CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: April 10, 1952 Released: April 13, 1952

MIAMI AIRLINE, INC.—ELIZABETH, NEW JERSEY, DECEMBER 16, 1951

THE ACCIDENT

A C-46F aircraft, N 1678M, operated by Miami Airline, Inc., Miami, Florida, an irregular air carrier, crashed shortly after takeoff from the Newark, New Jersey, Airport on December 16, 1951, at about 1509.[1] All 56 occupants were killed and the aircraft was destroyed by impact and fire.

HISTORY OF THE FLIGHT

The aircraft arrived at Newark following a non-stop flight from Fort Smith, Arkansas, on December 15 at about 2330. During this flight of about five and one quarter hours, there was no reported malfunctioning of the aircraft or its powerplants with the exception of both cabin heaters which were inoperative. This was reported to the Babb Company, a CAA approved repair station at the Newark Airport, and instructions were issued to repair the heaters. Mechanics worked during the night and the following morning with the result that one of the cabin heaters was believed to be repaired. This, however, could not be positively determined without test flying the aircraft; this was not done.

During the morning of December 16 the aircraft was serviced. The left engine required five gallons of oil and the right engine required 10 gallons to bring the respective tanks to a total of 34 gallons each. Fuel was added in the amount of 767 gallons, which filled the front and center tanks in each wing. The aircraft was loaded with 52 passengers including two infants in arms. The crew consisted of Captain Albert C. Lyons, Copilot John R. Mason, and Stewardess Doris Helms. A fourth company employee who was deadheading to Miami occupied the jump seat. The aircraft's center of gravity was located within prescribed limits. Actual takeoff weight of the aircraft was about 117 pounds over the prescribed maximum of 48,000 pounds.

A flight plan was made out and signed by both the captain and copilot. It specified VFR (Visual Flight Rules) direct flight at a cruising altitude of 4,000 feet to Tampa, Florida.

After the aircraft was loaded both engines were run up. The right engine was run up longer than the left engine, and a number of nearby persons saw smoke continuously coming from that engine. This smoke was variously described as being "white," "grey" and "light" in color. The Newark Control Tower then gave the aircraft taxying instructions and advised the captain that he had a choice of Runway Nos. 24 or 28 for takeoff. The captain chose No. 28. The flight was then cleared for takeoff at 1502 and immediately started down the runway. The tower recorded that the aircraft left the ground at approximately 1503. Immediately after becoming airborne, the landing gear was seen to retract. At this point tower personnel for the first time observed a trail of white smoke from the right side of the aircraft and the tower supervisor, fearing a fire, pressed the airport crash alarm button.

The tower then advised the flight as follows: "1678M, you can land any way possible, any way you wish, cleared back to the field." This was not acknowledged.

The takeoff run was normal but the subsequent climb was slow. The right engine emitted a continuous smoke trail as previously described.[2] A captain employed by Miami Airline witnessed the takeoff. Believing that the source of the smoke was an overheated right brake, he immediately telephoned the control tower and asked that the flight be advised of his impression, suggesting that the landing gear not be raised

[1] All times referred to herein are Eastern Standard and based on the 24-hour clock.

[2] See Attachment I, a photograph of the aircraft in flight. (Exhibit Number 28b-1)

and that it be extended if it had been raised. The tower complied, the flight acknowledged, and the landing gear was seen to extend. The tower then sent the following message: "1678M the wind is west at 20, Runway 6, the airport is yours, you're cleared to land, Runway 6." There was no acknowledgment.

The aircraft continued straight ahead in the direction of takeoff for a distance of approximately four miles, slowly gaining an altitude of approximately 800 to 1,000 feet. The smoke continued to increase in volume and shortly before the four-mile point was reached black smoke and actual flame were seen coming from the underside of the right nacelle as the landing gear was lowered. Shortly after the landing gear was extended, a large "ball of fire" was seen coming from underneath the right nacelle.[3] The aircraft then started a gradual left turn banked at an estimated 10 degrees. This turn and subsequent flight continued for an additional distance of approximately 4 1/2 miles with altitude continuously being lost, until the aircraft was approximately 3 miles southwest of Runway 28 of the Newark airport. During this period the flame from the right nacelle appeared to go out for a period of a few seconds, and then start again. It was indicated that the speed of the aircraft throughout the entire flight had been somewhat slow and that during the latter portion of the flight the speed became progressively slower, and the right propeller was turning slowly. The aircraft at this time was over the City of Elizabeth, New Jersey, and was nearly 60° from alignment with and approximately two and one-fourth miles distant from Runway 6 of the Newark Airport. At this point and at an estimated altitude of about 200 feet the aircraft's then low left wing dropped about vertically downward with the right wing coming vertically upward and the aircraft fell with relatively little forward speed. Just before striking the ground the aircraft's left wing tip struck the gabled roof of a vacant house near its ridge. The aircraft continued ahead and down, struck a brick building used by the City of Elizabeth as a storage for water supply department materials, damaged this building and plunged a few feet ahead to the bank of the Elizabeth River, where it came to rest. The wreckage was in a generally inverted position and partially submerged in shallow water. A severe gasoline fire developed instantly, spreading to and damaging the storage building. Nearby fire fighting apparatus arrived quickly and about 17 minutes later, the fire was extinguished. All aboard were killed and one person on the ground was seriously injured.

Newark weather was good, with a visibility of 15 miles, and a variable west wind of 20 mph.

INVESTIGATION

An inspection of the Civil Aeronautics Administration tower records showed that no communication was received from the aircraft which would assist in determining the nature of the trouble. The suggestion to lower the landing gear was acknowledged by "N 1678M," the number of the aircraft, and this was the only message from the flight after takeoff except for "Newark Airport, this is 78," just before the crash, obviously a message both dictated and interrupted by emergency.

Statements concerning the preflight preparations, the flight, the trail of smoke and fire, and the subsequent crash were taken from 64 persons on the ground, as well as from the captain of an aircraft that landed immediately after N 1678M had taken off. One witness employed as a fire guard and baggage handler at the Newark Airport, and who acted as a fire guard when the engines were started, testified that just before the engines were run up he noticed fresh oil smeared over the cowl flaps of the right engine. Five witnesses were Civil Aeronautics Administration employees in the Newark Control Tower at the time. Several others were also at the airport and the remaining 53 were located to the west of Runway 28 and, in general, located more or less under the flight path of the aircraft. There are variations in these statements but the consensus indicates that the flight path and fire propagation were as described above.[4] Several of

[3] See Attachment II, a later photograph of the aircraft in flight. (Exhibit Number 28b-2). (Mr. William E. Sparrow, an engineering correspondent, residing at 2065 Morris Avenue, Union, New Jersey, took these photographs from his residence.)

[4] See Attachment III, "Probable Flight Path Based on Distribution of Wreckage and Observations of Witnesses," (Exhibit No. 40-i), and Attachment IV, Chart 1, "Wreckage Distribution," (Exhibit No. 41-a).

these witnesses, including four of the tower operators, stated that immediately prior to the crash they observed the right wing fold upward approximately 90 degrees and separate from the aircraft. One of these operators was watching the aircraft through binoculars. Other persons described a maneuver which indicated a stall with the left wing dropping abruptly.

Impact with the ground was with the nose and left side of the aircraft and at a steep angle of descent, as evidenced by the pronounced localization of wreckage. Those recovered parts, except the powerplants, which were to be used in the reconstruction of the suspected areas, were taken to Building No. 50 at the Newark Airport. The powerplants were taken to the engine over-haul shop of the Pacific Airmotive Corporation at the nearby Linden, New Jersey, Airport. Layouts and reconstructions were conducted at both places.

