

PB88-910402



NATIONAL TRANSPORTATION SAFETY BOARD

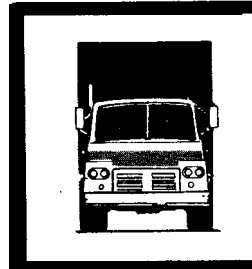
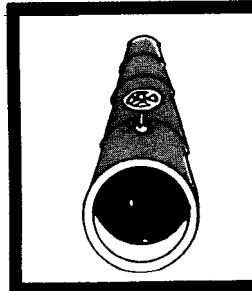
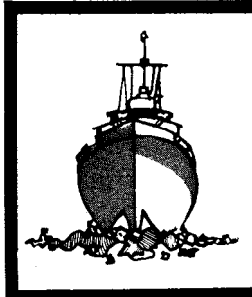
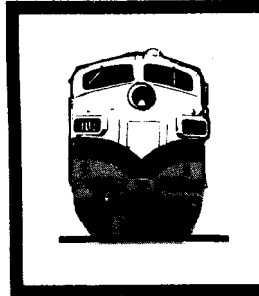
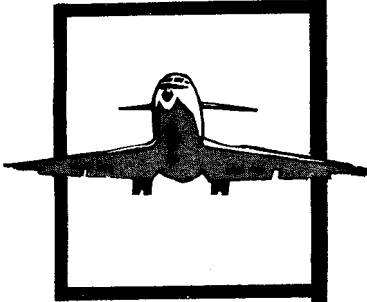
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

MIDAIR COLLISION OF CESSNA-340A, N8716K,
AND NORTH AMERICAN SNJ-4N, N71SQ,
ORLANDO, FLORIDA
MAY 1, 1987

NTSB/AAR-88/02

UNITED STATES GOVERNMENT



TECHNICAL REPORT DOCUMENTATION PAGE

| | | | |
|--|---|---|---|
| 1. Report No. NTSB/AAR-88/02 | 2. Government Accession No. PB88-910402 | 3. Recipient's Catalog No. | |
| 4. Title and Subtitle Aircraft Accident Report--Midair Collision of Cessna-340A, N8716K, and North American 5NJ-4N, N711SQ, Orlando, Florida, May 1, 1987 | | 5. Report Date February 16, 1988 | |
| | | 6. Performing Organization Code | 8. Performing Organization Report No. |
| 7. Author(s) | | 9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594 | 10. Work Unit No., 4658B |
| | | 11. Contract or Grant No. | 13. Type of Report and Period Covered Aircraft Accident Report May 1, 1987 |
| | | 12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D.C. 20594 | |
| 15. Supplementary Notes | | | |
| <p>16. Abstract On May 1, 1987, about 1548 eastern standard time, a Midwest Packaging Materials Company Cessna-340A, N8716K, and a Rosie O'Grady's of Orlando, Inc., North American SNJ-4, N71 1SQ, collided in midair about 3,000 feet over Orlando, Florida. The Cessna-340A was level at 3,000 feet operating under instrument flight rules on radar vectors to runway 18R at Orlando International Airport (MCO). The SNJ was in a descent to 1,500 feet and had completed a turn direct to Orlando Executive Airport (ORL) when the airplanes collided. The accident occurred 7 miles northwest of ORL in the outer area of MCO airport radar service area in visual meteorological conditions. Both airplanes were in contact with and were being radar vectored by the Orlando approach control. The Cessna-340A pilot, two passengers, and the SNJ-4 pilot were fatally injured. Both airplanes were destroyed by the collision, ground impact, and postimpact fire. A mobile home was also substantially damaged.</p> <p>The National Transportation Safety Board determines that the probable cause of the accident was the failure of the Orlando West controller to coordinate the handoff of traffic to the Orlando North controller and the failure of the North controller to maintain radar target identification. Contributing to the accident was the limited capability of the radar system to continually track the targets in proximity to one another and the lack of traffic advisories. Also contributing to the accident was the limitation of the "see and avoid" principle in the circumstances of this accident to serve as a means of collision avoidance.</p> | | | |
| 17. Key Words ARSA; radar identification; splat; coast; standard operating procedures; air traffic service; and ARSA outer area | | 18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161 | |
| 19. Security Classification (of this report) UNCLASSIFIED | 20. Security Classification (of this page) UNCLASSIFIED | 21. No. of Pages 27 | 22. Price |

CONTENTS

| | | |
|--------|---|----|
| | EXECUTIVE SUMMARY | v |
| 1. | FACTUAL INFORMATION | 1 |
| 1.1 | History of the Flight | 1 |
| 1.2 | Injuries | 2 |
| 1.3 | Damage to Aircraft | 2 |
| 1.4 | Other Damage | 2 |
| 1.5 | Personnel Information | 3 |
| 1.5.1 | The Pilots | 3 |
| 1.5.2 | The Air Traffic Control Specialists | 3 |
| 1.6 | Airplane Information | 3 |
| 1.7 | Meteorological Information | 3 |
| 1.8 | Navigational Aids | 4 |
| 1.9 | Communications | 4 |
| 1.10 | Aerodrome Information | 4 |
| 1.11 | Flight Recorders | 4 |
| 1.12 | Wreckage and Impact Information | 4 |
| 1.13 | Medical and Pathological Information | 4 |
| 1.14 | Fire | 6 |
| 1.15 | Survival Aspects | 6 |
| 1.16 | Tests and Research | 6 |
| 1.16.1 | Radar Ground Track Plot | 6 |
| 1.16.2 | Retrack Program | 8 |
| 1.17 | Other Information | 8 |
| 1.17.1 | Airspace | 10 |
| 1.17.2 | ATC Facilities | 11 |
| 1.17.3 | ATC Procedures and Requirements | 12 |
| 1.17.4 | ATC Handling | 12 |
| 1.17.5 | See and Avoid | 12 |
| 2. | ANALYSIS | 13 |
| 2.1 | General | 13 |
| 2.2 | Collision Geometry | 14 |
| 2.3 | Controller Actions and ATC Procedures | 16 |
| 2.3.1 | North Controller | 16 |
| 2.3.2 | Separation Procedures | 18 |
| 2.4 | Radar Beacon Interference | 19 |
| 3. | CONCLUSIONS | 20 |
| 3.1 | Findings | 20 |
| 3.2 | Probable Cause | 20 |
| 4. | RECOMMENDATIONS | 21 |
| 5. | APPENDIXES | 23 |
| | Appendix A--Investigation | 23 |
| | Appendix B--Personnel Information | 25 |

EXECUTIVE SUMMARY

On May 1, 1987, about 1548 eastern standard time, a Midway Packaging Materials Company Cessna-340A, N8716K, and a Rosie O'Grady's of Orlando, Inc., North American SNJ-4, N71 1SQ, collided in midair about 3,000 feet, over Orlando, Florida. The Cessna-340A was level at 3,000 feet operating under instrument flight rules on radar vectors to runway 18R at Orlando International Airport (MCO). The SNJ-4 was in a descent to 1,500 feet and had completed a turn direct to Orlando Executive Airport (ORL) when the airplanes collided. The accident occurred .7 miles northwest of ORL in the MCO airport radar service area outer area in visual meteorological conditions. Both airplanes were in contact with and were being radar vectored by the Orlando approach control. The Cessna-340A pilot, two passengers, and the SNJ-4 pilot were fatally injured. Both airplanes were destroyed by the collision, ground impact, and postimpact fire. A mobile home was also substantially damaged.

The safety issues examined in this investigation include coordination between the two approach controllers involved in the handling of the SNJ-4; local air traffic control procedures and the responsibilities of the approach controllers; and depiction of overlapped targets on the approach control radar.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the Orlando West controller to coordinate the handoff of traffic to the Orlando North controller and the failure of the North controller to maintain radar target identification. Contributing to the accident was the limited capability of the radar system to continually track the targets in proximity to one another and the lack of traffic advisories. Also contributing to the accident was the limitation of the "see and avoid" principle in the circumstances of this accident to serve as a means of collision avoidance.

As a result of the investigation, the Safety Board issued recommendations to the Federal Aviation Administration to require that on initial contact all pilots advise the air traffic controller of their assigned altitude to which they are cleared and when appropriate, the altitude vacating, and to include the aircraft's present navigational posture on other than published routes when contacting air traffic controllers. The Safety Board also recommended that specific coasting parameters be established and that an Air Traffic Service Bulletin be issued to reemphasize Section 15, Responsibility in the Air Traffic Control Handbook.



NATIONAL TRANSPORTATION SAFETY BOARD WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

MIDAIR COLLISION OF CESSNA-340A, N8716K, AND NORTH AMERICAN SNJ-4, N71 1SQ, ORLANDO, FLORIDA MAY 1, 1987

1. FACTUAL INFORMATION

1.1 History of the Flight

About 0900, eastern standard time, on May 1, 1987, a Cessna-340A, N8716K, departed Fort Madison, Iowa, for Orlando, Florida, with an intermediate stop at Huntsville, Alabama. The pilot, who had flown the trip before, logged the flight as a business and pleasure trip. The route of the flight from Huntsville to Orlando was via area navigation (RNAV) ^{1/} direct to Columbus, Georgia, direct to Ocala, Florida, direct to Orlando, Florida, on an instrument flight rules (IFR) flight plan. The normal time en route was about 2 hours. Accompanying the pilot on the flight was his wife and adult son; neither was aviation oriented.

