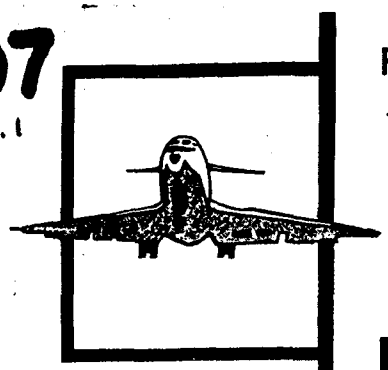

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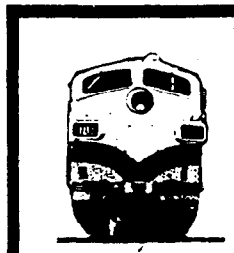

WASHINGTON, D.C. 20594

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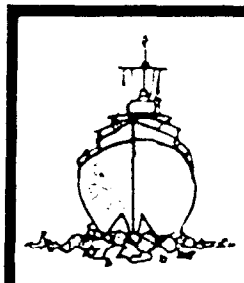
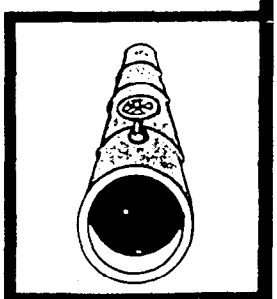


MIDAIR COLLISION OF
WINGS WEST AIRLINES BEECH C-99 (N6399U) AND
AESTHETEC, INC.,
ROCKWELL COMMANDER 112TC N112SM
NEAR SAN LUIS OBISPO, CALIFORNIA
AUGUST 24, 1985



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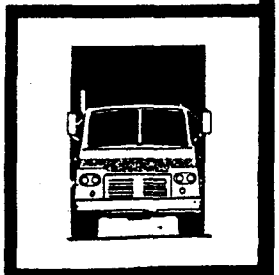

UNITED STATES GOVERNMENT

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20594

AVIATION ACCIDENT REPORT

Adopted: August 29, 1985

MIDAIR COLLISION OF WINGS WEST AIRLINES BEECH C-99 (N6399U) AND AESTHETEC, INC., ROCKWELL COMMANDER 112TC N112SM NEAR SAN LUIS OBISPO, CALIFORNIA AUGUST 24, 1984

SYNOPSIS

About 1117:38 Pacific daylight time, on August 24, 1984, Wings West Airlines, Flight 628, a Beech C-99 (N6399U), and Aesthetec Inc. Rockwell Commander 112TC, N112SM, collided in midair near San Luis Obispo, California. The weather at the time of the collision was clear. Flight 628 had just departed San Luis Obispo County Airport en route to San Francisco International Airport, California, and was climbing on a west bound heading. The Rockwell Commander had departed Paso Robles, California, on a training flight and was descending toward the San Luis Obispo County Airport on an eastbound track. The airplanes collided head-on at an altitude of about 3,400 feet. The wreckage of both airplanes fell into an open field about 8 nmi west northwest of the San Luis Obispo County Airport. All 17 persons, including the 2 pilots and 13 passengers onboard Flight 628 and the 2 pilots onboard the Rockwell, were killed.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the pilots of both aircraft to follow the recommended communications and traffic advisory practices for uncontrolled airports contained in the Airman's Information Manual to alert each other to their presence and to enhance the controller's ability to provide timely traffic advisories.

Underlying the accident were the physiological limitations of human vision and reaction time. Also underlying the accident was the short time available to the controller to detect and appraise radar data and to issue a safety advisory.

Contributing to the accident was the Wings West Airlines policy which required its pilots to tune one radio to the company frequency at all times.

1. FACTUAL INFORMATION

1.1 History of the Flight

Beech C-99, N6399U.--Wings West Airlines Flight 628, a regularly scheduled commuter flight, originated in Los Angeles, California, August 24, 1984, and was destined for San Francisco, with scheduled en route stops at Santa Maria and San Luis Obispo, California. Flight 628 landed at San Luis Obispo County Airport, an uncontrolled airport, 1/ about 1102 P.d.t. 2/

At 1110, Flight 628 left the gate at San Luis Obispo with 13 passengers and a flightcrew of 2 on board. According to the local surface weather observations, the

1/ A public use airport without a control tower or where tower is not in operation.
2/ All times herein are Pacific daylight time based on the 24-hour clock.

weather at the time was essentially clear and the visibility was 15 miles. Since the departure from San Luis Obispo and the ensuing flight to San Francisco could be flown under visual flight rules (VFR), the flightcrew had the option of requesting their instrument flight rules (IFR) flight plan either before takeoff or after takeoff while en route. The flightcrew elected to request their IFR clearance after takeoff which was the normal procedure during VFR conditions. The proposed IFR flight plan was stored in the Los Angeles Air Route Traffic Control Center's (ARTCC) air traffic control computer for recurrent use.

According to its IFR flight plan, Flight 628 was required to depart San Luis Obispo via the Crepe 1 Standard Instrument Departure (SID) to Crepe Intersection (a navigational fix formed by the intersection of the San Luis Obispo Localizer 3/ course and the 196° radial of the Paso Robles, California, VORTAC 4/); thence direct to Big Sur, California, VORTAC; and, thence direct to San Francisco at 8,000 5/ feet. The Crepe 1 SID requires the departing airplane to climb toward Crepe Intersection on the reciprocal course (heading 290° magnetic) of the San Luis Obispo Localizer. (See appendix C.)

Neither the Wings West flight follower (a company employee assigned to monitor the progress of the company's flights) nor the UNICOM 6/ operator recalled hearing any radio transmissions from Flight 628 as it taxied to and before it took off from runway 29. However, the pilot of an airplane which had departed San Luis Obispo just before Flight 628 said that he overheard the flight announce on UNICOM that Flight 628 was "departing runway two-nine straight out."

At 1116, after taking off, Flight 628 called the Los Angeles ARTCC. However, because of other radio communications on the frequency with IFR aircraft under his control, the radar controller did not answer until 1116:40 when he instructed the flight to "go ahead." At 1116:51, Flight 628 reported that it was climbing through 2,700 feet "IFR to San Francisco." The radar controller assigned discrete transponder code 6721 to Flight 628. Flight 628 acknowledged receipt of the discrete code and, at 1117:16, the radar controller reported to the flight that it was "in radar contact six (miles) northwest of San Luis Obispo airport, say altitude?" Flight 628 answered, "Three thousand one hundred (feet), climbing."

At 1117:23, the Los Angeles ARTCC's radar controller cleared Flight 628 to the San Francisco airport, as filed, to climb and maintain 7,000 feet, and, at 1117:32, Flight 628 acknowledged receipt of the clearance by reading it back to the controller. According to the controller, a few seconds after receiving Flight 628's clearance readback, and at a point about 5 nmi northwest of the point on his radar display that he had first observed Flight 628's discrete beacon code, he lost radar contact with the flight. At 1118:40, the radar controller called Flight 628 and said, "I've lost your transponder, reset, squawk six seven two one." Flight 628 did not respond to this radio call or to subsequent attempts to reestablish radio contact.

3/ Localizer--a transmitter which emits signals which provide the pilot with course guidance to the runway centerline.

4/ A collocated very high frequency omni range station and ultra high frequency tactical air navigation aid that provides azimuth and distance information.

5/ Altitudes herein are mean sea level unless otherwise specified.

6/ A non-government communication facility which may provide airport information at certain airports. Locations and frequencies of UNICOMs are shown on aeronautical charts and publications. When the UNICOM is designated as the Common Traffic Advisory Frequency (CTAF), it also is used for the purpose of carrying out traffic advisory practices while operating to or from an uncontrolled airport.

Rockwell Commander, N112SM.--The Rockwell Commander, N112SM, departed Paso Robles Airport on a training flight with two pilots on board; one was an instructor pilot based at the Paso Robles Airport, and the other a former military pilot being checked out on the airplane. No flight plan was filed, nor was one required.

About 1048, prior to taxiing, the pilot of the Rockwell Commander called the Paso Robles Flight Service Station (FSS) via radio for airport advisories and the FSS specialist on duty estimated that N112SM departed Paso Robles about 1052. N112SM was flying in visual meteorological conditions and under VFR in the vicinity of the San Luis Obispo Airport just before the collision.

Flight 628 and N112SM collided about 8 nmi west northwest of the San Luis Obispo Airport about 1117:38. Radar data retrieved from the Los Angeles ARTCC National Track Analysis Program (NTAP) indicated that the collision occurred at 3,400 feet and the airplanes' wreckage was located at 35°18'42" north latitude and 120°44'48" west longitude.

1.2 Injuries to Persons

	Crew	Passengers	Other	Total
Fatal	4*	13	0	17
Serious	0	0	0	0
Minor	0	0	0	0
None	0	0	0	0
Total	4	13	0	17

*Includes the 2 pilots on N112SM and the 2 pilots on N399U.

1.3 Damage to Aircraft

Both airplanes were destroyed by in-flight and ground impact forces and postimpact fires.

1.4 Other Damage

Ground damage was insignificant.

1.5 Personnel Information

Except as stated below, all pilots and ATC personnel were qualified in accordance with current regulations. (See appendix B.)

Flight 628's first officer's Commercial Pilot Certificate stated that his airplane multiengine land rating was limited to centerline thrust airplanes; the Beech C-99 is a spanwise thrust airplane. However, the first officer completed his proficiency check on the Beech C-99 on August 14, 1984, during which time he was required to demonstrate his ability to maneuver the airplane with one of its engines inoperative. Thus, although his Commercial Pilot Certificate did not reflect this, the first officer had demonstrated his ability to fly a spanwise thrust airplane with an inoperative engine; and, in particular, the Beech C-99. In addition, the first officer had several thousand hours' pilot time in the Boeing B-52, a spanwise thrust airplane, and the restriction could have been removed on the basis of military competency.

1.6 Aircraft Information

The Beech C-99, N6399U, was purchased new on July 14, 1982, by the Capital Equipment Company and since that date it had been leased to and operated continuously by Wings West Airlines. The airplane was within the maximum gross takeoff weight and allowable center of gravity limits at takeoff. The examination of the airplane's maintenance records showed that it had been maintained in accordance with current regulations.

N6399U was painted white with three green stripes running the length of the fuselage. The name of the company was painted in green letters along the top of either side of the fuselage, and the vertical and horizontal stablizers were painted green.

The Rockwell Commander 112TC, N112SM, was owned and operated by the Aesthetec Corporation. The airplane and engine logbooks were on board the airplane and were lost in the collision, crash, and subsequent ground fire.

N112SM was white with longitudinal orange trim along the fuselage and on the horizontal and vertical stablizers.

1.7 Meteorological Information

The weather in the vicinity of San Luis Obispo at the time of the accident was clear. Surface weather observations taken by a National Weather Service certified observer at the San Luis Obispo airport were, in part, as follows:

> Time-1050; clouds--15,000 feet scattered; visibility--15 miles; temperature--71° F; wind--calm; altimeter setting--29.95 inHg.
>
> Time-1130; clouds--15,000 feet scattered; visibility--15 miles; temperature--75° F; wind--240 at 03 knots; altimeter setting--29.95 in Hg; aircraft mishap.

At 1117:38, the elevation and azimuth of the sun were 55° and 128° respectively. Therefore, the sun would have been positioned about 18° to the left of the Rockwell Commander and to the left and rear of Flight 628.

1.8 Aids to Navigation

There were no known problems with the aids to navigation

1.9 Communications

There were no known communications problem.

1.10 Aerodrome Information

San Luis Obispo County Airport, elevation 206 feet, is a public use airport certificated under 14 CFR 139. The airport is serviced by two runways: 11/29 and 7/25. Runway 11/29 is the primary runway; it is 4,799 feet long and 150 feet wide and has an asphalt surface. Runway 7/25 has an asphalt surface and is 3,261 feet long and 150 feet wide. The traffic pattern altitude is 1,200 feet above the ground (AGL), and right traffic flow procedures are in use.

The San Luis Obispo County Airport is located within the control jurisdiction of the Los Angeles ARTCC's low altitude sector 15 (R-15). (See appendix C.) R-15's low altitude sector extends from the surface to 12,000 feet.

Since inbound and departing airplanes are not controlled by a tower or monitored by a Flight Service Station (FSS) located at the San Luis Obispo airport, an airborne radio receiver and transmitter is not required. However, the Airman's Information Manual (AIM), which is published by the Federal Aviation Administration (FAA), recommends that airplanes equipped with a radio use the UNICOM frequency to monitor traffic and to announce intentions. (See section 1.17.1) In addition, a sign located to the right of the taxiway used by departing aircraft stated, "Announce Intentions UNICOM 122.8."

The airport is served by a VOR station and a localizer approach to runway 11. The following fix (reference) points are associated with the approach procedure (see appendix D):

CREPE - The initial approach fix 13.1 nmi from the approach end of runway 11.

DOBRA - The outer marker and final approach fix (FAF) 6.1 nmi from the approach end of runway 11.

HASBY - The final let down fix 2.3 nmi from the approach end of runway 11.

In addition to the UNICOM, a remote receiver-transmitter radio facility enabling direct contact with the Los Angeles ARTCC was located at the airport.

Traffic Information.--During the year ending September 23, 1983, there had been 109,000 operations at the San Luis Obispo County Airport. As of August 26, 1982, the airport had met the qualifying criteria for candidacy for tower service; however, tower candidates must compete for priority with all other National Airspace System (NAS) projects. On February 1, 1984, the FAA was notified that the establishment of an airport traffic control tower at San Luis Obispo County Airport has been approved and funded for construction during the 1985 fiscal year. As of August 22, 1985, the site survey for the tower is in final review and is scheduled to be completed by the end of September 1985. Actual construction is scheduled to begin in July 1986 with a commissioning date of October 1987.

1.11 Flight Recorders

Neither airplane was equipped with nor were they required to be equipped with either flight data or cockpit voice recorders.

1.12 Wreckage and Impact Information

The wreckage of the airplanes fell into an open field about 8 nmi west northwest of the San Luis Obispo County Airport. The major structural portions of the Beech C-99 were found about 2,500 to 3,000 feet west of the major portions of the Rockwell Commander.

Rockwell Commander, N112SM

The main portion of N112SM's wreckage, which included the engine, portions of the cockpit instrument panel, the two aft passenger seats, the wing carry-through spar

structure, and the aft fuselage section, including the almost intact empennage, struck the ground in an almost vertical attitude. The propeller assembly had separated from the engine before the engine struck the ground. There was no postimpact fire.

Fuselage.--The fuselage crown structure from the cockpit windshield aft to fuselage station (FS) 178 7/ was severed along a horizontal plane through the right and left cabin entrance doors and the tops of the aft window frames. Black marks extending 18 inches aftward from the right externally mounted handgrip were on the right side of the crown structure along the aft window frame. (The leading edges of the Beech C-99's wings and horizontal and vertical stabilizers were covered by de-icer boots constructed of black rubberized material.)

The fuselage structure from FS 62 to FS 178 was destroyed. Aft of FS 178, the structure was torn and crushed severely and the aft fuselage and dorsal fin had been twisted and folded to the right. There were black marks aft of FS 223 on the right side and on the dorsal fin.

Empennage.--The lower portion of the vertical stabilizer was torn and crushed; the upper portion was torn and had been flattened. The rudder, which had sustained extensive compression damage, had separated from its two hinge points but was still attached to the horn assembly.

The horizontal stabilizer was partially attached to the vertical stabilizer. The leading edge of the left horizontal stabilizer had been crushed and a 12-inch section beginning about 2 feet outboard of the vertical stabilizer was crushed. The right elevator was attached to the horizontal stabilizer; the left elevator had separated from the horizontal stabilizer and was found along the wreckage path between the two airplanes.

The Left Wing.--The outboard panel of the left wing, which had separated at wing station (WS) 65, 8/ was found along the wreckage path between the two airplanes. Light green paint marks were on the leading edge of the panel at the point of separation. The inboard structure of the left wing was destroyed between WS 26 and WS 65.

The main spar between WS 65 and WS 121 was bent aft, and between WS 119 and WS 142, the leading edge of the wing had been crushed aft to the wing's main spar. There were three 12- by 1 1/2-inch fore and aft black marks near the leading edge of the wing at WS 154.

