NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, DC 20594

AIRCRAFT ACCIDENT REPORT

**PACIFIC SOUTHWEST AIRLINES, INC.,
B-727, N533PS AND**

**GIBBS FLITE CENTER, INC.,
CESSNA 172, N7711G**

**SAN DIEGO, CALIFORNIA
SEPTEMBER 25, 1978**

UNITED STATES GOVERNMENT

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16.Abstract About 0901:47, September 25, 1978, Pacific Southwest Airlines, Inc., Flight 182, a Boeing 727-214, and a Gibbs Flite Center, Inc., Cessna 172, collided in midair about 3 nautical miles northeast of Lindbergh Field, San Diego, California. Both aircraft crashed in a residential area. One hundred and thirty-seven persons, including those on both aircraft were killed; 7 persons on the ground were killed; and 9 persons on the ground were injured. Twenty-two dwellings were damaged or iestroyed. The weather was clear, and the visibility was 10 miles.

The Cessna was climbing on a northeast heading and was in radio contact with the San Diego approach control. Plight 182 was on a visual approach to runway 27. Its flightcrew had reported sighting the Cessna and was cleared by the approach controller to maintain visual separation and to contact the Lindbergh tower Upon contacting the tower, Flight 182 was again advised of the Cessna's position. The flightcrew did not have the Cessna in sight. They thought they had passed it and continued their approach. The aircraft collided near 2,600 ft m.s.1.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew of Flight 182 to comply with the provisions of a maintain-visual-separation clearance, including the requirement to inform the controller when they no longer had the other aircraft in sight.

Contributing to the accident were the air.traffic control procedures in

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AIRCRAFT ACCIDENT REPORT

Adopted: April 20, 1979

PACIFIC SOUTHWEST AIRLINES, INC.
BOEING 727-214, N533PS, FLIGHT 182
GIBBS FLITE CENTER, INC.
CESSNA 172, N7711G
SAN DIEGO, CALIFORNIA
SEPTEMBER 25, 1978

SYNOPSIS

About 0901:47 P.s.t., September 25, 1978, Pacific Southwest Airlines, Inc., Flight 182, a Boeing 727-214, and a Gibbs Flite Center, Inc., Cessna 172 collided in midair about 3 nautical miles northeast of Lindbergh Field, San Diego, California.

The Cessna was under the control of San Diego approach control and was climbing on a northeast heading. Flight 182 was making a visual approach to runway 27 at Lindbergh Field and had been advised of the location of the Cessna by the approach controller. The flightcrew told the approach controller that they had the traffic in sight and were instructed to maintain visual separation from the Cessna and to contact the Lindbergh Tower. Flight 182 contacted the tower on its downwind leg and was again advised of the Cessna's position. The flightcrew did not have the Cessna in sight, they thought they had passed it and continued the approach. The aircraft collided near 2,600 ft m.s.l. and fell to the ground in a residential area. Both occupants of the Cessna were killed; 135 persons on board the Boeing 727 were killed; 7 persons on the ground were killed; and 9 persons on the ground were injured. Twenty-two dwellings were damaged or destroyed. The weather was clear, and the visibility was 10 miles.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew of Flight 182 to comply with the provisions of a maintain-visual-separation clearance, including the requirement to inform the controller when they no longer had the other aircraft in sight.

Contributing to the accident were the air traffic control procedures in effect which authorized the controllers to use visual separation procedures to separate two aircraft on potentially conflicting tracks when the capability was available to provide either lateral or vertical radar separation to either aircraft.

1. FACTUAL INFORMATION

1.1 History of the Flights

About 0816 P.s.t. 1/ on September 25, 1978, a Gibbs Flite Center Cessna 172, N7711G, departed Montgomery Field, California, on an instrument training flight. Since the flight was to be conducted In visual meteorological conditions, no flight plan was filed and none was required. A flight instructor occupied the right seat, and another certificated pilot, who was receiving instrument training, occupied the left seat.

The Cessna proceeded to Lindbergh Field, where two practice ILS approaches to runway 9 were flown. Although the reported wind was calm, runway 27 was the active runway at Lindbergh. About 0857, N7711G ended a second approach and began a climbout to the northeast; at 0859:01, the Lindbergh tower local controller cleared the Cessna pilot to maintain VFR conditions and to contact San Diego approach control.

At 0859:50, the Cessna pilot contacted San Diego approach control and stated that he was at 1,500 ft, 2/, and "northeastbound." The approach controller told him that he was in radar contact and Instructed him to maintain VFR conditions at or below 3,500 ft and to fly a heading of 070°. The Cessna pilot acknowledged and repeated the controller's instruction.

Pacific Southwest Airlines, Inc., Flight 182 was a regularly scheduled passenger flight between Sacramento and San Diego, California, with an intermediate stop in Los Angeles, California. The flight departed Los Angeles at 0834 on an IFR flight plan with 128 passengers and a crew of 7 on board. The first officer was flying the aircraft. Company personnel familiar with the pilots' voices identified the captain as the person conducting almost all air-to-ground communications. The cockpit voice recorder (CVR) established the fact that a deadheading company pilot occupied the forward observer seat in the cockpit.

At 0853:19, Flight 182 reported to San Diego approach control at 11,000 ft and was cleared to descend to 7,000 ft. At 0857, Flight 182 reported that it was leaving 9,500 ft for 7,000 ft and that the airport was in sight. The approach controller cleared the flight for a visual approach 3/ to runway 27; Flight 182 acknowledged and repeated the approach clearance.

1/ All times herein are Pacific standard based on the 24-hour clock.

2/ All altitudes herein are mean sea level unless otherwise specified.

3/ An approach wherein an aircraft on an IFR flight plan operating in VFR conditions under control of an ATC facility and having an ATC authorization may proceed to the airport of designation in VFR conditions.

At 0859:28, the approach controller advised Flight 182 that there was "traffic (at) twelve o'clock, one mile, northbound." Five seconds later the flight answered, "We're looking."

At 0859:39, the approach controller advised Flight 182, "Additional traffic's twelve o'clock, three miles, just north of the field, northeastbound, a Cessna one seventy-two climbing VFR out of one thousand four hundred." According to the CVR, at 0859:50, the copilot responded, "Okay, we've got that other twelve."

At 0900:15, about 15 sec after instructing the Cessna pilot to maintain VFR at or below 3,500 ft and to fly 070°, the approach controller advised Flight 182 that "traffic's at twelve o'clock, three miles, out of one thousand seven hundred." At 0900:21, the first officer said, "Got em", and 1 sec later the captain informed the controller, "Traffic in sight."

At 0900:23, the approach controller cleared Flight 182 to "maintain visual separation," and to contact Lindbergh tower. At 0900:28 Flight 182 answered, "Okay," and 3 sec later the approach controller advised the Cessna pilot that there was "traffic at six o'clock, two miles, eastbound; a PSA jet inbound to Lindbergh, out of three thousand two hundred, has you in sight." The Cessna pilot acknowledged, "One one golf, roger."

At 0900:34, Flight 182 reported to Lindbergh tower that they were on the downwind leg for landing. The tower acknowledged the transmission and informed Flight 182 that there was "traffic, twelve o'clock, one mile, a Cessna."

At 0900:41, the first officer called for 5" flaps, and the captain asked, "Is that the one (we're) looking at?" The first officer answered, "Yeah, but I don't see him now." According to the CVR, at 0900:44, Flight 182 told the local controller, "Okay, we had it there a minute ago," and 6 sec later, "I think he's pass(ed) off to our right." The local controller acknowledged the transmission. (According to the ATC transcript the 0900:50 transmission was "think he's passing off to our right" and the local controller testified that he heard, "he's passing off to our right.")

The CVR showed that Flight 182's flightcrew continued to discuss the location of the traffic. At 0900:52, the captain said, "He was right over there a minute ago." The first officer answered, "Yeah."

At 0901:11, after the captain told the local controller how far they were going to extend their downwind leg, the first officer asked, "Are we clear of that Cessna?" The flight engineer said, "Supposed to be"; the captain said, "I guess"; and the forward jumpseat occupant said, "I hope."

At 0901:21, the captain said "Oh yeah, before we turned downwind, I saw him about one o'clock, probably behind us now."

At 0901:31, the first officer called, "Gear down."

At 0901:38, the first officer said, "There's one underneath," and then, 1 sec later, he said, "I was looking at that inbound there."

At 0901:28, the conflict alert warning began in the San Diego Approach Control Facility, indicating to the controllers that the predicted flightpaths of Flight 182 and the Cessna would enter the computer's prescribed warning parameters. At 0901:47, the approach controller advised the Cessna pilot of "traffic in your vicinity, a PSA jet has you in sight, he's descending for Lindbergh." The transmission was not acknowledged. The approach controller did not inform Lindbergh tower of the conflict alert involving Flight 182 and the Cessna, because he believed Flight 182's flightcrew had the Cessna in sight. The aircraft collided at 0901:47.

According to the witnesses, both aircraft were proceeding in an easterly direction before the collision. Flight 182 was descending and overtaking the Cessna, which was climbing in a wing level attitude. Just before impact, Flight 182 banked to the right slightly, and the Cessna pitched noseup and collided with the right wing of Flight 182. The Cessna broke up immediately and exploded. Segments of fragmented wreckage fell from the right wing and empennage of Flight 182.

Flight 182 began a shallow right descending turn, leaving a trail of vaporlike substance from the right wing. A bright orange fire erupted in the vicinity of the right wing and increased in intensity as the aircraft descended. The aircraft remained in a right turn, and both the bank and pitch angles increased during the descent to about 50° at impact.

Both aircraft were destroyed by the collision, in-flight and postimpact fires, and impact. There were no survivors. Seven persons on the ground were killed, and 22 dwellings were damaged or destroyed.

The aircraft crashed during daylight hours, into a residential area about 3 miles northeast of Lindbergh Field. The coordinates of the wreckage sites were 32″ 45'N, 117" 08'W. *Seismological data recorded at the Museum of Natural History, San Diego, California, showed that the in-flight explosion and ground impact occurred at 0901:47.9 and 0902:07, respectively.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	9 1/	128	7
Serious	0	0	0
Minor/None	0	0	9

1/ Includes persons on both aircraft.

1.3 Damage to Aircraft

Both aircraft were destroyed.

1.4 Other Damage

Twenty-two dwellings were either destroyed or damaged.

1.5 Personnel Information

All flightcrew personnel on both aircraft and controller personnel were qualified. The cabin crew personnel on Plight 182 were qualified. (See Appendix B.) The Lindbergh tower local controller's second-class medical certificate required him to "wear corrective lenses for distant vision while flying." The wording was incorrect and should have stated that "the holder shall wear correcting glasses while exercising the privileges of his airman's certificate." He was not wearing his glasses at the time of the accident; his uncorrected distant visual acuity for both eyes was 20/25. 14 CFR 65 contains the certification requirements for "airmen other than flightcrew members," and 14 CFR 65.1(a) designates air traffic control tower operators as airmen subject to these requirements; 14 CFR 65.33(d) requires a control tower operator to "Hold at least a second-class medical certificate...."

1.6 Aircraft Information

Flight 182, a Boeing 727-214, N533PS, was owned and operated by Pacific Southwest Airlines, Inc. The aircraft was within prescribed weight and balance limitations for the flight. There were 14,998 lbs of jet-A fuel on board on takeoff from Los Angeles, California. (See Appendix C.)

The Cessna 172M, N77llG, was owned and operated by Gibbs Flite Center, Inc. The aircraft was within prescribed weight and balance limits for the flight and had about 42 gallons of 80-octane gasoline on board at takeoff. Except for a mustard-colored stripe on each side of the fuselage, the aircraft was painted white.

1.7 Meteorological Information

At the time of the accident, the weather in the San Diego area was clear. The surface observations at Lindbergh Field were as follows:

0855, record: Clear, visibility--l0 mi, temperature--85°F, dewpoint--57°F, winds calm, altimeter setting--29.85 inHg, smoky offshore.

0907, local: Clear, visibility--lo mi, temperature--85°F, dewpoint--57°F, winds calm, altimeter setting--29.85 inHg, smoky offshore, aircraft mishap.

At 0902, at Lindbergh Field's latitude and longitude the sun's elevation and azimuth were 28.6° and 111.8°, respectively.

1.8 Aids to Navigation

Not applicable

1.9 Communications

There were no known communications malfunctions.

1.10 Aerodrome Information

Lindbergh Field is located 3 miles northwest of downtown San Diego, California, and it is served by two runways--9/27 and 13/31. Runway 9/27 is 9,400 ft long and 200 ft wide; there is an ILS approach to runway 9.

Two other airfields are located within 7 miles of Lindbergh Field; North Island Naval Air Station (NAS) is 2 miles south, and Montgomery Field is 6.4 miles north-northeast. (See Appendix F.) Each airport is surrounded by an airport traffic area which, by regulation, Is ". . . that airspace within a horizontal distance of 5 statute miles from the geographical center of any airport at which a control tower is operating, extending from the surface up to, but not including, an altitude of 3,000 ft above the elevation of the airport." Because of the proximity of Lindbergh and Montgomery Fields, their airport traffic areas overlap north of Lindbergh Field. (See Appendix H.)

Federal regulations govern operations In and around these areas. Pertinent sections of these regulations are:

14 CFR 91.85(b) Unless otherwise authorized or required by ATC, no person may operate an aircraft within an airport traffic area except for the purpose of landing at, or taking off from, an airport within that area....

> 14 CFR 91.87(b) No person may, within an airport traffic area, operate an aircraft to, from or on an airport having a control tower operated by the United States unless two way radio communications are maintained between that aircraft and the control tower.

Between 0858 and 0905, Lindbergh tower was in radio contact with six airborne aircraft: Flight 182 and Cessna N771lG; Pacific. Southwest Airlines (PSA) Flight 766 which landed about 090l:OO; PSA Flight 207 which took off at 0901:47; a Coast Guard helicopter which left Brown Field at 0904:25; and a Cessna 401, N3208Q, which was flying between Gatto and Sargo Intersections--5 to 10 nmi west of Lindbergh Field.

There are several other airfields within a 20 nmi-radius of Lindbergh Field. (See Appendix F.)

1.11 Flight Recorders

The Cessna was not equipped with any recorders and none were required.

Flight 182 was equipped with a Sundstrand FA-542 flight data recorder (FDR), serial No. 3729. The outer case was intact with mechanical damage to the right side of the rear section. The entire unit had been subjected to fire and extreme heat. Examination of the pertinent portion of metal foil recording medium disclosed that its surface was covered completely with heavy crusted deposits. Repeated chemical and ultrasonic cleanings finally removed sufficient deposits to permit the entire record of altitude, indicated airspeed, and magnetic heading to be seen. However, the traces containing minute marks, vertical acceleration, and radio transmission indications were not visible over the last 4 min of the flight. This condition created a problem since the minute marks were not available for timing the foil movement precisely, and the lack of radio transmission indications made correlation of the FDR with the CVR more difficult.

A readout was made of the last 4 min of the altitude, indicated airspeed, and magnetic heading traces. (See Appendix G.) Timing of this readout was done by measuring spacing of the the eight l-min marks visible on the foil and using their average spacing to determine a time interval constant for the last 4 min of the readout.

Flight 182 was equipped with a Fairchild A-100 CVR, serial NO. 1435. The recorder was damaged severely and had been subjected to intense heat. Despite this, the CVR yielded an excellent tape, the last 5 min of which was transcribed.

At 0901:47, a crunching sound was recorded and disturbances in the aircraft electrical system were detected on an unused radio channel in the CVR. Therefore, 0901:47 was fixed as the time of collision. Electrical power to the recorder ended at 0902:04.5, or about 2.5 sec before the ground impact was recorded on the seismograph.

The CVR also disclosed several remarks which were attributed to an unidentified voice. The Safety Board could not determine whether this unidentified voice was the voice of one of the previously identified cockpit occupants, or if there was a fifth person in the cockpit.

As Flight 182 descended into the terminal area, the dead-heading company crewmember engaged the captain in conversation over a subject that was not related to the conduct of the flight; however, the conversation ceased at 0900:10, about 5 sec before the approach controller pointed out the Cessna to the crew for the second time. Thereafter, only the three primary flightcrew members talked, and all conversation was directly related to the conduct of the flight. The flight engineer was still involved with transmitting information to the company's San Diego operations radio station until 4 sec before the collision. (See Appendix D.)

1.12 Wreckage and Impact Information

Flight 182 crashed on a heading of about 200° in a right wing-low, nosedown attitude. The Cessna 172 was damaged extensively by the collision and fell to the ground in several pieces.

The Boeing 727's fuselage was damaged severely by ground impact. The fuselage structure from the cockpit to the airstair compartment was collapsed almost completely and fragmented; major portions of it were consumed by ground fire.

The left wing had been subjected to severe ground impact forces and ground fire. A section of wing was identified from wing station (WS) 301 to WS 601, including the outboard section of the No. 4 leading edge slat and the No. 3 leading edge slat. These slats were In the extended position. The three flight spoiler panels were intact, attached to the wing, and in the retracted position.

The right wing was fragmented completely by ground impact. Almost all of the identifiable pieces of wing structure had been damaged by either in-flight or postimpact ground fire, or both.

Measurement of the flap jackscrews showed that the flaps were in the 15° position at impact.

The empennage, horizontal and vertical stabilizers, and rudder assembly were damaged severely by ground impact and ground fire.

All three engines had separated from the aircraft and were found In the main wreckage area. Except for some of the first stage fan blades of the Nos. 1 and 3 engines, which were bent rearward and in the direction of fan rotation, the blades on the fan and front compressor sections of all three engines were bent or broken in the direction opposite to compressor rotation. Metal splatter had adhered to the rear portions of the combustion chambers, the combustion chamber outlets' inner and outer ducts, and the concave side of the first stage turbine nozzle guide vanes. The engines' turbine sections showed evidence of rotational rubbing between the blades and the turbine cases, and some low pressure turbine blades were bent in the opposite direction to turbine rotation. There was no evidence of foreign object ingestion in the engine fan or compressor sections.

