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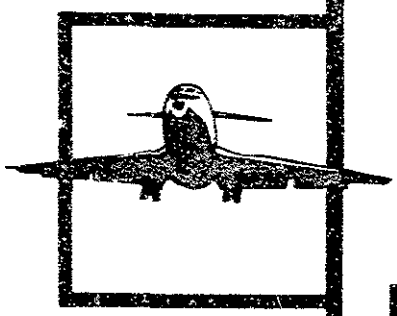

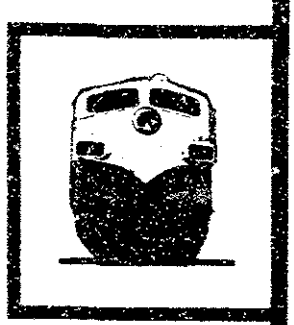

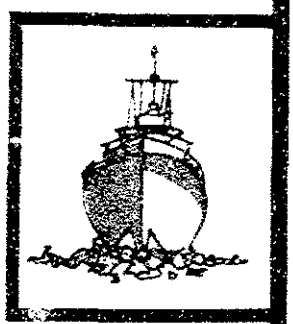

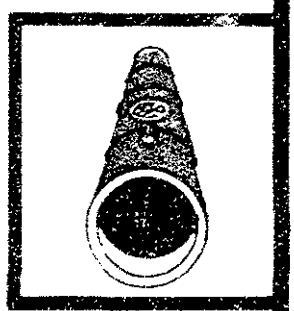

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

AIR U.S. FLIGHT 716, HP-137, N11360,
AND SKY'S WEST CESSNA TU-206, N4862F,
MIDAIR COLLISION
FT. COLLINS/LOVELAND MUNICIPAL AIRPORT
LOVELAND, COLORADO.
APRIL 17, 1981

NTSB-AAR-81-18

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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16. Abstract About 1601:17 m.s.t., April 17, 1981, Air U.S. Flight 716, a Handley Page HP-137 Jetstream, and a Sky's West Parachute Center Inc., Cessna TU-206 collided in midair about 2 nmi east-southeast of the Ft. Collins/Loveland Airport, Loveland, Colorado.

The Cessna had departed from the Ft. Collins/Loveland Airport on its second parachute jump flight of the day and was climbing through 13,000 feet m.s.l. Flight 716 was on an instrument flight rules clearance. The two aircraft collided near 13,000 feet m.s.l. and crashed. Two skydivers in the Cessna were killed during the in-flight collision. The pilot and the three other occupants of the Cessna were wearing parachutes, deployed them; and survived with injuries. All 13 persons on the HP-137 were killed. The weather was clear and the visibility was reported as 60 miles.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the Cessna pilot to establish communications with the Denver Center and his climbing into controlled airspace above 12,500 feet without an authorized deviation from the altitude encoding transponder (Mode-C) requirement, the practice of the Denver Center of routinely condoning Sky's West parachute jump operations above 12,500 feet without a Mode-C transponder and the failure of the pilots of both aircraft to "see and avoid' each other. Contributing to the accident was the Pact that existing regulations do not prohibit parachute jumping in, or immediately adjacent to, Federal airways.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: December 17, 1981

AIR U.S. FLIGHT 716, HP-137, N11360, AND SKY'S WEST CESSNA, TU-206, N4862F, MIDAIR COLLISION FT. COLLINS/LOVELAND MUNICIPAL AIRPORT LOVELAND, COLORADO APRIL 17, 1981

SYNOPSIS

About 1601:17 m.s.t., April 17, 1981, Air U.S. Flight 716, a Handley Page HP-137 Jetstream, and a Sky's West Parachute Center Inc., Cessna TU-206 collided in midair about 2 nmi east-southeast of the Ft. Collins/Loveland Municipal Airport, Loveland, Colorado.

The Cesna had departed from the Ft. Collins/Loveland Municipal Airport on its second parachute jump flight of the day and was climbing through 13,033 feet m.s.l. Flight 716 was en route from Denver, Colorado, to Gillette, Wyoming, cruising at 13,000 feet m.s.l. on an instrument flight rules (IFR) clearance. The two aircraft collided near 13,000 feet m.s.l. and fell to the ground in adjacent large open fields. Two skydivers in the Cessna were killed during the in-flight collision. The pilot and the three other occupants of the Cessna were wearing parachutes, were able to deploy them as they fell free of the aircraft, and survived with varying degrees of injuries. All 13 persons on board the HP-137 were killed. The weather was clear and the visibility was reported as 60 miles.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the Cessna pilot. to establish communications with the Denver Center and his climbing into controlled airspace above 12,500 feet without an authorized deviation from the altitude encoding transponder (Made-C) requirement, the practice of the Denver Center of routinely condoning Sky's West parachute jump operations above 12,500 feet without a Mode-C transponder and the failure of the pilots of both aircraft to "see and avoid" each other. Contributing to the accident was the fact that existing regulations do not prohibit parachute jumping in, or immediately adjacent to, Federal airways.

1. FACTUAL INFORMATION

1.1 History of the Flight

About 1358 m.s.t. 1/ on April 17, 1981, an official from Sky's West Parachute Center called the Denver Flight Service Station (FSS) to provide information regarding their intended parachute jump activities so that the FSS could issue the required NOTAM.

1/ All times herein are Mountain Standard Time based on the 24-hour clock.

The information specified that the jump area was to be 15 nmi southeast of Ft. Collins/Loveland Airport, from an altitude below 18,000 feel m.s.l. 2/ to surface. The duration of the jump activities was to be from 1358 until 1 hour after sunset. A Cessna TU-205, N4869Z, and a Cessna TU-206, N4862F, were identified as the aircraft to be used in the jump activities. Radio frequencies 122.7 and 124.8 MHz were to be monitored during the course of the jump operations.

At 1410:32, during the first parachute jump flight of the day, the pilot of the Cessna TU-206 (Cessna), contacted the Denver Air Route Traffic Control Center (ARTCC) and made the following transmission:

> Six-two-Fox will be skydiving 8,500 feet a mile and a half southeast Ft. Collins/Loveland Airport approximately. 1 minute, then well be climbing to 15,500.

The Denver Center Controller replied:

> Six-two-Fox - Roger.

At 1421:07, the Cessna pilot again called Denver Center with the following transmission:

> Denver Center Cessna six-two-Fox skydiving 15,500 feet 1 minute Ft. Collins/Loveland Airport.

Seven seconds later, the Denver Center controlier again replied "Six-two-Fox-roger." The Cessna pilot made no further communications with the Denver Center or any other air traffic control facility during the flight.

About 1530 m.s.t., the Cessna TU-206 departed the Ft. Collins/Loveland Municipal Airport, Loveland, Colorado, on the second parachute jump flight of the day. This flight, as with the first flight, was to be conducted in visual meteorological conditions. A flight plan was not filed for either flight, nor was one required to be filed. The pilot, who had also flown the first parachute jump flight, occupied the left seat and the five skydivers were positioned on the cabin floor. All the passenger seats hsd been removed from the aircraft for the jump activities.

After departure, the Cessna began climbing in a left "race track pattern" over the airport to an altitude of 15,500 feet. The Cessna pilot did not communicate with the Denver ARTCC or any other air traffic facility during the second flight, but was squawking transponder code 1-2-3-4 as he did during the first flight.

Air U.S. Inc. Flight 716 was a regularly scheduled commuter passenger flight between Denver's Stapleton International Airport and Gillette, Wyoming. Flight 716 departed Denver at 1546 on an instrument flight rules (IFR) clearance with 10 passengers and 3 crewmembers on board. The flight was proceeding direct from Denver (Colorado) VOR to Douglas (Wyoming) VOR. The collision occurred about 1 mile west of V19, 1 mile east of V1, and 2 miles south of V101 airways.

2/ Altitudes herein are mean sea level unles otherwise specified. (Terrain elevation Collins/Loveland Airport is 5,016 feet m.s.l.)

At 1554:01, the Denver departure controller instructed Flight 716 to change to Denver Center frequency 124.8 MHz when leaving 12,000 feet.

At 1559:25, Flight 716 contacted and advised Denver Center that it was cleared to climb to and maintain 16,000 feet and requested to remain at 13,000 feet. Denver Center approved the request to remain at 13,000 feet; Plight 716 acknowledged the approval at 1559:34.

At 1602:20 and at 1603:28, Denver Center called Flight 716, but received no response. At 1603:37, the Center controller again called Plight 716 to advise that the center had lost radar contact and tu squawk 5-1-2-7, repeat and identify. There was nu response to this transmission.

The Cessna was in a climbing left turn on a northwesterly heading and Plight 716 was in level flight on a northerly heading. The left wing tip'and fuselage nose section of the Jetstream (Flight 716) collided with the left side of the Cessna. The No. I propeller of the Jetstream cut through the aft fuselage section of the Cessna resulting in immediate loss of control to both aircraft. (See sketch appendix F.)

Two of the skydivers were killed inside the aircraft during the collision. The pilot and three parachutists fell free of the aircraft and parachuted to the ground. The remains of the Cessna descended out of control and crashed in an open field The Jetstream impacted the ground in a nearly vertical pitch attitude in an open field about 4,000 feet northeast of the Cessna wreckage.

The aircraft crashed during daylight hours about 2 miles east-southeast of the Ft. Collins/Loveland Municipal Airport. The Cessna wreckage site was at coordinates 40°25'40"N latitude and 104°58'45"W longitude. The coordinates of the Jetstream wreckage were 40°26' 15"N latitude and 104°58'30"W longitude.

12 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal */	3	12	0	15
Serious	1	2	0	3
Minor/None	0	1	0	1
Total	4	15	0	19

*/ Includes persons on both aircraft.

1.3 Damage to Aircraft

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

1.4 Other Damage

Farmland was damaged by the impact of the aircraft, and the soil was contaminated by spillage of the aircraft fuel.

1.5 Personnel Information

Flightcrew personnel on both aircraft and controller personnel were qualified. (See appendix B.)

1.6 Aircraft Information

Flight 716, a Handley Page HP-137 Jetstream, N11360, was owned and operated by U.S. Aviation Inc. doing business as Air U.S. Inc. The aircraft was within prescribed weight and balance limits for the flight. There were 1,503 lbs of jet-A fuel on board at takeoff from Denver. (See appendix C.)

The HP-137 Jetstream fuselage wings and empennage were painted white. Black deicer boots were attached to the wing leading edge between the outboard side of each engine and the wing tip; to the entire leading edge of the horizontal stabilizer; and to the upper portion of the leading edge of the vertical stabilizer. The engine cowlings of the two engines were not painted. The left side of the fuselage had separate blue, white, and red stripes between the lower edge of the passenger windows and the top of the wing root. The blue stripe extended from about midway between the nose and cockpit aft to the tail. and the white and red stripes extended from the nose aft to the tail. On the right of the fuselage, the stripes were painted blue, white, and green from the nose aft to fuselage station (FS) 223. From FS 223 to the tail of the aircraft, the stripes were blue, white, and red.

The Cessna TU-206, A N4862F, was owned by Harder Construction Co. and operated by Sky's West Parachute Center Inc. (See appendix C.) The aircraft was within prescribed weight and balance iimits for the flight and had about 150 lbs of 100-octane low-lead gasoline on board at takeoff. The Cessna had been modified to accommodate five skydivers by removing all the seats, except the pilot's seat, from the aircraft. The right cargo door also had been removed and had been replaced by a plywood door which the jumpers could open by sliding it to the rear. Lap belts had been installed to the floor at each seat location for use by the jumpers.

The Cesna TU-206 cowling, fuselage, wings, struts, horizontal stabiiizer, vertical stabilizer, and flight control surfaces were painted white. The vertical stabilizer tip had red, white, and black stripes. The fuselage tailcone, wing tips, and vertical stabilizer fairing were painted red. The left and right side of the fuselage had white and red stripes.

1.7 Meteorological Information

At the time of the accident, the weather in the Ft. Collins/Loveland area was generally clear. The 1600 local Denver weather observations of Stapleton International Airport were as follows:

> Clouds--7,000 feet scattered, 20,000 feet thin broken;
> visibility--60 miles; temperature--77°F; dewpoint--25°F;
> wind--020° 4 kns; altimeter--30.03 inHg; undetermined
> intermittent rain showers to the west.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

There were no known communications malfunctions.

1.10 Aerodrome Information

Not applicable.

1.11 Flight Recorders

Neither the Cessna nor the HP-137 Jetstream were equipped with any recorders and none were required.

1.12 Wreckage and Impact Information

The wreckage scatter of both aircraft was confined to a 900-foot-wide, 9,300-foot-long area of open, flat, rolling farmland. (See appendix G.)

At the wreckage site, there was a ground fire confined to the Jetstream main impact crater. None of the pieces of wreckage of either aircraft found along the wreckage path exhibited any signs of fire or soot damage.

The Jetstream impacted the ground at about an SO-degree nose down attitude and penetrated the ground to a depth of about 7.5 feet.