The right wing of the aircraft and the center section outboard of the fuselage, including the nacelle, were laid out on the floor in their respective relative positions. The nacelle parts were placed on, or wired to a wooden framework of the right engine nacelle in their approximate relative positions so that the fire pattern could be carefully studied. The fire damage in general fell into two distinct types, fire in flight and fire after impact. There was widespread damage throughout the structure by fire after impact. The fire in flight was confined to the right nacelle. In-flight fire under apparent heavy draft burned its way through the closed doors of the right-hand wheel well, burned an area some eight inches in diameter on the outer surface of the right-hand tire and continued backward destroying numerous pieces of secondary structure. The relatively small burned area on the tire tread is accounted for by the fact that the right wheel was well below the path of flame after the wheels were extended. However, the extension of the gear allowed the fire freer entry to the wheel well which damaged the numerous fuel, oil and hydraulic lines, all of which were behind the firewall shutoff valves. Fire left the structure in the vicinity of the nacelle tail cone at the rear spar. This in-flight fire laid a telltale trail of small burned and molten metallic objects on the ground more or less under the flight path for a distance of four miles back from the impact site. With the exception of two pieces of cowl flap structure, these recovered objects came from aft of the firewall, demonstrating that a fire also existed aft of the firewall in flight. Examination of the wreckage, particularly the primary structure, disclosed that the right wing did not separate from the aircraft prior to impact since it was found with the main wreckage. An examination of the reconstructed wing structure of the right nacelle area revealed that there was no in-flight buckling. Moreover, no evidence was found to indicate that deformation or twisting of the right wing occurred prior to impact.

Four cylinders of the left engine were removed and the power sections checked for mechanical failure. None was found. The oil screens were examined and no discrepancies were noted. This engine was severely damaged externally by impact and ground fire. The propeller shaft and the propeller barrel assembly were not recovered. There was no evidence of in-flight fire in this engine.

As the right engine had obviously developed trouble it was examined in great detail. The right propeller was found at a pitch setting of 57 degrees, an angle within the feathering range. No. 10 cylinder and all but about one and one-half inches of the crank end of the No. 10 articulating rod were missing and have not been recovered. The stub end of the rod was attached to the master rod. No. 10 piston was found. The fifteen hold-down studs of this cylinder had failed. All of the studs on the center case and three of the studs on the front case had failed as the result of fatigue fractures. One hold-down stud of No. 14 cylinder had failed as the result of a fatigue fracture. The studs that failed from fatigue do not show any deformation. Three of the broken studs showed rubbing of the threaded portion which would normally be covered by the hold-down nut. There was no evidence of metallurgical defects in these studs. The No. 10 cylinder crankcase pad bore evidence of galling, fretting and/or polishing with a pronounced ridge around the approximate front half of its circumference suggesting that the cylinder had been somewhat loose on its pad and that the stud failure had been progressive. The four sections comprising the crankcase were matched which was indicated by

each having the same serial number. The engine's front main bearing and the front master rod bearing had failed. Metal chips were found on the main oil screen and in all oil pumps which were moderately scored. Damage to the engine adjacent to the base of No. 10 cylinder occurred as the engine continued to operate for an appreciable period of time after the separation of that cylinder.

The right engine was laid on the shop floor in the same attitude as it was found in the shallow water of the Elizabeth River. In this manner the amount of submersion and an accurate water line were determined. This allowed a ready determination of those parts of the engine which could or could not have been damaged by ground fire. The engine was then turned to its normal flight position and all recovered identifiable adjacent parts were placed in their proper relative positions. This reconstruction went from the nose of the engine back to and including the firewall. Damage caused by fire in flight left its own highly descriptive pattern of destruction, localized, sharply defined and obviously of a nature that could have been produced only under extreme forced draft.

Before describing the fire path in the right engine it may be well to point out that the engine cowl flaps on the subject aircraft are located just forward of the firewall on the bottom one-third portion of the engine compartment cowling. Air entering at the front of the engine compartment can leave only through the opening provided by these controllable cowl flaps; therefore, any fire within the engine compartments would normally leave only through these bottom flaps. This fire did exactly that initially, although the cowling itself, and the oil cooler duct at its lowest point, subsequently burned through.

The in-flight fire in the right engine had its origin at, or near, the base of the No. 10 cylinder. No. 10 cylinder is on the extreme bottom of the front row. Behind it, in the rear row and on either side, are cylinders Nos. 9 and 11. Directly aft from No. 10 cylinder the fire destroyed the pressure baffle of No. 11 cylinder. The push rod cover of this cylinder was completely burned away and its rubber hose seal was burned severely. The fire extinguisher tubing to the No. 11 cylinder discharge nozzle was melted. No. 9 cylinder push rod cover was also burned severely and its rubber hose seal was blistered. Two braided metal strips, which ground the engine electrically to its mount ring and were behind Nos. 9 and 11 cylinders, respectively, had completely burned off. The large oil inlet flexible composite hose, running from the firewall to the lower portion of the rear crankcase, was consumed except for its metal braid. The oil outlet hose from the engine to the oil radiator, which is of the same composition as the inlet hose, was likewise consumed. The one-fourth inch flexible fuel drain lines running from the fuel pump on the bottom of the accessory case downward and rearward were burned to the metal braid. The flexible fuel pressure balance line running from the rear of the fuel pump to the carburetor had been completely consumed except for its metal braid.

The cowl flap actuating arm was burned away from the right engine nacelle and was found a considerable distance from the site of impact. The mounting ring for the cowl flap assembly was severely damaged by concentrated fire on its inboard side. A hydraulic line entering the accessory section through the firewall had only its forward portion burned down to the metal braid. This was a flexible line approximately 10 inches long, about one-half of which was affected. The affected portion was at the lower and slightly inboard side of the firewall.

As previously stated, the cowl flap actuating mechanism was almost completely destroyed by fire and portions of it, including some flap parts, were not recovered. The point at which the fire left the engine compartment ahead of the firewall was through the cowl flaps.

There were, of course, many other burned places in the generally straight line from the rear of the base of No. 10 cylinder to the point of exit on the inboard side of the cowl flaps. In studying this fire path it was noted that other parts of the engine structure only a relatively short distance away were undamaged by fire. All portions of the firewall except for the lower inboard portion still retained the customary smear of unscorched oil, as did many other objects within the nacelle that were not in the channeled and gutted course of the fire.

Thus, it is clear that a fire of great intensity left its unmistakable trace from No. 10 cylinder crankcase pad back to its point

of exit slightly inboard of the center of the cowl flaps. The fire pattern aft of this point has been described. Whether or not the three shutoff valves located just behind the firewall, for fuel, oil and hydraulic liquid, had been closed before impact cannot be positively determined, although from available physical evidence, it appears that they had not been closed.

Investigation revealed no failure of the aircraft's primary structure or control system, either prior to, or after the in-flight fire. The position of the wing flaps at the time of impact could not be positively determined, but the evidence available indicated that they were retracted. The position of the aileron trim tabs could not be determined by their actuating mechanism. Nor could the exact position of either the rudder trim tab or the elevator trim tab be determined. The main landing gear was definitely extended at the time of impact as was the tail wheel which extends and retracts with the main gear.

All three heaters were recovered. Two were relatively undamaged while the third, one of the two cabin heaters, was badly crushed. Careful examination of all three indicated that there had been no fire in or near them prior to impact. Earlier it had been mentioned that the landing gear was extended in flight because of the belief of the possibility of an overheated or burning right brake. Consequently, the right brake assembly was carefully studied; this study revealed no evidence of any brake malfunctioning, fire or overheating, and the wheel itself could be readily rotated.

Investigation of the aircraft's records indicated that the aircraft was equipped with a seat and belt for every occupant with the exception of the two infants in arms.