N8716K proceeded routinely en route to Orlando International Airport (MCO). The pilot contacted the MCO approach control North Sector at 1538:50, "... level at five, ah, with, ah, x ray."^{2/} This initial call was not acknowledged, but a second call was acknowledged at 1540:08, when the North controller advised N8716K to "... descend and maintain four thousand." N8716K was equipped with an altitude reporting (mode C) transponder. At 1543:33, N8716K was subsequently cleared to "... descend and maintain three thousand." The flight was transferred to the Final controller at 1545: 13. At 1545:41, N8716K reported, "Orlando Approach, eight seven one six kilo with you three thousand." The Final controller advised at 1545:45, "One six kilo, present heading maintain three thousand vectors straight into one eight right." At 1545:51, N8716K acknowledged, "Vector straight in eighteen right sixteen kilo." This was the last transmission from N8716K.

About 1415, N71 1SQ, a North American SNJ-4 (T-6), departed Orlando Executive Airport (ORL) on a daily, weather permitting, skywriting flight. N71 1SQ proceeded normally to the airspace above Disney World, Sea World, and then to downtown Orlando. The altitude routinely used for sky writing was 10,500 feet. Although N71 1SQ was equipped with a transponder, it did not have mode-C capability. At 1542:24, N71 1SQ contacted the MCO West Sector controller for a radio check

^{1/} RNAV is a random route, based on area navigation capability, between waypoints defined in terms of latitude/longitude coordinates.

^{2/} Xraywastheairportterminalinformationserviceinuseatthetime.

and then advised, "... yes sir, I am all through here. I would like to descend out to the west and, ah, back into Exec." The West controller cleared, "... one Sierra Quebec, roger, fly heading two seven zero for now, vectors for traffic, descend and maintain six thousand on a two seven zero heading." At 1544:16, the West controller had confirmed that N711SQ was descending through 7,700 feet and turned him further right to 340° for traffic separation.

Using the interphone, the West controller attempted to coordinate a lower altitude for N711SQ by calling the North sector controller, who was busy talking to other aircraft. The West controller then called the Final controller and requested and received approval to descend N711SQ to 2,500 feet. At 1544:44, a Boeing 727 arriving from the northwest and landing MCO was pointed out to N711SQ as traffic passing on his right side opposite direction, and the pilot responded, "... one Sierra Quebec has the traffic." At 1545, the West controller advised, "One Sierra Quebec, maintain visual separation with the seven twenty-seven and, ah, proceed direct to the VOR. Continue descent down to, ah, four thousand and contact approach one two one point one." This transmission was not acknowledged, but at 1545:32, N711SQ contacted the North controller, "Orlando, North American seven one one Sierra Quebec with you six thousand." The North controller responded, "Seven one one Sierra Quebec, roger, descend to, ah, one thousand five hundred." N711SQ acknowledged, "One point five." At 1546:24, the North controller advised, "One SQ, you can proceed to the airport anytime." The pilot responded, "One Sierra Quebec, roger." This was the last transmission from N711SQ. At 1547:16, and continuing for approximately 1 minute, the North controller attempted to establish contact with N711SQ at 10- to 15-second intervals, but there was no response. (See Section 1.17.4, ATC Handling, for additional information regarding the history of the two flights.)

Several eyewitnesses observed the two airplanes collide above the Rosemont area of Orlando. The eyewitnesses stated that they saw both airplanes wings level, and one then settled down on the other. Then the airplanes spiraled to the ground, attached together, exploded and caught fire on impact with the ground. The accident occurred about 1548 at 28 36' 21" latitude/81 25' 50" longitude, in daylight, visual meteorological conditions at about 3,000 feet msl.

1.2 Injuries

| <u>Injuries</u> | <u>Crew</u> | <u>Passengers</u> |
|-----------------|-------------|-------------------|
| Fatal | 2 | 2 |
| Serious | 0 | 0 |
| Minor | 0 | 0 |
| None | <u>0</u> | <u>0</u> |
| Total | 2 | 2 |

1.3 Damage to Aircraft

Both airplanes were destroyed by the inflight collision, ground impact forces, and postimpact fire.

1.4 Other Damage

One mobile home was substantially damaged.

1.5 Personnel Information

1.5.1 The Pilots

The Cessna-340A pilot held a private pilot certificate with airplane single- and multiengine land and instrument ratings. His total flying time was 2,335 hours, approximately 344 hours of which were in the Cessna-340A. He held a current third class medical certificate with the limitation that he wear corrective lenses while flying.

The North American SNJ pilot held a commercial pilot certificate with airplane single- and multiengine land and instrument ratings. He also held a type rating in the DC-3 for visual flight rules (VFR) only. His total flying time was 7,118 hours, approximately 296 hours of which were in the North American SNJ. He held a current second class medical certificate with no limitations. (See appendix B.)

1.5.2 The Air Traffic Control Specialists

There were three air traffic specialists providing air traffic services to both airplanes. They were the West controller, the North controller, and the Final controller. All three were qualified, certified, and medically fit to perform their duties in accordance with current regulations. (See appendix B.)

1.6 Airplane Information

The Cessna-340A, N8716K, was owned and operated by Midwest Packaging Materials Company of Fort Madison, Iowa. It was a low-wing, twin engine airplane, powered by two Continental 6-cylinder opposed engines and was equipped with strobe lights in addition to the required navigation lights. The airplane was painted off white with a brown stripe. It was found to be within the maximum gross takeoff and landing weight limits and allowable center of gravity limits at the time of the accident. The airplane had been maintained in accordance with applicable Federal regulations.

The North American SNJ-4, N7115Q, was owned and operated by Rosie O'Grady's of Orlando, Inc., of Orlando, Florida. It was a low-wing, single-engine airplane powered by a 6-cylinder radial engine and was equipped with the standard navigation lights. It was painted light yellow with dark red trim. The SNJ-4 was found to be within the maximum gross takeoff and landing weight limits and allowable center of gravity limits at the time of the accident. The airplane had been maintained in accordance with applicable Federal regulations.

1.7 Meteorological Information

The Orlando international Airport terminal forecast issued at 1245 and valid at the time of the accident was for clear skies with 4,000 feet scattered and 25,000 feet scattered clouds after 1600. The surface observations were as follows:

1448--sky clear, visibility 7 miles, wind 200/09, altimeter setting 29.99;

1555-- sky clear, visibility 7 miles, wind 230/08, altimeter setting 29.97; and

1652-- sky clear, visibility 10 miles, wind 240/14, altimeter setting 29.95.

1.8 Navigation Aids

Not applicable

1.9 Communications

There were no reported problems with airborne or ground communication equipment.

1.10 Aerodrome Information

Not applicable. (See Section 1.17, Additional Information, for a description of the airspace.)

1.11 Flight Recorders

Neither airplane was equipped with flight recorders nor were they required to be.

1.12 Wreckage and Impact Information

Both airplanes struck a mobile home at 4316 Davy Street, Orlando, Florida, about 7 miles northwest of ORL (figure 1). Damage to the mobile home was extensive. The distribution of the main wreckage of both airplanes was contained in the backyard of the residence. The general orientation of the wreckage path was on a bearing of about 168 magnetic. The majority of the wreckage was scattered over an area about 125 feet long by about 50 feet wide. All major components of both airplanes were within these boundaries. Two distinct impact penetrations were observed in the mobile home: one was through the front and rear walls and the roof of the home; the other was through its roof and rear wall. Red paint was found on the interior surface of the home. The right wing tip of the SNJ was found inside the larger opening. The right elevator tip of the Cessna-340A was found in the roof of the second penetration.

There was a 3-foot-deep crater where the radial engine and forward fuselage of the SNJ-4 had come to rest. To the left of and parallel to the overall wreckage path was a 6-inch-deep concave ground scar that passed underneath the SNJ-4 right wing. This ground scar was in line with the second smaller penetration in the mobile home.

Small pieces of the Cessna-340A were found about 0.7 mile north of the main wreckage on a bearing about 165 magnetic to the accident site. These small pieces consisted of foam glare shield, plexiglass windshield, aluminum sheet metal, weather stripping, the face of an oil gauge, an oil dip stick, and part of a valve cover, both from the right engine. A canopy latch from the SNJ-4 was also found at this location.

A blade of the SNJ propeller assembly had eight uniform gouge marks on the front side which measured about 2 inches long. The gouge marks were located 42 inches radially out from the centerline of the propeller assembly. The pitch of each gouge (distance apart) measured about 0.3 inch. The marks on the propeller blade matched the physical dimensions of the Cessna-340A right engine magneto drive gear. In addition, a 3- by 4-inch portion of the SNJ propeller's other blade tip was found in the melted aluminum of the right engine accessory case of the Cessna-340A.

1.13 Medical and Pathological Information

Postmortem examinations of the pilots of both airplanes revealed no evidence of preexisting disease. The occupants of both airplanes received massive traumatic injuries as a result of the impact with the ground. Toxicological analyses performed on the remains of the pilots revealed no evidence of alcohol or drugs.