The Right Wing.--The right wing assembly had separated at WS 26 and was found along the wreckage path. The wing structure was torn, crushed, and buckled.

A 10- to 12-inch-long propeller slash in the bottom of the wing began about 8 inches aft of the leading edge at WS 65. The slash extended inboard and aft on a 26 degree angle and had partially severed the main landing gear door.

Landing Gear.--The nose and right main landing gear were retracted and were found in the wreckage of the fuselage and right wing, respectively. The left main landing gear had separated from its mounts and was found along the wreckage path between the two airplanes.

7/ For identification purposes, the fuselage is measured in 1-inch increments beginning at an arbitrary reference point selected by the manufacturer. The reference point is at or near the nose of the airplane; FS 178 is 178 inches aft of the reference point.
8/ For identification purposes, the wing is measured outboard from an arbitrarily selected reference point at or near the fuselage centerline. WS 65 is 65 inches outboard of the reference point.

Powerplants.--The propeller had separated from the engine. The engine was connected to the main section of the fuselage only by cables and tubing. The engine was in an upright position with the nose of the crankshaft buried in the dirt at a 40 degree nosedown attitude.

The separated propeller was recovered along the wreckage path about 200 feet from N112SM's main wreckage. The propeller had separated when an overload was placed on the engine crankshaft flange.

About 90 percent of the propeller spinner had separated before ground impact, and the separated pieces of the spinner were found along the wreckage path between the two airplanes. About 60 percent of the main spinner section was found about 100 feet from the propeller. This section had separated when the sheet metal pulled from the mount screws attached to the spinner backplate. One side of the spinner cone was almost flattened. Green paint streaks were on the flattened section, and a black rubberlike substance was found on the opposite side. One side of the spinner's backplate had been bent back over the hub and was streaked with green paint similar to that applied to the trim of the Beech C-99.

The propeller hub and dome were virtually undamaged. The "A" blade 9/ of the propeller was attached to the hub and could be rotated in the clamp. The blade had rotated 180 degrees with the rear camber facing forward and had bent aft. The rear surface of the blade was covered with a yellowish-tan fibrous material which extended over the outer surface of the blade. The fibrous material was identical to the material used to insulate the cabin of the Beech C-99. A 3-inch section of the bladetip had separated but was recovered. The tip section was curled but did not contain any fibrous material.

The "B" blade, which was attached to the hub and could be rotated in the clamp, had rotated and was bent in the same manner as the "A" blade. As a result of an overload shear, the outer 11 inches of the "B" blade had separated from the remainder of the blade. The separated blade section was recovered in the field between the two airplanes; however the tip of this section was missing. The rear face of the recovered section was covered with the same type of material found on the "A" blade. The major portion of the "B" blade was not covered with this fibrous material. The forward face of the separated section of the "B" blade had deep transverse scratches and the leading edge was nicked and dented.

Cockpit Documentation.--The Rockwell's cockpit instrument and electrical panels were damaged severely by in-flight and ground impacts; however, the heading bug on the copilot's directional indicator was set to 200 degrees and the heading was 110 degrees. The No. 1 navigation radio receiver was set to 108.7 Mhz, 1 Mhz below the San Luis Obispo Localizer frequency. Both communication radio switches were on. The No. 1 radio was set to 120.8 Mhz, (the Safety Board could not relate this frequency to any nearby ATC facility), and the No. 2 radio was tuned to 122.8 Mhz, the San Luis Obispo UNICOM's frequency.

Beech C-99, N6399U

The main wreckage portion of N6399U, which included the fuselage structure below the cabin window upper frame area, the vertical stabilizer, the rudder, the left wing, engine, and propeller, and the right wing, engine, and propeller struck the ground in

9/ For the purpose of identification, the propeller blades have been identified as "A" and "B."

a horizontal attitude. A large percentage of the fuselage and wing structure was destroyed by ground fire. Other major sections of the fuselage crown structure were located about 800 feet from the main wreckage area and were not burned.

Fuselage.--Except for the center wing carry-through spar member, portions of the cabin floor, and sections of the fuelage crown structure, the fuselage was consumed by ground fire. The fuselage crown structure from the cockpit windshield aft to FS 418 had separated and was found in three sections along the wreckage path and apart from the main wreckage. The first section was 36 inches long and included the upper portion of the windshield center post and a shattered portion of the right windshield. The second section was 12 feet 8 inches long and included six right window upper frames; it was buckled severely in the area of the No. 4 window. The right emergency exit was severed and had separated from the fuselage; the upper portion was recovered. The third section was 10 feet 3 inches long and included the dorsal fin and right rear oval-shaped window. The cuts on the right sides of the fuselage crown structures were higher than the cuts along the left sides of the crown structure.

Empennage.--The vertical stabilizer was intact and attached partially to the aft fuselage structure. The lower area of the leading edge was crushed and the skin on the right side of the vertical stabilizer adjacent to the crushed areas had been torn severely. The rudder assembly had separated during ground impact and the rudder had been burned by ground fire.

The horizontal stabilizer assembly had separated into numerous pieces which were found along the wreckage path. The right horizontal stabilizer, including the assembly carry-through box structure and a 3 1/2-foot section of the inboard end of the left horizontal stabilizer structure, was recovered in one piece. The leading edge of the right stabilizer was crushed and torn at a point about 4 feet 5 inches from its inboard end. The outboard end of the right stabilizer was buckled upward; however, the right elevator was intact and attached to the stabilizer. The 3 1/2-foot section of the left stabilizer structure had been bent aft.

The left horizontal stabilizer was destroyed. Only small pieces of its inboard leading edge and a 3-foot section of the outboard end were recovered. The left elevator was recovered in three pieces and its inboard leading edge was crushed severely.

The Left and Right Wings.--Both wings were damaged severely during the ground impact sequence and by ground fire.

Powerplants.--Both engines had separated from their mounts but were found adjacent to their normal positions on the wings. The propellers had separated on impact and were found near their respective engines. There was no evidence of preground impact damage.

Cockpit Documentation.--Because the cockpit instrument and electrical panels of the Beech C-99 were damaged severely by the postcrash fire, no useful information concerning the radio frequencies in use at the time of the collision could be obtained. The heading bugs on the captain's and first officer's directional indicators were set on 295 degrees and both indicators were indicating 300 degrees. The captain's altimeter was set at 29.94 inHg and was indicating 3,200 feet.

1.13 Medical and Pathological Information

There was no evidence of any preexisting medical or pathological factors which would have affected either flightcrew's performance of their in-flight duties. The

results of the toxicological testing did not disclose the presence of alcohol or any other substance which would have affected either flightcrew's performance.

1.14 Fire

There was no evidence of in-flight fire on either airplane. A large portion of the fuselage and wing section of the Beech C-99 was destroyed by postimpact ground fire which remained confined to the area around the fuselage and wing structure.

There was no postimpact ground fire in the area containing the Rockwell's wreckage.

1.15 Survival Aspects

This was a non-survivable accident. The occupiable area of the cockpits of both airplanes and the passenger cabin of the Beech C-99 were destroyed during the collision and subsequent ground impacts. In addition, the cabin area of the Beech C-99 was further destroyed by the postimpact ground fire.

1.16 Tests and Research

Not applicable.

1.17 Additional Information

1.17.1 Air Traffic Procedures at Uncontrolled Airports

Provisions of Title 14 CFR Part 91, General Operating and Flight Rules, were relevant to the facts and circumstances of this accident. Title 14 CFR 91.65(a) states that "no person may operate an aircraft so close to another aircraft as to create a collision hazard."

Title 14 CFR 91.67 states, in part, that regardless of whether a flight is operated under IFR or VFR, weather conditions permitting "vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft in compliance with this section." The regulation also states that "when aircraft are approaching each other head-on, or nearly so, each pilot shall alter course to the right."

Title 14 CFR 91.89, which addresses operations at uncontrolled airports, states, in part, that the pilot of an airplane approaching to land shall make "all turns of that airplane to the left unless the airport displays approved light signals or visual markings indicating that turns should be made to the right." The regulation further states that the departing pilot shall "comply with any FAA traffic pattern for that airport."

Additional information designed to facilitate and enhance the safety of operations at uncontrolled airports is provided to pilots in the AIM. The AIM's foreword states, in part, that 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 fundamentals required in order to fly in the U.S. NAS. It also contains items of interest to pilots concerning health and medical facts, factors affecting flight safety, a pilot/controller glossary of terms used in the Air Traffic Control System, and information on safety, accident and hazard reporting." The procedures contained in the AIM, unless supported by a specific provision of the Federal Aviation Regulations (FAR), are not regulatory but are recommended procedures.

However, FAA written certification exams test pilots' knowledge of material contained in the AIM, and pilots are required during flight checks to demonstrate their knowledge of material contained in the AIM.

The following procedures, contained in the July 5, 1984, issue of the AIM, were relevant to operations at the San Luis Obispo County Airport. These procedures were unchanged from those in previous editions of the AIM.

> Paragraph 157 emphasizes the necessity for visual alertness in the vicinity of an uncontrolled airport and states, "To achieve the greatest degree of safety, it is essential that all radio-equipped aircraft transmit/receive on a common frequency identified for the purpose of carrying out airport advisory practices." Paragraph 157 recommends that all inbound traffic "should monitor and communicate as appropriate on the designated CTAF [Common Traffic Advisory Frequency] from 10 miles to landing. Departure aircraft should monitor/communicate on the appropriate frequency from start-up, during taxi, and until 10 miles from the airport unless the FARs or local procedures require otherwise."
>
> For those airports which have a UNICOM facility, paragraph 157 recommends, in part, that pilots "Call about 10 miles from the airport and state your aircraft identification, type of aircraft, altitude, location relative to the airport, and request wind information and runway in use; report on downwind, base, and/or final approach as appropriate; and report clearing the runway." The paragraph advises outbound aircraft to advise traffic of their departure by broadcasting the name of the airport, airplane type and call sign, and the departure runway.
>
> Paragraph 244c contains recommended communications procedures for conducting practice instrument approaches at uncontrolled airports and states: "At airports without a tower, pilots wishing to make practice instrument approaches should notify the facility having control jurisdiction of the desired approach as indicated on the approach chart. All approach control facilities and ARTCCs are required to publish a facility bulletin depicting those airports where they provide standard separation to both VFR and IFR aircraft conducting practice instrument approaches."

The San Luis Obispo County Airport LOC RWY 11 instrument approach is under the control jurisdiction of the Los Angeles ARTCC. Because of the limitations of radar coverage, the Los Angeles ARTCC does not provide standard separation service to any uncontrolled airports within its jurisdiction; consequently, it was not required to issue a facility bulletin, and had not done so.

1.17.2 Air Traffic Control Operations

ATC Computer.--A National Airspace Stage A (NAS Stage A) computer is installed at the Los Angeles ARTCC. The NAS Stage A computer provides radar data and flight data processing for en route air traffic control. Essentially, raw radar data from the radar antenna is provided to the Central Computer Complex (CCC), which processes the radar information and provides the processed data to the Computer Display Channel (CDC). The CDC, in turn, accepts the data display messages from the CCC and generates alphanumeric, symbolic, and map data for presentation on the controller's plan view

display (PVD), or radar scope. Data Entry Controls (DEC) at the controllers' operating positions permit controllers to communicate with the CCC.

The radar data provided by the Los Angeles ARTCC is from its NAS Stage A en route radar. The NTAP provided the capability to extract track and radar data from the Systems Analysis Recording (SAR) tape which is recorded after radar data processing has begun by the CCC and before transmission to the CDC. The NTAP produced listings for the period between 1100 and 1120 of all 1200 (VFR) and 6721 beacon coded targets in both system X and Y coordinates and latitude and longitude coordinates in addition to altitude information. The manager of the FAA's En Route Automation Program testified that, given the point in the system where the NTAP data is recorded and given the configuration of the R-15 radar scope at the time of the accident, "There was no functional reason why [the information displayed on the NTAP data] shouldn't have been displayed [on the R-15 radar scope]."

The NAS Stage A computer contains a conflict alert program designed to alert controllers to potentially hazardous traffic situations recognized by the program parameters that require immediate attention and or action. However, the program will only function if the airplanes involved are equipped with altitude encoding transponders, the transponders are operating, and the NAS Stage A computer has identified each airplane with a given track, i.e., a correlated target. Since the Rockwell Commander's track had not been inserted into the computer it was an uncorrelated VFR target and the conflict alert system did not function.

R-15 Radar Sector Controllers

At the time of the accident four controllers were at or near the R-15 radar position. The R-15 radar controller was a developmental controller 10/ undergoing a certification check on the R-15 sector, which was being administered by a full performance level (FPL) 11/controller. The controllers assumed their duties at the R-15 sector at 1045. The R-15 data position (D position), which is located to the right of and adjacent to the R-15 radar position, is a nonradar position. The D position was manned by an FPL controller. A first line supervisor controller was near the R-15 radar position.

According to the controllers, the radar scope had been set at the 60 nmi range, and at that setting, 1 inch on the scope equalled 5.45 nmi. With regard to displaying VFR transponder symbology at the time of the collision, the radar scope had been configured to display all VFR transponder symbol returns up to an altitude of 24,200 feet. The testimony of the controllers confirmed that these type of targets were displayed on the radar scope.

All four controllers said that the traffic at the time of the accident was "moderate."

R-15 Radar Developmental Controller.--At 1116, when Wings West Flight 628 initially called the Los Angeles ARTCC's R-15 radar sector, the developmental controller was sequencing two airplanes, Sonic Airlines Flight 766 and United Airlines Flight 1265 for landing at Santa Barbara. (Santa Barbara was portrayed at the bottom right quadrant of his radar scope.) Because Sonic 766, a slower airplane, was below and ahead of

10/ A qualified air traffic control specialist who is being trained for a new position or procedure for career development.
11/ A controller at an ARTCC who is qualified at all sectors in an area of specialization.

United 1265, the controller had to vector United 1265 around Sonic 766 while descending it below Sonic 766. He said that he "also had to keep an eye on the other airplanes to the east. I had one aircraft (going) in to Santa Maria (about 20 nmi southeast of San Luis Obispo) and a couple of other aircraft in there that I had to keep an eye. . . on."

The developmental controller cleared United 1265 and Sonic 766 from his frequency at 1116:23 and 1116:31, respectively, and at 1116:40, he acknowledged Flight 628's initial call. He testified that the sequencing problem caused a delay because "There was a lot of coordination to be done with my D controller and the Santa Barbara approach (control), and when that was all over with, I turned over the two aircraft." However, he also said that he had to continue to monitor United 1265 "because he was a little bit high in Santa Barbara. I had to watch to make sure he didn't have to be pointed out to Sector 14."

The developmental controller also testified that he did not immediately associate Flight 628's initial radio call with a San Luis Obispo departure and had, in fact, thought that it was another Wings West airplane, Flight 236, that had called. Therefore, at 1116:40, he called Flight 236 and told it to "go ahead." He scanned his entire radar scope and saw nothing that he could associate with the radio call. At 1116:46, Flight 628 called "with a request." The developmental controller again told the flight to "go ahead" and the flight answered" (Unintelligible) intersection, VFR, two point seven climbing, IFR to San Francisco." He then looked into his "active" traffic strip bay, saw Flight 628's flight plan, and realized that it was Flight 628 that had called earlier and that it was departing San Luis Obispo. (The flight plan strip had been placed in the "active" bay by the D controller.) At 1116:56, he assigned a discrete transponder code to the flight and tried to locate it on his radar scope. He said he saw a VFR transponder code 12/ just west of the San Luis Obispo County Airport [top left quadrant of the radar scope] and that he saw this return "right before I saw it turn to a six seven two one code (1117:10)." At 1117:16, he told Flight 628 that he had it "in radar contact," and requested the flight's altitude. At 1117:20, Flight 628 reported that "it was climbing through 3,100 feet." The developmental controller testified that there were no other VFR targets on his scope in the near vicinity of Flight 628 when he reported that he had it in radar contact.

The developmental controller further testified that after he had observed the discrete transponder code he had looked at Flight 628's flight plan before giving it an IFR clearance. He said that he had looked around the radar scope while he was reading the clearance (1117:23) to see where any possible traffic might be. However, since a northwest bound IFR airplane was at 8,000 feet about 10 nmi south of San Luis Obispo, he assigned an altitude limitation of 7,000 feet to Flight 628. He said that while there were "quite a few [VFR targets] down in the Santa Barbara, Santa Maria area," the nearest VFR traffic he saw was "at least 20 miles" from Flight 628.