When it was learned that the source of the trouble was in the right engine the maintenance records of this engine were probed. The company's maintenance manual, which is required to be submitted to the CAA, prescribes a 700-hour period between overhauls for the subject engine. It also prescribes that maintenance on the complete aircraft be accomplished by what are known as No. 1, No. 2 and No. 3 inspections. The intervals between inspections are not to exceed 40 hours for No. 1, 80 hours for No. 2, and 120 hours for No. 3, and so on. No. 2 check includes all items on No. 1, and others; and No. 3 check includes all items on No. 2, and others. The No. 1 inspection consists of the checking of 79 enumerated items on the aircraft. During this inspection the engines are run up and checked performancewise as indicated by the various engine instruments. Subsequently the engines are shut down and examined visually for leakage or seepage of any sort. Item No. 72 is, "Inspect through cowl flap opening for fuel, oil, hydraulic leaks." It is not required that the engine cowling be removed for this No. 1 inspection.

The right engine, newly overhauled by the Opa-Locka Engine Overhaul Base, Opa-Locka, Florida, was installed in the aircraft on November 5, 1951. Records indicate that the due periods of the various inspections had been complied with, the last No. 3 check having been completed on the aircraft after the engine had had 66 hours since overhaul. As previously mentioned, the last prior flight of this aircraft was from Ft. Smith, Arkansas, to Newark. At Ft. Smith the aircraft had logged 32 hours and 15 minutes since the last No. 3 inspection. As the flight time to the next intended stop, Newark, would bring the total time since the last No. 3 check close to the maximum of 40 hours, the company sent a copilot who was also a certificated A&E mechanic from Miami to Ft. Smith to perform the No. 1 inspection there. He started the No. 1 inspection at Ft. Smith and completed and signed for it at Newark, 5 hours and 15 minutes flight time later, which was still within the 40-hour prescribed limit. At the time the right engine had had approximately 103-1/2 hours since overhaul.

A thorough screening of all available maintenance records of this aircraft failed to disclose any item that may have been significant as to the source of the failure. Maintenance records, however, do not reflect the quality of the work accomplished.

Both engine nacelles were equipped with two CO_2 fire extinguishing bottles, one a cable control release type, the other a pressure release type actuated by pressure from the cable release bottle. Each pair of bottles provided a single discharge of CO_2 to its engine. This is known as a "one shot" system. Three of the four CO_2 bottles were recovered. Two of the bottles, one from each nacelle, were fitted with pressure type

control heads, and it could not be determined which of these bottles had been installed in the right nacelle. Investigation disclosed that these bottles had been discharged by heat rather than by the normal method. The other CO_2 bottle recovered was fitted with a series cable control head, and likewise it could not be determined in which nacelle this bottle had been installed. Although this bottle was also discharged, it was not possible to determine positively the manner in which the CO_2 had been released. At least one witness statement indicates that the fire in flight disappeared for a few seconds, and then re-ignited. This may well have occurred if heat had discharged the two CO_2 bottles at that time. The physical evidence gives definite indications that the CO_2 actuating system had not been actuated from the cockpit since the two pressure release type bottles were discharged by heat through the overflow outlet rather than by the normal method.

The fire detection system consisted of five unit type detectors installed on the engine mount ring. One was located on the top center line of the mount ring. Of the remaining four, two were located on the right side and two on the left side of the mount ring spaced approximately at 18-inch intervals from the top center line. Also, Fenwall continuous strip fire detectors were installed on the lower perimeter and horizontal center line of the firewall. Fire warning indicating lights, one for each engine, and a fire detection circuit test unit were installed in the cockpit, together with a means for CO_2 release. Nineteen fire extinguisher discharge nozzles were installed on the engine, one at the base of each cylinder and one near the carburetor. It could not be determined, by examination of the wreckage, whether fire detectors and extinguisher discharge nozzles were installed near the oil cooler. One extinguisher discharge nozzle was installed near the fuel selector valve in each nacelle.

Some C-46 aircraft, including those operated by this carrier, have engine fire warning lights equipped with shutters. In the "dim" position the shutters are nearly closed on some lights. Others can be fully closed. In the nearly closed position it is likely that the light would be seen at night; during daylight it might well not be seen at all. The engine fire warning lights were not recovered; however, it is believed the subject aircraft did have shutters on its engine fire warning lights since the other two C-46 aircraft operated by this carrier were so equipped and company officials stated that they believed that to be the case.

Investigation disclosed that the powerplant fire protection system installed in N 1678M was approved by the Civil Aeronautics Administration. CAA 's approval of the powerplant fire protection system was based on Technical Development Report No. 37 which presented the results of a series of tests conducted for the CW-20 aircraft (prototype of the C-46 type aircraft) which among other things specified that the CO_2 discharge rate in the engine compartment should be at least 8.8 pounds per second. The investigation indicated that the subject aircraft was equipped with approximately a five-pound per second discharge rate of CO_2 in the powerplant section. The CAA airworthiness directive 49-19-1, dated May 9, 1949, which applies to powerplant fire protection installation on C-46 aircraft, does not specify a discharge rate of CO_2. TDR No. 37 states that discharge rate is paramount; therefore, it appears that the fire protection system installed in N 1678M was inadequate in this regard although the powerplant fire protection system of the aircraft was in compliance with the applicable Civil Air Regulations.

Although this type of aircraft was not certificated under CAR Part 4, the provisions of CAR Amendment 42-2, dated November 11, 1946, which are applicable to C-46 aircraft operating in irregular service, specified that certain of the requirements of Part 4 (those relative to fire protection) must be complied with. The applicable portions of Part 4 do not specify either a "one shot" or a "two shot" system. The difference between these systems is that the "one shot" system provides a single discharge of CO_2 to each engine whereas the "two shot" system provides two discharges of CO_2 both of which may be directed to any engine. The majority of C-46 aircraft used in irregular carrier service are equipped with only a "one shot" system.

The Board is presently studying its powerplant fire protection requirements to determine if the rules adequately cover non-transport category aircraft, such as the C-46. This may require, among other items, an adequate "two shot" system.

The Weight and Balance Manifest for the subject flight was in error in regard to the total oil and fuel on board. Actual oil quantity was 68 gallons, the manifest showed 60 gallons; fuel quantity was approximately 1,072 gallons, the manifest showed 1,100 gallons. The company's passenger manifest for this flight originally indicated a fourth company employee, Copilot E. Lilly, as a passenger. However, his name was stricken from the passenger manifest and although on board, he was not listed on the flight plan as a crew member. An error was also made in the addition of the weight of the passengers listed on the passenger manifest. The flight plan listed only three crew members whereas it should have listed four. The company's Weight and Balance Manifest did not show the weight of this extra crew member and his baggage. A computation of the entire load aboard the aircraft was made by the Civil Aeronautics Board which disclosed an overload of approximately 117 pounds. This figure was reached by taking into account all known weight factors aboard the aircraft. All baggage was weighed before takeoff. The total weight of passengers was arrived at by adding their individual weights as stated by the passengers. This method is accepted by the Civil Aeronautics Administration and may be used in lieu of an arbitrarily established average passenger weight.

Investigation revealed that the carrier's pilot flight training in normal operating procedures was usually accomplished only during flight en route. Flight training in emergency procedures was also normally accomplished en route, but only when the aircraft was lightly loaded and without passengers.

