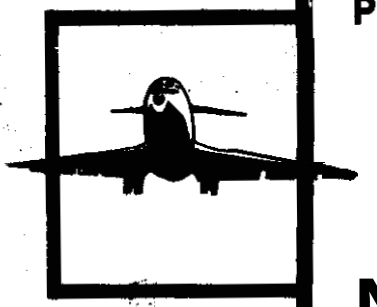
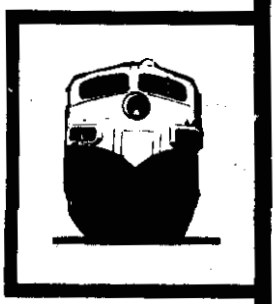
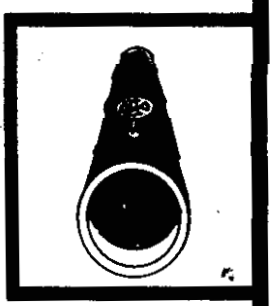
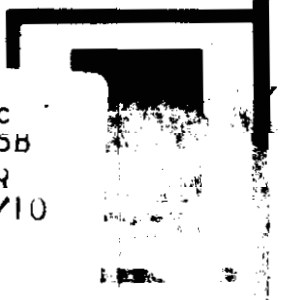
PB82-910410









NATIONAL TRANSPORTATION SAFETY BOARD

AIRCRAFT ACCIDENT REPORT

MIDAIR COLLISION
UNITED STATES AIR FORCE, F111-D,
BUILDING CONTRACTORS, INC., CESSNA TU-206G,
CLOVIS, NEW MEXICO
FEBRUARY 6, 1980

NTSB-AAR-82-10

UNITED STATES GOVERNMENT

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16. Abstract

About 1026, on February 6, 1980, a Cessna TU-206G, N7393N, and a United States Air Force tactical aircraft, a General Dynamics F-111D, collided in midair about 11 nmi northeast of Cannon Air Force Base. The Cessna had departed Alemeda Airport, Albuquerque, New Mexico, had made an en route stop at Tucumcari, New Mexico, and was destined for Clovis, New Mexico. On the morning of February 6, the General Dynamics F-111D had departed Cannon Air Force Base, located about 13 miles southwest of the Clovis Municipal Airport, on a cross country training flight. The F-111D was returning to Cannon Air Force Base to complete the mission. The two aircraft collided near 5,800 feet m.s.l. The pilot and passenger aboard the Cessna and both crewmembers of the F-111D were killed. The weather was clear and the visibility was reported as 30 miles.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of both aircraft to request radar traffic advisories, the failure of the F-111D flightcrew to see and avoid the Cessna TU-206G, and the failure of the RAPCON controllers to observe the Cessna radar target and to issue traffic advisories to the F-111D. Contributing to the accident were the limitations of the see and avoid concept in a terminal area with low speed/high speed traffic.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

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Adopted: August 24,1982

MIDAIR COLLISION
UNITED STATES AIR FORCE, F111-D,
BUILDING CONTRACTORS INC., CESSNA TU-206G,
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FEBRUARY 6,1980

SYNOPSIS

About 1026, on February 6, 1980, a Cessna TU-206G, N7393N, and a United States Air Force tactical aircraft, a General Dynamics F-111D, collided in midair about 11 nmi northeast of Cannon Air Force Base. The Cessna had departed Alemeda Airport, Albuquerque, New Mexico, had made an en route stop at Tucumcari, New Mexico, and was destined for Clovis, New Mexico. On the morning of February 6, the General Dynamics F-111D had departed Cannon Air Force Base, located about 13 miles southwest of the Clovis Municipal Airport, on a cross country training flight. The F-111D was returning to Cannon Air Force Base to complete the mission. The two aircraft collided near 5,800 feet m.s.l. The pilot and passenger aboard the Cessna and both crewmembers of the F-111D were killed. The weather was clear and the visibility was reported as 30 miles.

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1. FACTUAL INFORMATION

1.1 History of the Flight

On February 6, 1980, a Cessna TU-206G, N7393N, departed Albuquerque, New Mexico, on a business trip to Clovis, New Mexico. The aircraft, owned by Building Contractors, Incorporated, of Albuquerque, was piloted by the company president, who was accompanied by a business associate. The pilot made an en route stop at the Tucumcari (TCC), New Mexico airport, and before departing for Clovis he filed a visual flight rules (VFR) plan under the provisions of 14 CFR 91. At that time, the pilot was given a weather briefing and information on the jet traffic in the vicinity of Clovis, New Mexico. The plan, which was filed with the local flight service station (TCC-FSS), proposed a cruising altitude of 7,500 feet m.s.l. 1/ and a true airspeed of 125 knots. The plan also indicated that the Cessna was equipped with an emergency locator transmitter (ELT) and a transponder without an altitude encoder. The transponder was set to beacon code 1200. The en route weather was clear and the visibility was reported as 30 miles.

1/ All altitudes herein are mean sea level (m.s.l.), unless otherwise indicated.

The Cessna departed TCC for the Clovis Municipal Airport at 1007 m.s.t. 2/ There is no flight service station or tower facility at the Clovis Airport. Air to ground radio communications for airport information and landing advisories are provided by local fixed base operators on a uniform communications frequency (UNICOM). At 1026, just before the time of the accident, the TCC FSS operator heard a radio transmission from the Cessna, which apparently was attempting to establish radio contact with the FSS. The TCC FSS operator attempted to contact the Cessna, but there was no response. The FSS received no further radio transmissions from the Cessna, and none of the Clovis fixed base operators received transmissions from the Cessna on the day of the accident.

Cannon Air Force Base (AFB) is located about 13 miles southwest of the Clovis Municipal Airport at an elevation of 4,295 feet. During regular hours of operation, concentrations of high performance military jet aircraft operate from this airport on a routine basis. This military facility operates a radar approach control center (RAPCON), which provides Stage II radar service 3/ to all pilots, military and civilian, who request the service when arriving, departing, or transiting the Clovis area. The RAPCON facility is equipped with an AN/TPX-42 type radar equipment which enables the controllers to monitor, control, and advise flights in the controller's area of responsibility.

On the same morning that the Cessna was en route to Clovis, a United States Air Force tactical aircraft, radio call sign "Leggs 45," departed Cannon AFB at 0923 on a cross country training flight. This aircraft, a General Dynamics F-111D (F-111D), serial number 68-119, was assigned to the 27th Tactical Fighter Wing at Cannon AFB. A flight combat team, an aircraft commander and a weapons systems officer (WSO), manned the aircraft. The mission was planned to terminate at Cannon AFB.

Approximately 1006, when the F-111D was returning to Cannon AFB, Albuquerque Air Route Traffic Control Center (ABQ ARTCC) transferred control responsibilities of the aircraft to the Cannon RAPCON approach controller. The flight had been cleared by ABQ ARTCC to descend and maintain 16,000 feet and to proceed directly to the Curry Intersection, which is the 10-mile distance measuring equipment (DME) airborne fix on the 028° radial of the Cannon TACAN, an ultra high-frequency tactical air navigation aid. The TACAN transmitter is located on the Cannon airport. When the F-111D was at a point about 40 miles northwest of the TACAN, the RAPCON approach controller radar identified the aircraft and requested the type of landing approach that the aircraft commander desired. The commander requested a HI-TACAN runway 21 penetration (see appendix F) and an airborne instrument landing approach (AILA). This approach allows the tactical pilot to make a low visibility instrument approach, simulated or otherwise, to a programmed landing site which is displayed on the aircraft's radar screen. Accordingly, the F-111D was cleared to hold northwest of the Curry Intersection and about 1010, the flight was cleared to descend to 14,000 feet.

Shortly thereafter, the pilot of the F-111D advised the RAPCON approach controller that he would make a low approach to the runway, followed by a missed approach. He would then execute a circling maneuver to land on the same runway. The approach controller issued missed approach instructions and cleared the flight to descend to 13,000 feet. About 1017, the pilot was told to expect a turn in the holding pattern and to descend to 12,000 feet. At 1019, the F-111D was cleared for a HI-TACAN runway 21 approach, which authorized the pilot to descend to 5,800 feet, and was told to expect radar vectors at the 14-mile DME fix for an AILA approach. About 1021, the pilot was cleared to extend his outbound leg to provide spacing behind an aircraft turning base leg

2/ All times herein are mountain standard time, based on the 24-hour clock.
3/ A terminal area traffic advisory service.

for runway 21. Approximately 1024, air traffic control of the F-111D was transferred to the RAPCON arrival radar controller who was a trainee performing under the supervision of a fully rated controller. The transfer occurred while the F-111D was on the inbound approach track about 23 miles DME from the landing runway. Radio communications between the aircraft and the arrival controller were established routinely. The arrival radar controllers observed both primary and secondary radar returns of the F-111D on the radar scope.

Approximately 1026, the flight was flying inbound 12 miles northeast of the airport when the controller cleared the F-111D for the AILA approach on runway 21. Almost simultaneous with the issuance of this clearance, the secondary (beacon) transponder return of the F-111D disappeared from the controller's radar scope and the controller heard the sounds of an ELT on the tower watch frequency. The fully rated controller observed the primary radar return of the F-111D on the scope for about another mile until it also disappeared. At this time, another aircraft in the Cannon landing pattern notified the RAPCON controllers that a crash had occurred northeast of the airport.

The F-111D and the Cessna TU-206G had collided in midair. The occupants of both aircraft were killed. None of the RAPCON controllers had visually detected the Cessna or had observed on the radarscope the transponder signal of the aircraft. The Cessna pilot had not made radio contact with the controllers.

Safety Board investigators interviewed three ground witnesses who had seen the midair collision. All three witnesses stated that the skies were clear and that visibility was good at the time of the accident. One witness stated that the small aircraft exploded on collision and that the large aircraft continued to fly straight ahead with the wings level. The witness further stated that within seconds after the collision, he saw an explosion in the F-111D and that the aircraft gradually started downward until it disappeared from his view behind a hill.

A second witness stated that he believed both aircraft were flying straight and level before the collision. Upon in-flight impact, he saw the Cessna explode and, within seconds, he saw fire and an explosion in the tail area of the F-111D. He stated that he lost sight of the tactical aircraft before it struck the ground. A third witness stated that he believed that the Cessna may have been descending slightly before the collision. He recalled that several seconds after the collision a major explosion occurred in the F-111D. He stated that after the two aircraft had separated large pieces of debris started falling to the ground. He observed a ball of fire on the F-111D as it descended on a straight course for about 1 3/4 miles from where the in-flight impact occurred. According to this witness, the fighter aircraft then rolled to the left, the nose pitched down abruptly, and as the aircraft banked steeply the crew escape capsule 4/ separated from the aircraft. The capsule parachute opened as the escape capsule hit the ground. The witness stated that the aircraft rolled completely over and that the inverted nose raised vertically until the aircraft appeared to hang motionless as the tail swayed back and forth. The tail then descended and struck the ground. According to the witness, secondary explosions followed the initial ground explosion.

The accident occurred about 1026, during the hours of daylight, approximately 11 nmi northeast of Cannon AFB.

4/ A cockpit module which serves as an emergency ejection device. When separated from the aircraft in flight, it is lowered by parachute.

12 **Injuries to Persons**

Injuries	Crew	Passengers	Others	Total
Fatal	3	1	0	4
Nonfatal	0	0	0	0
None	0	0	0	0

13 **Damage to Aircraft**

Both aircraft were destroyed by the midair collision and the subsequent impact forces.

14 **Other Damage**

None

15 Crew Information

The crews of both aircraft were qualified for their respective flights. (See appendix B.)

16 Aircraft Information

The Cessna TU-206G was certified and maintained in accordance with existing Federal Aviation Regulations. The F-111D was maintained in accordance with applicable United States Air Force regulations. The weight and center of gravity for both aircraft were within prescribed limits.

A review of the maintenance history of both aircraft did not disclose any discrepancies or malfunctions which were relevant to this accident.

There were no pilot reports from either aircraft suggesting any mechanical difficulties before the collision.

The Cessna was painted white with blue and red trim. The F-111D was painted in camouflage colors.

17 Meteorological Information

The 1030 Cannon AFB surface weather observation was as follows: sky--estimated 8,000 broken, estimated 25,000 broken; visibility--30 miles; temperature--56° F; dew point--28° F; altimeter setting--30.09 inHg; winds from 230° at 13 knots.

18 Aids to Navigation

Not applicable.

19 Communications

A review of the ARTCC taped communications with the Cessna and the RAPCON taped communications with the F-111D revealed no communication difficulties between the ground base and the respective aircraft. The pilot of the Cessna did not establish radio contact with Cannon RAPCON or Clovis UNICOM, nor was he required to.

1.10 Aerodrome and Ground Facilities

Not applicable.

1.11 Flight Recorders

Neither the Cessna nor the F-111D were equipped with recorders and none were required.

1.12 Wreckage and Impact Information

The total wreckage scatter was confined to a 10,080-foot-long, 2,160-foot-wide area with most of the separated parts scattered onto farm land.

The fuselage, empennage, engine, and other components of the Cessna were located in an area approximately 1,620 feet downstream of the location of the first ground fire. (see appendix C.)

The entire Cessna fuselage showed massive compression damage diagonally from the left front to the right rear. The right side of the cabin was displaced approximately 3 feet to the right and aft. The fuselage firewall, both front door posts, the instrument panel and pilot controls were displaced to the right and rear. Major instruments, avionics, and control components had separated and had fallen free. The top engine cowling, cabin doors, and the top fuselage section, which includes the wing carry-through structure, were separated from the aircraft.

