

43.41

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REPORT OF THE CIVIL AERONAUTICS BOARD

Of the investigation of an accident involving civil aircraft of the United States NC 21727 which occurred near Vero Beach, Florida, on April 3, 1941.

CONDUCT OF INVESTIGATION

An accident involving aircraft NC 21727 occurred in the vicinity of Vero Beach, Florida, on April 3, 1941, about 9:07 A.M. while the aircraft was being operated in scheduled air carrier service between Miami, Florida, and New York, New York, as Trip 14 of Eastern Air Lines, Inc. (hereinafter referred to as "Eastern"). The accident resulted in the destruction of the airplane, serious injury to ten passengers and the three members of the crew, and minor injuries to the remaining three passengers. Although the accident occurred at approximately 9:07 A.M., the wreckage was not located until approximately 6:00 P.M. The Washington office of the Civil Aeronautics Board (hereinafter referred to as the "Board") was officially notified of the aircraft being overdue about 11:40 A.M. The Board immediately instructed their Senior Air Safety Investigator stationed at Atlanta, Georgia, to remain in constant contact with Eastern's personnel and assist them in locating the airplane. Confirmation of the aircraft being overdue, and its whereabouts unknown, was received at 3:20 P.M. the same day.

Inspection and Preservation of the Wreckage

Immediately after receiving this confirmation at 3:20 P.M. the Board initiated an investigation in accordance with the provisions of Section 702 (a)(2) of the Civil Aeronautics Act of 1938, as amended (hereinafter referred to as the "Act"). An Air Safety Investigator of the Safety Bureau of the Board was immediately dispatched from Atlanta, Georgia, to Miami, Florida. En route he learned that the accident had occurred near Vero Beach, Florida, and so proceeded there, arriving about midnight, April 3, 1941. In accordance with instructions of the Board, the damaged airplane was placed under guard by members of the rescue party as soon as they arrived at the scene of the accident. About daylight, April 4, the first of the Board's investigators arrived at the scene of the accident immediately took custody of the wreckage and employed guards to relieve the members of the rescue party from this responsibility. The wreckage was not disturbed prior to the arrival of the Board's investigator except for damage necessarily involved in removing the injured passengers and crew. The guard was maintained until the inspection of the aircraft was completed and the aircraft released to Eastern on April 8, 1941.

Public Hearing

In connection with the investigation of the accident, a public hearing was held at Miami, Florida, beginning on April 10, and continuing through April 14, 1941. G. Grant Mason, Jr., one of the five members of the Board, was designated by the Board to preside as Examiner at the hearing. He was assisted by Robert W. Chrisp, an attorney of the Board, who acted as Associate Examiner, Robert D. Hoyt, Assistant Director of the Safety Bureau of the Board; Frank E. Caldwell, Chief of the Investigation Division of the Safety Bureau; W. K. Andrews, Chief of the Investigation Section of the Safety Bureau; Paul A. Gareau, Air Safety Specialist in Meteorology of the Safety Bureau; James N. Peyton, Investigator in Charge of the Atlanta Office of the Safety Bureau; and Ervin N. Townsend, Air Safety Investigator.

All of the evidence available to the Board at the time was presented at the hearing. Testimony was given by 35 witnesses and 27 exhibits were received in evidence. The depositions of the passengers and others were taken and have been made a part of the record of this investigation.

1/ All times used herein are Eastern Standard unless otherwise indicated.

Captain O'Brien and First Officer Crabtree were severely injured and the Board's representatives, after securing permission from the pilots' respective doctors, took their depositions while they were confined to the hospital. Captain O'Brien, subsequent to the taking of the deposition, had a head operation and after convalescing, advised the Board that his "head had cleared and memory returned", and that he could give further information. In accordance with Captain O'Brien's request, a supplemental deposition was taken September 16, 1941. First Officer Crabtree was granted the same opportunity and his supplemental deposition was taken on September 23, 1941.

While the Examiners and the representatives of the Safety Bureau were the only ones designated to ask questions directly of the witnesses, the Presiding Examiner, acting under instructions of the Board, announced at the opening of the hearing that any person who had any evidence, questions, or suggestions for consideration in the proceedings might submit them to the Examiners. Accordingly, 27 written questions were submitted and were asked of the appropriate witnesses.

Upon the basis of all the evidence accumulated in the investigation and hearing, the Board now makes its report in accordance with the provisions of the Act.

II.

SUMMARY AND ANALYSIS OF EVIDENCE

Air Carrier

Eastern, a Delaware Corporation, was operating at the time of the accident as an air carrier under currently effective certificates of public convenience and necessity and air carrier operating certificates theretofore issued to it pursuant to the Act, authorizing it to engage in air transportation with respect to persons, property and mail on various routes including that between the co-terminal points Newark, New Jersey, and New York, New York, and the terminal point, Miami, Florida, via numerous intermediate points, among them being West Palm Beach, Florida; Vero Beach, Florida; Daytona Beach, Florida; and Jacksonville, Florida.

Flight Personnel

On the flight in question, the crew consisted of Captain Gerald O'Brien, First Officer Byron M. Crabtree, and Flight Steward Albert Marin.

Captain O'Brien, aged 32, had at the time of the accident accumulated a total of 3,557 hours of flying time, of which 2,486 hours had been with Eastern on Douglas equipment. He had logged 1,065 hours DC-3 time. He had served as a first officer for Eastern for about two years before becoming a captain on January 1, 1941. He had logged 197 hours of flying time as captain. Company records showed that since employment by Eastern, he had logged 338 hours of instrument time, of which 12 hours had been instrument practice under the hood. In addition to flight experience he had about 30 hours Link Trainer time. His last physical examination, required by the Civil Air Regulations, was taken on November 1, 1940, and showed him to be in satisfactory physical condition.

First Officer Byron M. Crabtree, aged 32, had at the time of the accident accumulated a total of approximately 469 hours on Douglas equipment since his employment by Eastern on September 17, 1940. He had 64 hours and 20 minutes of instrument time, and 8 hours and 50 minutes of Link Trainer time. Prior to employment by Eastern he had accumulated a total flight time of 4,100 hours. His last physical examination required by the Civil Air Regulations was taken on December 11, 1940, and showed him to be in satisfactory physical condition.

Captain O'Brien had had a rest period of more than 12 hours prior to going on duty April 3, 1941, and had flown 5 hours and 18 minutes during the 24-hour period preceding the departure of the trip in question. First Officer Crabtree had had the same amount of flying time and rest as had Captain O'Brien during the 24-hour period preceding the departure of Trip 14 from Miami. O'Brien and Crabtree had flown together as captain and first officer for approximately 37 hours.

It appears from the evidence that both Captain O'Brien and First Officer Crabtree were physically qualified and held proper certificates of competency covering the flight and equipment involved.

Airplane and Equipment

Aircraft NC 21727 was a Douglas Model DC-3, manufactured by the Douglas Aircraft Corporation of Santa Monica, California, and purchased by Eastern on August 15, 1939. It was powered with two Wright Cyclone G2E engines, each rated at 1,000 h.p. for take-off, and was equipped with Hamilton Standard, constant speed hydromatic, full-feathering propellers. The hub model of these propellers was 23E50-III and the blade design was 6153A-18. This model aircraft and its equipment had been approved by the then Civil Aeronautics Authority for air carrier operation over routes flown by Eastern with 21 passengers and crew of three. The airplane had been certificated for operation with a standard weight of 24,295 pounds. The airplane and its equipment had received the overhauls, periodic inspections, and checks which are provided for in company practice and approved by the Civil Aeronautics Administration.

History of the Flight

Eastern's Trip 14 of April 3, 1941, originated at the Thirty-Sixth Street Airport, Miami, Florida, with New York, New York, as its destination. Intermediate stops were scheduled at West Palm Beach, Daytona Beach, and Jacksonville, Florida; 2/ Brunswick and Savannah, Georgia; Charleston, South Carolina, Raleigh, North Carolina; Richmond, Virginia; Washington, D. C.; Baltimore, Maryland; and Philadelphia, Pennsylvania. Captain O'Brien, First Officer Crabtree, and Flight Steward Marin were assigned to operate the flight to Jacksonville, Florida.

On the morning of April 3, 1941, Captain O'Brien arrived at the airport at approximately 7:00 o'clock and attended to routine matters in connection with the flight. He and the company meteorologist prepared a flight plan for the Miami-Jacksonville leg, which was based on hourly weather sequence reports, forecasts issued by the United States Weather Bureau at Atlanta, Georgia, for various points along the route and a trip forecast previously prepared by the company meteorologist.

2/ A usual point of crew change for this flight.

The Weather Bureau forecast issued at 5:00 A.M. covering the period of 5:30 A.M. to 1:30 P.M. indicated that over northern and central Florida there would be broken to overcast cloudiness at 2000 feet to 4000 feet with rain showers and scattered local thundershowers. The forecast further indicated that by mid-morning lower cloudiness would form at 2600 feet to 3000 feet over southern Florida. The trip forecast made at 5:20 A.M. by the meteorologist of Eastern at Miami indicated scattered thundershowers from Vero Beach to Jacksonville with light to occasionally moderate turbulence. There was no substantial difference between the forecast of the Weather Bureau and Eastern's forecast. Neither of these forecasts indicated the existence of abnormal conditions.^{4/}

The company flight dispatcher in charge, stationed in New York City, issued authority for the clearance ^{5/} of Trip 14 from Miami to Jacksonville via West Palm Beach and Daytona Beach. Captain O'Brien's flight plan specified contact flight from Miami to West Palm Beach with an estimated flying time of 28 minutes. In accordance with this authority, Trip 14 was cleared and the 6:35 A.M. weather sequence ^{6/} was attached to the clearance. The trip departed from Miami about 7:45 A.M. and proceeded normally to West Palm Beach in accordance with the flight plan.