ANALYSIS

The physical evidence indicated that a severe fire originated at or near the base of No. 10 cylinder of the right engine which progressed rapidly and soon became uncontrollable. Although the genesis of this fire cannot be stated with finality, it may be pointed out that all factors necessary for a severe fire existed when the cylinder failed. These were, a high draft through the nacelle, a continuous egress from No. 10 cylinder hole of both liquid and atomized lubricating oil, a flailing broken connecting rod, and opened exhaust and inlet ducts to that cylinder. The opened exhaust duct would emit flame and the opened intake duct would continue to emit inflammable and/or explosive fuel mixture. (The engine operated after the cylinder failure, as stated.) A fire thus started would quickly develop in intensity, generating extremely high temperatures and in a relatively short time burn through fire resistant lines carrying inflammable liquids forward of the firewall, and, once aft of it, would very rapidly burn through other lines that are not fire resistant. This, in fact, did occur.

Although no trouble with No. 10 cylinder had been logged or discovered before the takeoff of this flight, the failure probably was initiated prior to takeoff. The possibility of hydraulicing has been considered and eliminated as a contributing factor. The lack of deformation of the studs which failed from fatigue supports this belief since for hydraulicing to have contributed to the failure, some deformation of the studs would have had to precede the start of the fatigue fracture. Hold-down stud failures do not fit into the pattern of engine failures which have been attributed to hydraulicing. Rubbing of stud threads which are normally covered by the hold-down nut indicates that loosening and backing off the hold-down nuts preceded the failure of the studs. Obviously these nuts had been improperly installed. Also the failure due to a fatigue fracture of one hold-down stud of No. 14 cylinder whose position precludes hydraulicing is further evidence that some factor other than hydraulicing existed, and, as stated, there was no evidence of metallurgical defect in these studs. Failure prior to takeoff was indicated by the smoke coming from the right engine during the run-up. Furthermore, indications are that the failure was progressive. This probability is further strengthened by an abnormally long run-up of the right engine, suggesting some engine irregularity, and the continuing smoke trail during takeoff and the slow climb indicating some power loss. The high manifold pressure of about 52 inches of mercury normally used on takeoff undoubtedly augmented the initial failure and precipitated complete separation of the cylinder.

Several factors plainly indicate that a substantial amount of power was being developed by the right engine up to the time the aircraft reached its peak altitude and a left

turn was started. At the maximum gross takeoff weight of 48,000 pounds, the rate of climb for the horizontal distance of about four miles from the point of takeoff to an altitude of about 800 to 1,000 feet, would have required an appreciable amount of power from both engines. The condition of the major rotating parts of the right engine indicated that considerable power was being developed during the takeoff and climb. Furthermore, it was not until the latter part of the flight that ground witnesses observed the right propeller turning slowly.

It has been mentioned that the oil consumption of the right engine was twice that of the left engine during the last flight prior to the accident. (This higher consumption was, however, within the prescribed maximum limits established for this type engine.) Inasmuch as the subject engine had only approximately 103 hours of running time since overhaul and the left engine had approximately 275 hours of running time since overhaul, it is reasonable to assume that there was oil seepage somewhere in the structure of the right engine which could well account for this increased oil consumption. The fact that No. 10 cylinder crankcase pad was galled, fretted and/or polished shows that movement of the cylinder occurred which indicated that it was improperly secured. Seepage could have occurred at that point.

As previously mentioned, the No. 1 inspection was conducted at Fort Smith, Arkansas, the day before the accident. The report itself, as well as the testimony of the mechanic who did the work, indicated no apparent leaks or oil seepage from the right engine at that time. However, the fact remains that had the engine cowling been removed, it is quite possible that any existing oil seepage from the No. 10 cylinder pad would have been observed. Following a five-hour and fifteen minute flight from Fort Smith to Newark, the aircraft was re-serviced and a pre-flight inspection conducted. The right engine required twice as much oil as the left which was an abnormal indication, (although within the prescribed maximum limits), since the right engine had less than half as much operating time since overhaul as the left engine. In addition, the fire guard at Newark testified that the right engine cowl flaps were smeared with fresh oil just before the engines were run up. Therefore, the abnormal oil consumption of the right engine over the left and the presence of fresh oil on the right engine's cowl flaps, which should have been noted during the pre-flight inspection, should have definitely suggested the need for a thorough inspection of the right engine to determine the source of the smeared oil prior to further operation.

It is believed that the afore-mentioned failure of the right engine's front main and front master rod bearings occurred because of oil starvation when fire destroyed the oil line feeding the engine, and was thus secondary to the cylinder failure.

It has previously been mentioned that the right propeller was found in the feathering range. By this was meant that the propeller was at an angle much too large for cruise position, and although not fully feathered, was enough so that it would normally, under the flight conditions that existed, continue to rotate slowly as described by witnesses. Of course, the fact that it was found in the feathering range is conclusive proof that the feathering mechanism had been actuated. As to why the propeller was not fully feathered, it may only be surmised that the in-flight fire had destroyed an electrical line or an oil lead, either of which would cause feathering to be discontinued, or that full feathering was interrupted by impact.

The possibility of the right wing failing in flight by separation, buckling or by slight deformation has been thoroughly explored. Although the nature of the crash and the extensive impact and ground fire damage that resulted therefrom precluded the identification of the complete nacelle and wing box structure, a sufficient number of pieces from this area were identified and matched to provide a relatively clear picture of the extent of the in-flight fire damage. In general, the damage done by the in-flight fire to those pieces of primary structure identified and examined was not sufficient to reduce the strength of the affected parts to a value below which they could not sustain the air loads being imposed by the existing flight condition. For the most part, the items found along the flight path were small, relatively light pieces of secondary structure which would normally be expected to be affected by the fire before any substantial damage was done to the primary structure.

A few witnesses thought that they saw the right wing actually separate from the aircraft in flight, however, the right wing was found with the main wreckage. An examination of the fractured wing parts disclosed no evidence of in-flight separation; therefore, the Board can only advance the explanation that this appearance of wing separation was an optical illusion, since the stream of smoke and, or, fire which is known to have been at the location where it was indicated the wing separated, caused them to believe that they were actually seeing open sky between wing and center section. The testimony of those persons who believed that they saw the right wing fold 90° upward can be accounted for by the possibility that they may not have noticed the left wing drop simultaneously an equal amount. Had the right wing folded upward, examination of the primary structure at its nacelle area, would have clearly indicated any in-flight buckling. None was found. Furthermore, if the wing had folded, the aircraft would have rolled to the right, instead of to the left, since the lift on the right wing would be reduced by such folding. The possibility of slight deformation of the wing structure sufficiently to affect adversely the flight characteristics of the aircraft was also explored. An examination of the pertinent parts that were recovered did not reveal any evidence of deformation in flight.

There are two apparent reasons why the in-flight fire aft of the firewall did not inflict sufficient damage to the right wing box structure to affect adversely the control of the aircraft. As previously stated heat released the CO_2 in the area aft of the firewall. Its attendant cooling and flame smothering effects somewhat abated for a short period the intensity of the fire in this area. Furthermore, with the landing gear lowered, the turbulent air flow which existed in the lower nacelle area would, in effect, scavange this area of flame and heat, and retard fire damage.

The exact maneuver that the aircraft underwent before its final plunge has been a subject of conflicting testimony, but careful analysis of all evidence indicates that the maneuver was a stall with the then low left wing dropping abruptly. That the aircraft stalled and fell abruptly is further substantiated by the extreme localization of the wreckage within a small area and the fact that other buildings closely surrounding this area were not struck. There is no doubt that in attempting to maintain a minimum rate of descent during the latter phase of the flight to reach the airport, the speed of the aircraft became progressively lower until a marginal value was reached. The following militating factors contributing to this condition were: extended landing gear, windmilling right propeller and the effect of the maximum gross load. It is clear from the evidence that the flight was attempting to return to the Newark Airport, and, in all probability, to a landing on Runway 6. An analysis of the progress of the flight as established is certainly indicative of this intent. Further analysis indicates definitely that the flight was on a southeasterly heading just prior to the accident and still descending, and that a 60° left turn would have been required, at the then low altitude of about 200 feet, to align it with Runway 6, approximately two and one-fourth miles distant. Evidence indicates that this turn was started whereupon the aircraft stalled with an abrupt roll to the left and fell almost vertically, crashing in a nearly inverted attitude.