All seats were deformed rearward and from left to right as viewed looking forward. None of the seat structures exhibited any evidence of downward compression. The support structures of the two most forward seats were separated into several pieces. All seatbelts and shoulder harnesses were intact except for the left outboard pilot seatbelt which was cut during rescue operations.

Both wing fuel cell bladders were fragmented and pieces of various sizes were recovered. Although both the left and right wings were fragmented, a major portion of the wing structure was recovered, including the leading edge and front spar of the left wing. The leading edge exhibited a deep indented fold with black scuff marks within the fold area. The right bomb rack fairing of the F-111D was recovered within the leading edge fold. The front spar was deformed and bowed and was marked by multi-colored paint which matched the colors of the camouflage painted F-111D.

All flight control surfaces were accounted for. The left and right flap and aileron surfaces were separated from their respective wings. These surfaces sustained various degrees of breakup damage. The elevators and rudder were found attached to the horizontal and vertical stabilizers.

The engine was separated from the aircraft. The aft crankcase closure end exhibited a deep gouge mark with thread imprints within the gouged area. The gouge and thread imprints were measured along a line 80° to 82° left of the aircraft's longitudinal axis. All engine cylinders were attached to the engine crankcase but all the large cooling fins on top of the cylinders were broken off. The upper surface of the Nos. 6, 4, and 2 cylinders on the left side had deep diagonal gouge marks across the cooling fins. Each of these marks was measured along a line about 80° left of the aircraft's longitudinal axis.

The F-111D impacted the ground about 9,480 feet from the Cessna wreckage site. It was relatively intact prior to ground impact. Several parts separated from the aircraft during the in-flight collision and were found along the wreckage path. These parts showed evidence of fire damage as a result of the explosion during in-flight impact. At the time of collision, the aircraft's spoilers, flaps, slats, and landing gear were in the retracted position; the inlet spike system was in the full open position; and the speed brake was in the full extended position.

The right wing bomb rack unit, which was installed on the wing outboard pylon, had separated from the aircraft and was found along the wreckage path. The right bomb rack fairing was separated from the bomb rack and was found in the area of the Cessna wreckage. The right outboard side of the bomb rack body displayed heavy white scuff and scratch marks from the forward end running aft for 11 feet. Blue paint and scratch marks were noted on the rear aerodynamic fairing and rear bomb release mechanism. The inner barrel of the bomb rack unit contained numerous pieces of aircraft structure which were identified as being parts of the Cessna. These pieces consisted of wing stringers, wing spar and cap, wing access inspection plates, and a piece of the wing tank refueling cap.

Both engines separated from the fuselage attachment structures and sustained various degrees of damage as a result of ground impact. Although no evidence indicated that the left engine had incurred in-flight damage; the right engine evidenced collision damage and extensive foreign object injection. The right engine alternator assembly had separated from the constant speed drive and was not recovered. The constant speed drive unit sustained heavy impact damage--deep gouge marks, a large hole in the housing, and one displaced alternator stud. The engine gear box had a wide gouge mark which ran about 22° relative to the engine centerline. Impact damage to the accessory gear box allowed depletion of both hydraulic systems, which would have led to loss of flight control. The right engine hydraulic oil cooler was found in the area of the main Cessna wreckage area.

The crew ejection module impacted the ground nose down on its left side. After the initial ground impact, the module bounced approximately 30 feet and came to rest in an inverted position. The forward portion of the module sustained severe structural damage and the lower forward section separated from the main body at initial ground impact. The left windscreen was broken from the frame and both windscreens and canopy transparencies were shattered. Both canopies remained attached to the module. There was no evidence of fire or soot on the crew module.

The stabilization parachute, aft pitch flaps, forward chain straps, and the recovery parachute deployed properly. All three reefing line cutters had fired and the repositioning release retractor had functioned. The module struck the ground just before the repositioning bridles were to deploy.

Both ejection handles were found; the pilot's ejection handle was in the fired position and the WSO's handle was in the stowed position. The position of the pilot's ejection handle indicates that he initiated the ejection process. The rocket motor was found to have functioned properly. The diaphram of the secondary nozzle had been severed, indicating that the input to the air pressure actuated selector dictated that the system operate in the high speed ejection mode. The high speed mode operates at speeds of 300 knots or greater.

An altitude of about 2,000 feet is required for a successful module ejection. Evidence indicates that module ejection occurred at an altitude of about 1,300 feet above ground level (a.g.l.).

The positions, the tape, and digital displays of the various instruments within the module are retained as of the moment of module separation. The following instrument readings from the module were recorded:

TACAN Bearing	-	207, range 12.5 miles
Course Headings	-	210°
Vertical Velocity	-	1,850 fpm rate of descent
Altitude	-	5,650 feet [terrain 4,300 feet]
Airspeed	-	300 knots
Airspeed Select Window	-	149 knots
Standby Attitude Indicator	-	95' right wing down 32' nose down
Wing Sweep	-	26'

Engine Instrument

Engine	Left	**Right**
TIT	1,128° C	346' C
Fuel Flow	42,900 PPH	**330 PPH**

1.13 Medical and Pathological Information

Autopsies and toxicological examinations of the pilot of the Cessna and the crew of the F-111D did not disclose any preexisting physiological problems that could have affected their performance.

1.14 Fire

Witnesses saw an explosion at the time of collision and a fireball on the F-111D as it descended for about 1 3/4 miles before impacting the ground. When the F-111D struck the ground, there was an initial impact explosion followed by numerous small explosions.

1.15 Survival Aspects

This accident was nonsurvivable for the occupants of the Cessna TU-206G. The crew of the F-111D survived the in-flight collision. However, the crew escape module was not released from the aircraft until the aircraft reached a right bank of 95' and a nosedown attitude of 32. In this attitude, at an altitude of about 1,300 feet a.g.l., there was insufficient time for the parachutes to deploy and properly orient the module for a successful landing. The crew of the F-111D died as a result of the module's impact with the ground.

1.16 Tests and Research

1.16.1 Vibility Aspects

In conjunction with the FAA National Aviation Facilities Experimental Center (NAFEC), now the the FAA Technical Center (FAATC), the Safety Board conducted a visibility study to determine if aircraft structures in cockpit areas of either aircraft would have restricted or prevented the flightcrew of either aircraft from observing the other. Ground tracks and headings for both aircraft were established from data supplied from the FAA Air Route Traffic Control Center Track Analysis Program. Aircraft attitudes were based on manufacturer's data using heading, aircraft configuration, and

airspeed. The collision geometry and slant range between the two aircraft for the 105-second period before the collision have been calculated and plotted on binocular photographs. (See appendix D.) It is to be noted that the accuracy of a photo depiction of visibility is inherently limited because of the basic assumptions necessary in its construction.

A review of the data disclosed the altitudes and rates of descent of the F-111D, a level flight path for the Cessna, the ground speeds of both aircraft, and the projected collision point. The collision time was estimated to be 1026:34 and the in-flight impact was estimated to have occurred at an altitude of about 5,800 feet. Immediately before flight impact, the Cessna was on a magnetic heading of 111.5° and the military aircraft was on a magnetic heading of 210. Impact ground airspeeds were 128 knots for the Cessna and 380 knots for the F-111D. For the last 105 seconds, the average rate of closure was 625 ft/sec, or about 370 knots.

A dual lens (binocular) camera was used to record a panoramic view of the design eye-reference point of each crewmember or occupant station in both aircraft. (see appendix J.) The binocular photographs present the position of each target aircraft in 15-second intervals as viewed from the fixed eye-reference point. Naturally, any movement from this position would alter the vision envelope and the position of any cockpit obstructions relative to the other aircraft. The photos revealed that during the last 105 seconds, the F-111D was never in the vision envelope of the Cessna pilot. However, the F-111D was within the vision envelope of the Cessna passenger in the right seat at a point 55° left of his eye-reference point during the last 45 seconds. The F-111D pilot's vision of the Cessna was obstructed some 90 seconds before impact. Before this time period, the Cessna would have been in his vision envelope at a point 30° to the right of his eye-reference point. However, from 90 seconds until in-flight impact, the Cessna was within the WSO's monocular vision envelope. The complete vision envelope was obstructed by the left canopy lateral post.

1.16.2 Operation of RAPCON Radar Equipment

On February 11, 1981, a Safety Board investigator visited Cannon AFB to observe the operation of the RAPCON radar equipment and the control procedures applicable to military and civil aircraft flying in the Clovis area. According to the chief controller, facility radar operation and control procedures during the visit were the same as those in effect at the time of the accident. Primary and secondary radar returns did not show any evidence to indicate that they were less than satisfactory for control use. Additionally, the transponder code depiction on the radar display was unremarkable. Many VFR code 1200 returns of aircraft operating in the Clovis and Portales Airport areas were observed. The VFR code 1200 flights that established radio contact with the RAPCON were arriving/departing Clovis Municipal Airport via the NW sector (270° - 360°). These flights were provided radar services and traffic advisories.

1.16.3 F-111D Flight Simulation

On February 12, 1982, a F-111D simulator was used to demonstrate to the Safety Board investigator a TACAN/AILA runway 21 approach to Cannon AFB. The demonstration was conducted by crewmen assigned to the accident aircraft's tactical unit. The simulated flight profile, including airspeeds, altitudes, and descent points, was used in the analysis of this accident.

1.17 Additional Information

1.17.1 F-111D Approach Procedures

Following a HI-TACAN runway 21 approach, 5/ the F-111D was cleared by the RAPCON approach controller to complete an AILA. The initial portion of the approach requires the aircraft to be at or above 12,000 feet at the 24-mile DME fix (Bardo) and to descend and cross the 10-mile DME fix at 5,800 feet. This altitude is maintained to the 6.5-mile DME fix, where the final descent is made to the runway or missed approach point. If applicable, the AILA approach transition is made at the final fix. This type of approach provides the F-111D pilot the capability, with the assistance of the WSO, to fly a low visibility approach, either simulated or actual, to a landing site which has been entered on the aircraft's radarscope. The WSO, who occupies the right cockpit seat, programs the touchdown point coordinates and glide slope angle into the radar computer. Throughout the approach, the WSO's attention is directed to the cockpit equipment as he monitors the precision of the aircraft's course and descent path. This flight guidance information is displayed on the pilot's head-up display (HUD), which is located in line with his forward windshield. Various other functions related to the approach procedures are completed by both crewmembers. Glide slope angle, heading selection, "Before Landing" and "Landing Pattern" checklists, altitude calibration, and aircraft position update are completed before the aircraft reaches the final descent fix. Upon glide slope intercept, the glide slope angle is confirmed by the WSO for the final descent.

The F-111D is exempt from the provisions of 14 CFR 91.70 which restrict indicated airspeed to 250 knots when operating an aircraft below 10,000 feet. Accordingly, the recommended procedure for the F-111D during this type of approach is to establish an airspeed of 300 knots during the descent from Bardo and to reduce the indicated airspeed to 140 knots for glide slope intercept and descent. The descent is flown with the speed brakes extended, and a rate of descent of about 3,500 feet per minute is required. An altitude of 5,800 feet is reached about the 15-mile DME point, where the speed brake is retracted and level flight is maintained by a small amount of additional thrust. At the 10-mile DME fix, the landing gear is extended and the landing flaps are set for the final descent.

According to USAF directive, 6/ the pilot must obtain approval for an AILA approach from the controlling agency (RAPCON) before commencing an approach. The aircrew is directed to request separation from other traffic if separation service is available. It is also recommended that the aircraft commander adjust crew duties as required for safety. The aircraft commander is also required to establish and brief the WSO on flight parameters which will be maintained during the critical phases of flight. When the established parameters are exceeded, the crewmember not flying is to advise the other crewmember of the deviation. During flight in visual flight conditions, crewmen are directed to insure that they are never occupied with cockpit duties simultaneously. The directive states that the "see and avoid" policy is mandatory and the aircraft's flight path should be visually cleared by at least one crewmember at all times.

Following the accident, ABQ ARTCC provided a track analysis of the VFR code 1200 beacon signals from N7393N and the assigned code 0245 beacon signals transmitted from Leggs 45, the flight identification of the F-111D. Beacon signals from both aircraft were recorded by the computer at ABQ ARTCC until the point of collision.

5/ Appendix F, HI-TACAN runway 21 Cannon AFB, High Altitude Instrument Approach procedures, Southwest United States, DOD Flight Information Publication (Terminal), effective November 29,1979.

6/ Ref; 3-14 and 3-17, TACR/USAFER 55-111, January 1980.

1.17.2 Cannon AFB RAPCON Facility and Transponder Codes

The F-111D was equipped with a multi-channel transponder and an associated automatic altitude reporting feature (Mode C). The Cessna 206 was equipped with a multi-channel transponder, without the Mode C capability.

Air Traffic Control service in the Cannon AFB area is provided by a radar approach control center (RAPCON), which is located on the airport. The facility is equipped with an AN/FPN-47 radar antenna and radar information is displayed on an AN/TPX-42 radar console. The unit has several selective features, including a moving target indicator (MTI), bracket video, fast time or standard time constant, selected altitudes, and either circular or linear polarization selection. Ten selected transponder code assignments can be entered for secondary target identification or, alternatively, all transponder codes can be selected for display. Transponder code 1200 is the beacon code used normally by transponder equipped aircraft during VFR flight. Display of the code 1200 transponder beacon normally would be eliminated only if the selective feature of the first option had been programmed for 10 code assignments and VFR code 1200 had not been entered into the selection console. However, the Cannon RAPCON facility chief stated during the investigation that, because of an Air Force regulation, the radar control panel must be set up regularly to receive VFR code 1200. The RAPCON controllers, who were on duty at the time of the accident, stated that the radar console was selected to receive the VFR code when the collision occurred.

