

- 21. The inability of the Convair crew to sight the Cessna in time to avoid the collision was more a product of the substantial limitations on their visual detection capabilities than lack of outside vigilance.
- 22. In view of the situation confronting the Convair crew, they should have requested a radar avoidance vector.

(b) Probable Cause

The Board determines that the probable cause of this accident was the inability of the Convair 580 flight-crew to detect the Cessna 150 visually in sufficient time to take evasive action, despite having been provided with three radar traffic advisories concerning the latter aircraft. Visual detection capabilities were substantially reduced by the heavy accumulation of insect smears on the forward windshield and direct vision windows of the Convair. Visibility was further reduced by haze, smoke and sun glare, and by the inconspicuous color and lack of relative motion of the Cessna. Under these circumstances, the crew of the Convair should have requested a radar avoidance vector.

3. RECOMMENDATIONS AND CORRECTIVE MEASURES

The subject accident is part of the general midair collision problem which is becoming of increased concern to the Safety Board as well as to all members of the aviation community. An in-depth study of the dimensions of this problem has recently been completed by the Board, and a report will be published in the near future outlining the relevant factors and causal areas. Included in this report will be a series of recommendations designed to lower the midair collision accident rate.

A number of these accidents in recent years have involved a collision in a terminal area between an air carrier aircraft, on an IFR flight plan, and a general aviation aircraft, operating under VFR without a flight plan. These circumstances are evident again in the subject accident, and the recommendations set forth below are directed at preventing a recurrence of this type of collision.

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Traffic Separation in Terminal Areas

The control service and traffic separation provided by the Air Traffic Control system currently in effect are almost wholly predicated upon "known" traffic. Accordingly, when unknown traffic is mixed with known traffic, as frequently occurs in terminal areas, ATC cannot assure an appropriate level of safety. Even when the unknown traffic is observed on radar, its altitude is unknown, and therefore separation in the final analysis falls back on visual detection, which in this instance proved to be inadequate.

It therefore follows that separation of "known" and "unknown" traffic operations, to the broadest extent practicable, is desirable from a safety viewpoint. One possible solution would be the designation of larger segments of the navigable airspace as positive control areas to include terminal areas. This would require, however, that both the pilots and their aircraft operating in such areas meet certain standards in terms of qualifications and equipment. We recognize that such a measure would have an adverse impact on many of the airspace users for a variety of reasons, not the least of which would be economic.

With specific reference to the Milwaukee terminal area, the mix of unknown and known traffic could be reduced by a restructuring of Victor Airway 479. This airway, along which both of the aircraft involved in the collision were or had been navigating, is the first overland airway west of the Lake Michigan shoreline. For pilots who are adverse to over-water flights because of equipment limitations or other reasons, V 479 is the most convenient means of navigation for north and south bound flights between Chicago, on the one hand, and Milwaukee and points north of Milwaukee, on the other hand.

Complicating this situation is the fact that V 479 crosses the transition area for the approach to Runway 7R at General Mitchell Field in such a manner that an aircraft navigating on the airway becomes tangential to the radar at that point. In addition, flight training involving small aircraft is generally conducted in the quadrant southwest of the field. The final outcome is that an air carrier aircraft making an approach to Runway 7R must fly through an area containing a substantial amount of unknown traffic, some of whose primary radar targets may be lost due to tangential effect. This situation not only aggravates

the radar controller's separation problems, but also increases the workload of air carrier pilots who must depend on the "see and be seen" concept.

In view of the foregoing, the Board recommends that the FAA take under consideration the relocation to the west of V 479 between OBK (Northbrook) and MKE in the manner depicted on Attachment 1. We believe that such a measure would enhance traffic separation in a critical approach area without unduly disrupting the safe and orderly flow of traffic navigating on that airway.

"See and be Seen" Concept

In view of the incapability of the air traffic control system to provide positive separation between all aircraft at all times, and until some system with that capability is put into effect, the "see and be seen" concept will remain the basic means of collision avoidance. Notwithstanding the substantial limitations of this concept, many of which were factors in the subject accident, the Board urges, as it has repeatedly, that all users of the airspace make every effort to achieve the maximum benefit from visual detection. No less than constant vigilance on the part of both pilots and controllers is required, particularly in terminal areas where there is apt to be a mixture of large high-speed aircraft and small, relatively low-speed, aircraft. At the same time, the Board recognizes the difficult burden placed on airline crews of balancing such outside vigilance with the frequent, but necessary, diversion of their attention to cockpit duties, such as assuring maintenance of proper altitudes.

The Board notes with some concern that, in the majority of recent collisions involving an air carrier, the large aircraft was being flown by a relatively inexperienced first officer while the small aircraft was converging from the right. In view of the natural tendency of a pilot in such circumstances to become somewhat preoccupied with operating the aircraft, maximum outside vigilance may have been compromised. While on-line training and a safe level of outside vigilance are not incompatible, the Board urges that in such situations, and particularly when traffic advisories have been received, both pilots coordinate their efforts to assure that the designated areas are thoroughly scanned.