An intermediate clearance was received at West Palm Beach which contained the 7:35 A.M. weather sequence ^{6/} from Miami to Jacksonville. Captain O'Brien's flight plan covering that portion of the trip from West Palm Beach to Daytona Beach called for instrument flight with a cruising altitude of 3000 feet above sea level and with an estimated time of one hour and five minutes. Savannah, Georgia, was designated as the alternate airport.

The total weight of the airplane on departure from West Palm Beach, including mail, express, company material, 450 gallons of gasoline, 44 gallons of oil, 13 passengers, and a crew of 3, was approximately 22,330 pounds and thus well within the approved standard weight. From the evidence it appears that the airplane was loaded so that the center of gravity was well within the limitations prescribed by the Civil Aeronautics Administration.^{7/}

Trip 14 departed from the ramp at West Palm Beach at 8:16 A.M. and took off at 8:20 A.M. Following the take-off the airplane had climbed to an altitude of 3000 feet and the flight proceeded toward Daytona Beach. The flight steward served breakfast to those passengers who desired it, requesting them to finish the meal as soon as possible because rough air might be encountered within a short time.

About 8:30 A.M., approximately 10 minutes after Trip 14 had departed from West Palm Beach, Eastern's Trip 10, which had departed from Miami at 7:15 A.M. for Jacksonville via Orlando, Florida, was a short distance southwest of Vero Beach. Captain Meyers,

^{3/} See Appendix A for Weather Bureau Forecast.

^{4/} See Appendix B for Eastern's Weather Forecast.

^{5/} A clearance is a company authorization for a flight to depart. It is signed by or for the dispatcher and also by the captain, and incorporates current weather reports, load manifests, flight plan, etc.

^{6/} See Appendix C for 6:35 A.M., 7:35 A.M., 8:35 A.M., and 9:35 A.M. weather sequence reports.

^{7/} The center of gravity limitations prescribed by the Administrator for this airplane were: Forward, 11 percent; rearward, 28 percent with the landing gear extended, and 31 percent with the landing gear retracted.

in command of Trip 10, after encountering "severe turbulence" requested his co-pilot, Mr. Toth, to transmit a message "to any station that he (you) could pick up, advising that Trip 14 be held, not go get into this, it is too tough." ^{8/} The copilot, in carrying out Captain Meyers' request, first called Orlando but to no avail. He stated that "he then called West Palm Beach and Miami, and Miami answered." Copilot Toth further stated, "I told Miami to hold 14 at West Palm Beach as conditions were then such we did not want him (Trip 14) to get into that mess until we could advise him as to the exact nature of the storm." The Miami radio log indicates that the message was not received in its entirety at Miami but the West Palm Beach radio log contains the following message:

"10 TO WZ (West Palm Beach) - TELL 14 TO HOLD AT WZ (West Palm Beach) AS WE ARE RUNNING INTO INST WX (instrument weather) WITH HEAVY TURBULENCE."

The transportation agent at West Palm Beach immediately acknowledged receipt of the above-quoted message from Trip 10, advising that Trip 14 had already left West Palm Beach and was flying to Daytona Beach. The West Palm Beach radio log contains the following message from Trip 10 to West Palm Beach:

"10 TO WZ (West Palm Beach) OK. TELL 14 TO STAY OUT UNTIL WE ARE CLEAR."

The transportation agent at West Palm Beach testified that he contacted Trip 14 at 8:35 A.M. and delivered the following message:

"WEST PALM BEACH TO 14. TRIP 10 SAYS HE IS ON INSTRUMENTS WANTS YOU TO STAND BY UNTIL HE IS IN CLEAR."

This communication was acknowledged by Trip 14 with the following message:

"OK 14". "14 WILL CIRCLE ABOUT 15 (miles) N (north of) WZ (West Palm Beach) UNTIL 10 (is) IN CLEAR NOTIFY US WHEN 10 IS CLEAR."

Complying with this stated intent, Captain O'Brien of Trip 14 then circled for about ten minutes in the vicinity of Stuart, Florida, approximately 35 miles north-northwest of Palm Beach, Florida, at an altitude of 3000 feet. ^{9/} The Melbourne, Florida, radio range was tuned in by the captain so that he could receive the benefit of any weather information that might be broadcast. The captain stated that the reception was good, but that he did not receive the 8:35 A.M. weather sequence broadcast. ^{10/} The weather sequence reports were broadcast at 8:43 A.M. Captain O'Brien either was not tuned to the radio range frequency or had greatly reduced the volume while the reports were being broadcast because, according to his statement, he was in communication with West Palm Beach at 8:43 A.M.

Captain O'Brien stated that about 8:43 while circling in the vicinity of Stuart, Florida, he called West Palm Beach by radio and asked about Trip 10 and was told that Trip 10 had passed north of Vero Beach about ten minutes ago. He then assumed that Trip 10

^{8/} For a detailed account of Captain Meyers' experience which prompted this message see Page 9.

^{9/} See map opposite page 8.

^{10/} The 8:35 A.M. weather sequence reports for Miami, West Palm Beach, Vero Beach, Melbourne, Orlando, Daytona Beach, and Jacksonville, Florida, were broadcast by the Melbourne, Florida, Civil Aeronautics Communications Station at 8:43 A.M.

was far enough ahead to permit him to proceed to Daytona Beach and at 8:45 A.M. advised West Palm Beach that he was going "on top" to Daytona Beach but that if forced to go on instruments he would stand by until Trip 10 was clear. Receipt of this message was acknowledged by West Palm Beach and was the last radio contact with the flight.

Trip 14 then resumed flight toward Daytona Beach in accordance with the flight plan. The captain stated that shortly after passing over Fort Pierce he turned on the instrument lights because it appeared that he would go on instruments shortly, probably within the next five or six miles. O'Brien at this time ordered the steward to have all passengers fasten their safety belts as he also expected to encounter rough air. After flying for a short distance at an altitude of 3000 feet in a northerly direction, the aircraft entered a hazy region between a solid cloud mass, the base of which was about 5000 feet, and a broken stratus condition, the top of which was about 1500 feet. The captain described the hazy region between the base of the overcast and the top of the stratus formation as gray and opaque. He stated that this haze appeared to be a normal overcast condition and that there did not appear to be any cumulus clouds or a thunderstorm condition above the haze.

O'Brien said that shortly after entering the hazy atmospheric condition they encountered very turbulent air and then a violent updraft, and while they were in this, the first updraft, the air speed dropped back to about 100 m.p.h. while the rate of climb indicator showed an ascent close to 1000 feet per minute. While in the updraft, according to the captain's testimony, he pushed the control wheel forward to nose the airplane down, and upon reaching an altitude of approximately 4000 feet, the air became smooth and the ascent was stopped. He further stated that at this time he started to make a flat turn to the left in an effort to get out of the storm and that while he was making this turn, First Officer Crabtree, after securing his permission lowered the landing gear. According to the captain's testimony, the airplane, before starting the left turn, was on an initial heading of 340 degrees and when the turn had progressed to 240 degrees he tried to "straighten out the turn", but the airplane continued to turn and his efforts to stop the turn were of no avail. The (directional) gyro indicated that the turn continued until the airplane was headed due north, thus making almost a complete circle. Captain O'Brien stated that after the turn had been stopped the air became extremely turbulent and, since he was fully occupied with the control wheel, he requested the first officer to handle the throttle. While in this turbulent air, according to the captain's account, the left wing went down, and remained down even though full opposite aileron was used. Captain O'Brien said that he reached for the throttle in order to apply power to the left engine in an effort to bring the wing up, but that before he could apply power the left wing came up and the right wing went down. He testified that on bringing the airplane to a level attitude the power was reduced due to the violence of the turbulence and with this reduced power the air-speed meter indicated about 130 m.p.h.

The captain, although not able to reconstruct the exact sequence of events from this point on, was of the opinion that they encountered three updrafts and three downdrafts. The highest altimeter reading he recalled was approximately 4500 feet. The captain testified that there "was an extremely strong rotary pressure while in the updrafts" and that the airplane had a tendency to turn to the left in a flat attitude. During these flat turns the (directional) gyro indicated that the heading of the airplane changed more than 180 degrees. According to O'Brien's recollection, the air-speed indicator during the flat turns oscillated between 100 and 120 m.p.h.

O'Brien stated that he was of the opinion that he encountered the "core or center of

this disturbance" while headed west at an altitude of about 2000 feet; that while they were ascending in the "core", the airplane turned approximately 270 degrees to the left in a flat attitude; and that at the time the ascent was stopped they were headed approximately north (10 degrees).

The captain testified that during the third and last downdraft they broke out of the overcast. As they broke into the clear, according to his testimony, the air speed was between 190 and 200 m.p.h. and he had the control wheel fairly well back and was using a normal amount of power in an effort to hold altitude. O'Brien stated that he saw a black shaded area ahead of him which he believed to be trees, and that he immediately pulled back on the control wheel and used the left rudder but did not use any aileron control since any effort to bank the airplane would have resulted in the wing making contact with what appeared to be trees. The captain stated that this was the last thing he remembered.

Upon being questioned, Captain O'Brien stated that he was of the opinion that they "broke out in a downwind position" (heading) and in a "heavy layer of air" which reduced air speed from 190 m.p.h. to approximately 100 m.p.h. and that the sudden decrease in air speed reduced their chances of gaining altitude. Captain O'Brien stated that he was positive that "the airplane did not go into a spin". He also testified that during all of the maneuvers the turn indicator needle was approximately centered.

Captain O'Brien could not fix the time at which they entered the storm area, nor could he describe the weather conditions while they were in the turbulent air. This was due to the fact that he was directing all of his attention to the instrument panel and the airplane controls. O'Brien stated that the elapsed time in which they were in the thunderstorm was very brief but that during the interval it was impossible to have complete control of the turning radius of the airplane and control of the ascent and descent at all times.