Eight controllers were on duty in the RAPCON facility at the time of the accident. A watch supervisor (crew chief), an approach/departure controller, and two arrival controllers were involved in the surveillance of the F-111D during that aircraft's approach. One of the arrival controllers was monitoring the training of the other arrival controller. The other controllers were assigned to duties not related to the accident. The controllers were qualified in accordance with United States Air Force and Federal Aviation Administration standards.

Following the collision, the navigation aids and the RAPCON radar equipment were flight checked to determine their operational capability and accuracy. The accident site was overflown in several directions at altitudes between 5,800 feet and 7,500 feet. Primary and secondary beacon returns were observed to be satisfactory in all cases. The flight inspection report stated that since the initial flight check numerous targets, including a Cessna 206, have flown through the accident area with satisfactory beacon identification. There were no observed cases in which aircraft generated strength one (weak) or zero returns.

1.17.3 Aeronautical Charts

The chart most commonly used for piloting by General Aviation pilots is the Sectional Aeronautical Chart, published in accordance with specifications agreed upon by the Department of Defense, the Federal Aviation Administration, and the Department of Commerce. The title page of the chart advises users to consult appropriate NOTAMS and Flight Information Publications for supplemental data and current information. The 24th edition of the ALBUQUERQUE (ABQ) Sectional Chart, dated November 29, 1979, was current at the time of the accident. This chart depicted the Cannon AFB control zone as generally encompassing a 5-statute-mile radius of the airbase. The control zone was extended 8 statute miles to the northwest and southwest to accommodate approach/departure paths to runway 21. The chart depicts terrain and ground features, airport traffic services, and airspace information as well as radio aids to navigation and

communications. Radio frequencies are listed for the tower or approach control and for the automated terminal information service (ATIS). It was not determined during the investigation if the Cessna pilot was familiar with the ABQ Sectional Aeronautical Chart. A chart of this type was not found in the Cessna wreckage following the accident.

The State of New Mexico publishes the New Mexico Aeronautical Chart. 7/ The features are illustrated on this chart in a manner similar to the Federal Sectional Chart series. It depicts the Cannon AFB control zone and controlled airspace within a 19-nmi radius; however, radio frequencies for the Cannon Tower are included but not for the RAPCON. A copy of the New Mexico Aeronautical Chart was found in the Cessna wreckage.

1.17.4 Terminal *Area* Graphic Notices and Other Aeronautical Charts of *the* Cannon APB Areas

The terminal area graphic notice for CLOVIS Cannon AFB, New Mexico, current at the time of the accident, was published in the January 1980 issue of "Graphic Notices and Supplemental Data," a FAA Flight Information publication 8/ issued quarterly.

On this particular chart, dated February 22, 1979, the northern portion of the Cannon AFB controlled airspace was designated as a cautionary area between the altitudes of 5,800 feet and 6,300 feet. The remaining southern portion was noted as a cautionary area between the altitudes of 5,800 feet and 7,000 feet. Recommended VFR corridors for entry/exit to the civilian airports, Clovis and Portales, were depicted to the east and south of the cautionary area. A geometric outline appears in the northeast quadrant of the cautionary area. This trapezoidal-like outline originates north of the cautionary area where there is a numerical symbol on the chart intended to denote that the maximum altitude in that airspace is 5,300 feet m.s.l. The symbol is illustrated as a straight line over numerals (5300). Neither the outline nor the symbol is explained in the accompanying legend. It is not known if the Cessna pilot was familiar with the FAA publication "Graphic Notices and Supplemental Data."

Similar graphics were not explained on a revised chart completed on May 15, 1980, and distributed by the Air Force locally after May 22, 1980, for local users. (See appendix H.) National distribution of the revised chart was made in the January 1981 issue of "Graphic Notices and Supplemental Data." The chart was revised again on March 9, 1981, and published by the FAA in the April, 1981 issue of "Graphic Notices and Supplemental Data." (See appendix I.)

1.17.5 Mid-Air Collision Avoidance Program

In April 1979, a Mid-Air Collision Avoidance Program (MACA) was started at Cannon AFB to inform persons associated with flight in the Cannon controlled airspace of the problems existing because of the concentration of military traffic at Cannon AFB, in close proximity to Clovis Municipal and Portales Municipal Airports and, further, to disseminate to all concerned the local ATC procedures. FAA Air Traffic representatives participated in the program during visits to the fixed base operators at the civilian airports. In May 1980, the USAF issued a pamphlet entitled "Radar Air Traffic Control Services, Cannon AFB, NM," which strongly urged all pilots operating VFR and arriving, departing, or transiting the Cannon control areas to contact the Cannon

7/ Appendix E, New Mexico Aeronautical Chart, published for the State of New Mexico.
8/ See Appendix G, Terminal Area Graphic Notice (Term 17). January 1980 issue Graphic Notices and Supplemental Data.

RAPCON for radar flight tracking and associated services. The pamphlet advised pilots to use the ATIS to receive local information, which included an advisory to contact the Cannon RAPCON facility. The terminal area graphic notice chart dated February 22, 1979, was included in the pamphlet distributed to the fixed base operators at Clovis Municipal Airport.

Thereafter, a revised terminal area chart was developed by Cannon AFB personnel for inclusion in the pamphlet. The revision provided more detailed information concerning arrival and departure routes. The transient VFR route through the original northwest corridor was moved farther east in the Cannon control zone. The chart was revised on May 15, 1980, for inclusion in the forthcoming "Graphic Notices and Supplemental Data." A further revision on March 5, 1981, moved the northern recommended VFR route farther east, which placed it outside the Bardo initial approach fix for landings on runway 21 at Cannon AFB.

An attachment to the pamphlet entitled "Pilot/Controller Responsibilities" and outlining the duties of air and ground crews in the air traffic control system of the terminal area was also prepared. The written material was based upon the responsibilities contained in the Federal Aviation Regulations, the Air Traffic Control Handbook 7110.65, and supplemental directives and included references to the Airman's Information Manual (AIM), Notices to Airmen, Advisory Circulars, and aeronautical charts.

This pamphlet and other information provided by the Cannon AFB MACA program had been made available to the flightcrew of the F-111D and to the RAPCON controllers who were on duty at the time of this accident.

1.17.6 Aircraft Separation

Pilot Responsibilities--The right-of-way rules of 14 CFR 91.67 state that when weather conditions permit, regardless of whether an operation is conducted under Instrument Flight Rules (IFR) or Visual Flight Rules (VFR), vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft. The rules also provided that when the rules give another aircraft the right-of-way, a pilot shall give way to that aircraft and may not pass over, under, or ahead of it, unless well clear. Section (e) of these rules, entitled "Overtaking," states that "Each aircraft that is being overtaken has the right-of-way and each pilot of the overtaking aircraft shall alter course to the right to pass well clear." Section (f), entitled "Landing," states, in part, that "Aircraft, while on final approach to land, or while landing, have the right-of-way over other aircraft in flight or operating on the surface."

The Airman's Information Manual (AIM) is designed to provide airmen, civilian and military, with basic flight information and basic information regarding ATC procedures for operating in the U.S National Airspace System (NAS). In the preamble, the AIM states that:

> It is a pilot's inherent responsibility that he be alert at all times for and in anticipation of ell circumstances, situations, and conditions which affect the safe operation of his aircraft. For example, a pilot should expect to find air traffic at any time or place. At or near both civil or military airports and in the vicinity of training areas, a pilot should expect concentrated air traffic although he should realize concentrations are not limited to these places.

In 1968, the Safety Board published the study "Midair Collisions in U.S. Civil Aviation," which contained a number of recommendations to prevent midair collisions. In addition to addressing pilots and other elements of the aviation community, the study contained recommendations to the FAA. (See appendix K.) In 1970, as part of a FAA program to reduce the potential for midair and near midair collisions, the FAA published Advisory Circular (AC) No. 90-48. This circular is still issued and is available to pilots and others. AC No. 90-48 states that the "See and Avoid" concept requires that vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft when weather conditions permit. It also advises that pilots must always keep in mind their responsibility for continuously maintaining a vigilant lookout regardless of the type of aircraft being flown or whether operating on an IFR flight plan or under a VFR flight plan. It admonishes pilots to "Remember that most MAC (midair collision) and reported NMAC (near midair collision) incidents occurred during good VFR weather conditions and during the hours of daylight." The circular warns pilots that the view of the surrounding airspace is restricted by the inherent cockpit design and flight attitude of the aircraft. It directs attention to the performance capabilities of many aircraft, in both speed and rates of descent or climb, which result in high closure rates and limited time for detection, decision, and evasive action. The AC recommends that the pilot systematically sweep his eyes over the entire visible area and increase his visual field by head movements. 9/ It states that pilots should also be familiar with, and use caution in, those operational environments where pilots may expect to find a high volume of traffic. These cautionary areas include airport traffic patterns, instrument approach areas, and areas of high density jet arrival and departure routings, especially in the vicinity of military bases and major terminals. The publication emphasizes the use of communications equipment and air traffic radar advisory services. It states?

> One of the major factors found, during the FAA NMAC study as contributing to the likelihood of an NMAC incident, was the mix of known arriving and departing aircraft with UNKNOWN traffic in terminal areas with an operating control tower. The known aircraft were in radio contact with some function of the tower (local, approach, or departure control) and other aircraft were not in two-way radio contact and unknown to the tower at the time of the NMAC. This precluded the tower from issuing traffic advisory information to either aircraft. Although pilots must adhere to the necessary communications requirements when operating VFR, they are also urged to take advantage of the air traffic advisory services available to VFR aircraft.

Pilots are urged to use the AIM for information dealing with services available to pilots, including information regarding VFR radar advisory services and, further, to develop a working knowledge of those facilities providing traffic advisory services and the area in which such services are available. Notably, according to FAA Advisory Circular 90-48, pilots are advised to use currently effective aeronautical charts for the area in which they intend to operate and to understand the aeronautical legend and chart symbols related to airspace information depicted on aeronautical charts.

Controller Responsibilities--Basic Air Traffic procedures as applied to the National Airspace System (NAS) are set forth in Air Traffic Control Handbook 7110.65, a publication of the Federal Aviation Administration. The procedures contained in this publication apply to military and civilian ATC facilities, unless changes are justified by unusual local circumstances and approved by appropriate authorities. Accordingly, the

9/ A scan pattern is accomplished by a series of head and eye movements designed to cover the region in airspace where aircraft may appear.

procedures promulgated in this Handbook, as supplemented by military procedures, were applicable to the Cannon RAPCON controllers on duty at the time of the accident. As part of the USAF Mid-Air Collision Avoidance Program, a pamphlet containing an attachment entitled "Pilot/Controller Responsibilities" was also available to the RAPCON controllers. This attachment summarized information from FAA publications 10/ and also included local information.

According to the publications, air traffic controllers are responsible to give first priority to the separation of aircraft in the IFR environment and to the issuance of radar safety advisories. Second priority is to provide other services that are required but do not involve the separation of aircraft. Third priority is to provide additional services to the extent possible. The AT system provides that the pilot-in-command is directly responsible for and is the final authority as to the safe operation of the aircraft, but in many areas the responsibilities assigned to the pilot and the controller are intentionally overlapping to provide a degree of redundancy. The system is designed, according to the FAA criteria, so that should either the pilot or the controller fail to carry out his assigned responsibility in any manner, the overlapping of responsibility (or redundancy) should compensate for failures that may affect safety. In order to maintain a safe and efficient air traffic system, it is necessary that both pilots and controllers fulfill their responsibilities to the fullest extent.

The discussion of pilot and controller responsibility contained in the AIM advises controllers to issue an Aircraft Conflict Advisory immediately to an aircraft under his control if he is aware of an aircraft not under his control that is at an altitude believed to place the aircraft in unsafe proximity to each other. The pilot is warned that this radar service is not a substitute for pilot adherence to safe operating practices as he must be aware that safety advisories are not always available and that many factors affect the ability of the controller to be aware of a situation in which unsafe proximity to another aircraft is developing.

AT controllers are instructed to provide radar vectors for separation in controlled and uncontrolled airspace upon the request of the pilot and to issue traffic advisories to the maximum extent consistent with higher priority duties. Cannon AFB provides Stage II Radar Advisory Service and Sequencing for VPR aircraft. This service extends the terminal radar service that is provided to IFR aircraft to VPR aircraft. Pilot participation in the advisory service is urged but it is not mandatory. Although this participation is primarily designed for arriving and departing VFR aircraft at terminal airports, pilots of aircraft transiting the area and in radar contact and communication with approach control will be given traffic information. Since on initial radio contact the approach controller will assume that Stage II radar service is requested, 11/ pilots who request the service should give their position, altitude, transponder code, destination, and route of flight.

Additional services--The requirement for AT controllers to provide additional services, including traffic advisories for aircraft separation, is referenced in the FAA Air Traffic Handbook 7110.65. The handbook states that the primary purpose of the AT system is to prevent a collision between aircraft operating in the system and to organize and expedite the flow of traffic. In addition to the primary function to IFR users of the system, there is a capability, with certain limitations, to provide additional services. In

10/ ATC Handbook 7110.65 and Airman's Information Manual Part 1.
11/ A description of full service is contained in the AIM, Basic Flight Information and ATC Procedures.

this case, the pertinent limitations include controller workload and higher priority duties. The provision of additional services is not optional on the part of the controller, but rather is required when the work situation permits.

1.17.7 The "See and Avoid" Concept and Collision Avoidance Systems

On March 9, 1967, near Urbana, Ohio, a midair collision occurred between a McDonnell Douglas DC-9 and a Beechcraft Baron. 12/ In its investigative report, the Safety Board stated that the "see and avoid" concept—was not a practical solution to the problems of high speed closure rates which, on certain occasions, confront the crews of modern aircraft. The Board found that environmental conditions and the high speed of the DC-9 limited visual detection capabilities in the air traffic control system which did not separate controlled and uncontrolled traffic. The accident report went on to state "...the Board is of the opinion that the development of a practical Collision Avoidance System (CAS), suitable for use on the majority of aircraft, would provide a great contribution to flight safety."