Except for parts of the Cessna's left wing and left wing fuel tank, the major portion of the Cessna's wreckage fell to the ground about 3,500 ft northwest of the wreckage of the Boeing 727.

The Cessna's vertical stabilizer was bent to the left and had separated from the empennage. The rudder had separated from the stabilizer and was bent in the same manner as the stabilizer.

The upper structure of the fuselage from the left cabin doorpost to the empennage was crushed downward, and beginning at the leading edge of the horizontal stabilizer, the fuselage was buckled upward severely.

Various pieces of the Boeing 727's right wing Kruger leading edge flap system were recovered in the Cessna wreckage. These included parts of the Nos. 5 and 6 flaps, and the forward end of the No. 5 flap actuator with the piston and attachment bracket assembly attached. These pieces were not damaged by fire.

The Cessna's left wing fuel tank was recovered at the Boeing 727's wreckage site, Half of the tank was missing and the remaining portion was crushed.

The Cessna engine and propeller separated from the aircraft. Although the propeller remained attached to the engine, portions of each blade section had been torn off. The separated portion of the right Propeller blade was found. The leading edge of the blade section had three small contact marks, and there was a fresh cylindrical impact mark about 1 in. in diameter and l/2 in. deep within the fracture area.

A section of the Boeing 727's right wing No. 5 leading edge flap assembly was identified. A 5-in. portion of the flap actuator's forward end, including the piston rod assembly, was still attached to the section. The flap actuator rod assembly was in the extended position and bent about 75° inboard near the actuator. A small piece of the leading edge of the Cessna's propeller blade was lodged between the pistonrod and the actuator end.

1.13 Medical and Pathological Information

A review of the autopsies and toxicologic examinations of the flightcrews of both aircraft disclosed no evidence of pre-existing physiological problems which could have affected their performance.

1.14 Fire

The Cessna was subjected to in-flight collision fire. Flight 182 was subjected to both in-flight fire and severe ground fire.

1.15 Survival Aspects

This accident was not survivable.

1.16 Tests and Research

1.16.1 Study of Photographs

Enlargements of two postcollision photographs were used to try to determine the Boeing 727's flight control displacements and the condition of its fuel and hydraulic systems during the latter portions of the flight. (See Figures 1 and 2.)

The right wing, as shown in Figure 2, was studied. The examination revealed that the Nos. S and 6 leading edge flaps were missing, a portion of the No. 5 leading edge slat was missing, and a large portion of the wing's leading edge back to about the front spar was peeled off the aircraft.

Hydraulic tubing from both the System A and the standby hydraulic systems was routed to the leading edge devices forward of the front spar. It was not possible to determine from the photographs if the tubes were broken or flattened. The B hydraulic system's tubing was located just aft of the rear spar of the wing. Because the extent of damage that could have existed in that area could not be determined, the status of the tubing could not be determined.

Fuel lines from the fuel pumps to the fuel pressure sensors were located immediately behind the leading edge flaps. These lines contain fuel under pressure and, if severed, would spray fuel out as long as the fuel pumps were operating. Because of fire which covered the aft section of the wing in the area of the inboard aileron, it was not possible to ascertain whether any of the surfaces in that area were missing.

Except for the upper and lower rudders, which were centered in the first photograph and positioned 10° left in the second, the deflections of the other control surfaces in both pictures were the same. The left wing flight spoilers were full up; the left wing ailerons were full up; the right wing outboard aileron was down; the elevators were almost full up; the trailing edge flaps were extended to 15°; and the leading edge devices were extended fully.

Figure 1. Flight 182 after colliding with the Cessna.

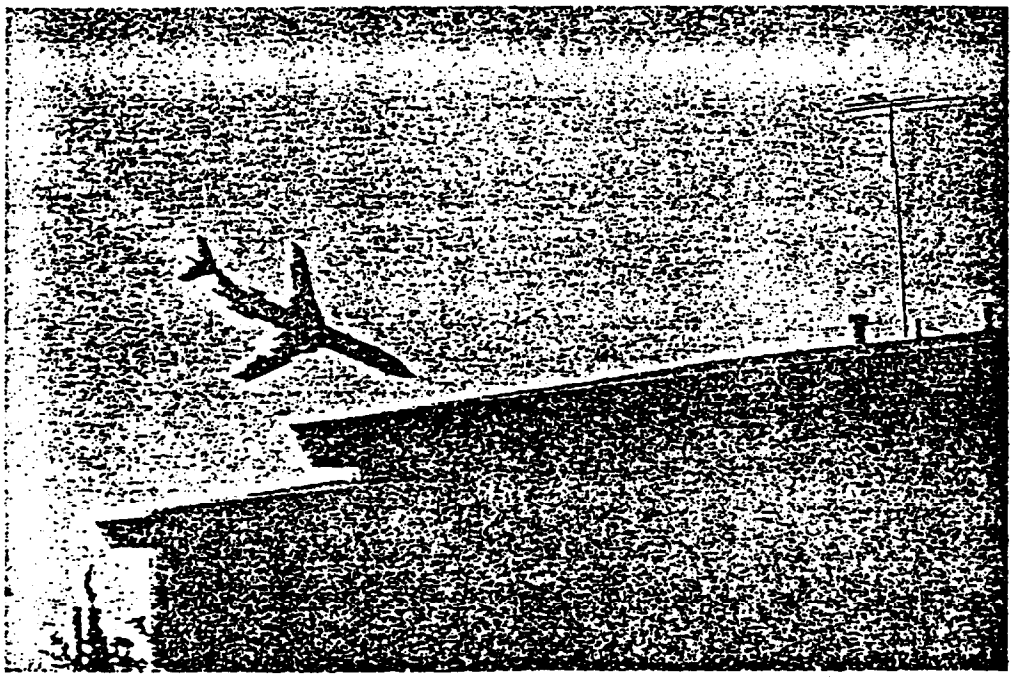


Figure 2. Flight 182 descending. (Photo taken after Figure 1)

1.16.2 Probable Ground Track Plot

Data from the FDR readout, CVR, and ATC communications transcripts, D-log plot information from the Los Angeles Air Route Traffic Control Center (ARTCC), Cessna 172 performance data, and seismological data were used to reconstruct the probable ground tracks of Flight 182 and the Cessna. Time correlation of the FDR and CVR data was achieved by matching identifiable aberrations of the FDR's altitude, airspeed, and heading traces with similar events on the CVR. (See Appendix H.)

The ground tracks showed that Flight 182 overflew the Mission Bay (MZB) VORTAC, turned left to a heading of about 090°, and maintained that heading until the collision. At the time of collision, the altitude trace was about 2,600 ft. The track showed that Flight 182 flew about 4.2 miles south of Montgomery Field. The ground tracks showed that the Cessna turned to the northeast just west of Lindbergh Field and maintained that approximate heading for about 1 min. At 0900:45, the Cessna turned right to a heading of about 090° and maintained that approximate heading until the collision.

1.16.3 Cockpit Visibility Study

The cockpit visibility study was based on a series of photographs taken with a binocular camera mounted within the cockpit of a Boeing 727-200 series aircraft at the design eye reference points for the pilot and copilot seats and at an arbitrary eye position for the observer seat. Similar photographs were taken from inside the cockpit of a Cessna 172 with the camera mounted at the pilot's design eye reference point. Another set of photographs was produced for the Boeing 727 with the camera mounted 5 ins. forward of the pilots' normal design eye reference points and represents a pilot leaning forward 5 ins. to search for an airborne target. This position was called the alert position. Since the exact position of the flight engineer's seat during this part of flight could not be determined, binocular photographs were not made for his position.

The photographs show a panoramic view of the window configuration as seen by the crewmember as he rotates his head from one extreme side to the other. Visibility from the right cockpit seat was simulated by reversing the negative of the photograph taken fron the left cockpit seat. A grid of horizontal and vertical lines in 5" increments was superimposed over the photographs. Each photograph contains 17 points which represent the calculated location of the target aircraft on the viewing aircraft's windshield from 170 sec to 10 sec before the collision. The points--which are numbered from 1 to 17--were plotted at 10-sec intervals. The plotted target points take into account the heading, Pitch angle, and bank angle of the viewing aircraft. (See Appendix E.)

The photographs taken from the captain's and first officer's seats showed that the Cessna would have been almost centered on their windshields from 170 sec to 90 sec before the collision, and thereafter it was positioned on the lower portion of the windshield just above the windshield wipers. Movement to the alert position elevated the position of the Cessna targets during the last 80 sec slightly. The view from the observer's seat showed that the Cessna target, for the most part, would have been hidden by the captain's head and shoulders and aircraft structure.

The photographs taken from the Cessna showed that at 90 sec before the collision Flight 182 would have been positioned on the upper portion of the left door window for about 10 sec. The remainder of the time it was hidden behind the cockpit's ceiling structure.

The Boeing 727-200 series is equipped with a design eye reference point locator on the post between the two windshields to provide guidance to both pilots in adjusting their seats so that their eyes are near the design eye ref.erence point. The device consists of three balls in a triangular arrangement, two of which will be aligned when each pilot's eyes are near the design eye reference point. Several members on the Safety Board's Visibility Study Croup sat in the left and right pilot seats and adjusted the seat using the locator device until, in their judgment, their eyes were at the design eye reference point. Each subject reported that, with their seat so adjusted, the glareshield did not mask *or* interfere with their view of the instrument panel displays.

Federal and company regulations do not require pilots to adjust their seats so as to position their eyes at the design eye reference point. The chief pilot of PSA testified that he and other company pilots are not able to either move the aircraft's rudder pedals and elevator column to their stops, or see the entire instrument panel when the pilot's seat is positioned to place their eyes at the design eye reference point. In order for him to obtain full use of the controls and full visibility of the instruments, it was necessary to move his seat slightly aft. He also testified that the company recommends that the pilot position his seat to place his eyes at the design eye reference point, and then move it as little as possible to scan all his instruments and have full displacement of the aircraft controls. According to him the seat movement to achieve this was "probably no more than 1 inch aft." However, other company pilots stated that the seat had to be moved both aft and down.

1.17 Other Information

1.17.1 Air Traffic Control Procedures

Recommended procedures for the control of air traffic are contained in the Air Traffic Control Handbook 7110.658. All handbook paragraphs cited herein were in effect at the time of the accident.

Safety advisories based on conflicting traffic are contained in paragraph 33, which requires the controller to issue a safety advisory to an aircraft under his control if he is aware the aircraft is in unsafe proximity to other uncontrolled aircraft. The 'controller may discontinue the issuance of further advisories if the pilot informs him that he is taking action to correct the situation "or has the other aircraft in sight." Paragraph 33b states:

> "Aircraft conflict advisory--Immediately issue an advisory to an aircraft under your control if you are aware of an aircraft that is not under your control at an altitude which, in your judgment, places both aircraft in unsafe proximity to each other. With the advisory, offer the pilot an alternate course of action when feasible."

The paragraph contains three examples of recommended terminology for this advisory. All the examples require the controller to either vector the aircraft to a new heading or clear it to a new altitude, or both.

Paragraph 490 states that "aircraft may be separated by visual means when other approved separation is assured before and after the application of visual separation.*" Paragraph 490a permits the application of visual separation within the terminal area provided.

> "(1) You are in communication with at least one of the aircraft involved, and,
> (2) You see the aircraft and maintain visual separation between them or,
> (3) A pilot sees another aircraft and you instruct him to maintain visual separation from it. If the aircraft are on converging courses, inform the other aircraft that visual separation is being applied."

The controller is required to issue traffic advisories as an additional service. Paragraph 511 states that the controller should issue this information to an aircraft on his frequency when, in his judgment, 'their proximity may diminish to less than the applicable separation minima. Provide this service as follows:

> "a. To radar identified aircraft:
> Traffic, twelve o'clock, one zero miles, southbound DC-8, one seven thousand,"

The controller can, if requested by the pilot, issue vectors to help him avoid the traffic, provided the aircraft being vectored is within his area of jurisdiction or coordination has been effected with "the sector/facility in whose area the aircraft is operating."

Paragraph 511a(6) states, "If the pilot informs you he does not see the traffic you have issued, inform him when the traffic is no longer a factor."

Paragraph 796c authorizes a controller to clear a radar controlled aircraft for a visual approach provided:

"(1) Potential traffic conflicts with other aircraft under your control have been resolved, and
(2) The aircraft is and can remain in VFR conditions, and,
(3) At Tower Controlled Airports, the tower is informed of the aircraft's position . ..."

1.17.2 Air Traffic Control Procedures in the San Diego Area

The procedures cited herein are based upon facility orders and letters of agreement which were in effect at the time of the accident.

A circular Terminal Radar Service Area (TRSA) overlays a portion of the San Diego terminal area airspace. (See Appendix F.) Within the TRSA, ATC provides radar vectoring, sequencing and separation for all IFR and participating VPR aircraft. Service provided within a TRSA is called stage III service. The base altitude of the TRSA over and in the immediate vicinity of Lindbergh Field is 4,000 ft.

Stage II service was provided to participating aircraft in the area around Lindbergh Field below the TRSA. The services provided were full time radar vectoring and sequencing of all arrivals and traffic advisories to aircraft.

The San Diego Approach Control Facility is on the Miramar Naval Air Station (NAS) about 8 nmi north of Lindbergh Field. This facility had an ASR-5 radar 4/ and an automated radar terminal system (ARTS) computer. Its radarscopes displayed an aircraft's primary and secondary transponder returns and alphanumeric data tags for transponder-equipped aircraft. The facility did not have recording equipment available to record and retain radar data. Both Flight 182 and the Cessna were equipped with altitude encoding transponders, and their data tags displayed their identifications, computed groundspeeds, and altitude readouts.

The ARTS computer at the facility was equipped with an automatic data block offset function (auto-offset) which is designed to prevent the data blocks from merging. The auto-offset function is assigned the lowest priority in the executive scheduler of the ARTS computer. When the computer predicts that the data blocks of aircraft on a controller's radar display are about to merge, the data block will be offset 90° from its position to an area around the aircraft's radar return on the display where there is the most room to write. The auto-offset function is display oriented, and automatic offsetting is limited to those aircraft tracks which are being controlled by the display and have full data blocks. A controller can inhibit the auto-offset function at his display by making the appropriate entry into the computer through the data entry keyboard at his radar display. There are no lights on the keyboard, or symbols on the display to indicate to a controller that the auto-offset function in his display either is inhibited or enabled.

4/ Search radar which provides azimuth and range information at lower levels of flight within a 50 smi range of the airport.

The coordinator and approach controller were working at the same radar display and had taken their position about 14 min and 21 min before the collision, respectively. Both controllers said that they did not recollect inhibiting the auto-offset function at the radar display; however, they could not state whether the function was inhibited or enabled while they were working their positions.

A controller can offset data blocks on his display manually if they merge and the auto-offset function either is inhibited or fails to operate. The data blocks can be offset in any direction the controller wishes by a keyboard entry into the ARTS computer.

The radar and transponder data at the approach control facility was transmitted via microwave link to Lindbergh tower, where it was displayed on a bright radar indicator tower equipment 4 (BRITE 4) which hung from the tower ceiling directly above the local controller's position. This equipment did not display alphanumeric data or altitude readouts.

The control of air traffic within the San Diego area is governed by various facility orders and letters of agreement between the participating facilities. Miramar Order NKY.2066, "Lindbergh Sector Operations," states that all southbound turbojet and turboprop aircraft that are executing a VFR or visual approach to Lindbergh Field "shall be instructed to maintain at or above 4,000 feet until clear of the Montgomery Airport traffic area."

The investigation disclosed that not all controller personnel were adhering to the procedure. Some approach controllers commonly cleared aircraft for a visual approach and monitored its altitude readout. If it appeared that the aircraft would descend below 4,000 ft before or while in the Montgomery airport traffic area, the controller would stop the descent or effect coordination for the descent with the Montgomery Field tower.

Controllers at the San Diego Approach Control Facility stated that the traffic areas of Montgomery and Lindbergh Field overlap and that a straight line drawn between the intersecting points of the circumferences of the two air traffic areas defined the extent of each field's traffic area in the region of the overlap. The largest segment of this line, if constructed, lies north of the 090° radial of the MZB VORTAC. The controllers stated that aircraft south of this line were outside Montgomery Field's traffic area and need not be restricted. However, there was no letter of agreement or order reflecting this concept. (See Appendix H.)

The two controllers at the San Diego approach control involved in controlling Flight 182 stated that it did not enter the Montgomery Field airport traffic area. The approach controller stated that since Flight 182 was not going to enter the Montgomery traffic area, he did not issue the 4,000-ft restriction. He said that he used the MZB VORTAC's 090° radial as the demarcation line for the Montgomery airport traffic area; "if they are going to remain south of that they are not going to be in Montgomery's traffic area.... PSA was south, he was approximately 1 to 2 miles north of Lindbergh."

The coordination procedures between San Diego approach control and Lindbergh tower are contained in the September 17, 1978, letter of agreement between the two facilities. As a result of this letter, the Lindbergh tower was a limited radar approach control facility. The tower was authorized to provide approved separation "between IFR aircraft, between IFR and Special VFR aircraft and between Special VFR aircraft as specified in the current Air Traffic Control Handbook." However, in accordance with paragraph 3C(l) of the letter, the tower must insure that aircraft receiving this service remain within the confines of the prescribed airspace set forth in the letter. The prescribed airspace extends 4.7 nmi east and west of runway 9/27's threshold and is about 1.6 nmi wide at these distances. Lindbergh tower controllers' authorization to provide radar separation services was limited to those aircraft operations conducted within the confines of the prescribed airspace.