The company manual's emergency procedures for the C-46 stated that the landing gear shall not be lowered in case of engine fire. In the cockpit of the aircraft a placard likewise stated the proper emergency procedure to follow in case of fire, i.e.,

"1. Shut off fuel, oil, and hydraulic
2. Feather propeller
3. Turn off ignition
4. Close cowl & oil cooler flaps
5. Retract landing gear
6. Pull fire extinguisher
7. Land as soon as possible"

There was some indication that the captain attempted to initiate the above procedure before the crash, since the right propeller was found in the partially feathered position; however, it is indicated that the No. 1 item of the emergency procedure had not been accomplished since the shutoff valves to the fuel, oil and hydraulic systems to the right engine were found in the open position. There is no doubt that the company captain on the ground acted in good faith when he suggested to the flight that the gear be lowered

since he thought the right brake was on fire. Likewise, Captain Lyons cannot be criticized for lowering the gear when he received this information since it is entirely possible that from the crew's position in the cockpit, they could not see and probably did not have knowledge at that time that the right engine was on fire.

The carrier had established a ground training program for pilots including Link Trainer practice and Aids to Navigation. However, it had not established a formal flight training program. Flight training in emergency procedures was accomplished intermittently en route when circumstances permitted. This training program, insofar as emergency procedures are concerned, is considered inadequate due to lack of a formal course of flight training and irregularity of its application. The lack of adequate training in emergency procedures could have had a bearing on what appears to have been a delayed application of the emergency procedures for an engine fire by the crew.

A review of Miami Airline's operations from February 18, 1947, to September 10, 1950, as reflected by CAA records, shows that the company allegedly violated the Civil Air Regulations in 16 instances, 14 of which involved loading of the aircraft in excess of the approved gross takeoff weight. The Civil Aeronautics Administration accepted a total compromise settlement of $1,800 for these alleged infractions. Investigation of this accident has revealed that Miami Airline did not conform to requirements set forth in CAR in that the weight and balance manifest did not reflect the total load aboard and the flight plan did not include the total number of crew.

The maximum gross takeoff weight of any aircraft is an ultimate figure, established by the United States Government, to be approached as a carrier deems fit, but never to be exceeded. When a carrier wilfully overloads its aircraft it then creates a grave public danger. Although the 117 pounds overload in this instance was operationally inconsequential, this overload and the numerous previous cases of overloading are plainly indicative of the carrier's attitude toward sound and accepted practices pertinent to safe operation. When Miami Airline was granted its letter of registration and an irregular air carrier operations certificate to engage in irregular air transportation of persons and property, it was incumbent upon the company to conduct such operations with the highest degree of care and in full compliance with required regulations and standards. Although the captain was primarily responsible for the proper dispatching of this flight, this in itself did not relieve the company from exercising the overall responsibility for its operations.

The employment of a combination copilot-mechanic to accomplish periodic inspections at intermediate points en route while the aircraft is away from its base can involve long continuing periods of duty. Although this is not a violation of the CAR, it is not considered good and accepted practice and is not conducive to either good maintenance or piloting efficiency.

A reconstruction of the events leading up to the accident shows that a failure of No. 10 cylinder of the right engine occurred during or shortly after takeoff. This precipitated dense smoke and fire, followed by the lowering of the landing gear and a critical loss of power. This power loss with the increased drag of the lowered landing gear and the windmilling propeller due to only partial feathering, together with the effect of the maximum gross load, resulted in a stall and loss of control of the aircraft.

FINDINGS

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

1. The aircraft, the crew and the carrier were properly certificated.
2. The aircraft was loaded above its maximum allowable takeoff weight.
3. An abnormal amount of smoke trailed from the right engine during runup, takeoff and climb.
4. The hold-down studs of No. 10 cylinder were sound metallurgically.
5. The failure from fatigue of No. 10 cylinder's hold-down studs, due to improper installation of their nuts, caused the cylinder to separate completely from the crankcase during or shortly after takeoff.
6. A fire started at the base of No. 10 cylinder, rapidly becoming uncontrollable.
7. The flight was cleared by the tower to return and land at Newark Airport using any runway.

8. The wheels were lowered upon advice from the ground, relayed by the tower, by a company employee, acting in his best considered judgment.

9. The right propeller was partially feathered in flight.

10. The right wing did not fail in flight.

11. While attempting to return to the Newark Airport, the aircraft stalled at an altitude of approximately 200 feet, fell sharply to its left, struck buildings, and crashed on the bank of the Elizabeth River.

12. The carrier's pilot training program on emergency procedures was informal, irregular, and therefore inadequate.

—39349

PROBABLE CAUSE

The Board determines that the probable cause of this accident was a stall with the landing gear extended following a serious loss of power from the right engine. This loss of power was caused by the failure of the hold-down studs of the No. 10 cylinder, precipitating a fire in flight which became uncontrollable.

BY THE CIVIL AERONAUTICS BOARD:

/s/ DONALD W. NYROP
/s/ OSWALD RYAN
/s/ JOSH LEE
/s/ CHAN GURNEY

Joseph P. Adams, Member, did not take part in the adoption of this report.

Supplemental Data

INVESTIGATION AND HEARING

The Civil Aeronautics Board's New York office was notified of this accident at 1520, December 16, 1951, by telephone from CAA Communications, LaGuardia Field, New York. An investigation was immediately initiated in accordance with the provisions of Section 702(a)(2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board and was held in Elizabeth, New Jersey, on January 10, 11 and 12, 1952.

AIR CARRIER

Miami Airline, Inc., an irregular air carrier, was incorporated under the laws of the State of Florida with its principal place of business at Miami, Florida. The company is engaged in the irregular interstate and overseas air transportation and irregular foreign air transportation as authorized by Letter of Registration No. 85 issued by the Civil Aeronautics Board on July 8, 1947. Miami Airline also holds Irregular Air Carrier Operating Certificate No. 2-264, issued by the Civil Aeronautics Administration dated October 1, 1947.

FLIGHT PERSONNEL

Captain Albert C. Lyons, age 30, was employed by Miami Airline on September 21, 1951, as a captain. He had instructed in flight training for a four year period during World War II. Captain Lyons had a total flight time of 8,679:45 hours, 500 hours of which were accrued as C-46 copilot time, and 2,600:00 hours of which were as C-46 pilot-in-command time. He had 513:10 hours of instrument time. Captain Lyons had passed his last CAA physical examination on July 27, 1951. He held a valid airline transport pilot rating No. 65621, multi-engine land, and commercial single and multi-engine land, instrument, flight instructor ratings.