During the course of the investigation of another midair collision, which involved an air carrier and a general aviation aircraft on August 4, 1968, 13/ the Safety Board was informed of the activities of the Collision Advisory Group (COPAG), which was comprised of representatives of Government agencies and civil aviation associations and directed primarily toward the development of airborne systems designed to prevent midair collisions. As a result of the COPAG studies, the Safety Board concluded that Collision Avoidance Systems (CAS) or Pilot Warning Instruments (PWI) would provide a substantial contribution to collision avoidance and, therefore, supported their developmeht.

On September 9, 1970, near Fairland, Indiana, another midair collision occurred between an air carrier and general aviation aircraft. 14/ In its report, the Safety Board stated that "...the operating characteristics of present and future jet aircraft appear to preclude speed restrictions to a level at which "see and avoid" can be relied upon, particularly where high descent rates are involved. Of more than passing interest is the fact that in nearly all of the midair collisions, whether between military and civil aircraft or between general aviation and airline aircraft, at least one of the aircraft was changing altitude." In this report, the Safety Board noted that one common premise underlying analysis of collision probability is the existence of some minimum "warning time", admittedly variously estimated by different sources. After reviewing several physiological studies, the Board concluded that 15 seconds is the absolute minimum time for detection, evaluation, and evasive action if a collision is to be avoided. The Board further concluded "...that the 'see and avoid' concept of collision avoidance, which has been demonstrably deficient in the past, is now totally unacceptable in providing separation between aircraft during descent into terminal areas where high- and low-speed traffic is intermixed under IFR and VFR control." The Board further stated that "...recognition of the vast scope and far-reaching effects of this conclusion prompted the Board to conduct a public hearing on the Midair Collision Problem." 15/

12/ Aircraft Accident Report—Trans World Airlines, Inc., Douglas DC-9, Tann Company Beechcraft Baron B-55, In-Flight Collision, near Urbana, Ohio, March 9, 1967.

13/ Aircraft Accident Report—North Central Airlines, Inc., Convair 580, N46345 and Home Airmotive, Inc., Cessna 150 Midair Collision Near Milwaukee, Wisconsin, August 4, 1968.

14/ Aircraft Accident Report—Allegheny Airlines, Inc., DC-9 N988VJ and Forth Corporation Piper PA 28, N7374J, Fairfield, Indiana, September 9, 1969.

15/ Report of Proceedings of the National Transportation Safety Board into the Midair Collision Problem, November 4 through 10, 1969.

In its report following the public hearing, the Safety Board stated that it appears under certain circumstances the rate of closure of very high-speed aircraft is such that the total time in which an aircraft may be visible to a pilot of another aircraft is so short that the pilots cannot be expected to insure separation between aircraft, irrespective of the weather conditions in which they are flying. The Safety Board also noted that the inadequacy of the "see and avoid" concept had received recognition in the 10 years between 1960 and 1970, and studies were conducted to determine the feasibility of devices in the cockpit to warn the pilots of potentially conflicting traffic. One such study 16/ concluded that the chances of collision avoidance would be higher if the pilot were aware that potentially conflicting traffic was present and knew approximately where to look for it. At the conclusion of the public hearing, the Safety Board recommended that the Federal Aviation Administration support the expeditious development of low-cost Collision Avoidance Systems for all civil aircraft. 17/

In the midair collision report, which occurred between a military tactical aircraft and an air carrier at Duarte, California, on June 6, 1971, 18/ the Safety Board reiterated the position taken many times that for certain operational conditions, the "see and avoid" concept is a valid but limited one, and the development of collision avoidance systems must be vigorously pursued. Following the collision between an air carrier and a general aviation aircraft at San Diego, California, on September 25, 1978, 19/ the Safety Board stated that some levels of "see and avoid?' will remain a valid concept for collision avoidance whenever an aircraft is flown in visual conditions and will be a part of any collision avoidance system. However, the concept appears to place a disproportionate burden on the flightcrews of high performance aircraft. This is especially true where the concept is used for collision avoidance in a mixture of high-speed and low-speed traffic in a terminal area.

In June 1981, the Administrator of the Federal Aviation Administration announced a National Standard for airborne collision systems. The Safety Board commends the FAA for this action. The designated equipment is described as the "threat-alert collision avoidance system" (T-CAS). Several models of this system have different capabilities; however, all models operate without dependence on ground equipment. The T-CAS offers protection for small general aviation aircraft against similar aircraft if one aircraft has at least a conventional transponder and the other has the basic T-CAS 1 warning system. If a T-CAS 1-equipped aircraft is in the vicinity of a T-CAS 2-equipped aircraft, the latter can determine the separation distance, relative bearing, and altitude separation between the two aircraft. The latter aircraft then transmits these data to the T-CAS 1 aircraft, where the data can be displayed if the general aviation aircraft is equipped with a modified basic system. When there is a potential conflict between two T-CAS 2-equipped aircraft, each evaluates the threat and determines the optimum evasive maneuver. The equipment will be available on a voluntary basis within 3 or 4 years.

In the Clovis, New Mexico, midair collision, if either the civil aircraft or the military aircraft, or both, had been equipped with a collision avoidance system, the

16/ A Study of Requirements for a Pilot Warning Instrument for Visual Airborne Collision Avoidance - Sperry Gyroscope Company, December, 1963.
17/ See Appendix K of this Report--A Summary of Safety Board Midair Collision Recommendations.
18/ Aircraft Accident Report--Hughes Air West DC-9, N9345 and U.S. Marine Corps F-4B, 151458, near Duarte, California, June 6, 1971.
19/ Aircraft Accident Report--Pacific Southwest Airlines, Inc. B-727, N533PS and Gibbs Flite Center, N7711G, San Diego, California, September 25, 1978.

pilot(s) would have been aware of the proximity of the other aircraft and if evasive action had been taken, the midair collision might not have occurred.

2. ANALYSIS

The circumstances involved in this accident concern a midair collision between a Cessna TU-206G which was on a VFR flight plan to land at Clovis Municipal Airport and a General Dynamic F-111D, a military aircraft, performing a simulated instrument approach to Cannon AFB under an IFR flight plan. The military aircraft was in radio contact and under positive control of a RAPCON facility. The civil aircraft was unknown to the RAPCON controllers and was not required to contact the RAPCON controllers.

The pilots of both aircraft were properly certificated to operate their aircraft. Except for the arrival controller trainee who was working under supervision, the AT controllers were fully rated to perform their assigned duties by authority of the United States Air Force and the Federal Aviation Administration. A detailed examination of the entire structure of both aircraft indicated that neither aircraft had incurred any in-flight mechanical problems or structural failure before the collision.

The Collision impact markings and gougings were used to determine the collision angles of each aircraft. The initial contact of the two aircraft was between the F-111D's right wing bomb rack and the wing tip of the Cessna's left wing. After the initial impact, the Cessna struck the F-111D's bottom right fuselage engine nacelle. Scratches and gouge marks, which were imprinted with white and blue paint, were found on the bottom of the F-111D's right engine. The impact damage indicated that the Cessna collided with the F-111D about 22° right of the F-111D's centerline axis. Impact markings on the Cessna indicated that the Cessna collided with the F-111D about 82° to the left of the Cessna's axis centerline. The evidence further indicated that there was no relative vertical motion between the two aircraft, which also indicates that at the time of impact both aircraft were in level flight.

The ABQ ATC radar track recording was smoothed to provide the average ground speed during the last 105-second period before the collision. This information in combination with the collision angles determined from impact markings provided an average closure rate. Further, as the radar track recording did not provide information below 6,400 feet and after the aircraft descended below 6,400 feet, and the collision occurred 14 seconds later, the recommended AILA approach profile and the instrument readings from the crew escape module at the time of module ejection were used to estimate the altitude and indicated airspeed at the time of collision.

The AILA approach profile prescribes that a F-111D descend, with the speed brake extended, from the BARDO 24-mile DME fix to cross the 10-mile DME fix at 5,800 feet and 300 KIAS (knots indicated airspeed). As the desired airspeed is reached, the speed brake is retracted. The smoothed radar data indicate that the F-111D descended at an average rate of about 3,600 feet per minute and an average ground speed of 380 knots. Applying the wind velocity factor, the aircraft's true air speed was about 395 knots and then applying the density altitude factor, the F-111D indicated airspeed averaged 340 knots.

The crew escape module instruments recorded that at the time of ejection the airspeed indicated 300 knots, the rate of descent was 1,850 fpm, the right wing was down 95° and the nose was lowered 32°, and the left engine fuel flow indicated that the engine

was in the after burner range. When considered with the radar track ground speed, the speed brake extension, the high speed mode of the module ejection, and the time from the last usable radar information to ejection, these recordings in the module indicate that the indicated airspeed of the F-111D was less than 340 knots and greater than 300 knots at the time of collision. Furthermore, as the speed brake was still extended at the time of collision, the collision occurred at 5,800 feet or slightly higher. The indicated airspeed and ground speed of the Cessna were 125 knots and 128 knots, respectively. The closure rate between the two aircraft was about 370 knots or 625 feet per second.

Neither pilot had reported any mechanical problem or system malfunction with his aircraft which might have caused a distraction to disrupt his scanning for other aircraft. There was no evidence that the Cessna pilot had communication difficulties since shortly before the collision he had made a radio call to the TCC flight service station. Although he was not required to, the Cessna pilot had the capability to transmit to the RAPCON controllers and make his position and intentions known. The controllers stated, however, that the Cessna pilot was never in radio contact with them. The Safety Board believes that had the Cessna pilot been in radio contact with the RAPCON facility, timely traffic advisories or radar vectoring might have prevented the collision.

A State of New Mexico Aeronautical Chart was found in the Cessna wreckage. This chart displayed the Cannon AFB control zone and the airspace controlled by the Cannon AT facilities. The features of this chart are illustrated in a manner similar to the U.S. ABQ Sectional Aeronautical Chart. Neither contained notations to caution pilots of heavy concentrations of low-altitude jet traffic in the Clovis area, to advise that Cannon AFB provided Stage II radar service, or to advise pilots to consult the publication "Graphic Notices and Supplemental Data" when flight is planned in the Clovis area.

Charts similar to the Federal Sectional Aeronautical Chart and the State of New Mexico Aeronautical Chart are the charts most commonly carried by pilots on cross country flights. Other publications carry notices of AT advisory services, terminal area IFR routes versus VFR recommended corridors, and advisories of cautionary areas and altitudes, but are not normally carried aboard aircraft by private pilots, particularly noninstrument rated pilots. Even though a private pilot is aware of a terminal cautionary area, without an advisory note on his Aeronautical Chart suggesting that he contact the controlling AT facility for traffic advisories and recommended routes, he must rely on his memory for safe piloting in the recommended airspace. Although the pilot of the Cessna had flown in the Clovis area several times, there was no evidence that he was aware of recommended flight routes in the Cannon AFB terminal area. The Safety Board believes that had there been an advisory notation on the aeronautical chart, the Cessna pilot might have been prompted to establish radio contact with the Cannon RAPCON.

The terminal area graphic notice for Clovis-Cannon AFB, New Mexico, dated February 22, 1979, was published in the January 1980, issue of "Graphic Notices and Supplemental Data," a FAA Flight Information publication. (See appendix G.) The same graphic notice was distributed by the Cannon MACA program to other airport operators, military and civilian, including fixed base operators at Clovis Municipal Airport. Distribution had also been made to Cannon AFB personnel and the notice had been available to the pilot of the F-111D and the RAPCON controllers. It is not known if the terminal area graphic notice had been seen by the pilot of the Cessna. The Safety Board believes that it is a rule of prudent airmanship that all pilots acquaint themselves with en route and airport information along their intended flight path.

The geometric outline in the northeast sector of the 15-nmi cautionary area of the chart, which relates to a VFR corridor but cannot be readily identified as a VFR corridor, does not appear in the legend although there is an unrelated symbol described in the legend as "Recommended VFR corridors". A numerical symbol which appears outside the cautionary area is intended to indicate that the maximum altitude to be flown in that area is 5,300 feet. This symbol, which is used on instrument approach charts, is not described in the legend of the subject graphic notice. The meaning of the geometric outline and the numerical symbols might not be known to a noninstrument rated pilot.

The collision occurred about 5,800 feet as the Cessna was descending from its cruising altitude. The Cessna pilot possibly had not seen the published chart, which had been distributed in the Clovis area, or did not recall the altitudes that he had seen on the chart, or did not understand the significance of the altitude notations on the chart. Without a clearly stated explanation of the symbols used on the subject graphic notice, the Cessna pilot might have understood that he was flying at a safe altitude when he flew at or below 5,800 feet. This altitude was designated for the segment of the F-111D's runway 21 AILA approach where the collision occurred.

USAF directives require that a military pilot obtain approval for an AILA approach from the AT controlling agency before commencing the approach. The pilot is also required to request separation from other traffic if the radar service is available. While the pilot of the F-111D did request approval for the AILA, he did not request separation from other traffic. If he had requested traffic separation, the RAPCON controllers may have been on the alert for and seen the radar return of the Cessna and have issued an advisory. An AILA approach in the F-111D is a maneuver which is coordinated between the pilot and the WSO. The USAF directive states that the pilot is required to establish and brief the WSO on flight parameters which will be flown during the approach. If the established parameters are exceeded, the crewmember not flying is to advise the other crewmember. Flight guidance for the maneuver is provided by cockpit instrumentation and, therefore, the crewmembers are required to concentrate a significant amount of their attention inside the cockpit. During flight in visual flight conditions, crewmen are directed to insure that they are never occupied with cockpit duties simultaneously. The directive states that the "see and avoid" policy is mandatory and that the aircraft's flight path should be visually cleared by at least one crewmember at all times.