Handley Page HP-137

About 17 inches inboard of the tip, the left wing outboard! panel leading edge exhibited deep indentations. The entire leading edge was buckled and the deicer boat was torn in various areas. The upper wing skin about 22 inches inboard from the wing tip exhibited spanwise score marks ani, tears at about a 40-degree angle measured clockwise at the front spar', and running from the front spar rearward and, outboard. This section of wing also exhibited a deep gouge mark forward of the rear spar, 32 inches inboard from the tip. Two scratch marks running from about the leading edge aft and outboard, were located on the top skin between wing station (WS) 295 and WS 307. The scratches were at 18-degree angles as measured from the wing tip attachment splice. A small piece of the left wing leading edge was recovered separated from the inboard and outboard wing sections. The outboard end of this piece of leading edge matched the front spar of the outboard wing panel. This small piece of leading edge exhibited an impact curvature which fitted and matched the Cesna left main landing gear spring near the fuselage.

The left side of the vertical stabilizer exhibited red paint scuff marks near its leading edge and about 8 inches from its bottom edge.

The face of one of the left propeller blades exhibited clockwise surface scratch marks 24 inches outboard of its butt end. The blade leading edge had four blunt impact marks ranging from 0.25 to 1.5 inches in length. Another left propeller blade, which had several clockwise scratches about 14 inches inboard of the blade tip, had separated from the propeller hub. Several blunt impact marks were also visible in line with the scratch marks. The third blade also had scratch marks in the same general location as the other two blades. All three blade faces of the right propeller had deep scratches and gouges running parallel to the blade span.

Cessna TU-205

During the collision, the Cessna TU-206 fuselage was broken into three major pieces; the forward fuselage section, the cabin top and fuselage sidewall, and the fuselage tail cone.

The lower left side edge of the fuselage between FS 0.00 and FS 90 had black scuff marks with deep scratches and grooves visible within those marks. Propeller cuts through the Cessna's fuselage structure were present in the general area of FS 90 on the left side and FS 130 on the right side. Another propeller cut was located on top of the tail cone between FS 124 and FS 138.

The left wing strut remained attached to the wing. The lower end of the strut bottom surface Rad black scuff marks. The rivet holes at the lower end of the strut were elongated. The right wing had no collision damage.

The vertical stabilizer was separated left-to-right from the fuselage, dorsal fin, and rudder. A 24- by 16-inch section of left fuselage structure remained attached to the stabilizer. The left side of the stabilizer skin was torn, wrinkled, and buckled, bowed from left to right, and had blue paint scuff marks. Samples of the blue scuff marks from the Cessna vertical stabilizer and the blue paint stripe from the left side of the Jetstream were examined by the Laboratory of the Federal Bureau of Investigation and found to be identical with respect to color, texture, type, and organic composition.

The stabilizer tip 6 inches down from the top rib exhibited a 12-inch-long propeller cut extending from the leading edge aft. The anti-collision light on top of the fin was broken.

The horizontal stabilizer was separated from the fuselage structure. The top surface of the left section of the stabilizer had scratch and scuff marks inboard of the stabilizer tip. These marks, extending from the trailing edge forward and inboard as viewed looking forward, measured 110 degrees in a clockwise direction relative to the longitudinal axis of the aircraft.

The left aileron remained attached to the left wing and was intact except for the otitboard end. The aileron damage at the outboard end extended 15 inches inboard et about a 30-degree angle. The upper and lower skin from this area was separated from the remaining aileron section, but when mated farmed a rounded channel. Heavy black scuff marks inside the top skin extended from the trailing edge forward and inboard and were at a 30-degree angle from a line parallel to the longitudinal axis of the aircraft.

The left elevator balance weight tip was separated from the elevator by a propeller cut. The direction of the cut was from bottom to top, from the trailing edge forward, and at a 45-degree angle measured counterclockwise relative to the longitudinal axis of the aircraft,

1.13 Medical and Pathological Information

Toxicological examination of the captain of Flight 716 did not disclose any evidence of preexisting physiological problems which could have affected his performance. A toxicological examination of the first officer of Flight 716 was not possible.

The surviving pilot of the Cessna sustained a twisted left ankle with multiple contusions and lacerations. He was initially treated and released from the emergency room of McKee Medical Center in Loveland. Four days later he was admitted to the Weld County Hospital, Greeley, Colorado, for what was reported to be a possible blood clot in his left leg. The pilot was not subjected at either time to an extensive physiological or toxicological examination for other than accident-related injuries. The National Transportation Safety Board did not ask for such examinations nor was the pilot required to *undergo* such examinations.

The skydiver positioned in the right front of the Cessna suffered a stomach muscle strain and multiple contusions. The two skydivers directly behind the front seat positions were also injured. One had a fractured right ankle and the other sustained a chop/slash injury to his right foot almost severing the foot at the arch. Both men also received multiple contusions and lacerations. The two fatally injured skydivers in the rear of the Cessna sustained chop/slash injuries.

1.14 Fire

The Cessna TU-206 did not sustain any in-flight *or* ground fire. The Jetstream (Flight 716) sustained fire after impacting the ground.

1.15 Survival Aspects

The accident was classified as not survivable for the occupants of either aircraft. However, because four of the Cesna occupants were experienced skydivers wearing parachutes and were able to fall free of the aircraft after the collision and deploy their parachutes, they survived the accident.

1.16 Tests and Research

1.16.1 Cessna 206 Flight Simulation

A series of flights were. made with a Cessna.206 lo simulate the accident flight of N4862F. The purpose of these flights was to attempt to determine the quality and type of radar return the aircraft would generate with and without certain transponder configurations and with certain selections of display modes at the Denver ARTCC consoles Results of the test flights were inconclusive because of possible differences in atmospheric conditions and difficulties in duplicating precisely the aircraft's attitude and positions relative to the radar antenna; however, during this test the aircraft target was depicted intermittently on the radar scope.

1.17 Additional Information

1.17.1 Applicable Provisions of Federal Aviation Regulations Part 91.67

Federal Aviation Regulations, subchapter F, Air Traffic and General Operating Rules, Part 91.67, General Operating and Flight Rules, outlines responsibilities to "see and avoid" as follows:

> (a) General. When weather conditions permit, regardless of whether en 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 in compliance with this section. When a rule of this section gives another aircraft the right of way, he shell give way to that aircraft and may not pass over, Under, or ahead of it, unless well clear.

1.17.2 Visibility Aspects

In order to determine the physical limitations to visibility from flightcrew seats, a study was conducted ox each type of aircraft involved in the collision. Using the reconstructed flight path data for each aircraft, the physical limitations to vision, which may have precluded either flightcrew from detection and observation of the other, were determined.

Look angles and separation ranges from the cockpits of both aircraft were determined from 120 seconds before impact to the time of impact in 15-second intervals. The time of impact was determined to be at 1601:16. The look angles from each aircraft have been calculated and plotted on binocular photographs. The photographs depict the target aircraft as a series of points in the cockpit windows of the viewing aircraft. (See appendix D.) It is to be noted that the accuracy of the photographs is inherently limited because of the basic assumptions necessary in their construction.

1.17.3 Federal Aviation Regulations and Air Traffic Control Procedures Pertaining to Parachute Jumping

Prescribed procedures, applicable regulations, and guidance material relative to parachute jumping are contained in the FAA's Air Traffic Control Handbook 7110.65B, and Federal Aviation Regulations Parts 91 and 105. All regulatory and advisory materials cited herein were in effect and applicable at the time of the accident.

1.17.4 Applicable Provisions of Federal Aviation Regulations Part 91.24

Federal Aviation Regulations, subchapter F, Air Traffic and General Operating Rules Part 91.24, General Operating and Flight Rules, outlines the requirements for the use of ATC transponders and altitude reporting equipment as follows:

> (a) All airspace: U.S. registered civil aircraft. For operations not conducted under parts 121, 123, 127, or 135 of this chapter. ATC transponder equipment installed after January 1, 1974, in U.S. registered civil aircraft not previously equipped with an ATC transponder, and all ATC transponder equipment used in U.S. registered civil aircraft after July 1, 1975, must meet the performance and environmental requirements of any class of TSO-C74b or any class of TSO-C74c as appropriate, except that the Administrator may approve the use of TSO-C74 or TSO-C74a equipment after July 1, 1975, if the applicant submits data showing that such equipment meets the minimum performance standards of the appropriate clan of TSO-C74c and environmental conditions of the TSO under which it was manufactured.
>
> (b) Controlled airspace: all aircraft. Except for persons operating helicopters in terminal control areas at or below 1,000 feet AGL under the terms of a letter of agreement, and except for persons operating gliders above 12,500 feet m.s.l. but below the floor of the positive control area, no person may operate an aircraft in the controlled airspace prescribed in paragraphs (b)(1) through (b)(4) of this paragraph, unless that aircraft is equipped with an operable coded radar beacon transponder having a mode 3/A4096 code capability, replying to mode

3/A interrogation with the code specified by ATC, and is equipped with automatic pressure altitude reporting equipment having a Mode-C capability that automatically replies to Mode-C interrogations by transmitting pressure altitude information in 100-foot increments. This requirement applies-

(1) In Group I Terminal Control Areas governed by S 91.90(a);

(2) In Group II Terminal Control Areas governed by S 91.90(b), except as provided therein;

(3) In Group III Terminal Control Areas governed by S 91.90(c), except as provided therein; and

(4) In all controlled airspace of the 48 contiguous States and the District of Columbia, above 12,500 feet MSL, excluding the airspace at and below 2,500 feet AGL.

(c) ATC authorized deviations. ATC may authorize deviations from paragraph (b) of this section-

(1) Immediately, to allow an aircraft with an inoperative transponder to continue to the airport of ultimate destination, including any intermediate stops, or to proceed to a place where suitable repairs can be made, or both;

(2) Immediately, for operations of aircraft with an operating transponder but without operating automatic pressure altitude reporting equipment having a Mode-C capability; and

(3) On a continuing basis, or for individual flights, for operations of aircraft without a transponder, in which case the request for a deviation must be submitted to the ATC facility having jurisdiction over the airspace concerned at least four hours before the proposed operation.

Sky's West parachute jump aircraft operated in controlled airspace (see appendix E) above 12,500 feet m.s.l. without Mode-C transponder (altitude encoding) capability. Denver ARTCC personnel were aware of such operation; however, there was no record of any written or verbal authorization by ATC for Sky's West to deviate from the requirements of FAR 91.24. There was also no record of any violation, enforcement, or investigative action regarding Sky's West unauthorized deviations from FAR 91.24.

The Cessna pilot stated that he believed that the response, "Roger" given to him by the Center Controller during the first parachute jump flight on the day of the accident was an "authorization to climb to 15,500 feet m.s.l. without the Mode-C" transponder capability.

1.17.5 Assignment of Transponder Codes and ATC Rader Display of Targets

If the Sky's West aircraft had been Mode-C equipped and the transponder were turned on, the target would have been displayed on the scope along with the altitude of that aircraft expressed in three digits and a four digit transponder code. These indications would have appeared irrespective of the specific coda that the aircraft was squawking or the options selected for display by the controller.

A transponder code is assigned by ATC to a flight for the duration of that flight only, or for a shorter period if operational requirements warrant; however, a code was not assigned to the Cessna pilot by any air traffic *control* facility on the day of the accident for either of the parachute jurnp flights. Some controllers stated that they had habitually assigned code 1-2-3-4 to this Sky's West aircraft, and the pilot stated that he believed that he was permanently assigned that code. The Cessna pilot stated that OR

several previous occasions he had come on frequency announcing that he was on code 1-2-3-4 and bad received the response *"roger"* from ATC. The Cessna pilot further stated that it was his understanding that by merely "squawking" 1-2-3-4, positive radar identification for the aircraft was provided.

In configuring his radar scope *on* the day of the accident, the Sector 14 controller had several relevant options with respect to the display of nontracked targets as shown in the following aircraft table.

Table 1.—Controller's Relevant Options to Display Nontracked Targets.

OPTIONS	KEYS SELECTED			Codes in "Select List"	DISPLAY
	All Primary	Non Mode-C	Selected Limit data	For example: Code 1-2-3-4	Description of non-"racked targets
I.*	X		X		Presented as +, !, or is deleted, depending on strength.
a	X	X			Presented as /
III.	X		X	X	/ 1-2-3-4

* Option employed during accident case.

The Sector 14 controller activate the "All Primary" key. As a consequence, all primary targets above a certain radar return strength threshold were displayed on his scope. At the same time, he did not activate the "non-Mode-C" key nor did he have code 1-2-3-4 entered in his code select list because he had not assigned the code to any aircraft. The selection of the non-Mode-C function *was* optional according to the Denver ARTCC Facility Directive 7110.65A. Most controllers at the Denver Center operated with the "non-Mode-C" in the deselected position in order to reduce clutter *on* the scope. With the "All-Primary" *on* and the "non-Mode-C" off, the Cessna target would have been displayed as an uncorrelated, untracked, beacon-reinfarced primary return provided the radar return had sufficient strength to be displayed. A computer generated printout of target information was examined following the accident. It disclosed that the Cessna was displayed about *75* per cent ob the time while it was in the controller's sector.