AIRPORT RADAR SERVICE AREA
(NOT TO BE USED FOR NAVIGATION)
ORLANDO, FLORIDA
ORLANDO INTERNATIONAL AIRPORT
FIELD ELEV. 96' MSL

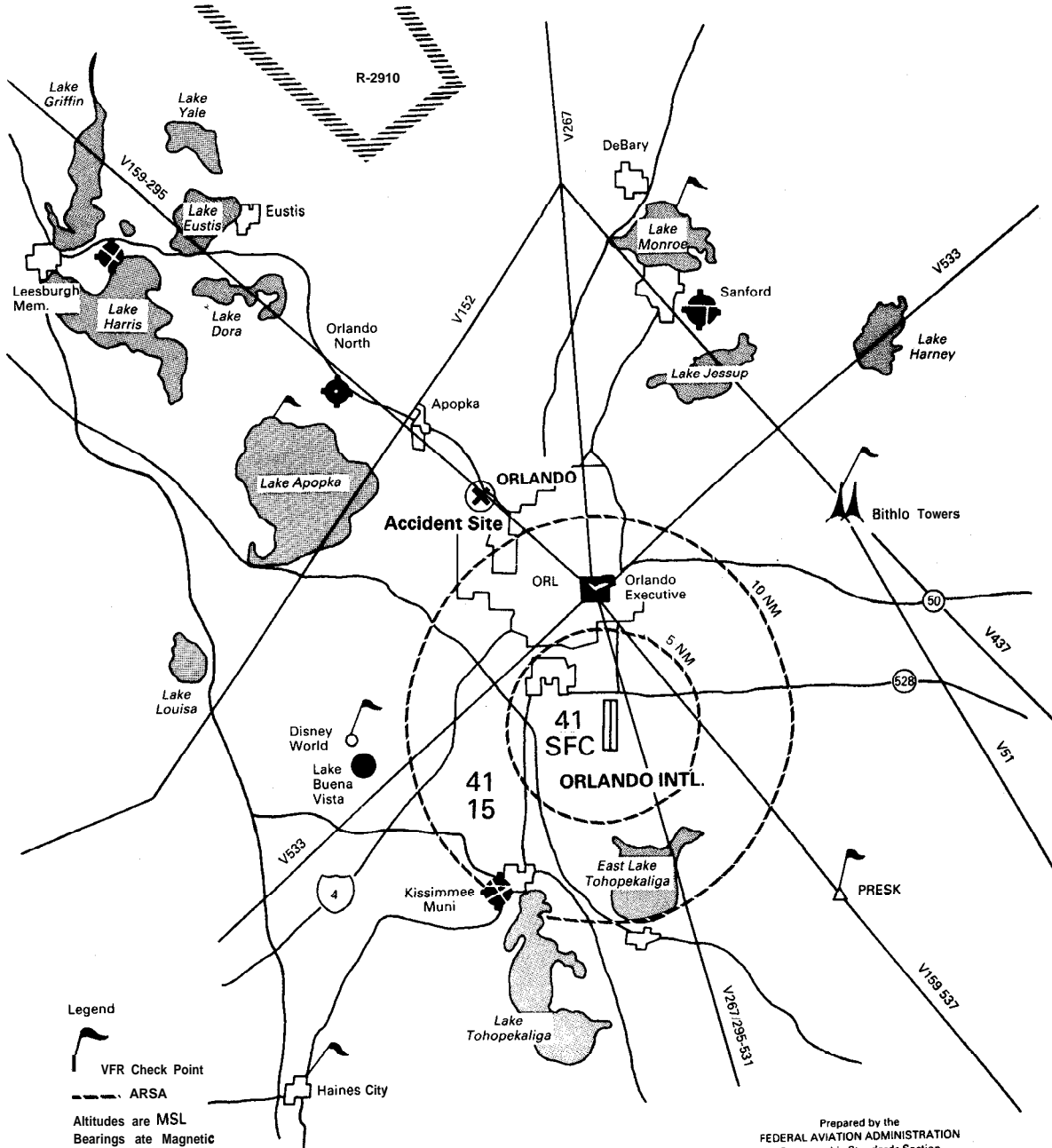


Figure I--Accident site.

The three Orlando approach controllers provided urine samples for toxicological examination about 43 hours after the accident. The tests were negative for alcohol and drugs.

1.14 Fire

There was no evidence of inflight fire. Witnesses observed the airplanes explode and burn on ground impact. The fire consumed most of the structures of the airplanes.

1.15 Survival Aspects

The accident was not survivable.

1.16 Tests and Research

1.16.1 Radar Ground Track Plot

Radar data recorded by the Orlando Terminal Radar Approach Control (TRACON) radar site, located at MCO and air traffic control (ATC) communication transcripts were evaluated in order to determine the ground track and to establish the relative positions of the two airplanes during the accident sequence. (See figure 2.)

The recorded radar data provided by the Federal Aviation Administration (FAA) indicated that a primary target was about 2 miles to the left of their track northwestbound and parallel to the flightpath of N711SQ and N8716K while they were southeastbound just before the accident. The type of aircraft and its altitude and destination were not determined.

While N711SQ and N8716K were both southeastbound and close to each other, a new, separate beacon return was presented to the controllers that replaced the beacon codes assigned to N711SQ and N8716K.

1.16.2 Retrack Program

A replication of the alphanumeric generated by the Automated Radar Terminal Systems (ARTS) IIIA computer program and its associated logic aspects was performed. The retrack program approximated the visual display that would have been presented to the controllers on their radarscopes. However, primary target^{3/} returns and beacon slashes, although used for traffic separation in an operational environment, are not generated by the retrack program.

During the replay of the preaccident sequence, investigators noted that at 1545:22, the data block representing N711SQ began a turn to the north with the position symbol displaying an "N." Then, at 1545:39, the data block representing N711SQ began to coast.^{4/} That is, the data tag no longer followed the target of N711SQ but continued to track across the radar screen depicting a computer prediction of where N711SQ may be. This prediction is based on the last known track of an aircraft (N711SQ). When a data tag is coasting, the letters "CST" appear in the data tag. A data tag

^{3/} Primary target is information presented on a controller's radarscope that represents the radar-perceived image of an aircraft or other object and is not dependent on receipt of transponder information.

^{4/} Coast occurs when a track fails to correlate with a beacon target. The letters "CST" appear in the data block.

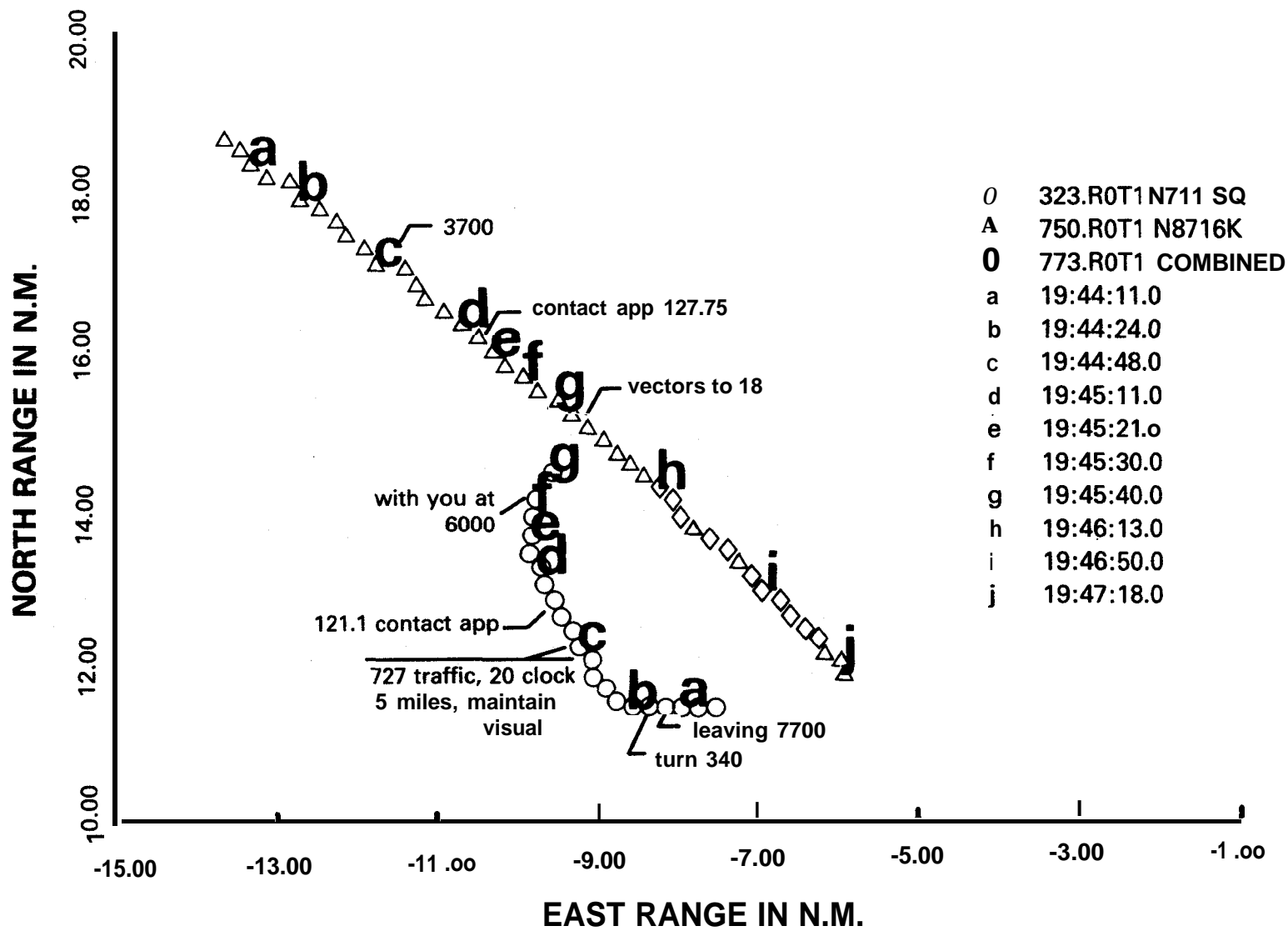


Figure 2-Radar ground track plots.