According to the letter of agreement, the approach control facility would issue approach clearances and provide the tower with the arrival sequence of all aircraft sequenced to the airport or airport traffic area. Approach control will initiate a radar handoff within the coverage of the BRITE 4; this coverage encompasses a 15-nmi radius of Lindbergh Field.

The tower's use of the BRITE 4 radar was covered in SAN Order 7110.23B, November 10, 1977. The pertinent portions of the order are:

> "4a(l) Use of BRITE 4 shall be limited to radar monitoring and the issuance of traffic information. It is an aid to the Local Controller in extending his visual range and in assisting in the spacing and sequencing of aircraft. It does not relieve the controller from the responsibility of visually scanning the surrounding airspace.
>
> 4a(2) Controllers using the BRITE 4 to determine the relative positions of aircraft are not to be considered to be exercising radar control so long as vectors are not issued.
>
> 4b(3) Tower controllers shall not:
> (a) Assign a heading
> (b) Give a vector or use turns for radar identification"

The controllers in the Lindbergh tower were not radar qualified. The local control position in the Lindbergh tower faces south and overlooks runway 9/27. In order to see traffic on the north side of the tower, the controller must turn 180° from his position.

Although the order did not relieve the controller "from the responsibility of visually scanning the surrounding airspace," the tower local controller stated that he did not actually see Flight 182 until after the collision. The 0900:37 advisory, "PSA one eighty two, Lindbergh Tower, traffic twelve o'clock, one mile, a Cessna," was based on his observation of the radar returns on his BRITR display. At 0900:44 Flight 182 answered, "OK, we had him there a minute ago" and the controller responded, "One eighty two, roger."

According to the ATC transcript, at 0900:49, Flight 182 told the local controller, "Think he's passing off to our right" and the controller answered, "Roger." The local controller said that he did not remember hearing the word "think," but he did hear "passing." The local controller said that the communication "meant that he was passing a Cessna to his right." He later testified, "That when PSA 182 first said that we had him a minute ago and later came back and indicated that he was passing off to the right, it told me that PSA knew as much or more about the traffic than I did, and I did not relay any further information to him."

1.17.3 Conflict Alert System and Procedures

An automated conflict detection system called "conflict alert" had been incorporated into the San Diego ARTS III to alert controllers of closures between two or more aircraft. The conflict alert system had the No. 4 priority in the computer's executive programmer. The system monitors separation between tracked Mode C aircraft 5/ and provides an alarm when a conflict situation is detected. The conflict alert system projects a horizontal and vertical volume of airspace around a target to a future position point. Whenever the airspace envelope associated with an aircraft is predicted to overlay the airspace envelope of another aircraft, a conflict situation is likely and the controller is furnished a visual alarm--the characters "CA" blink on the top line of the data tags--and a 5-sec aural alarm sounds.

To reduce nuisance alarms around an airport and its approaches, three types of airport areas have been established and each type of area has different separation parameters. Type I and II areas are around a major or satellite airport and extensions to accommodate IFR approaches. Type III includes the remaining area 'outside the Type I and II areas.

5/ Aircraft equipped with an altitude encoding transponder.

The conflict alert which sounded at the San Diego Approach control was a Type III airport area alert, and its separation parameters were as follows:

Altitude: (±) 375 ft.
Lateral: 1.2 nmi
Parallel: 1.2 nmi
Look ahead: 40 sec

Any track projections which would intrude into these areas would initiate a conflict alert. The conflict alert for Flight 182 and the Cessna began at 0901:28.

The action to be taken by the controllers in the event of a conflict alert is contained in Paragraph 723a of the ATC Handbook which states:

"When a conflict alert is displayed, take appropriate action to resolve the confliction. Initiate coordination with the controller involved to determine the best resolution if the alert involves an aircraft:

(1) In another controllers airspace
(2) Under position/track control of another controller
(3) In handoff status

Coordination is not necessary, if immediate control action is required to maintain separation or both aircraft will be under your control in adequate time to insure separation.'*

The approach controller stated that when he heard and saw the conflict alert he discussed the situation with the coordinator. At that time Flight 182 was no longer on his frequency, the targets were beginning to merge, the aircrafts' data blocks were overlapping, and he was not able to discern their altitude readouts. Although the data blocks could have been offset by a keyboard entry into the ARTS computer, the controller did not try to reposition them. He said that he had pointed out the traffic to Flight 182; the flightcrew had stated that they had the traffic in sight and that they would maintain visual separation from the Cessna. As far as he was concerned, there was no 'conflict, and therefore, no further action was required. He said that the coordinator concurred with his decision, and the coordinator corroborated his testimony. At 0901:47, the approximate time of the collision, the controller did advise the Cessna again that Flight 182 was in his vicinity and had him "in sight."

The San Diego Approach Control's conflict alert system was commissioned August 7, 1978. Since that time the facility has experienced an average of 13 conflict alerts per day. Some of these were nuisance alerts; however, it is not known what percentage of these alerts were nuisance alerts.

The approach controller and coordinator stated that they were not startled by the alert, because they *were* accustomed to experiencing them during their duty shifts and because of the many conflict alerts where there either was "no actual conflict" or no aircraft close enough to require further action. The approach coordinator said that anytime

there are two aircraft in proximity under circumstances similar to those of Flight 182 and the Cessna, one can expect the conflict alert to activate. He also said that whenever he was directly involved with a confiict alert on traffic he was controlling, he was not required to take further action or to inform the pilots of the aircraft of the conflict.

1.17.4 Pilot Responsibilities

The pilot's responsibilities for conducting either an IFR flight, or VFR flight, or both are contained in 14 CFR 91. 14 CFR 91.67(a) states that when weather conditions permit, regardless of whether a flight is conducted under VFR or IFR, "vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft in compliance with this section. When a rule of this section gives another aircraft the right of way he shall give way to that aircraft and may not pass over, under, or ahead of it unless well clear.**' 14 CFR 91.67(e) states, "Each aircraft that is being overtaken has the right of way, and each pilot of an overtaking aircraft shall alter course to the right to pass well clear."

14 CFR 91.75(b) states, "Except in an emergency, no person may, in an area in which air traffic control is exercised, operate an aircraft contrary to an ATC instruction." The regulation also states, "If a pilot is uncertain of the meaning of an ATC clearance, he shall immediately request clarification from ATC."

Other information is published by the ***FAA*** in the Airman's Information Manual (AIM). The manual "is designed to provide airmen with basic flight information and ATC procedures for use in the National Airspace System (NAS) of the United States.... This manual contains the basic fundamentals required in order to fly in the US NAS."

The AIM contains a discussion of the procedures and duties of pilots and controller when a pilot is cleared to maintain visual separation. It states on page 54:

> 2. A pilot's acceptance of traffic information and instructions to follow another aircraft or provide visual separation from it is considered by the controller as acknowledgement that the pilot sees the other aircraft and will maneuver his aircraft as necessary to avoid it....
>
> 3. When pilots have been told to follow another aircraft or to provide visual separation from it, they should promptly notify the controller if they do not sight the other aircraft involved, if weather conditions are such that they cannot maintain visual contact with the other aircraft to avoid it, or if for any reason they cannot accept the responsibility to provide their own separation under these circumstances.**

According to the testimony of the controllers and the assistant chief flight instructor of the Gibbs Flite Center, the 0859:56 transmission from approach control to the Cessna only imposed an altitude limitation on the pilot, he was not required to maintain the 070° heading. However, the assistant chief flight instructor testified that he would expect the pilot to fly the assigned heading or inform the controller that he was not able to do so.

The chief pilot of PSA testified that his pilots were familiar with visual approach procedures. He estimated that about 25 percent of the company's approaches were visual approaches.

The chief pilot testified that upon receipt of a traffic advisory the company required the flightcrew to "look for the traffic until you sight him or acknowledge that you do not have him in sight." After the traffic was sighted, the pilot was to keep it in sight until it was no longer a factor to his flight. This policy included all three flight crewmembers. The flight engineers role in this procedure is set forth in the company's Basic Flight Operations Manual, page 6.10, paragraph 12:

> "Assist the pilots in maintaining a traffic watch. Particular attention should be given to delaying paperwork and radio contacts until such time as en route traffic is at a minimum. Routine paperwork and radio contacts should be planned to be accomplished at altitudes above 10,000 ft."

The chief pilot stated that the instruction to maintain-visual-separation was a valid clearance and that the company pilots were trained to comply with it in the same way they would comply with any clearance. If the pilot lost sight of the traffic from which he was to maintain separation, it was his responsibility to advise ATC of that fact. He also stated that the material contained in the AIM describing the pilot's responsibilities was not quoted in the company's flight operations manual; however, he thought that the manual reflected its meaning.

He testified that the company used the AIM to extract information to be presented in their ground school classes. They also keep a current copy in the pilots' lounge for the flightcrew's reference and study.

1.17.5 Boeing 727 Hydraulic Systems and Flight Controls

Hydraulic power is provided by three independent sources--system A, system B, and the standby system. System A pressure is provided by engine driven pumps on the Nos. 1 and 2 engines. System B pressure is provided by two electrically driven pumps, and standby system pressure is provided by one electrically driven pump. Normal pressure for the systems is 3,000 psi.

All flight controls are hydraulically powered. Mechanical inputs from the cockpit controls position the control valves which determine the hydraulic input to the power units. The control surfaces are held in position regardless of airloads until repositioned by a change to the control valves.

The ailerons are powered by hydraulic pressure from the A and B systems, and either system will operate them. Pull aileron travel is 35°. In the event hydraulic pressure is lost, the ailerons can be operated manually (manual reversion); however, one-third additional control wheel movement is required in the manual mode than is required in the power mode for the same control deflection.

The flight spoiler system is operated by systems A and B hydraulic pressure, and there is no manual reversion or alternate system backup if pressure is lost in these systems. The two outboard spoiler panels in each wing are operated by system A pressure; the three inboard panels in each wing are operated by system B pressure. The maximum deflection of the panels when operated in the spoiler mode is 30°.

The left and right elevators are independent of each other, and are operated by pressure from systems A and B. Pressure from either system will operate them if either the A or B system is lost. Manual reversion, similar to that in the aileron system, is available; however twice as much control column movement is required in the manual mode than in the power mode to achieve the same control deflection.

The upper and lower rudders operate independently. The upper rudder is powered by reduced system B pressure and there is no manual reversion or alternate system pressure supply if the B system fails.

The lower rudder is powered by reduced system A pressure when the trailing edge flaps are retracted. When the trailing edge flaps are lowered, hydraulic pressure to the rudder is increased. There is no manual reversion for this rudder, but it can be operated by a standby system. The shutoff valve in the lower rudder module on Flight 182 was found in the No. 1 position, which indicated that the standby system had not been activated.

1.17.6 Other Aircraft in the Lindbergh Field Area

Sixteen witnesses said they saw a third aircraft in the vicinity of the collision. Two witnesses described an aircraft heading north; three described an aircraft heading west; sir described an aircraft heading east; four saw an aircraft but were unable to place it on any heading; and one witness saw a twin engine aircraft circling the accident site after the smoke began to rise. This aircraft left the site on a northerly heading.

Three of the four witnesses who were unable to place the aircraft on any heading were located over 5 mi from and either north or northwest of the collision site. Two of these witnesses saw a third aircraft but were unable to fix either its location or altitude; the third said it was just south of the collision and slightly above the collision altitude. The fourth witness-who was about 2 mi west of the collision-saw a third aircraft just before the collision. He said it was "considerably south" of the Cessna and Flight 182.

The two witnesses who saw an aircraft heading north were 1 to 2 mi east of the collision site. One said that the aircraft was 1 mi northwest and higher than Flight 182 at or right after the collision; the other said the aircraft was 1 mi northeast and higher than Flight 182 at or right after the collision. Both said that the small aircraft flew off in a northerly direction.

The three witnesses who saw an aircraft flying in a westerly direction were located over 6 mi from the collision site. One witness saw an aircraft about 2 min before the collision and it was about 4 mi southeast of the collision site. The other two witnesses saw an aircraft fly past the crash site after the collision; one said the aircraft he saw was about two-thirds of the way up the smoke plume rising from the site, and the other said the aircraft he saw was a black twin-engine aircraft.

Except for one witness who was 6 mi north of the collision site, the five other witnesses who saw an aircraft on an eastbound track were within 1 to 3 mi of the collision site. The most distant witness saw an aircraft about 3 mi behind and below Flight 182. Four witnesses saw aircraft which were on eastbound tracks about l/2 to 2 mi north of and slightly behind Flight 182 at or about the time of the collision. Two of these four witnesses said the aircraft was higher, or much higher than Flight 182; one said it's altitude was about 1,500 ft; and one said it was a twin-engine aircraft and it was "lower than the normal jet pattern." The last of these five witnesses was about 3 mi southeast of the collision site. This witness saw two small aircraft flying east. The first passed from her view and she continued to watch the second small aircraft for "approximately a minute before PSA came into view." She continued to watch Flight 182 and the second aircraft until they collided.

During the investigation the witness group selected 25 statements as representing the observations of those witnesses who had the best view and recollection of the accident. Three of these 25 saw a third aircraft and their observations are included above; 8 stated that they did not see a third aircraft in the vicinity of Flight 182 and the Cessna; the remainder made no reference to the presence of other aircraft in their statements.

Two aircraft which were in the vicinity of the collision were identified. A Beechcraft Baron inbound to Montgomery Field passed over the Mission Bay VORTAC at 1,200 ft and landed at Montgomery Field. After landing and turning his aircraft off the active runway, the pilot saw Flight 182 on fire and descending.

A Grumman T-Cat--a low wing monoplane--was proceeding northbound from Imperial Reach to Gillespie Field at 3,500 ft. As the aircraft crossed the intersection of highways 15 and I-94--about 5 mi east of Lindbergh Field--the pilot saw Flight 182 on downwind leg for landing. He pointed it out to his student pilot. He also pointed out other aircraft which were to the right, or east, of his projected course. He did not see any aircraft between his aircraft and Flight 182, and he did not see the Cessna. He did not see the collision, but did see Flight 182 descend and crash. He contacted San Diego approach control, and immediately proceeded to the crash site. He circled the site in a right turn at 3,500 ft for about 5 min. The smoke plume was rising but it did not reach his altitude. He said he saw the Coast Guard rescue helicopter coming up on the crash scene and he left almost immediately and proceeded in a northerly direction toward Gillespie Field.

The controllers at the San Diego approach control said that, except for the traffic they reported to Flight 182, they did not see any primary or secondary targets that could have been considered as a factor to the flight.

The Lindbergh tower local controller said that he did not observe any targets around Flight 182 at the time of the collision on his BRITE 4 display.

In addition, numerous runs of D-log plot data used to plot the ground track were examined. A number of primary target returns were recorded, but no logical ground track for these returns could be established. The targets were numerous and could be classified as typical ground clutter. There were no data points that could be identified positively as a primary return from an aircraft.

2. Analysis and Conclusions

2.1 Analysis

The flightcrew of Flight 182 and the pilots of the Cessna were certificated properly and were qualified for the flight. There was no evidence that medical problems affected their performance.

The controllers in the San Diego Approach Control Facility and the Lindbergh tower were certificated properly and were qualified to exercise their duties. Although the local controller at the Lindbergh tower was not wearing his glasses as required by his medical certificate, the evidence showed that this irregularity did not contribute to the accident.

Both aircraft were certificated, equipped, and maintained in accordance with regulations and approved procedures. There was no evidence of any malfunction which could have caused or contributed to the collision; Flight 182's engines were not damaged by in-flight foreign-object ingestion.

While the evidence showed that the air traffic control services provided Flight 182 and the Cessna were appropriate for the ATC environment, it also disclosed that controller personnel did not comply with the provisions of one facility directive and that two traffic advisories did not comply precisely with the prescribed procedures of FAA Handbook 7110.65A.

Contrary to Miramar Order NKY 206G, the approach controller at San Diego approach control did not direct Flight 182 to maintain 4,000 ft until clear of the Montgomery Field airport traffic area. The controller said that Flight 182 was outside the area when he cleared it for the visual approach and that he monitored its course on his radar. Since the flight did not enter the Montgomery Field airport traffic area, he said there was no need either to place the restriction on the flight or coordinate its passage with Montgomery Field. His determination was based on the fact that Flight 182's course placed it south of the MZB VORTAC's 090" radial which, to him, constituted the end of the Montgomery Field airport traffic area and the beginning of the Lindbergh Field air traffic area. However, Flight 182's ground track showed that it passed about .8 mile inside Montgomery Field's airport traffic area.

The purpose of the altitude restriction in the order was to avoid a potential conflict with Montgomery Field operations. In this instance neither aircraft was a Montgomery Field operation. One could infer that, had the restriction been applied to Flight 182, the two aircraft would have remained separated and that, even though the Cessna was not a traffic oneration protected by the order', the failure to apply it was a causal factor. This inference might be valid if the controllers had taken no other action to insure that they were separated; however, they did take other action. The evidence is conclusive that the controllers pointed out the traffic to Flight l82 and then applied approved traffic separation procedures to separate the aircraft.

After Flight 182 was cleared for the visual approach, it was still an IFR flight although it was operating in visual flight conditions. Federal regulations required the crew to "see and avoid" other aircraft. Stage II radar services are designed to aid the pilot in accomplishing this regulatory responsibility. Thus, beginning at 0859:30, Flight 182 was given three traffic advisories by the approach controller, and one by the Lindbergh tower local controller. At 0859:30, Flight 182 was advised of traffic 1 mile in front of it and heading in a northerly direction. The crew's response indicated that they did not see the aircraft and were looking for it. The controller stated that this was a primary radar return, that it had passed Flight 182, and that he had no idea of its altitude or where it went after that.