The captain stated that he did not request the copilot to assist him on the controls nor did he observe the copilot on the controls while they were in the turbulent air. He also stated that he could not determine from the feel of the controls whether the copilot had assisted him, because when "in that type of violent air with all the pressure you have on the control surfaces of the Douglas, it is quite hard to tell whether somebody is on the controls with you."

First Officer Crabtree stated that shortly after going on instruments they encountered extreme turbulence and that O'Brien, who was on the controls, started a left turn from a heading of 340 degrees. He testified that the turn had progressed to about 270 degrees when they experienced a severe bump which was immediately followed by the airplane being carried in an updraft to an altitude of about 4500 feet. Crabtree stated that while in the updraft the rate of climb indicator showed an ascent of about 2000 feet a minute and that the air-speed indicator went past a reading of 250 m.p.h. He further stated that he closed both throttles and assisted the captain on the control wheel in an effort to reduce this high air speed. The first officer testified that after the air speed had been reduced to a normal indication of approximately 140 m.p.h. and the airplane was again in level flight, he released the controls to the captain and, after securing O'Brien's permission, lowered the landing gear.

Crabtree testified that the air at this time was comparatively smooth and that O'Brien continued in the left turn in an effort to get out of the storm. According to the first

officer's testimony, the turn had progressed to approximately 230 degrees when the airplane was thrown into a vertically banked condition to the left and the air speed dropped off very rapidly. The first officer testified that as the air speed dropped the airplane seemed to fall or side-slip and the nose of the airplane went down. Crabtree stated that as the nose dropped, the air speed seemed to pick up and the airplane started a left spin. He further testified that the instruments indicated that the airplane was in a left spin (bank and turn indicator needle pointed to the left while the ball was to the extreme right; the directional gyro was turning rapidly; the horizon showed the airplane nose down and wing down). The first officer stated that he again assisted the captain on the controls and that during the spin the right rudder was used constantly and the control column was pushed forward as far as it would go. After reaching an altitude of 1000 feet, according to the first officer's testimony, both he and O'Brien pulled back on the wheel and immediately following this shift of controls the pressure increased on the controls to such an extent that the rudder could hardly be held. The first officer testified that "immediately following this my next impression was of the instruments being centered and the airplane not turning in a spin and the wings or lateral attitude of the airplane being normal, level." The altimeter showed between 300 and 400 feet, the rate of climb showing neither ascent nor descent, and the air-speed indicator showing 60 to 70 m.p.h.^{11/} The first officer stated that they were "mushing" forward, that the pressure on the controls became very "light", and that he started to apply power slowly in order to prevent the torque of the engines from throwing the airplane into another spin. He estimated that approximately one-half take-off power was being applied at the time they crashed. Crabtree stated that the visibility at the time they broke out of the overcast was reduced due to heavy rain and that he did not see the trees previously described by Captain O'Brien.

Crabtree, in describing the storm, stated that he did not see the cloud mass until they encountered it. He attributed his inability to see the clouds to the condition which he described as solid purplish haze in which they were flying prior to entering the storm. The first officer testified that while in the storm they encountered heavy rain, sleet, and possibly hail, and extreme turbulence.

The evidence indicates that the airplane struck the ground shortly after Crabtree's last reading of the altimeter and air-speed meter. It struck with power on in a swamp in shallow water at a point 10-1/2 miles west-southwest of the Vero Beach Airport,^{12/} at approximately 9:07 A.M.^{13/}

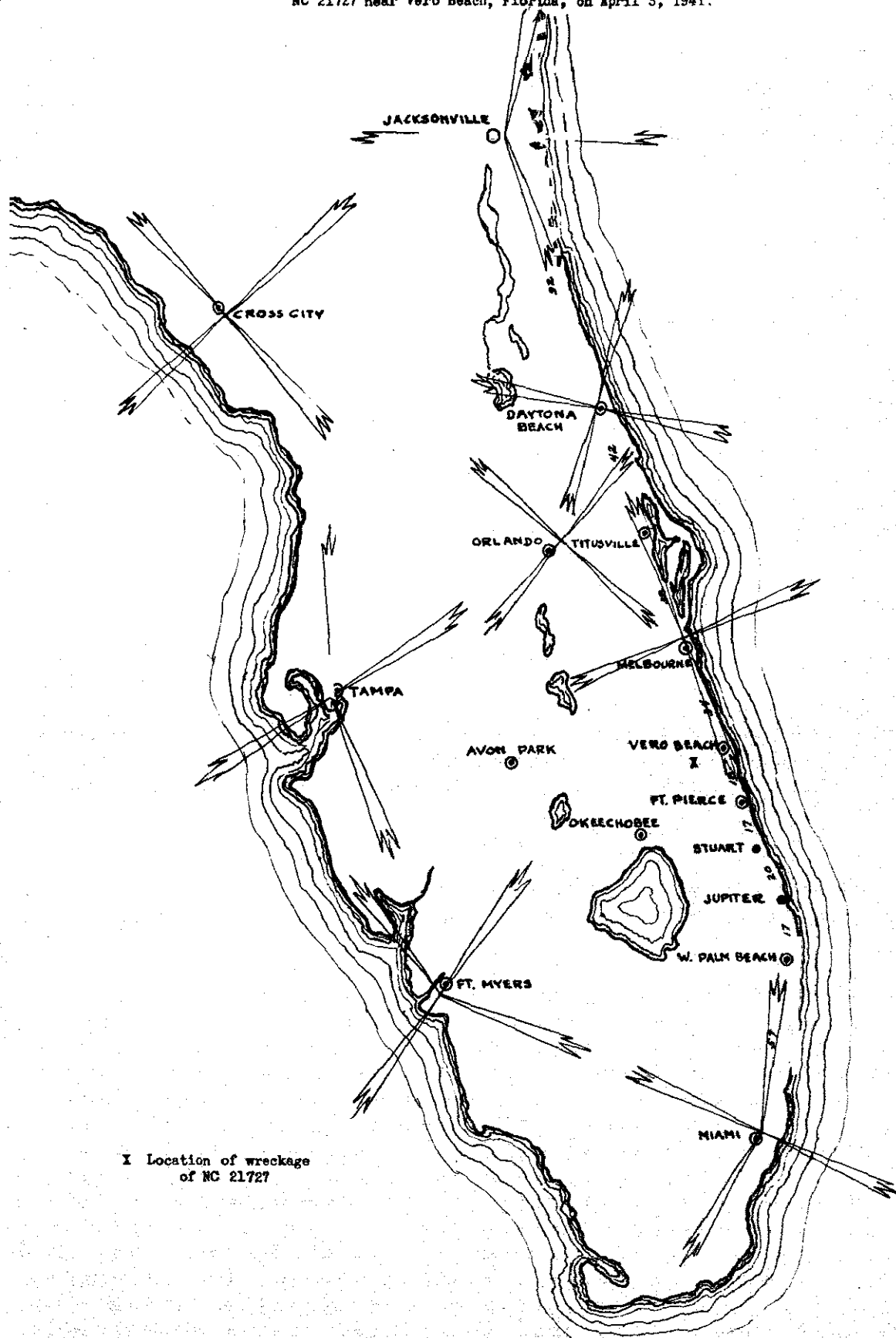
Shortly after 10:00 A.M. the operations manager of Eastern, stationed at Miami, was advised by operations personnel at Miami that Trip 14 was 20 minutes overdue at Daytona Beach and had not reported since 8:45 A.M. All company radio messages were checked and Easter's Miami radio station broadcast intermittently in an effort to contact Trip 14. About 1:00

^{11/} The stalling speed of the DC-3, with flaps up, throttle closed, and a weight of 21,800 pounds, which appears to have been the approximate weight in this case, is approximately 74 m.p.h. It is an established fact that when an airplane is at or near the stalling speed the air-speed indicator often shows a reading lower than the speed at which the airplane is actually traveling. This may explain the extremely low air-speed indicator reading recalled by the copilot.

^{12/} See map on opposite page showing approximate location of the scene of the accident and the location of the cities and other points to which reference is made in this report.

^{13/} This time was fixed by the stopping of the first officer's watch.

Report of Accident to Eastern Air Lines aircraft
NC 21727 near Vero Beach, Florida, on April 5, 1941.



X Location of wreckage
of NC 21727

Map of Florida showing location of the scene of the accident and
the location of cities to which reference is made in this report.

P.M. it became evident that Trip 14 was down since no replies to the broadcasts were received and since the fuel supply must necessarily be exhausted. Eastern sent out three airplanes from Miami with instructions to search the general region between West Palm Beach and Daytona Beach. These airplanes encountered low ceilings in the vicinity of Vero Beach and were obliged to confine their search to the north and south of this area. Shortly after 6:00 P.M., the weather conditions having improved, company personnel in Eastern's airplane No. 370 sighted the missing airplane and radioed its location to an Eastern ground station. Ground searching parties immediately set out from Vero Beach for the scene of the accident. Ambulances and other aids were driven as near as possible to the crashed airplane and boats were used to complete the journey. The first passengers reached the waiting ambulance about 11:00 P.M. and all the injured except the captain had been removed from the scene of the accident by 1:30 A.M., April 4. He was removed by 6:00 A.M.

The passengers stated that a few minutes after entering the dark overcast the airplane became involved in a series of very rapid ascents and descents. They further stated that after entering the turbulent air small articles including hats, blankets, etc., were thrown from the overhead shelves and at times the small articles were suspended in mid-air. Most of the passengers experienced the feeling of being held down by their safety belts and then of being forced into their seat. One of the passengers stated that he was sure the airplane made a left turn but did not spin. Another passenger who was a certificated pilot stated that the aircraft encountered some "rapid ascents" and then made a "terrific" drop. Another passenger stated that after encountering the turbulent air the left wing had a tendency to drop and that after experiencing a strong up-current he recalled a "very long dive". A student pilot who was a passenger in the airplane stated that she experienced two ascents and two descents.

Neither Captain O'Brien nor First Officer Crabtree was able to establish the exact time at which they first encountered the turbulence and we are unable, upon the basis of available testimony, to arrive at any definite determination of this question.

