

## CIVIL AERONAUTICS BOARD

## ACCIDENT INVESTIGATION REPORT

Adopted: July 16, 1946

Released: July 19, 1946

EASTERN AIR LINES - FLORENCE, SOUTH CAROLINA - SEPTEMBER 7, 1945The Accident

Eastern Air Lines' Flight 42 of September 6, enroute from Miami, Florida, to New York, N. Y., crashed near Florence, S. C., about 0213, September 7, 1945. All nineteen passengers (of which ten were military personnel) and the three crew members were fatally injured. The DC-3 was totally destroyed by impact and fire.

Description of the Flight

Flight 42 departed Miami for New York City at 2122 EDT\*, September 6, 1945, with routine stops at Jacksonville, Fla., and Savannah, Ga. Having obtained an instrument clearance from Airway Traffic Control to cruise at 5,000 feet to Raleigh, N. C., the flight departed Savannah at 0041, September 7, with Washington and Baltimore listed as alternates. At 0150 the flight transmitted a position report to the company station at Washington indicating that it had passed over Florence at 0144 at 5,000 feet. The flight was advised that Raleigh, N. C., its next scheduled stop, was reporting a 300 foot overcast. Since the weather at Raleigh was below authorized minimums, Flight 42 requested permission from the company dispatcher to proceed past Raleigh without landing. The station at Washington advised the flight at 0155 that it had been re-cleared to Washington with Baltimore as an alternate, but no acknowledgment of the message was received.

At 0205, a radio transmission from Flight 42 was intercepted in which it was indicated that the pilot intended to return to Florence and that he desired clearance to land at Florence Field. Because of the unusually severe radio interference, the entire message was not readable and no reason was apparent at that time for the pilot's decision to return to Florence. Several subsequent attempts by company, CAA and army stations in the vicinity to contact the flight were unsuccessful.

While attempting to return to Florence the aircraft crashed at 0213 in a swampy, wooded area 6 miles ENE of Florence Army Air Field. The wreckage was located at approximately 1040, September 7.

#### The Investigation

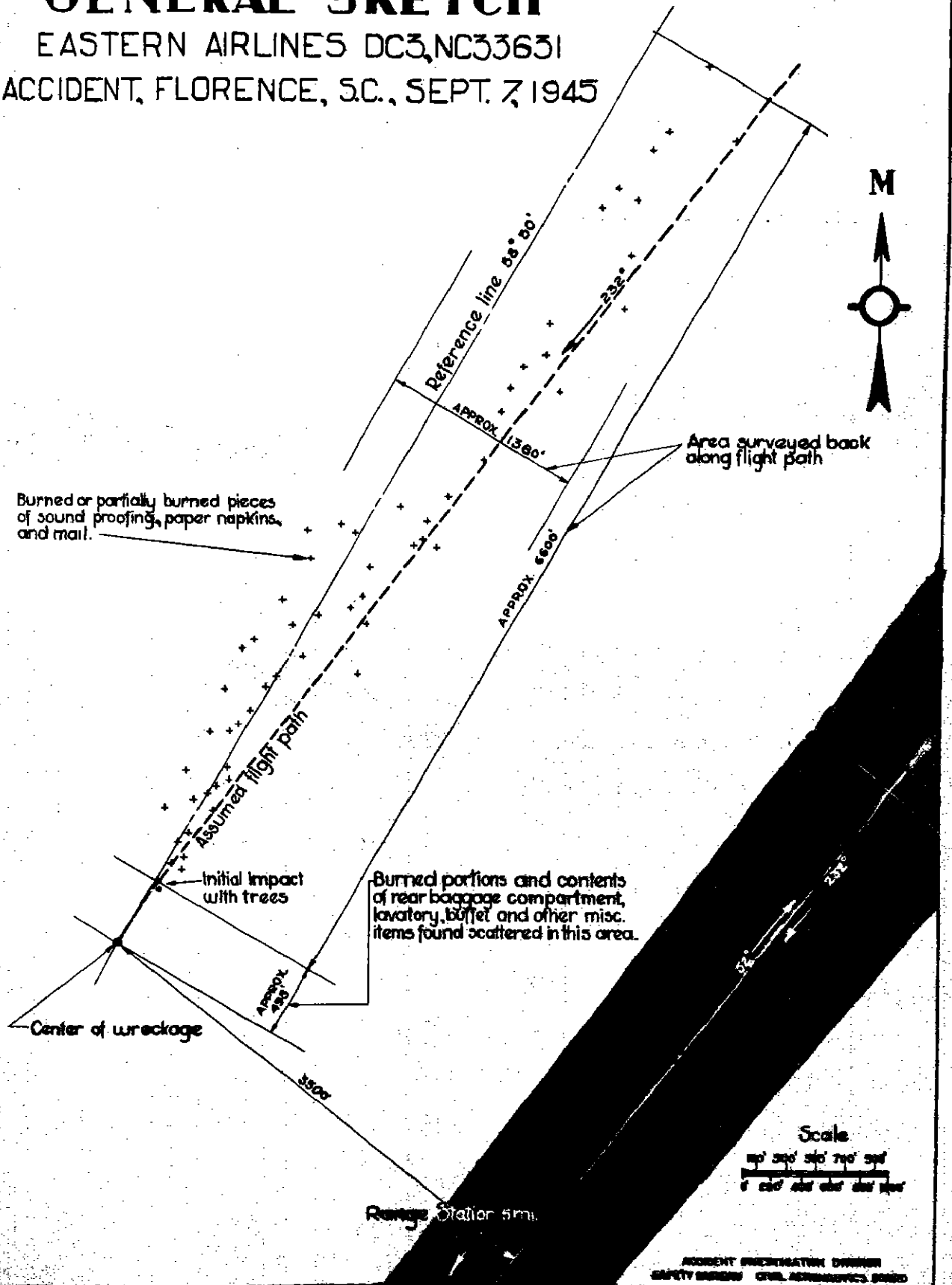
The accident occurred near the edge of a dense, marshy forest with thick underbrush and miscellaneous swamp vegetation. The major portion of the wreckage was confined to a relatively small area of about 100 feet square, however, other parts and contents of the airplane were strewn along the flight path over a distance of approximately 7,000 feet northeast of the scene of the wreckage.