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Finally, and as an extension of our comments in the Analysis section, the Board recommends that air carriers emphasize, both during training and operations, the entire spectrum of situations in which the use of an avoidance vector would be advisable. It is only through the judicious utilization of such vectors, based on a thorough understanding of their advantages and disadvantages, that the "see and be seen" concept can be supplemented to the fullest extent by bringing into play, when appropriate, the last available means of collision avoidance.

Windshield Cleaning

The insect accumulation which was such a substantial factor in this accident was both unpreventable and uncorrectable, considering available equipment and procedures. Following departure from Chicago with a clean windshield, the Convair was not equipped with any means of preventing the insect accumulation or, once it occurred, of removing the smears. Although the aircraft was equipped with a liquid rain repellent which can be discharged onto the windshield, its use would only have served to aggravate the problem.

The Board recognizes that the insect problem encountered on this flight may represent only an isolated occurrence. Indeed, the investigation disclosed that there is a dearth of evidence on the dimensions of this particular hazard. Accordingly, the first step which should be taken is a comprehensive survey by air carriers of their pilots with a view toward defining the extent of the problem. If a problem of sizable proportions is found to exist, then specific remedial measures can be explored.

The first point which should be stressed is the importance of having a clean windshield at the commencement of a flight. It is therefore recommended that inspection forms include a windshield cleaning requirement at all maintenance stations as well as a mandatory cleaning and sign-off of any dirty windshield complaint made by a flightcrew.

With respect to in-flight measures, one device which might be studied would be a deflector located forward of the windshield which would deflect the airflow containing the insects away from the windshield. A more practical system, particularly since it could be utilized subsequent

to the insect strikes, would involve in-flight window washing. The Board is aware that one air carrier is conducting experiments to develop a rain repellent chemical that also has detergent or cleaning qualities for use in the present rain repellent systems. Another system which might be adaptable for use on other aircraft is the windshield washer being installed on the B-747. On the other hand, while built-in washing systems may prove to be extremely useful during flight, we are not convinced that they would provide a completely adequate substitute for manual windshield cleaning on the ground.

Collision Avoidance Systems

During the course of the investigation, the Board was brought up to date on the activities of the Collision Prevention Advisory Group (COPAG), which is comprised of representatives from Government agencies and civil aviation associations 20/ and whose primary concern is with airborne systems designed to prevent midair collisions. The efforts of COPAG are primarily concentrated in three areas:

- (1) conspicuity enhancement (generally through exterior paint and lighting),
- (2) Pilot Warning Instruments (PWI), and
- (3) Collision Avoidance Systems (CAS).

PWI is an instrument whose function is to warn a pilot of the proximity of another aircraft and provide him with suitable information to assist him in evaluating a collision threat. CAS is more comprehensive in that it performs all of the necessary functions, such that its output is a signal indicating an appropriate avoidance maneuver at a suitable time. PWI is self-contained, while CAS is a cooperative system which requires that all participating aircraft be equipped with devices capable of exchanging information with each other.

With respect to the current stage of development, PWI equipment is being fabricated and flight tests should be held this year. Users have made known their need for devices costing \$1,000 to \$2,000. Two versions of CAS will

20/ To avoid any of the problems associated with self-interest, the composition of COPAG does not include any companies or organizations involved in the design, development or fabrication of any equipment.

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be flight-tested starting in the summer of 1969. The estimated cost of a complete CAS is \$30,000 to \$50,000, with a lower cost of possibly \$8,000 for limited equipment that might be used by executive aircraft.

The Board is of the view that the CAS and PWI systems will provide a substantial contribution to collision avoidance, and therefore urges that their development be continued toward a successful conclusion as expeditiously as possible. With respect to CAS, which appears to be the system receiving the most attention at this point, one of the most critical factors is the cost of the airborne equipment. If this cost is beyond the means of most of the general aviation community, the overall ability of the system to prevent collisions between large aircraft and small aircraft will be drastically reduced. The subject accident, for example, could have been prevented by CAS only if the Cessna had been equipped with a device capable of transmitting warning signals to the fully equipped Convair. Accordingly, it is hoped that some such "minimum" device can be developed at a cost which will foster its widespread installation on small aircraft.

Finally, it should be emphasized that CAS, even when developed to its most sophisticated level, is designed to supplement, rather than replace, the Air Traffic Control system. It is therefore critical to the maximum effectiveness of both systems that the developmental efforts in each be fully coordinated. To this end, the FAA is investigating, in part by a planned 6-month flight test program, the interaction between the maneuvers that would be engendered by a collision avoidance system and the Air Traffic Control system in order to optimize their relationship.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

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