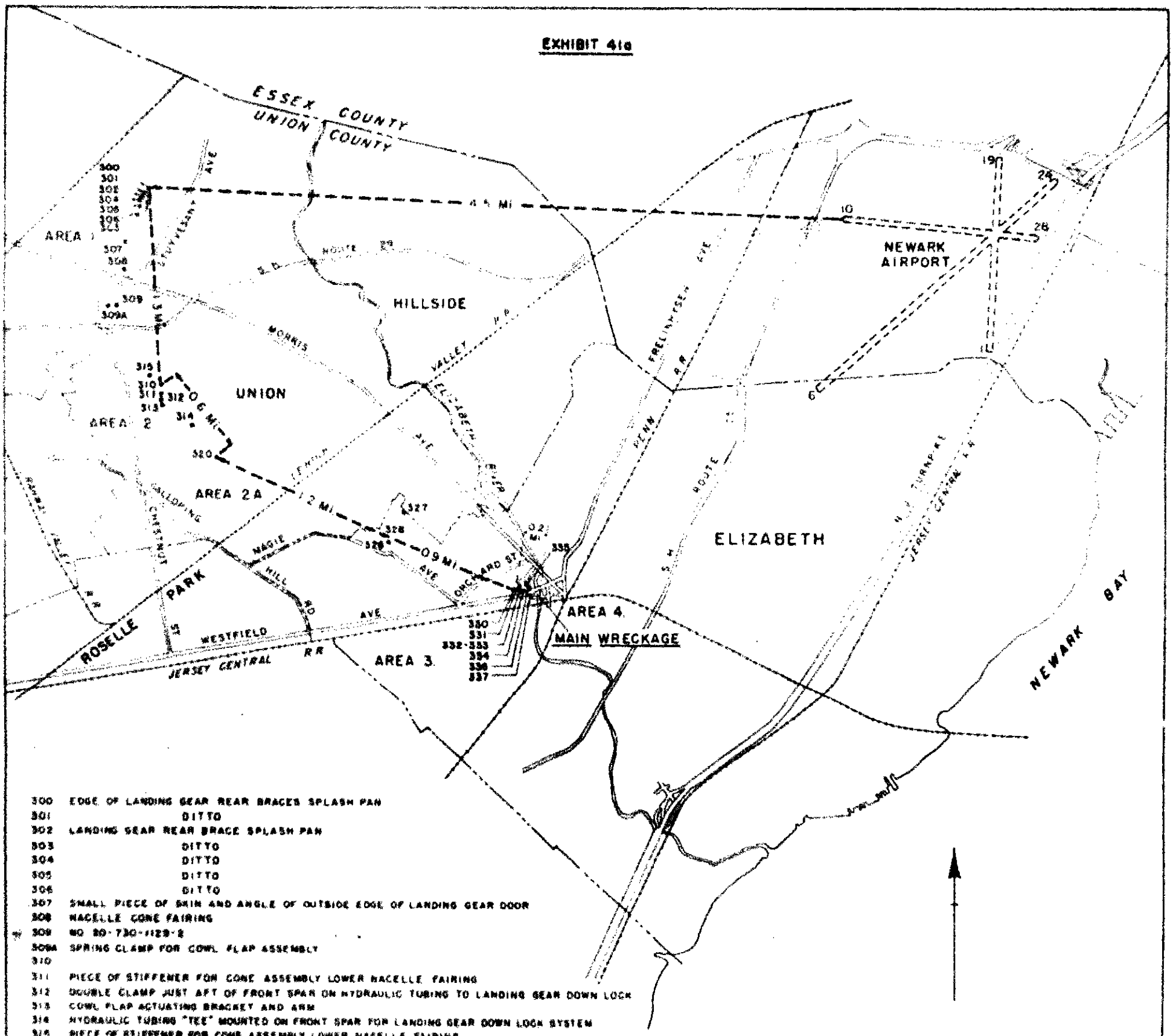
Copilot John R. Mason, age 36, was employed by Miami Airline on October 17, 1951, as a copilot. He had received previous flight training with an export company, and at an airline training school. Copilot Mason had a total flight time of 1,224:15 hours, 234:15 hours of which were in C-46 type aircraft, and 154:50 hours of instrument time. He had passed his last CAA physical examination on July 16, 1951. He held a valid commercial rating No. 443479, airplane single and multi-engine land, and an instrument rating.

Stewardess Doris P. Helms was employed by Miami Airline in April 1951.

THE AIRCRAFT

N 1678M was a Curtiss Wright C-46-F, manufactured on August 15, 1945, and had a total of 23 flight hours before delivery to Miami Airlines, Inc., by the U. S. Air Force from which the aircraft was leased. This aircraft was placed in civilian service on December 14, 1948, after conversion to civil status, as indicated by CAA Form ACA-337, dated December 13, 1948. It was recertificated from 45,000 lbs. gross to 48,000 lbs. gross per ACA-337 dated August 15, 1950. On December 9, 1951, N 1678M had 4,115:05 total flight hours since entering civilian service. The aircraft was equipped with two Pratt and Whitney engines, Model R-2800-51 and Hamilton Standard Hydromatic propellers.

EXHIBIT 41a



300 EDGE OF LANDING GEAR REAR BRACES SPLASH PAN
301 DITTO
302 LANDING GEAR REAR BRACE SPLASH PAN
303 DITTO
304 DITTO
305 DITTO
306 DITTO
307 SMALL PIECE OF SKIN AND ANGLE OF OUTSIDE EDGE OF LANDING GEAR DOOR
308 NACELLE CONE FAIRING
309 NO 80-730-1129-2
309A SPRING CLAMP FOR COWL FLAP ASSEMBLY
310
311 PIECE OF STIFFENER FOR CONE ASSEMBLY LOWER NACELLE FAIRING
312 DOUBLE CLAMP JUST AFT OF FRONT SPAR ON HYDRAULIC TUBING TO LANDING GEAR DOWN LOCK
313 COWL FLAP ACTUATING BRACKET AND ARM
314 HYDRAULIC TUBING "TEE" MOUNTED ON FRONT SPAR FOR LANDING GEAR DOWN LOCK SYSTEM
315 PIECE OF STIFFENER FOR CONE ASSEMBLY LOWER NACELLE FAIRING

320 REAR LEFT SIDE OF RIGHT NACELLE SKIN AT CORNER OF WHEEL DOOR

325 OIL TANK CHAFING STRAP INBOARD PART OF CRADLE
OIL TANK CHAFING STRAP SUPPORT
326 PIECE OF OIL TANK CRADLE AREA

330 80-720 1046-4R
80-20100-2
FRONT SPAR WEB BULB "TEE" SECTION STIFFENER
331 PIECE OF OIL TANK CHAFING STRAP
BOTTOM SKIN OF CENTER SECTION NACELLE AREA REAR
332 LANDING GEAR DRAG STRUT REAR SPAR ATTACHMENT FITTING INSPECTION COVER
333 1 CO_2 LINE FOR FUEL SELECTOR AREA IN NACELLE CONE 2 LAND GEAR DOWN LOCK CABLE
3 CO_2 CABLE PULL PULLEY 4 OIL TANK CARBON PLUG 5 OVERHEAD CABLE TUNNEL COVER FASTENER
334 1 PULLEY FOR FIREWALL SHUTOFF FOR 3 VALVES 2 AIR LINE FOR DE-ICEN BOOT
335
336 C-4 FUEL STRAINER
337
338 1 FRONT SPAR WEB BULB "TEE" SECTION STIFFENER 2 TWO FOOT SECTION OF SELECTOR CROSS-FEED LINE ON RIGHT HAND SIDE OF NACELLE AT FRONT SPAR
339 FRONT SPAR WEB BULB "TEE" SECTION STIFFENER