At 1117:32, Flight 628 began reading back its clearance. Thereafter, the developmental controller spoke to two other airplanes. At 1118:40, he tried to contact

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12/ A VFR transponder code would be portrayed on the Los Angeles ARTCC's radar scope by the symbol "V." If the VFR airplane had an encoding altimeter (Mode C equipment), its altitude would be displayed next to the "V"; i.e. an altitude of 3,400 feet would be displayed as "034." When Flight 628 changed to its assigned discrete transponder code, the VFR symbology would have been replaced initially by a slash and a partial data block containing the assigned discrete code and the flight's altitude readout until the computer correlated the assigned discrete code with the airplane's target. Upon completion of the correlation--two sweeps of the radar antenna--the target symbology would change from a slash to an asterisk accompanied by a full data block containing the flight's call sign, altitude, and groundspeed.

Flight 628 to inform it that the center was no longer receiving its transponder code. Flight 628 did not answer the radio call and it did not answer any of the subsequent radio calls.

The developmental controller testified that he had not configured the radar scope so as to inhibit the display of the VFR transponder symbol. He stated that he did not see the radar return of the Rockwell Commander, N112SM and that "I know that if it had been there, I sure would have called it to the Wings West aircraft because it definitely was traffic from the indications. I cannot understand why it would not have been on my scope."

FPL Controller at the D Position.--The D controller testified that he was monitoring the radio transmissions at the time of the collision. He said that he could see the R-15 radar scope from his position, but that he was not monitoring the screen at that time because he was involved with administrative and coordination tasks required by the D position. His duties consisted of making computer inputs, updating flight plans, and coordinating traffic between sectors. He said that there was no requirement that a D controller monitor the radar scope.

The D controller also testified that he heard Flight 628's initial call and that he had then taken Flight 628's flight plan strip from the "proposal" bay, put it in the "active" bay, and entered a departure message into the ATC computer. At 1116:18, he received a call on the interphone line from Santa Barbara approach control which required him to "go and talk to Santa Barbara approach." The ATC transcript showed that this conversation began at 1116:18 and that the last transmission occurred at 1116:49.

FPL Controller.--The FPL controller administering the certification check to the developmental controller testified that he was standing directly behind the developmental controller and was plugged in at the radar so he could, if required, override the developmental controller's radio transmission to the aircraft under his control. He had an unobstructed view of the radar scope. He said that he saw Flight 628's radar return, saw it change from VFR symbology to the correct discrete symbology, and thereafter, he checked the flight plan strip in the "active" bay to verify that Flight 628's clearance had been issued correctly. He said that he saw an IFR beacon return about 10 nmi south of San Luis Obispo, however, he did not see any VFR targets to the northwest of Flight 628. He said that there also were some VFR targets about 20 nmi away "in the Santa Maria, Santa Barbara area."

The FPL controller stated that he did not observe the Flight 628 target at the moment it entered coast status. 13/ Since the Los Angeles ARTCC's recorded NTAP radar data showed that the last transponder beacon signal from Flight 628 was received at 1117:33, the earliest the coast status symbol could have been displayed was 1118:09; however, the loss of the beacon code was not noticed and reacted to until 1118:40. The FPL controller testified that he did not notice the loss of Flight 628's beacon target earlier because "other parts of the sector had aircraft in [it] and [that] required attention also. That apparently was the time when [my] attention was [directed back to] the San Luis Obispo area."

First Line Supervisor Controller.--The Los Angeles ARTCC area supervisor plugged into the R-15 sector about 1115 to evaluate the developmental controller's performance.

13/ When a beacon target is lost or becomes too weak to correlate for three sweeps of the radar antenna (36 seconds), the track is placed in a coast status. The letters "CST" are displayed in place of the Mode C derived altitude in the data block.

The supervisor testified that he had anticipated sequencing problems developing in the Santa Barbara area and that he wanted to evaluate how the developmental controller dealt with them. He testified that he was qualified on three other of the center's radar sectors, but that he was not qualified on the R-15 sector. However, based on his experience, he was qualified to evaluate the procedures and techniques used by the developmental controller to control traffic. He said that he could see the R-15 radar scope but that he did not have any radio override capability.

The supervisor testified that he heard Flight 628's initial call but that he did not believe that "he was looking at the scope. . .I could have been jotting down some notes, because I did have some comments that I wanted to make to help [the developmental controller] out on the sequencing situation we had into Santa Barbara at that time." He said that he did not look at the radar scope while the developmental controller was talking to Flight 628, and that the first time he noticed the track "it had already gone into coast."

1.17.3 ATC Procedures

The prescribed ATC procedures and phraseology for use by personnel providing air traffic control services are contained in FAA Order 7110.65C, "Air Traffic Control." The Order does not contain any provisions which require controllers to provide separation between VFR and IFR traffic; however, paragraph 22 states, "Give priority to separating [IFR] aircraft as required in this handbook. Good judgment shall be used in prioritizing all other provisions of this handbook based on the requirements of the situation at hand."

Air traffic controllers issue two different type of traffic advisories to alert pilots of other known or observed air traffic in their vicinity that in the judgment of the controller, warrants the pilot's attention. The most commonly used advisory is the basic "traffic advisory," described in Paragraph 46, Section 3, "Additional Services," of FAA Order 7210.65C. This advisory may be based on visual observation, observation of radar identified and non-identified aircraft target, or verbal reports from pilots or other facilities. The word "traffic" is used to provide the advisory followed by azimuth from the aircraft by reference to the 12-hour clock, distance from aircraft in miles, the direction the traffic is proceeding, and the type of aircraft and altitude, if known. Traffic advisories will be provided, as possible, depending on higher priority duties of the controller or other limitations, such as controller workload, radar limitations, traffic volume and radio frequency congestion. Traffic advisories do not relieve pilots of their responsibility to see-and-avoid other traffic. Pilots are cautioned that the controller is not always able to give traffic advisories for all traffic in the aircraft's proximity.

The second and more urgent advisory is called a "safety advisory." Safety advisories are issued by controllers to aircraft under their control, when in the controller's judgment the aircraft is at an altitude which is in unsafe proximity to terrain, obstructions, or other aircraft. In the case of proximity to another aircraft, "traffic alert" is used to provide this advisory service followed by an alternate course of action to the pilots, such as a turn or climb/descent. Paragraph 33 of FAA Order 7110.65C states, in part, "The issuance of a safety advisory is a first priority once the controller observes and recognizes a situation of unsafe proximity to terrain, obstacles, or other aircraft. Conditions, such as workload, traffic volume, the quality/limitations of the radar system, and the available lead time to react are factors in determining whether it is reasonable for the controller to observe and recognize such situations. While a controller cannot see immediately the development of every situation where a safety advisory must be issued, the controller must remain constantly alert for such situations and issue a safety advisory when the situation is recognized." Note 2 of paragraph 33 states, in part, that recognition

of situations of unsafe proximity may result from the operation of the computer's automatic alerting systems, "automatic altitude readout, observations on a (radar) scope, and pilot reports." Paragraph 33b, Aircraft Conflict Advisory, states, in part, "immediately issue/initiate an advisory to an aircraft if you are aware of another aircraft at an altitude which you believe places them in unsafe proximity. If feasible, offer the pilot an alternate course of action."

The 11-minute transcript of the R-15 activities showed that the R-15 radar controller issued two aircraft traffic advisories. In both cases, the traffic was directly ahead of the airplanes at 2 and 3 miles, respectively; in one case, the pilot acknowledged visual contact with the other aircraft. No "safety advisories" were issued during that time period.

On July 25, 1984, the Procedures Division, Air Traffic Services, issued General Notice (GENOT) RWA 4/127 concerning the issuance of traffic advisories. The GENOT recommended that in instances when traffic increases to a point where not all VFR traffic can be assessed by the controller, "the area of concentration on VFR traffic should be reduced to Mode C traffic in the immediate vicinity of IFR targets. This concentration might improve our ability to issue critical safety advisories as defined in Agency Order 7110.65C paragraph 33b even though IFR workload precludes issuance of all traffic advisories." The GENOT also recommended that when the saturation point is reached, periodic broadcasts should be made advising all pilots that some traffic advisories "may not be issued due to workload."

On August 13, 1984, GENOT 4/139 was issued, superseding GENOT RWA 4/127. Essentially, GENOT 4/139 stated that the provisions of FAA Order 7110.65C, and in particular the contents of paragraph 33b were not to be modified. GENOT 4/139 required that all personnel be briefed immediately on its contents. However, due to a breakdown in administrative procedures, many of the controllers at the Los Angeles ARTCC had not been briefed on GENOT 4/139 at the time of the accident. The developmental controller testified that he was not aware of either GENOT at the time of the accident. He also testified that only one thing would have changed how he controlled Flight 628. He said that, "it might have been different if I had seen. . . the Rockwell (N112SM)."

Whenever a controller either assumes or is relieved from an air traffic control position within a facility, he must personally sign in or out on the applicable position log (FAA Form 7230-10). He also must enter on the Form 7230-10 the time he either assumed or was relieved from duty at the applicable position. Examination of the applicable Los Angeles ARTCC Form 7230-10s showed that neither the developmental controller nor the FPL controller supervising the developmental controller's check had signed the Form 7230-10 properly. The testimony at the public hearing also indicated that a practice had developed within the center whereby the oncoming controller was signed in by the controller he had relieved at the time the relieved controller signed out on the Form 7230-10. Irrespective of the failure to properly accomplish the sign-in procedures, the evidence also showed that the R-15 radar position was manned properly throughout the accident sequence.

With regard to the administrative procedures involved in the handling of the two GENOTs and the Form 7230-10's, the manager of the Los Angeles ARTCC testified that these procedures were reviewed after the accident and that corrective measures had been taken to insure that the Form 7230-10's were completed properly and that the administrative breakdown involved in the failure to brief personnel in the applicable GENOTs would not recur.

Because of the difficulty of contacting ATC centers at some uncontrolled airports, the practice of taking off in VFR conditions and requesting an IFR clearance after takeoff is not uncommon. However, because a remote radio transmitter/receiver was located near the airport, this difficulty did not exist at San Luis Obispo County Airport. With regard to San Luis Obispo, the R-15 radar controller, the FPL controller, and the Los Angeles ARTCC area supervisor agreed that pre-takeoff requests for IFR clearances would ease their workload. The FPL controller testified that this would allow him to assign a discrete beacon code to the flight before takeoff and make it easier to identify when it departed.

1.17.4 Wings West Airlines Procedures

The following Wings West Airlines procedures are relevant to Flight 628's departure from San Luis Obispo County Airport.

There were two radios on the airplane. Flightcrews are required to always tune one radio to and remained tuned to the company frequency. The other radio must be tuned to the UNICOM frequency during engine start, taxi, and takeoff. The flightcrew must use the UNICOM frequency to notify all airplanes on the frequency of the pending takeoff, the direction of takeoff and takeoff runway, and departure heading. These radio calls were broadcast in the "blind."14/

The airplane's navigation lights, strobe lights, two rotating beacons, and landing lights are required to be turned on for takeoff. The landing lights are required to be turned off after the airplane reached 5,000 feet.

After takeoff, the flying pilot calls for landing gear retraction; the non-flying pilot retracts the landing gear and checks the gear indication lights. Thereafter, at the request of the flying pilot, he sets climb power and completes the After Takeoff Checklist. Wings West pilots testified that the checklist was usually started about 500 to 1,000 feet above the ground (AGL) and was completed by about 2,000 feet AGL. Since these duties require the non-flying pilot's attention to be directed inside the cockpit, the flying pilot is responsible for scanning for traffic. The Wings West Chief Pilot testified that the flying pilot decreases the airplane's pitch attitude after takeoff to establish about a 750 fpm rate of climb; the resultant airplane pitch attitude is about 6° to 7° nose-up and this is maintained until the airplane reaches cruise altitude.

According to Wings West pilots, they monitor the UNICOM frequency during and after takeoff until they are required to contact ATC. At that time, the non-flying pilot will switch the radio tuned to the UNICOM frequency to the ARTCC frequency and will get the flight's IFR clearance. This generally occurs in the vicinity of the Dobra marker, about 6 nmi west of the airport. (See appendix D.)

The Chief Pilot testified that the company does not have a formal training program teaching visual scanning techniques. He further testified that the company expected new-hire pilots to have already received this type of training. However, the company's Director of Training stated, "it is stressed over and over again to keep the head out of the cockpit." The Director of Training also stated the see-and-avoid principle is a key subject during training.

1.17.5 Training Given by the Rockwell Commander's Instructor Pilot

A former student pilot who had received instruction from the instructor pilot aboard N112SM described the procedures used by the instructor pilot at San Luis Obispo

14/ A radio call directed to no one in particular. It does not require a response and the originator does not expect a response.

County Airport. The student pilot testified that the instructor pilot wore eyeglasses but that he was not sure if they were prescriptive lenses.

He stated the instructor pilot always was concerned about maintaining a constant scan outside the airplane for other traffic. He said that the instructor pilot always used the airplane's strobe lights and rotating beacons; however, he did not recall using the landing lights while in the vicinity of the airport.

The student pilot said that N112SM had two radios and that they used one to monitor the UNICOM before they arrived at Crepe Intersection. With regard to instrument training flights, the student pilot testified that they would fly direct to Crepe at 4,500 feet, turn inbound, and call in the "blind" on the UNICOM that they were over Crepe, inbound, and state their heading. He also said that they would, "not always, but on occasion, indicate [on] the UNICOM that we were approaching Dobra and also Hasby."

About 1115, on the morning of the accident, the UNICOM operator at the airport recalled hearing an airplane (call sign unknown) report "Inbound, approaching Dobra." The student pilot also said that on instrument training flights they would generally contact Los Angeles ARTCC on the second aircraft radio and request the Localizer RWY 11 approach. However, there was no evidence on the ATC transcript of such a request on the day of the accident.

The student pilot also testified that "VFR training flights were different." He testified that after departing Paso Robles, they would turn to a heading of about 180°, climb to 3,500 feet, and "fly over what is known in the area as Questa Grade" (Questa Pass about 10 nmi north of San Luis Obispo County Airport). According to the student, after crossing Questa Grade, they would descend to traffic pattern altitude, enter the pattern, and land.

The student pilot testified that on VFR flights they would proceed direct to the airport from Paso Robles at 3,500 feet and would call on the UNICOM while inbound. Thereafter, they would continue to monitor the UNICOM, making several calls apprising the UNICOM of their position relative to the airport.

The student pilot did not recall using an instrument training hood on the instrument training flights. He said that the instructor pilot preferred to have his students use "foggles" (training goggles which preclude the trainee pilot from looking outside the airplane) for instrument training because they did not obstruct his vision outside the airplane. (Neither an instrument training hood nor "foggles" were found at the accident site.)

1.17.6 Radar Ground Track Plot and Visibility Studies

The NTAP data showed that both airplanes were recorded as beacon targets with Mode C altitude information being received by the Los Angeles ARTCC's radar.

The NTAP data for Flight 628 were identified as beacon codes 1200 and 6721 covering a 1 minute 11 second period from 1116:22 to 1117:33. Seven radar returns were received during this period; the first four were code 1200 returns which were received at 1116:22, 1116:34, 1116:46, and 1116:58; the last three were code 6721 returns which were received at 1117:10, 1117:21, and 1117:33. The 1117:10 and the 1117:21 returns were uncorrelated target symbols accompanied by a limited data block; the 1117:33 return was a correlated target symbol accompanied by a full data block.

N112SM's radar returns were recorded continuously for 7 minutes 21 seconds starting at 1110:12 and ending at 1117:33. N112SM's radar returns were identified by correlating them to the track of Flight 628 and the collision point. In addition, the radar data showed that N112SM passed abeam Crepe Intersection and was within 10 nmi of the San Luis Obispo County Airport about 1115:32 and 1117, respectively.