Initial contact of the airplane was with two tall pine trees at a point about 70 feet above the ground. One of these trees tore the bottom of the fuselage from just aft of the nose to about the rear of the cabin. The other tree was glanced by the left wing. Miscellaneous parts of the airplane and its contents were torn out and fell to the ground. The next contacts of the airplane, which was then in a slightly nose-low attitude, were with several medium size trees, one of which severed the left wing tip. After these contacts, the aircraft assumed increasingly a left wing-low attitude, shedding structural parts and contents while

# GENERAL SKETCH

EASTERN AIRLINES DC3, NC33631

ACCIDENT, FLORENCE, S.C., SEPT. 7, 1945



continuing through smaller trees. With the left wing dropping until it was almost vertical, the airplane struck the ground, the left wing taking the brunt of the impact. At about this time the vertical tail surfaces were sheared off by two medium size trees and the fuselage broke in two near the main cabin door, the forward part whipping over to the left. Ignited gasoline spread fire consuming most of the forward part of the aircraft and its contents.

Examination of objects which fell from the aircraft between the points of first and final contacts (495 feet apart) indicated that most of them were from the general region of the lavatory, buffet and rear baggage compartment. All of the objects from this part of the airplane were either severely burned or showed signs of fire. Along the probable flight path back of the point of initial contact were found numerous pieces of burned soundproofing, partially burned paper napkins, a few partially burned letters and a small piece of material from personal luggage. These items were scattered over an area about 400 feet wide and at least a mile long, and are conclusive evidence that the aircraft was afire prior to the crash. (Attached sketch shows their distribution.)

A detailed study of the wreckage and of the parts which fell from the airplane prior to impact with the ground indicates definitely that the concentration of fire in flight was in the rear of the fuselage. The great number of pieces of burned paper napkins indicates the presence of fire within the buffet compartment. Burned soundproofing and various items from the lavatory compartment which were found almost completely consumed by fire prior to final impact indicate a strong possibility that the lavatory was the location of the initial fire. However the presence of burned mail and the piece of luggage suggests the possibility

of the fire originating within the rear cargo compartment. In general the origin of the fire can be fixed in the area of the right side of the rear baggage compartment, the lavatory and possibly the adjacent portion of the buffet. Apparently flames, sparks and thick smoke were being forced into the tail cone of the fuselage from where they extended into the stabilizers. Fire was so intense in the right stabilizer as to burn through the rear spar web fabric covering and ignite the right elevator in flight.