WRECKAGE DISTRIBUTION
ELIZABETH, NEW JERSEY
CURTISS C-46 N1678M
DECEMBER 16, 1951

JOHN W MEIXELL JR COUNTY ENGINEER

JANUARY 1952

1000 0 1000 2 3 4 5000 6 7 8 9 10000

SCALE OF FEET

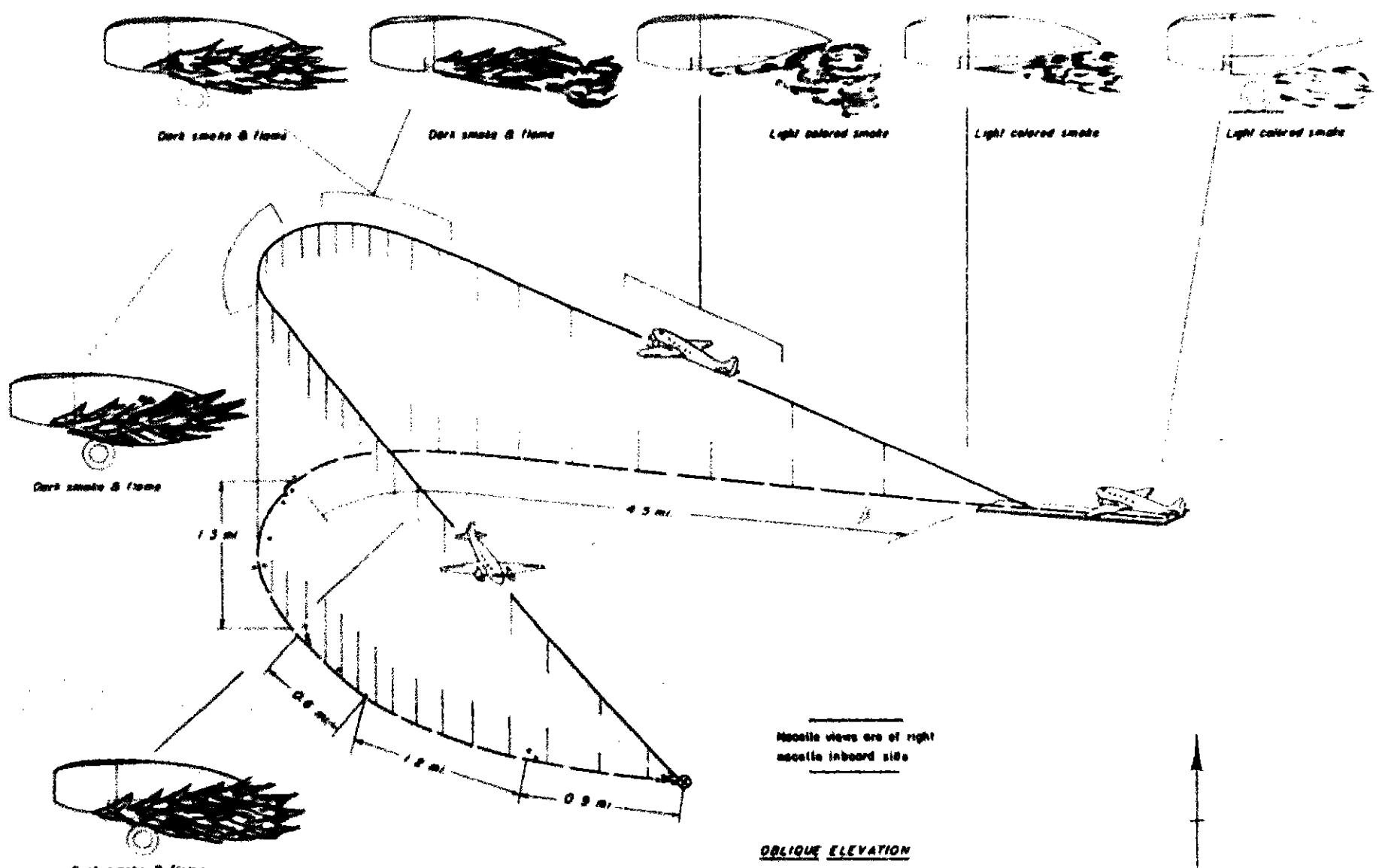
EXHIBIT 401

AIRCRAFT ACCIDENT - ELIZABETH, N. J., 12-16-51

MIAMI AIRLINE, INC. - C46-F N1678M

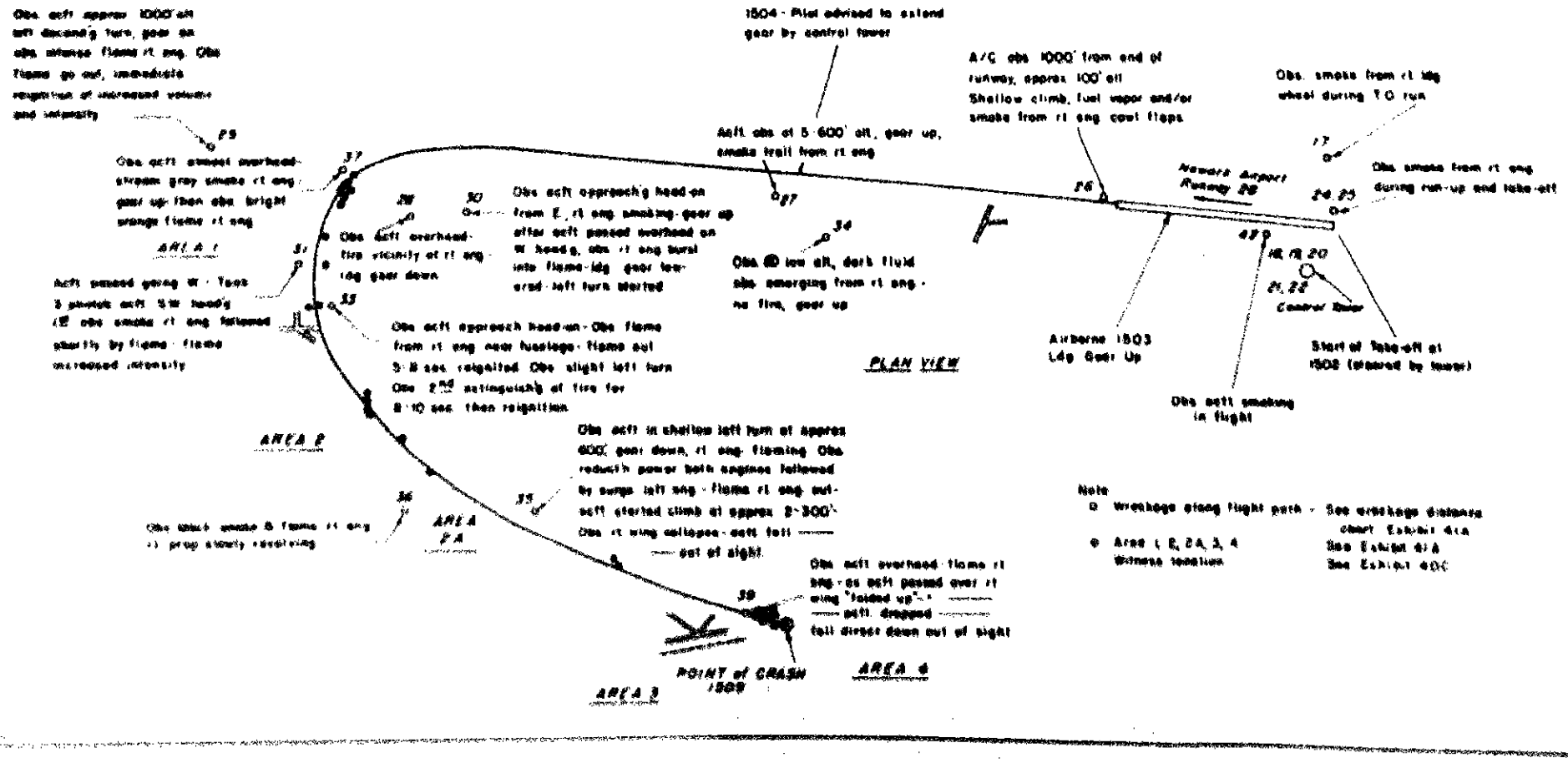
FIRE PROPAGATION (RIGHT ENGINE)