The radar coordinate plot showed that the last returns for each airplane deviated from their established paths and moved away from each other. The plot was inconsistent with the physical evidence showing that the airplanes had collided because of the "beam splitting" process used by the NAS Stage A radar processing equipment to resolve the azimuth of two targets in close proximity. Therefore, the tracks of both airplanes were adjusted to compensate for the deviations produced by the resolution process. The airplanes' tracks were further adjusted to compensate for transponder induced range errors. The resultant radar ground track plot produced a collision point altitude and time of 3,400 feet and 1117:38, respectively. (See appendix E.)

The radar ground track plot indicated that N112SM was either executing or had executed a slight right turn toward the localizer course at or just before the collision. However, there was no indication that either pilot performed any type of evasive maneuver. About 1 minute 16 seconds before colliding (1116:22), the airplanes were 6.8 nmi apart, and, thereafter, they closed on each other on a virtually head-on course at about 544 fps (322 kn). Given the R-15 radar scope's distance scale of 1 inch equals 5.45 nmi, the two radar targets would have been about 1.24 inches apart at 1116:22. By 1116:40 and 1117:36, the two radar targets would have closed to about 0.97 inch and 0.4 inch, respectively, on the radar scope.

A visibility study was conducted to determine the physical limitations to visibility from the seats of the flightcrews of the respective airplanes. To accomplish this, the time histories of both airplanes' flightpaths and altitudes contained in the radar ground track plot were combined with binocular photographs of the respective cockpits. 15/ The viewing angles for each airplane were then calculated and plotted in relation to the design eye reference (DER) points for each airplanes windshields. (See appendix F.) The visibility study showed that, during the last 20 seconds before impact, Flight 628's target was positioned slightly below and to the right of the DER points on both windshields of N112SM and that they remained almost stationary in that position through the final 20 seconds. During this same period, N112SM's target was positioned almost on the DER points on the windshields of the pilots of Flight 628 and remained almost stationary through the 20-second period.

Physiological and Psychological Studies.--Many physical, physiological, and psychological parameters serve as constraints on achieving and maintaining the vigilances demanded by the "see-and-avoid" mandate to pilots and the air traffic controllers radar detection task. These limitations include: target characteristics, such as size, color, duration and clutter in the case of controllers; task variables, such as workload and time at task; observer characteristics, such as age and fatigue; and environmental parameters, such as weather, clouds, and glare.

Research data indicate that the human eye (20-20 vision as measured by the Snellen eye chart) is capable of identifying letters of the alphabet if these letters subtend a visual angle 16/ of at least 0.08 degree or 5 minutes of arc. Letters are considered

15/ Photographs taken by a camera which uses two lenses. The spacing between the lenses is equal to the average distance between the human eyes.

16/ An angle subtended at the eye by the viewed object. Visual angle is a function of both the size of the object measured perpendicular to the line of sight and the distance of the object from the eye. The angle is directly proportional to the size of the object and inversly proportional to the distance of the object.

highly discriminable whereas target identification can be quite complex. Research shows that, as a minimum, targets should subtend 0.2° (12 minutes) of arc to insure reasonably accurate recognition. In lessened conditions or for difficult target patterns, the minimum size for recognition should be increased by factors of two or three which would be equivalent to 0.4° or 0.6° of arc, respectively. 17/

Reaction time after visual acquisition of a target is also a factor in avoiding a collision. FAA Advisory Circular (AC) 90-48C provides military-derived data on the time necessary for a pilot to recognize a potential mid-air target and execute an evasive maneuver. (See table I.)

Table I.--Reaction time (seconds).

	Specific	Cumulative
See Object	0.1	0.1
Recognize Airplane	1.0	1.1
Perceive Collision Course	5.0	6.1
Decision to Turn Left or Right	4.0	10.1
Muscular Reaction	0.4	10.5
Airplane Lag Time	2.0	12.5
Total		12.5

Finally, there is the concept known as "diffusion of responsibility" which describes a tendency on the part of pilots in some circumstances to relax pilot vigilance. A National Aeronautics and Space Administration (NASA) study on near midair collisions indicates that a subconscious idea of "shared responsibility" may occur when an airplane is under ATC radar control. That is, the pilot relegates a portion of his vigilance responsibility for "seeing and avoiding" to the controller under circumstances. The study states, in part, "If ASRS [Air Safety Reporting System] reports are representative, many pilots under radar control believe that they will be advised of traffic that represents a potential conflict and behave accordingly. They tend to relax their visual scan for other aircraft until warned of its presence."18/

Studies and research indicate that physical limitations do not constitute a major deterrent to sighting targets on a radar scope; however, the studies do indicate that physiological and psychological factors can influence target acquisition on the radar scope. Perception, stress, and motivational research studies indicate that there is a relationship between workload and operator performance. With an increase in workload, there is an initial increase in performance due to some extent because irrelevant task cues are not being attended to. With further increases in workload, optimum and even maximum performance may be attained. At some point, workload can increase so that it physiologically or psychologically overloads the operator, relevant cues are not being attended to or are disregarded, and task performance deteriorates. This results in a tunneling or a narrowing of operator perception or attention. It has been repeatedly demonstrated that primary or "priority" tasks will be maintained or focused on during increased workload, and performance on secondary tasks will deteriorate. This narrowing

17/ "Human Engineering Guide to Equipment Design," Van Cott, H, and Kinkade R. Revised Edition. American Institute for Research, Washington, D.C., 1972.
18/ Billings, C., Grayson, R., Hecht, W., and Curry, R., "A Study of Near Midair Collisions in M.S. Terminal Airspace," NASA Technical Memorandum 81225, 1980.

of the attentional field has been found to occur with many other factors, including time at task, alcohol, and noise. 19/

The testimony of the ATC controllers indicates that neither the FAA's ATC Academy nor the facility training curricula provided formal training on monitoring techniques to optimize radar scope target detection. In addition, both Academy and facility training for ATC controllers emphasizes that their primary responsibility is to separate IFR traffic. The R-15 developmental controller stated that he had been "written up" for providing advisory services to VFR traffic during period of high traffic concentration and thus increasing his workload to the detriment of his primary responsibility of separating IFR traffic.

1.17.7 Airborne Collision System

The Safety Board repeatedly has recommended that the FAA support the development and implementation of an airborne collision avoidance system for all civil aircraft in order to provide a practical and effective backup for other aircraft separation assurance programs and to reduce the potential of midair collisions. Collision avoidance systems are intended to warn pilots about potential collision threats and, in some systems, provide resolution advisories for both horizontal and vertical maneuvers.

In June 1981, the Administrator of the FAA announced a national standard for airborne collision avoidance systems. Equipment known as Traffic Alert and Collision Avoidance System (TCAS) was forecast to be available for use on a voluntary basis within 3 or 4 years.

Although the TCAS program has moved forward, it has not reached a state where certification for use and general implementation is imminent. The Phase I operational evaluation was completed in March 1982. This evaluation involved the installation of prototype equipment in two Boeing B-727 aircraft that operated in regularly scheduled passenger service. During the Phase I evaluation, flightcrews were not provided with collision threat advisories and, hence, were unaware of the system-recommended collision avoidance maneuvers. However, cockpit observers and data recorders were used to document system performance.

Although the Phase II evaluation was originally scheduled to begin in June 1985, it has not been initiated at this writing. This evaluation will involve a Piedmont Air Lines B-727 which will be operating in regularly scheduled passenger service and is scheduled to continue for 8 months. During this evaluation, flightcrews will be allowed to respond to collision avoidance advisories provided by the onboard TCAS equipment and cockpit observers will record information concerning the advisories presented and the crew's reaction to them. The delay in the Phase II evaluation is attributed to the certification process required to approve the installation of TCAS equipment in the Piedmont B-727 for use in scheduled passengers service.

The FAA presently forecasts that a TCAS system will be available for operational use in the second quarter of calendar year 1988; however, the FAA has indicated that there are no current plans to mandate the use of TCAS when it become available. Nevertheless, the design concept of the TCAS is such that operators who equip their airplane with a TCAS will receive collision threat information and protection against intruder aircraft which are equipped with altitude reporting transponders. Thus, air carrier aircraft, for example, would enhance their level of collision protection significantly since much of their operation is in areas in which operating transponders are required.

19/ Duffy E. The Psychological Significance of the Concept of "Arousal" or "Activation." "Psychological Review," 1957.

2. ANALYSIS

2.1 General

Both airplanes were maintained in accordance with prescribed Federal Aviation Regulations and, with regard to Wings West, prescribed company maintenance procedures.

The flightcrews of both airplanes were qualified for the flights. While it might be argued that the Wings West first officer was not certificated properly due to the "certerline thrust only" limitation on his airman's certificate, this limitation could have been removed based either on his military competency or on his demonstration of competency during his Beech C-99 qualification. The Safety Board concludes that the presence of the restriction was a technical oversight rather than evidence of a lack of qualification in the airplane.

The four controllers at the R-15 radar scope were qualified in accordance with existing Federal Aviation Regulations to perform their assigned tasks.

2.2 The Accident

The fuselage and engine of the Rockwell Commander cut off the Beech C-99's cockpit roof and fuselage crown. Based on the paint marks found on the airplanes' wreckage, the angle of the propeller slash in the bottom of the Rockwell Commander's right wing, the Beech C-99 cabin insulation material on the Rockwell Commander's propeller blades, and the fact that the cuts on the right side of the fuselage structure of the Beech C-99 were higher than those on the left, the Safety Board concludes that although the collision was virtually head-on, the Rockwell was in a slight descending right turn at impact. The damage noted on the two airplanes is consistent with the radar ground track plot, which indicated that the Rockwell Commander had turned slightly to the right at or just before impact.

Since both airplanes were flying clear of clouds, neither pilot was relieved of his regulatory responsibility to "see and avoid" the other airplane. However, in this instance, because the airplanes was approaching each other head-on, each pilot was presented with a wingtip to wingtip view of the approaching plane and the rate of closure between the two airplane was such that the pilots may have been unable to see the other airplane in time to maneuver and to avoid it. At least, the possibility for either pilot to maneuver to avoid the collision was very marginal.

Using a wing tip to wing tip view and the data contained in the visibility study, the Safety Board analyzed the visual angles available to each pilot and the time to collision for each visual angle. With regard to the pilots of the Beech C-99, at 17 seconds before the collision (1117:21), the Rockwell subtended a 0.2° arc; at 8 seconds before the collison, the subtended arc would have increased to 0.43°, and to 0.58° at 6 seconds before the collision. With regard to the pilots of the Rockwell, at 23 seconds before the collision (1117:15), the Beech would have subtended an arc of 0.2°; at 12 seconds before the collision, the subtended arc would have increased to 0.4°; and to 0.6° at 8 seconds before the collision.

From these figures, it can be determined that the pilots of the Rockwell had more time (6 seconds) to see and avoid the Beech C-99. Under ideal conditions, theoretically they first would have been able to detect the Beech about 23 seconds before the collision and, based on the values in table I, would have had time to sight the Beech

C-99 and to avoid it. However, conditions were less than ideal because both airplanes were painted white with either green or orange trim and the predominantly white coloration would have washed out any color contrast in the existing bright daytime conditions. In addition, the head-on closure would have resulted in little or no relative movement by either airplane across the windshields of the other airplane and would have reduced further the ability of the pilots to see the other airplane at the precise moment the sighting angle subtended the minimum 0.2 degree of arc required for visual detection. With regard to sighting the Beech C-99, when the visual angles increased by factors of two and three so as to be more readily recognizable (based on the cited research), the pilots of the Rockwell would have detected the Beech C-99 about 12 and 8 seconds before the collision, respectively. In the first case, a successful evasive maneuver would have been marginally possible; in the second case, the collision would have been unavoidable.

Had the pilots of the Beech C-99 been able to sight the Rockwell Commander at the precise moment its visual angle subtended the minimum 0.2 degree of arc, they would have had 17 seconds to avoid colliding with it. Based on the values in table I, there was time available to execute an evasive maneuver. However, since less than ideal sighting conditions existed, the Board believes that it would have been highly unlikely that they could have sighted the Rockwell precisely at 17 seconds before the collision. In addition, the visual angle of 0.4 was not reached until the airplane was within 12 seconds of colliding with the Rockwell Commander--less than the 12.5 seconds required to detect and evade as shown in table I. Given these data, the Safety Board concludes that the conditions on the day of the accident were such that it may have been impossible for the pilots of each airplane to see and avoid the other or, at best, the possibility of their doing so was marginal.

2.3 ATC Operations

The Safety Board then sought to determine whether the performance of the ATC controllers, or the ATC system itself, either caused or contributed to the accident. The radar ground track plot showed that the accident occurred at 1117:38 and that Flight 628's radar return (initially as a 1200 code) was not displayed until 1116:22. The evidence showed that the developmental controller initially communicated with Flight 628 at 1116:40. At 1116:56, he assigned a discrete transponder code to the flight, and, at 1117:16, 22 seconds before the collision, he told Flight 628 that he had it "in radar contact." Thereafter, he read the flight's IFR clearance to it and listened to the readback. At 1116:22, the airplanes were about 6.9 nmi apart and the Rockwell was almost directly in front of Flight 628. Between 1116:22 and the collision, the airplanes closed on each other at about 544 fps and, except for the Rockwell Commander's slight right turn, their headings remained the same.

The proximity of the Rockwell Commander to Flight 628 during this period was such that the developmental controller, had he perceived the developing conflict, should have issued a traffic or aircraft conflict advisory to Flight 628. In fact, the developmental controller testified that he would have issued a "safety advisory" if he had seen the Rockwell Commander's radar return; however, he said that he had not seen the return, that it had not been portrayed on his scope, and that he did not know the reason it was not portrayed. Since none of the controllers at the R-15 radar scope testified that they had seen the Rockwell Commander radar beacon return on his scope, the Safety Board sought to determine whether it had been displayed, and if it had been displayed, why it was not seen so that a traffic or aircraft conflict advisory could have been issued in time to prevent the accident.

The NTAP data reduction showed that processed radar data containing the Rockwell's and other airplane's VFR transponder symbols were provided from the CCC to

the CDC. The testimony and evidence showed that, at the time of the accident, VFR transponder symbol returns were being displayed on the R-15 scope and that the display controls and display filter key at the R-15 scope were not positioned to inhibit the display of any VFR 1200 transponder code returns. Since the manager of the FAA En Route Automation Program had testified that, under these conditions, there was no functional reason why the Rockwell Commander's radar return, or any other VFR transponder return, should not have been displayed on the R-15 radar scope, the Safety Board concludes that the Rockwell radar return had been displayed and that the reason the controllers did not observe it cannot be attributed to any failure or malfunction of the NAS Stage A's computers or associated equipment.

The ATC transcript showed that, other then the departure of Flight 628, there was only one IFR aircraft in the San Luis Obispo area of concern to the developmental controller. Most of the traffic on the R-15 sector was concentrated in its southern part and in the Santa Barbara area. At 1116, when Flight 628 initially called, the developmental controller was in the process of sequencing two aircraft operating in close proximity to each other for handoff to the Santa Barbara approach control, and he did not complete the transfer of communications control of the last airplane in the arrival sequence to Santa Barbara approach control until 1116:31. At 1116:40, the developmental controller answered Flight 628's initial call. Since the arrival sequence had involved two IFR air carrier airplanes and coordinating the handoff of these two airplanes to another ATC facility, the Safety Board believes that the developmental controller's decision to delay answering Flight 628's initial call until he completed the handoff was a proper exercise of his discretionary authority. While the developmental controller used an incorrect call sign in his initial response to Flight 628, this error was corrected almost immediately and played no part in the accident sequence.

FAA Order 7110.65C requires controllers to "give first priority to separating aircraft and issuing safety advisories as required in this handbook." However, the evidence showed that the training provided to the controllers also emphasized that their primary responsibility is to separate IFR traffic and that the developmental controller had been "admonished" earlier for providing advisory services to VFR airplanes during conditions of increased workloads. Since there was only one other IFR airplane near San Luis Obispo, there was no reason for the developmental controller to direct continuous attention to that area of his radar scope until Flight 628 called. Although the developmental controller had handled Flight 628 on its arrival at San Luis Obispo, he did not know when, or if, it would depart San Luis Obispo, and he was not required to be aware of this information. Thus, when Flight 628 called to request its IFR clearance, the developmental controller was faced with the routine tasks of locating the flight, identifying it, providing it with its clearance, and either separating it from other IFR traffic, or providing a traffic or aircraft conflict advisory, as appropriate.