Nothing in the wreckage indicated malfunctioning or mechanical failure of any part of the airplane other than that caused by the fire. Both throttles were back, the master switch was off and both propellers were set near low pitch at the time of final impact. No fire existed in the front part of the fuselage or in the engine nacelles until after impact which caused ignition of the fuel. The fuel dump valves were not used nor was the engine fire extinguisher. Wheels and flaps were retracted and the right landing light was on. The elevator tabs were found deflected and the indicator on the pedestal showed a 10° nose-up setting with the tab control wheel being jammed. Two hand fire extinguishers of a carbon dioxide type were located in the vicinity of the wreckage and their appearance indicated that they had been used prior to impact.

Search for articles which might have started the fire was unfruitful. The only foreign items located were pieces of glass identified as part of a cordial bottle found among the burned remains of the lavatory. Both flares, the chutes for which are located aft of the baggage compartment, were found burned and away from the main wreckage. It was established that they were pulled out of their chutes as the airplane crashed through the trees.

The bodies of the Flight Attendant, the First Officer and all passengers were located in the front part of the wreckage which

would normally include the companionway between the cabin and the pilot's compartment. It was subsequently determined that 17 adults could be crowded into the companionway and the door to the passenger compartment closed behind them.

The aftercast of the weather situation within the area indicated a weak high pressure cell centered off the North Atlantic seaboard causing on-shore winds from Maryland to Florida. A shallow trough of low pressure remained through the southeastern part of North Carolina following the dissipation of a stationary front. This trough extended west-southwestward from Cape Hatteras passing just north of Florence. Stratus overcasts with low ceilings and fog formed in the northern portion of North Carolina and late on September 6 began extending southward toward the center of the trough line. Because of the high moisture content of the on-shore circulation, low ceilings were forecast for the middle Atlantic states with progressive lowering and fog accompanying diurnal cooling.

Weather Bureau and Company forecasts both predicted that Florence and its vicinity would maintain fairly high ceilings and good visibilities throughout the period, but that the flight could expect a gradual increase of sky cover and lowering of ceilings as it proceeded north of Florence. The subsequent analysis of the weather situation indicated that they correctly anticipated the trends throughout the area. It was determined that the visibility and sky condition in the proximity of the crash were good and that the aircraft was clearly visible to ground observers for several minutes prior to the crash.

## Discussion

In reconstructing the flight path of the aircraft from the time it passed over Florence enroute to Washington until it crashed near Florence Army Air Field, it appears likely that return flight was started at 0158 when the airplane was 45 miles northeast of Florence. Assuming a direct flight path to Florence Field, at 0205, when the message from the flight was intercepted requesting clearance to land at Florence, the aircraft would have been approximately 28 miles from the field. Although there is no conclusive evidence to indicate the reason for returning to Florence, it is assumed that discovery of the fire prompted this action. The flight was no doubt either in or above an overcast at the time it turned back to Florence. Since the only information the captain had received concerning the weather immediately north was the Raleigh sequence report which indicated below minimum conditions at that station, and, since forecasts available to him predicted low ceilings and visibilities throughout that area, he evidently elected to turn south where better weather conditions existed. The nearest field, Lumberton, North Carolina, although it did possess light facilities, was not served by a radioaid, and would have been difficult to locate. It therefore appears reasonable to assume that, having detected the fire in flight, the captain chose to return to Florence for an emergency landing rather than attempt to locate a nearer field under adverse weather conditons.

It is probable that the pilot had intended to descend to a low altitude in order to be able to land at Florence without delay but there is also a possibility that the severity of the fire had become increasingly apparent and that he intended to make an emergency landing

on the first open field. The densely wooded area over which he was flying ended a few hundred yards beyond the point of impact after which it may have been possible to crash land the aircraft. The fact that the right landing light was on indicates that the pilot may have been looking for a suitable landing area at the time of impact.

Examination of the wreckage indicates that the right elevator caught fire immediately prior to the final crash. It is also apparent that all of the passengers, the Flight Attendant and the First Officer were crowded into the companionway. These factors would have rendered longitudinal control very difficult and probably made the collision with the first of the trees unavoidable.