Both the Sector 14 controller and the team supervisor assisting him testified that they did not recall *seeing* a target in the vicinity of the collision site that they considered to be conflicting traffic far Air U.S. 716.

About 2 1/2 years before the accident, an air traffic controller at the Denver ARTCC submitted an "Employee Suggestion" 5/ proposing to make non-Mode-C beacon filter key selection mandatory for low altitude sectors. 6/ The reason for his proposal was that some primary "targets could be overlooked or not-displayed at all" unless the non-Mode-C filter key is selected. The Controller's Team Supervisor and the Assistant Chief of the facility concurred with the suggestion, indicating that this procedure would enhance safety by displaying traffic not normally presented. The concurrence further indicated that there are instances where non-Mode-C VFR aircraft are squawking a code that is not in the "Code Select List" and in these cases the target is not displayed and could potentially be conflicting traffic for aircraft under the control of the sector. The Facility Air Traffic Technical Advisory Committee (FATTAC) also recommended adoption of the suggestion. However, the Chief of the Denver ARTCC did not adopt the suggestion, indicating that any advantage of non-Mode-C selection would be outweighed by the increased clutter in displaying non-Mode-C aircraft in terminal areas on assigned codes that were not being monitored by the Denver ARTCC.

On April 21, 1981, 4 days after the collision, the Denver ARTCC facility manual 7110.65A was revised by change 6 to require selection of non-Mode-C filter key in the low altitude sector "to allow all discrete non-Mode-C aircraft to be displayed on the low attitude displays."

1.17.6 Applicable Provisions of Federal Aviation Regulations Part 105

Federal Aviation Regulations Part 105 prescribe rules for parachute jumping into navigable airspace and requirements for notification of Air Traffic Facilities when such jumps are anticipated. Applicable rules are as follows

(1) 105.14 Radio Equipment and use requirements

(a) Except when otherwise authorized by ATC-

(1) No person may make a parachute jump, and no pilot in command of an aircraft may allow a parachute jump to be made from that aircraft, in or into controlled airspace unless, during that flight-

(i) The aircraft is equipped with a functioning two-way radio communications system appropriate to the ATC facilities to be used;

(ii) Radio communications have been established between the aircraft and the nearest FAA air traffic control facility or FAA flight service station at least 5 minutes before the jumping activity is to begin, for the purpose of receiving information in the aircraft about known air traffic in the vicinity of the jumping activity; and

(iii) The information described in paragraph (a)(1)(ii) of this section has been received by the pilot in command and the jumpers in that flight; and

(2) The pilot in command of an aircraft used for any jumping activity in or into controlled airspace shall, during each flight

(i) Maintain or have maintained a continuous watch on the appropriate frequency of the aircraft's radio communciations system from the time radio communications are first established between the aircraft and ATC, until he advises ATC that the jumping activity is ended from that flight; and

5/ "Employee Suggestion" - Part of FAA Incentive Awards Program; per FAA Order 3450.7c.

6/ Low Altitude Sector - Sectors covering altitudes up to 24,005 feet m.s.l.

(ii) Advise ATC that the jumping activity is ended for that flight when the last parachute jumper from the aircraft reaches the ground.

(b) If, during any flight, the required radio communications system is or becomes inoperative, any jumping activity from the aircraft in or into controlled airspace shall be abandoned. However, if the communications system becomes inoperative in flight after receipt of a required ATC authorization, the jumping activity from that flight may be continued."

(2) 105.23 Jumps in or into Other Airspace

(a) No person may make a parachute jump, and no pilot in command of an aircraft may allow a parachute jump to be made from that aircraft. in or into airspace unless the nearest FAA air traffic control facility or FAA flight service station was notified of that jump at least 1 hour before the jump is to be made, bui not more than 24 hours before the jumping is to be completed, and the notice contained the information prescribed in § 105.25(a).

(b) Nothwithstanding paragraph (a) of this section, ATC may accept from a parachute jumping organization a series of jumps to be made over a stated period of time not longer than 12 calendar months. The notification must contain the information prescribed by § 105.25(a), identify the responsible persons associated with that jumping activity, and be submitted at least 15 days, but not more than 30 days, before the jumping is to begin. ATC may revoke the acceptance of the notification for any failure of the jumping organization to comply with its terms.

This section does not apply to parachute jumps in or into any airspace or place described in §§ 105.15, 105.19, or 105.21. 7/

(3) 105.25 Information required, and notice of cancellation or postponement of jump.

(a) Each person requesting an authorization under § 105.19 or §105.21, and each person submitting a notice under §105.23. must include the following information (on an individual or group basis) in that request or notice:

(1) The date and time jumping will begin.

(2) The size of the jump zone expressed in nautical mile radius around the target.

(3) The location of the center of the jump zone in relation to

(i) The nearest VOR facility in terms of the VOR radial on which it is located and its distance in nautical miles from the VOR facility when that facility is 30 nautical miles or less from the drop zone target; or

(ii) The nearest airport, town, or city depicted on the appropriate Coast and Geodetic Survey WAC or Sectional Aeronautical chart, when the nearest VOR facility is more than 30 nautical miles from the drop zone target.

(4) The altitudes above the surface at which jumping will take place.

7/ 105.15, 105.19 and 105.21 are not relevant to this accident.

(5) The duration of the intended jump.

(6) The name, address, and telephone number of the person requesting the authorization or giving notice.

(7) The identification of the aircraft to be used.

(8) The radio frequencies, if any, available in the aircraft.

(b) Each persons requesting an authorization under § 105.19 or §105.21, and each person Submitting a notice under 5105.23. must promptly notify the FAA air traffic control facility or FAA flight service station from which it requested authorization or which it notified, if the proposed or scheduled jumping activity is canceled or postponed.

Sky's West advised the Denver Flight Service Station (FSS) of their intended jump activities 23 minutes before their first flight of the day rather than 1 hour before, as required by FAR 10593. Sky's West provided the required information on this occasion as they had done routinely in the past so that the FSS could issue a NOTAM. The pilot of the Cessna had established radio communication with the ARTCC during the first parachute jump flight on the day of the accident. The Cessna departed from the airport on the second parachute jump flight about 16 minutes before the collision, The pilot testified that he was about to call the Denver Center when the accident occurred,

According to the FAA's U.S. Civil NOTAM System Publication 7930.2, paragraph 22, the FAA Flight Service Station Team Supervisor who received the information was required to distribute a NOTAM io nearby airports and air traffic control facilities, The facilities affected by this NOTAM would have included: Arapahoe County (APA), Jefferson County (BJC), Stapleton International @EN), Eagle County (EGE), Grand Junction (GJT), Aspen-Pitkin County (ASE), Pueblo Municipal (PUB), Colorado Springs (COS), Cheyenne Municipal (CYS) Airports, and the Denver Air Route Traffic Control Center (ARTCC). In addition to the adjacent airports and air traffic control facilities, the FAA procedures required distribution of the NOTAM within the Plight Service Station to the "Inflight radio position, Broadcast position, weather posting and flight watch positions."

The Flight Service Station Team Supervisor, who had been working in the Denver area for about 34 years, prepared a NOTAM and posted it on the weather posting board ae his own facility but did not effect any further distribution. He testified that he "was under the impression" that the Pr. Collins/Loveland airport was an approved jump area, listed in the Southwest United States "Airport/Facility Directory" and therefore that there was no requirement to "do anything with it."

Neither the applicable Airport Facility Directory for Southwestern United States nor the Cheyenne Sectional chart showed the Ft. Collins/Loveland airport area or airport as a designated parachute jump area. The directory did, however, show Ft. Collins Yankee Field 10 nmi to the north as a jump area. Organizations desiring listing of their jumping activities in the directory may contact the nearest FAA facility, such as a Flight Service Station, Control Tower, or Air Route Traffic Control Center. To qualify fa charting on a sectional aeronautical chart, a jump area must meet the following criteria:

1. Been in operation for at least 1 year.
2. Operate year round (at least on weekends).
3. Log 4,000 or more jumps each pear.

In addition, jump sites can be nominated for charting by FAA Regions.

Sky's West Parachute Center Inc. conducted more than 10,000 individual parachute jumps per year and had been in operation for more than 1 year on a year round basis at the time the 23d edition of the applicable Cheyenne Sectional Aeronautical Chart was published on March 19, 1981.

1.17.7 Flight Service Station and Air Traffic Control Procedures

Chapter 7, Section 5 of the Air Traffic Control Handbook 7110.65B, change 2, provides applicable instructions to Air Traffic Control personnel for the handling of notification to conduct parachute jump operations in controlled airspace. Paragraph 1493 of this handbook addresses controlled airspace other than positive control areas and control zones. It directs Air Traffic Controllers to issue a traffic advisory to the jump aircraft before the jump, to include aircraft type, altitude, and direction of flight of all known traffic which will transit the airspace within which the jump will be conducted. Controllers are also directed to issue advisories to all known aircraft which will transit the airspace within which the jump operations will be conducted, the advisories to consist of the location, time, duration, and altitude from which the jump will be made. When time or numbers of aircraft make individual transmissions impractical, advisories to nonparticipating aircraft may be broadcast on appropriate control frequencies or, when available, the ATIS broadcast. When requested by the pilot and to the extent possible, controllers are to assist nonparticipating aircraft to avoid the airspace within which the jump will be conducted.

1.17.8 Sky's West Parachute Jump Operations and General Procedures

The Sky's West Parachute Center is located at Ft. Collins/Loveland Airport, Loveland, Colorado. The Center conducts skydiving instruction and exhibitions and is engaged in parachute sales, repairs, and replacement. At the time of the accident, the Center operated two aircraft, a Cessna TU-205, and a Cesna TU-206 from Ft. Collins/Loveland Airport for parachuting acitivites.

Sky's West started operations at the Ft. Collins/Loveland Airport in November 1979 and is currently required to conduct its operations in accordance with Parts 91 and 105 of the Federal Aviation Regulations. All flights are conducted under VFR conditions.

By these regulations, Sky's West is required to notify the Denver Flight Service Station (FSS) or FAA Air Traffic Control facilities by telephone or radio before starting any daily operation. The FAA facility must be advised of the tail number of the parachute drop aircraft, the location of the jump, the altitude (m.s.l.) at which the jumps are to take place, and the time at which the operation will terminate.

Because of a suggestion by local FAA General Aviation District Office Inspectors, a manual was developed by Sky's West for their pilots, jump masters, and groundcrew about the same time it started its operations. The manual prescribes specific flight patterns and communication procedures. It states that all climbs and descents will be made away from any controlled areas - such as airways or airport traffic patterns. It further advises pilots that they should be aware of three airways within flight distance of the Ft. Collins/Loveland Airport, (V101, V4, and V19) and that the preferred climb and descent area is an area avoiding all airways.

With regard to communications, the manual reiterates the requirements set forth in 14 CFR 105.14 but elaborates as follows:

> For effective communications at this Parachute Center, we require each airplane to have two communication radios, one transponder, one

altimeter, and all normal instruments required for the airplane. An encoding altimeter is recommended, but not required

The pilot will maintain communications with the following throughout the flight:

Denver Center (Air Route Traffic Control Center). Tune to 124.b Longmont Center (Ralph Kiss Ed Olsen).

Denver Radar (unless they dictate shifting to another frequency).
The initial contact will commence at 8,000 feet m.s.l. Information to be relayed: Aircraft identification, aircraft location, aircraft altitude, direction of flight, purpose of flight (flying skydivers), altitude climbing to, where you intend to climb to altitude (unless they dictate otherwise), that you are transponder equipped.

One minute prior to exit, contact Denver *again.* Indicate: Aircraft identification, aircraft location, aircraft altitude, direction of flight, one minute prior to exit of skydivers. Upon receiving information fmm Denver, contact Loveland Unicom *on* 122.7. Indicate: Aircraft identification, aircraft location, aircraft altitude, direction of flight, one minute until exit of skydivers, visually check for any traffic at an altitude Chat would conflict with the jump.

The contents of Sky's West manual were reviewed by FAA General Aviation District *Office* inspectors *during* November 1979. FAA inspectors recommended several changes and additions to the manual. Sky's West incorporated the recommended changes. Official FAA approval of the manual was not required.

1.17.9 Air U.S. Operation

The air carrier, U.S. Aviation, operated and conducted business as "Air U.S." Air U.S., a Part 135 operata based in Sheridan, Wyoming, operated three Handley-Page Jetstream (HP-137) aircraft and two P i p Navajo Chieftain (PA-31-350) aircraft at the time of the accident. Its routes are from Denver, Colorado, to Gillette, Wyoming, and to Sheridan, Wyoming.

Air US. had authority to operate "an demand chaster" with airplane multiengine land, VFR and IFS, day and night, passenger and cargo.