The accident circumstances showed that the developmental controller probably detected Flight 628's VFR transponder symbol just before Flight 628's VFR symbology changed to an uncorrelated discrete transponder symbol. Flight 628's first uncorrelated discrete transponder symbol was received at 1117:10, and, at 1117:16, 22 seconds before the collision, the developmental controller told the flight that it was "in radar contact" and to report its altitude in order to verify the altitude portrayed in the flight's limited data block. At 1117:23, 3 seconds after the flight reported its altitude and 15 seconds before the collision, the developmental controller issued the flight its IFR clearance. He said that he looked around his radar scope while he was reading the clearance and, except for the IFR airplane which prompted him to change Flight 628's assigned level off altitude to 7,000 feet, he saw no other radar targets near Flight 628. Flight 628 began its clearance readback at 1117:32, and, at 1117:33, 5 seconds before the collision, Flight 628's full data block was showing on the radar.

The facts and circumstances showed that, from the time the developmental controller began to concentrate on Flight 628, his attention was focused primarily on the mechanical tasks involved in entering the airplane into the IFR traffic structure. These tasks included reading from the flight strip, making pencil notations on the strip, scanning the radar display, and coordinating as necessary with his assistant ("D" side). In addition, there was evidence indicating that in the little time, if any, the controller took during this period to scan his radar scope for other traffic, his attention during this search, as a result of his training, may have been "tunneled" or focused on detecting IFR traffic. The conclusion that he was aware of IFR traffic is substantiated by his action to change Flight 628's en route altitude, based on an IFR radar return located south of San Luis Obispo (10 nmi behind Flight 628). Nevertheless, he did not observe the Rockwell Commander's VFR radar return 5 nmi ahead of and closing on Flight 628. In addition, the developmental controller was concerned that he might have to provide a radar point-out to Sector 14 due to a potential violation of the sector's airspace by United Flight 1265. This concern might also have focused his attention away from the area surrounding Flight 628. This focusing or "tunneling" of mental and visual attention could be one reason the developmental controller did not detect the Rockwell Commander's radar return, even though it was displayed on the radar scope within 1 inch of Flight 628's radar return. The Safety Board believes that this explanation is far more plausible than the possibility that the developmental controller disregarded the Rockwell Commander's VFR radar beacon return because of a priority sequence presented to him in his earlier training.

At 1116:40, when the developmental controller was able to turn his attention to Flight 628, the airplanes were within 1 minute of colliding. However, in order to determine which traffic, if any, posed a threat to Flight 628, the developmental controller had to locate Flight 628 on his radar scope and establish its heading and altitude. Assuming the developmental controller had sighted the Rockwell Commander at 1117:10, he would have had about 28 seconds before the collision to evaluate the relative positions of the two airplanes, perceive the impending collision, and thereafter deliver a timely airplane conflict advisory to Flight 628 describing the Rockwell's Commander's position and distance from Flight 628. The time interval within which the developmental controller's perceptions, decisions, and actions had to be made and performed was extremely small. In addition, the issuance of a traffic or aircraft conflict advisory at this point in time would not have assured that the pilots of Flight 628 would either have detected the Rockwell Commander or, given its dimensions, that they would have detected it in sufficient time to avoid the collision. However, the Safety Board cannot rule out the possibility that the issuance of either a traffic or aircraft conflict advisory would have led to increased efforts by the flightcrew of Flight 628 to detect and avoid a threatening target. The fact that an advisory was not sent deprived the flightcrew of Flight 628 of any of the benefits which might have accrued from a higher level of vigilance, however small they might have been due to the time constraint, and therefore, the Safety Board concludes it was a contributory factor to the accident. The Safety Board further concludes that the inability of the controller to detect the conflict and thus to provide a traffic or aircraft airplane conflict advisory was due to the limited time available to him to detect and to assess the collision threat, as well as the aforementioned "tunneling" or focusing of attention.

The R-15 D controller did not see the Rockwell Commander's radar return because he was not looking at the radar scope at the time of the accident. His primary duty tasks were administrative in nature and involved coordination tasks connected with flight plans arrivals, departures, and handoffs to other sectors. There was no requirement for him to monitor the radar scope presentation, and he was not doing so when the accident occur.

The FPL controller supervising the developmental controller's certification check testified that he did not observe any VFR transponder symbols near Flight 628 at

the time the flight's VFR transponder symbol was changing to a discrete transponder code symbol. However, his testimony indicated that his attention also was diverted to another area of the radar scope shortly after the changeover had occurred. After assuring himself that Flight 628's uncorrelated beacon symbol was being received, and after monitoring the flight plan strip in the "active" bay to insure that the IFR clearance had been delivered correctly and receipt acknowledged properly, the FPL controller transferred his attention to other areas of the radar scope where other traffic was located. He did not observe Flight 628's radar return again until after the track had entered coast mode. The evidence indicates that the FPL controller was preoccupied with insuring that the radar symbology had changed, that the clearance was delivered and received properly, and then, with monitoring traffic located in another area of the radar scope. Given this narrowing or "tunneling" of attention, the FPL controller's scan of the radar scope apparently was so limited that he did not detect the Rockwell Commander's radar return and, therefore he was unable to detect or point out the presence of the target to the developmental controller.

The testimony of both the FPL controller and the ARTCC area supervisor indicated that the major traffic concentration was in the southern portion of the R-15 sector. The area supervisor said that he had heard Flight 628 call in; however, at the time of the call he was "jotting down some notes" to critique the developmental controller's performance during the Santa Barbara sequencing situation, and therefore he did not look at the radar scope. The evidence indicated that because of his concern with a higher density traffic area, he was not concerned with the developmental controller's acceptance of one IFR airplane into an area of low traffic volume. His attention was concentrated on the completed performance in the Santa Barbara area and he never observed Flight 628's radar track until after it entered coast mode.

The circumstances surrounding the July 25 and August 13, 1985, GENOT were examined by the Safety Board. The earlier GENOT attempted to limit the requirement for issuing safety advisories in situations involving traffic conflicts between IFR and VFR airplanes. Since the earlier GENOT, as worded, constituted a limitation on services required by paragraph 33b of FAA Order 7110.65C, the FAA, on August 13, issued a second GENOT which cancelled the earlier GENOT and restored full force to the requirements of paragraph 33b. However the developmental controller testified that he had not read either GENOT. Therefore, his handling of the traffic was not affected by them and he would have managed traffic in accordance with the provisions of FAA Order 7110.65C. In addition, the evidence indicates that the developmental controller did not issue a safety advisory because he did not see the Rockwell Commander's radar return and not because of any procedural or regulatory order of priority. Although the Safety Board was concerned with the breakdown in the administrative procedures within the Los Angeles center relating to the position logs (FAA Form 7230-10) and the processing of the two GENOTs, the Board also believes that these breakdowns did not contribute to the accident.

2.4 Flightcrew's Actions

The Safety Board also examined the evidence to determine whether the accident might have been avoided if the pilots of either or both airplanes had followed the recommended communication and traffic advisory practices described in the AIM. According to a pilot who had flown numerous times within the instructor pilot on VFR flights, the instructor pilot usually flew direct to the San Luis Obispo County Airport from Paso Robles and entered the airport traffic pattern from the north on a 180° heading. Since, in this case, the radar data showed that the Rockwell had approached the San Luis Obispo County Airport from the northwest and was virtually aligned with the localizer approach course as it neared the airport, the Safety Board concludes that the instructor

pilot was most probably conducting a practice instrument approach to the airport. In addition, since the Rockwell was the only airplane in the vicinity that was inbound to Dobra Intersection, the Safety Board concludes that the radio call on the UNICOM frequency, "Inbound approaching Dobra," was transmitted by the Rockwell Commander. In addition, given the terminology in the transmission, the Safety Board believes that it was made after the Rockwell had passed Dobra and was approaching the 10 nmi radius of San Luis Obispo County Airport. Since the Rockwell had passed abeam Dobra at 1115:32 and was within 10 nmi of the airport at 1117, the Safety Board concludes that the "Inbound approaching Dobra" transmission was most probably made between 1116 and 1117.

The pilot, who had flown numerous times with the instructor pilot aboard the Rockwell, also testified that the instructor pilot had almost always informed Los Angeles ARTCC of his intention to conduct practice instrument approaches. Such a practice would be in compliance with two recommended procedures described in the AIM. In this instance, there is no evidence the instructor pilot did. Had he done so, the developmental controller would have known of the presence of the Rockwell northwest of the airport before he began to handle Flight 628. In addition, he would have known that the Rockwell's pilot was flying toward the airport on the localizer course and directly at Flight 628. Under these circumstances, the Safety Board believes that the developmental controller not only could have issued either a traffic or aircraft conflict advisory to Flight 628 but, given his foreknowledge of the intended courses of the airplanes, he also might have availed himself of the option contained in FAA Order 7110.65C, paragraph 33b, and suggested in the advisory, as an alternate course of action, that Flight 628 alter course well to one side or the other of the localizer course. Had this occurred and been done, the accident probably would not have happened. Consequently, the failure of the Rockwell Commander pilot to advise the Los Angleles ARTCC, although not required to do so, was causal to the accident.

The accident also might have been avoided if the flightcrew of Flight 628 had complied with the traffic advisory procedures described in the AIM which recommended that pilots departing an uncontrolled airport monitor the airport's common traffic advisory frequency (the UNICOM at San Luis Obispo) until 10 miles from the airport "unless Federal Aviation Regulations or local procedures require otherwise." The AIM also recommends that pilots approaching an uncontrolled airport call on the common traffic advisory frequency and announce their position and intentions, a procedure with which the Rockwell pilot did comply.

The ATC transcript and the radar ground track plot showed that Flight 628 initially contacted the Los Angeles ARTCC at 1116 when it was only 5 nmi from the airport. Although two communication radios were installed on Flight 628, a Wings West operational procedure in effect at the time of the accident required that one radio be kept on the company frequency at all times. Thus, the flightcrew transferred the other radio from the UNICOM frequency to that of the Los Angeles ARTCC sometime before 1116 and no longer monitored the UNICOM. Therefore, Flight 628 most likely did not hear the communication, "Inbound approaching Dobra." (There was no evidence that the Rockwell pilot made additional transmissions about his intentions.) Had Flight 628 been monitoring the UNICOM, the flightcrew would have been aware of traffic ahead of them. In addition, they would have been able to talk to the Rockwell Commander, and both pilots might have made their respective positions and intentions known to each other and then taken appropriate evasive maneuver actions. (The UNICOM operator did not hear such communications.) Consequently, the failure of Flight 628's flightcrew to avail themselves of the protection contained in the recommended communication procedures described in the AIM was causal to the accident.

Because Flight 628 had announced on the UNICOM frequency that it "was departing runway two nine, straight out," the Safety Board also examined the possibility that the Rockwell pilots might have heard this broadcast. Given the takeoff performance duties of Flight 628's pilots, the Board believes that this transmisison was made either at, or before, the initiation of Flight 628's takeoff roll. The first known position of Flight 628 was the 1116:22 radar fix 5.3 nmi from the northeast end of runway 29. Assuming average groundspeeds of 165 knots, 140 knots, and 120 knots, the latest possible times that the departure transmission could have been made were 1114:26, 1114:06, and 1113:43, respectively. Since the Rockwell did not arrive abeam of Crepe Intersection until about 1115:39, the Safety Board believes that it was improbable that its pilots would have been monitoring the UNICOM frequency closely at the time Flight 628 transmitted its departure message. Therefore, the Safety Board concludes that the pilots of the Rockwell most likely did not hear Flight 628's departure transmission.

The collision occurred at a sufficient distance from the airport that neither flightcrew should have been preoccupied with prelanding or takeoff duties, although the possibility does exist that if the flightcrew of the Rockwell was, in fact, conducting a practice instrument approach, the student pilot might have been using a vision-limiting device, and the instructor pilot might have had his attention directed to the instrument panel momentarily to check the progress of the approach. Since the weather was clear, each flightcrew had the regulatory responsibility to see and avoid the other. The collision occurred because neither flightcrew detected the other airplane in sufficient time either to initiate or to execute an evasive maneuver to avoid the collision.

Although the analysis of the airplane's ground tracks and closure rates indicated that there may have been sufficient time for the pilots of each airplane to have detected the other airplane and begin an evasive maneuver, the time interval for detection and collision course recognition was small. Based on table I, the time between the decision to turn and airplane reaction is 6.5 seconds. If the pilots of each airplane had been able to sight the other airplane at the precise moment they were physiologically capable of seeing the airplane, the pilots of the Rockwell Commander and Flight 628 had about 16.5 and 10.5 seconds, respectively, to detect the other airplane and recognize that the airplanes were on a collision course. The Safety Board believes that it is not reasonable to expect that either pilot would have sighted the other airplane at the precise moment it crossed the eyes' physiological detection threshold. Given the physiological limitations of the human eye, the rapid rate of closure caused by the fact that the airplanes were closing each other head-on, the lack of relative motion of the airplanes to each other, and the fact that the predominantly white color of both airplanes would be difficult to detect on a bright sunny day, the Safety Board concludes that the failure of the flightcrews to detect the other plane in time most probably was caused by a combination of the prevailing physical circumstances described above and the physiological limitations of the human eye. The flightcrews' limited ability to see and avoid each other contributed to the cause of the accident which occurred in the "see-and-avoid" environment.

2.5 Prior Recommendations

On November 20, 1984, while the investigation still was in progress, the Safety Board directed three safety recommendations to the FAA aimed at correcting deficiencies identified at the San Luis Obispo County Airport. The first recommendation urged the FAA to :

> Issue an Air Carrier Operations Bulletin directing the Principal Operations Inspectors of Wings West and Imperial Airlines to require that the airlines amend their operating procedures so that their flights contact Los Angeles Center prior to departure from San Luis Obispo County Airport and obtain either an IFR clearance or a discrete transponder code if departing VFR. (Class I, Urgent Action) (A-84-125)

The FAA responded on January 28, 1985, that its "investigation into the use of discrete transponder codes disclosed that the assigning of discrete transponder codes in this situation could lead pilots into believing they are receiving a service that the controller may not be able to provide. The advisory services provided to VFR traffic are predicated on workload, frequency congestion, radar limitations, and traffic volume. Safety Advisories, while a higher priority action by the controller, also are influenced by the same factors. In addition, the assigning of discrete transponder codes from takeoff could encourage departing traffic to expedite changing to an air traffic control frequency and not monitoring the Common Traffic Advisory Frequency (CTAF) for airport advisories, which in our opinion is more important." Based on its investigation, the FAA stated that it does not plan to issue an Air Carrier Operations Bulletin directing the Principal Operational Inspectors of Wings West and Imperial Air Lines to require that the airlines amend their operational procedures in accordance with the Safety Board's recommendation.

The FAA's response also stated that it had directed its Principal Operations Inspectors to ensure that their carrier's training programs stress the importance of maintaining external vigilance. Finally, the FAA stated that "we share the Board's concern; however, the airspace system in which we are operating demands that the flightcrews must, at all times, comply with the basic principles of see and avoid. We believe that present procedures, when properly observed and executed are adequate."

The Safety Board has evaluated the FAA's response, and in view of the results of the analysis of this accident still believes that additional operating procedures are necessary to improve the safety of air carrier operations at San Luis Obispo County Airport. The fact that the standard instrument approach procedures (SIAP) course also is used for the standard instrument departure (SID) procedure, and the potential inability of the pilots reasonably to "see-and-avoid" each other in this situation under VFR conditions, as well as the inability of the ATC controllers consistently to provide separation in this situation suggests strongly the need for positive steps to prevent future accidents of this type. As a result, the Safety Board has classified Safety Recommendation A-84-125 as "Open-Unacceptable Action" pending a reevaluation by the FAA. The Safety Board believes that similar hazardous conditions may exist at other uncontrolled airports served by air carrier aircraft, i.e., whenever SIAPs and SIDs share the same localizer course so as to place airplanes on a head-on collision course in a see-and-avoid environment under conditions where the ability of pilots to actually see-and-avoid each other may be so marginal as to place air carrier passengers unnecessarily at risk. These hazards should be reduced by appropriate remedial measures similar to those recommended for San Luis Obispo.

