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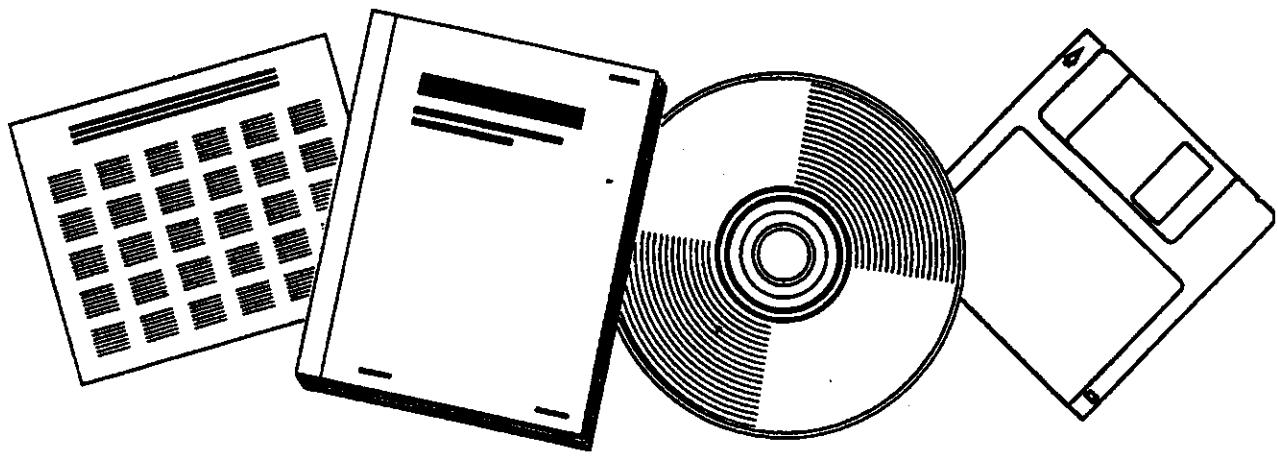
REPORT OF PROCEEDINGS OF THE NATIONAL TRANSPORTATION SAFETY BOARD INTO THE MIDAIR COLLISION PROBLEM, NOVEMBER 4 THROUGH 10, 1969

NATIONAL TRANSPORTATION SAFETY BOARD,
WASHINGTON, D.C

12 NOV 1970



DEPARTMENT OF COMMERCE
nal Technical Information Service

REPORT OF PROCEEDINGS

OF THE

NATIONAL TRANSPORTATION SAFETY BOARD

INTO THE

MIDAIR COLLISION PROBLEM

NOVEMBER 4 THROUGH 10, 1969

ADOPTED: NOVEMBER 12, 1970

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20591

REPORT NUMBER: NTSB-AAS-70-2

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I. INTRODUCTION

The National Transportation Safety Board, on November 4, 1969, convened a public hearing for the purpose of inquiring into the cause and prevention of midair collisions. The Board, sitting en banc, heard the testimony of 26 witnesses, including representatives of the United States Government, the aviation industry, and members of the public. Also received into the record were written statements from 12 organizations and individuals.1/

The midair collision between an Allegheny Airlines DC-9 and the Forth Corporation PA-28 was the 19th collision of 1969, and brought the year's fatalities to 115 from this type of accident. This accident prompted the Board to review the entire collision problem to determine its magnitude, what actions were being taken to solve the problem, additional research required, and the state of the art in collision avoidance systems.

In the 10-year period, 1959 through 1968, there were 223 midair collisions involving U. S.-registered aircraft. About half of these accidents, 109, were fatal, resulting in 528 fatalities. Initially, it would appear that the problem of midair collisions is predominantly one involving general aviation aircraft, since 98 percent of these collisions involved this segment of aviation. Examination disclosed, however, that, although air carrier aircraft were involved in only 6.7 percent of the accidents, the occupants of these aircraft accounted for 66 percent of the fatalities.