may coast anytime an aircraft exceeds established parameters (e.g. a sharp or tight turn, course reversal). The data tag may reacquire on the target when the computer determines, based on the discrete beacon code assigned to an aircraft, an aircraft's actual position. In the case of N71 1SQ, the data tag did not reacquire.

At 1546:17, the data block representing N8716K displayed an "M" symbol and within that symbol "splats"^{5/} began to appear and continued until about 1546:30. At 1546:21, the notation "18R" was entered into the scratch pad ^{6/} area of the data block representing N8716K. At 1546:29, the data block representing N71 1SQ, discontinued coasting and defaulted to the tab list. ^{7/}

From this point, the data block for N71 1SQ no longer existed on the North controller's radarscope. The only alphanumeric information available to the North controller was the aircraft call sign and assigned altitude in the coast tab list. Subsequently, the data block representing N8716K also discontinued coasting and defaulted to the coast tab list.

1.17 Other Information

1.17.1 Airspace

Orlando TRACON is delegated the airspace extending from the surface to 12,000 feet vertically and laterally within about 35 miles of the Orlando VORTAC. Within these boundaries the airspace is divided into six radar sectors. The radar sectors providing air traffic services to N711SQ and N8716K were designated Radar West, Radar North, and MCO Final (see figure 3).

The Radar West position controls the airspace between 6,000 feet and 12,000 feet, generally west of the extended center lines of runways 18R and 36L at MCO to the lateral limits of the Orlando TRACON airspace. The letter "W" is assigned to the West position for identification purposes.

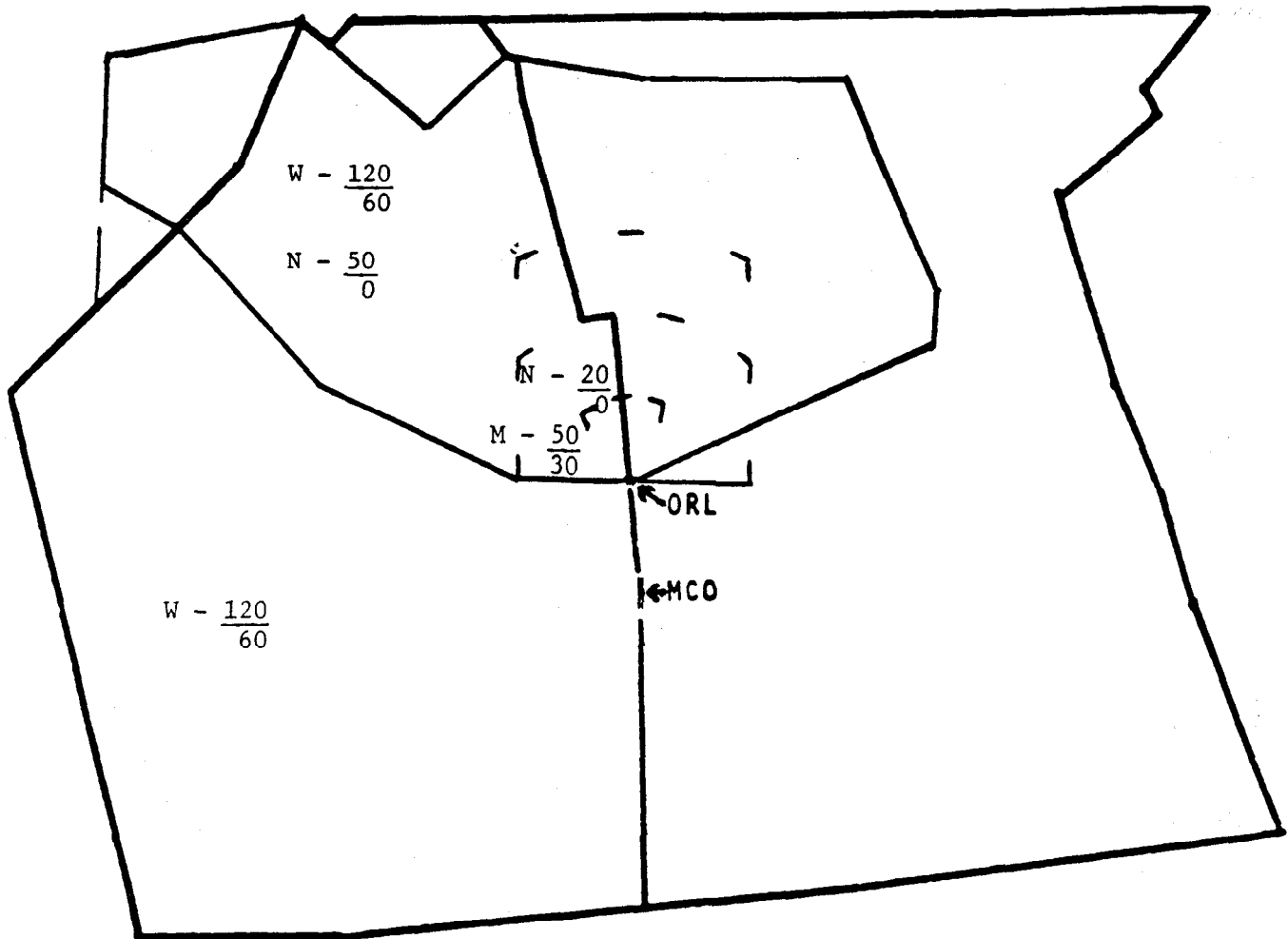
The Radar North position controls the airspace between the surface and 5,000 feet generally north of an east-west line through the ORL, excluding the airspace designated to the MCO Final position. The letter "N" is assigned to the North position for identification purposes.

The MCO Final position controls the airspace between 1,500 feet and 5,000 feet near ORL and graduating to between 4,000 feet and 5,000 feet about 10 miles north of ORL. The airspace is laterally defined as being from ORL to about 10 miles north of ORL and about 5 miles both east and west of ORL. The letter "M" is assigned to the Final position for identification purposes.

^{5/} Splat is ATC slang indicating an asterisk that is computer generated and displayed on a radarscope. The asterisk indicates a nonselected, mode-C target.

^{6/} The ARTS data tag contains two scratch pad or "Y" areas in fields two and four located on the second line of the data tag. Field two contains altitude and beacon code information; field four contains ground speed, aircraft type and VFR (V) and/or heavy (H) symbols. Other information may be manually entered into field two per facility directives.

^{7/} A tabular list, arranged alphabetically, listing controlled aircraft that are not in an active tracking status. The coast/suspend tabular list identifies active (controlled) tracks that fail to correlate with a radar beacon target after several scans. Coast tracks are automatically displayed in the coast/suspend tabular list.



LEGEND

- M - Radar Final Sector
- N - Radar North Sector
- W - Radar West Sector

Figure 3--West, North, and Final Radar sector boundaries.

The Orlando, Florida, area is encompassed by the Orlando airport radar service area (ARSA). The ARSA, implemented on March 13, 1986, consists of two circular areas centered on MCO. The first circular area is the airspace within a 5-nmi radius of MCO, beginning at the surface and extending up to and including 4,100 feet. The second circular area is the airspace within a 10-nmi radius of MCO, beginning at 1,500 feet and extending up to and including 4,100 feet except that ARSA contains the ORL airport traffic area.

Additionally, ARSA service is provided in an outer area within a 20-nmi radius of MCO extending from the lower limits of radar/radio coverage upward and including 12,000 feet. Pilot participation within this area is not mandatory; however, when requested, the same ARSA services are provided when two-way radio communications and radar contact are established. ARSA services for IFR and VFR aircraft include traffic separation, traffic advisories, and safety alerts. A traffic advisory is issued when, in the controller's judgment, the proximity of two or more aircraft may diminish to less than the applicable separation minimums. A safety alert is issued by ATC when, in the controller's judgment, an aircraft's altitude places the aircraft in unsafe proximity to terrain, obstructions, or other aircraft.