Areas of operation are the Continental United States. Canada, and Mexico. Air U.S. flightcrew training programs provide specific material regarding the "see and avoid" concept and also require its pilots to read the Airman's Information Manual.

Air U.S. flightcrews normally receive NOTAM's from the Denver Flight Service Station with weather information for stations along their intended routes of flight. There was no record of a telephone call or other communication by Air U.S. to the Denver FSS on the day of the accident. There also was no record to indicate that any NOTAM's were received by the Air U.S. Flight 716 flightcrew on the day of the accident.

2. ANALYSIS

The flightcrews for both aircraft were properly certificated and qualified in accordance with existing regulations. There was no evidence that medical or physiological problems affected their performance. Weather was not a factor in the accident. Both aircraft were properly certificated and maintained, with the exception of items noted in appendix C which were not considered contributory to the accident. There were no uncorrected discrepancies in the maintenance records of either aircraft which were related to the accident.

2.1 Operational Factors

2.1.1 Operational Procedures in Use at Time of Accident

FAR 91.24(b)(4) prohibits flight above 12,500 feet without a Mode-C encoding altimeter unless deviation has been authorized by the FAA in accordance with FAR 91.24(c). Sky's West had been conducting parachute jump operations from the Ft. Collins/Loveland Airport since November 1979 at the rate of more than 10,000 jumps per year. The great majority of these operations involved flight above 12,500 feet for jump purposes. None of the Sky's West aircraft were equipped with Mode-C altitude encoding transponders and no continuing waiver had been issued to Sky's West to permit such operations above 12,500 feet without a transponder as required by FAR 91.24. Rather, the Denver Center controllers on a routine basis allowed these flights to operate at altitudes above 12,500 feet. The controllers testified that they believed that they were not granting permission to these flights, but were simply acknowledging advisories that they were, in fast, operating at these altitudes. The Board believes that this routine practice of the Denver Center in not questioning such operations or in any way restricting these aircraft from operating above 12,500 feet without a Mode-C transponder indicated taat approval. The permissiveness of the Denver Center created a situation wherein Sky's West believed that they had a standing waiver from the regulatory requirements for operations of this type, and it became an acceptable practice not oniy to Sky's West but also to Denver Center personnel. It is further believed that this permissiveness generated an atmosphere of complacency both at the Center and within the Sky's West operation which also led to laxity, even with respect to the existing communications procedures. This was exemplified by the communications between the Sky's West pilot and the Denver Center during the flight about 2 hours before the accident flight, when the pilot advised the Center that he was going to 15,500 feet and the controller simply replied with "roger."

The Board believes that the Sky's West aircraft without Mode-C transponders should have been prohibited from routinely operating above 12,500 feet. The requirement for Mode-6 altitude encoding transponders was established to enhance safety above 12,500 feet m.s.L (where many high performance aircraft operate) by prohibiting flights by aircraft at those altitudes without this required equipment. However, even without a Mode-C transponder, adequate air traffic control procedures existed to provide for aircraft separation if proper notification and communications procedures (in accordance with deviation provisions of FAR 91.24(c)(2)) had been followed by the pilot and the air traffic control facility involved

The Cessna TU-206 departed on its second parachute jump operation of the day from the Ft. Collins/Loveland Municipal about 18 minutes before the collision. The pilot did not call the center to request a deviation to go above 12,500 feet without a Mode-C transponder nor did he make an initial call at 8,000 feet as set forth in the Sky's West manual as a recommended procedure. The pilot testified that he was abut to call the Denver Center when the accident occurred. Since he was at 13,000 feet and

climbing to 15,500 feet at a rate of about 500 fee: per minute; he would have been in compliance with the 5-minute jumping advisory provision of FAR 105.14. However, if the pilot had complied with FAR 91.24 and requested an ATC authorized deviation he would have had to communicate earlier with the Denver Center. This communication would have alerted the controller to the presence of the Cessna in his sector, and if he granted the deviation and radar identified the aircraft, he could have started to "track" ?he target. Thus, the Safety Board believes that the pilot's failure to communicate with the Denver Center forestalled the use of any possible air traffic control procedures which could have been used by the controller to track this aircraft and which possibly could have averted the collision.

It should also be noted that the pilot of the Cessna had frequently been assigned code 1-2-3-4 by the controllers for use during parachute jump operations. Consequently, the pilot believed that this was e permanently assigned code and that by merely squawking 1-2-3-4 positive radar identification was provided for the aircraft. This misconception created an *unsafe* condition in that it provided a false sense of security for the Cessna pilot.

The Sector 14 controller did not recall having seen a target associated with the Cessna and observed no conflicting traffic for Air US. 716. The non-Mode-C filter button was not activated thereby eliminating radar target display of non-Mode-C equipped aircraft. if the non-Mode-C filter key had been activated, the radar return of the Cessna would have been continuously visible on the display. Even this would not necessarily have alerted control personnel to a potential conflict since they would have expected all non-Mode-C targets to be below 12,500 feet. However, if the accident aircraft had been equipped with a Mode-C transponder, the controller's radar display would have depicted the aircraft as a specific target including a data block containing three digit altitude information and a four digit transponder code. This would nave provided ample information which the controller could have used for separating the jump aircraft from any conflicting traffic.

2.1.2 Distribution of NOTAM Regarding Jumping Activities

The information necessary for the Flight Service Station to issue a NOTAM was provided by Sky's West 23 minutes before their first flight of the day rather than 1 hour before, as required by FAR 105.23. The notification, once received by the Denver FSS, was required to be treated as a NOTAM with loca! distribution but was merely posted on the FSS weather board.

The FSS team supervisor stated that he believed the NOTAM pertained to the Ft. Collins Yankee jump area (about 10 nmi north of Ft. Collins/Loveland). The Yankee area is listed in the U.S. Flight Information publication, "Airport Facility Directory," published by the National Oceanic and Atmospheric Administration (NOAA); the supervisor, therefore, believed that distribution of the NOTAM was not required.

Since ehe Ft. Collins/Loveland area clearly qualified for listing in the Airport Facility Directory, either Sky's West or any FAA facility could have had the area listed and thus have clarified the location of the active jump area. Based on the testimony of the controller involved, knowledge of the NOTAM at his sector would not have altered the control procedures he employed. The NOTAM would only have served to notify the controller to expect a call from a jump aircraft. There is no evidence that Air U.S. Flight 716 involved in the accident requested any NOTAM information from the FAA on the day of the accident.

2.2 Regulatory Improvements

The Safety Board believes that the FAA should prohibit jumping on or within a specified distance from airways or in congested airspace. (This accident occurred about 1 nmi off airways, in airspace normally used for aircraft departing Denver's Stapleton International Airport.)

Additionally, the Board believes that FAA should direct their ATC facilities to notify the appropriate General Aviation District Office when any of its control facilities become aware of violations of regulations or safety issues concerning parachute jumping. Had this occurred prior to the accident, a better understanding of their respective responsibilities on the part of the jump school operator and the FAA facilities would have been effected.

In view of the information developed during the investigation of this accident, the United States Parachute Association should immediately make its members aware of this accident and encourage them to communicate on the aircraft radio with the control facility having jurisdiction of the airspace in which the jump is to be initiated. This communication should include a request for VFR traffic advisories as soon as practicable after takeoff and should be accomplished in addition to the 5-minute notification required by FAR 105.14.

The Board also believes that the intent of FAR 105.14 would be better served if 105.14 (a) (1) (ii) were to require that radio communication be established between the jumy aircraft and the air traffic control facility having jurisdiction of the airspace in which the jump is to be initiated. The present regulation permits contacting the "nearest FAA air traffic control facility or FAA flight service station." It should be noted that the nearest facility mag not necessarily be the facility having control jurisdiction over the airspace in whicn the jump is to be conducted. Moreover, the regulation in its present form would have allowed Sky's West to have contacted a flight service station and satisfied the requirements of the regulation. However, the flight service station would not have been able to provide traffic advisories.

To cover the situation of a jump being initiated in one control facility's airspace and descending into another facility's airspace, the regulation should provide that the facility contacted should be the air traffic control facility which has jurisdiction of the airspace in which the jump is to be initiated. Air Traffic Control Handbook 7110.65B should then be revised to require that the controller in communication with the jump aircraft, when the jump is initiated, coordinate with the control facility having jurisdiction over the airspace into which jumpers will descend. This would then enable a complete exchange of traffic information between the pilot of the jump aircraft, the jumpers, and all potentially conflicting aircraft involved. The Board believes that these changes to FAR 105.14 would enhance aviation safety,

The Board recognizes that the primary intent of Part 105 is to provide protection to parachute jumpers from collision with transiting aircraft. However, the circumstances of this accident dramatize the fact that an aircraft in a parachute jump operation is in effect an "elevator in the sky." It is generally not "straight and level" but is circling in a climb or descent attitude. This reduces cockpit visibility and makes the sighting of other potentially conflicting traffic more difficult. Because of the large number of such operations annually, the Safety Board believes that the attendant safety provision is of significant magnitude. Accordingly, we believe the compass of Part 105 should be expanded to include an increased level of safety via traffic advisories while a jump aircraft is proceeding to and departing from the location where jumpers are released.

2.3 Visibility Factors

2.3.1 Physical Factors--Binocular Photographs

The binocular photographs reproduced in appendix D approximate the flightcrew's field of view with respect to the target aircraft. The photographs were produced using design eye reference points, 8/ smoothed aircraft flight paths, computed aircraft attitudes, and flight path angles. All four of the above items are variable and have some inherent uncertainties and errors. Further, the resultant field of view does not directly account for pilot seat adjustment, slouching, or normal head movement either singularly or in combination. Notwithstanding the limitations of the binocular photographs cited above, the Safety Board believes they provide a valid and adequate approximation of the field of view available to the cockpit crewmembers and, as such, provide an appropriate baseline from which a rational analysis of visibility factors can be developed.

Cessna TU-2'06

Examination of the photographs taken from the pilot's position indicate that the view of the Jetstream would have been unobstructed and within the binocular vision envelope of the windshield. If the pilot's eyes were in a position 1 inch above the design eye reference point, the Jetstrean target would have been present within that vision envelope in the lower right hand corner very near the glare shield for a period of at least about 120 to 75 seconds before the collision. The pilot's seat was found adjusted to the full-up position. Had the pilot's seat been adjusted forward of the reference point, the over-the-me visibility would have been increased. Conversely, if the seat was located aft and/or below the reference point, the visibility near the lower edge of the windshield would have been less, due to the position of the instrument panel glare shield.

There were several reasons why the Cessna pilot did not observe the Jetstream. The pilot stated that he was not looking for traffic and was in a climbing left turn with his attention focused on the ground as he approached the jump area. He also stated that he was looking at the airport and his relationship to the drop zone. Clearly, he was not concerned about scanning the sky for potential traffic. Also, the pilot, as well as personnel at the jump school, believed that they were being protected by ATC while flying in the drop zone even though the pilot had not notified ATC of the accident flight. The Safety Board believes that the Cessna pilot had a responsibility to insure that the airspace in which this operation was to be conducted was clear of any traffic or other hazard. In this respect, it would have been prudent for this pilot, while in the climbing turn over the drop zone, to have cleared the area by periodically lowering the nose of the aircraft, leveling the wings and intently scanning the airspace around the aircraft to see if there was any potential conflicting traffic that could in any way be hazardous to this operation. The Cessna was struck from behind as it was turning. The binocular photographs show that the Jetstrean was completely out of view of the Cessna for about the last 60 seconds (35 to 4 nmi) before the collision.

Handley Page HP-X37

The Cessna as presented to the captain and first officer, assuming they were seated at the design eye reference point, would have been unobstructed and clearly and unmistakeably within the binocular vision envelope of both crewmember's windshields. The Cessna target would have been present very near the vertical zero reference point

8/ "Design Eye Reference Position" is defined by FAA Policies contained in Civil Aeronautics Manual (CAM) 4b.351-3(a).

from about 60 to 15 seconds before the collision for the first officer and from about 60 to 30 seconds before the collision for the captain. Variations in eye placement forward or aft of the eye reference point would not have taken the Cessna outside the pilot's binocular vision envelopes. Due to the Cessna's proximity to the vertical zero reference point, vertical seat adjustment also would not have removed the Cessna from the pilot's binocular vision envelopes. The Jetstream Bightcrew had not been advised by ATC of any air traffic, and therefore, probably were not scanning for a specific target. Nevertheless, the difficulties of target detection and recognition must be considered in an effort to explain why the Cessne went undetected.