At 0859:39, the approach controller advised Flight 182 of "additional traffic" and described the aircraft type, location, heading, and altitude. The advisory described the Cessna's heading and its position in relation to Lindbergh Field. At 0859:50, the first officer told the approach controller that "Okay, we've got that other twelve."

At 0900:15, the approach controller again advised Flight 182 of the Cessna's position and altitude. Since this traffic advisory did not contain the direction of traffic movement or the aircraft type, it did not meet the requirements of Handbook 7110.658, paragraph 511. However, at 0900:21, the first officer said, "Cot em", and 1 sec later the captain told the controller, "Traffic in sight." The approach controller cleared the flight to maintain visual separation and to contact the Lindbergh tower, and the captain answered, "Okay."

The acceptance of a *'maintain-visual-separation" clearance requires that the pilot separate his aircraft from traffic that has been pointed out to him. While there was no doubt that the controller was pointing out the Cessna to the crew of Flight 182, the question arises as to whether the flightcrew was referring to it when they called "traffic in sight."

The two traffic advisories concerning the Cessna placed it at 1,400 to 1,700 ft, northeastbound, just north of Lindbergh Field, and in front of Flight 182. If the flightcrew had identified another aircraft as the Cessna at this time, then it is logical to assume that it was flying in the same area about the same time as the Cessna and on a similar course and altitude. In order to be flying in this area it would have had to have been operating within Lindbergh Field airport traffic area. About the time of the collision Lindbergh tower controllers were in radio contact with two airborne aircraft--Flight 207, a Boeing 727 which took off at 0901:47, and a Cessna 401, N3208Q which was 9.5 nmi east of the field. Therefore, if a third aircraft was operating in this area its pilot was doing so in violation of Federal regulations.

All of the witnesses who saw another aircraft in the vicinity saw it either immediately before, during, or just after the collision; however, no one saw another small aircraft just north of Lindbergh and on a northeasterly track at the time the Cessna was in the area. Thus, it was necessary to determine ff any of these aircraft could have transited the area north of Lindbergh at the time the Cessna was sighted by the flightcrew of Flight 182.

It was highly improbable that there were 16 different small aircraft in the area during the time interval described above; however, there was no one aircraft track that was supported by a majority of the witnesses. The aircraft sightings--based on their reported flight paths--fell into four groups: aircraft on a northerly track, on an easterly track, on a westerly track, and those for which no track could be determined.

The two witnesses who saw an aircraft fly north are in fairly close agreement as to its location, altitude, and 'course. Since both witnesses placed the aircraft in an area 1 mi north of and higher than Flight 182, it seems probable that they are describing the same aircraft. However, it is unlikely that a small aircraft of the Cessna category would have the performance capability to proceed from the probable sighting area north of Lindbergh Field, climb to an altitude above the collision height, turn, and be established on a northbound track in the time interval between the flightcrew's sighting of Cessna N77llG and the collision. Since the pilot of this third aircraft would have to have been flying within the Lindbergh Field airport traffic area with no intention to land there, or intending to land without contacting the tower, he would have been in violation of pertinent Federal regulations. The more logical assumption would be that the pilot overflew the Lindbergh area on a northbound track at 3,000 ft or above and was not in the same area as the Cessna.

Five of the six witnesses who saw aircraft on an eastbound track are in some agreement. Al.1 said it was behind Flight 182 when they saw it. Three placed it about 3/4 to 1 mi north of Flight 182, and one said it was 2 mi north. Since it was improbable that five small aircraft were in this vicinity simultaneously, it would appear they were describing the same aircraft. However, there is little or no agreement thereafter. One witness said it was a twin engine aircraft flying below the normal "jet pattern." Two said it was below the collision altitude, while two said It was higher, or much higher than, Flight 182. It was possible that this aircraft could have been in the area just north of Lindbergh at the time the Cessna was sighted. However, the probability of this being true was dependent on the fact that the pilot transited the Lindbergh airport traffic area without contacting the tower. The aircraft described by the last witness which disappeared from view to the east of her position about 1 minute before Flight 182 came into her sight could not--based upon light aircraft time and performance constraints--have been in a position to have been mistaken for Cessna N7711G.

Three witnesses saw an aircraft on a westbound track. It was obvious that the aircraft described by two of these witnesses did not fly past the collision site until after the accident. Based on the aircraft's heading, altitude, location, and the time of the observations the aircraft seen by these two witnesses was probably the Grumman T-Cat. The aircraft seen by the third witness was sighted before the collision and southeast of the collision site. This aircraft could have entered the Lindbergh area about the time Flight 182 was on the downwind leg, however, based on the direction of its flight, the possibility of it being misidentified as the Cessna was remote.

There were five witnesses who were not able to place the aircraft on any specific track; however, one of these saw an aircraft circle the smoke plume from the crash and then fly off to the north. This aircraft was the Grumman T-Cat.

Three of the remaining four witnesses of this group were over 5 mi from the crash and were looking in a southeasterly direction when they saw the third aircraft; one of these said it was a little above and just south of the fireball. The last witness was 2 mi west of the collision site and saw another aircraft "considerably south" of the collision site. All four witnesses saw the aircraft southeast of the collision site and there was an aircraft in that sector of the sky--the Grumman T-Cat.

The tower and local controllers said that their radars did not depict any primary or beacon targets near the Cessna when it was pointed out to Flight 182. The D-log data did not disclose any logical ground track for any of the primary targets which it displayed, and the performance group concluded that these targets were ground clutter. In order for any third aircraft to have been mistaken for Cessna N7711G, it would be necessary to conclude that the aircraft was flying In the vicinity of the Lindbergh Field traffic pattern at the same time Cessna N7711G was sighted by Flight 182's flightcrew; that it was not equipped with a transponder; that It was not tracked by the San Dfego approach controller radar; that its pilot did not comply with the Federal regulations governing flight in this area; and, that--based on the flightcrew's identification of the aircraft type--it was a Cessna or an aircraft closely resembling a Cessna. While it is possible that all this might have occurred, the weight of the evidence indicated that there was not a third aircraft in the vicinity of the Cessna that could have been mistaken for it by the flightcrew of Flight 182.

The visibility study showed that when the 0859:39 and 09OO:15 advisories were issued, the Cessna would have been almost centered on both pilots' windshields. Even if their eyes were lower and slightly aft of the design eye reference points, the cockpit structure of the Boeing 727 would not have prevented either pilot from sighting the Cessna. Since the sun was above the horizon and the Cessna was below It, the pilots would not have had to look directly into the sun to find the Cessna', and the white surface of the Cessna's wing could have presented a relatively bright target in the sunlight.

The cockpit conversation from 0900:15 and 0901:21 showed that the captain and first officer sighted an aircraft; that they had identified the aircraft as a Cessna; that they sighted the aircraft in the same area that the controller had said the Cessna was flying; and that air traffic control was informed that the traffic was "in sight." The evidence showed that the captain and first officer did have the Cessna, N7711G, In view at or shortly after it was first pointed out to them.

The evidence was conclusive that the flightcrew's transmissions to the approach controller convinced him that they had the Cessna in sight and that they were capable of meeting the criteria imposed upon them by their acceptance of the instruction to maintain visual separation. The two later advisories issued to N7711G which stated that a "PSA jet" descending into Lindbergh "has you in sight" offered confirmation of the approach controller's state of mind. From the time he accepted control of Flight 182 until he transferred communications to the tower, the approach controller used the procedures prescribed by Handbook 7110.65A, with the one exception noted earlier.

At 0900:38, Flight 182 received its last traffic advisory. The Lindbergh tower local controller advised that there was a Cessna 1 mile in front of the flight. The advisory was based on the portrayal of the BRITE 4 radar display and it was timely. Although the controller did not scan the area visually, it is doubtful that values and directions derived from the radar display could have been improved upon by an estimate based on visual observations of two aircraft that were over 2 mi from the tower and were separated from each other by at least 1 mi. However, the advisory did not contain the direction of traffic movement; therefore, it did not comply with the provisions of paragraph 511 of the Handbook 7110.65A. Regardless, the lntracockpit conversation showed that the flightcrew associated this advisory with the Cessna--the aircraft they had reported sighting in response to the earlier advisories issued by the approach controller. The conversation also showed that after sighting the Cessna the flightcrew either dismissed it as no hazard, or lost sight of It; this had happened before they received the tower's advisory. While they did inform the local controller initially that they had lost sight of the Cessna, the flightcrew's subsequent transmissions convinced him that they had the Cessna in sight and that it was no longer a factor. He turned his attention to releasing departing traffic. Regardless of the reason, Flight 182's flightcrew did not keep the Cessna in sight and they did not convey this fact to the local controller clearly.

The visibility study showed that when the tower's advisory was received the Cessna would have been positioned at the bottom of both the captain's and first officer's windshields, just above the windshield wiper blades. If the pilots' eyes were positioned aft of and below the design eye reference points, the Cessna could have been masked by the B-'727's cockpit structure. Therefore, they could not see it unless they either leaned forward or raised their seats, or both. Even had they done this, their ability to sight the Cessna would have been further complicated by other factors. The Cessna was now on virtually the same course as Flight 182 and apparent motion of the target would have been lost, making the target more difficult to discern; there would be a foreshortening of the Cessna's fuselage which would have made the target smaller and more difficult to sight; and the target would have been

viewed against the multicolor hues of the residential area beneath it and the ratio of its color and the color of the ground would have been minimal. The cockpit conversation showed that the flightcrew did not have the Cessna in sight, and that they thought it had passed behind or underneath them.

The approach controller's handling of the Cessna was also in accordance with Handbook 7110.65A. The ground track plot showed that had the pilot of the Cessna maintained the 070° heading contained in the controller's 0859:57 instruction, he would have cleared Flight 182's track with about a 1,000-ft altitude separation. The reason for the Cessna's deviation from the heading could not be determined; however, the pilot was flying in an area in which air traffic control was being exercised and he either should have complied with the instruction or informed the controller otherwise.

At 0900:31, the controller informed the pilot of the Cessna of the presence of Flight 182. This advisory was given while N7711G was still on what appeared to be a crossing track to that of Flight 182. Shortly thereafter, the Cessna began a right turn to a flightpath that would coincide with Flight 182's flightpath. According to the visibility study, during the time between this advisory and the collision, Flight 182 would not have been visible to the Cessna pilots. Since the Cessna pilots were told that they were being overtaken by an aircraft whose flightcrew had them in sight, It would be unrealistic to conclude that they would have made any attempt to turn their aircraft in order to sight Flight 182.

Regardless of the Cessna's change of course, Flight 182 was the overtaking aircraft and its flightcrew had the responsibility of complying with the regulatory requirement to pass "well clear" of the Cessna. The regulations do not establish minimum lateral and vertical separation distances for this maneuver; consequently, the "well clear" distance was a matter of pilot judgment, and, as stated by the company's chief pilot, l/2 mile would have been adequate separation for this maneuver, even though it would place the aircraft within the conflict alert system's Type 'III warning parameters.

The conflict alert warning began about 19 sec before the collision. Handbook 7110.65A required a controller to take appropriate action to resolve a conflict when the alert is displayed; however, he must also decide if the conflict has been resolved. Corrective actions do not necessarily require the controller to notify a pilot that his aircraft is involved in a conflict. For example, in this case, the responsibility for separation was in the cockpit of Flight 182, and while the separation maintained by that flightcrew did not satisfy the conflict alert computer, it could have been more than adequate for clearing the Cessna In visual flight conditions. The approach controller's decision of whether this conflict had been resolved or whether it required action on his part was based on his judgment and experience.

Based on all information available to him, he decided that the flightcrew of Flight 182 were complying with their visual separation clearance; that they were accomplishing an overtake maneuver within the separation parameters of the conflict alert computer; and that, therefore, no conflict existed.

In retrospect, there is little doubt that the controllers were misled (1) by their belief that Flight 182's flightcrew were visually separating their aircraft from the Cessna and (2) by their previous experiences with similar conflict alerts wherein no action on their part was necessary. Based on the procedures, their requirements were satisfied. They, therefore, did not try to reposition and unscramble the data blocks and reacquire the altitude readouts to further monitor the situation because they believed that visual separation was being applied.

The Safety Board was not able to determine why Flight 182's and the Cessna's data blocks did not separate automatically. While it was possible that the auto-offset function was enabled at the display but was being delayed by higher priority computer functions, the more likely probability was that the function was inhibited at the display, either by the controllers on duty or by controller teams that had worked the display during earlier duty shifts.

However, the failure of the air traffic control procedures to require that the controllers notify the pilots that their aircraft were involved in a conflict alert resulted in a less-than-optimum use of the system, particularly in a situation where visual separation procedures were being used in a terminal area. Had this requirement existed, it was possible that warnings and perhaps suggested evasive maneuvers could have been delivered to the pilots of one or even both aircraft. While the Safety Board cannot conclude that the delivery of a warning or suggested Instruction to the pilots would have altered the course of events, the failure of the procedures to require this to be done may have deprived the pilots of one more chance to avoid the collision.

The planes collided shortly after the tower's traffic advisory. The damage to the Cessna's propeller and matching damage noted on the No. 5 leading edge flap actuator of Flight 182 show that the impact occurred on the forward and underside of its right wing about 12.5 ft outboard of the wing root. Almost every witness who saw the collision confirmed this conclusion.

The study of the two photographs showed that the structural damage to the Boeing 727's right wing leading edge extended from the No. 4 inboard leading edge flap outboard to, and including, the No. 3 leading edge slat--a distance of 30 feet or more. The chordwise penetration of this damage appeared to extend rearward to the front spar of the wing. The calculated positions of the flight controls in Figure 2 show almost full deflection in the proper direction to arrest the abnormal attitude and to restore controlled flight. The deflected position of the flight controls and the left wing flight spoiler surfaces indicated that at least partial hydraulic pressure was available from system A and system B.

The Safety Board was not able to assess precisely what effect the structural damage, the impingement of Cessna parts on the structure, and the existing fire had upon Flight 182 aerodynamic capabilities and control effectiveness. Considering the extent and magnitude of the collision damage, the Safety Board concludes that the aircraft was probably uncontrollable.

Although the evidence showed that approved ATC separation procedures were used by the controllers, the Safety Board's investigation disclosed other areas which may have contributed to the accident.

Although Flight 182 was provided all the services appropriate under Stage II radar procedures, these procedures merely helped the pilot apply the regulatory "see and avoid" principles. The Safety Board recognizes that some level of "see and avoid" will remain a valid concept for collision avoidance whenever an aircraft is flown in visual conditions and will be a part of any collision avoidance system. However, the concept appears to place a disproportionate burden on the flightcrews of air carrier aircraft, high performance general aviation aircraft, and high performance military aircraft. This is especially true where the concept is used for collision avoidance in a mixture of high-speed and low-speed traffic in a terminal area. Because of the performance characteristics of their aircraft, these flightcrews are almost always operating the overtaking aircraft, and, therefore, are solely responsible for avoiding the slower moving aircraft. Their overtake rate is usually high, and they can expect little assistance from the other aircraft.

Since most of these aircraft are flown by two or more persons, one might conclude that the avoidance problem would be lessened. However, several factors reduce the amount of time spent in traffic scan. Configuring these aircraft for landing requires the execution of a checklist, and many of these checklist items require attention after the aircraft has entered the terminal traffic mix. Many of these aircraft require several flap settings and airspeed adjustments to reach the landing flap configuration. These aircraft generally enter the terminal area on a descending flightpath that ends either at entry into the traffic pattern or at the beginning of the final approach. These descents are often flown with the aircraft in a noseup deck angle, which limits the flightcrew's visibility in the area where they are descending. Finally, the traffic they are required to detect and avoid may not be detected easily and may be further camouflaged by the surface background.

While extra persons may aid in the scan, the pilot must manage his cockpit to insure that the extra person either assists in the scan, or does not interfere with it. In this instance, although the captain and first officer saw the aircraft, there is no evidence to indicate that it was pointed out to any other cockpit occupant. Although company procedures urge the flight engineer to plan "routine paperwork and radio contacts . . . to be accomplished at altitudes above 10,000 ft," he was Involved with radio contacts with the company when the Cessna

was pointed out to Flight 182 and the visual separation instruction was issued. Since the extraneous conversation within the cockpit ceased after the flightcrew told the approach controller that they had the Cessna in sight, the conversation cannot be considered a contributing factor. However, this conversation persisted until the flight descended to 3,200 ft and while a checklist was being accomplished. Even though a flightcrew is responsible primarily for communications addressed to them, advisories to other aircraft can be valuable and may aid in their assessment of traffic which could become a factor. According to the CVR, at 0857:44, while the extraneous conversation was in progress, a company flight preceding Flight 182 was advised of the presence of the Cessna and its future flightpath. The first officer asked if the message, which included a clearance to the tower frequency, was for Flight 182. Since the message was not for Flight 182, no assumption can be made as to whether or not its flightcrew heard or understood the advisory preceding the clearance. Although the conversation was not causal, it does point out the dangers inherent in this type of cockpit environment during descent and approach to landing.

The issuance of the "maintain-visual-separation" clearance and Flight 182's response to the instruction raises several areas of concern. This method of separation can be applied not only in Stage II, but also in a TRSA and a Terminal Control Area. The use of this type of separation does little else but place the pilot into a "see and avoid" situation even though he is flying in an area where the ATC system is capable of providing vertical or lateral separation. San Diego approach control had the capability of providing either vertical or lateral separation criteria between IFR aircraft and participating VFR aircraft. Had this been done, Flight 182 and the Cessna would not have collided. The Safety Board believes that participating aircraft operating on random courses to each other should be afforded this type of separation until they are clear of each other. This would be particularly appropriate for high performance aircraft.