1. 17. 2 ATC Facilities

The Orlando Tower is a single building with the tower cab on top. The administrative offices, training facilities, and the TRACON are on the first floor. The TRACON room is equipped with six vertical radar displays. Each display is designed to accommodate an associated handoff position. Coordinator's positions are at the east and west side of the control room. A flight data position and an area supervisor's desk are at the south side of the control room.

Orlando Tower was authorized 42 controllers; 40 were employed at the time of the accident, and 30 of these were qualified at the full performance level. Orlando TRACON was normally staffed with eight controllers and one supervisor per shift, day and evening. On May 1, 1987, the evening shift (1500 to 2300) was staffed with eight controllers. At the time of the collision, all radar positions were operated and staffed. In addition, the area supervisor was in the TRACON at the supervisor's console which is located about 15 feet from the North and Final sectors.

Three positions at the Orlando TRACON controlled one or both of the airplanes involved in the collision at different times during the accident sequence. The West controller controlled N71 1SQ, the North controller controlled N71 1SQ and N8716K, and the Final controller controlled N8716K.

The Radar North and the MCO Final positions are located side-by-side along the west side of the control room. The Radar West position is located on the east side of the control room about 15 feet from the North and the Final position.

The Orlando TRACON uses an ASR-8 radar system augmented with an ARTS IIIA computer that includes Minimum Safe Altitude Warning and Conflict Alert features. Normally, the beacon intensity is turned down so that primary targets are the dominant feature on the controller's display.

Daily record of facility operation and facility maintenance logs indicate that all radar and ARTS IIIA functions and interfaces were certified at 0900 on May 1, 1987. At the time of the collision there were no known system, equipment, or navigational aid outages.

Postaccident technical evaluations were performed on all systems and equipment. Facility maintenance logs indicate that all certifications were completed by 2355. The quality of the recorded radar data was sufficient to preclude a flight check of the radar.

1.17.3 ATC Procedures and Requirements

FAA Handbook 7110.65E, Air Traffic Control, defines ARSA separation between VFR and IFR aircraft as visual, 500 feet vertical, or conflict resolution when using broadband radar systems. "Conflict resolution" in this case means that the controller does not allow targets to touch; "visual" means that, after sighting an aircraft, pilots assume the responsibility for separating their aircraft from other aircraft.

The Handbook also states that controllers may use the ARTS data block to maintain target identification unless it is in coast status *or* displaced from the appropriate target. The Radar Identification section of the Handbook instructs controllers to use more than one method of identification when proximity of targets, duplication of observed action, or any other circumstances raise doubts as to target identification. Further, the use of ARTS equipment does not relieve the controller of the responsibility of ensuring proper identification, maintenance of the identity, handoff of the correct target associated with the alphanumeric data, and separation of aircraft.

When circumstances arise where controllers must coordinate aircraft handling with one another; Handbook 7110.65E, supplemented by MCO order 7232.1 H, provide guidance. Handbook 7110.65E contains procedures that require controllers to coordinate changes in heading, airspeed, or altitude with the receiving controller, once the receiving controller has accepted a handoff on the aircraft and before an aircraft enters the delegated airspace. These procedures specify that when controllers transfer control of an aircraft in their airspace the transferring controller must inform the receiving controller of any previously issued restrictions, as they may be necessary to provide separation from other aircraft for which the transferring controller has separation responsibility. Further, if a controller needs to change an aircraft's heading, route, speed, or altitude within another controller's airspace, the change must be coordinated, and the controller must coordinate with any intervening controller through whose area the aircraft will pass before making the change. Moreover, the transferring controller will verbally obtain the receiving controller's approval before making any changes to an aircraft's flight path, altitude, or data block information while the handoff is being initiated or after acceptance. The transferring controller must also ensure that potential conflicts are resolved before transferring radio communications. Finally, the transferring controller will advise the receiving controller of pertinent information not contained in the data block or flight progress strip unless covered in a letter of agreement or facility directive. Pertinent information includes assigned heading, airspeed restrictions, altitude information issued, observed track or deviation from the last route clearance, and the beacon code, if different from that normally used or previously coordinated.

Orlando Tower Order 7232.1H outlines controller responsibilities and duties for specific positions of operation at the Orlando TRACON. The position standard for the Orlando Tower West position provides direction for VFR operations. The standard states, in part, that VFR arrivals to ORL are to be assigned a heading that will retain the aircraft within the airspace assigned to the Radar West position. If an aircraft penetrates surrounding airspace, the West controller must coordinate with the other controller. Further, if coordination is accomplished with the other controller, the West controller will verbally advise the receiving sector controller of the coordination.

Included in the standard operating procedures for the Radar West position is the responsibility to enter the letter "T" if the aircraft is landing at ORL. (Each airport is assigned a specific letter.) For aircraft not equipped with mode C, the controller must enter the altitude and the appropriate airport identifier into the scratch pad area of the data block (e.g., 50T to signify an altitude of 5,000 feet landing ORL). Additionally, the standard states that coordination should be kept to a minimum unless the operation or user will benefit. Finally, the order states, "Do not coordinate with another controller when he/she is obviously too busy to handle the distraction."

The Handbook section on Coordinate Use of Airspace mandates that controllers should not allow an aircraft under their control to enter airspace delegated to another controller without first completing coordination.

1.17.4 ATC Handling

The West controller told the Safety Board investigators that he entered a "T" in the data tag of N711SQ and attempted to get a lower altitude for N711SQ from the North controller, but the North controller was talking to an aircraft and he could not break in.

The voice tape recordings of the West and the North positions indicate the presence of an override tone that verifies the West controller's attempt to coordinate the handoff with the North controller. Subsequently, the West controller requested a lower altitude from the Final controller who released "down to 2,500" feet in his airspace.

The West controller stated that he descended N711SQ to 4,000 feet because he saw an "M" tag on N8716K, a position symbol assigned to the Final controller, indicating that the target was at or descending to 3,000 feet. He then transferred N711SQ to the North controller's frequency. He received no acknowledgment from N711SQ and tried to call him again. He said his attention was then diverted to performing a manual handoff of another aircraft landing at Tampa. The West controller further stated, "I assumed that he [North controller] would see him [N711SQ] in the turn." After transferring N711SQ to the North controller, the West controller concentrated on other duties. He described his workload as moderate.

The North controller told Safety Board Investigators that he was working N8716K about 20 miles before N711SQ came on his frequency. He observed N711SQ's data tag in a handoff status about 8 miles northwest of the Orlando VOR on a northwest track with a "T" in the data block representing an ORL arrival and a "V" representing VFR. He transferred N8716K to the Final controller's frequency. N711SQ reported on the North controller's frequency at 6,000 feet, and the North controller descended N711SQ to 1,500 feet believing he said, that the aircraft was on a northwesterly heading; at this time N8716K was about 2 miles away at N711SQ's 2 o'clock position. He said he then observed the data block go into coast, but with N8716K close to N711SQ, he was not surprised or concerned. Subsequently, he cleared N711SQ to go to the airport "anytime." He said he gave this clearance based on a primary target he observed tracking northwest in the vicinity of the coasting data block of N711SQ. The airplane's pilot answered the clearance by saying, "One SQ, roger."

The North controller's attention was then diverted to another quadrant in his sector where a helicopter was requesting advisories. The North controller described his workload as moderate.

The Final controller stated that when he approved a descent to 2,500 feet for N711SQ after a request from the West controller, he did not see another aircraft to the northwest nor was N8716K in a handoff status to him at this time. He recalled that later when N8716K was handed off to him (while still in the North sector's airspace), he advised N8716K to expect runway 18R at MCO. The final controller described his workload as light.

1.17.5 See and Avoid

The responsibility for pilots to maintain an adequate outside scan to "see and avoid" other aircraft is mandated by Title 14 Code of Federal Regulations 91.67:

When weather conditions permit, regardless of whether an operation is conducted under IFR or VFR, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft, in compliance with this section.

This regulation requires that operation of a flight under IFR, but in visual meteorological conditions, does not relieve pilots of the responsibility to “see and avoid” other aircraft. Neither would the providing of radar services or receipt of traffic advisories relieve VFR pilots of their responsibilities “toseeandavoid” othertraffic.

Nonetheless, many physical, physiological, and psychological constraints have been shown to reduce the human ability to exercise the required degree of vigilance. These limitations include target characteristics, size, color, task variables such as workload and time at task, observer characteristics such as age and fatigue, and environmental parameters such as weather, clouds, and glare.

Finally, there is a concept known as “diffusion of responsibility” which is a tendency of pilots to relax their vigilance in some circumstances. A National Aeronautics and Space Administration ^{8/} study on near midair collisions indicated that pilots have a subconscious idea of shared responsibility when an airplane is under ATC radar control. The study concluded that pilots relegate a portion of their vigilance responsibility for seeing and avoiding to the controller. The study states, in part, “If Aviation Safety Reporting System reports are representative, many pilots under radar control believe that they will be advised of traffic that represents a potential conflict and behave accordingly. They tend to relax their visual scan for other aircraft until warned of its presence.”

2. ANALYSIS

2.1 General

The investigation found that both airplanes were equipped and maintained in accordance with applicable FAA rules and regulations. There was no evidence that an airworthiness problem or an equipment malfunction was a factor in the accident.