Effects of Target Size

Target size is a consideration in this accident in light of the Cessna's observable angular size. The Cessna TU-236 is 28 feet Long and its fuselage height is about 4 feet. From the Jetstream's vantage point, very near its vertical zero reference point, the visual angles of the Cessna's foreshortened length (VAL) and height (VAH) were calculated at 3 points, 15 seconds apart and beginning 45 seconds before the collision. Pitch and roll attitudes of the Cessna were not considered. Thus, virtually no wing surface area of the Cesna was presented to the Jetstream. The visual angles are as follows:

45 seconds	30 seconds	15 seconds
VAL = .14°	VAL = .07°	VAL = .20°
VAH = .03°	VAH = .04°	VAH = .07°

Similarly, the visual angles far the Cessna viewing the Jetstream were determined at the only three pints during the time the Jetstream was in the pilot's binocular vision envelope. The three points were at 120, 105, and 90 seconds before the collision. The Jetstream is 47 feet long and 6 feet high and was viewed nearly straight on by the Cessna. Visual angles were determined without considering the pitch and roll attitudes of the Jetstream and are 8s follows:

120 seconds	105 seconds	90 seconds
VAL = .02°	VAL = .02°	VAL = .04°
VAH = .01°	YAH = .01°	VAH = .01°

These would have been small targets and as previously mentioned they were located in the lower right hand corner of the pilot's windshield very near the giare shield.

A review of the binocular photographs indicates that relative motion was present as to each of the viewing aircraft. In the case of the Jetstream crew, the Cessna target traveled directly across their windshields and was present in their binocular vision envelope for ai least 45 seconds.

23.2 Psychophysiological Factors--Target Detection and Recognition[9/]

The binocular photographs described above represent the probable location of the target aircraft as presented to the viewing aircraft's crewmembers with respect io the boundaries of the viewing aircraft's windshield. The information is only part of the equation. The presence of a target within a windshield does not assume its detection and recognition. The physiological and performance limitations of the human eyes in

9/ "Human Engineering Guide to Equipment Design," Editors: Harold P. Van Cott, Ph.D., and Robert G. Kinkade, PhD., 1972.

any in-flight situation are significant in explaining why targets go undetected. These limitations and factors singularly or in combination can derogate a person's ability to datect and recognize a target. Such limitations end failures apply to any flightcrew or person, but for this accident they more appropriately relate to the Jetstream flightcrew. These factors are widely known and have been cited in previous Board reports since 1971, dealing with in-flight collision,

Contrast would have been no problem in this case and should have assisted the Jetstream crew in sighting the Cessna. The predominantly white Cessna would have been at or below the horizon, as shown in the binocular photographs, when viewed from the Jetstream during the 50 seconds before the collision. Even if the Cessna was slightly above the horizon, the nature of the assumptions made and the variability of the date used in producing the binocular photographs, the Cessna would have been viewed by the Jetstrean against the homogeneous background of the blue sky rather than the darker, somewhat homogeneous background of the brown and green terrain. (The latter situation would have produced the best contrast.) The position of the sun would not have been a factor in producing glare.

While searching a clear sky or a homogeneous field tends to produce a condition in the viewer's eyes known as "empty field myopia" in which the eyes will accommodate or tend to focus at a distance of 30 to 35 feet because no specific reference points are present, empty field myopia was not a factor in this accident. The Jetstream crew would have had several points to focus on, such as the horizon, mountains, and clouds.

2.3.3 Pilot Vigilance

The possibility of a pilot's detecting airborne targets depends upon his expectations in finding a target that he has been alerted to, his physical well-being, how he time-shares the instrument scanning and outside scanning, and the techniques used in searching for airborne targets. Obviously, if a pilot assumes that he is protected by ATC and/or is fatigued, bored, preoccupied, or distracted, his ability to scan the airspace while simultaneously watching cockpit displays, flying the aircraft, and monitoring ATC communications will be seriously impaired,

In this accident, there was no evidence to indicate that the Jetstream pilots were fatigued or physically unfit. It is not possible to determine how much time during the final 120 seconds of flight each pilot could have devoted to outside scanning, nor is it known what each pilot's scanning habits or techniques might have been.

A recent NASA study of data from the Aviation Safety Reporting System (ASRS) on near midair collisions 10/ indicated that half of 78 near midair collisions in Terminal Controlled Airspace (TCA's) involved one aircraft not known to ATC. "If ASRS 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; when warned of a conflicting aircraft, they tend to look for it to the exclusion of within-cockpit tasks and scanning for unreported traffic." The report continues: "The air traffic controller

10/ "A Study of Near Midair Collisions in U.S. Terminal Airspace," Billings, Grayson, Hecht, and Curry, NASA TM 81225, August, 1980..

cannot inform the pilot of traffic that is not visible on his radar scope, nor can he provide separation from such traffic. It is plain that at least some pilots receiving Stage III services believe that they will be told about all traffic that represents a threat, yet controllers can handle traffic only with regard to threats they can see.. ."

A general aviation pilot in one ease study said:

> ...I have been able to practice more effective collision avoidance by listening to communications on the frequency than by receiving advisories ...I'm afraid many pilots get a false sense of security when under radar control or advisory. ... Those pilots who do not understand them must be taught the limitations of terminal radar, and of the controllers who use it as their primary source of information- Many aircraft in TRSA's, -and some intruders in TCA's, are not transponder-equipped; such aircraft are often not visible to controllers. These aircraft, and many others near TCA boundaries, may represent a threat detectable only by the pilot, and then only if he is looking for them. The highest level of pilot vigilance must be maintained to avoid midair collisions, regardless of the airspace in which operations are being conducted and regardless of the ATC services being utilized. No pilot should permit himself to be lulled into a false sense of security by ATC procedures that cannot necessarily guarantee separation under visual meteorological conditions. ... The system of separation assurance is not 'error-proof,' nor, in all probability, will it ever be. Separation can be assured most effectively by providing air traffic controllers with the best possible information about all aircraft within their area of responsibility; by minimizing flightcrew workload in terminal airspace, thus permitting them to maintain the best possible outside surveillance; and by making pilots aware of the critical importance of maintaining such surveillance, regardless of the services they are receiving. It is hoped that this study and report will help to increase that level of awareness. ...

In summary, the authors of the 1980 NASA study concluded tha,: "A variety of human and system factors was found to be associated with these near midair collisions. Flightcrew workload, limited visual scan while under radar control, misunderstanding of the limitations of the ATC system, and failure to utilize transponders were observed. A substantial number of reported near midair collisions in Stage III terminal airspace involved at least one aircraft not participating in Stage III services. For these reasons, pilots must exercise the highest level of vigilance for other traffic, regardless of airspace or radar services being utilized." Although the Safety Board could not determine precisely why the Jetstream flightcrew did not see the Cessna 206, these conclusions are applicable to the present accident situation as Likely explanations for the failure of the "see and avoid" concept to have prevented this collision. The Safety Board recognizes the inherent limitations of the see and avoid concept and have cited them in numerous Board reports involving midair collisions. Although the FAA has published considerable data regarding the need for continued pilot vigilance in order to minimize the colliiion hazard, the Board believes that there is still insufficient, detailed information available for the enlightenment of pilots and controllers regarding the limitations associated with this concept. Notwithstanding the above cited limitations, the Safety Beard believes that strict adherence by all concerned to existing rules contained in FAR 91 and 105 and applicable procedures set forth in the Airman's Information Manual could possibly have prevented this accident.

3 CONCLUSIONS

31 Findings

1. The flightcrews of both aircraft were properly certificated and qualified for their flights.

2. The aircraft were certificated and maintained in accordance with applicable regulations. (Except as noted in appendix C.)

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

4. The pilot of the Cesna TU-206 misunderstood the use of the ATC transponder and based on his prior experience at Denver's Stapleton Airport erroneously, but understandably, interpreted the meaning of the word "roger" as an approval by the controller to deviate from ?he Mode-C trensponder requirement above 12,500 feet m.s.l.

5. The pilot of the Cesna TU-206 did not establish and maintain radio contact with Denver Center as required by Sky's West procedures.

6. The Cessna pilot continued flight to an altitude above 12,500 feet m.s.l. without a Mode-C encoding altimeter aboard the aircraft as required by FAR 91.24(b)(4) and without authorization to deviate from the regulation.

7. The Cessna pilot erroneously asumed that he was protected from collisions with other aircraft by ATC even though he never contacted ATC during the accident flight.

8. Had the Cesna Seen equipped with Mode-C, the resultant target with an indication of the altitude of the Cessna would have been presented clearly on the controller's radar display.

9. An untracked, beacon reinforced primary target was presented on the controller's display for about 75 percent of the Cessna's flight path, but was not noted by the controller.

10. FAA management personnel at the Denver Center did not take decisive action when they had knowledge of routine parachute jump operations being conducted by Sky's West above 12,500 feet without Mode-C transponders.

11. The Flight Service team supervisor did not disseminate the NOTAM on the parachuting activity to the Denver Center or to any other facility as required by FAA instructions.

12. Sky's West and FAA did not initiate any action to have the Ft. Collins/Loveland area listed in the NOAA Airport/Facility Directory.

13. Cesna TU-206 binocular photographs taken 1 inch above the CAM4b design eye reference point indicate that the Jetstream would have been

within the binocular vision envelope of the pilot's windshield for at least a 45-second interval, beginning 120 seconds before the collision, but not for the last 60 seconds.

14. Any aft movement of the Cessna pilot's seat would have altered his physical constraints to visibility and reduced the binocuiar vision envelope.

15. The Cessna pilot was not looking for traffic prior to the collision because he was looking at the airport and drop zone.

16. Jetstream binocular photographs taken at the design eye reference point indicate that the Cessna would have been present within the binocular vision envelope of both pilots' windshields for about a 45-second interval begining about 60 to 75 seconds before the collision.

17. The physical constraints to visibility for the Jetstream flightcrew would not have been significantly altered by the flightcrew's seat adjustments.

18. The Jetstream crew had not been advised of any traffic in its area and may not have been scanning for traffic in any particular sector just before the collision.

19. Psychophysiological factors and scanning techniques could have affected the Jetstream flightcrew's ability to detect and identify the Cessna as a potential hazard.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the Cessna pilot to establish communications with the Denver Center and his climbing into controlled airspace above 12,500 feet without an authorized deviation from the altitude encoding transponder (Mode-C) requirement, the practice of the Denver Center of routinely condoning Sky's West parachute jump operations above 12,500 feet without a Mode-C transponder and the failure of the pilots of both aircraft to "see and avoid" each other. Contributing to the accident was the fact that existing regulations do not prohibit parachute jumping in, or immediately adjacent to, Federal airways.

4. RECOMMENDATIONS

As a result of this investigation, the National Transportation Safety Board made the following recommendations:

--to the Federal Aviation Administration:

Direct ATC facilities to notify the appropriate General Aviation District Office when any of its control facilities become aware of violations of regulations or safety issues concerning parachute jumping. (Class I, Urgent Action) (A-81-163)

Revise 14 CFR 105.23 to prohibit parachute jump operations in or near Federal airways and determine an acceptable safe distance from such airways at which jump operations can be conducted without conflict with other air traffic. (Class II, Priority Action) (A-81-164)

Establish a special transponder code with an appropriate and readily identifiable radar display for all parachute jump operations. (Class II, Priority Action) (A-81-165)

Revise Advisory Circular 90-48B, "Pilot's Role in Collision Avoidance" to include detailed information regarding the psychophysiological factors affecting pilots' ability to see and avoid other aircraft. (Class II, Priority Action) (A-81-166)

Amend 14 CFR 105.14 to require that a parachute jump aircraft contact the air traffic control facility having jurisdiction of the airspace in which the jump is to be initiated rather than the "nearest FAA air traffic control facility or FAA flight service station." (Class II, Priority Action) (A-81-167)

Amend 14 CFR 105 to require that the pilot of a jump aircraft contact all control facilities having jurisdiction of the airspace in which the aircraft will transit during the operation for the purpose of receiving traffic advisories while proceeding to and departing from the location where jumpers are released. This should be in addition to the requirement of 105.14 (a) (1) (ii) for a 5-minute notification before jump operations are begun. (Class II, Priority Action) (A-81-168)

Amend Air Traffic Control Handbook 7110.65B to require a controller who receives a notification from a jump aircraft, required by 14 CFR 105.14, that the jumpers will descend into another facility's airspace coordinate with that facility so that a complete exchange of traffic can be effected between the jump aircraft, the jumpers, and all potentially conflicting aircraft involved. (Class II, Priority Action) (A-81-169)

--to the United States Parachute Association:

Immediately (1) inform members of the circumstances of this accident, (2) recommend that members seek VFR traffic advisories from the control facility having jurisdiction of the airspace in which jump operations will be conducted as soon as practicable after takeoff, and that this be done in addition to the "5-minute" communication required by 14 CFR 105.14, and (3) advise members of the increased level of safety which can be attained by the use of Mode-C transponders in jump operations at all altitudes. Publish the advisory information in the next revision of the US. Parachute Association Manual. (Class II, Priority Action) (A-81-170)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ G. H. PATRICK BURSLEY
Member

PATRICIA A. GOLDMAN, Member, did not participate.

December 17, 1981

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The Safety Board was notified of the accident about 1930 on April 17, 1981, by the FAA's Washington Command Center. An investigator from the Board's Denver Field Office was dispatched to the accident site immediately. An investigation team was dispatched from the Board's Washington Headquarters with operations, human factors, system and structures groups. An Air Traffic Control Specialist was dispatched from the Boards Chicago Field Office.