Weather Conditions

The pilots of four other scheduled flights of Eastern which on April 3 traversed the area in the region of the accident, testified as to the weather conditions existing at the time.

Captain Meyers was in command of Trip 10, which departed from Miami at 7:15 A.M. north-bound en route to Jacksonville via West Palm Beach and Orlando. His flight plan indicated that he would cruise at 1500 feet. Trip 10 departed from West Palm Beach at 7:48 A.M. at which time weather reports showed a ceiling of 700 feet and light rain with moderate thunderstorms in the vicinity of Orlando. Captain Meyers stated that as he passed Stuart, he observed dark clouds to the north and northwest, but that visibility was good to the east, west and south. Vision from the cockpit was reduced as he proceeded north, and realizing that a storm prevailed in that area, he turned westward toward a "light spot". Shortly thereafter he encountered heavy rain and hail which he estimated to be the size of golf balls, and considerable turbulence. After encountering the turbulence, the landing gear was lowered to reduce the air speed and thus the effect of turbulence upon the airplane. While in this turbulence, strong up-drafts and downdrafts were encountered causing the airplane to descend from 2000 to 500 feet. The captain stated that after starting a turn to get back out of the storm, the airplane "slued in its own course" and "..... turned 180 degrees in

practically its length flat." Captain Meyers further stated, "It felt as though something took hold of the tail of the plane and turned it a full 180 degrees in practically its length and I did not have anything to do with it. It was all we could do to stop it and I had already told my copilot to get on my controls with me. The controls became heavy and stiff. We were able to straighten that out but we started a fast descent. I saw 2000 feet a minute down on my rate of climb indicator and ended up at 500 feet with full power on; and at the bottom of that descent I called for gear up, with the hope of having additional speed to help stop that descent in case I had not stopped it at that time. The gear was brought up. We pulled on and out with full power and were able to climb back, but at that time we were headed back out of the storm and were gradually running into smooth air."

Captain Meyers got out of the severe storm area near Sebring,^{14/} Florida, and at approximately 8:30 A.M. instructed his copilot to transmit the message previously referred to, requesting that Trip 14 be held at West Palm Beach. Captain Meyers stated that his "intention was to try to stop that trip before he (O'Brien) got into it (the storm)" and the heavy turbulence. Captain Meyers then proceeded west, skirting the southern edge of the storm. This westerly course was held until a point west of Avon Park, Florida, was reached, a deviation of approximately 65 miles west of the normal course. Captain Meyers stated that he then turned and proceeded eastward skirting the storm to the south, with the intention, if it were not possible to go around the storm to the east, to return to West Palm Beach and wait until there was a change of weather. This easterly course was held until he arrived at the east coast of Florida about ten miles south of Fort Pierce. Since the storm extended out to sea he radioed West Palm Beach at 9:15 A.M. that he was returning. He landed at West Palm Beach at 9:40 A.M.

Captain Meyers testified that an examination of the airplane while it was on the ground at West Palm Beach did not disclose any damage or dents on the leading edge of the wings, as a result of encountering hail, nor did he observe any effects of hail on other parts of the airplane. He remained at West Palm Beach about an hour and a half. Then Trip 10 proceeded at an altitude of 1500 feet up the east coast of Florida past Stuart where, according to the captain's testimony, it encountered rain and low clouds and flew on instruments for about ten minutes. After passing Vero Beach he ran into scattered clouds and the trip proceeded contact to Orlando. The flight was uneventful from Orlando to Jacksonville.

Captain Whipprecht, in command of Trip 40, departed from Miami at 9:00 A.M., northbound en route to Jacksonville via Orlando. The flight plan called for cruising at 3000 feet. He passed over West Palm Beach at 9:27 A.M. Near Jupiter Light (about 15 miles north of West Palm Beach), he intercepted a radio report that Trip 10 was returning to West Palm Beach. As he passed Stuart, at approximately 9:38 A.M., he saw thunderstorms ahead. At that time the visibility was unlimited to the west and south. He headed west with the expectation of circling the storm. While flying west of Fort Pierce he saw what he described as two small tornadoes.^{15/} He descended to 1500 feet, and encountered moderate turbulence at this altitude. He finally turned north at a point where conditions appeared better and arrived at Orlando at 10:54 A.M. At the time he turned north, he was approximately 45 miles west of his course.

^{14/} Sebring, Florida, is approximately 60 miles west-southwest of Vero Beach, Florida.

^{15/} There were no tornadoes reported at ground level near Vero Beach, Florida, on the morning of April 3, 1941.

Jacksonville, Florida. His flight plan called for cruising at 3000 feet. He flew over scattered clouds in the vicinity of West Palm Beach. After viewing the weather to the north of West Palm Beach, which the captain described as "pretty black", he descended to 1000 feet and proceeded northwest toward what appeared to be more favorable weather. After flying on this course for a short distance he realized that the weather was worse to the west. He therefore returned toward Stuart and proceeded north up the coast. He passed Vero Beach, the point on his flight nearest the scene of the accident, at 10:31 A.M., approximately 1 hour and 25 minutes after the accident, where he encountered light rain and reduced visibility. He landed at Jacksonville at 11:50 A.M. without having encountered more than moderate turbulence at any point.

Captain Robertson, in command of Trip 315, departed from Jacksonville at 7:30 A.M. southbound en route to Miami via Daytona Beach, Orlando, Vero Beach, and West Palm Beach, under a flight plan calling for cruising at 4000 feet to Daytona Beach; 1000 feet from Daytona Beach to Orlando; and 2000 feet from Orlando to Miami. He flew by reference to the ground to Daytona Beach, arriving there at 8:15 A.M. and departing at 8:20 A.M. He arrived at Orlando at 8:40 A.M. where he encountered light rain. The trip departed from Orlando at 8:50 A.M., cruised at 2000 feet to Vero Beach, and arrived there at 9:35 A.M. At the time Captain Robertson arrived at Vero Beach visibility was one mile to two miles with heavy rain and the ceiling was 1000 feet variable. At 9:38 A.M. he departed from Vero Beach and climbed to 2000 feet but, after encountering severe turbulence at this altitude, he changed his flight plan to 1000 feet. In the vicinity of Fort Pierce, he passed under what he described as a "line squall" where he encountered some turbulence. The remaining portion of the trip was normal.

Three United States Coast Guardsmen stationed at Fort Pierce, Florida, which is about 22 miles southeast of the scene of the accident, testified at the hearing. These men, occupationally accustomed to observe weather, stated that about 9:00 A.M. a very dark and low cloud system approached from the north, accompanied by heavy hailstones about the size of a quarter. A few minutes later a heavy rain began to fall, which was accompanied by a gusty wind that uprooted trees and was estimated to be about 40 m.p.h.

An airplane was observed by one of the Coast Guardsmen to pass just east of the Fort Pierce Coast Guard Station about 8:55 A.M. This airplane was later identified as an Army airplane en route from Miami to Jacksonville. The pilot of this plane (Major Kenneth A. Rogers, United States Army Air Corps) stated that at the time he passed Vero Beach the ceiling was about 800 feet and that just north of Vero Beach he had encountered heavy rain, accompanied by severe turbulence.

The United States Airway Weather Observer at Vero Beach issued a special weather bulletin at 8:55 A.M. which reported a wind shift from east-southeast 26 m.p.h. to north-northwest 20 m.p.h. and a mild thunderstorm with light rain. At 9:10 A.M. the Airway Weather Observer at Vero Beach issued another special weather bulletin reporting a moderate thunderstorm with heavy rain.

Examination of the Wreckage

The wreckage of NC 21727 was examined by representatives of the Civil Aeronautics Board. The examination did not reveal any evidence of failure of the structure, or control system, or of malfunctioning of either engine or of either propeller, prior to impact. An examination

of the aircraft's radio equipment did not indicate malfunctioning or failure of any of the radio equipment during flight.

The airplane came to rest in the swamp at a point where the water was approximately 2-1/2 feet deep. It was headed in an easterly direction (approximately 80 degrees). Inspection at the scene of the accident indicated that at the time of impact with the water the airplane was approximately level longitudinally and laterally, but was skidding to the right, with little forward speed. These conclusions are derived from the fact that the right and left landing gears were sheared from the airplane and were found approximately 40 feet to the left of the left wing tip. Both engines were also torn from their mountings and the left engine came to rest just forward and about 14 feet to the left of the nacelle in which it had been mounted. The right engine came to rest under the left wing tip and the examination of the undersurfaces of the wings indicated that after it was broken from its mounting the airplane actually passed over this engine traveling sidewise.

Examination of the surrounding terrain further substantiates the conclusion that the airplane was traveling in a southerly direction (sidewise) with little forward speed. A tree on an island approximately 160 feet north of the left wing tip had been very recently broken. There was a deep impression on the under-surface of the left stabilizer which indicated that it had struck this tree, and there were rubber markings upon the broken portions of the tree which also indicated that the leading edge of the stabilizer, which is covered with a rubber guard, had caused the break. The damage to the airplane indicates that it was not traveling at a high velocity at the time it struck the water.

This airplane carried a flight analyzer^{16/} (barograph), the purpose of which is to automatically record the altitude at which the airplane has been flown. The instrument records this information by an ink marking upon a barograph card made of specially designed paper by the manufacturer of the barograph. The ink supplied by the manufacturer of the instrument, when used in conjunction with the card, makes a marking that is virtually water proof.

The flight analyzer installed in NC 21727 was broken from its mounting and was found immersed in water on the floor of the companionway between the cockpit and the cabin door. Examination of the flight analyzer card did not reveal any markings to indicate the altitudes at which the airplane had been flown. This card was sent to the Federal Bureau of Investigation and their laboratory tests failed to bring out any markings, thus indicating that the instrument had not been in operation during the flight. This conclusion is further substantiated by the fact that Trip 14 departed from Miami at 7:45 A.M. and even though the water may have washed away those ink markings made just prior to the crash before they had become dry, it is reasonable to assume that had the flight analyzer been working the ink markings made during the early part of the trip, i.e., Miami to West Palm Beach, would have dried into the card and not have been obliterated by the water.