The weather was not a factor in this accident. The sun was from the rear of both aircraft, and therefore, should not have been a factor in either pilots’ ability to see and avoid each other. The pilots of both airplanes were appropriately qualified for the flights, and both were adequately prepared for the flights.

The controllers assigned to the Orlando TRACON West, North, and Final Radar positions were appropriately trained, certified, and qualified to perform their respective functions and to provide the required ATC services in accordance with FAA rules and procedures. The TRACON equipment was found to be properly maintained and operational.

The TRACON was staffed in accordance with the standards for ORL to provide air traffic services within the confines of the TRACON airspace. The control room layout and the position of the supervisor’s console provided adequate span of control for the area supervisor.

A review of the activities of the West, North, and Final controller suggests that their workload demands were not excessive. Therefore, the Safety Board believes that the controllers’ workload was not a factor in this accident.

^{8/} Billings, C. Grayson, R., Hecht, W., and Curry, R., “A Study of Near Midair Collisions in MS. Terminal Air Space.” NASA Technical Memorandum 81225, 1980.

The Safety Board's analysis of this accident focused on the "see and avoid" abilities of the pilots, the role of the Orlando TRACON controllers, ATC procedures, and the ARTS IIIA computer.

2.2 Collision Geometry

The collision occurred at 3,000 feet as the C-340A was southeast bound in level flight, and while the SNJ-4, after just completing a right turn, was southeast bound descending wings level to 1,500 feet. Allowing for a descent from 6,000 feet to 3,000 feet, the minimum average rate of descent of the SNJ-4 until the collision would have been about 2,000 feet per minute. The ground speed for the last 1.5 minutes was calculated to be about 175 knots for both airplanes. About 15:45:25, the SNJ-4 started the right turn from a northwest heading toward the airport and ended the turn about 15:46:08. At 175 knots, the turn would have required a bank angle of about 45°. Radar tracks plotted from the radar data also indicated that the C-340A was tracking about 134° true, and the SNJ-4 was also tracking about 134° true for about 46 seconds before the collision.

The collision angle of the two airplanes was determined by the SNJ-4's propeller marks on the C-340A (see figure 4). The SNJ-4's propeller struck the right engine and slashed through the right side of the cockpit of the C-340A. One propeller struck the accessory gearbox of the right engine of the C-340A leaving 4 inches of the blade tip in the right engine. The propeller strike evidence placed the SNJ-4 almost directly over the right engine of the C-340A. With this collision geometry, the large 8-foot 4-inch diameter propeller of the SNJ-4 also was in a position to slash through the cockpit.

Analysis of the radar track information in figure 2 revealed that at 19:45:11 (point d), the SNJ-4 was on a 340° heading flying straight at the C-340A. The distance was about 3.2 and 3,000 feet vertical. At that point, the SNJ-4 pilot would have been watching the B-727 as directed by ATC, and the C-340A would have been below his nose.

Once the SNJ-4 started the right turn, the roll angle and the nose of the airplane through the turn would have kept the C-340A well below his field of view. The SNJ-4 pilot most likely would have been clearing the area by looking to the right, high through the canopy, scanning between himself, the B-727, and ORL.

The C-340A pilot, if seated at the normal eye reference point would have had to look out the right front window very high in the windscreen (up 8° and right 320). However, investigators determined that this pilot sat much higher than the normal eye reference point and lowered his sunvisor for additional head room. As a result, the pilot was unable to see the SNJ-4 unless he leaned over and looked up. Had the pilot leaned over and looked up, he would have seen an airplane passing overhead in an opposite direction. As the SNJ-4 was turning in, the C-340A pilot would have had to look even higher to as much as 30° over the next 30 seconds until point g (see figure 2).

From 19:45:40 until the airplanes collided, the vertical separation angle was too great (the SNJ-4 was over the C-340A) unless the pilots performed unusual clearing turn maneuvers. It appears that the SNJ-4 pilot may have been able to see the C-340A before 19:45:11 had clearing turns been made. However, at that range, acquisition would not have been ensured. The C-340A would have seen a passing airplane until 19:45:11. Once the SNJ-4 turn started, the C-340A pilot had less than 20 seconds to see the SNJ-4, and then only by leaning over and looking up at a greater than normal angle.

During the last seconds of flight, the C-340A pilot could not see the SNJ-4 because it was above and to the rear of his airplane. Similarly, the SNJ-4 pilot could not see the C-340A because it was forward and below him. Therefore, the positions of the two airplanes during the last portion of the flight precluded either pilot from seeing each other because of cockpit and other aircraft structure restrictions.

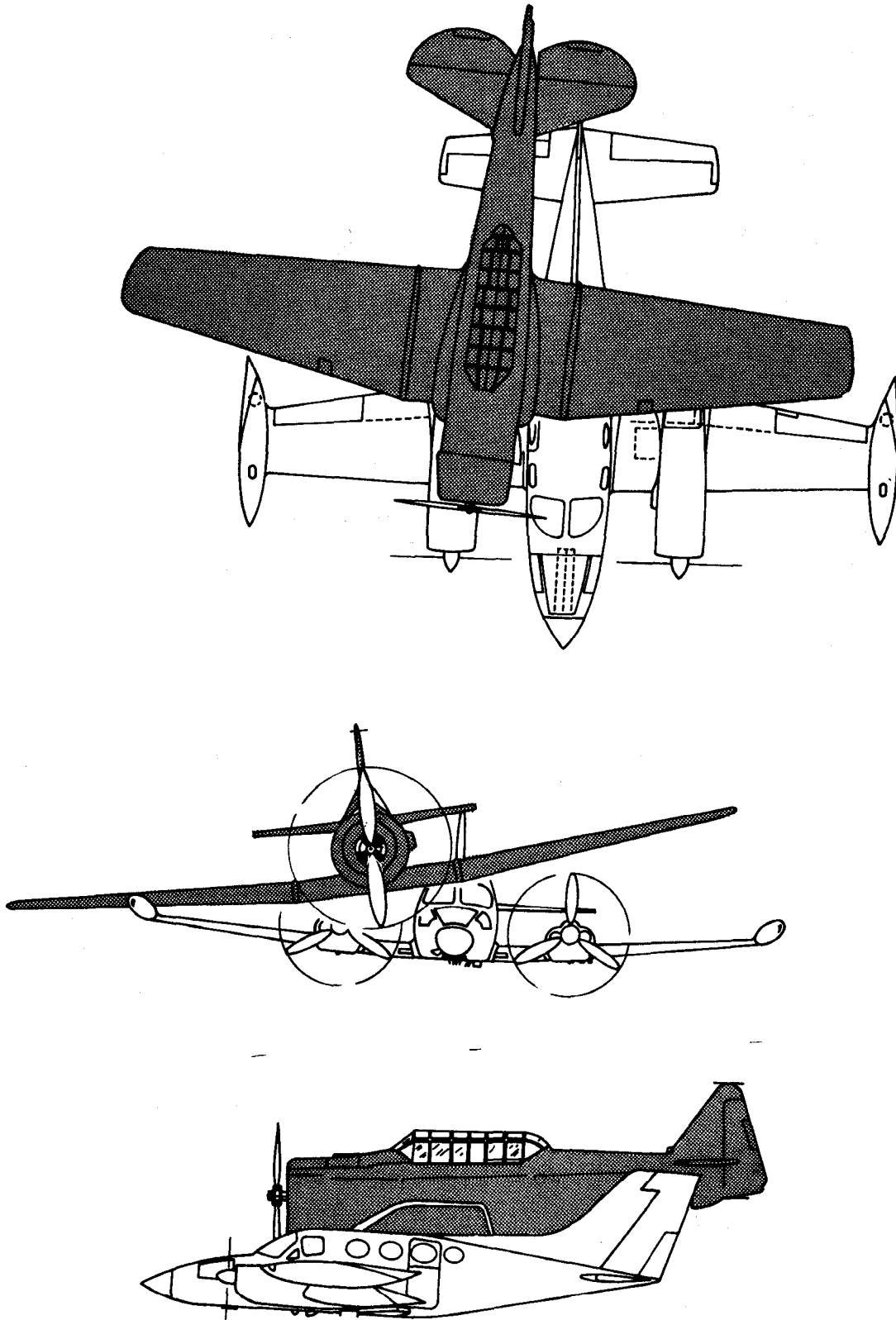


Figure 4.--Collision angle between SNJ4 and Cessna -340.

The Safety Board believes that the actions of the C-340A pilot were appropriate in that he was in level flight, on radar vectors, and unable to see the SNJ-4 at any time before the collision. Likewise, the actions of the SNJ-4 pilot were appropriate in that he was complying with his clearance of going direct to the airport, maintaining visual separation behind the B-727, and descending to 1,500 feet. Although clearing turns are recommended in visual meteorological conditions during a descent for collision avoidance purposes, he would not be expected to make such turns when complying with radar vectors. Also, he would expect to receive traffic advisories when appropriate.