Based on available evidence, the Safety Board cannot conclude whether the flightcrew of Flight 182 knew what they were required to do when they accepted the "maintain-visual-separation" clearance from the controller. In addition to maintaining proper separation from the designated aircraft, their acceptance of the clearance required them to tell the controller when they no longer had it in sight. The failure to notify controller personnel specifically that they had lost sight of the traffic could indicate that they were not aware of what was embodied in the instruction and that they may have considered it as merely another traffic advisory.

The company's chief pilot testified that the procedures embodied in the visual separation clearance are set forth in the regulations, which his pilots carry with them on all flights. He further testified that they are well aware of the requirements embodied within the instruction. However, the visual separation procedures are contained in the AIM and not in the Federal regulations carried by the pilots. He

He stated that AIM information is excerpted for presentation to their flightcrews in ground school, but he could not identify precisely what areas of Information were used. The evidence indicates that there may be a communications gap between pilots and controllers as to the proper use of the ATC system. The ATC controllers are responsible for, and are required to apply, the procedures contained in Handbook 7110.65~ in their control of traffic. Despite the fact that the successful use of these procedures requires a mutual understanding on the parts of pilots and controllers of the other's responsibilities, pilots are not required to read Handbook 7110.65A. One Federal publication containing a description of the interrelationship of pilot and controller roles and responsibilities is the AIM, and this is not--by regulation--required reading for pilots. Considering the responsibilities placed on both the pilot and the controller for the safe operation in the National Air Space system, industry and the Federal Aviation Administration must take steps to insure that the pilots are made cognizant of what this relationship requires of them. Either the AIM should be compulsory reading for all pilots--at least those sections relating to ATC rules, procedures, and pilot and controller roles and responsibility--or pilots should be tested annually or semi-annually on their knowledge of these procedures.

In conclusion, the evidence indicates that even though flight-crews are still In a "see and avoid" environment, they exercise a lower degree of vigilance in areas where they receive radar assistance than in non-radar areas. Instead of attempting to seek, acquire, and then maintain visual contact with traffic, they seem to rely on the radar and radar controller to point out the aircraft, particularly an aircraft that may be in conflict with theirs. Pilots also seem to have a less-than-complete knowledge of the specific type of traffic separation services being provided. The types of traffic separation procedures available in a TRSA vary from that provided in a Stage II and Stage I area. At San Diego, depending either on the aircraft's position or altitude, or both, the pilots could receive either Stage II or Stage III services and could pass rapidly from one area to another. Pilots must recognize the level of radar services they are receiving. In areas where traffic separation services are not being furnished they must be aware of this, and that they will be required to make a more diligent effort, not only to find conflicting traffic, but to keep previously acquired traffic in sight until they are absolutely certain it is no longer a factor to their flight. These efforts may even require that they maneuver their aircraft In a manner that will enhance their ability to sight and to maintain sight of conflicting traffic.

Controllers seem to similarly relax vigilance. The evidence permits an inference that the vigilance of the approach controller and his standards for assessing the resolution of possible conflicts may have lowered because he believed that the flightcrew which had reported traffic "in sight" had a better view of the traffic and a better grasp on the situation than he did. This accident illustrated that this is not a hard and fast rule on which the controller can rely. Even though

the pilot had assumed the burden of maintaining separation, the controller should have not assumed that the pilot's ability to do so will remain unimpaired. He should be prepared to update the pilot's information, and, time permitting, stand ready to alert the pilot to changes in the situation. The principle of redundancy has been recognized as one of the foundations of flight safety, and redundancy between the pilot and controller can only be achieved when both parties exercise their individual responsibilities fully regardless of who ha8 assumed or been assigned the procedural or regulatory burden.

3. CONCLUSIONS

3.1 Findings

1. Flight 182 was cleared for a visual approach to runway 27 at Lindbergh Field.

2. The Cessna was operating in an area where ATC control was being exercised and its pilot was required either to comply with the ATC Instruction to maintain the 070° heading or to advise the controller if he was unable to do so.

3. The Cessna pilot failed to maintain the assigned heading contained in his ATC instruction.

4. The cockpit visibility study shows that if the eyes of the Boeing 727 pilot were located at the aircraft's design eye reference point, the Cessna's target would have been visible.

5. Two separate air traffic control facilities were controlling traffic In the same airspace.

6. The approach controller did not instruct Flight 182 to maintain 4,000 ft until clear of the Montgomery Field airport traffic area in accordance with established procedures contained in Miramar Order NKY.206G.

7. The issuance and acceptance of the maintain-visual-separation clearance made the flightcrew of Flight 182 responsible for seeing and avoiding the Cessna.

8. The flightcrew of Flight 182 lost sight of the Cessna and did not clearly inform controller personnel of that fact.

9. The tower local controller advised Flight 182 that a Cessna was at 12 o'clock, 1 mile. The flightcrew comments to the local controller indicated to him that they had passed or were passing the Cessna.

10. The traffic advisories issued to Flight 182 by the approach controller at 0900:15 and by the local controller at 0900:38 did not meet all the requirements of paragraph 511 of Handbook 7110.65A

11. The approach controller received a conflict alert on Flight 182 and the Cessna at 0901:28. The conflict warning alerts the controller to the possibility that, under certain conditions, less than required separation may result if action is not, or has not been, taken to resolve the conflict. The approach controller took no action upon receipt of the conflict alert, because he believed that Flight 182 had the Cessna in sight and the conflict was resolved.

12. The conflict alert procedures in effect at the time of the accident did not require that the controller warn the pilots of the aircraft involved in the conflict situation.

13. Both aircraft were receiving Stage II terminal radar services. Flight 182 was an IFR aircraft; the Cessna was a participating VFR aircraft. Proper Stage II services were afforded both aircraft.

14. Stage II terminal service does not require that either lateral or vertical traffic separation minima be applied between IFR and participating VFR aircraft; however, the capability existed to provide this type separation to Plight 182.

15. The Boeing 727 probably was not controllable after the collision.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the flightcrew of Flight 182 to comply with the provisions of a maintain-visual-separation clearance, including the requirement to inform the controller when they no longer had the other aircraft in sight.

Contributing to the accident were the air trafffic control procedures In effect which authorized the controllers to use visual separation procedures to separate two aircraft on potentially conflicting tracks when the capability was available to provide either lateral or vertical radar separation to either aircraft.

4. SAFETY RECOMMENDATIONS

As a result of this accident, the National Transportation Safety Board has recommended that the Federal Aviation Administration:

"Implement a Terminal Radar Service Area (TRSA) at Lindbergh Airport, San Diego, California. (Class I-Urgent Action) (A-78-77)"

"Review procedures at all airports which are used regularly by air carrier and general aviation aircraft to determine which other areas require either a terminal control area or a terminal control radar service area and establish the appropriate one. (Class II-Priority Action) (A-78-78)

"Use visual separation in terminal control areas and terminal radar service areas only when a pilot requests it, except for sequencing on the final approach with radar monitoring. (Class I, Urgent Action) (A-78-82)"

"Re-evaluate its policy with regard to the use of visual separation in other terminal areas. (Class II, Priority Action) (A-78-83)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ PHILIP A. HOGUE
Member

McADAMS, Member, dissented. (See dissenting statement on page 39.)

April 20, 1979

McADAMS, Member, dissenting

I disagree sharply with the majority, for the reason that the inadequacies of the air traffic control system were not cited as being a probable cause of the accident.

Although the majority does cite the inadequacies of the air traffic control system as being contributory, this is neither acceptable nor sufficient. The difference between a probable cause and a contributing factor is not semantics--there is a clear-cut distinction. A probable cause is an act, or an omission of an act, that is in the direct line of causation and without which the accident would not have occurred, whereas a contributory factor is an event which possibly could have (but not necessarily) intervened and caused the accident. A contributing factor is not a primary cause; it is more remote and does not carry the same weight or implications as that of a probable cause.

In my opinion, these inadequacies should have been given equal weight in the probable cause with the failure of the PSA crew to maintain visual separation rather than being merely mentioned as a contributory factor. The San Diego approach control had the capability of providing either vertical or lateral separation between IFR aircraft and participating VFR aircraft, and this procedure should have been used for the control of both aircraft. If it had, the accident would not have occurred. Apparently the majority agrees but is either reluctant or diffident to include this issue in the probable cause, since it is stated (p. 33) that if either vertical or lateral separation had been used, "...Flight 182 and the Cessna would not have collided." Such language clearly implies that this omission was a direct cause of the accident and therefore should have been included as a probable cause.

The controller, instead of using available procedures, gave PSA 182 a visual separation clearance which placed the pilot in an exclusively see-and-avoid situation where the last redundancy of the system was removed. The redundancy should not have been eliminated in a dense terminal traffic area such as San Diego. In my opinion, the concept of see and avoid is outmoded and should not be used in high volume terminal areas. Positive radar separation should be used with the backup, or redundancy, being the pilot's visual ability to see and avoid. In this case, both aircraft should have remained under positive radar separation since it was available and could have provided safe separation. The failure to do so, therefore, must be considered as causal.

Furthermore, despite strong urging on my part, the majority has not named several other factors which I consider as being contributory. It is true that the majority has included three issues which I had suggested as contributing factors, but they have been included in the report only as conclusions. For example, the majority concludes that the approach controller failed to restrict Flight 182 to a 4,000 - foot altitude; obviously, that logically means the controller had a duty to issue an altitude restriction, and if such altitude restriction had been issued, it is possible the accident would not have occurred. Ergo, it is a contributing factor as well as a conclusion. A similar argument can be made with respect to the other two conclusions of the majority, i.e., the Cessna failed to maintain the assigned heading, and two separate facilities were controlling traffic in the same airspace. Therefore, rather than isolated conclusions with little or no support, they should have been cited as contributory.

Additionally, as contributing factors, I would have cited the failure of the controller to restrict PSA 182 to a 4,000-foot altitude until clear of the Montgomery Field airport traffic area. The evidence is clear that PSA 182 was approximately eight-tenths of a mile inside the Montgomery Field traffic area and therefore should have been restricted to the 4,000-foot altitude. The majority eliminates this issue as a contributing factor for the reason the controller took other action to insure the separation of the aircraft. The other action was to issue a visual separation clearance. This action,of course,is not relevant, since the imposition of the restriction does not depend upon other action; it is to be imposed in all cases upon southbound air carrier aircraft into the San Diego area. If the restriction had been imposed, the accident possibly would not have occurred, and therefore, it should be considered as contributory.

I would also assign as a contributing factor the failure of the controller to advise PSA 182 of the direction of movement of the Cessna. The last two traffic advisories at 0900:15 and 0900:38 eliminated the direction of movement of the Cessna. I believe this to be a critical omission since it is not only required but is an essential aid to the pilot in acquiring and maintaining the traffic that has been pointed out. If the crew of PSA 182 had known the direction of movement, it is possible the target would not have been lost. Also, if these advisories had contained the direction of movement and PSA had replied "traffic in sight," the possibility of misidentification or any misunderstanding would have been substantially lessened. Furthermore, at the time of the second advisory the Cessna had already turned

from a heading of 070 to a heading of 090, the same heading as PSA 182. At this time, according to the CVR and the ATC transcriptions, PSA 182 had lost contact with the Cessna, the reason being, obviously, the Cessna had turned beneath PSA 182 and to the same heading. PSA 182 was never advised by ATC that the Cessna which had been previously reported to be on a northeast heading had turned to 090. Therefore, if PSA 182 had been advised that the Cessna was now on a heading of 090 and beneath them, they possibly would have been able to reacquire the target visually or to request avector for separation.

Although the majority has now added as a conclusion, two separate air traffic control facilities were controlling traffic in the same airspace," there is no discussion in the report to support this conclusion. Such a procedure is not the most efficient or the safest way to handle traffic; it would have been far better if only one facility was handling both aircraft, since the communications to both aircraft would then have been much more expeditious, meaningful, and efficient. The lack of coordination was emphasized by the mishandling of the conflict alert.

Contrary to the majority, I would cite.the improper resolution by the controller of the conflict alert as contributory. The Air Traffic Control handbook, 7110.65A, requires a controller to resolve all conflict alerts. The controller failed to do this. The conflict alert was received approximately 19 seconds before the collision. Although this might be considered a rather short time, it was still sufficient to have permitted the controller to relay this information to either the Cessna or to the Lindbergh Tower or to have attempted to relay it. Irrespective of the time element, the controllers had no knowledge that there were only 19 seconds to collision, but the duty still existed. According to the majority, the reason the controllers did not take the required action was they considered that the conflict had been resolved based upon PSA 182's response to the traffic advisory, "Traffic in sight." This response had been made 66 seconds prior to the conflict alert and, in my opinion, the controller should not have assumed in such an area as San Diego that the situation was static and that the conflict was resolved.

I am at a loss to understand the reasons the majority did not include this failure as a contributing factor since it is stated in the report (p. 31), "...the failure of the procedures [conflict alert] to require this to be done may have deprived the pilots of one more chance to avoid the collision." The existing procedures did require action to resolve the conflict. The issuance of a previous visual separation clearance by no means resolves a later conflict.

The majority has now concluded that the Cessna failed to maintain the assigned heading contained in the ATC instruction, but it is not cited as a contributing factor for some unknown reason. In my opinion, the failure of the Cessna to maintain the assigned and mandatory heading was a critical factor in this accident. If the required heading had been maintained, the aircraft would have been separated 1,000 feet vertically; therefore, it is a factor to be considered as contributory. The Cessna was told to "maintain a heading of 070 and vector final approach," which was a mandatory instruction to maintain a heading until the controller was able to vector the aircraft to a downwind leg and the final approach course. This procedure was obviously for separation reasons, since the Cessna was crossing and ascending toward the flightpath of the descending PSA 182. However, the Cessna turned to a downwind leg of 090 prematurely and beneath PSA 182. If this had not been done, the accident may not have occurred.

In my opinion there still exists the possibility that there was a third unknown and unreported aircraft in the area which could have been mistaken by the crew of PSA 182 for the Cessna. Analysis-of the CVR could be interpreted to mean that PSA never acquired the Cessna but was observing some other aircraft that was unknown or unseen by ATC. Even the Eajority concedes this point since they state (p. 26).

> the question arises as to whether the flightcrew was referring to it /the Cessna/ when they called 'traffic in sight." At 0859:39, a traffic advisory indicated the Cessna at 3 miles, and at 0859:50 PSA replied, "We've got that other twelve." Whether he was referring to a previous traffic advisory or to the Cessna is not clear. At 0900:15 -- 37 seconds after the first traffic advisory -- another advisory was given but without aircraft identification or direction of movement, but still reporting the target at 3 miles. This mileage was corrected at the hearing, but insofar as PSA was concerned these two traffic advisories could have been related to two different aircraft since the second advisory did not either identify the target or the direction of movement, and the distance remained the same 3 miles. Obviously, the mileage would have changed by approximately 2 miles between the two aircraft, and at the time of the second advisory the separation was approximately 1 mile. This could have led PSA to assume there were two different aircraft. Further, if PSA 182 had the Cessna in sight at 0900:21 on a north-northeast course, he would have expected the target to pass off to the left of his aircraft and not to the right as he stated at 0900:50.

Additionally, the captain reported he had seen the target at 1 o'clock before turning downwind, whereas it has been well established by the ground track of both aircraft that at this time the Cessna would have been at the 11 o'clock position. This is a difference of approximately 60 degrees, a substantial change, and could indicate the captain was looking at a target other than the Cessna, either unreported or unknown to ATC.

At 0901:38 and 0901:39, the first officer pointed out a target, "There's one underneath," and "I was looking at that inbound there." The only known and reported inbound traffic was a PSA flight that at this time had completed its landing roll and was in the 6 o'clock position to PSA 182. The first officer could not have been looking at this aircraft but must have been looking at unreported and unknown inbound traffic. Significantly, 16 ground witnesses reported additional traffic in the area that could be interpreted as being notential traffic to PSA 182. However, the important fact is there appears to have been at least one inbound aircraft that was unknown or unreported by ATC.

Despite the conclusion of the majority that the evidence indicates there was not a third aircraft in the area, my reading of the evidence is contrary. The evidence is inconclusive on this point, and the existence of a third unknown or unrenorted aircraft was a distinct possibility. If there was a third aircraft and the crew of PSA 182 was watching it, this could explain the reason why the crew of PSA 182 either did not see the Cessna or subsequently lost contact with it.

Based upon the foregoing, I would state the probable cause as follows:

"I was the failure of the flightcrew of Flight 182 to maintain visual separation and to advise the controller when visual contact was lost; and the air traffic control procedures in effect which authorized the controllers to use visual separation procedures in a terminal area environment when the capability was available to provide either lateral or vertical radar separation to either aircraft. Contributing to the accident were:

1. The failure of the air traffic control system to establish procedures for the most effective use of the conflict alert system at the San Diego approach control facility.

2. The failure of the controller to restrict PSA 182 to a 4,000-foot altitude until clear of the Montgomery Field airport traffic area.

3. The improper resolution by the controller of the conflict alert.

4. The procedure whereby two separate air traffic control facilities were controlling traffic in the same airspace.

5. The failure of the controller to advise PSA 182 of the direction of movement of the Cessna.

6. The failure of the Cessna to maintain the assigned heading.

7. The possible misidentification of the Cessna by PSA 182 due to the presence of a third unknown aircraft in the area.

/s/ FRANCIS H. McADAMS
Member

APPENDIX A

Investigation and Hearing

1. Investigation

The National Transportation Safety Board was notified of the accident about 1210 e.s.t. on September 25, 1978, and immediately dispatched an investigative team to the scene. Investigative groups were established for operations, air traffic control, aircraft systems, structures, powerplants, human factors, witnesses, maintenance records, performance, flight data recorder, and cockpit voice recorder.

Parties to the investigation were the Federal Aviation Administration, Pacific Southwest Airlines, Inc., Gibbs Flite Center, the Southwest Flightcrew and Flight Attendants Association, the Boeing Company, Cessna Aircraft Company, Professional Air Traffic Controllers Organization, Pratt and Whitney Aircraft Group of United Technologies Corporation, Air Line Pilots Association, and the Aircraft Owners and Pilots Association.