Investigation of the wreckage, review of the history of the flight and analysis of records of fire in flight available to the Board failed to disclose the source of the fire. The extent of fire following impact was such that a considerable portion of the aircraft structure, accessories and baggage was consumed on the ground complicating the subsequent inspection of the wreckage. It was determined, however, that once started, the fire spread to such an extent that the several combustible materials contained on board the aircraft such as toilet and lunch accessories, baggage and mail became ignited and contributed to the severity of the fire. It is apparent that the structural sheet aluminum between compartments was eventually burned through and further complications involving additional air flow and the ignition of other combustible materials were subsequently encountered. The severity of the fire, therefore, can to a large measure be attributed to the presence of a considerable amount of materials of relatively high combustibility on board the aircraft although the exact origin of the fire was not determined.



In discussing the causes for the fire it is necessary to analyze the inflammable characteristics of various materials in that part of the airplane where the fire apparently started. Baggage and mail are obviously inflammable as is much of the buffet and lavatory equipment. Cabin interiors are lined with fabric treated to reduce inflammability. This treated material will not burn as readily as doped fabric but it is nevertheless inflammable. Soundproofing also will burn. Paper probably burns the most readily of all materials present in the airplane cabin. During tests conducted subsequent to the accident by a government agency a fire of wrapping paper attained a temperature of over 1100<sup>0</sup> F. Inasmuch as the aluminum alloy used for skin and structural members of the DC-3 has a melting point under 1200<sup>0</sup>, it is apparent that paper alone could have been responsible for the burning of the metal in the rear of the fuselage during flight and that no other inflammable material need have been present.

The speed with which fire would spread within the fuselage of a DC3 depends upon the presence and the direction of draughts. Two factors influence the air flow conditions; namely, the settings of the heating and ventilating systems and the opening or closing of doors and windows in the pilots' cockpit. Opening of doors tends to increase air circulation sharply. In general the direction of air flow is toward the front of the cabin. This condition is aggravated appreciably if the side windows in the pilots' cockpit are open. Thus, with a fire in the rear of the cabin or in the lavatory, open doors would accelerate its spread toward the front of the cabin. In view of the very definitely marked area of fire concentration it appears that the air flow was not conducive to the spreading of the fire until portions of the lavatory and baggage compartment partitions were burned through.

While the source of the fire has not been determined, the portion of aircraft in which the fire originated has been fairly accurately established.

It is not known whether the fire originated within the baggage compartment or the lavatory but it is apparent that the greatest concentration of fire existed near the partition adjoining these two compartments and that it spread forward into the buffet section and coat rack as well as rearward into the tail cone after having reached fairly intense proportions. In view of the inaccessibility of the baggage compartment, it is probable that a fire in that area would have reached such intensity as to have made subsequent efforts at extinguishment futile. It is of prime importance that fire in aircraft be detected immediately upon ignition or, in the case of an incipient fire, before a blaze is started. In investigating the development of automatic fire detecting equipment, it was noted that there are available smoke detectors which provide an extremely effective device for the detection of smoldering fires before they become of intense proportions. However, inasmuch as little testing has been accomplished with smoke detectors in flight, the applicability of present designs to the DC-3 has not been known until recently and they are therefore not in general use within DC-3 aircraft.

Had the fire been detected in the baggage compartment the problem of extinguishment would have been further complicated by the fact that access to the baggage compartment was possible only through an opening which is approximately four and a half feet from the floor and the average dimensions of which are 21 inches by 16 inches. It is obvious that the angles from which the fire extinguishing agent may be directed against a fire are extremely limited and that some difficulty may be experienced in directing the agent against the burning substances particularly in a compartment in which several bulky parcels are stored. As an added precaution against the recurrence of such a situation, it is apparent that a larger opening should be provided into the baggage compartment to permit the entry of a crew member when necessary. Some DC-3 aircraft are currently in operation which possess

a door large enough to permit entry into the baggage compartment from the cabin or lavatory but such design is by no means standardized throughout the industry.

The investigation disclosed the fact that the carbon dioxide hand fire extinguishers carried on board the aircraft were used in flight apparently without success. While the circumstances under which they were used in this instance are not known, serious questions have since arisen concerning the effectiveness of carbon dioxide as compared with other available agents. In tests conducted by the Civil Aeronautics Administration, it has been demonstrated that the effectiveness of methyl bromide as a fire extinguishing agent is superior to that of carbon dioxide particularly in gasoline and oil fires. It is common knowledge that smoldering fires in such items as luggage and pillows are more effectively subdued by carbon tetrachloride extinguishers. It is apparent that further consideration needs to be given the subject of fire extinguishing agents. The toxicity of the lesser known agents must be determined and their use made contingent upon additional investigation into airflow within the fuselage and its control.