Although the flight analyzer was not required by regulation to be carried at the time

^{16/} Section 61.341 of the Civil Air Regulations, which requires that all air carrier aircraft having a gross weight in excess of 10,000 pounds used in scheduled air transportation of passengers be equipped with instruments for automatically recording altitudes while in flight, was passed by the Board on February 21, 1941, and will become effective on April 1, 1942.

this accident occurred, it is regrettable that the instrument which was being carried was not in operation, for a barograph record would have been of inestimable value in determining the degree of turbulence encountered by NC 21727.

Conduct of the Flight

In seeking to determine the cause of the accident to Eastern's Trip 14, we have concluded previously in this report that the aircraft had been properly maintained and was in airworthy condition when it took off from West Palm Beach. We have also determined that there was no structural or mechanical failure of the aircraft or any of its equipment until it crashed with power on into the swamp west-southwest of Vero Beach. It also appears that the airplane was properly loaded and that it had ample fuel for the flight. From the evidence it is clear that the radio range stations involved, Miami and Melbourne, operated and maintained by the Civil Aeronautics Administration, were operating normally on April 3, 1941.

The investigation included a study of the forecasts made by the United States Weather Bureau and Eastern's Miami meteorologists, the hourly weather sequence reports, and the weather conditions that actually existed along the Florida sector of Route 6 on the morning of April 3, 1941, to determine whether Trip 14 should have been dispatched and whether the trip was furnished current weather information while en route to Jacksonville.

The weather forecasts made by the United States Weather Bureau covering the period from 5:30 A.M. to 1:30 P.M. and the trip forecast made by Eastern's Miami meteorologist at 5:20 A.M. both predicted that there would be scattered thunderstorms along the Florida sector of the route. The prediction did not indicate that the weather conditions to be encountered would be in any respect unusual for the Florida area at that time of year. This prediction was borne out by the weather observations contained in the 6:35 A.M. weather sequence reports. However, the 7:35 A.M. and 8:35 A.M. weather sequence reports indicated the approach of more unfavorable weather conditions. The 7:35 A.M. weather sequence report indicated general thunderstorm and shower activity extending eastward across the State of Florida, with Tampa reporting a northeast wind of 32 m.p.h. with strong gusts and light rain showers. Both Orlando and Daytona Beach reported mild thunderstorms. The rain area extended about 120 miles northward from Tampa and Daytona Beach. The 8:35 A.M. weather sequence report showed an extensive thunderstorm and rain area in the central part of Florida. Tampa reported a northeast wind of 28 m.p.h. with strong gusts and a thunderstorm with rain showers. West Palm Beach and Vero Beach were reporting thunderstorms. The rain area extended north to Tallahassee on the west coast of Florida and to Jacksonville on the east coast.

In determining the characteristics of the thunderstorm activity as it actually occurred, we have, in addition to the Weather Bureau sequence reports, the observations of the Fort Pierce Coast Guardsmen, the testimony of the pilots flying four of Eastern's trips in that area and the statements of the crew and passengers of Trip 14. From this evidence we conclude that the storms in the vicinity of Vero Beach were accompanied by heavy turbulence, lightning, heavy rain, and hail. The reports of uprooted trees indicate that wind velocity in gusts may have ranged up to 40 or even 60 m.p.h. in certain portions of the storm although no official reports of such high velocity were recorded at any Weather Bureau station in the storm area. This general thunderstorm activity which extended in a line across the State of Florida by 7:35 A.M. with winds northerly or northeasterly in the northern portion of the thunderstorm area was probably of a cold front type with thunderstorms caused by the

displacing action of colder air from the north moving southward into warm unstable air. In such an extensive area of thunderstorm activity it is probable that thunderstorms of all intensities would be found scattered all through the general storm area.

A study of the weather data available to the Weather Bureau for its 5:30 A.M.-1:30 P.M. forecast and to Eastern's meteorologist for his 5:20 A.M. trip forecast indicates that they predicted weather conditions to be expected along the route with reasonable accuracy considering the present knowledge of thunderstorm forecasting. However, these weather forecasts were made more than two hours before the departure of Trip 14 and failed to predict the severity of the storms, especially the degree of turbulence that might be expected.

Both forecasts were available to Captain O'Brien before he left Miami, and the 6:35 A.M. weather sequence was attached to his clearance. There was nothing in the weather data to lead him to believe that any unusual weather conditions would be encountered along his route. However, when he left West Palm Beach at approximately 8:20 A.M., the 7:35 A.M. weather sequence report was attached to his intermediate clearance and before he actually entered the thunderstorm area the 8:35 A.M. weather sequence became available. These hourly teletype sequences gave all the necessary indications of the development of a frontal condition such as was actually encountered. By the time the 7:35 A.M. sequence report had been received, a definite trend toward the development of a cold front or line squall type of thunderstorm was indicated. The 8:35 A.M. weather sequence reports confirmed this.

Since the regular practice of the United States Weather Bureau does not provide for revised or intermediate forecasts, the airlines depends largely upon their own meteorological services for up-to-the-minute route and terminal forecasts. Therefore, it is clearly the responsibility of the company dispatcher and meteorologist to keep in constant touch with developments in the weather and to advise pilots if forecasts upon which they are depending appear to be erroneous. The 7:35 A.M. sequence report should have created a reasonable doubt in the mind of Eastern's Miami meteorologist as to the adequacy of both the trip and Weather Bureau forecasts, but after receiving, and presumably studying, that report, he made no attempt to supplement his original forecast or to issue a special revised forecast. By the time the 8:35 A.M. weather sequence reports were available, the weather conditions were such that efforts should have been made through the issuance of a strongly worded forecast or otherwise to advise pilots proceeding into the storm area that they would encounter, not scattered thunderstorms, but a line squall thunderstorm condition.

The dispatch and communications organization and procedure of Eastern Air Lines were also carefully considered during the course of the investigation and the evidence disclosed in that portion of the investigation shows a lack of adequate coordination between ground and flight operations and among aircraft in flight. At 8:20 A.M. Captain O'Brien took off from West Palm Beach on a weather forecast which indicated that he was to encounter scattered thunderstorms rather than a line squall or cold front which current weather data then available showed was to be anticipated. About 8:30 A.M. Captain Meyers of Trip 10, which had preceded Trip 14 by about 30 minutes, stated that he encountered this line squall and experienced violent turbulence. After having turned back out of the storm he was impelled by his experience to radio West Palm Beach stating that Trip 14 should be held on the ground at West Palm Beach because he was "running into instrument weather with heavy turbulence". The transportation agent at West Palm Beach acknowledged receipt of the message by informing Trip 10 that Trip 14 had already departed West Palm Beach. Trip 10 then sent to West Palm Beach a message asking that Trip 14 be told to "stay out until we are clear". The transpor-

tation agent then contacted Trip 14, which was at that time north of West Palm Beach, but, apparently failing completely to comprehend the significance of Captain Meyers' first message, only told Trip 14 that Trip 10 was on instruments and wanted Trip 14 to stand by until he was in the clear. In accordance with this request, Trip 14 did stand by for approximately 10 minutes until 8:45 A.M., when he sent the following message to West Palm Beach:

"14 IS GOING ON TO DB (Daytona Beach) ON TOP IF WE RUN INTO INSTRUMENT WEATHER WILL STAND BY 'TIL 10 IS CLEAR."

Captain O'Brien and Pilot Crabtree stated that they interpreted the message received from West Palm Beach as a request for them to remain in the clear, thus allowing Trip 10 sufficient time to clear the cloud mass and avoid the possibility of collision.^{17/} Since the message sent by West Palm Beach did not include any reference whatsoever to the "heavy turbulence" that Captain Meyers had reported, it is not surprising that this message was misinterpreted by Trip 14 in just this way. Trip 14 then proceeded north and encountered the line squall with its attendant severe turbulence.

After having sent the message to West Palm Beach, Captain Meyers of Trip 10 broke out into the clear and in an effort to get around the storm proceeded west across the State of Florida to a point approximately 10 miles west of Avon Park, a deviation of approximately 65 miles west of his normal course. Being unable to get around the storm, he returned to West Palm Beach, landing at 9:40 A.M. During this flight Captain Meyers apparently made no effort to get in contact with ground stations to give them further advice as to the violence of the storm which he had encountered.^{18/} Nor did he attempt to report his position, notwithstanding the wide deviation he had made from his normal course. On the other hand, West Palm Beach made no effort to get in touch with Captain Meyers in order to secure from him more details as to the storm conditions he had encountered even though the transportation agent there knew that Trip 14 was proceeding along the same route on which Captain Meyers had encountered the "heavy turbulence". Captain Meyers did not make a full report of his experience until after he had returned to West Palm Beach at 9:40 A.M. when he reported to Miami by telephone that he had "encountered heavy hail, heavy rain, and severe turbulence in the vicinity south of OR (Orlando)".

In addition to the above-described failure of coordination between Trips 10 and 14 and the ground station, another trip of Eastern was permitted to take off from Miami for Orlando notwithstanding the reported storm conditions. Captain Whipprecht of Eastern's Flight 10 was permitted to depart from Miami for Orlando at 9:00 A.M. despite Trip 10's 8:30 A.M. message that he had encountered heavy turbulence. Trip 10 radioed at 9:15 A.M. that the flight was returning to West Palm Beach. The only conclusion that could be reached from those two messages was that the captain of Trip 10 had encountered weather that he did

^{17/} At the time of this accident Airway Traffic Control had not been established in Florida and the area south and east of Alma, Georgia. An Airway Traffic Control Center is being established in Jacksonville, Florida, for this area and will be in operation on or about December 15, 1941.