Forecasts indicate a growth by a factor of 1.7 in the general aviation fleet and by a factor of 1.5 in the air carrier fleet over the next 10 years. In the same time period, the total number of operations of these fleets will be half again as large as they are today. Assuming the accident and fatality rates are the same for the next 10 years as they were for the last 10, we could expect the number of such accidents and the resulting fatalities to increase by 50 percent; that is, 335 accidents and 792 fatalities for the 10-year period.

The Safety Board has been concerned for the past few years with the difficulties confronting the Nation's Air Traffic Control System, namely, the reported lack of controllers, the workload on those manning the system, and the deficiencies in detecting aircraft within the normal operating range of their radars. In three recent accidents involving high-performance transport category aircraft and small general aviation airplanes, the controller indicated difficulty in detecting the small aircraft. In one instance (the Fairland, Indiana, collision), the target of the small aircraft was not detected on radar. In the Urbana, Ohio, case, the target of the small aircraft was detected by the controller about twenty-five seconds prior to the accident; while in the third, the Milwaukee, Wisconsin, collision, the target of the small aircraft was detected and lost from the radarscope prior to the collision.

1/ See Appendix 1 for summary of testimony and written comments.

Additionally, there was a disparity of opinion on how to avoid collisions around terminals which have a high density of traffic. The Board considered that a complete airing of views with respect to positive air traffic control, intermix of VFR and IFR traffic, pilot qualifications, and separation of high-performance and low-performance aircraft in high density areas was warranted.

The vast majority of midair collisions have occurred in weather conditions which would permit the pilots to detect one another visually. In many cases, the collision closure rate has been much lower than the cruising speed of either aircraft. Such accidents have prompted concern on the part of the Board with the limitation of the "see and be seen" concept of collision avoidance.2/ The views of the aviation industry were sought on that subject during the hearing as were methods for detecting other aircraft within the environment by other than visual means.

II. DISCUSSION

The Safety Board is grateful for the enthusiastic participation in its hearing into the midair collision problem. Not only the many associations and Government agencies, but also the individuals who testified in their own behalf, made a substantial contribution to the record of the hearing. Many who could not attend personally submitted their comments and recommendations to the Board for inclusion in the record. We have summarized both the witnesses' statements and the written data contained in the public record. These summations are included in Appendix 1 to this report.

We have not discussed the automation of the Air Traffic Control System or the desirability for expanded radar coverage in terminal areas herein. The FAA has an active program in these areas and, as funds become available, these programs will be expanded. The Board believes that the automation program, including automated communication, will relieve the controller of many of his present duties and permit him to concentrate on traffic flow. The expanded radar service is intended to permit the controller to separate all participating air traffic in his area. The Safety Board supports the FAA's endeavor to accelerate these programs.

There was considerable discussion during the hearing regarding the desirability of increasing both the distance from clouds and minimum visibility standards for VFR operations. The Board has no quantitative suggestions for changing these minima; however, it believes that the FAA should examine the appropriateness of the present minima in view of the increase in aircraft performance since the original promulgation of the regulations.

2/ See Appendix 3, a reproduction of the historical development of the "see and be seen" concept which was included in the Safety Board's accident report Docket SA-417, Allegheny Airlines, DC-9, N988VJ, and a Forth Corporation, PA-28, N7374J, 4 miles northwest of Fairland, Indiana, September 9, 1969

A number of suggestions and recommendations made during the hearing warrant further discussion and recommended action. The Board's views on these follow:

TRAFFIC SEGREGATION IN TERMINAL AREAS

For the past several years, the Safety Board has been extremely interested in the procedural relationship of flight operations conducted in accordance with Visual Flight Rules (VFR) and those under Instrument Flight Rules (IFR).