The Safety Board's November 20, 1984, recommendation letter also urged the FAA to:

> Require that the instrument approach chart for the localizer approach to runway 11 at San Luis Obispo County Airport and the Crepe One Departure Chart include a cautionary note with appropriate communication frequencies advising VFR flights on

practice instrument approaches and departures to contact Los Angeles Center for traffic advisories. (Class II, Priority Action) (A-84-126)

The FAA responded that it concurred, in part, with the recommendation and that it had initiated a program to include a "note" on each of the subject charts to read, "During VFR conditions, watch for opposing traffic on the localizer." The FAA also responded that the appropriate communications frequencies now are on the charts.

Beyond the action taken by the FAA, the Safety Board recommended that the "cautionary" note advise VFR flights on practice instrument approaches and on departures to contact Los Angeles ARTCC for traffic advisories. The note added to the chart does not do this. Again, the conclusion reached in this report that the pilots' ability to see and avoid each other is quite marginal under these circumstances dictates the need for more positive measures to prevent midair collisions. The note advising pilots to "watch for opposing traffic" does not reach the point that "see-and-avoid" is of limited utility in such marginal conditions. The ability of an ATC controller to prevent such accidents would be greatly enhanced by knowledge of the presence of an airplane conducting practice approaches as contemplated by the Board's recommendation. Consequently, Safety Recommendation A-84-126 has been classified as, "Open Unacceptable Action" pending reconsideration by the FAA. Further, the Safety Board believes that similar hazardous situations may exist at other uncontrolled airports served by air carriers and the FAA should take similar steps to improve safety of operations at those airports.

Lastly, the Safety Board's November 20, 1984, recommendation letter urged the FAA to:

Disseminate the contents of this safety recommendation letter to fixed based operators in the general vicinity of the San Luis Obispo County Airport. (Class II, Priority Action) (A-84-127)

The FAA responded on January 28, 1985, that its Western-Pacific Regional Office had disseminated the contents of the Board's recommendation letter to the Flight Standard District Offices most likely to have contact with operators and fixed base operators using and operating in the vicinity of the San Luis Obispo County Airport. The Safety Board considers that action satisfactory and has classified the recommendation as "Closed--Acceptable Action." However, the Safety Board believes that dissemination of the circumstances of the accident should be more widespread to enlighten pilots to the hazards of operations at uncontrolled airports with departure and arrival procedures similar to San Luis Obispo County Airport. The Safety Board believes that the various pilots, aircraft owners, and aircraft operators professional associations should disseminate the contents of this accident report to its members. In addition, those organizations should encourage their members to adhere to the recommended communications and traffic advisory procedures of the AIM for operations at uncontrolled airports and, where feasible, to request an IFR flight clearance, or at the minimum, traffic advisory service before departure.

In summary, the Safety Board recognizes the inherent need for the see-and-avoid mandate for VFR flights. However, the facts of this accident demonstrate that there may be occasions in which the physical factors of a traffic conflict can approach or may even exceed the physiological capabilities of the pilots to see and avoid an oncoming airplane. Compliance with recommended communications procedures can provide additional safeguards since they may, when used, provide the VFR pilots with advance warning of other traffic and may, in some cases, require the ATC system to

provide advisory and traffic separation services. Consequently, the Safety Board believes that, if accidents of this type are to be prevented, action must be taken to encourage pilots more strongly to follow these recommended procedures.

The Safety Board repeatedly has recommended that the FAA support the development and implementation of an airborne collision avoidance system for all civil aircraft which provide a practical and effective backup for aircraft separation assurance capability to reduce the potential of midair collisions. Collision avoidance systems warn pilots about potential collision threats and, in some systems, provide resolution advisories for both horizontal and vertical manuevers.

The circumstances of this accident once again demonstrate the need for an airborne collision avoidance system for all civil aircraft. The Safety Board believes that any required research work, operational evaluation, or other developmental efforts should be expedited so as to facilitate introduction of a collision avoidance system at the earliest possible date. Further, the Safety Board believes that the FAA should reevaluate its stated intention that it will not require the installation of TCAS equipment on large aircraft used in air carrier service. The effectiveness of TCAS equipment will not be realized until the systems are in widespread use and this is not likely to occur without regulations mandating the installation of the equipment.

CONCLUSIONS

3.1 Findings

1. The airplanes collided head-on, about 3,400 feet m.s.l. at about 1117:38. The collision occurred about 8 nmi west northwest of the San Luis Obispo County Airport.

2. The flightcrews of both airplanes were governed by the VFR "see-and-avoid" mandate.

3. The flightcrews of both airplanes failed to observe the recommended practices in the AIM.

4. The weather at the collision site was clear.

5. The standard instrument approach and departure procedures shared a common track which, under VMC conditions, put both airplanes in a head-on situation.

6. Based on the physiological limitations of the human eye, under ideal conditions, the pilots of Flight 628 theoretically could have seen the Rockwell Commander as early as 17 seconds before the collision; based on the same considerations, the pilots of the Rockwell Commander theoretically could have seen Flight 628 as early as 23 seconds before the collision.

7. The total time required for a pilot to sight an object, recognize that it is a collision threat, start an evasive maneuver, and have the airplane respond has been estimated to be about 12.5 seconds.

8. There was no evidence that either pilot tried to perform an evasive maneuver. The failure of the pilots of each airplane to see and avoid the other airplane most probably was caused by a combination of the

prevailing physical circumstances and the physiological limitations of the human eye.

9. The airplanes were on a collision course by reason of the SIAP and SID procedures rather than any direction from the air traffic controllers.

10. Although the R-15 radar sector developmental controller and the FPL controller said that the radar return of the Rockwell Commander was not displayed on the radar scope, the evidence indicates that the Rockwell Commander's radar return was displayed on the radar scope. The controllers' failure to see it is not attributable to a failure or malfunction of the NAS Stage A's computers or associated equipment.

11. There was only one other IFR aircraft in the San Luis Obispo area at the time of the accident, whereas, there was an attention demanding control situation in the Santa Barbara area located in the southern portion of the R-15 radar sector. As a result, the developmental controller's attention was concentrated on the portion of the radar scope which displayed the southern portion of the R-15 sector.

12. The developmental controller did not establish Flight 628's location on his radar scope until about 28 seconds before the airplanes collided.

13. With more time available it is likely that the developmental controller would have detected the conflict and issued a safety advisory.

14. The pilot of the Rockwell Commander did not inform the Los Angeles ARTCC of his intention to perform practice instrument approaches on the localizer; he did call the UNICOM and announce that he was over Dobra Intersection and flying toward the airport.

15. Flight 628 stopped monitoring the UNICOM frequency 5 nmi west northwest of the field.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the pilots of both aircraft to follow the recommended communications and traffic advisory practices for uncontrolled airports contained in the Airman's Information Manual to alert each other to their presence and to enhance the controller's ability to provide timely traffic advisories.

Underlying the accident were the physiological limitations of human vision and reaction time. Also underlying the accident was the short time available to the controller to detect and appraise radar data and to issue a safety advisory.

Contributing to the accident was the Wings West Airlines policy which required its pilots to tune one radio to the company frequency at all times.

4. RECOMMENDATION

On November 20, 1984, the Safety Board recommended that the Federal Aviation Administrator:

Issue an Air Carrier Operations Bulletin directing the Principal Operations Inspectors of Wings West and Imperial Airlines to require that the airlines amend their operating procedures so that their flights contact Los Angeles Center prior to departure from San Luis Obispo County Airport and obtain either an IFR clearance or a discrete transponder code if departing VFR. (Class I, Urgent Action) (A-84-125)

Require that the instrument approach chart for the localizer approach to runway 11 at San Luis Obispo County Airport and the Crepe One Departure Chart include a cautionary note with appropriate communication frequencies advising VFR flights on practice instrument approaches and departures to contact Los Angeles Center for traffic advisories. (Class II, Priority Action) (A-84-126)

Disseminate the contents of this safety recommendation letter to fixed based operators in the general vicinity of the San Luis Obispo County Airport. (Class II, Priority Action) (A-84-127)

As a result of the investigation, the National Transportation Safety Board recommended that

--the Federal Aviation Administration:

Issue an Air Carrier Operations Bulletin to require certificated air carriers, when conducting passenger revenue operations, to comply with the traffic advisory practices at uncontrolled airports, as recommended in the Airman's Information Manual. (Class II, Priority Action) (A-85-59)

Amend 14 CFR Part 91 to require pilots intending to practice an instrument approach at an uncontrolled airport to notify the appropriate air traffic control facility of the type of approach to be flown and to request traffic advisories. (Class II, Priority Action) (A-85-60)

As an interim measure, disseminate the facts, conditions, and circumstances of the midair collision at the San Luis Obispo County Airport, through operations bulletins, aviation periodicals, and accident prevention programs, and urge pilots and flight crews to adhere to the recommended traffic advisory practices and procedures for the conduct of a practice instrument approach at uncontrolled airports in the Airman's Information Manual. (Class II, Priority Action) (A-85-61)

Identify airports where an airplane on a standard instrument approach procedure (SIAP) will be on an opposing flightpath with an airplane departing on a standard instrument departure (SID) and, where possible, modify one or both of the procedures to eliminate potential conflicts between arriving and departing traffic. Where modification is not possible, include a cautionary note on the SIAP and SID charts advising visual flight rules (VFR) flights intending to conduct practice instrument approaches and departures to contact the appropriate air traffic control facility for traffic advisories. (Class II, Priority Action) (A-85-62)

Amend the operations specifications of commuter air carriers to require that flights transporting revenue passengers either be on an instrument flight rules (IFR) flight plan or, at a minimum, request radar traffic advisory services, when available. (Class II, Priority Action) (A-85-63)

Expedite the development, operational evaluation, and final certification of the Traffic Alert and Collision Avoidance System (TCAS) for installation and use in certificated air carrier aircraft. (Class II, Priority Action) (A-85-64)

Amend 14 CFR Parts 121 and 135 to require the installation and use of Traffic Alert and Collision Avoidance System (TCAS) equipment in certificated air carrier aircraft when it becomes available for operation use. (Class III, Longer Term Action) (A-85-65)

--the Regional Airline Association and the National Business Aircraft Association, Inc.:

Disseminate the facts, conditions, and circumstances of the midair collision at the San Luis Obispo County Airport to members of your organization, urging them to adhere to the recommended traffic advisory practices and the procedures for the conduct of a practice instrument approach at uncontrolled airports in the Airman's Information Manual. (Class II, Priority Action) (A-85-66)

Encourage members of your organization to obtain an instrument flight rules (IFR) clearance, where conditions permit, or assignment of a discrete transponder beacon code with traffic advisory service before departure from an uncontrolled airport. (Class II, Priority Action) (A-85-67)

—the Aircraft Owners and Pilots Association, the Pilots International Association, Inc., the Helicopter Association International, and the National Association of Flight Instructors:

Disseminate the facts, conditions, and circumstances of the midair collision at the San Luis Obispo County Airport to members of your organization, urging them to adhere to the recommended traffic advisory practices and the procedures for the conduct of a practice instrument approach at uncontrolled airports in the Airman's Information Manual. (Class II, Priority Action) (A-85-68)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ G.H. PATRICK BURSLEY
Member

PATRICIA A. GOLDMAN, Vice Chairman, filed the following concurring/dissenting statement.

I believe that the probable cause of this accident is the ineffectiveness of the "see and avoid" concept to assure traffic separation under the conditions of the conflict.

The deficiencies of the "see and avoid" concept have long been recognized by the Board. To that end, the Board has repeatedly, since 1968, recommended the development and installation of an airborne collision avoidance system to supplement "see and avoid" and back up other air traffic services. The development of such a system, now called the Traffic Alert and Collision Avoidance System, has been slow and is yet to be implemented. Also, there are no present indications that the system, even when available, will be required to be used by aircraft of the category involved in this accident.

Additional procedures, beyond both technological improvements and pilot vigilance, that would enhance "see and avoid" are recognized in the Airman's Information Manual. It contains procedures which are "required" for safe flight. However, since the AIM procedures are not subject to regulation, there really is no requirement that they be followed, even though failure to abide by these essential procedures jeopardizes the entire system.

Two recommended procedures which were not adhered to in this case were:

1) **Recommended Advisory Practices.** All inbound traffic should monitor and communicate as appropriate on the designated CTAF from 10 miles to landing. Departure aircraft should monitor/communicate on the appropriate frequency from startup, during taxi, and until 10 miles from the airport unless the FARs or local procedures require otherwise.

2) **Instrument Approaches.** At airports without a tower, pilots wishing to make practice instrument approaches should notify the facility having control jurisdiction of the desired approach as indicated on the approach chart. All approach control facilities and ARTCCs are required to publish a facility bulletin depicting those airports where they provide standard separation to both VFR and IFR aircraft conducting practice instrument approaches.

That the pilots involved in this accident did not fully abide by these AIM-recommended procedures reduced their opportunity for awareness of the traffic conflict.

The validity of "see and avoid" is further compromised in situations, such as San Luis Obispo County Airport, where approaching and departing aircraft are placed on the same course, minimizing the time and visual opportunities for pilots to see and avoid.

The fact that a collision could occur because none of the supplements to "see and avoid" was available illustrates the deficiencies of the "see and avoid" concept.

/s/ Patricia A. Goldman

August 29, 1985

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was notified of the accident at 1600 on August 24, 1984. A team of investigators was dispatched from Washington, D.C., to the scene the next morning. Investigative groups were established for operations, air traffic control, structures, powerplants, systems, maintenance records, aircraft performance, human performance, and survival factors.

The parties to the investigation were the Federal Aviation Administration, Beech Aircraft Corporation, Pratt and Whitney Division of United Technologies Corporation, Wings West Airlines Incorporated, and the Aircraft Owners and Pilot Association. The Air Line Pilots Association was given observer status.

2. Public Hearing

A 2-day public hearing was held in Los Angeles, California, beginning November 1, 1984. Parties represented at the hearing were the Federal Aviation Administration, Wings West Airlines, Inc., the Aircraft Owners and Pilots Association, and the Air Line Pilots Association.

APPENDIX B

PERSONNEL INFORMATION

Wings West Flight 628

Captain Paul A. Nebolon

Captain Paul A. Nebolon, 28, was employed by Wings West Airlines on December 22, 1983. He held Airline Transport Pilot Certificate No. 565175798 with airplane multiengine land rating and commerical privileges in airplane single engine land. The captain's first class medical certificate was issued April 27, 1984, with no limitations.

Captain Nebolon qualified as captain in the Beech C-99 on April 7, 1984, and his line and route checks were completed satisfactorily on May 1 and 2, 1984. The captain had flown 4,110 hours, 873 of which were in the Beech C-99. During the last 90 days, 30 days, and 24 hours, the captain had flown 271 hours, 91 hours, and 4.2 hours, respectively. The captain had been off duty about 14 hours before reporting for the accident flight. At the time of the accident, he had been on duty 4 hours 18 minutes, 2 hours 2 minutes of which was flight time.

First Officer Deverl H. Johnson

First Officer Deverl H. Johnson, 46, was employed by Wings West Airlines on August 2, 1984. He held Commercial Pilot Certificate No. 1761649 with airplane single engine land rating and airplane multiengine land rating limited to centerline thrust with instrument privileges. The first officer's second class medical certificate was issued July 3, 1984, with no limitations.

First Officer Johnson completed the Wings West Airlines' Beech C-99 initial ground school and flight training on July 27 and August 3, 1984, respectively. His initial pilot proficiency check was completed satisfactorily on August 14. Based on information obtained from his August 4, 1981, application for an airman medical certificate on May 19, 1969, his resume, and Wings West records, the first officer had flown 6,194 hours, 62 of which were in the Beech C-99. During the last 17 days, 72 hours, and 24 hours, the first officer had flown 62.2 hours, 11.5 hours, and 4.2 hours, respectively. The first officer had been off duty about 14 hours before reporting for this flight. At the time of the accident, he had been on duty 4 hours 18 minutes, 2 hours 2 minutes of which was flight time.

