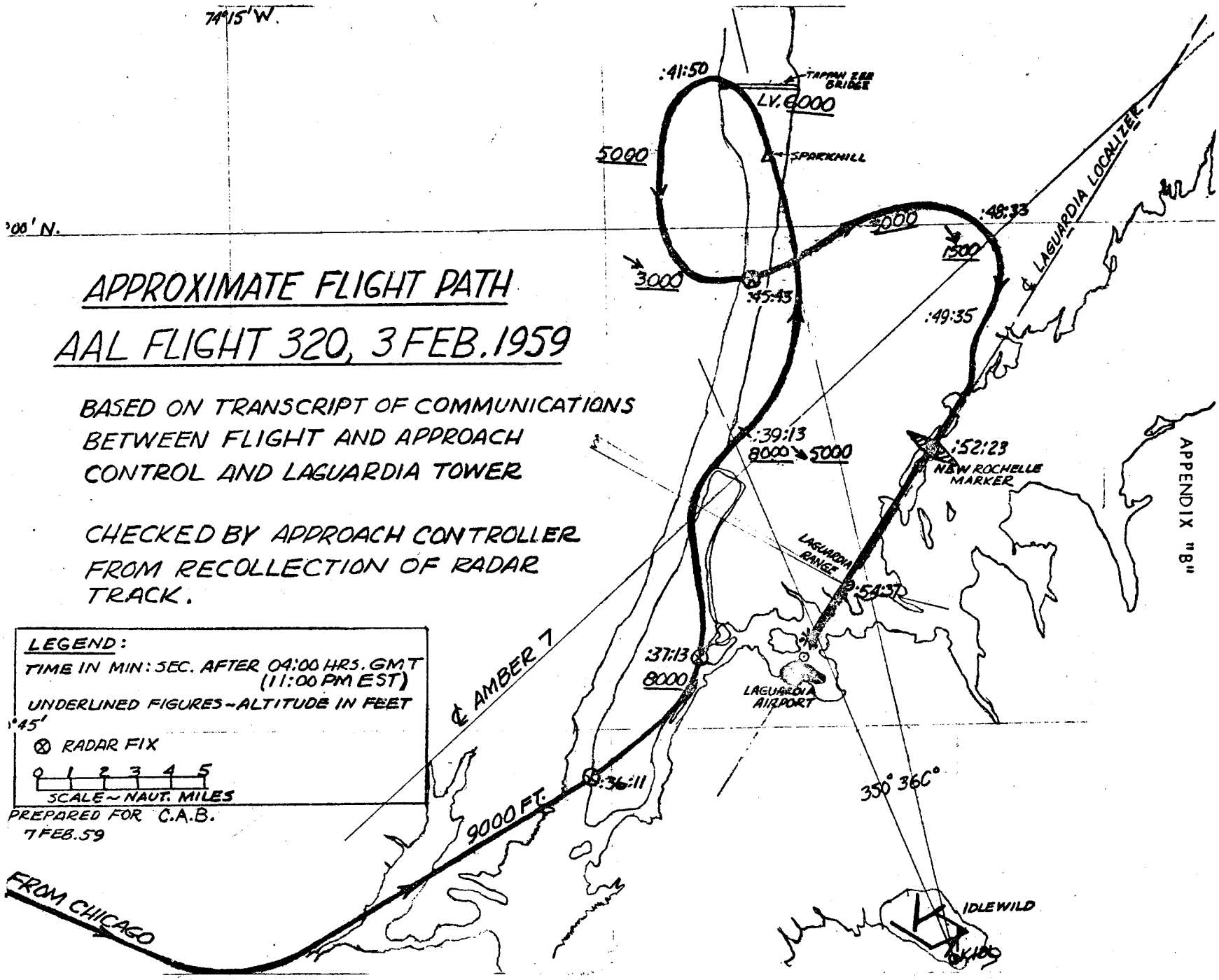
(2) **ALTERNATE MISSED APPROACH:** (with ARTC approval)
1. Make a climbing left turn to 1500'asl. return to RWC H or 2. if unable to proceed from RWC H with 3 mi visibility and clear of all clouds, make a climbing right turn to 1500'asl, and return to RWC H holding pattern.