^{18/} Section 61.770 of the Civil Air Regulations provides as follows:
"61.770 Weather interruption. If any hazardous flight condition is encountered en route, the pilot shall broadcast information as to the course of action which he is taking and as to his reasons therefor."

not consider safe to operate through. Notwithstanding this opinion on the part of one captain, another captain was permitted to proceed into the storm without even being told by Eastern's West Palm Beach ground station that severe storm conditions existed along his route.

All of this indicates that at least on this route of Eastern's, and on this occasion, after a pilot had once taken off from the originating point named in his formal clearance he received little subsequent assistance from ground personnel. The primary reasons for this condition apparently lay in the failure of the operations management of Eastern to provide an adequate dispatching system on Route 6, together with a sufficient number of trained dispatchers to keep in constant contact with flights in order to provide them with current and accurate flight information.

The dispatching of all Eastern's flights between New York and Miami is handled by a dispatcher stationed in New York. Eastern's currently effective certificate of convenience and necessity for the New York-Miami operation (designated as Route 6) authorizes it to engage in air transportation between the co-terminal points New York, New York, and Newark, New Jersey, and the intermediate points, Philadelphia, Pennsylvania; Baltimore, Maryland; Washington, D. C.; Richmond, Virginia; Raleigh, North Carolina; Charleston, South Carolina; Savannah, Georgia; Brunswick, Georgia; Jacksonville, Florida; Daytona Beach, Florida; Orlando, Florida; Vero Beach, Florida; and West Palm Beach, Florida, and the terminal point, Miami, Florida. The length of this route is approximately 1,250 miles. The dispatcher in New York in addition to handling all through north and south bound flights between New York, New York, and Miami, Florida, handles all flights between the terminal points and intermediate points on this route. The New York dispatcher also handles all north and south flights on Route 5 between New York, New York; Washington, D. C.; and Richmond, Virginia. The New York dispatcher has, during the 8:00 A.M. to 4:00 P.M. tour of duty, jurisdiction over some 30 flights, apart from extra sections. Of these, eight or ten are sometimes in flight simultaneously.

Gerald S. Ritchie was the dispatcher on duty 19/ at LaGuardia Field, New York, New York, on the morning of April 3, 1941. Mr. Ritchie issued a clearance at New York for Trip 14 to proceed from Miami to Jacksonville. This clearance which was transmitted via teletype to Miami 20/ was based on current weather information available to him. The dispatcher "did not think it was necessary to talk to the captain" (by telephone) since he "did not think anything would occur except routine flight". Dispatcher Ritchie was relieved of duty at 8:00

19/ Dispatcher Ritchie stated it was his understanding that it was the duty of Eastern's dispatchers to "go over the weather forecast and consult the meteorologist; clear flights from originating points to destination; and keep track of the flight en route by position reports; and plane dispatches from the station where it left, and in general assist the flight, that is the crew, any way we can, furnishing any information to them that we do not believe they would receive otherwise or that would be of interest to them or to the safety of the flight".

20/ In clearing flights from cities other than New York, on Route 6 (New York-Miami) and that portion of Route 5 outlined above, the clearances are issued via teletype and no contact is made with the captain when the dispatcher is of the opinion that the flight will be routine. However, if conditions exist which, in the opinion of the dispatcher, seem to be doubtful, he may contact the pilot by telephone before issuing the clearance.

A.M. by Larry C. Stevens.

The first fragmentary flight progress report concerning Trip 14 was received by Dispatcher Stevens in New York about 9:10 A.M. (a few minutes after the accident had occurred). This message from Eastern's Miami station contained the information that "Trip 10 had asked Trip 14 to hold in the vicinity of Palm Beach until Trip 10 got in the clear". This message also contained the information that Trip 14 was proceeding to Daytona Beach. Stevens further testified that "after 10 o'clock (A.M.)" he "received a message from Miami which was a copy of a report sent to them (Miami) by Captain Meyers as to the weather he had encountered".

As a result of the delay in transmitting communications, the New York dispatch office of Eastern had absolutely no information concerning Trip 14 from the time of the departure from Miami at 7:45 A.M. until about 9:10 A.M. which was after the accident had occurred. The New York dispatcher did not receive any weather reports from Eastern's Florida stations until after 10 o'clock that would cause him to be concerned with the safety of flight operations in the vicinity of Vero Beach. The New York dispatcher did not have the information that Trip 14 had been holding in the vicinity of Stuart and had then continued north, until approximately 25 minutes after the flight had proceeded north. According to the testimony the New York dispatcher did not know that Trip 10 had decided to return to West Palm Beach because of the weather condition until approximately 50 minutes after the decision to return was made. The New York dispatcher, who was stationed approximately 1100 miles from the locale of the bad weather and the scene of the accident, did not receive a report of the weather encountered by Trip 10 at 8:30 A.M. until after 10 o'clock.

The duties of the aircraft dispatcher are not limited to the dispatching of flights from one terminal point to another. He cannot consistently with the proper performance of his functions dispatch an aircraft and leave the remainder of the flight entirely to the pilot. He is responsible for keeping in frequent, regular contact with the flight in order that he can furnish the flight with all weather, traffic, and other pertinent information relating to the operation of the trip. It is obvious that Dispatcher Stevens of New York was not in frequent, regular contact with Trip 14 or any other trips operating in Florida about that time and that he could not possibly have furnished Trip 14 with the assistance to which Captain O'Brien was entitled. The only one who was actually in possession of sufficient information with respect to the operation of Trip 14 was the transportation agent at West Palm Beach.

Before persons are permitted to perform the functions of an aircraft dispatcher they must have an aircraft dispatcher certificate issued by the Administrator of Civil Aeronautics, which certificates are issued only after a showing of extensive aeronautical experience and a demonstration of adequate skill through written and practical examination. The purpose of these provisions is completely defeated if an airline fails to provide adequate dispatchers thus requiring them to communicate over such long distances that they cannot secure current information and by requiring them to have so many flights under their control that they cannot pay adequate attention to any of them. If a trained dispatcher had been located in the Florida sector of Route 6, he would have recognized the significance of Captain Meyers' 8:32 A.M. radio message that he was on instruments and encountering heavy turbulence. A qualified dispatcher could have been expected to transmit this message to Trip 14 accurately and would not have been satisfied with Captain Meyers' rather general weather report. He would have requested complete weather information promptly and would have

assisted the pilot of Trip 14 by reporting such information to him immediately. It is equally certain that such a trained dispatcher would not have failed to acquaint Captain Whipprecht with Captain Meyers' experience.

Section 61.55 of the Civil Air Regulations, dealing with dispatchers, provides in part as follows:

"61.550 Number required. The air carrier shall provide an adequate number of certificated aircraft dispatchers, necessary for the type of operation involved, for the purpose of dispatching air carrier aircraft."

"61.551 Location. One or more aircraft dispatchers shall be located at such points as may be deemed necessary by the Administrator to insure the safe operation of the air carrier."

It is a primary responsibility of the air carrier to establish its ground organization so as to comply with these regulations. As the result of the facts disclosed in the investigation of this accident, it was the considered judgment of the Board that Eastern had not provided sufficient dispatch centers on Route 6, and the Board on May 8, 1941, recommended to the Administrator of Civil Aeronautics that he conduct an informal investigation of the operating procedures of Eastern. The Board has been advised that Eastern has established an additional dispatch center at Miami to better facilitate flight operations on Route 6.

We have concluded that Eastern's ground personnel failed to properly apprise Captain O'Brien of the weather conditions that he might expect to encounter, but it does not necessarily follow that this omission by itself caused the accident. In view of the known frequency with which violently turbulent conditions are associated with thunderstorms, Captain O'Brien should have made the most careful observation of the thunderstorm area into which he was proceeding, since even the inadequate weather information furnished by Eastern's ground personnel predicted "light to occasionally moderate turbulence in scattered thundershowers" along the flight path. While it is impossible to determine whether or not mere visual observation of the cloud mass would have given warning that it possessed unusual characteristics, there is enough possibility that it might have done so to cause unfavorable comment on the lack of evidence of any concern on the pilot's part for the making of the closest possible examination of the characteristics of the storm, and of its apparent lateral extent, before entering it.

We must consider whether Trip 14 encountered turbulence of such extraordinary intensity that it was impossible for the captain, exercising the degree of skill expected of an airline pilot, to maintain control of the airplane. If the turbulence encountered did not approach that degree of severity, then an additional inquiry must be made into the degree of care and skill exercised by O'Brien after he entered the cloud mass.

In determining the degree of turbulence we have the testimony of the four Eastern Air Lines pilots who flew through the storm area on the morning of April 3, a meteorological analysis and the testimony of Captain O'Brien and First Officer Crabtree and of their passengers.

Of the four Eastern Air Lines pilots who flew through the storm, two described the turbulence encountered as "moderate"; another stated that he encountered "severe turbulence".

and the fourth pilot said that he encountered "some turbulence". Similarly, these statements are by no means conclusive of the precise degree of turbulence that was encountered by Trip 14, since these pilots did not enter the storm at the same time and the same point at which Captain O'Brien made his entry.

The Specialist in Meteorology of the Board made a thorough analysis of weather conditions in the area in question based upon sequence reports, radio sound data, and reports from pilots flying in the area on the morning of April 3. He concluded that the condition existing near Vero Beach at the time of the accident could not be considered as more than a mild frontal system in which severe turbulence could be expected. The analysis did not indicate the presence of turbulence more severe than might be expected in a local thunderstorm or moderate frontal condition, there being no evidence of a tornado or severely cyclonic condition existing in the area.

The passengers, in describing their sensations while the airplane was in the storm area, stated that articles in the cabin were thrown from the racks and at times were suspended from the top of the cabin. They alternately had the sensation of being pressed in their seats and being restrained from leaving their seats by the safety belts, thus indicating that the airplane did ascend and descend rapidly. These statements lead to the conclusion that the airplane did encounter severe turbulence, but they are by no means conclusive in determining whether the turbulence was of that degree of intensity that would have made control of the airplane impossible.