2. Public Hearing

A 5-day public hearing was held in San Diego, California, beginning November 27, 1978. Parties represented at the hearing were the Federal Aviation Administration, Pacific Southwest Airlines, Inc., Gibbs Flite Center, Aircraft Owners and Pilots Association, Professional Air Traffic Controllers Organization, Southwest Flightcrew and Flight Attendants Association, Air Line Pilots Association, Boeing Aircraft Company, National Business Aircraft Association, Cessna Aircraft Company, General Aviation Manufacturers Association, Aviation Consumers Action Project, City of San Diego, and County of San Diego.

APPENDIX B

PERSONNEL INFORMATION

PSA Flight 182

Captain James E. McFeron, 42, was employed by Pacific Southwest Airlines, Inc., August 7, 1961. He held Airline Transport Pilot Certificate No. 1314617 with an airplane multiengine land rating and commerical privileges In airplane single engine land. He was type-rated in Lockheed L-188 and Boeing 727 aircraft. His first-class medical certificate was issued June 30, 1978, and he was required to wear correcting glasses while exercising the privileges of his airman certificate. His distant vision for both eyes was 20/25 corrected to 20/15.

Captain McFeron qualified as captain on Boeing 727 aircraft on January 11, 1967. He passed his proficiency check on June 30, 1978; and his last line check on July 14, 1978; he completed recurrent training in June 1978. The captain had flown 14,382 hrs, 10,482 hrs of which were in the Boeing 727. During the last 90 days and 24 hrs before the accident he had flown 176 hrs and 5 hrs 3 min, respectively. At the time of the accident, the captain had been on duty 3 hrs 47 min, 1 hr 30 min of which was flight time. He had been off duty 7 hrs 7 min before reporting to duty for this flight.

First Officer Robert Eugene Fox, 38, was employed by Pacific Southwest Airlines, Inc., September 22, 1969. First Officer Fox held Airline Transport Pilot Certificate No. 1598761 with an airplane multiengine land rating and commercial privileges in single engine land airplanes. His first-class medical certificate was issued March 2, 1978, with no limitations.

First Officer Fox qualified as first officer on Boeing 727 aircraft on September 22, 1970. He passed his last proficiency check in October 1977, and completed recurrent training in August 1978. The first officer had flown 10,049 hrs, 5,800 hrs of which were in the Boeing 727. During the last 90 days and 24 hrs before the accident he had flown 142 hrs and 5 hrs 3 min, respectively. His rest and duty time on the day of the accident were the same as the captain's.

Flight Engineer Martin J. Wahne, 44, was employed by Pacific Southwest Airlines, Inc., September 5, 1967. He held a Flight Engineer Certificate No. 1459971 with reciprocating and turbojet engine-powered ratings. His second-class medical certificate was issued December 21, 1977, with no limitations.

Flight Engineer Wahne qualified in the Boeing 727 aircraft on October 18, 1967. He completed his last proficiency check In August 1978, and his last line check February 1978. He completed recurrent ground training in August 1978. Flight Engineer Wahne had flown 10,800 hrs, 6,587 hrs of which were in the Boeing 727. During the last 90 days and 24 hrs before the accident he had flown 142 hrs, and 5 hrs 3 min, respectively. His duty and rest times on the day of the accident were the same as the captain's.

Flight Attendants

The four flight attendants were qualified in the Boeing 727 aircraft in accordance with applicable regulations and had received the required training.

Cessna N7711G

Instructor Pilot Martin B. Kazy, Jr., 32, was employed by the Gibbs Flite Center on October 15, 1977. Mr. Kazy held Commercial Pilot Certificate No. 2004779, with airplane single and multiengine land and instrument ratings, and Flight Instructor Certificate No. 2004779CFI with the same ratings. His first-class medical certificate was Issued May 19, 1978, with no limitations. Mr. Kazy had flown 5,137 hrs. In the last 90 days before the accident he had flown 347 hrs.

David T. Boswell, 35, held Commercial Pilot Certificate No. 2019358, with airplane single and multiengine land rating. His second-class medical certificate was issued on October 25, 1977, and he was required to "possess glasses for distant and near vision while exercising the privileges of his airman certificate." Mr. Boswell had flown 407 hrs, 61 hrs of which were flown during the last 90 days. At the time of the accident, Mr. Boswell was receiving training in instrument flying procedures.

San Diego Approach Control

Mr. Abran N. Lehman was employed by the Federal Aviation Administration in 1968. Mr. Lehman came to duty at the San Diego Approach Control in December 1975, received his facility rating in May 1976. He is a full performance level controller at that facility. His second-class medical certificate was issued May 24, 1978. At the time of the accident, Mr. Lehman was working the coordinator position.

Mr. Nelson E. Farwell was employed by the Federal Aviation Administration in June 1970 and was assigned to the San Diego Approach Control in June 1973. Mr. Farwell received his facility rating in August of 1974, and Is a full performance level controller at the San Diego Approach Control Facility. His second-class medical certificate was issued March 9, 1978. At the time of the accident, Mr. Farwell was working the approach controller position.

APPENDIX B

Lindbergh Field Tower

Mr. Stephen H. Majoros was employed by the Federal Aviation Administration in August 1975. He was assigned to the Lindbergh tower In July 1976 and received his facility rating in May 1976. Mr. Majoros Is a full performance level controller at the Lindbergh tower. His second-class medical certificate was issued December 20, 1977. At the time of the accident, Mr. Majoros was working the tower cab coordinator position.

Mr. Alan M. Saville was employed by the Federal Aviation Administration in December 1968. Mr. Savllle was assigned to the Lindbergh tower in 1974, and received his facility rating on October 13, 1974. He is a full performance level controller at the facility. His second-class medical certificate was issued January 11, 1978 and he was required to "wear corrective lenses for distant vision while flying." At the time of the accident, Mr. Saville was working the local controller position.

APPENDIX C

Aircraft Information

Boeing 727, N533PS

A review of the airplane's flight logs and maintenance records showed that no mechanical deficiencies were noted for September 24, 1978. The review of the maintenance records for 1978 disclosed no data which the maintenance review group characterized as other than routine maintenance.

The following statistical data were compiled.

a. Aircraft

Total Hours		24,088.3
Total Landings		36,557
Last Phase Check (No. 3)	-	September 11, 1978
Hours at No. 3 Phase	-	24,006.9
Hours Since No. 3 Phase	-	81.4

b. Powerplants

Engine	No. 1	No. 2	No. 3
Serial Number	P655297B	P656034B	P649487B
Date of Installation	June 6, 1978	July 15, 1977	Sept. 21, 1978
Total Time	17,180	19,120	23,715

Cessna 172, N7711G

The total time on the airplane was 2,993 hrs. A review of the airplane's maintenance records shows that the date of the last annual inspection was January 9, 1978, when the total airframe time was 2,410 hours. The most recent maintenance was accomplished on the airplane on September 22, 1978, when airframe hours totaled 2,987. One of the items included was a 100-hour airframe and engine inspection. Time flown since this last inspection was 6 hours.

APPENDIX C

N7711G was equipped with a Lycoming Model 0-320-E2D reciprocating engine. The engine was placed in service initially on March 5, 1974. The engine was overhauled on November 2, 1976, and installed in N7711G on September 28, 1977. The propeller was a McCauley Model DTM 755-3. Additional data included:

Engine serial number	L-36868-27A
Engine total time	3,086 hours
Engine time since overhaul	879 hours
Propeller serial No.	726458
Propeller total time	2,987 hours

APPENDIX D

TRANSCRIPT OF A FAIRCHILD A-100 COCKPIT VOICE RECORDER S/N 1435 REMOVED FROM THE PSA BOEING 727 WHICH WAS INVOLVED IN AN ACCIDENT AT SAN DIEGO CALIFORNIA, ON SEPTEMBER 25,1978

LEGEND

CAM	Cockpit area microphone voice or sound source
RDO	Radio transmission from accident aircraft
-1	Voice identified as Captain
-2	Voice identified as First Officer
-3	Voice identified as Second Officer
-4	Voice identified as off-duty PSA Captain
-?	Voice unidentified
APP	San Diego Approach Control
TWR	Lindbergh Tower
SO	PSA company radio
766	Other traffic
207	Other traffic
xxx	Other traffic
ARINC	ARINC radio
*	Unintelligible word
#	Nonpertinent word
( )	Questionable text
(( ))	Editorial insertion
---	Pause

Note: All times are expressed in Pacific Daylight time.

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY

TIME & SOURCE	CONTENT
0856:56 SO	Is this one eighty-two or seven sixty-six
766	This is seven sixty-six
SO	Okay I'm sorry you depart at ten oh five then
766	Okay we're still going to twelve alpha
SO	Yes sir
766	Okay and oil number one
SO	Okay thank you

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
0856:48 APP	PSA one eighty-two, contact San Diego approach control one two four point three five
0856:52 RDO-1	Good day
0856:57 XXX	Six zero zulu ---
0857:01 RDO-2	Approach PSA one eighty-two's out of nine five, descending to seven thousand, the airport's in sight

INTRA-COCKPIT

TIME & SOURCE	CONTENT
0856:46 CAM-4	He started himself way back beyond this new contract, ya see what I mean, ya know, what's good for the goose is ya know
CAM-1	Yeah
CAM-4	Not good for the gander in this case
CAM-4	See what I mean
CAM-1	Yeah
0857:00 CAM-1	I've been out of touch for so long that I haven't talked to anybody about these subjects in awhile
CAM-4	(Boy) it's bad you couldn't of been to that one meeting down there

COMMUNICATIONS TO & FROM AIRCRAFT
APPEARING ON CAM-3 JACKBOX ONLY

TIME & SOURCE	CONTENT
0857:07 RDO-3	San Diego one eight-two
0857:21 SO	One eighty-two, good morning, stick it into eleven alpha one, correction nine eighty-one, is your turn ready to copy?
0857:27 RDO-3	Okay eleven alpha, we're about eight minutes out, Biffy service, water service, soda three, coffee four hot cups twelve, towels two, liquer napkins two, sugar one, cream one, they need swizzle sticks, schedules and that's the list, and we --- we're going to need a mechanic on arrival

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
0857:06 APP	PSA one eighty-two's cleared visual approach runway two seven
0857:09 RDO-2	Thank you, cleared visual approach two seven

INTRA-COCKPIT

TIME & SOURCE	CONTENT
0857:06 CAM-4	Really but I'll tell you, the guys that we know of are taking money and advantage and the one's who don't participate are not going to get their money back, the company is not going to give away money, they're only going to give it to the one's if they're forced to do it, right * *
CAM-1	Yeah
CAM-1	I can't believe they're keeping this (still) because they're (very much) interested in it
0857:26 CAM-4	I got --- we got this little thing in our mail box the other day about being able to sign away your ah * * ya know, if your killed, now that, I've seen this happen and before we signed and even before this transfer we had, you know, if you don't gotta clear procedure here * * procedure

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY

TIME & SOURCE	CONTENT
SO	Okay Marty, like to know who's first out there between you and company, also can you give me the nature of your maintenance problem?
RDO-3	It's just a forward baggage compartment door seal, it's out of the track a little bit
SO	Okay fine thank you
RDO-3	I'm not sure who's forward here
SO	Okay
RDO-3	I don't know who's first
0858:25 SO	Okay thank you
766	I think seven sixty-six is first, we're cleared to land

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
0857:44 APP	PSA seven sixty-six, traffic will be a Cessna one seventy-two just making a low approach off of runway nine, uh, northeastbound, contact Lindbergh tower now one three three point three, have a nice day

INTRA-COCKPIT

TIME & SOURCE	CONTENT
0857:44 CAM-4	In the past so I'm call the attorney and ask him about this one cause I think it oughta be notarized, ah, and you have a signed copy too, it disturbs me, you know, even after you're

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY

TIME & SOURCE	CONTENT

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
0858:01 RDO-2	Sir, was that PSA one eighty-two?
0858:03 APP	No, that was for the company, sir
0858:05 RDO-2	Okay

INTRA-COCKPIT

TIME & SOURCE	CONTENT
CAM-1	Yeah
CAM-4	Dead, you can't do nothing about it, you know, your wife is left with a hell of a, hell of a problem, like if you sign that thing they put before you and then * * they give it to Waller what's gonna happen to it from then on, you know what I mean?
CAM-1	Well * *
CAM-4	I have eighteen thousand dollars, I just got my thing from, ah, got my information from, ah, Aetna the other day
CAM-1	Yeah
CAM-?	That's your * *
CAM-1	I think I had about ten or eleven thousand dollars
CAM-4	Yeah
CAM-?	Boy would that be nice
CAM-1	The maximum is ten percent * *

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY

TIME & SOURCE	CONTENT
0858:32 RDO-3	San Diego Ops, PSA flight one eighty-two
0858:37 ARINC	Ah, one eighty-two, this is ARINC one thirty point four
0858:40 RDO-3	Yeah, we're out, ah, Los Angeles three two diagonal three four airborne at four one, San Diego at zero nine zero five
0858:50 ARINC	PSA one eight two San Francisco roger
0858:53 RDO-3	A little late but thank you
0858:55 ARINC	Okay

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT

INTRA-COCKPIT

TIME & SOURCE	CONTENT
0858:32 CAM-4	It sounded like a good deal to me at that time
CAM-1	Yeah
CAM-?	Boy that is good, I'll tell ya for that length of time * * show up
CAM-?	* * ((unidentifiable, unintelligible for approximately twenty-five seconds))
0859:01 CAM-3	Breakers checked, pressurization set, the airspeed and EPR bugs
0859:02 CAM-?	I like that * *

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY

TIME & SOURCE	CONTENT

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT

INTRA-COCKPIT

TIME & SOURCE	CONTENT
0859:04 CAM-1	Twenty-four set left
0859:06 CAM-2	Twenty-four two five two
0859:09 CAM-1	Two five two
0659:10 CAM-3	The altimeters, instruments
0859:11 CAM-4	Are we there yet?
0859:12 CAM-2	Just about, eighty-six
0859:13 CAM-1	Eighty-six on left * *
0859:16 CAM-3	Landing, turn off lights
0859:17 CAM-1	On
0859:18 CAM-3	Seatbelt sign on to
0859:19 CAM-2	It's on

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY

TIME & SOURCE	CONTENT	AIR-GROUND COMMUNICATIONS TIME & SOURCE	AIR-GROUND COMMUNICATIONS CONTENT	INTRA-COCKPIT TIME & SOURCE	INTRA-COCKPIT CONTENT
				0859:20 CAM-3	Fuel, shoulder harnesses
				0859:21 CAM-1	On
				0859:21 CAM-2	On the right
				0859:24 CAM-3	Just gave my off report to ARINC and the guy started laughing, said so I'm a little late
		0859:30 APP	PSA one eighty-two, traffic twelve o'clock, one mile northbound		
		0859:35 RDO-1	We're looking		
				0859:36 CAM-1	Go ahead and give the off report from LA to San Diego then
		0859:39 APP	PSA one eighty-two, additional traffic's ah, twelve o'clock, three miles just north of the field northeastbound, a Cessna one seventy-two climbing VFR out of one thousand four hundred	0859:39 CAM-3	Yeah ((sound of laughter))
				CAM-2	Very nice
				0859:41 CAM-3	He really broke up laughing I said so I'm late

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY	
TIME & SOURCE	CONTENT
0900:15 RDO-3	San Diego Ops, PSA one eighty-two is number two because we try harder
0900:28 RDO-3	Did you get all that, Frank?