2.3 Controller Actions and ATC Procedures

An analysis of the actions of the West controller indicated that he failed to perform required coordination responsibilities. The West controller should have coordinated the use of the North controller's airspace below 6,000 feet, and he should have forwarded to the North controller both the heading he (West) had assigned the SNJ-4 and the lower altitude (2,500 feet) the Final controller had approved. Further, because the West controller initially descended N711SQ to only 4,000 feet, based on another aircraft's descent to 3,000 feet, the Safety Board believes that the West controller was aware of a potential conflict, and he should have informed the North controller that he (West) was using vertical separation.

The West controller may have hurried to complete the communications transfer on N711SQ in order to return to the impending coordination of another aircraft with Tampa approach control. If this was the case, he should have asked for assistance from his supervisor. Since the West controller did not coordinate with the North controller, the North controller was led to believe that N711SQ was at or descending to 6,000 feet on a northwesterly track at the time he (N711SQ) reported to the North controller on his frequency. Therefore, the Safety Board believes that this coordination breakdown was the precipitating event that led to this accident.

In reviewing the FAA Handbook and Orlando TRACON procedures, the Safety Board determined that there were no radio procedures to compensate for deficiencies in controller coordination, such as those that occurred in this case. If N711SQ had advised the North controller on initial contact that he was descending to 4,000 feet and was turning toward the Orlando VOR, it is unlikely that the North controller would have issued N711SQ a clearance to descend to 1,500 feet. There are presently no procedures whereby pilots provide controllers such information. In view of the fact that on occasion controllers will make such coordination errors, the Safety Board believes that as a good operating practice, pilots should advise controllers of their intended final altitude and other clearance limits.

However, the Safety Board does not believe that the West controller's breakdown in coordination alone was the cause of the collision. Since the West controller only cleared N711SQ to descend to 4,000 feet, this action alone would not have caused the collision. It is necessary to consider the role of the North controller, the only controller who controlled both airplanes.

2.3.1 North Controller

N8716K came on the North controller's frequency when he was at 5,000 feet. The North controller descended him to 4,000 feet and subsequently to 3,000 feet. He handled the airplane in a normal manner, initiated an automated handoff to the Final controller, and transferred communications at a point consistent with current directives.

The North controller accepted an automated handoff on N711SQ about 1 1/2 minutes before transferring N8716K to the Final controller. Although the West controller did not receive an acknowledgment of the clearance which he had issued to N711SQ, the airplane did change

frequencies and did turn toward the Orlando VOR. Since N7115Q performed two of the three clearance items, the Safety Board concludes that N7115Q also was complying with the West controller's instruction to descend to 4,000 feet. On initial contact and after having transferred N8716K to the Final controller, the North controller immediately descended N7115Q to 1,500 feet. Although he believed N7115Q to be on a northwesterly heading, the North controller should have ascertained N7115Q's heading or route before issuing a descent clearance.

The focal point in the collision sequence centers on the time when N7115Q began its turn from the 340°-heading, until the collision--a distance of about 5 miles or 2 minutes. The Safety Board believes that there was ample opportunity for the North controller to have verified the track of N7115Q after issuing the final clearance and before the collision.

The radar plots developed by the Safety Board, the plots obtained from the data systems specialists at the Orlando Tower, the North controller's interview, replication of ARTS IIIA symbology immediately before the accident, and the transcript of the West and North radar positions indicate that N7115Q began to turn right toward the southeast about 15 seconds before the North controller issued the descent clearance to 1,500 feet. At this point, the airplane data tag was tracking N7115Q in a normal manner. The data tag tracked N7115Q for one more sweep before going into coast on about a 01 So-track. The Safety Board believes that the data tag began to coast because his antenna, which is on the bottom of the airplane, was shielded from the ARTS IIIA antenna during his turn just before the collision. In addition, he was close to another tracked target (N8716K), and the system could not discriminate between the beacon codes of the two airplanes.

Further, the Safety Board believes that about this time, the two targets began to merge on the radar scope and were presented to the controller as one target. If the North controller displayed beacon targets prominently on his display in addition to the primary target returns already being displayed, the Safety Board cannot determine whether the North controller would have seen the beacon returns or recognized any irregular shapes or sizes while the two airplanes were concurrently tracking southeastbound. This fact was verified by the data tag of N8716K which was also coasting intermittently. During these intermittent coasting periods, a splat, which is a discrete beacon code with mode C, was being displayed. The Safety Board believes that this splat was the result of the two targets being so close to one another that the radar antenna received both returns at the same time. The resultant combined signal of the two airplanes was displayed as a single separate return to the controllers. When a ground-based mode-S equipment is implemented, the Safety Board believes that this situation should become less probable. The mode-S antenna and surveillance processing should effectively reduce the frequency of proximity garbling occurrences so that radar target identification is not compromised. (See Section 2.4 Radar Beacon Interface for more information.)

The North controller said he did not observe the splat; neither did the Final controller who made a data entry to the data tag of N8716K about the same time. The retrack program clearly showed the splatting, but it did not show the radar target and how much "clutter" that may have obscured the splat. Therefore, the Safety Board cannot determine how visible the splatting symbols were.

Although the North controller stated that his attention was diverted to data entries on a helicopter, those entries were made about 2 minutes after the accident, and therefore, the Safety Board believes it was not a factor in distracting the controller.

During the course of these conversations and activities, the North controller was providing ARSA separation between VFR and IFR airplanes (radar separation so that targets do not touch). Because of the proximity between N7115Q and N8716K when the North controller issued a descent clearance to N7115Q, N8716K was at N7115Q's 2 o'clock position and 2 miles on about a 134°-track.

The Safety Board believes that these circumstances indicated that the controllers should have issued a traffic advisory to the pilots, although traffic advisories are not required when separation minimums exist. If N711SQ had been advised of N8716K, the pilot may have questioned his descent clearance or informed the controller that he (N711SQ) was proceeding toward the Orlando VOR. Had the West controller alerted the pilot of N711SQ to the target that he (West controller) observed at 3,000 feet (N8716K) and subsequently issued a clearance to N711SQ to provide vertical separation from that target, the pilot of N711SQ may have been aware of a potential conflict. Similarly, had the North controller alerted the pilot of N711SQ of N8716K's position, the pilot of N711SQ would have had a heightened awareness of the traffic situation involving his airplane and may have asked the North controller for additional or periodic updates on N8716K's position. Therefore, the Safety Board believes, that due to the proximity of the airplanes, both pilots should have been alerted to each other. Further, the Safety Board is concerned that two airplanes can come close to each other, as was the case in this collision, and controllers were not required to issue traffic advisories, even on a workload-permitting basis.

The North controller also stated that he observed a primary target that he "assumed" to be N711SQ proceeding northwest. The FAA provided data that indicated that this primary target did not cross the path of the coasting data tag until after the collision, because it was about 5 miles southeast of the coasting data tag at the time. Further, the primary target, at the time the coasting data tag dropped off the radar screen, had not yet reached the point where N711SQ had turned toward the Orlando VOR. The closest that the primary target came to the coasting data tag was about 2 1/2 to 3 miles. As a result, the Safety Board concludes that the primary target was not N711SQ and that the North controller should have been able to recognize that the primary target was not N711SQ.

The North controller was an experienced controller with more than 15 years of experience at Orlando and should have been capable of discerning changes in aircraft tracks of at least 30°, and therefore, he should have detected that N711SQ was turning and was not heading northwest. N711SQ had apparently turned 35° while being tracked by the ARTS IIIA computer. (Turns of at least 30° are used for primary radar identification purposes.) Therefore, the Safety Board concludes that the North controller's failure to observe the target during the three sweeps of the radar contributed to the cause of the accident.

The Final controller worked N8716K for about 5 nmi, but he was not involved in the handling of N711SQ. Therefore, the Safety Board concludes the handling of N8716K by the Final controller was appropriate and was not a factor in the cause of the accident.

2.3.2 Separation Procedures

The data tag of N711SQ coasted continually for 10 radar sweeps (about 46 seconds) before dropping off the radar screen and going into the tab list. In other Safety Board investigations of operational errors and near-midair collisions, the Safety Board has found similar errors ^{9/} in maintaining target identification. For example, there have been cases of coasting data tags that resulted in misidentification of radar targets and a lack of traffic situation awareness by controllers. The Safety Board believes that these instances, as well as the circumstances of this accident, indicate a lack of proper radar identification techniques, a failure to maintain target identification, and an over reliance on automation on the part of controllers. These findings also suggest the lack of

^{9/} May 29, 1987, Cocoa Intersection, 12 nmi southwest of Chicago O'Hare Airport; August 8, 1987, Wheeling, Illinois, 1 nmi south of Palwaukee Airport

adequate traffic scan and search techniques by controllers. The Safety Board is concerned that controllers may have a tendency to control on the basis of the aircraft target data tag and not the aircraft itself. Further, the Safety Board believes that controllers should be required to discontinue radar separation procedures and to revert to nonradar separation procedures when a coasting data tag exceeds a specific number of radar sweeps (continually coasting for more than four radar sweeps). If such a procedure had been used, this accident and other operational errors by controllers could have been avoided.

Further, the Safety Board notes that current FAA training at the Radar Training Facility and at field facilities does not include scenarios or simulations demonstrating target identification/reidentification resulting from coasting data tags whose associated targets are close to one another. The Safety Board believes that the FAA should include specifically these scenarios in its controller training curriculums.