The rules of 14 CFR 91.67, which pertained to the flight of the F-111D and the Cessna, state that when weather conditions permit, regardless of whether an operation is conducted under Instrument Flight Rules or Visual Flight Rules, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft. The FAA's AIM explains in detail that it is the pilot's inherent responsibility at all times to anticipate circumstances, situations, and conditions which affect the safe operation of his aircraft. This widely distributed publication warns crewmembers that when near both civil and military airports and in the vicinity of training areas, they should expect concentrated air traffic. FAA AC No. 90-48 states that the see and avoid concept requires that vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft. It advises that pilots must keep in mind their responsibility for continuously maintaining a vigilant lookout regardless of the type of aircraft being flown and regardless of the type of flight plan in effect.

Analysis of the Board visibility study photographs indicate that reasonable head or body movements of the Cessna pilot or his passenger would not have placed the other aircraft in their respective fields of vision, when distance and target size are

considered. In fact, during the 105 seconds before the collision, or from the time the F-111D was about 10 miles away from the collision point, the F-111D would have been above the left wing and completely hidden from the Cessna pilot. During the 90 seconds before the collision, the Cessna was within the monocular vision of the WSO but the F-111D pilot's vision was obscured by his cockpit structure. Reasonable head or upper body movements by the pilot would not have placed the Cessna within his view; however, similar reasonable movement by the WSO relative to his windshield would have placed the Cessna within his full binocular vision. However, *to* continually maintain the aircraft's required course and descent angle for a precision approach, particularly as a qualifying crewmember, the WSO's attention to the radar's flight guidance information would have preempted his visual scanning for other aircraft.

Analysis of the collision geometry shows that the F-111D was descending at a high rate of speed and struck the Cessna from the left side at approximately an 80° angle. As the flight paths converged during the last 10 miles of the F-111D's flight, the Cessna would have moved from slightly right to directly in front of the F-111D. ,Despite the difficulties that would have been encountered by the F-111D flightcrew in observing the Cessna because of the high closure rate and the position of the Cessna relative to the F-111D cockpit structure, the Safety Board concluded that the F-111D flightcrew failed in their responsibility to see and avoid the Cessna.

The Safety Board recognized that the Cessna pilot also had a responsibility to see and avoid all relevant traffic in the airspace it was traversing. However, based on its projected flight path, the acute collision angle, the limitations to the field of vision imposed by the aircraft structure and the high closure rate of the F-111D, the Safety Board concluded that the Cessna pilot could not have reasonably been expected to see and avoid the F-111D.

According to the FAA Handbook 7110,65C, the AT controllers are required to provide traffic advisories, with certain limitations, to aircraft operating in the IFR system. This requirement would have applied to the F-111D which was under the positive control of the RAPCON. In this accident, the restrictive limitations which might have applied were controller workload or priority duties; however, neither of these limitations was applicable since the F-111D was the only aircraft directly under the control of the arrival controllers and no higher priority duties were evident. The Safety Board concludes that there was adequate time for the controllers to monitor the controlled airspace and to issue a traffic advisory to the F-111D had the controllers seen the potentially conflicting "unknown" traffic.

Following the accident, the Cannon RAPCON radar equipment was checked for operational capability and all components were found to function satisfactorily. At a later date, a Safety Board investigator observed the facility equipment to check particularly for adequate reception of primary targets and code 1200 secondary returns. The reception of all radar returns was adequate for AT control services. In addition, the ABQ ARTCC radar antenna received and recorded the code 1200 beacon response of the Cessna until the time of collision. The Safety Board was not able to identify any technical reason why the RAPCON facility would have failed to receive the primary or secondary radar return of the Cessna at any time after the aircraft entered the Cannon AFB controlled airspace, the radius of which extends 20 nmi around the military airport.

The Safety Board concludes that the radar and beacon returns of the Cessna were displayed on the RAPCON radar scope. However, the Safety Board was unable to determine positively why the controllers did not observe the radar returns. It can be reasonably concluded that their attention was directed elsewhere. This controller

oversight compromised the safety margin provided by the shared and overlapping responsibilities of the pilot and the controller which are intended to prevent collisions in the see and avoid environment.

3. CONCLUSIONS

3.1 Findings

1. The pilots of both aircraft were properly qualified to operate their respective aircraft.

2. Except for an arrival controller trainee who was performing under supervision, the controllers were fully rated to perform their assigned duties.

3. The military aircraft, a General Dynamics F-111D, was under positive air traffic control of the Cannon AFB RAPCON facility.

4. The Cessna pilot did not establish radio contact with the Cannon RAPCON control facility nor was he required to.

5. There was no evidence that either pilot had any mechanical problem, system malfunction, or communication difficulty with his aircraft before the collision.

6. The pilots of both aircraft were required by regulations to "see and avoid" each other.

7. The relative positions of the collision aircraft with respect to each other was such that both pilots were precluded from having an unobstructed view of the other aircraft during the 90 seconds preceding the accident.

8. Before the collision, the Cessna was within the monocular vision of the F-111D WSO and reasonable movements by the WSO relative to the windshield would have placed the Cessna within his full binocular vision.

9. However, the high closure rate of the two aircraft and the precise requirements of the F-111D's AILA approach precluded the WSO from scanning for other aircraft.

10. While the pilot of the F-111D did request approval for the AILA approach, he did not request separation service from other aircraft.

11. The evidence did not establish whether or not the Cessna pilot had consulted appropriate aeronautical charts for his route of flight.

12. The terminal area graphic chart for Clovis-Cannon AFB,. which was published in the January 1980 issue of "Graphic Notices and Supplemental Data," contained symbols not depicted in the legend and notations not clearly defined on the chart. The Cessna pilot may not have understood that he was flying at an unsafe altitude even if he had consulted the chart.

13. The controllers had adequate time to monitor their controlled area and to issue a traffic advisory to the F-111D.

14. There was no technical reasons why the primary or secondary returns of the Cessna would not have been displayed on the controller's radar-scopes.

15. The radar and beacon returns of the Cessna were displayed but the controllers failed to see them.

16. The circumstances of this accident reflect the limitations of the see and avoid collision avoidance concept, particularly when there is an intermix of high and low speed aircraft which are IFR and VFR, respectively.

32 Probable Cause

The Safety Board determines that the probable cause of this accident was the failure of both aircraft to request radar traffic advisories, the failure of the F-111D flightcrew to see and avoid the Cessna TU-206G, and the failure of the RAPCON controllers to observe the Cessna radar target and to issue traffic advisories to the F-111D. Contributing to the accident were the limitations of the see and avoid concept in a terminal area with low speed/high speed traffic.

4. RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board recommended:

—to the Federal Aviation Administration:

Simplify and standardize, to the extent feasible, the terminal area graphic notices, published in the "Graphic Notices and Supplemental Data," and explain all symbols used in a notice in the accompanying legend. (Class II, Priority Action) (A-82-112)

Add to all terminal area charts, which are published in "Graphic Notices and Supplemental Data," a notation encouraging all pilots intending to operate VFR within the terminal area to contact the controlling AT facility and an advisory notation, when applicable, indicating that radar traffic advisory services are available on request. (Class II, Priority Action) (A-82-113)

Add to all federal sectional aeronautical charts a prominent advisory notation pertinent to terminal areas at which radar traffic advisory services are available on request. (Class II, Priority Action) (A-82-114)

Advise state aviation authorities that they should include on state aeronautical charts the information contained on federal sectional aeronautical charts pertinent to safe navigation, particularly in regard to radar traffic advisory services in terminal areas where there are multiple airfields. (Class II, Priority Action) (A-82-115)

--to the National Association of State Aviation Officals:

Advise state aviation authorities that they should include on state aeronautical charts the information contained on federal sectional aeronautical charts pertinent to safe navigation, particularly in regard to radar traffic advisory services in terminal areas where there are multiple airfields. (Class II, Priority Action) (A-82-116)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ G.H. PATRICK BURSLEY
Member

/s/ DONALD D. ENGEN
Member

PATRICIA A. GOLDMAN, Vice Chairman, did not participate.

August 24, 1982

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was notified of the accident about 1415 on February 6, 1980. An investigator from the Safety Board's Denver field office was dispatched to the scene immediately. Later, Human Factors, Structure, and Air Traffic Control specialists were assigned to the investigation from the Washington, D.C. office.

Parties to the investigation included the Federal Aviation Administration, the United States Air Force, the General Dynamics Corporation, and the Cessna Aircraft Company.

2. Hearing

No public hearing was held.

APPENDIX B

PERSONNEL INFORMATION

Flightcrew of F111D

Captain Roy W. Westerfield, 34, entered the U.S. Air Force on November 18, 1969. He completed undergraduate pilot flight training on December 12, 1970. He was rated as a senior pilot and, at the time of the accident, he was serving as an instructor pilot. He had accumulated a total of 2,505 flight hours, with about 980 hours in the F-111D. He had served as an instructor pilot in the F-111D for 516 hours. Captain Westerfield had qualified as an instrument pilot on April 2, 1979, and he had completed recurrent instrument training on September 19, 1979. His medical qualification, issued without waivers, was updated on April 24, 1979.

During the initial instrument qualification flight in April 1979, Captain Westerfield was criticized by the flight examiner for incorrectly lowering the wing slats during gear extension while executing a simulated single engine approach and he was also criticized for rough handling of the aircraft and poor airspeed control during the final approach. During the recurrency flight for instrument proficiency in September 1979, he was criticized by the flight examiner for not performing a complete Before Landing Check during a No Flap/Slat approach and for losing 300 feet of altitude in a VFR pitchout maneuver. These critical areas were debriefed by the flight examiners and neither examiner recommended further corrective actions. The second flight was flown as a 2-ship mission; the briefing and in-flight instructions were reported as excellent. During the past 30, 60, and 90 day periods, he had flown approximately 12, 23, and 34 hours, respectively. He had flown the day before the accident.

Second Lieutenant Stephen P. Anderson, 23, entered the U.S. Air Force on May 26, 1978. He completed undergraduate navigator training April 25, 1979. He was rated as a navigator and, at the time of the accident, he was serving as a student weapons system officer. He had accumulated a total of 126 flight hours, with about 18 hours in the F-111D. His medical qualification, issued without waivers, was updated March 21, 1979. Since Lieutenant Anderson was in initial student training, his flightcrew proficiency in the F-111D had not been evaluated. During the past 30, 60 and 90 day periods, he had flown approximately 7, 15, and 18 hours, respectively. His last flight previous to the accident was on January 23, 1980.

Cessna 206 Pilot

Homer D. Douglas, 43, held private pilot certificate number 2076056, with aircraft single engine land privileges. It was issued February 22, 1971. He held a third class medical certificate, issued without limitations on August 9, 1979. .His log book was destroyed in the accident; however, his medical certificate stated that he had 150 flight hours on the date of his physical examination. Other records disclosed that he had received 13.7 hours of dual flight instruction in the Cessna 206 during August 1979. It was estimated that he had accumulated about 55 solo hours in the Cessna 206 when the accident occurred. He had flown the route between ABQ to CVN, via TCC, two times before the accident. One of these flights was on December 6, 1979. The Cannon RAPCON communication log did not contain a record of radio contact with Mr. Douglas on that date. Mr. Douglas was the President of Building Contractors, Incorporated, Albuquerque, New Mexico.

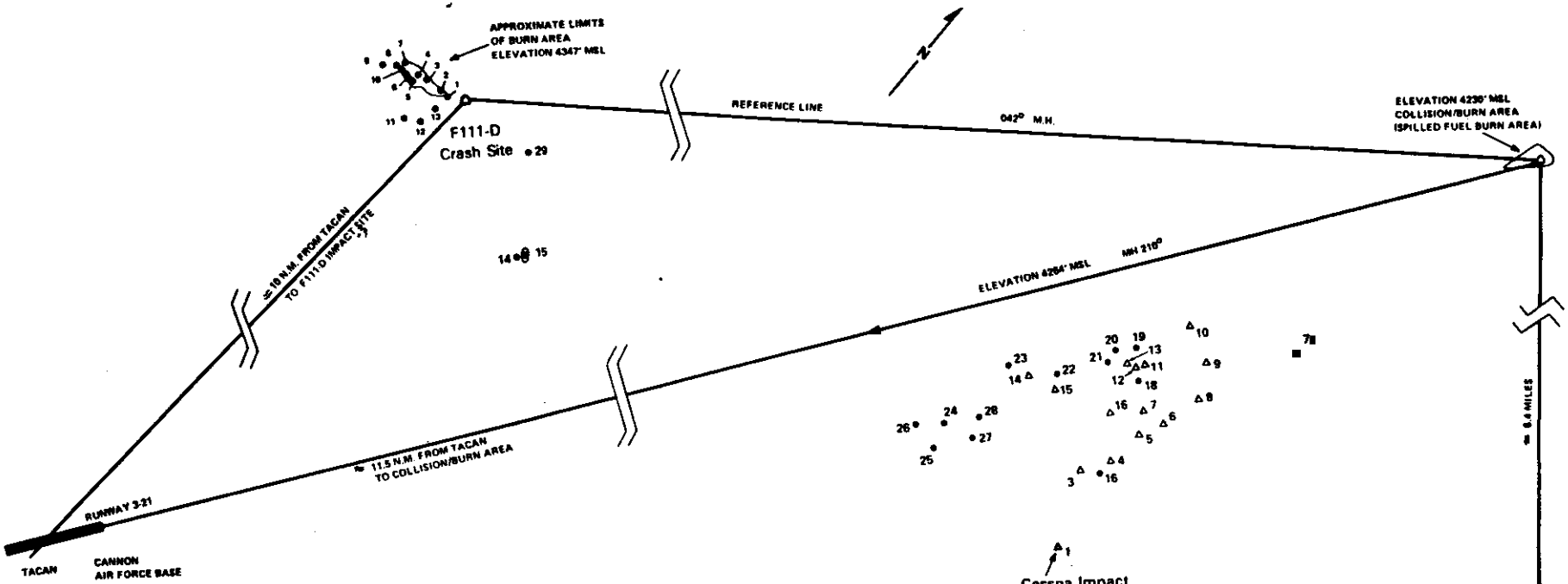
RAPCON Personnel

Staff sergeant Mark R. Hilleren was the watch supervisor in the RAPCON facility at the time of the accident. He was fully rated as an approach controller (RAPC) and fully rated as a radar final approach controller (RFC). He had a total of 9 years and 8 months of air traffic control experience. He had 3 years and 6 months experience as a Cannon AFB radar controller.