#### Findings

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

1. The company, aircraft and crew were properly certificated for the flight.
2. Until reporting over Florence, S. C., the flight had been of a routine nature with no unusual circumstances having been observed.
3. Fire was discovered on board the aircraft after having passed Florence.
4. The fire originated in the general area of the right side of the rear cargo compartment and lavatory.

5. The aircraft descended to a low altitude while returning to Florence, struck two large trees and crashed.

6. Two hand fire extinguishers had been used in flight without success.

7. No evidence was found to indicate mechanical failure of any part of the aircraft, engines, or accessories prior to the crash other than caused by fire.

8. No evidence was found to indicate negligence on the part of the company or crew.

#### Probable Cause

The Board determines that the probable cause of this accident was fire of undetermined genesis in the rear cargo compartment or lavatory which resulted in the inability of the pilot to maintain altitude long enough to effect a landing.

#### Conclusion

On the basis of investigation of this accident and the available records of fire in flight the Board concludes that:

1. All DC-3 passenger equipment is not provided with adequate access to the baggage compartment from the cabin.
2. Maximum safety in flight requires the installation of fire detecting equipment in the cargo compartments.
3. The use of paper lunch and lavatory accessories in flight constitutes a fire hazard.
4. Further emphasis must be placed in aircraft design on the use of non-combustible materials in cabin lining, sound-proofing, and waste containers.
5. Carbon dioxide fire extinguishers are not adequate for all types of fire.

On the basis of conclusions reached as a result of investigation of ~~this~~ accident and review of available records of aircraft fires, the Board has completed an exhaustive study of the problems of fire in flight and has under consideration extensive revision of the Civil Air Regulations to include requirement of additional installation of fire-prevention equipment on air carrier aircraft. The proposed revisions are currently being coordinated throughout the industry, and it is anticipated that provisions will be made within Civil Air Regulations in the near future to remedy the above deficiencies.

BY THE CIVIL AERONAUTICS BOARD:

/s/ James M. Landis

/s/ Harllce Branch

/s/ Josh Lee

/s/ Clarence M. Young

Ryan, Vice-Chairman, did not participate in the decision.

## SUPPLEMENTAL DATA

### Investigation and Hearing

The Atlanta office of the Civil Aeronautics Board received notification during the morning of September 7, 1945 and the Board immediately initiated an investigation in accordance with Section 702 (a) (2) of the Civil Aeronautics Act of 1938 as amended. Air Safety Investigators from the Board's Atlanta office arrived at the scene of the accident at 1830, September 7, 1945, and were joined by others of the Safety Bureau staff.

The Board ordered a Public Hearing which was held at Miami, Fla., on September 19 and 20, 1945. The Chief, Investigation Division, Safety Bureau, presided and other personnel of the Safety Bureau staff participated.

### Air Carrier

Eastern Air Lines, Inc., a Delaware corporation with headquarters in New York City was operating under a certificate of public convenience and necessity and an air carrier operating certificate, both issued pursuant to the Civil Aeronautics Act of 1938 as amended. These certificates authorized the company to transport persons, property and mail between various points in the United States including Miami, Fla. and New York, N. Y.

### Flight Personnel

Capt. John Olen King, age 51, had been employed by the company since June 8, 1931 and had accumulated a total of 16,390 hours of which 6,500 hours were as first pilot in DC-3 equipment. First Officer Robert A. Kelley, Jr., age 25, had been employed by the company since November 11, 1944, and had accumulated a total of 2,492 hours of which 650 hours were as co-pilot in DC-3 equipment. Gertrude Graham was Flight Attendant. Both pilots were properly certificated for the flight involved and the captain was qualified for the route.

## Aircraft

The Douglas DC-3, NC 33631, was properly certificated. It had flown a total of 17,532 hours with about 6,524 hours since the last major overhaul. It was equipped with two Wright Cyclone G-202A engines with 3,684 and 217 hours respectively for the left and right engines and 217 hours since the last overhaul. Hamilton Standard hydromatic propellers were installed. On departure from Savannah the total weight and the load distribution were within approved limits.