For Airport Map see ILS Apch to Rnwy 4

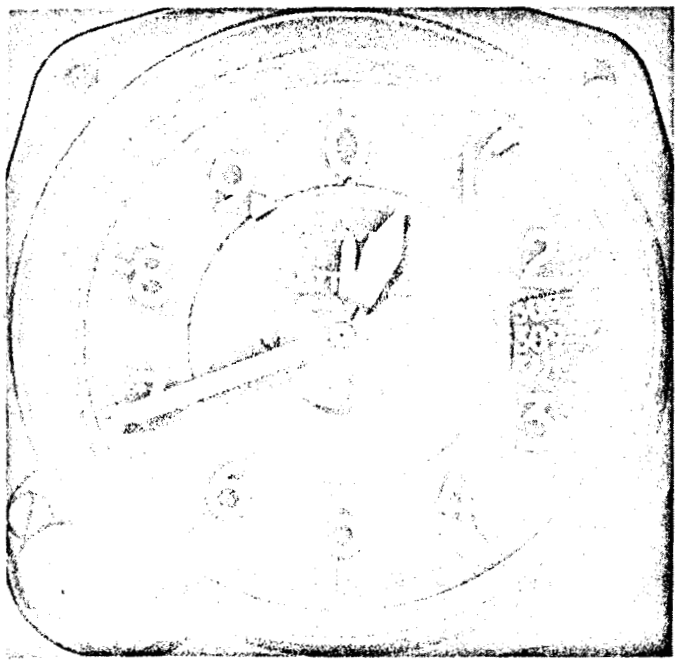
PROCEDURE UTILIZING BACK COURSE ILS WITHOUT GLIDE SLOPE

Radar vectors may be substituted for above transitions

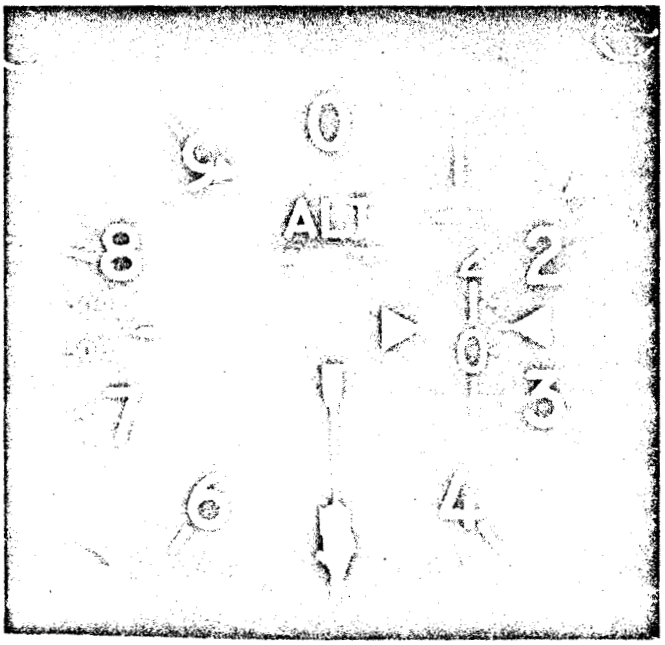
RUNWAY	TAILWINDS GIVING AN APPROXIMATE 8.7 KNOT TAILWIND LANDING COMPONENT							
22	Wind	NNW	N	NNE	NE	ENE	E	ESE
	Magnetic	349°	12°	34°	57°	79°	102°	124°
	Velocity	0-14	0-9	0-8.7	0-8.7	0-12	0-18	0-26