Parties to the investigation included the Federal Aviation Administration, British Aerospace Limited, Cessna Aircraft Company, the Professional Air Traffic Controller's Association, Air US., and Sky's West Parachute Center, Inc.

2 Public Hearing

A public hearing was held in Northglenn, Colorado, on May 13, and 14, 1981. Parties to the hearing were The Federal Aviation Administration, the Professional Ai, Traffic Controller's Association, Cessna Aircraft Company, Air US., and Sky's West Parachute Center, Inc.

APPENDIX B

PERSONNEL INFORMATION

Cessna TU-206 N4862F

Pilot

Pilot David L. Vigen was a part-time pilot for Sky's West Parachute Center, Inc., and pilot-in-command of Cessna TU-206, N4862F. He held airline transport pilot certificate No. 2160386 issued on March 27, 1978, with multiengine privileges and commercial privileges for airplane single-engine land. He also held a flight instructor certificate with airplane single- and multiengine and instrument airplane authorizations. He held a second class medical certificate with no limitations issued on January 20, 1981.

Pilot Vigen had about 4,600 flight hours of which about 1,900 flight hours were in multiengine aircraft. He had about 400 flight hours in Cessna 206-type aircraft.

Pilot Vigen's past experience includes pilot-in-command duties for an FAR Part 135 operator He was given a Part 135 VFR proficiency check in a Cessna 206 during June of 1979, with satisfactory results.

The president of Sky's West Parachute Center Inc., estimated that Pilot Yigen had flown about 30 hours during the past 90 days.

Air U S Handley Page HP-137

Captain

Captain Ezra J. Lebowitz, age 27, was employed by Air U.S. in July, 1980. He held airline transport pilot certificate No. 15508105 with ratings of airplane single- and multiengine land and commercial privileges. He also held a flight engineer certificate with a turbojet rating. He had a first class medical certificate dated February 17, 1981, with no limitations.

Captain Lebowitz had a total of 4,784 flying hours of which 1,784 flying hours were in Handley-Page Jetstream aircraft.

He completed his last proficiency and line checks on February 21, 1981.

First Officer

First Officer Dennis J. Beavers, age 23, was employed by Air U.S. on January 20, 1981, held commercial pilot certificate No. 524749041 with airplane single- and multiengine land and instrument ratings. He also held a flight engineer certificate.

First Officer Beavers had a total of 2,280 flight hours of which 210 flight hours were in Handley-Page Jetstream aircraft.

He completed his annual proficiency check on January 26, 1981.

First Officer Beavers possessed a second class medical certificate dated August 15, 1980, with no limitations.

Flight Attendant

Ms. Celeste Reid, age 22, served as flight attendant on Flight 716, although there was no FAA requirement for a flight attendant on this flight.

APPENDIX C

AIRCRAFT INFORMATION

Air U.S. Handley-Page HP-137

Air U.S. obtained the aircraft in December 1979 and it had been operated continuously by the company since that date.

Statistical Data

Aircraft

Aircraft Total Time -	3,795.3 hours
Aircraft Total Landings -	3,791
Company Serial No. -	238

The aircraft was' equipped with two Garrett AiResearch engines, Model TPE-331-U-303V, and two Hartzell Propellers, Model HCB3TN-5P.

Powerplants	Left	Right
Serial Number	PO3158C	P32005
Date Installed	1-21-81	3-8-81
Time Since New	7978.9 hours	5776.6 hours
Time Since Hot Section Inspection	N/A	298.7 hours
Cycles Since Hot Section Inspection	NIA	212
Time Since Overhaul	2783.4 hours	N/A
Cycles Since Overhaul	2572	NIA

Propellers	Left	Right
Serial Number	BV4642	BV4643
Date Installed (New)	11-21-80	11-21-80
Time Since New	1108.4 hours	1108.4 hours

Sky's West Cessna TU-206

Sky's West obtained the aircraft in July 1980, and from that date maintenance checks and inspections were completed within their specified time limits. The Airworthiness Directive ccmpliance list did not show that. the following AD's were complied with:

AD-70-14-07	Teiedyne Continental Fuel Injection Pump.
AD-71-24-04	Cesna Flexible Hoses Engine Compartment.
AD-80-06-05	Slick Electro Magneto Impulse Couplings.

In reference to the noncompliance with the above AD's, the Sky's West mechanic submitted the following statements:

AD-70-14-07 Teledyne Continental-Fuel Injection Pump.

The engine was overhauled twice since issued. Unknown to the undersigned whether or not compliance was ever accomplished. The overhauls were accomplished prior to our taking control of the aircraft.

AD-71-24-04 Cessna Flexible Hoses Engine Compartment.

This was complied with during the 100-hour inspection and not recorded.

AD-80-06-05 **Slick** Electro-Magneto Impulse Couplings.

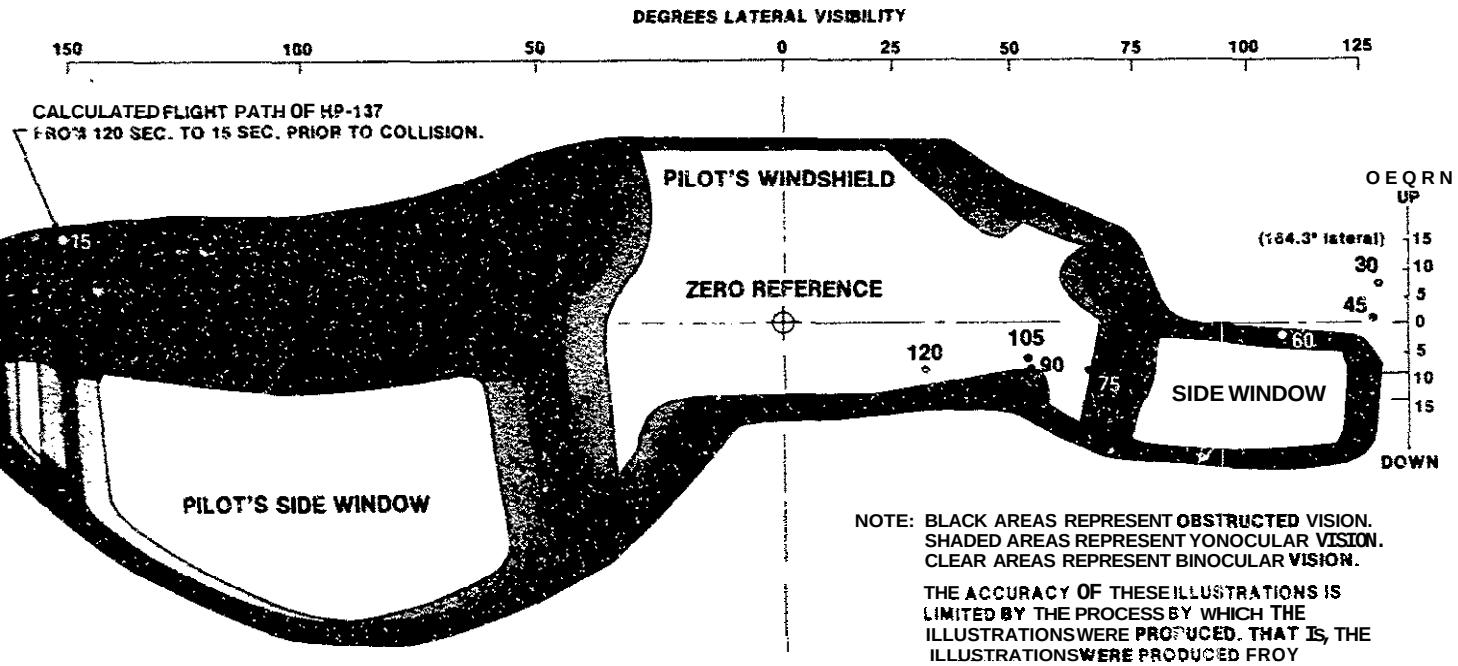
Left mag was overhauled March **1981.** Compliance not recorded. Right mag status unknown.

The records also revealed that the **ATC** transponder had not received a check since December **5, 1977.** The check is required every **24** calendar months.

The records also showed that the magnetic compass had been removed, repaired and replaced on March **27, 1981.** The records did not indicate that the compass was checked for accuracy after installation.

Statistical Data

Aircraft Total time -	3222:31 Hours (Tach Time)
Last 100-Hour Inspection -	3203:61 Hours **4-10-81**
Last **Annual** Inspection -	2803:11 Hours **7-17-80**
Engine Type -	Continental, **Model** TSIO-520C **S/N** 140216-8C
Propeller Type -	McCauley **Model D2A34C78-IV S/N702739**
Engine Total Time -	754:28 **Hours** since major overhaul
Propeller Total time -	1012:3 Hours

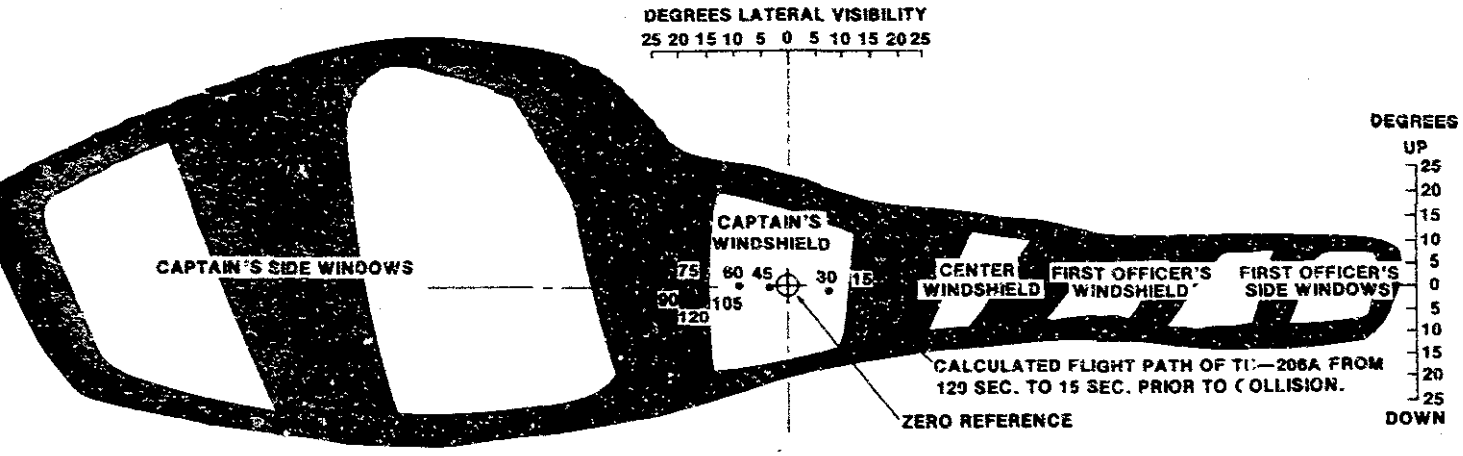


NOTE: BLACK AREAS REPRESENT OBSTRUCTED VISION.
SHADED AREAS REPRESENT YONOCULAR VISION.
CLEAR AREAS REPRESENT BINOCULAR VISION.