AIR-GROUND COMMUNICATIONS	
TIME & SOURCE	CONTENT
0859:50 RDO-2	Okay we've got that other twelve
0859:57 APP	Cessna seven seven one one golf, San Diego departure radar contact, maintain VFR conditions at or below three thousand five hundred, fly heading zero seven zero, vector final approach course
0900:15 APP	PSA one eighty-two, traffic's at twelve o'clock, three miles out of one thousand seven hundred
0900:22 RDO-1	Traffic in sight
0900:23 APP	Okay, sir, maintain visual separation, contact Lindbergh tower one three three point three, have a nice day now
0900:28 RDO-1	Okay

INTRA-COCKPIT	
TIME & SOURCE	CONTENT
0859:48 CAM-4	Yesterday we took off out of San Francisco, we're supposed to go over to Bay approach, you know, and I switched twenty-four nine, I guess, and I said, Bay departure PSA five * a gal comes on and she says, this is Oakland tower and I said oh I'm sorry about that, then I hesitated and then I said in a way, I'm not sorry though, ((sound of laughter)) that really broke her up
0900:10 CAM-?	((Sound of laughter))
0900:21 CAM-2	Got 'em
0900:26 CAM-2	Flaps two

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY		AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
		0900:34 RDO-1	Lindbergh PSA one eighty-two downwind		
		0900:38 TWR	PSA one eighty-two, Lindbergh tower, ah, traffic twelve o'clock one mile a Cessna		
0900:40 RDO-3	San Diego Ops, PSA flight one eighty-two is number two because we try harder				
				0900:41 CAM-2	Flaps five
				0900:42 CAM-1	Is that the one (we're) looking at
				0900:43 CAM-2	Yeah, but I don't see him now
0900:44 SO	We figured that, thank you	0900:44 RDO-1	Okay, we had it there a minute ago		
		0900:47 TWR	One eighty-two, roger		
0900:48 RDO-3	Did you get all that, Frank?				
0900:50 SO	Yeah, we got it, thanks	0900:50 RDO-1	I think he's pass(ed) off to our right		

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY

TIME & SOURCE	CONTENT

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
0900:51 TWR	Yeah
0900:53 TWR	How far are you going to take your downwind one eighty-two company traffic is waiting for departure
0900:57 RDO-1	Ah probably about three to four miles
0900:59 TWR	Okay
0901:01 TWR	PSA two zero seven, taxi into position and hold
0901:04 207	Two oh seven, position and hold
0901:07 TWR	PSA one eighty-two, cleared to land
0901:08 RDO-1	One eighty-two's cleared to land

INTRA-COCKPIT

TIME & SOURCE	CONTENT
0900:52 CAM-1	He was right over here a minute ago
0900:53 CAM-2	Yeah

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY

TIME & SOURCE	CONTENT
XXX	* * affirmative
0901:11 XXX	Ah, okay do not open the, ah, aft door, the aft stair and ah, list coffee five, hot cups eleven, towels two, liquer napkins two, peanuts, spoons, and stand by for a second * *

AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT

INTRA-COCKPIT

TIME & SOURCE	CONTENT
CAM-?	* *
0901:10 CAM	((Sound similar to door closing))
0901:11 CAM-2	Are we clear of that Cessna?.
0901:13 CAM-3	Suppose to be
0901:14 CAM-1	I guess
0901:15 CAM-2	(Fifteen)
CAM-?	((sound of laughter))
0901:20 CAM-4	I hope
0901:21 CAM-1	Oh yeah, before we turned downwind, I saw him about one o'clock, probably behind us now
0901:31 CAM-2	Gear down
0901:34 CAM	((Sound of clicks and sound similar to gear extension))

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY		AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
				0901:38 CAM-2	There's one underneath
				0901:39 CAM-?	*
				0901:39 CAM-2	I was looking at that inbound there
0901:42 XXX	Fuel will be eighteen, we'll have that fuel onboard			0901:42 CAM	((Sound of thump similar to nose gear door closing))
0901:43 XXX	What's the number going back up	0901:43 TWR	PSA seven sixty-six, contact ground point seven		
				0901:45 CAM-1	Whoop!
		0901:46 766	Roger	0901:46 CAM-2	Aghhh!
				0901:47 CAM	((Sound of impact))
				0901:47 CAM-4	Oh # #

COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY

TIME & SOURCE	CONTENT

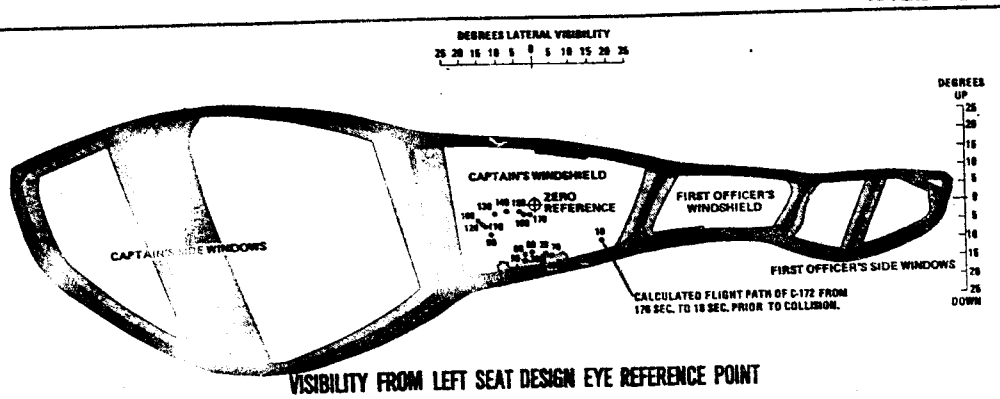
AIR-GROUND COMMUNICATIONS

TIME & SOURCE	CONTENT
0901:48 TWR	PSA two oh seven, clear for takeoff
0901:50 207	Two oh seven rolling
0901:55 RDO-1	Tower we're going down, this is PSA
0901:57 TWR	Okay, we'll call the equipment for you

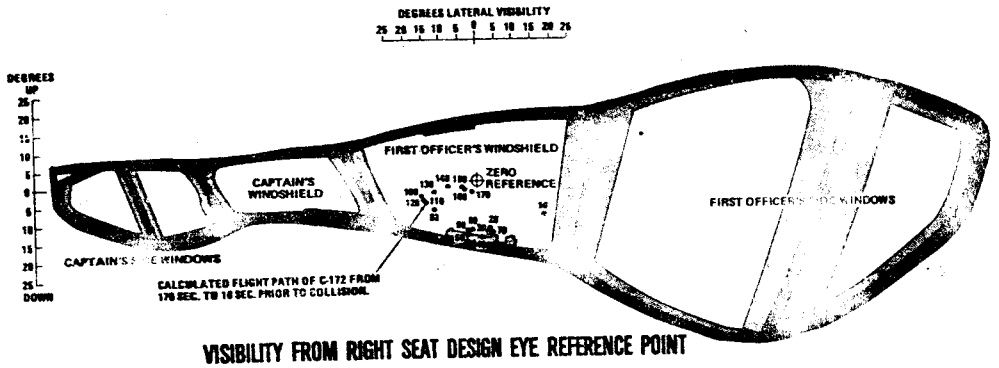
INTRA-COCKPIT

TIME & SOURCE	CONTENT
0901:48 CAM-?	#
0901:49 CAM-1	Easy baby, easy baby
0901:50 CAM-?	Yeah
0901:51 CAM	((Sound of electrical system reactivation tone on voice recorder, system off less than one second))
0901:51 CAM-1	What have we got here?
0901:52 CAM-2	It's bad
0901:52 CAM-1	Huh?
0901:53 CAM-2	We're hit man, we are hit

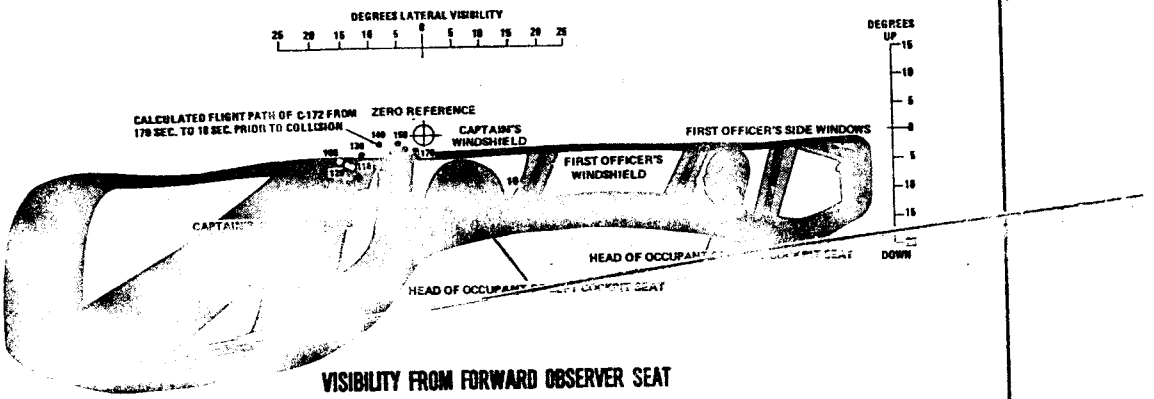
COMMUNICATIONS TO & FROM AIRCRAFT APPEARING ON CAM-3 JACKBOX ONLY		AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT	TIME & SOURCE	CONTENT
				0901:58 CAM-?	Whoo!
				0901:58 CAM	((Sound of stall warning))
		0901:59 RDO-1	This is it baby	0901:59 CAM-?	Bob
				0902:00 CAM-2	# # #
				0902:01 CAM-?	# #
				0902:03 CAM-1	Brace yourself
				0902:04 CAM-?	Hey baby *
				0902:04 CAM-?	Ma, I love yah
				0902:04.5 CAM	((Sound on cockpit voice recorder ceases, electrical power to recorder stops))



VISIBILITY FROM LEFT SEAT DESIGN EYE REFERENCE POINT



VISIBILITY FROM RIGHT SEAT DESIGN EYE REFERENCE POINT

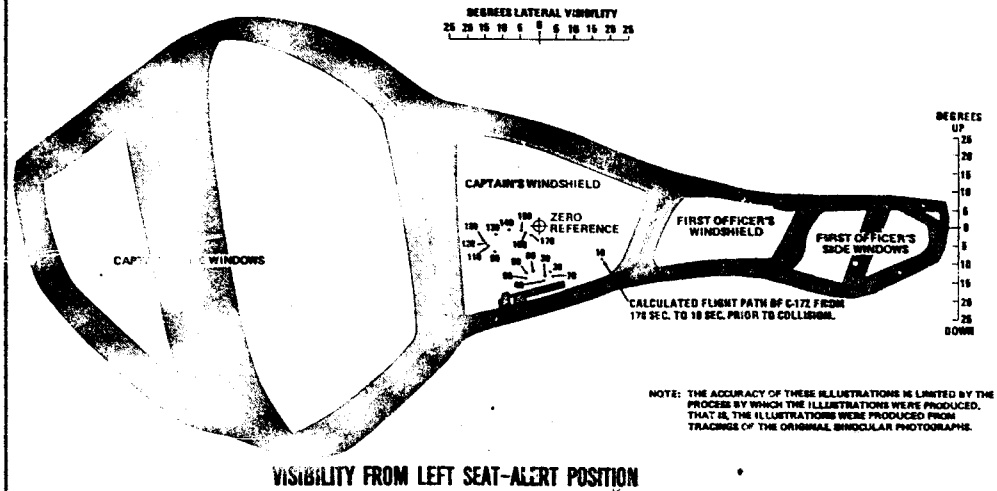


VISIBILITY FROM FORWARD OBSERVER SEAT

NOTE: BLACK AREAS REPRESENT OBSTRUCTED VISION.
SHADED AREAS REPRESENT MONOCULAR VISION.
CLEAR AREAS REPRESENT BINOCULAR VISION.

THE ACCURACY OF THESE ILLUSTRATIONS IS LIMITED BY THE PROCESS BY WHICH THE ILLUSTRATIONS WERE PRODUCED. THAT IS, THE ILLUSTRATIONS WERE PRODUCED FROM TRACINGS OF THE ORIGINAL BINOCULAR PHOTOGRAPHS.

COCKPIT VISIBILITY - BOEING 727



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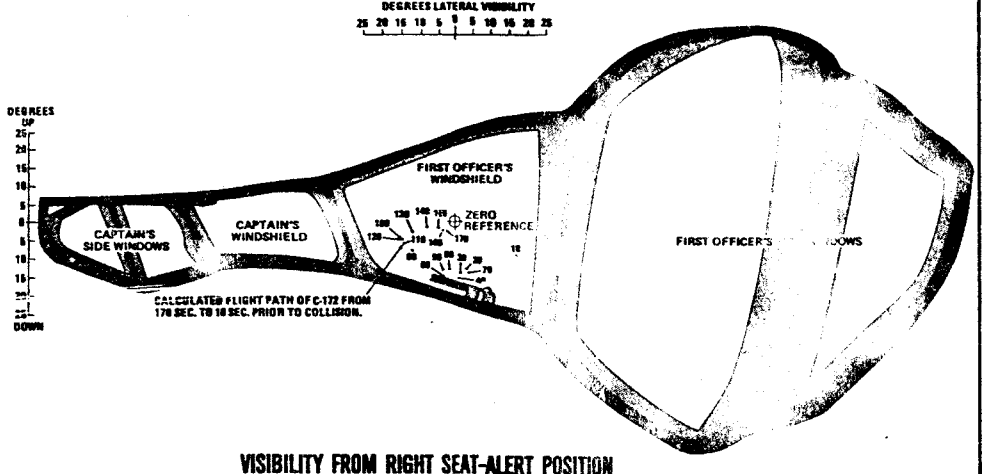
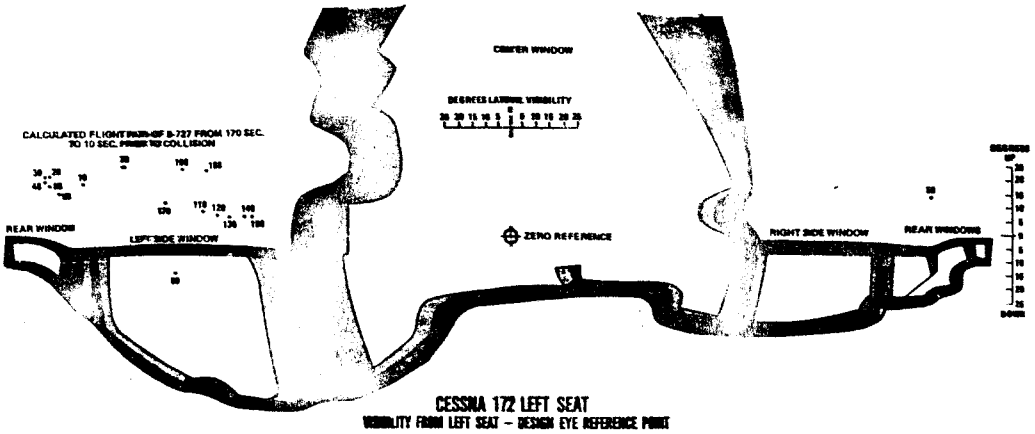
VISIBILITY FROM LEFT SEAT-ALERT POSITION



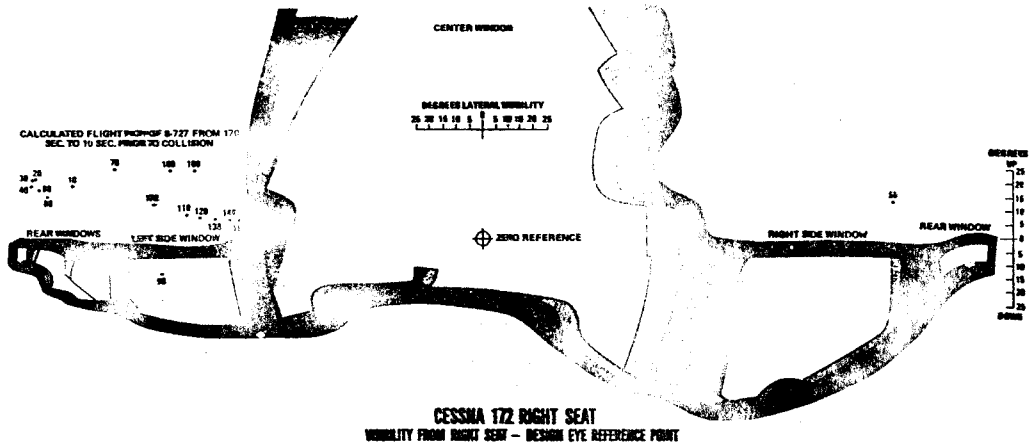
VISIBILITY FROM RIGHT SEAT-ALERT POSITION

NOTE: BLACK AREAS REPRESENT OBSTRUCTED VISION.
SHADED AREAS REPRESENT MONOCULAR VISION.
CLEAR AREAS REPRESENT BINOCULAR VISION.

COCKPIT VISIBILITY - BOEING 727



CESSNA 172 LEFT SEAT
VISIBILITY FROM LEFT SEAT – DESIGN EYE REFERENCE POINT



CESSNA 172 RIGHT SEAT
VISIBILITY FROM RIGHT SEAT – DESIGN EYE REFERENCE POINT

NOTE: BLACK AREAS REPRESENT OBSTRUCTED VISION.
SHADED AREAS REPRESENT MONOCULAR VISION.
CLEAR AREAS REPRESENT BINOCULAR VISION.

THE ACCURACY OF THESE ILLUSTRATIONS IS LIMITED BY THE PROCESS BY WHICH THE ILLUSTRATIONS WERE PRODUCED. THAT IS, THE ILLUSTRATIONS WERE PRODUCED FROM TRACINGS OF THE ORIGINAL BINOCULAR PHOTOGRAPHS.