Rockwell Commander, N112SM

Instructor Pilot Ladell C. Sandy

Mr. Ladell C. Sandy, 58, held the following pilot certificates: commercial pilot certificate No. 569-22-4622 with airplane single and multiengine land, and instrument ratings, and flight instructor certificate No. 569 22 4622 with airplane single engine land rating issued November 23, 1983. Mr. Sandy received his initial certified flight instructor (CFI) certificate on November 23, 1981. The 1983 CFI certificate date constituted his CFR renewal and also satisfied the biennial flight review requirements contained in 14 CFR 61.57(a). Mr. Sandy's second class medical certificate was issued July 30, 1984, with the limitation that he wear correcting lenses while exercising the privileges of his airman certificate.

Mr. Sandy had flown 4,857.6 hours, 4,395.3 of which were in single engine airplanes. He had flown 73.1 hours in N112SM, 53.8 hours of which were as a flight instructor, the remainder were solo hours. During the preceding 90 days, 30 days, and 24 hours he had flown 251.1 hours, 92.5 hours, and 5.2 hours, respectively. The instructor pilot had 12 hours of rest before arriving at the airport for the accident flight. At the time of the accident, he had been on duty about 2.3 hours, about 25 minutes of which was flight time.

Student Pilot Carl M. Rubel

Mr. Carl M. Rubel, 42, held commercial pilot certificate No. 580-86-9780 with an airplane multiengine land rating. The certificate was issued on the basis of military competency. Mr. Ruble's second class medical certificate was issued December 2, 1983, with the limitation that he wear correcting lenses while exercising the privileges of his airman certificate.

Mr. Rubel had recently retired from the U.S. Navy and, based on a personal resume, he had flown about 2,450 hours while in the service. According to the president of the Aesthetec Corporation, the purpose of the flight was to prepare him to obtain an airplane single engine land type rating. Mr. Rubels had more than 12 hours' rest before reporting for the accident flight and, at the time of the accident, his duty and flight times were the same as the instructor pilot.

Air Traffic Control Personnel

Developmental Controller William P. Simons

Mr. William P. Simons, 25, was hired by the FAA on June 1, 1982. Mr. Simons had no prior ATC experience. His second class medical certificate was issued on March 1, 1984, and contained no restrictions. His training folder contained 23 proficiency entries and 18 oral qualification entries; all entries were graded satisfactory. The controller had been on duty 5 hours 17 minutes at at the time of the accident.

Full Performance Level Controller Gary W. Hobbs

Mr. Gary W. Hobbs, 35, was hired by the FAA on June 22, 1975. His second class medical certificate was issued September 3, 1983, and contained no restrictions. Mr. Hobbs achieved full proficiency level (FPL) status on December 2, 1980, and had received a satisfactory technical appraisal at the R-15 sector on March 9, 1984. He was certified to conduct on-the-job training (OJT) at the ARTCC on December 28, 1983. The controller had been on duty 5 hours 17 minutes at the time of the collision.

Manual Controller Randall C. Peterson

Mr. Peterson, 34, an FPL controller, was working the D, or manual position, at the R-15 radar scope at at the time of the accident. He was hired by the FAA on September 24, 1981. His unrestricted second class medical certificate was issued December 6, 1983.

On August 22, 1984, while on duty as a radar controller, he cleared an aircraft to descend through another aircraft's assigned altitude. This action resulted in less than the prescribed minimum separation standards between the two airplanes and he was decertified as an FPL and required to take 4 hours of remedial training. He was recertified on August 23, 1984. The controller had been on duty about 5 hours 17 minutes at the time of the accident.

Area Supervisor James E. Smith

Mr. James E. Smith, 47, was hired by the FAA on May 2, 1960. His second class medical certificate was issued on May 14, 1984, and contained no restrictions. He was certified as an FPL controller and was certified to conduct OJT at the ARTCC on November 7, 1983. At the time of the accident, the supervisor had been on duty 5 hours 17 minutes.

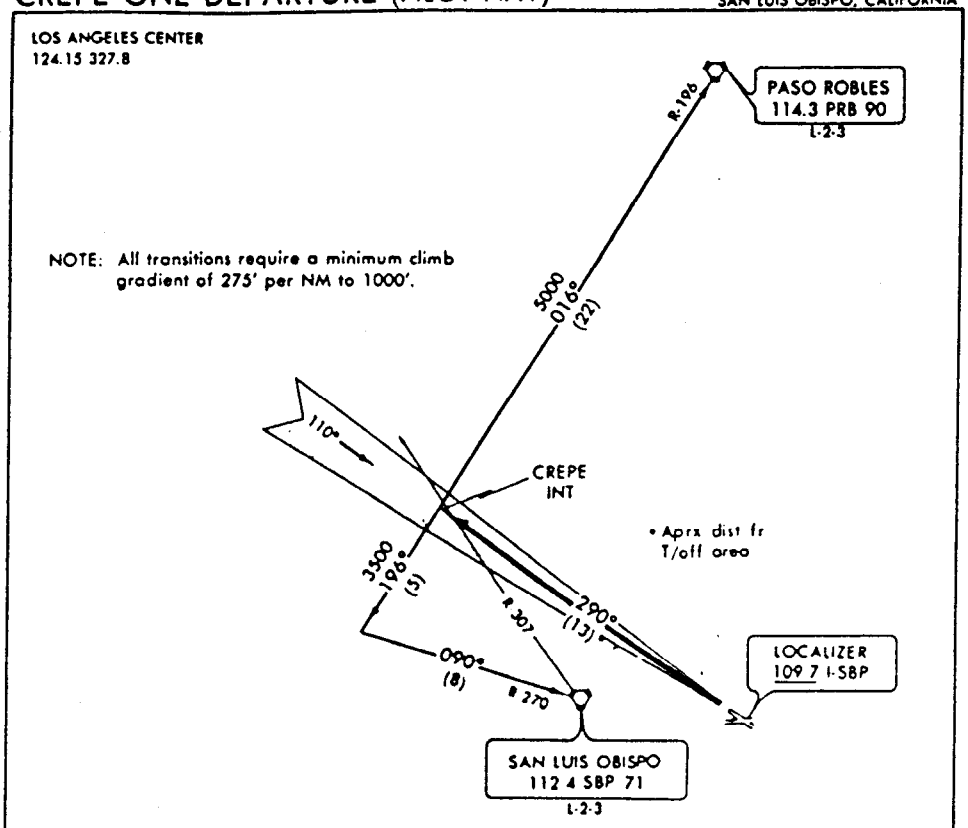
APPENDIX C

DEPARTURE ROUTE DESCRIPTION

(CREPE1.CREPE) 192

CREPE ONE DEPARTURE (PILOT NAV)

SAN LUIS OBISPO COUNTY
SAN LUIS OBISPO, CALIFORNIA



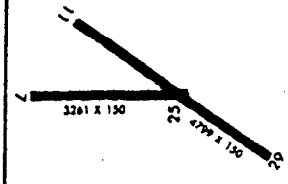
▽ DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAY 29: Climb via San Luis Obispo localizer I-SBP northwest course to CREPE INT; thence via (transition) or (assigned route).

SAN LUIS OBISPO TRANSITION (CREPE1.SBP): From CREPE INT via I-SBP localizer and PRB R-196 to SBP R-270 thence via SBP R-270 to SBP VORTAC.

PASO ROBLES TRANSITION (CREPE1.PRB): From CREPE INT via PRB R-196 to PRB VORTAC.

ELEV 209



CREPE ONE DEPARTURE (PILOT NAV)
(CREPE1.CREPE) 192

SAN LUIS OBISPO, CALIFORNIA
SAN LUIS OBISPO COUNTY

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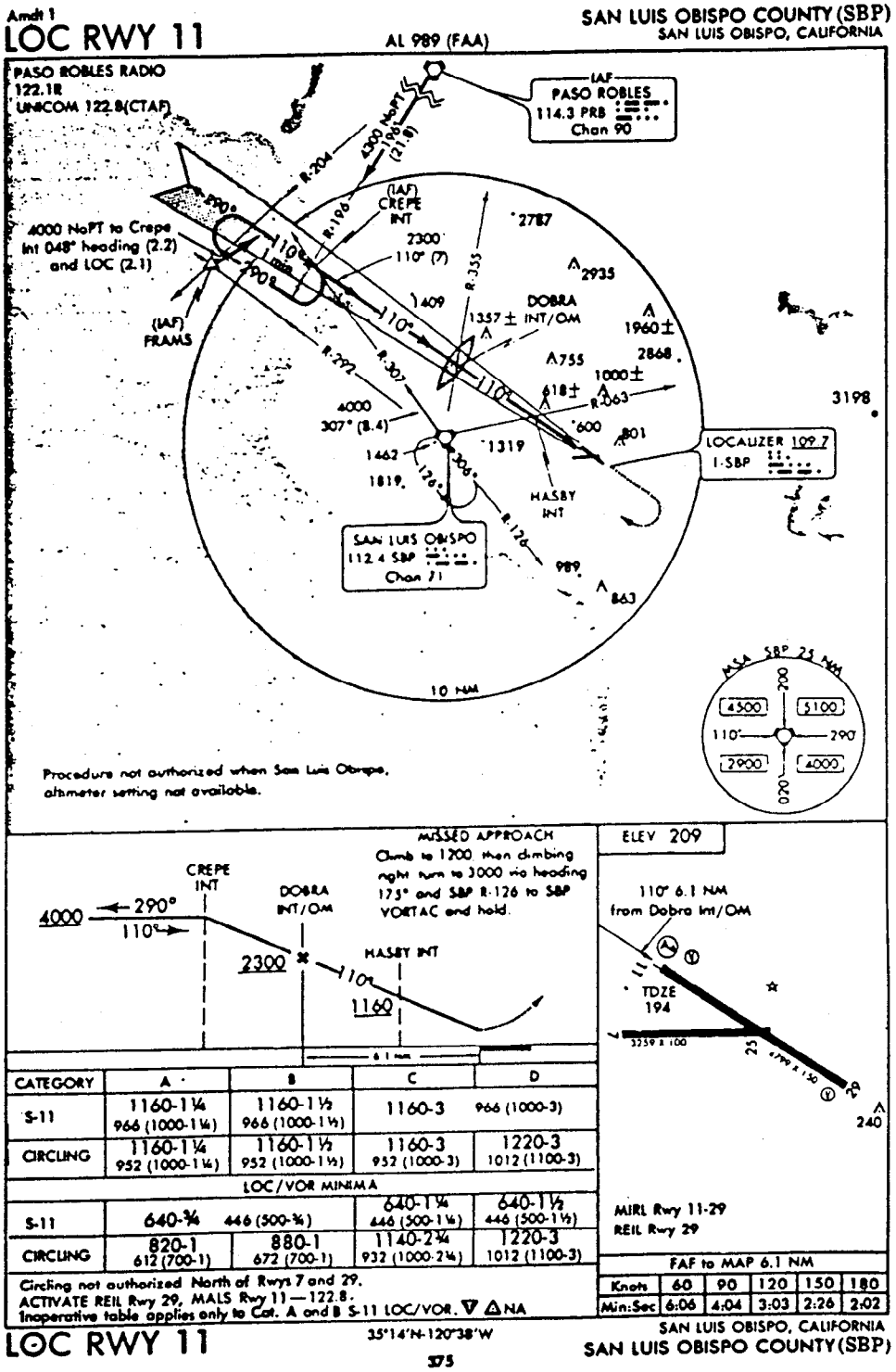
APPENDIX D

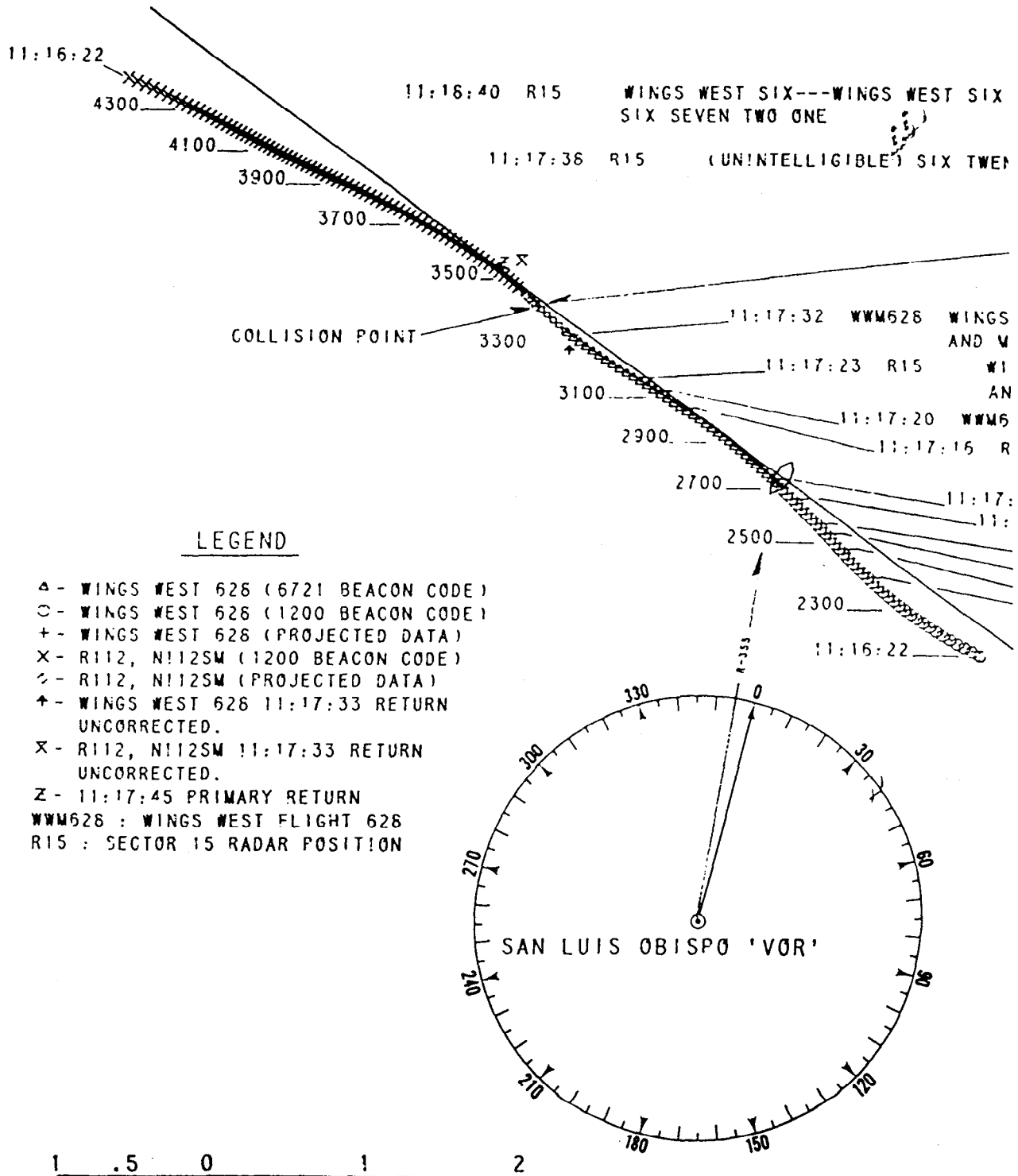
APPROACH CHART FOR RUNWAY 11



CATEGORY	A	B	C	D
S-11	1160-1¼ 966 (1000-1¼)	1160-1½ 966 (1000-1½)	1160-3	966 (1000-3)
CIRCLING	1160-1¼ 952 (1000-1¼)	1160-1½ 952 (1000-1½)	1160-3 952 (1000-3)	1220-3 1012 (1100-3)
LOC/VOR MINIMA				
S-11	640-¾ 446 (500-¾)		640-1¼ 446 (500-1¼)	640-1½ 446 (500-1½)
CIRCLING	820-1 612 (700-1)	880-1 672 (700-1)	1140-2¼ 932 (1000-2¼)	1220-3 1012 (1100-3)

"ILLUSTRATION ONLY - NOT TO BE USED FOR NAVIGATIONAL PURPOSES"

RADAR GROUND TRA
MIDAIR COLLISION WINGS WEST FLT. 62
SAN LUIS OBISPO, CA. AUGU



APPENDIX E

PLOT
- ROCKWELL 112,N112SM
24, 1984

PASO ROBLES RADAR

NTY EIGHT I'VE LOST YOUR TRANSPONDER RESET SQUAWK

EIGHT ROGER YOU CAN EXPECT EIGHT THOUSAND SHORTLY

21 (N.M.)