In theory, each group (VFR/IFR) should be able to operate in a cooperative National Airspace System without hazardous conflict within the group or between groups. This concept has been used with an acceptable level of safety for a number of years. However, in recent years the growth of the aviation industry has resulted in a tremendous increase in the number of aircraft operating in the airspace. In addition to the increased number of aircraft, the new equipment has widely varied performance characteristics. The net result has been a substantial increase in flight operations and a greater demand for Air Traffic Control (ATC) service. To accommodate the additional numbers of those who wished to obtain this service or to operate within the IFR group, the capabilities of the Air Traffic System had to be improved. A few of the major improvements were: extensive utilization of radar; secondary radar response from aircraft; introduction of automation into the control facilities; development of improved navigational aids; and establishment of procedures tailored to meet requirements of the ATC system and the IFR operators.

In addition to the increase in IFR operations, there has been a significant increase in the number of VFR operations in recent years. The effect of the IFR operation increase is readily apparent on the ATC system; however, the VFR increase also has a significant effect on the system. The Safety Board believes that the point has been reached where previous concepts relating to VFR and IFR procedural control are no longer feasible or practical under existing regulations with respect to acceptable levels of safety. The operating rules, in our opinion, by which each group must comply, are not compatible with safe standards where a mix of VFR and IFR traffic occurs.

The Board has noted, from studies of recent near midair collision reports and its findings in the investigation of several catastrophic midair collision accidents of the past several years, that conflict between the "known" and "unknown" traffic (VFR/IFR mix) was a factor. The problem stems from traffic cleared to operate under instrument flight rules but operating in VFR conditions. Such operation does not relieve the IFR operator from the responsibility to see and avoid, even though the cockpit duties for instrument flight are more numerous than those for VFR operations. This conflict is now beginning to reveal the true magnitude of the impact on our Air Traffic System created by the ever-growing number of VFR and IFR operations. Predictions for the future show even a greater increase in all flight operations.

Although there are a number of measures which could be taken to enhance safety and reduce the midair collision potential, one suggested method involves the designation of Terminal Control Areas (TCA). Specific airspace in the terminal area would be defined and limitations established requiring minimum airborne equipment to be carried on all operations into the defined area. Specific procedures would be established to require all pilots operating into the designated area to advise ATC so that all traffic in the area would be known and separated. Whereas a proposal of this kind would have been impossible to implement in the past, the state of the art is such that the capability now exists. It is the Board's view that the free mix of "unknown" and "known" traffic especially in terminal areas must be eliminated.

There was considerable discussion during the Board's hearing regarding the methods of designating TCA airspace. Two concepts or configurations of designated airspace for terminal areas were discussed; one was the Corridor concept, and the other was FAA's proposed Terminal Control Area (TCA) concept.

The proponents of the Corridor concept are of the opinion that more efficient utilization of the airspace would be accomplished by designating climb and descent corridors to serve an airport and by requiring that the traffic operating within the corridor be controlled by ATC. These corridors would be easy to depict on an aeronautical chart and their geographical limitations would be easily identifiable by the average pilot. Advocates of the Corridor concept claim that the system would effectively segregate the "known" from the "unknown" traffic without imposing unnecessary restrictions or complex procedures.

The TCA concept provides a positive control area around the entire airport. Those who favor this concept claim that it offers more flexibility to the ATC system by enabling controller personnel to make the most efficient use of the available airspace, under varied conditions of traffic loads and types of aircraft desiring service. The principal advantage of the latter plan would be the recognition of all traffic in the terminal control area by the controller, permitting effective separation of the traffic.

The TCA plan was designed primarily for use in high-density terminal areas. The FAA proposed the implementation of this plan at a number of locations throughout the United States.

The Board believes that for areas of low density air traffic, climb and descent corridors would meet all airspace user and ATC requirements adequately and, at the same time, enhance safety of flight. It also appears that, for airports located in areas where traffic flow would be of medium density, a modified version of the TCA concept could be used, incorporating portions of the Corridor concept. In high-density terminal areas, the Board believes that the TCA proposal offers the most acceptable method of accomplishing the desired objectives. The Board considers that each terminal area must be examined for its particular problems prior to

the designation of the controlled area.