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

VISIBILITY FROY LEFT SEAT ONE INCH ABOVE OESIQN EYE REFERENCE POINT

COCKPIT VISIBILITY
CESSNA TU—206A
VIEWING HANDLN PAGE HP—137

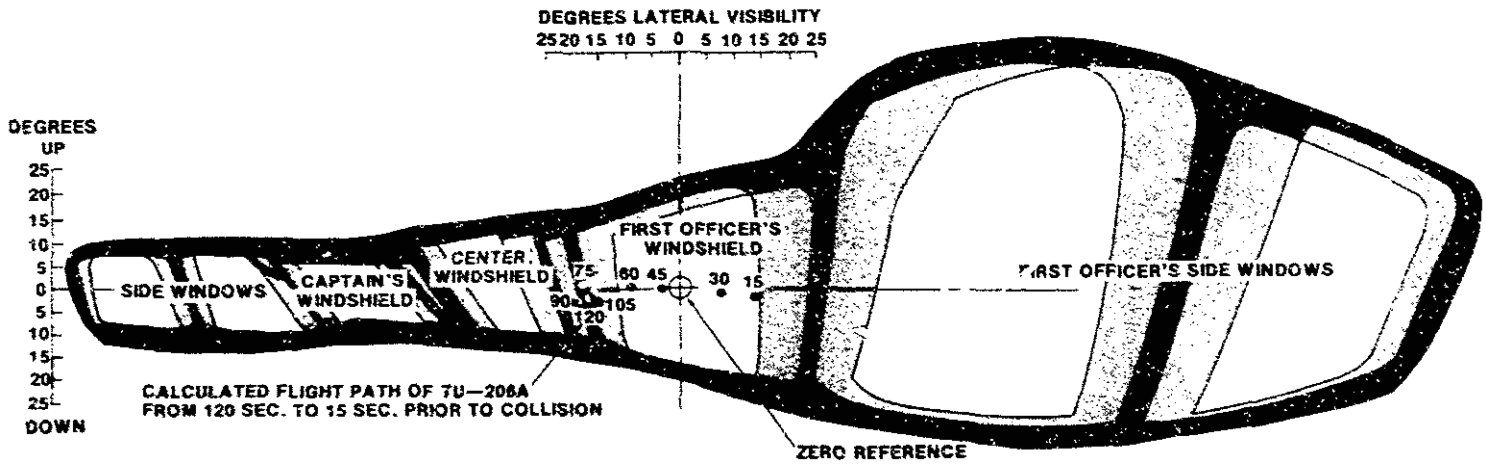


VISIBILITY FROM LEFT SEAT DESIGN EYE REFERENCE POINT

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

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

COCKPIT VISIBILITY
HANDLEY PAGE HP—137
VIEWING CESSNA TU—206A



VISIBILITY *mom* RIGHT SEAT **DESIGN** EYE *REFERENCE POINT*

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

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

COCKPIT VISIBILITY
HANDLEY PAGE HP—137
VIEWING CESSNA TU—206A

APPENDIX E

FEDERAL AVIATION REGULATIONS PART 71.5

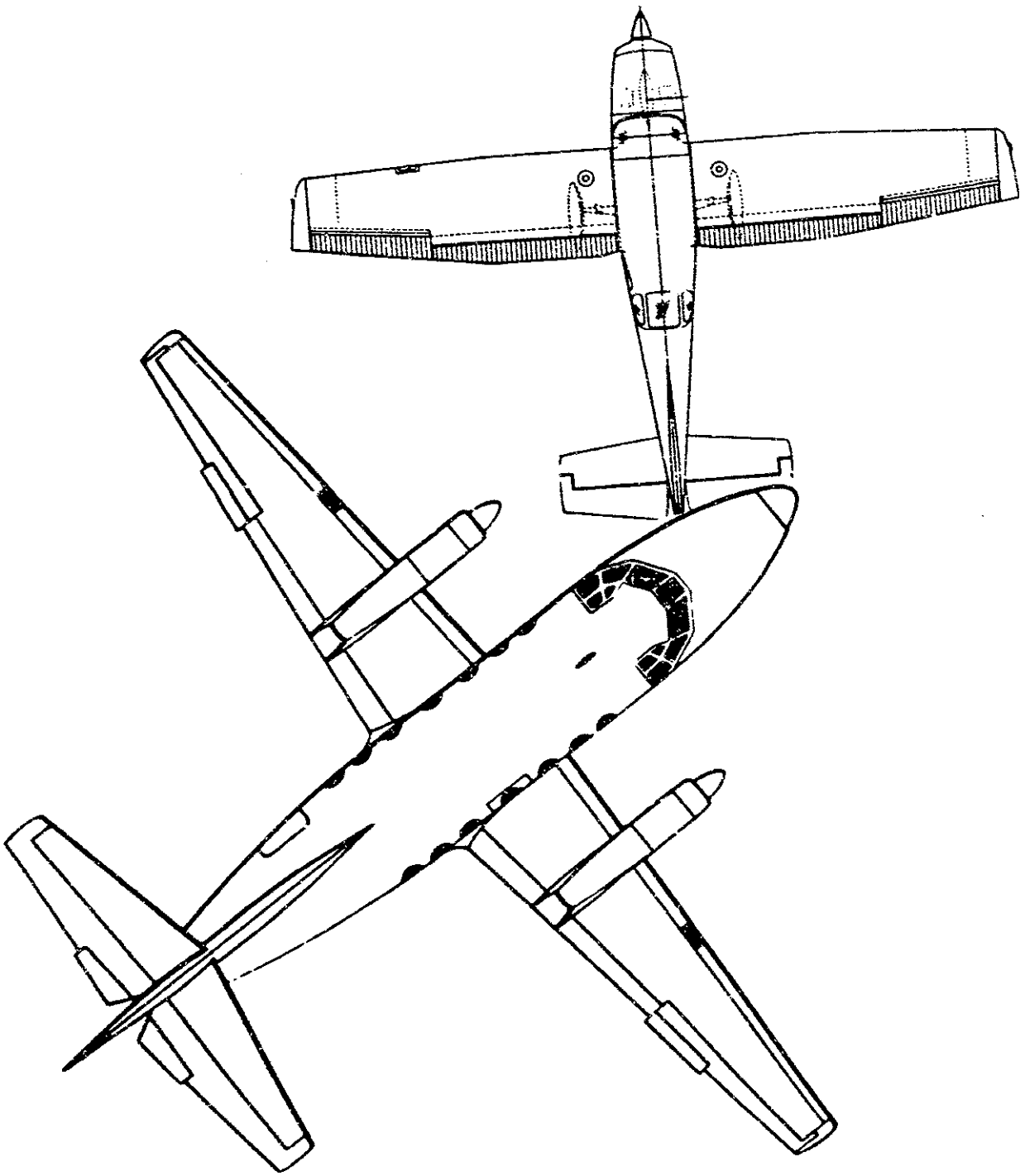
Federal Aviation Regulation Subchapter E, Airspace Part 71.5 defines the extent of Federal Airways (a control area or portion thereof established in the form of a corridor the centerline of which is defined by radio navigational aids) as follows:

> (a) Each Federal airway is based on a centerline that extends from one navigational aid or intersection to mother navigational aid (or through several navigational aids or intersections) specified for that airway.
>
> (b) Unless otherwise specified in Subpart B or C 10/
>
> (1) Each Federal airway includes the airspace within parallel boundary lines 4 miles each side of the centerline. Where an airway changes direction, it includes that airspace enclosed by extending the boundary lines of the airway segments until they meet.
>
> (2) Where the changeover point for an airway segment is more than 51 miles from either of the navigational aids defining that segment, and
>
> (i) The changeover point is midway between the navigational aids, the airway includes the airspace between lines diverging at angles of 4.5° from the centerline at each navigational aid and extending until they intersect opposite the changeover point; or
>
> (ii) The changeover point is not midway between the navigational aids, the airway includes the airspace between lines diverging at angles of 4.5 from the centerline at the navigational aid more distant from the changeover point, and extending until they intersect with the bisector of the angle of the centerlines at the changeover point; and between lines connecting these points of intersection and the navigational aid nearer to the changeover point.
>
> (3) Where an airway terminates at a point or intersection more than 51 miles from the closest associated navigational aid it includes the additional airspace within lines diverging at angles of 4.5" from the centerline extending from the associated navigational aid to a line perpendicular to the centerline at the termination point.
>
> (4) Where an airway terminates, it includes the airspace within a circle centered at the specified navigational aid or intersection having a diameter equal to the airway width at that point. However, an airway does not extend beyond the domestic/oceanic control area boundary.
>
> (c) Unless otherwise specified in Subpart B or C
>
> (1) Each Federal airway includes that airspace extending upward from 1,200 feet abave the surface of the earth to, but not including, 13,000 feet MSL, except that Federal airways for Hawaii have no upper limits.

10/ Subparts B and C not pertinent to this accident.