The testimony of Captain O'Brien and First Officer Crabtree displays substantial differences of opinion as to the degree of turbulence encountered, the instrument readings and the maneuvers of the airplane while they were in the turbulent air. Captain O'Brien's description of the flight with the attendant turbulence leads to the conclusion that the turbulence was of such intensity that it became impossible to have complete control of the maneuvers of the airplane. First Officer Crabtree's testimony leads to the conclusion that the airplane did encounter severe turbulence, but not of a degree of intensity that should have resulted in loss of control of the airplane. In weighing this testimony, we must take into consideration the relatively limited experience Captain O'Brien had accumulated as captain in operating DC-3 equipment on instruments in turbulent conditions and the fact that First Officer Crabtree's DC-3 experience was limited to operation as copilot for about seven months. Captain O'Brien stated that during the first updraft the air-speed indicator showed an ascent of 1000 feet a minute, while Crabtree testified that during this first updraft the air-speed indicator went past a reading of 250 m.p.h. and the rate of climb indicator showed an ascent of 2000 feet per minute. Captain O'Brien stated that the indicated air speed was between 190 and 200 m.p.h. at the time they broke out of the overcast, while Crabtree testified that as they broke out of the overcast the indicated air speed was between 60 and 70 m.p.h.

Captain O'Brien and First Officer Crabtree also expressed a difference of opinion as to the reading of the bank and turn indicator. Captain O'Brien stated that during the turning maneuvers the ball in the bank and turn indicator was in the right corner and the hand was as nearly centered as possible, only oscillating approximately its own width. First Officer Crabtree testified that at least during what he believed was a spin, the ball in this indicator was in the right corner and the hand was in the left corner. As to the maneuvers of the airplane while it was in the turbulent air, the captain stated that following the first updraft they encountered a series of up and downdrafts, each approximating

1000 feet. Captain O'Brien further stated that "it was absolutely impossible to have control of the turning radius of the airplane and control of the ascent and descent at all times"; this he attributed to an "extremely strong rotary pressure" that resulted in the airplane making flat turns. First Officer Crabtree testified that they encountered only the one updraft followed by the steep left bank, the loss of air speed, the subsequent spin, and recovery. It is impossible to conclude from this testimony whether the airplane was actually in a spin or making a number of flat turns in rapid succession. However, from the testimony it would appear that if the airplane was in a spin it was a relatively flat one and at a relatively low air speed with a small inclination of the longitudinal axis to the horizontal. We have found no record of any occurrence of this sort involving large modern multi-engine aircraft. In spite of a careful analysis of the record, we find it impossible to reach a definite conclusion on this point.

After giving proper weight to the testimony of Captain O'Brien and First Officer Crabtree, the passengers aboard the aircraft, and the four Eastern Air Lines pilots, and to the meteorological analysis, we conclude that the airplane encountered severe turbulence. However, it is impossible to determine with any degree of certainty the intensity of the turbulence and for this reason we cannot reach a conclusion as to whether Captain O'Brien exercised that degree of skill which could reasonably be expected of an airline pilot while the airplane was in the line squall. Captain O'Brien stated in his testimony that he observed a cloud formation extending across his course out to sea and inland indicating a frontal condition to be entered at right angles. Since in this instance the flight was at right angles to the line squall, a left turn probably served to keep the flight in the turbulent area for a longer period than would have been the case if the flight had continued on its original course. Moreover, in making a turn in such conditions, the difficulty of keeping the airplane under control is increased as the power required to maintain level flight in a banked turn is greater than in straight flight and the stalling speed is increased.

In conclusion, it must be said that this accident was the result of lax operating procedures and a severe weather condition. The most clearly remediable factor is, of course, the operating procedures of Eastern. In fact, this accident might have been prevented if Eastern's operations had been so conducted as to insure the pilot's receiving such information and instructions as were, or could reasonably have been expected, to have been available to ground personnel. Special caution in these matters should always be displayed when flights are dispatched over routes where they may encounter distinctly unfavorable weather conditions such as a cold front or line squall type of thunderstorms.

III

CONCLUSION

Findings

We find, upon all of the evidence available to the Board at this time, that the facts relating to the accident involving NC 21727, which occurred about 10-1/2 miles west-southwest of Vero Beach, Florida, on April 3, 1941, are as follows:

1. The accident which occurred at approximately 9:07 A.M. on April 3, 1941, to Eastern Air Lines Trip 14 of that date resulted in major damage to aircraft NC 21727 and serious injuries to ten passengers and the three crew members, and minor injuries to three passengers.

2. At the time of the accident Eastern Air Lines held a currently effective certificate of public convenience and necessity and an air carrier operating certificate authorizing it to conduct the flight.

3. Captain O'Brien and First Officer Crabtree were physically qualified and held proper certificates of competency to operate as air carrier pilots over the subject route.

4. Aircraft NC 21727 was currently certificated as airworthy at the time of the accident.

5. Trip 14 was cleared in accordance with company procedure from Miami, Florida, to Jacksonville, Florida, with Savannah, Georgia, as an alternate.

6. At the time of departure from Miami, Florida, at the time of departure from West Palm Beach, Florida, and at the time of the accident, the gross weight of the airplane did not exceed the permissible gross weight and its load was properly distributed.

7. At the time of departure from Miami, Florida, for Jacksonville, Florida, the aircraft carried sufficient fuel to permit flight at normal cruising power to Jacksonville and thereafter to permit it to proceed to its alternate airport with sufficient fuel still remaining in the tanks for about 45 minutes of flight.

8. Trip 14 proceeded normally from Miami, Florida, to West Palm Beach, Florida, and from that point on, except for circling in the vicinity of Stuart, Florida, until it entered a thunderstorm accompanied by severe turbulence in the vicinity of Vero Beach, Florida.

9. The weather forecasts predicted scattered thunderstorms and moderate turbulence along the Florida sector of Route 6. The airplane encountered a line squall accompanied by severe turbulence of undetermined intensity.

10. Eastern Air Lines' meteorologist did not observe weather sequence reports to the extent of recognizing a frontal system which was developing across Florida and extending to the east coast in the vicinity of Vero Beach.

11. A short time after entering the region of the thunderstorm west of Vero Beach, the aircraft went out of control and, after executing a series of maneuvers, struck the surface of a swamp about 10 miles west-southwest of Vero Beach, Florida, with resultant major damage.

12. There was no structural or power plant failure prior to the accident.

13. The engines were functioning normally at the time the aircraft struck the swamp.

14. The company transportation agent at West Palm Beach did not relay to Trip 14 a verbatim report of the weather conditions that Trip 10 reported at 8:32 A.M.

15. Eastern did not provide an adequate dispatching system together with a trained

number of certificated dispatchers on Route 6 so that aircraft could be informed of changing flight conditions as they progressed along the airway. The distance between New York and Miami is about 1,250 miles and it was not possible for the dispatcher stationed at LaGuardia Field to maintain adequate supervision and control over the numerous aircraft simultaneously in flight and nominally under his supervision.

PROBABLE CAUSE

Upon the basis of the foregoing findings and of the entire record available at this time, we find that the probable cause of the accident to NC 21727 (Eastern Air Lines Trip 14) on April 3, 1941, was loss of control of the airplane while being operated on instruments and while encountering severe turbulence in a line squall, the existence of which the carrier's ground personnel had failed to make known to the captain.

CONTRIBUTING FACTORS

1. Failure of carrier to provide an adequate dispatching system with a number of trained dispatchers on Route 6 to keep in constant contact with flights in order to provide them with current and accurate flight information.
2. Failure of carrier's West Palm Beach ground station to transmit to Trip 14 the full text of the message received from Trip 10 at 8:32 A.M.
3. Failure of carrier's meteorologist to make a more thorough analysis of weather conditions and issue a supplementary forecast to that originally issued for the operation of Trip 14.
4. Although as we have previously stated, it is impossible to reach a definite conclusion as to the degree of severity of the problem presented to the pilot, it appears very possible that the handicap of the captain's limited experience in flying transport aircraft under conditions of severe turbulence was a factor contributing to the occurrence of the accident.

RECOMMENDATIONS

I. The Civil Aeronautics Board now recommends to the Administrator of Civil Aeronautics that unless appropriate action has already been inaugurated, he make a thorough study of all air carrier pilot training and checking programs to determine whether present procedures are adequate to insure instruction and checking in methods of recovery solely by instruments from unusual attitudes which air carrier aircraft may assume, or unusual maneuvers they may execute, while being operated.

II. The Civil Aeronautics Board recommends that the National Advisory Committee for Aeronautics

- (1) Continue and intensify its study of improved methods of classifying and describing turbulence with reference to its effects on the pilot's control on the path and attitude of aircraft;

- (2) Compile and analyze the experience of pilots who have flown aircraft through turbulence of extra-ordinary severity; and
- (3) Conduct spinning tunnel tests to determine the spin characteristics of the DC-3 and especially its susceptibility to flat spins.

III. It would appear from the present investigation that the carrier's management has failed to provide enough dispatching centers, and so to distribute them as to give prompt service and instruction to pilots in flight over all parts of the carrier's system; and that procedures with respect to flight control were inadequate and should be improved. These matters among others becoming apparent in the first stages of the investigation of this accident, and of the accident which took place near Atlanta, Georgia, on February 26, 1941, were communicated to the Administrator of Civil Aeronautics on May 8, 1941, with a recommendation that he conduct, through his staff, a further examination of these and related matters. The Board is informed that further studies were made by the Air Carrier Inspection Section and that shortly after the accident the carrier established a dispatch office in Miami to supplement the dispatch centers at Atlanta and New York.

BY THE CIVIL AERONAUTICS BOARD:

/s/ Edward Warner
Edward Warner, Acting Chairman

/s/ Oswald Ryan
Oswald Ryan, Member

/s/ G. Grant Mason, Jr.
G. Grant Mason, Jr., Member

/s/ George P. Baker
George P. Baker, Member

Branch, Chairman, did not take part in the decision.