74°15' W.
'00' N.
APPROXIMATE FLIGHT PATH
AAL FLIGHT 320, 3 FEB. 1959
BASED ON TRANSCRIPT OF COMMUNICATIONS BETWEEN FLIGHT AND APPROACH CONTROL AND LAGUARDIA TOWER
CHECKED BY APPROACH CONTROLLER FROM RECOLLECTION OF RADAR TRACK.
LEGEND:
TIME IN MIN: SEC. AFTER 04:00 HRS. GMT (11:00 PM EST)
UNDERLINED FIGURES ~ ALTITUDE IN FEET
RADAR FIX
0 1 2 3 4 5
SCALE ~ NAUT. MILES
PREPARED FOR C.A.B.
7 FEB. 59
FROM CHICAGO
9000 FT.
℄ AMBER 7
:41:50
TAPPAN ZEE BRIDGE
LV. 6000
SPARKHILL
5000
3000
:45:43
:48:33
1500
℄ LAGUARDIA LOCALIZER
:49:35
:39:13
8000
5000
:52:23
NEW ROCHELLE MARKER
LAGUARDIA RANGE
:54:37
:37:13
8000
LAGUARDIA AIRPORT
:36:11
350° 360°
IDLEWILD
APPENDIX "B"

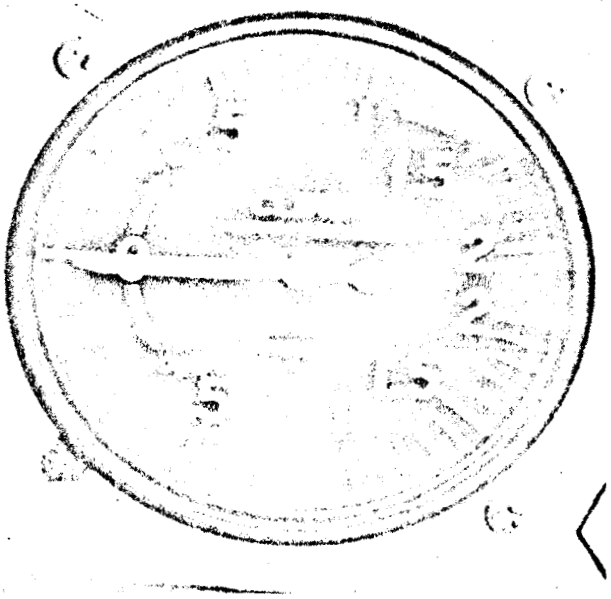
APPENDIX "C"



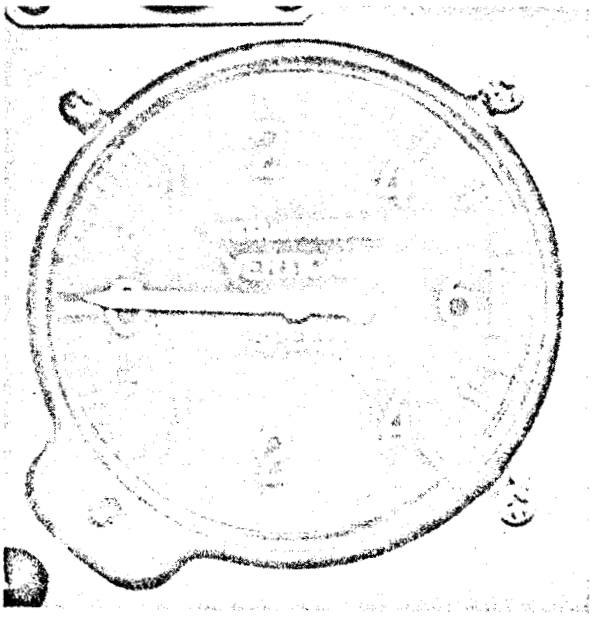
CONVENTIONAL THREE POINTER TYPE SENSITIVE ALTIMETER



PRECISION DRUM TYPE ALTIMETER



RATE OF CLIMB INDICATOR



INSTANTANEOUS VERTICAL SPEED INDICATOR