Airman First Class Allison was on duty at the time of the accident as the approach/departure controller. He also held RAPC and RFC ratings. He had 1 year and 3 months total ATC experience; all of his ATC experience was at Cannon AFB.

Staff sergeant Rita Jimenez was assigned to the arrival controller position. At the time of the accident, she was monitoring a trainee at the same position. She held RAPC and RFC ratings. She had 3 years and 2 months total ATC experience; all of her ATC experience was at Cannon AFB.

Staff sergeant David Torres was assigned as an arrival controller trainee. He was not a rated controller. He had 2 years and 8 months total ATC experience; he had 2 weeks experience in the Cannon RAPCON facility.



LEGEND:

F111-D ACCIDENT SITE COORDINATES:
Latitude: 34° 30', 0"
Longitude: 103° 11', 42"

CESSNA 206 ACCIDENT SITE COORDINATES:
Latitude: 34° 30', 97"
Longitude: 103° 9', 98"

0 1000 1500 2000 FEET

Scale: 1" = 240'

COMPONENT IDENTIFICATION

● F-111 D ▲ Cessna TU206G

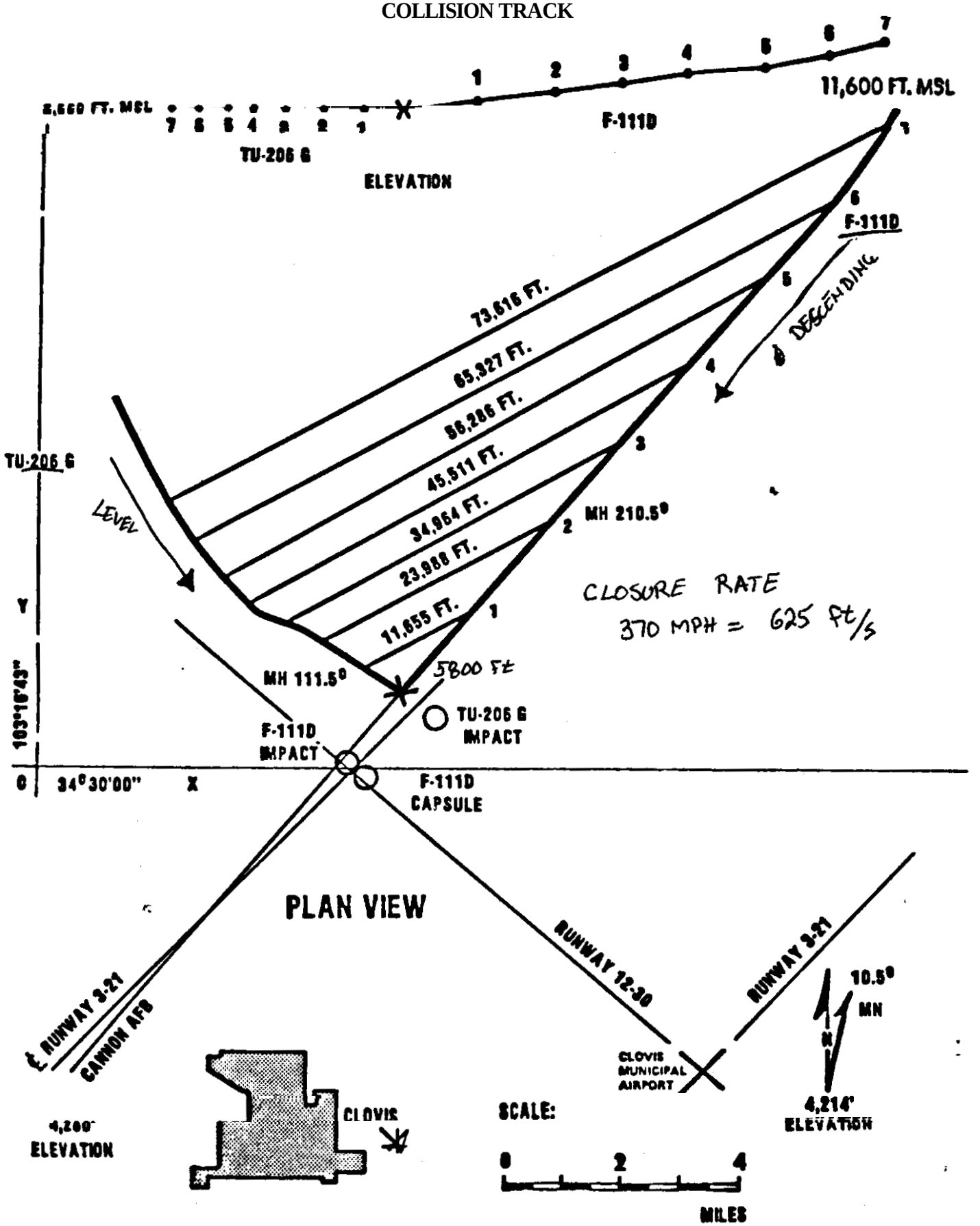
ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	RIGHT UNDERWING FAIRING	1	AIRCRAFT FUSELAGE
2	RIGHT STABILIZER	2	ENGINE
3	LEFT STABILIZER	3	STEERING WHEEL
4	LEFT WING TIP	4	PROPELLER HUB
5	FWD. EQUIPMENT BAYS	5	WING STRUT
6	RIGHT WING TIP	6	LEFT FRONT SPAR
7	A.C. MID-SECTION	7	RIGHT WING FLAP
8	LEFT ENGINE	8	LEFT WING FLAP
9	RIGHT ENGINE	9	LEFT WING OUTER PANEL
10	RADOME	10	RIGHT WING OUTER PANEL
11	BOAT TAIL	11	CABIN DOOR (LEFT)
12	RUDDER	12	WING FUEL BAY
13	HORIZONTAL STABILIZER	13	LEFT WING FRONT SPAR
14	CREW CAPSULE	14	VAC. PUMP/PORTION OF PROP.
15	CAPSULE IMPACT AREA	15	LEFT WING FRONT SPAR
16	AFTERBURNER SECTION	16	RIGHT AILERON
17	PANEL		
18	AFTERBURNER SECTION		
19	AFTERBURNER SECTION		
20	PANEL		
21	BRU NOSE		
22	RIGHT ENGINE BAY PANEL		
23	PORTION OF RIGHT STRAKE		
24	BOTTOM SECTION RIGHT ENGINE NACELLE FRAME, FS 725		
25	BOTTOM SECTION RIGHT ENGINE NACELLE FRAME, FS 770		
26	BOMB RELEASE UNIT (BRU)		
27	CONSTANT SPEED DRIVE OIL FILLER INLET CAP		
28	RIGHT ENGINE HYDRAULIC OIL COOLER		
29	PIECES OF NOSE GEAR DOORS		