APPENDIX A-- Report on Accident to Eastern Air Lines Aircraft NC 21727 near Vero Beach, Florida, on April 3, 1941

WEATHER BUREAU AIRPORT STATION, ATLANTA, GEORGIA,
AIRWAY FORECAST FOR 0530--1330 E, APRIL 3, 1941.

"Southern Georgia and northern and central Florida, broken to overcast cloudiness at 2 to 4 thousand with rain showers and scattered local thundershowers will prevail. Scattered to broken high cloudiness with scattered to broken lower cloudiness forming at 2 to 3 thousand by mid-morning will prevail southern Florida. Visibility generally 6 or better aside from precipitation limitation except locally limited somewhat in city smoke first half period."

"Miami Terminal. Scattered to broken high cloudiness throughout period with scattered to broken lower cloudiness at 2 to 4 thousand after around 0930 E. Visibility over 6."

"Jacksonville Terminal. Variable low cloudiness with broken to overcast intermediate cloudiness above. Occasional light rain showers will occur last half period. Ceiling 2 to 5 hundred in low cloudiness and 3 to 5 thousand otherwise. Visibility 4 to 10. Low cloudiness will dissipate after about 0830 E."

APPENDIX B-- Report on Accident to Eastern Air Lines Aircraft NC 21727 near Vero Beach,
Florida, on April 3, 1941

"EASTERN AIR LINES TRIP FORECAST ISSUED AT MIAMI
AT 5:20 A. M., APRIL 3, 1941

"Route forecast: Light to occasionally moderate turbulence in scattered thundershowers Vero Beach to Jacksonville."

"Terminal forecasts: West Palm Beach CAVU (ceiling and visibility unrestricted); Daytona Beach scattered to broken 3 to 5 thousand. Occasional light thundershower. Visibility over 3; Jacksonville, becoming broken 4 thousand or higher. Visibility 2 to 4 in occasional light thundershowers."

APPENDIX C-- Report on Accident to Eastern Air Lines Aircraft NC 21727 near Vero Beach, Florida, on April 3, 1941

The 6:35 A. M., 7:35 A. M., 8:35 A. M., and 9:35 A. M. Weather Sequence from Miami to Jacksonville, Florida, on April 3, 1941

6:35 A. M. Sequence:

MIAMI, Class C Weather
0635 E

High broken clouds, lower scattered clouds at 5000 feet, sea-level pressure 1010.8 millibars, temperature 75, dew point 67, wind southeast 16 miles per hour, altimeter setting 29.85.

WEST PALM BEACH
0635 E

Ceiling estimated 5000 feet, upper and lower broken clouds, pressure 1011.2 millibars, temperature 73, dew point 64, wind southeast 13, altimeter setting 29.85.

VERO BEACH
0635 E

Ceiling estimated 8000 feet, overcast, pressure 1011.2 millibars, temperature 70, dew point 62. Wind direction missing, velocity 13 miles per hour, altimeter setting 29.85.

MELBOURNE
0635 E

Ceiling estimated 6500 feet, overcast, visibility 8 miles, pressure 1010.8 millibars. Temperature 69, dew point 63, wind east 14, altimeter setting 29.84.

ORLANDO
0635 E

Ceiling estimated 900 feet, overcast, lower broken, visibility 2 miles, mild thunderstorm, moderate rain, light fog. Temperature 63, dew point 59, wind east southeast 9. Remarks: Lightning all quadrants.

DAYTONA BEACH

Ceiling estimated 5000 feet, overcast, visibility 8 miles, light rain, pressure 1012.5 millibars. Temperature 64, dew point 61, wind southwest 4, altimeter setting 29.89.

JACKSONVILLE
0635 E

Ceiling unlimited, high overcast, visibility 10 miles or better, pressure 1010.8 millibars. Temperature 62, dew point 55, wind southeast 8, altimeter setting 29.84.

7:35 A. M. Sequence:

MIAMI, Class C Weather
0735 E

Ceiling 1600 feet, high broken clouds, lower broken clouds, visibility 8 miles, pressure 1011.2 millibars. Temperature 74, dew point 68, wind east southeast 10, altimeter setting 29.85.

WEST PALM BEACH
0735 E

Ceiling estimated 5000 feet, overcast, pressure 1011.5 millibars. Temperature 74, dew point 63, wind southeast 15, altimeter setting 29.86. Pressure tendency falling then rising. 0.4 millibars in the last three hours. Stratocumulus clouds moving from the southeast.

VERO BEACH
0735 E

Ceiling estimated 6500 feet, high overcast, lower broken, pressure 1010.8 millibars, temperature 71, dew point 63, wind southeast 14, altimeter setting 29.84, pressure tendency falling unsteadily 0.4 millibars.

MELBOURNE
0735 E

Ceiling estimated 2000 feet, overcast, lower broken, visibility 6 miles light rain, pressure 1012.9 millibars. Temperature 68, dew point 63, wind northeast 9, altimeter setting 29.90. Base of overcast at 5000.

ORLANDO
0735 E

Ceiling estimated 800 feet, overcast, lower broken clouds, visibility 2 miles, mild thunderstorm, light rain, light fog. Temperature 61, dew point 60, wind east 12, estimated 1500 feet overcast. Low broken clouds, altostratus clouds moving from the east.

DAYTONA BEACH
0735 E

Ceiling estimated 4000 feet, overcast, visibility 7 miles, mild thunderstorm, light rain, pressure 1013.7 millibars. Temperature 63, dew point 61, wind south-southwest 5, altimeter setting 29.93. Cumulonimbus clouds, altostratus moving from the northwest.

JACKSONVILLE
0735 E

Ceiling unlimited, high overcast, visibility 10 miles or better, pressure 1011.9 millibars. Temperature 62, dew point 57, wind east 9, altimeter setting 29.87.

8:35 A.M. Sequence:

MIAMI
8:35 A.M. EST

Classification Contact, special, ceiling estimated 16 hundred feet, high overcast, lower broken clouds, visibility 5 miles, hazy, pressure 1011.2 millibars, temperature 75, dew point 69, wind southeast 15, altimeter setting 29.85.

WEST PALM BEACH
8:35 A.M. EST

Special, ceiling estimated 5 thousand feet, overcast, visibility 8 miles, mild thunderstorm, pressure 1011.5 millibars, temperature 74, dew point 62, wind southeast 15, altimeter setting 29.86, remarks showery conditions.

VERO BEACH
8:35 A.M. EST

Special, ceiling estimated 2 thousand feet, high overcast, lower broken clouds, visibility 7 miles, mild thunderstorm, light rain, pressure 1008.5, temperature 69, dew point 64, wind east-southeast 26, altimeter setting 29.77, remarks thunderstorm centered west to northwest.

MELBOURNE
8:35 A.M. EST

Ceiling estimated 8 hundred feet, overcast, lower broken clouds, visibility 1 mile, moderate thunderstorm, moderate rain, pressure 1015.2 millibars, temperature 61, dew point 59, wind southeast 3, altimeter setting 29.97, remarks thunderstorm overhead brightening west.

ORLANDO
8:35 A.M. EST

Ceiling estimated 6 hundred feet, overcast, visibility 3 miles, light rain, temperature 60, dew point 59, wind east-northeast 5.

DAYTONA BEACH
8:35 A.M. EST

Ceiling estimated 3 thousand feet, overcast, scattered clouds at 15 hundred feet, visibility 6 miles, mild thunderstorm, light rain, pressure 1014.2 millibars, temperature 63, dew point 61, wind southeast 5, altimeter setting 29.94.

JACKSONVILLE
8:35 A.M. EST

Classification Contact.

Ceiling estimated 7 thousand feet, overcast, scattered clouds at 3 hundred, visibility 4 miles, light rain, pressure 1012.2 millibars, temperature 62, dew point 59, wind southeast 6, altimeter setting 29.88.

9:35 A M Sequence:

MIAMI
9:35 A.M. EST

Classification Contact.

Ceiling estimated 16 hundred feet, high broken clouds, lower broken clouds, visibility 6 miles, hazy, pressure 1011.5 millibars, temperature 78, dew point 71, wind southeast 19, altimeter setting 29.86.

WEST PALM BEACH
9:35 A.M. EST

Ceiling estimated 6 thousand feet, overcast, visibility 7 miles, pressure 1010.8 millibars, temperature 75, dew point 66, wind southeast 16, altimeter setting 29.84.

VERO BEACH
9:35 A.M. EST

Special, ceiling estimated 6 hundred feet, overcast, visibility 1 mile, mild thunderstorm, moderate rain, pressure 1012.9 millibars, temperature 62, dew point 62, wind east-northeast 12, altimeter setting 29.90, remarks thunderstorm moving southwestward.

MELBOURNE
9:35 A.M. EST

Special, ceiling estimated 25 hundred feet, overcast, scattered clouds at 1 thousand feet, visibility 3 miles, mild thunderstorm, light rain, pressure 1013.5 millibars, temperature 63, dew point 60, wind east-northeast 18, altimeter setting 29.92, remarks thunderstorm centered west.

ORLANDO
9:35 A.M. EST

Ceiling estimated 6 hundred feet, overcast, visibility 5 miles, light rain, temperature 59, dew point 59, wind east 9, remarks occasional mild thunderstorm.

DAYTONA BEACH
9:35 A.M. EST

Special, ceiling estimated 12 hundred, overcast, lower broken clouds, visibility 4 miles, light rain, pressure 1012.5 millibars, temperature 60, dew point 59, wind southeast 18, altimeter setting 29.89.

JACKSONVILLE
9:35 A.M. EST

Classification Contact, ceiling estimated 7 thousand feet, overcast, thin scattered clouds at 3 hundred feet, visibility 4 miles, light rain, pressure 1013.5 millibars, temperature 62, dew point 59, wind south 14, altimeter setting 29.92.