COCKPIT VISIBILITY - CESSNA 172

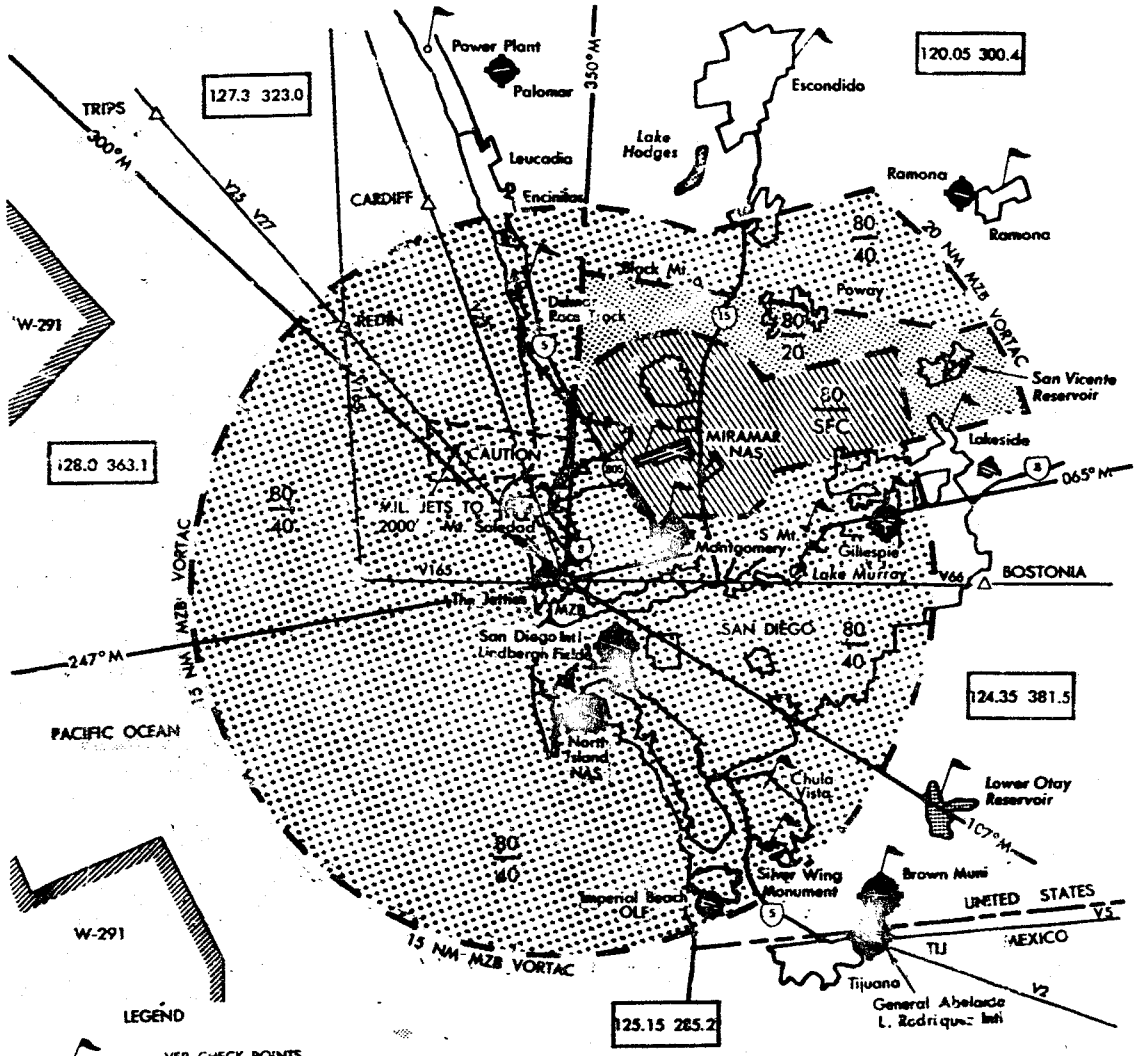
APPENDIX F

TERMINAL RADAR SERVICE AREA
(NOT TO BE USED FOR NAVIGATION)

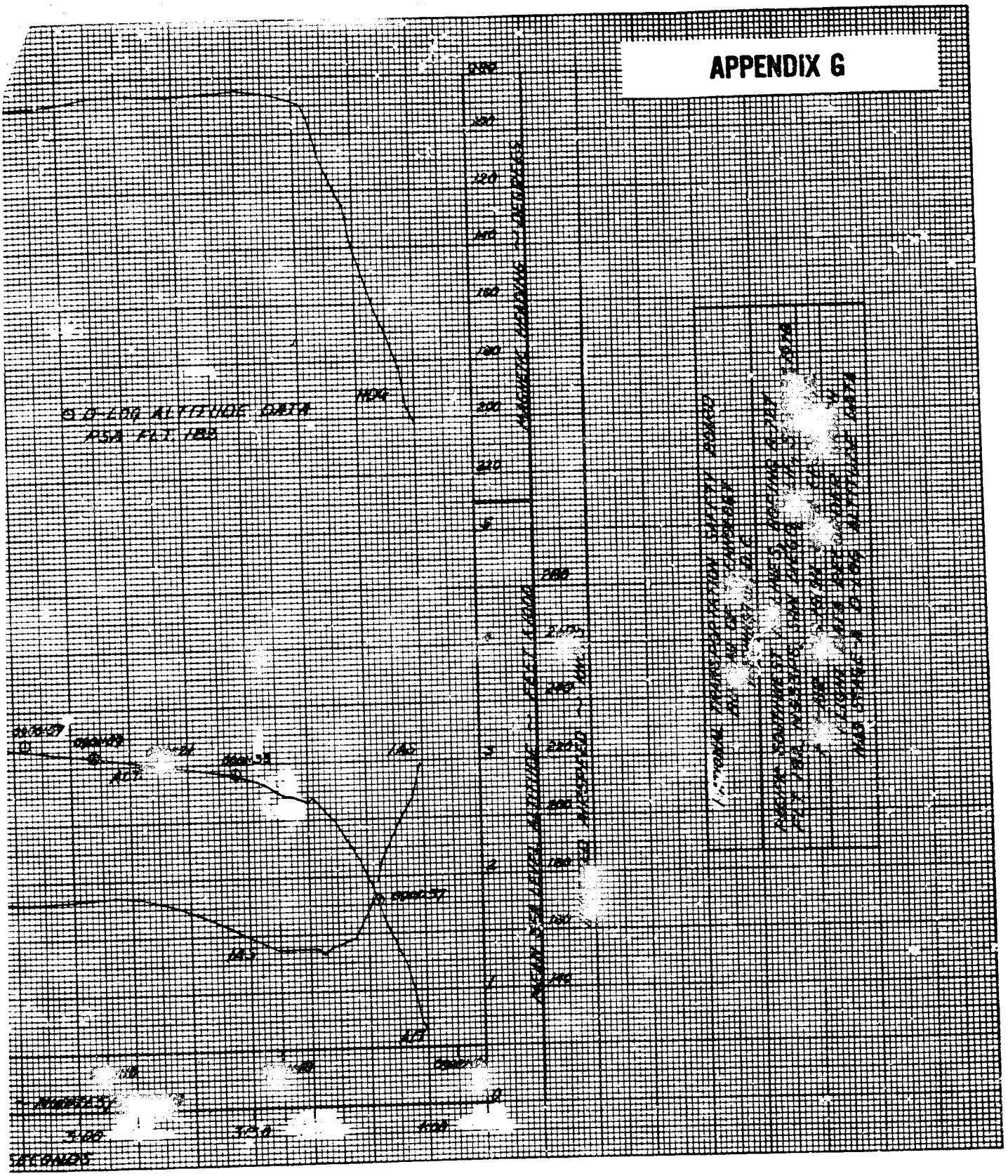
TRSA-[redacted]

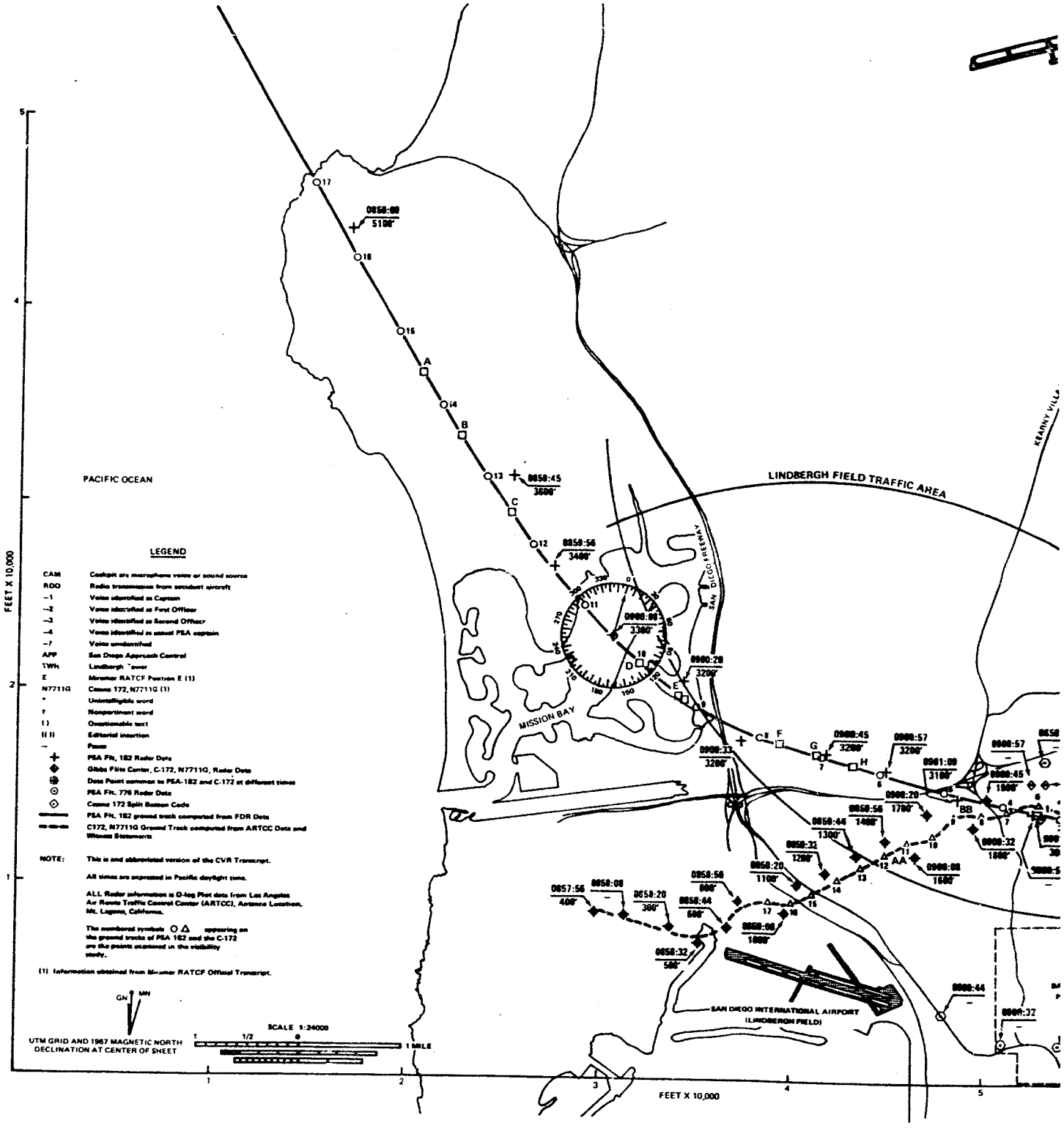
TRSA-[redacted]

SAN DIEGO, CALIFORNIA
MIRAMAR NAS
FIELD ELEV. 477'MSL

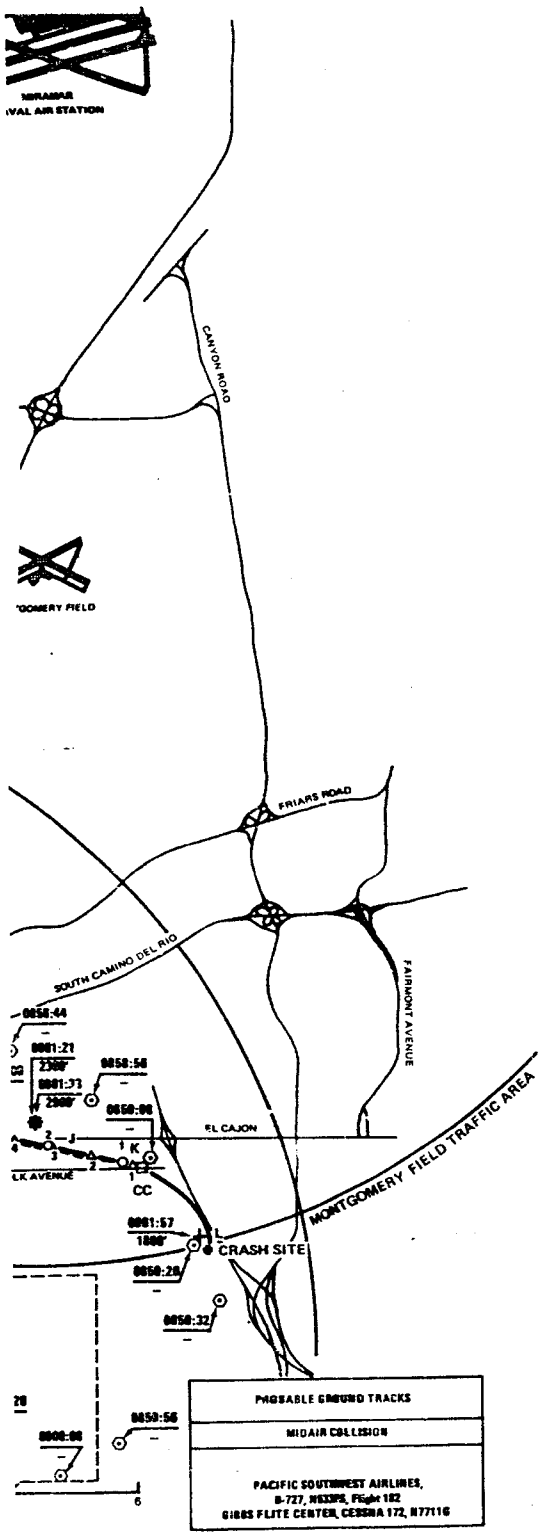


APPENDIX G




PACIFIC OCEAN
LINDBERGH FIELD TRAFFIC AREA
SAN DIEGO FREEWAY
MISSION BAY
KEARNY VILLA
SAN DIEGO INTERNATIONAL AIRPORT
(LINDBERGH FIELD)
LEGEND
CAM Cockpit area microphone voice or sound source
RDO Radio transmission from accident aircraft
–1 Voice identified as Captain
–2 Voice identified as First Officer
–3 Voice identified as Second Officer
–4 Voice identified as second PSA captain
–7 Voice unidentified
APP San Diego Approach Control
TWR Lindbergh Tower
E Miramar RATCF Position E (1)
N7711G Cessna 172, N7711G (1)
* Unintelligible word
† Nonpertinent word
( ) Questionable text
(( )) Editorial insertion
– Pause
PSA Flt. 182 Radar Data
Gibbs Flite Center, C-172, N7711G, Radar Data
Data Point common to PSA-182 and C-172 at different times
PSA Flt. 776 Radar Data
Cessna 172 Split Beacon Code
PSA Flt. 182 ground track computed from FDR Data
C172, N7711G Ground Track computed from ARTCC Data and Witness Statements
NOTE: This is and abbreviated version of the CVR Transcript.
All times are expressed in Pacific daylight time.
ALL Radar information is D-log Plot data from Los Angeles Air Route Traffic Control Center (ARTCC), Antenna Location, Mt. Laguna, California.
The numbered symbols ○ △ appearing on the ground tracks of PSA 182 and the C-172 are the points examined in the visibility study.
(1) Information obtained from Miramar RATCF Official Transcript.
GN MN
UTM GRID AND 1967 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
SCALE 1:24000
1/2
1 MILE
FEET X 10,000
FEET X 10,000

APPENDIX H



0858:38
APP PSA one eighty-two, traffic twelve o'clock, one mile northbound

0858:45
RDO-1 We're looking

B 0858:48
APP PSA one eighty-two, additional traffic's, ah, twelve o'clock, three miles just north of the field northeastbound, a Cessna one seventy-two climbing VFR out of one thousand four hundred

C 0858:58
RDO-2 Okay we've got that other twelve

0858:57
APP Cessna seven seven one one golf, San Diego departure radar contact, maintain VFR conditions at or below three thousand five hundred, fly heading zero seven zero, vector final approach course

D 0900:15
APP PSA one eighty-two, traffic's at twelve o'clock, three miles out of one thousand seven hundred

E 0900:21
CAM-2 Get 'em

0900:22
RDO-1 Traffic in sight

0900:23
APP Okay, sir, maintain visual separation, contact Lindbergh tower one three three point three, have a nice day [illegible]

0900:28
RDO-1 Okay

0900:34
RDO-1 Lindbergh PSA one eighty-two downwind

F 0900:38
TWR PSA one eighty-two, Lindbergh tower, ah, traffic twelve o'clock one mile a Cessna

0900:41
CAM-2 Flaps five

0900:43
CAM-1 Is that the one we're looking at

0900:43
CAM-2 Yeah, but I don't see him now

G 0900:44
RDO-1 Okay, we had it three a minute ago

0900:47
TWR One eighty-two, roger

H 0900:50
RDO-1 I think he's paralled off to our right

0900:51
TWR Yeah

0900:52
CAM-1 He was right over here a minute ago

0900:53
CAM-2 Yeah

0900:53
TWR How far are you going to take your downwind one eighty-two, company traffic is waiting for departure

0900:57
RDO-1 Ah probably about three to four miles

0900:58
TWR Okay

0901:07
TWR PSA one eighty-two, cleared to land

0901:08
RDO-1 One eighty-two's cleared to land

0901:11
CAM-2 Are we clear of that Cessna?

0901:13
CAM-3 Suppose to be

0901:14
CAM-1 I guess

0901:28
CAM-4 I hope

I 0901:29
CAM-1 Oh yeah, before we turned downwind, I saw him about one o'clock, probably behind us now

0901:38
CAM-2 There's one underneath

J 0901:38
CAM-2 I was looking at that inbound there

0901:45
CAM-1 Whoop!

0901:46
CAM-2 Aghhh!

K 0901:47
CAM ((Sound of impact))

0901:48
CAM-1 Easy baby, easy baby

0901:51
CAM ((Sound of electrical system reactivation tone on voice recorder, system off less than 1 second))

0901:51
CAM-1 What have we got here?

0901:52
CAM-2 It's bad

0901:53
CAM-2 We're hit man, we are hit

0901:56
RDO-1 Tower we're going down, this is PSA

0901:57
TWR Okay, we'll call the equipment for you

0901:58
CAM ((Sound of stall warning))

L 0902:04:5
CAM ((Sound of cockpit voice recorder ceases, electrical power to recorder stops))

0858:51 N7711G: (Unintelligible) Seven Seven One One Golf (Unintelligible) one thousand five hundred ah northeastbound

AA 0859:58 E: Cessna Seven-Seven One One Golf San Diego Departure radar contact maintain VFR conditions at or below three thousand five hundred fly heading zero seven zero vector final approach course

0900:08 N7711G: Zero seven zero on the heading and VF'n'R below three thousand five hundred (unintelligible)

BB 0900:31 E: Cessna One One Golf and traffic's at six o'clock two miles eastbound a PSA jet inbound to Lindbergh out of three thousand two hundred has you in sight

0900:43 N7711G: One One Golf Roger

CC 0901:47 E: Cessna One One Golf a traffic ah is your vicinity a PSA jet has you in sight he's descending for Lindbergh