APPENDIX C

Wreckage Distribution Chart

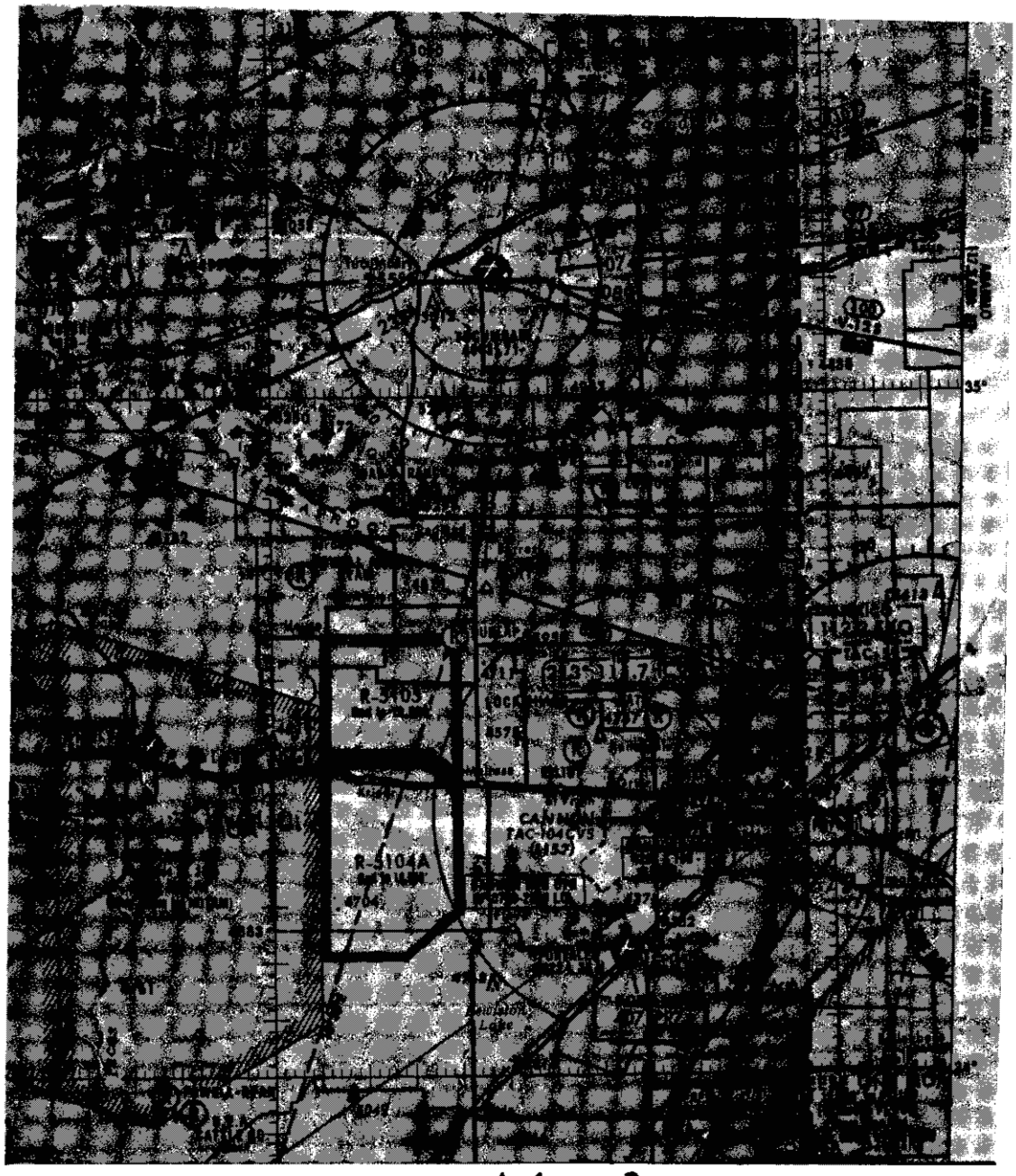
APPENDIX D

COLLISION TRACK



APPENDIX E

AERONAUTICAL CHART, STATE OF NEW MEXICO



NEW MEXICO

AERONAUTICAL CHART

data on this chart is up-to-date as of August 6, 1981

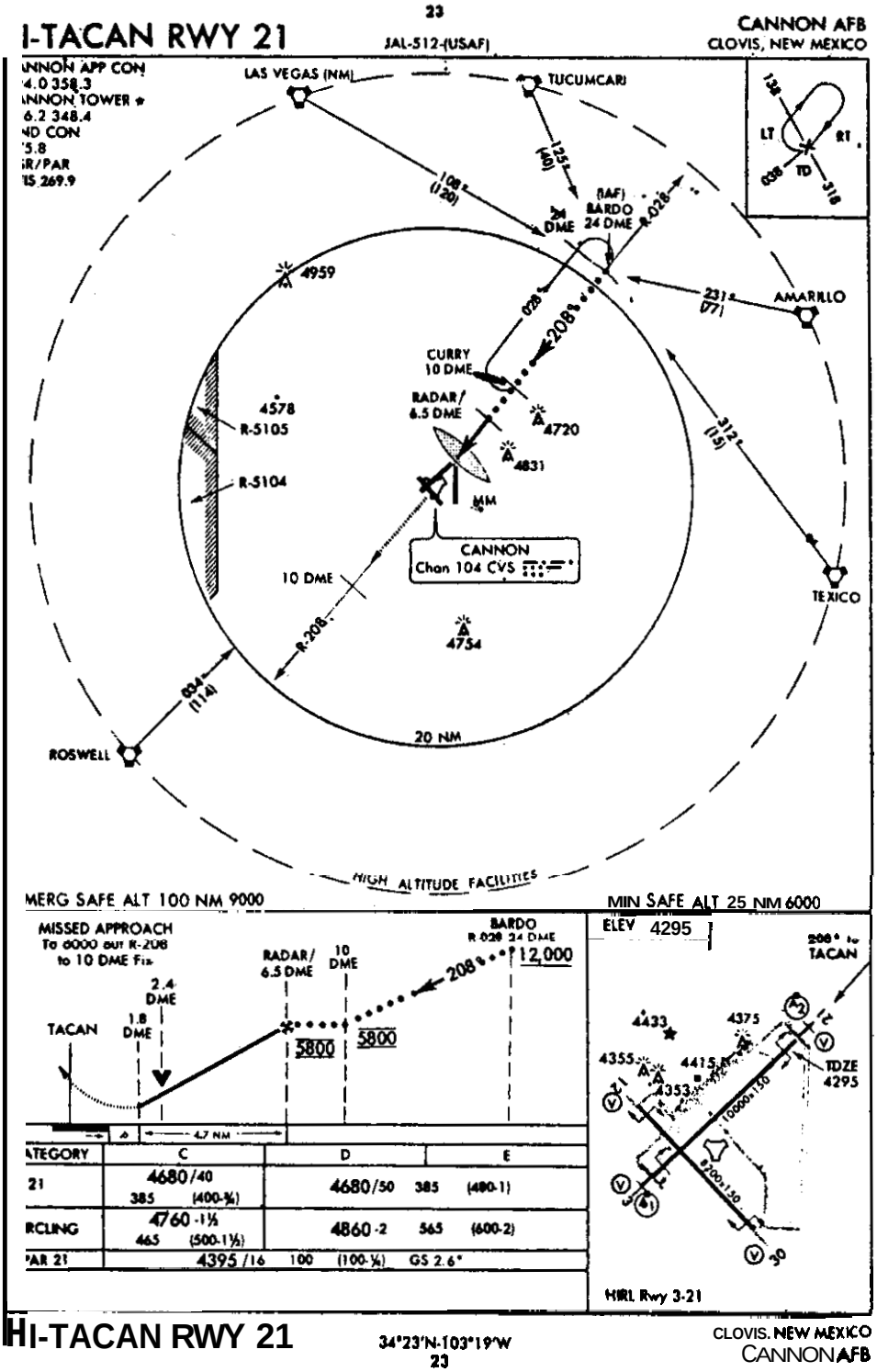
SCALE 1:1,000,000

STATUTE MILES 10 0 10 20 30 40 50 60 70

NAUTICAL MILES 10 0 10 20 30 40 50 60

APPENDIX F

HI–TACAN RUNWAY 21 APPROACH CHART

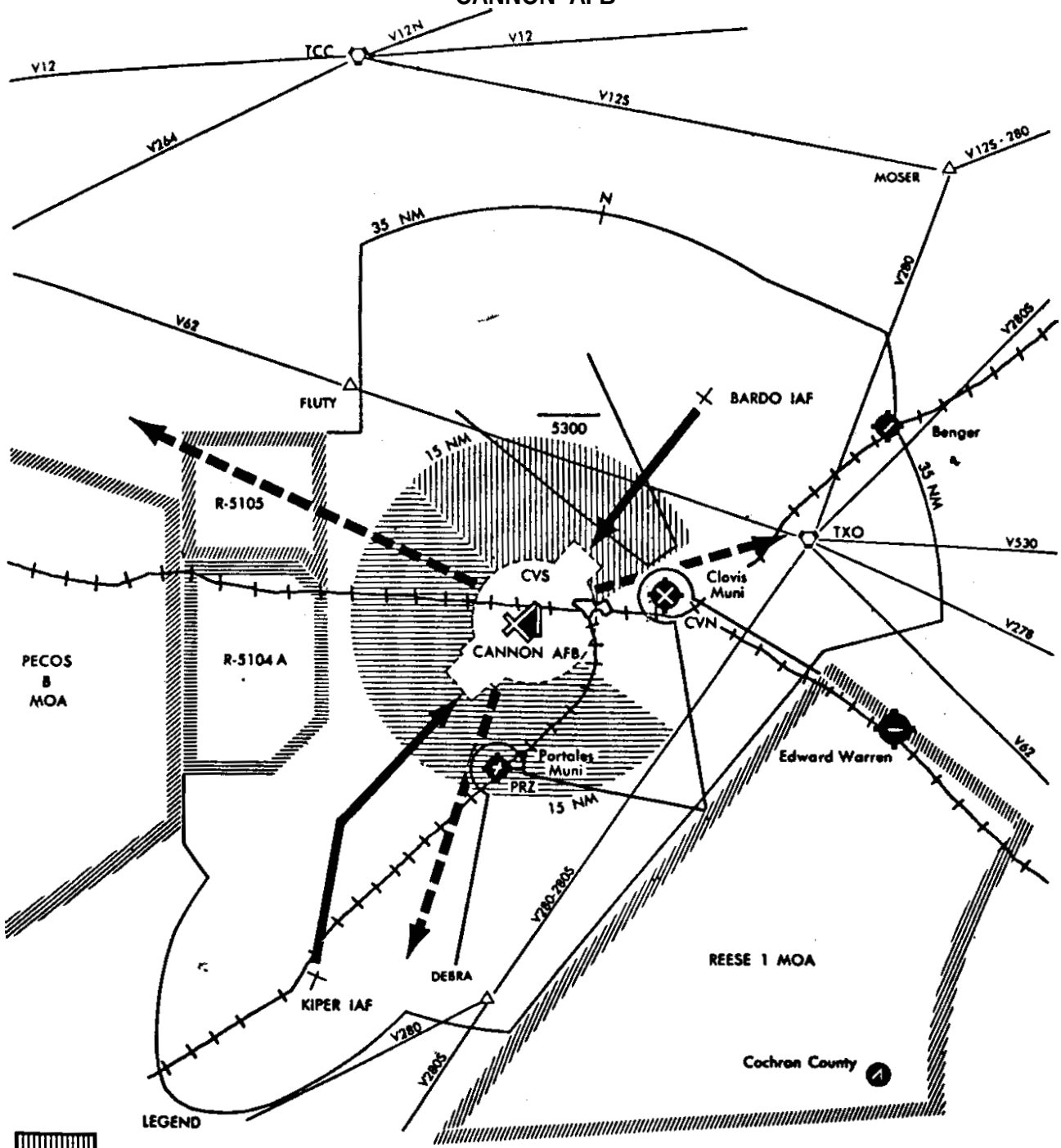


APPENDIX G

TERMINAL AREA GRAPHIC NOTICE, CHART DATED FEBRUARY 22,1979

(NOT TO BE USED FOR NAVIGATION)

CLOVIS, NEW MEXICO
CANNON AFB

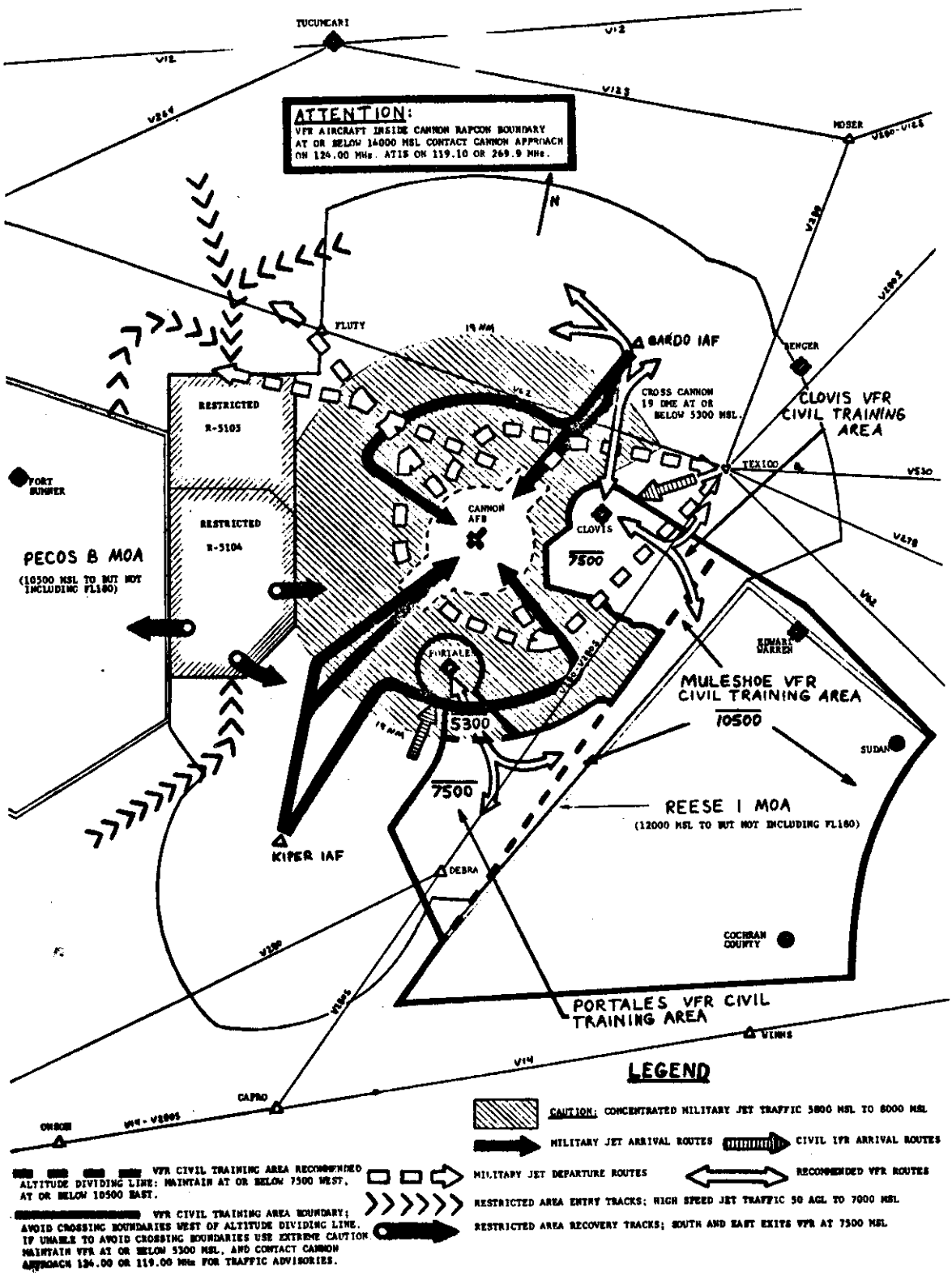


Prepared by the National Ocean Survey
at the direction of the
FEDERAL AVIATION ADMINISTRATION

22 FEB 1979

APPENDIX H

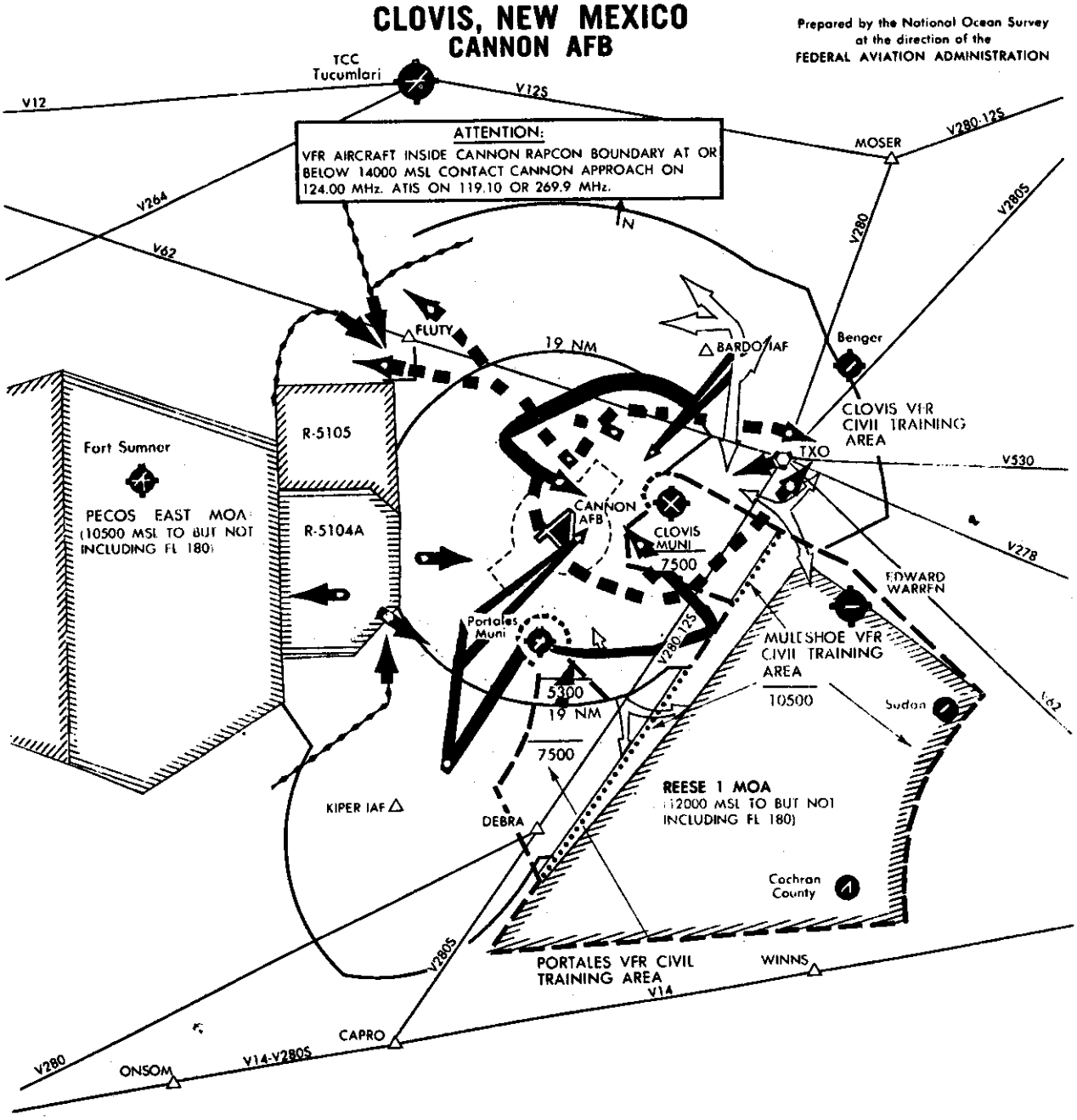
'RADAR *AIR* TRAFFIC CONTROL SERVICE, CHART DATED MAY 1980