Controllers must maintain constant vigilance over the aircraft they direct. When information is presented to them that is not consistent with what they believe is occurring, assumptions, such as occurred in this case, may not be appropriate. Even though the circumstances of this accident involved a tracking compromise resulting from a unique extended beacon code overlap, coasting in general is common because problems such as poor or nonexistent beacon returns and ghosts or reflections. However, just as the professionally trained flightcrews must act on each warning signal as appropriate and consider each signal valid until demonstrated otherwise, controllers must consider each discrepancy, nuance, or other inconsistent information that prevents them from maintaining positive identity, ensured separation, and positive target and flight information as a potential threat to safety. Controllers must be aggressive in their search to determine authenticity of those "alerts" and act to resolve them. Therefore, ATC procedures and directives should be established and enforced to require controllers to do so.

2.4 Radar Beacon Intefference

The inability of the ARTS IIIA computer system to maintain separate tracks on N711SQ and N8716K as their respective ranges and azimuth (antenna direction) from the beacon antenna merged demonstrates a recognized limitation of the beacon subsystem. The current beacon sensing subsystem cannot separate beacon returns on the same azimuth for targets that are within 1 1/2 nmi of one another. At distances less than 1 1/2 nmi, the beacon replies from two aircraft interfere with each other and are generally decoded as a nonsensible response.

This problem will be resolved with the introduction of the Mode Select Beacon System (mode S). The installation of 137 mode-S sensors is scheduled to begin in 1989. Mode S is intended to prevent the loss of tracking data due to beacon garbling because it interrogates only one transponder at a time. Each aircraft or registration number will have a unique mode-S code assigned to it for life and will reply only to interrogations directed to it or to special all call interrogations. The all-call interrogations are special beacon reponse requests issued to determine aircraft presence and identification. Once an aircraft is identified to the system, it will then respond only to its unique interrogation, and unlike the present system, its position for that sweep will be determined after that one response. This is called monopulse surveillance. Because of the discrete interrogations of the system's ability to determine aircraft position on one reply, the system should suffer no proximity garble and will have greatly expanded capacity.

These sensors can track mode-A and mode-C proximate aircraft through most garbled situations. When at least one of the aircraft is equipped with a mode-S transponder, the situation is designed to maintain transponder identity and be free of garble. Additionally, both the mode-S transponders, and ground sensors are completely compatible with mode-A and mode-C surveillance system.

As a result of the proposed rulemaking by the FAA for a Traffic Alert and Collision Avoidance System (TCAS), mode S, an integral part of the TCAS installation, may be mandated for large transport type aircraft and certain turbine-powered smaller aircraft used in commercial service under Parts 121, 125, 129, and 135. Further, the FM has issued rulemaking that provides for phased installation of mode-S equipment throughout the aviation community. The rule requires that transponders installed after January 1, 1992, must be mode S. While it may take as long as 10 to 15 years for existing transponder equipment to retire, that equipment will remain compatible during the phase-in of mode S.

3. CONCLUSIONS

3.1 Findings

1. The pilots were properly certificated and qualified for their respective flights.
2. The pilots were unable to see and avoid each other during the last portion of the flight because their positions relative to each other blocked the view of the other airplane.
3. The airplanes were properly certified and maintained in accordance with applicable Federal regulations and established maintenance procedures.
4. The controllers were trained, qualified, and certified according to current regulations to operate the positions to which they were assigned.
5. The Orlando TRACON was properly staffed and supervised at the time of the accident.
6. The equipment used at the Orlando TRACON was certified after the accident and no discrepancies were noted.
7. The West controller did not coordinate the arrival of N711SQ with the North controller.
8. The North Controller did not maintain positive identity of N711SQ and failed to recognize the various discrepancies in target information, perceived ground track, and additional targets.
9. Traffic advisories were not issued to N711SQ or N8716K.
10. The workload of the West and the North controllers should not have affected the controllers' ability to provide separation.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the Orlando West controller to coordinate the handoff of traffic to the Orlando North controller and the failure of the North controller to maintain radar target identification. Contributing to the accident was the limited capability of the radar system to continually track the targets in proximity to one another and the lack of traffic advisories. Also contributing to the accident was the limitation of the "see and avoid" principle in the circumstances of this accident to serve as a means of collision avoidance.

4. RECOMMENDATIONS

As a result of its investigation, the National Transportation Safety Board made the following recommendations to the Federal Aviation Administration:

Recommend that pilots, on initial contact, advise controllers of their altitude preceded by the word "level," "climbing," or "descending" and provide the present vacating altitude if applicable, and final altitude. Also, when on other than published routes, pilots should include their present navigational position on initial contact with each air traffic controller (e.g., direct VOR, heading 240, turning right to heading 330, etc.). (Class II, Priority Action) (A-88-29)

Establish specific coasting parameters whereby controllers must discontinue using radar separation procedures and reidentify targets. (Class II, Priority Action) (A-88-30)

Issue an Air Traffic Service Bulletin to reemphasize Air Traffic Control Handbook 7110.65E, Chapter 5, Section 15, Paragraph S-211, Responsibility. Further, develop lesson plans and associated training exercises to be administered at the Radar Training Facility in Oklahoma City, Oklahoma, and in facility development and annual refresher training demonstrating target identification/reidentification situations resulting from coasting data tags whose associated targets are in close proximity to one another. (Class II, Priority Action) (A-88-31)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

/s/ JAMES L. KOLSTAD
Member

February 16, 1988

5. APPENDIXES

APPENDIX A

INVESTIGATION

1. Investigation

The Safety Board's Miami field office was initially notified of the accident about 1640, eastern standard time, May 1, 1987, and immediately responded to the accident scene. Late on May 1, 1987, five additional investigators were dispatched to the scene from Washington, D.C.

Parties to the investigation were the Federal Aviation Administration, Cessna, Rosie O'Grady's of Orlando, and Midwest Packaging Materials Company.

APPENDIX B
PERSONNEL INFORMATION

Pilot, Bernard William LeFils (N8716K)

Pilot LeFils, 62, held a private pilot certificate No. 267209830 with airplane single- and multiengine land and instrument ratings. His most recent airman medical certificate was a third class issued on May 9, 1985, with the limitations "defective near vision: airman must have available correcting glasses for near vision while exercising the privileges of this certificate." He had approximately 2,335 hours total flying time, 3444 hours of which were in the C-340A.

Pilot Robert Peter Favrean (N711SQ)

Pilot Favrean, 43, held a commercial pilot certificate No. 2116533 with ratings for airplane single- and multiengine land and instrument. He had approximately 7,118 hours total time, 296 hours of which were in the SNJ-4. His most recent airman medical certificate was a second class issued on May 13, 1986, with no limitations. He had been flying for Rosie O'Grady's since October 14, 1981.

ATC Specialist David R. Tally

Mr. Tally, 36, was a full performance level controller at the ORL and TRACON. He has been an FAA controller for 6 years 7 months, 4 years 8 months of which were at MCO. Mr. Tally had previously worked in the Atlanta Air Traffic Control Center (ARTCC) for 3 months and at the ORL Tower for about 3 months before attending the FAA Academy in Oklahoma City, Oklahoma. After successfully completing his training he returned to ORL and remained there for about a year, where he became a full performance level controller. He then transferred to MCO Tower and TRACON. Mr. Tally has a second class medical certification with no limitations issued on March 17, 1987. At the time of the accident, he was working the Radar West position.

ATC Specialist Kenneth Hart

Mr. Hart, 39, was a full performance level controller at the ORL and TRACON. He has been an FAA controller at this facility for 19 years. Mr. Hart has a second class medical certificate with a restriction to wear glasses for reading issued on June 23, 1986. At the time of the accident, he was working the Radar North position.

ATC Specialist George Blakeney

Mr. Blakeney, 45, was a full performance level controller at the MCO Tower and TRACON. He has a total of 18 years as an FAA controller. Mr. Blakeney worked at the Jacksonville ARTCC for about 1 year. He then transferred to Huntsville, Alabama, where he received nonradar and radar training. He became a full performance level controller at Huntsville. In August 1972, he transferred to Orlando, Florida, and was then certified as a full performance level controller in December 1972. Mr. Blakeney has a second class medical certificate with the restriction to wear glasses issued in May 1986. At the time of the accident, he was working the Radar Final position.

Supervisory ATC Specialist Huev Napier

Mr. Napier, 52, was a fully operational rated area supervisor at the MCO Tower and TRACON. He has a total of 28 years 3 months service as an FAA controller. Mr. Napier had previously worked 1 year at New Orleans ARTCC then went to San Juan, Puerto Rico, where he was a manual controller for 3 years 6 months. He then went to Jackson, Mississippi, for 6 years where he became a full performance level controller. Following his stay in Jackson, Mississippi, he became an instructor at the FAA Aeronautical Training Academy for 2 years. Then went to the Huntsville, Alabama Tower as a training specialist. He next went to San Juan, Puerto Rico, as an area supervisor for 2 years. He has been at the MCO Tower and TRACON as an area supervisory for the last 13 years.

Mr. Napier has a second class medical certificate with no restrictions issued in September 1986. At the time of the accident he was working the area supervisor position.