ST SIX TWENTY EIGHT UNDERSTAND CLEARED TO SAN FRANCISCO AS FILED AND CLIMB
TAIN SEVEN THOUSAND
WEST SIX TWENTY EIGHT UNDERSTAND CLEARED TO SAN FRANCISCO AS FILED AND CLIMB
AINTAIN --- SEVEN THOUSAND---AND PASO ROBLES ALTIMETER TWO NINER NINER FIVE
THREE THOUSAND ONE HUNDRED CLIMBING
WINGS WEST SIX TWENTY EIGHT RADAR CONTACT SIX NORTHWEST OF SAN LUIS OBISPO AIRPORT
SAY ALTITUDE
WWM628 SEVEN TWO ONE
56 R15 WINGS WEST SIX TWENTY EIGHT ROGER SQUAWK SIX SEVEN TWO ONE
16:51 WWM628 (UNINTELLIGIBLE) INTERSECTION VFR TWO POINT SEVEN CLIMBING IFR TO SAN FRANCISCO
11:16:49 R15 WINGS WEST SIX TWENTY EIGHT LOS ANGELES CENTER GO AHEAD
11:16:46 WWM628 WINGS WEST SIX TWENTY EIGHT WITH A REQUEST
11:16:40 R15 WINGS WEST TWO THIRTY SIX LOS ANGELES CENTER ROGER
11:16:00 WWM628 LOS ANGELAES CENTER WINGS WEST SIX TWO EIGHT

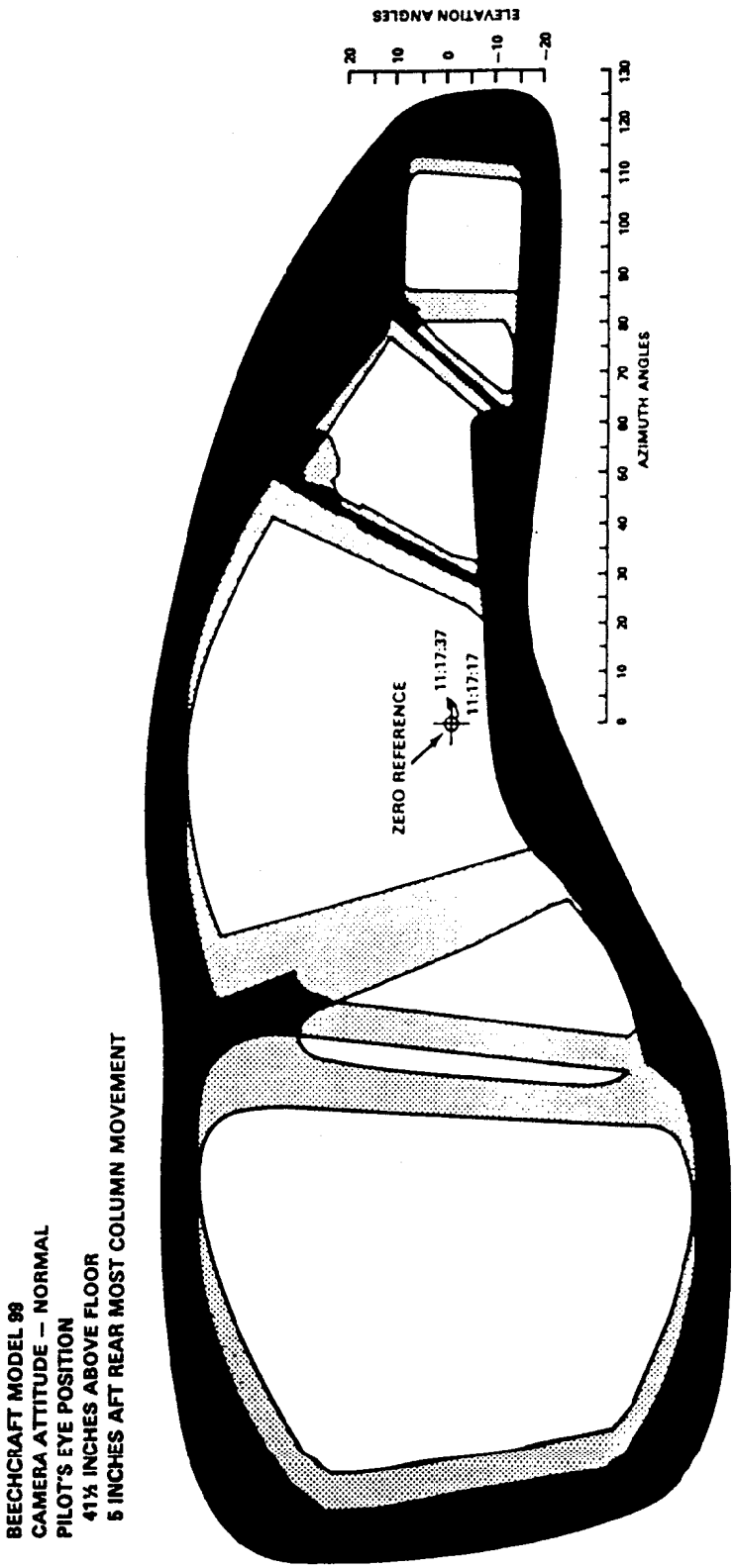
THE ANNOTATED ATC COMMUNICATIONS ARE EXCERPTS FROM THE TRANSCRIPT PREPARED BY THE LOS ANGELES ARTCC, AND CONTAINS ONLY THOSE COMMUNICATIONS BETWEEN WINGS WEST FLT. 628 AND SECTOR 15 RADAR POSITION.

SAN LUIS OBISPO AIRPORT

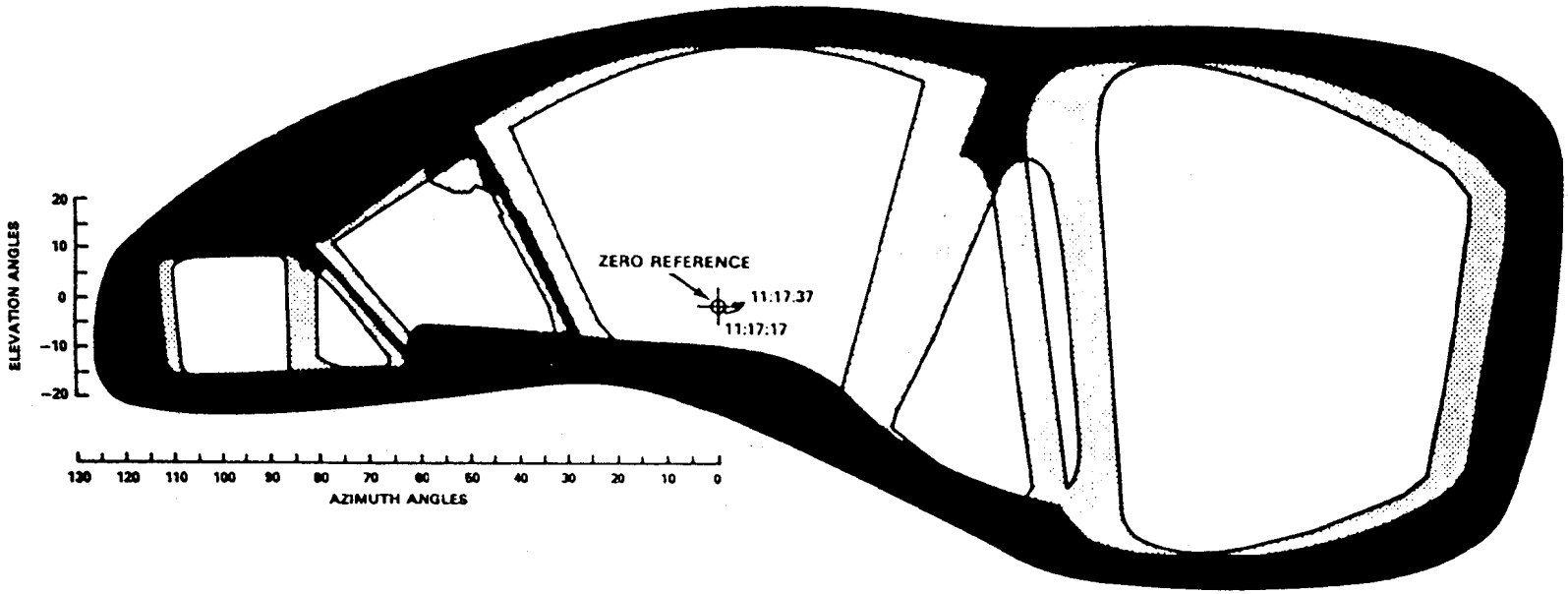
29

APPENDIX F

FLIGHTCREW'S VIEWING ANGLES

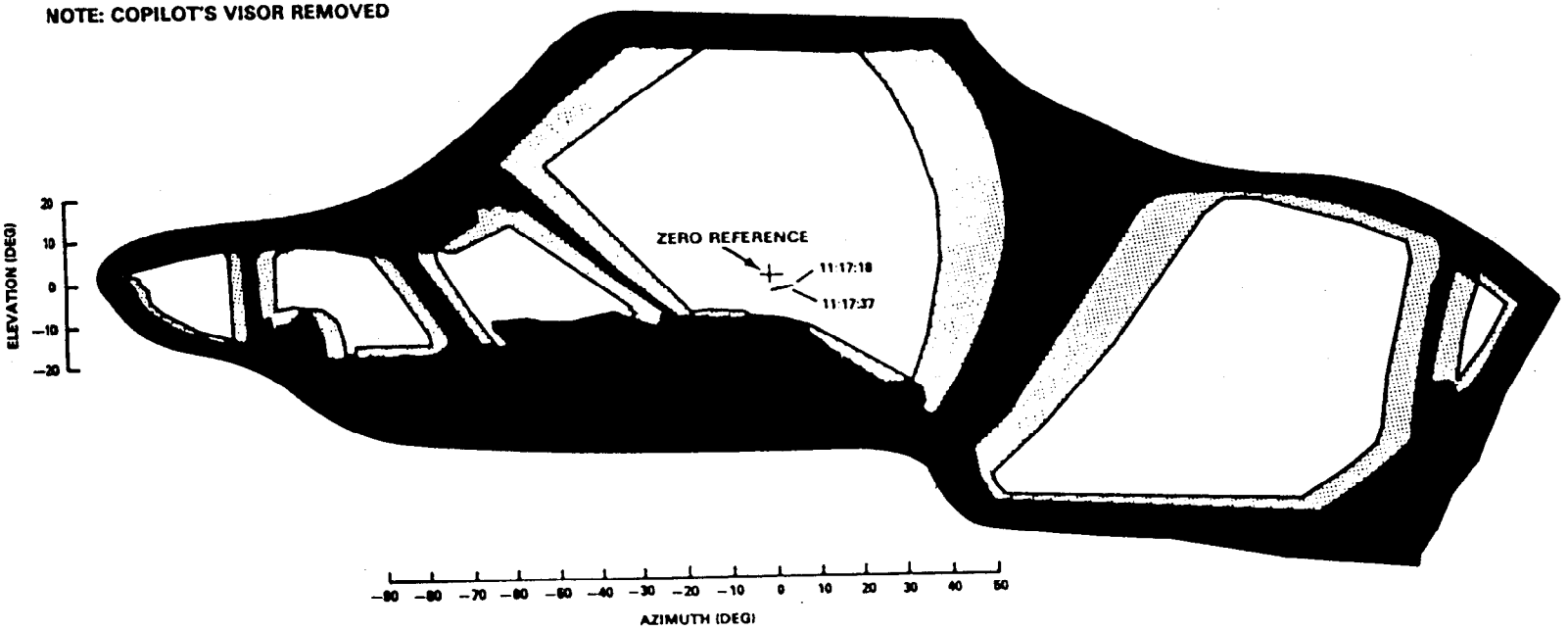


BEECHCRAFT MODEL 99
CAMERA ATTITUDE – NORMAL
COPILOT'S EYE POSITION
41½ INCHES ABOVE FLOOR
5 INCHES AFT REAR MOST COLUMN MOVEMENT

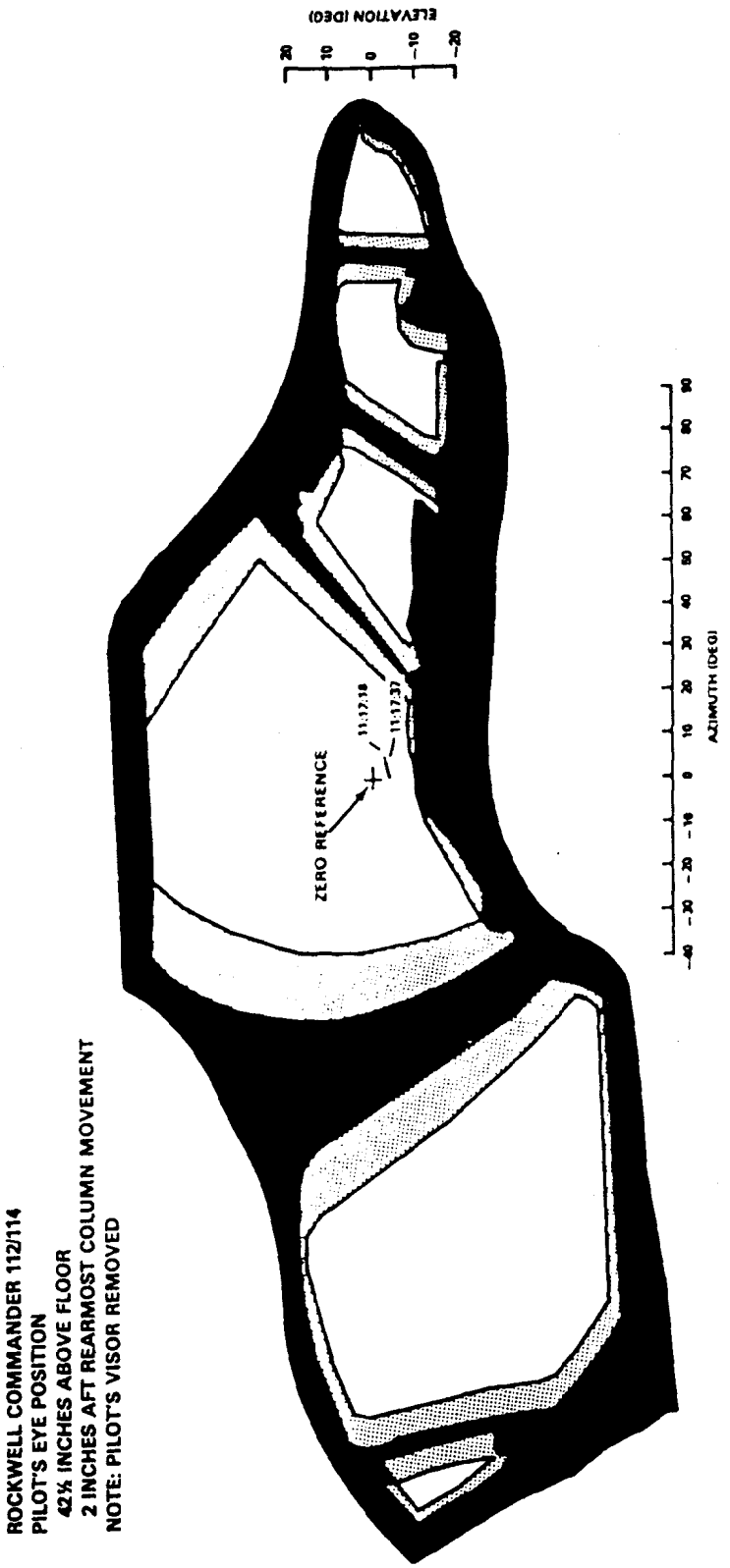


First Officer

ROCKWELL COMMANDER 112/114
COPILOT'S EYE POSITION
42½ INCHES ABOVE FLOOR
2 INCHES AFT REARMOST COLUMN MOVEMENT
NOTE: COPILOT'S VISOR REMOVED



Instructor



ROCKWELL COMMANDER 112/114
PILOT'S EYE POSITION
42½ INCHES ABOVE FLOOR
2 INCHES AFT REARMOST COLUMN MOVEMENT
NOTE: PILOT'S VISOR REMOVED

Pilot

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