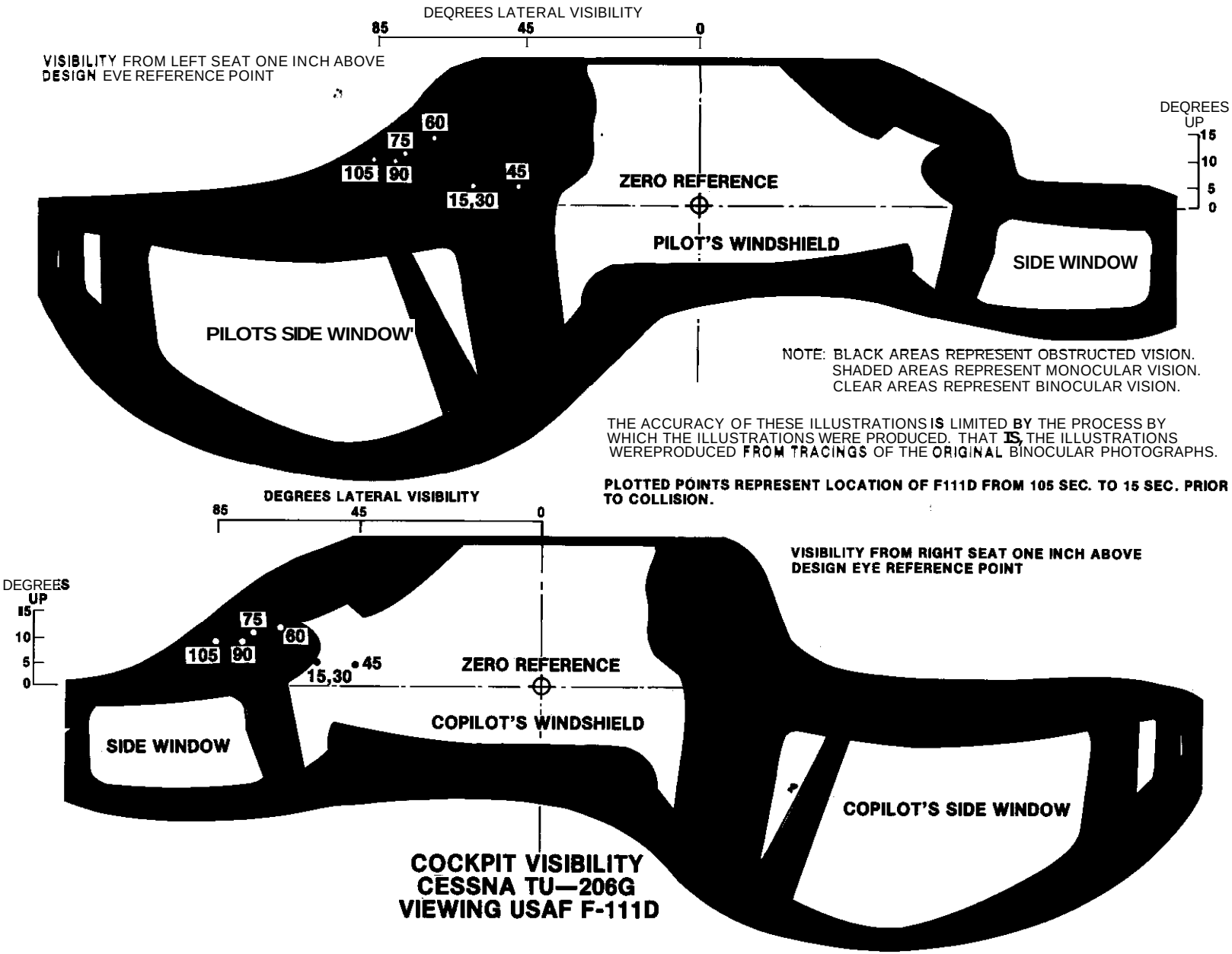


APPENDIX I

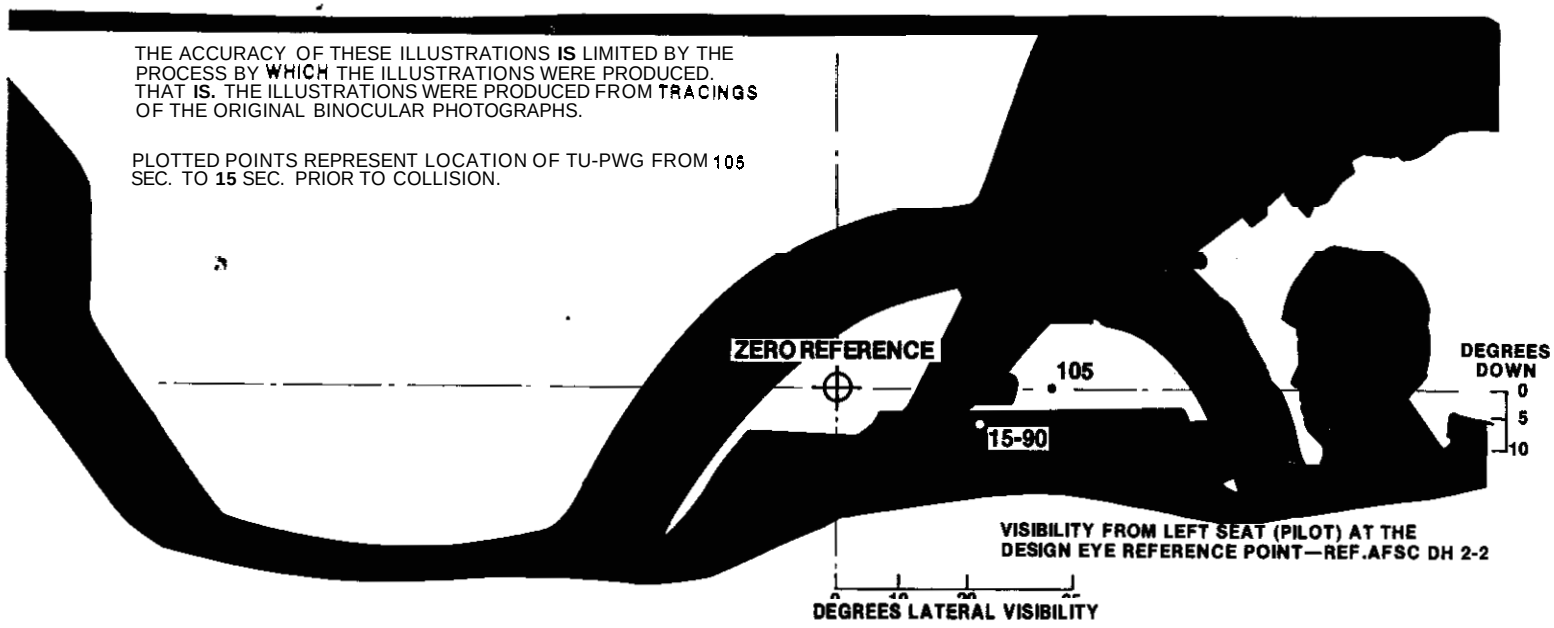
TERMINAL AREA GRAPHIC NOTICE, CHART DATED MARCH 9, 1981

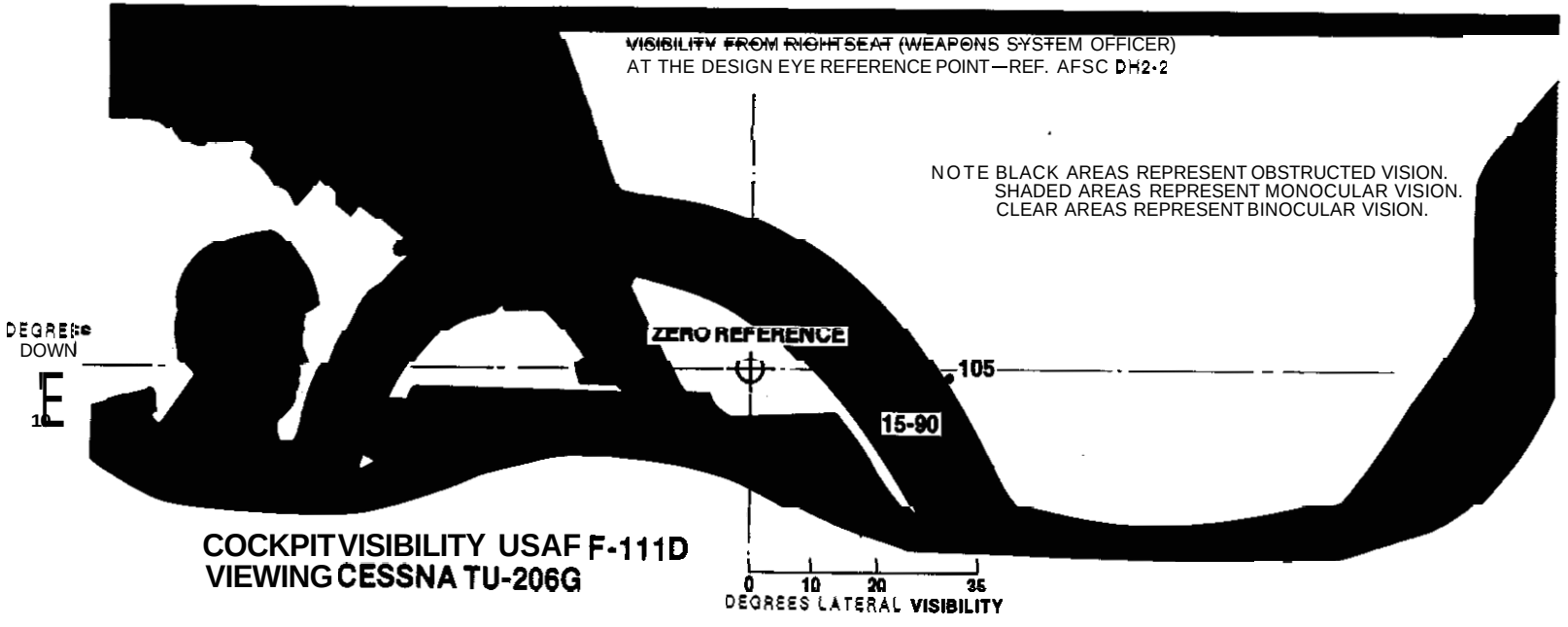
(NOT TO BE USED FOR NAVIGATION)





COCKPIT VISIBILITY
CESSNA TU—206G
VIEWING USAF F-111D





COCKPIT VISIBILITY USAF F-111D VIEWING CESSNA TU-206G

APPENDIX K

SUMMARY OF SAFETY BOARD MIDAIR COLLISION RECOMMENDATIONS

In July 1969, the National Transportation Safety Board released the report of a special accident prevention study entitled "Midair Collisions in U.S. Civil Aviation." That study of 38 midair collisions, which occurred in calendar year 1968, involved 76 aircraft, 24 of the 38 collisions resulted in 71 fatalities -- all occupants of general aviation aircraft.

On November 4, 1969, the Safety Board convened a public hearing for the purpose of inquiring into the cause and prevention of midair collisions. The Board, sitting en blanc, heard the testimony of 26 witnesses, including representatives of the United States Government, the aviation industry, and members of the public.

The public hearing and the accident prevention study resulted in conclusions and from these conclusions, 25 safety recommendations were forwarded to the Federal Aviation Administration. Also, in 1968, the FAA released a near-midair collision study which contained 20 recommendations.

Since 1969, the Safety Board has issued 74 recommendations to minimize the hazards of midair collisions and to emphasize to the aviation community the inherent dangers of the "see and avoid" environment. At least 7 of these safety recommendations apply to this accident.

NTSB A-71-008: Make funds available for the ground equipment which may be necessary for support of collision avoidance systems (CAS). NTSB status -- Closed--Acceptable Action.

NTSB A-71-012: Amend the pilot training requirements in the Federal Aviation Regulations to require the addition of scanning techniques to the training syllabus. NTSB status -- Closed--Acceptable Action.

NTSB A-71-051: Institute a program to provide more publicity to the existence, function and use of the FAA radar advisory service in those instances where VFR flight is required through high-density traffic area, consideration should be given to making the request for such service a mandatory procedure. NTSB status -- Closed--Acceptable Action.

NTSB A-72-157: Develop a total midair collision prevention system approach to include training, education, procedures, ATC equipment and practices, and the development of collision avoidance systems and proximity warning instruments that are cost feasible to the general aviation community. NTSB status -- Closed--Acceptable Action.

NTSB A-73-028: Establish a requirement for pilots to be trained in the techniques of time sharing between visual scanning for airborne targets and cockpit duties. NTSB status -- Closed--Acceptable Action.

NTSB A-73-032: Expedite the development and issuance of national standards for systems to provide protection from midair collisions that the industry can proceed without further delay to develop and market economically viable hardware. NTSB status -- Closed--Acceptable Alternate Action.

NTSS A-79-074: Prescribe a method to insure that all general aviation pilots are tested periodically on ATC radar procedures, radar services, pilot/controller relationships, and ATC clearance as appropriate to their operations. NTSB status -- Closed--Acceptable Alternate Action.