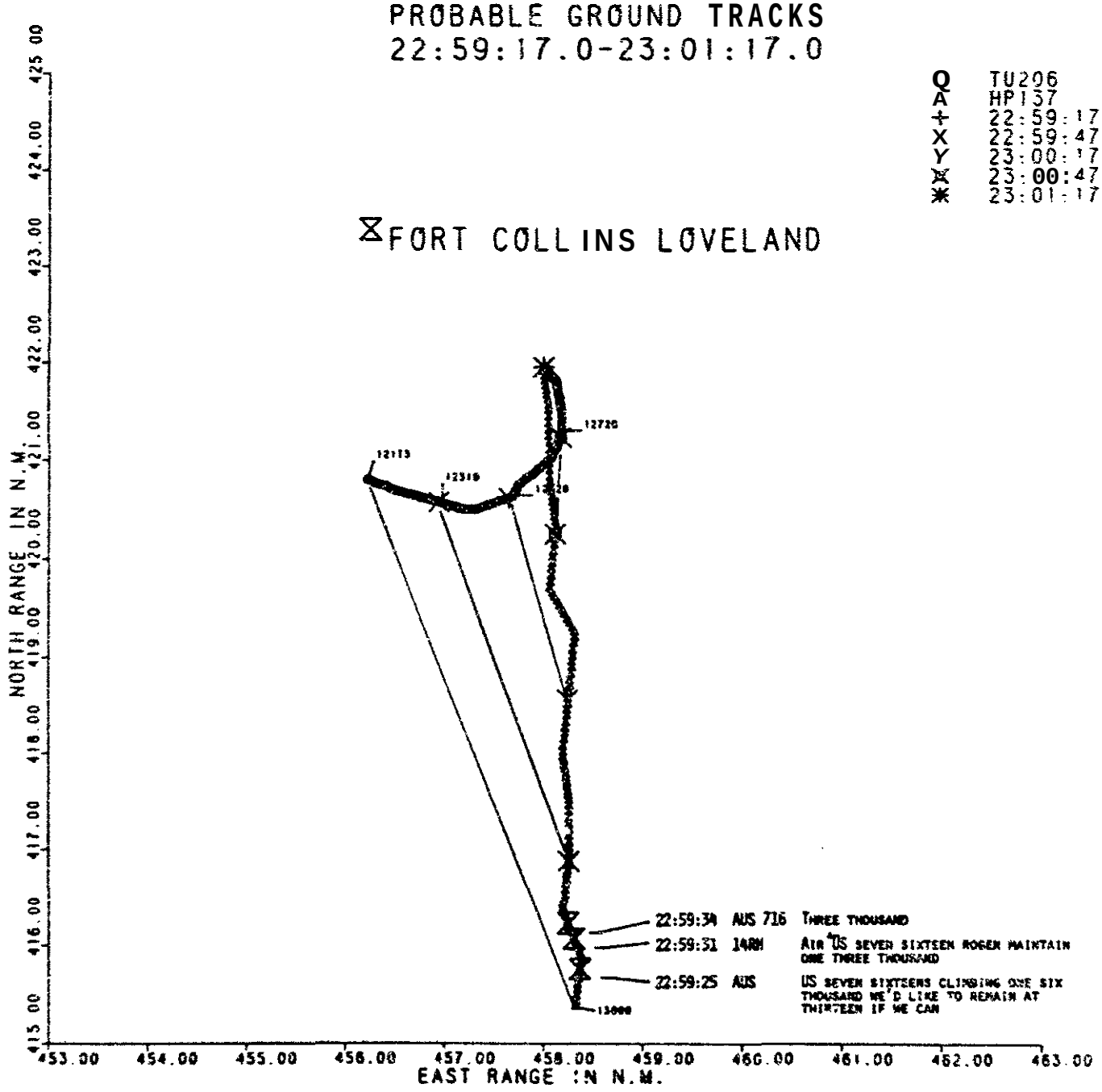
APPENDIX F

SKETCH OF ACCIDENT POSITIONS



APPENDIX H

PROBABLE GROUND TRACKS



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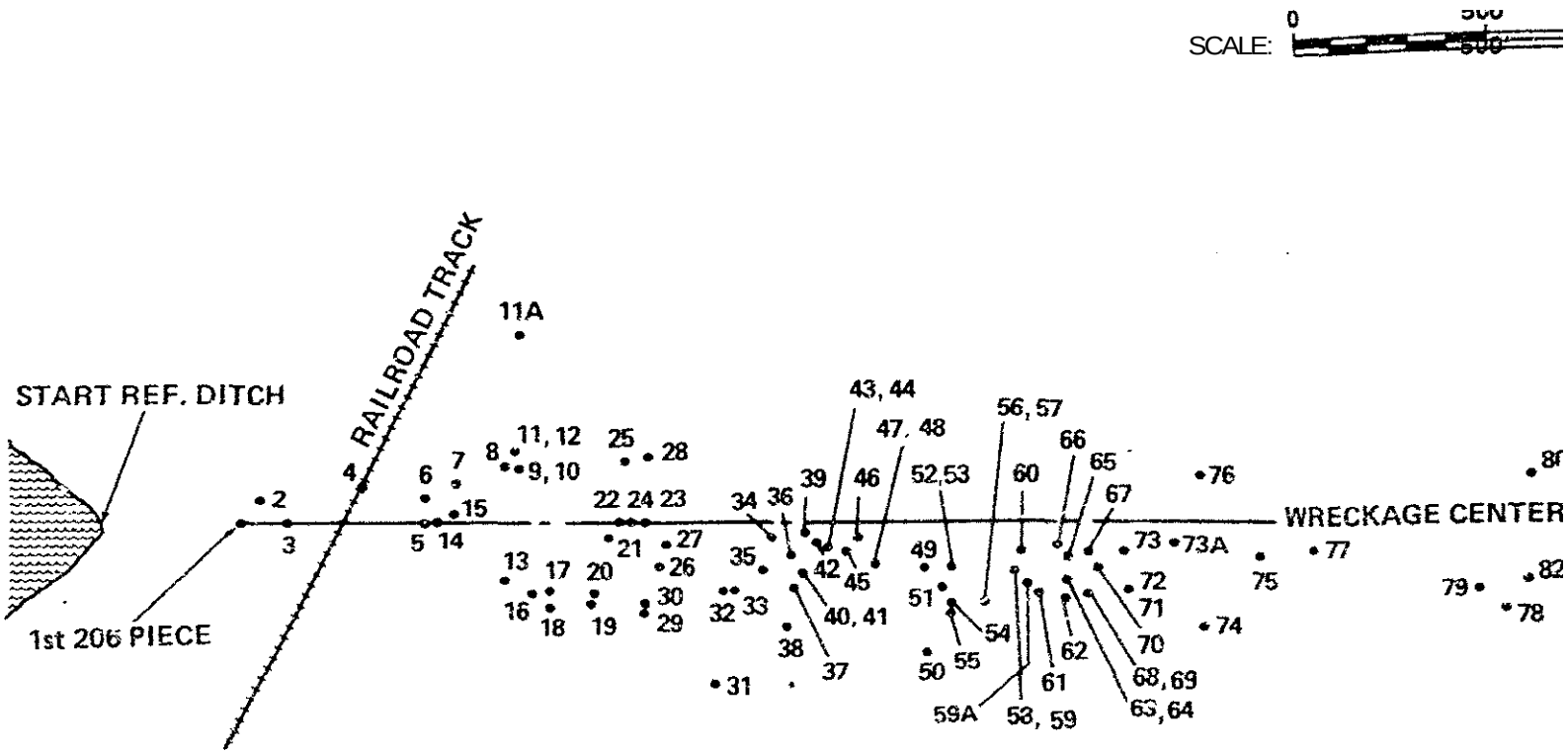
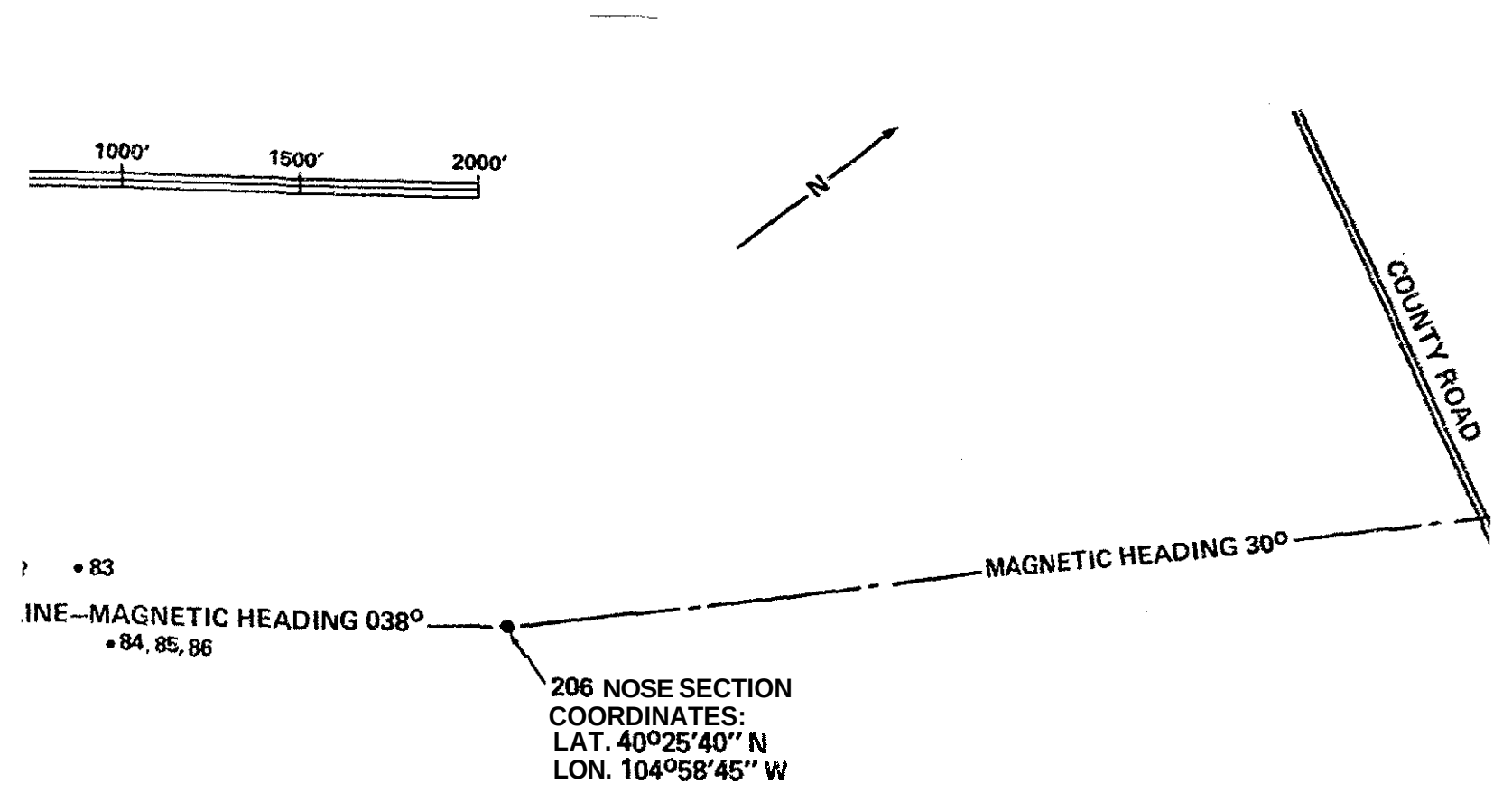
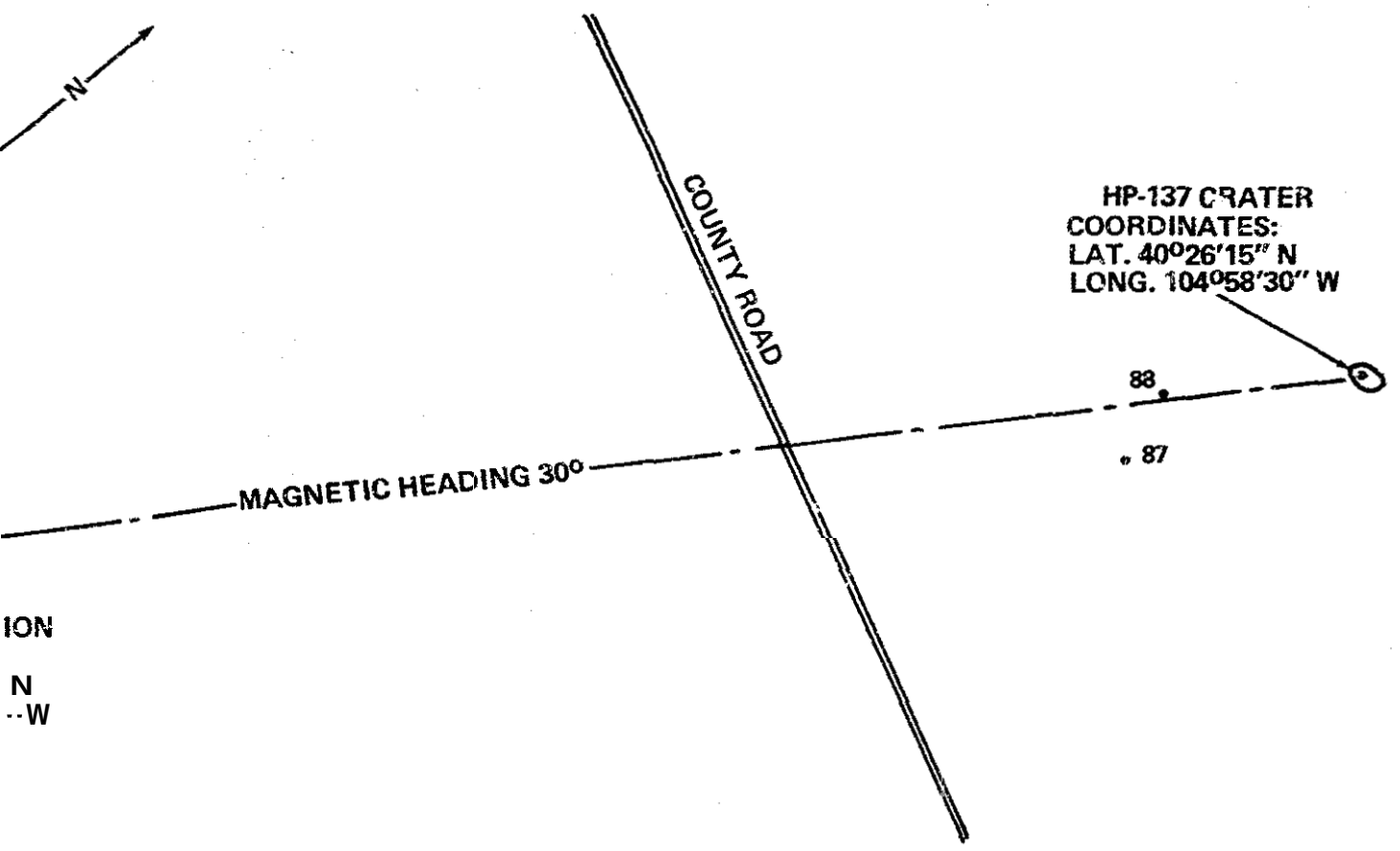


1. Wing Skin *206*
2. Tail Cone Skin 206
3. Control Surface Skin 206
4. Tail Cone Skin 206
5. Tail Cone Skin Aft Left 206
6. Cold Air Inlet Rt 206
7. Control Surface Skin 206
8. Taii Fairing Skin 206
9. Control Surface Skin 206
10. Tail Cone Skin 206
11. Rudder 206
11A. Door 206
12. Rudder Tip 206
13. Helmet Foam 206
14. Tail Cone Skin 206
15. Tail Cone Piece 206
16. Blue Strap (Unidentified)
17. Tail **Cone** Skin 206
18. **Lt** Lower Wing Skin 206
19. Aft Tail Cone Skin 206
20. **Aft** Tail Cone Skin 206
21. Tail Cone Skin 206
22. Raar Window 206
23. Tail Cone Parr 206
24. Rear Door Wind Scren 206
25. Tail Cone Skin 206
26. Tail Con0 Part 206
27. Rear Window Piece 206
28. Tail Fairing Piece 206
29. Dorsal Fin 206
30. Wing Root Fairing 206
31. Aft Left Wing Tip 206
32. Belly Skin Antenna Loop 206
33. Helmet Part 206
34. Wing Skin HP 137
35. Wing Skin 206
36. Helmet
37. Left Wing Tip Piece 206
38. Vertical Fin 206
39. Plywood *206*
40. HP **137** Wing Skin
41. Rear Window 206
42. Plywood 206
43. HP 137 Wing Skin
44. Nav Light Seal HP 137
45. Wing Tip Closeure Rib 206
46. Front Windshield 206
47. **Aft** Cabin Skin 206
48. Belly Skin 206
49. Belly Skin 206
50. HP 137 Wing Skin
51. Emp. Leading Edge 206
52. Aft Fuselage **Skin** 206
53. Aft Fuselage Skin 206
54. Left Wing Tip 206
55. Left Wing **Tip** 206
56. Windshield Part 206
57. Windshield Part 206
58. **Lower** Wing Skin 206
59A. Wing Root Lug 206 (Left)
59. Wing *Root* Lug Rt 206
60. Horizontal Stabilizer 206
61. **HP** 137 Wing Skin
62. HP **137** Wing Skin
63. Tail Cone Faring 206
64. Tail Cone Skin 206
65. Oxy Filler 206
66. Aft Cabin Window Frame 206
67. Cowi Flap 206
68. Rudder **Part** 206
69. HP 137 Skin
70. Lower Rudder Rib 206
71. Tail Cone Part 206
72. Tail Cone 206
73. **Box206**
73A. **Box** 206
74. Tail Cone Part 206
75. HP 137 **Aileron** Left (Part)
76. Door Part 206
77. Lt Outboard **Wing** Section HP **137**
78. Elevator Control **Box** 206
79. Lt Wing206
80. Closure Rib206
81. **Rt** Wing. Cabin Top, Lt-Rt Fixed Cabin Side 206
82. Aft Cabin Skin 206
83. Seat206
84. Headphones 206
85. Safety Belts **2** Pair 206
86. Wing Leading Edge Piece HP 137
87. **HP 137** Front **Spar Web.** Lt Wing
88. HP 137 Aileron Section Lt.


1000'
1500'
2000'
N
COUNTY ROAD
• 83
MAGNETIC HEADING 30°
INE–MAGNETIC HEADING 038°
• 84, 85, 86
206 NOSE SECTION
COORDINATES:
LAT. 40°25'40" N
LON. 104°58'45" W

WRECKAGE DI



WRECKAGE DISTRIBUTION CHART

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