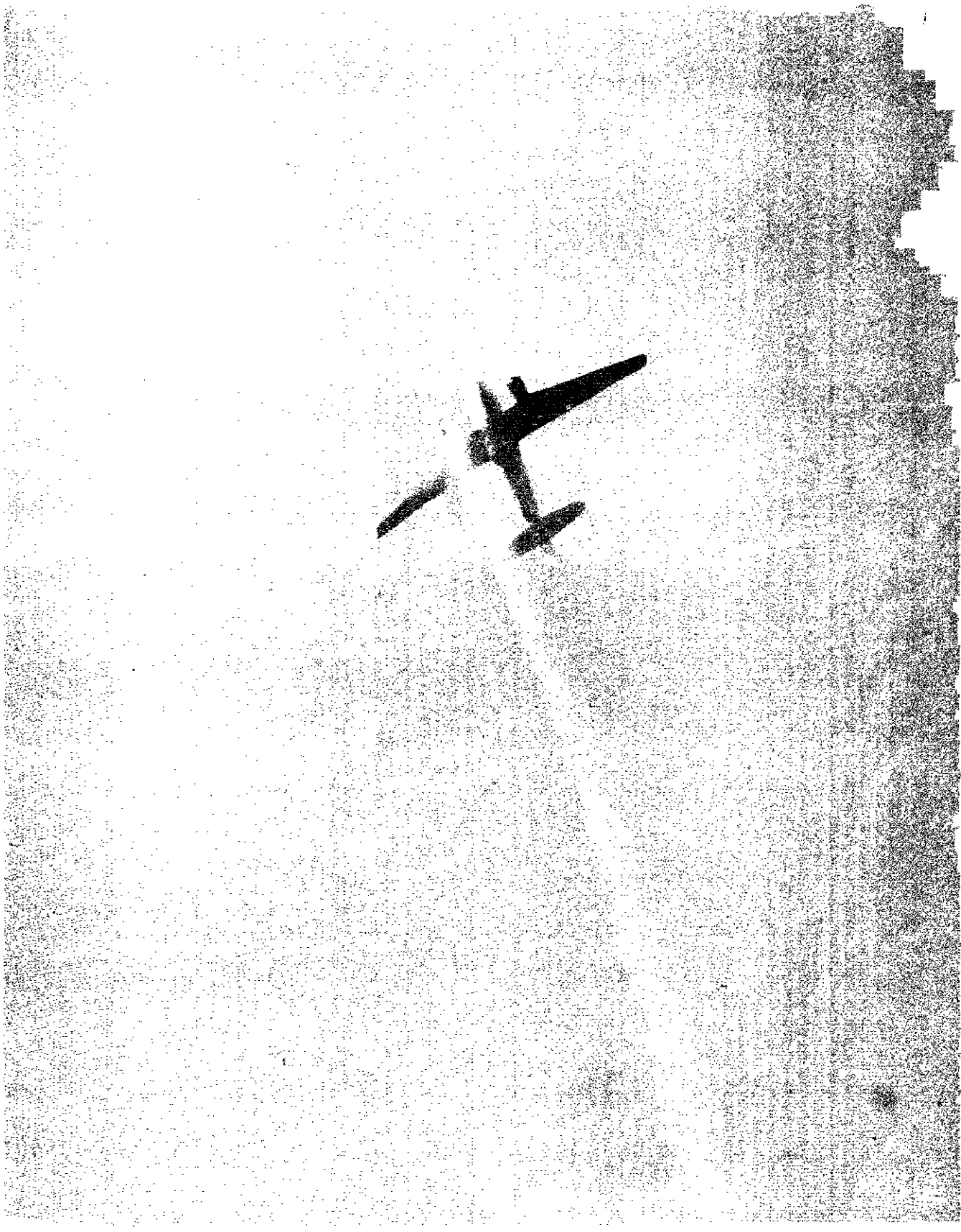
PROBABLE FLIGHT PATH BASED ON DISTRIBUTION OF WRECKAGE AND OBSERVATIONS OF WITNESSES



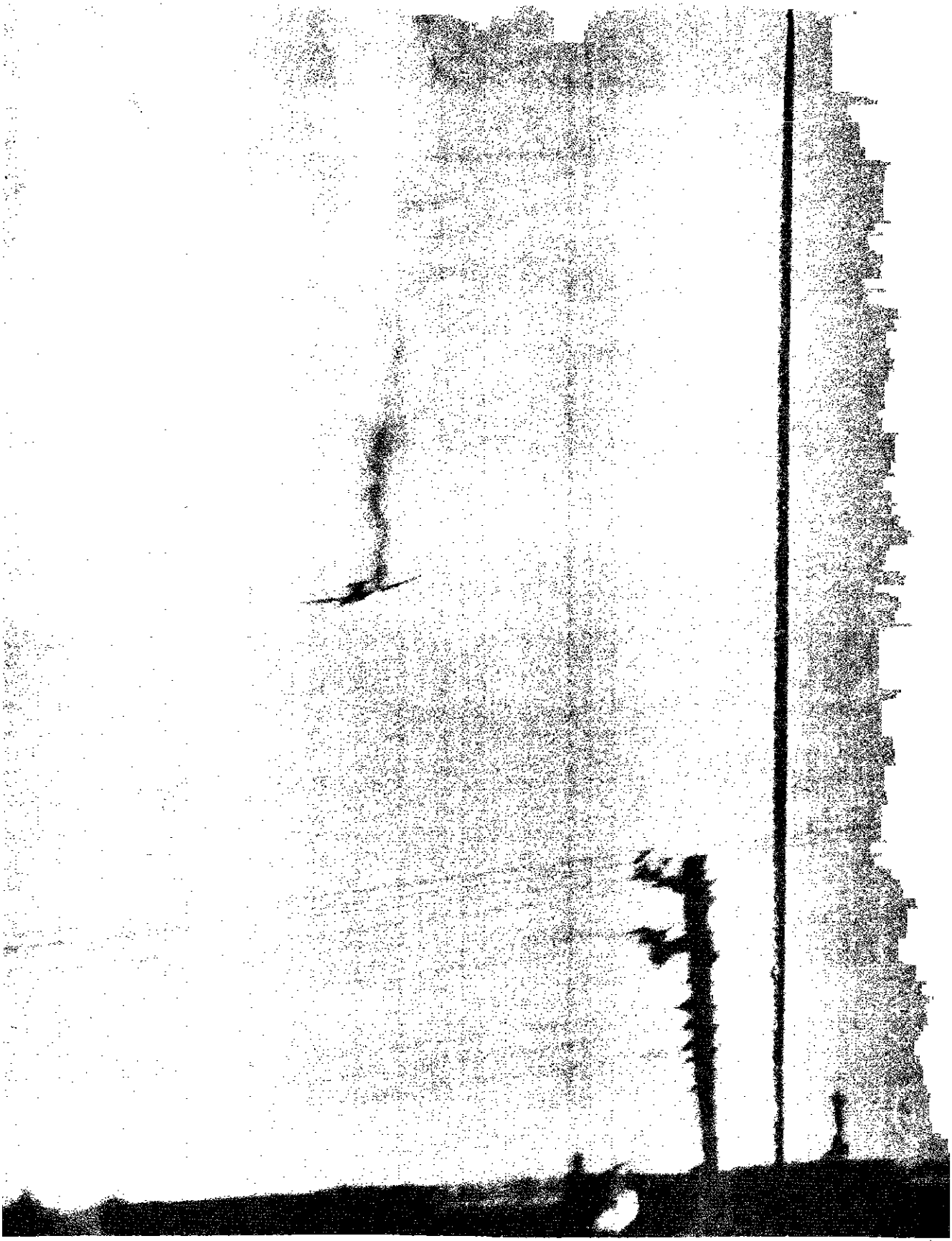
Nacelle views are of right nacelle inboard side

OBLIQUE ELEVATION





ATTACHMENT 1



ATTACHMENT 2