Operations into high-density terminal areas require considerable skill on the part of the pilot. The Board believes that the FAA should study further the pilot qualifications and minimum airborne equipment necessary to operate safely into high-density terminal areas, with a view toward increasing the minimum standards for each.

In addition to the intermix between IFR and VFR operations within the terminal area, still another operational mix deserves our attention, that is, the intermix of high-performance and low-performance aircraft in the traffic patterns of airports wherein TCA's have not been designated. This too, in the Board's opinion, creates a high potential for midair collisions. Some strides have been made in separating traffic patterns and providing separate runways for these two types of aircraft. The Board believes that the program to provide separation of high and low-performance aircraft should be accelerated.

COLLISION AVOIDANCE SYSTEMS

During the public hearing, the Safety Board received testimony on two collision avoidance systems (CAS). The equipment for one system, utilizing time-frequency technology, has been fabricated and flight tested. This CAS equipment was built to meet the technical description developed by an Airline Transport Association (ATA) committee composed of airlines, manufacturers, and Government representatives. The second system, developed by the Radio Corporation of America (RCA) consists of a transmitter and receiver, permitting aircraft to interrogate one another.

The time-frequency technique necessitates an extremely rapid exchange of information at frequent intervals between aircraft. The ATA system permits each aircraft in the system to transmit to all others within a 3-minute time bracket. The system would permit up to 2,000 aircraft to exchange information within this time interval. While not transmitting its own information, the aircraft would be listening for others to transmit. Information regarding distance to the aircraft, the rate of closure and the altitude of the aircraft must be provided. From this information, an automatic assessment is made regarding the collision threat of other aircraft and, where evasive action is required, the pilot's display shows him the avoidance maneuver to take, i.e., fly up or fly down.

This system is a cooperative one in that each aircraft to be protected must have the equipment aboard and operative. It will then be protected only from those aircraft similarly equipped. The presently proposed system will cost approximately $30,000 per installation. Since this is considerably more than is economically feasible for most general aviation operators, the manufacturers are endeavoring to develop a compatible version for general aviation which, it is estimated, would

cost about $10,000 per installation. At best, with high production, the cost could come down to $8,500.

The Board considers that, even if the time-frequency CAS is developed to a point where a unit for general aviation can be installed for $8,500, the cost would be prohibitive for most operators in this segment of the industry.

The RCA version of a CAS, utilizing a transmitter and receiver, is being developed. Three different installations were described. The full system for the air carrier type aircraft would include a computer and a Plan Position Indicator (PPI) scope on which each potential collision target would be displayed to the pilot, thus permitting him to take evasive action. The cost of the full system was estimated to be between $20,000 and $30,000. An intermediate system would include a transmitter and receiver and a pilot warning indicator to advise the pilot that another aircraft is close. This system would cost between $1,500 and $2,000. The simplest system would merely receive the interrogation from the higher level systems and transmit a return signal. This would permit the aircraft with the higher level systems to know of the presence of the aircraft in the vicinity, but would give no indication to the pilot of the simply equipped aircraft. The latter system would cost about $500.

The RCA concept would, in the Board's opinion, be a reasonable one for general aviation aircraft participation. However, it must be recognized that, at the present time, it is a "paper" system which has not been built or flight-tested. The time-frequency system, on the other hand, has been flight-tested, and this concept has been used successfully in the flight test range of McDonnell-Douglas since 1965.

The Board believes that the increased speeds of the turbine-powered aircraft will justify the development of a collision avoidance system, even though the system may not protect the large aircraft from the small aircraft in which a CAS is not installed. In addition, the installation of a pilot warning indicator should be required in all aircraft in order to assure complete protection from all other aircraft.

The FAA should, therefore, encourage development of a CAS for installation in air carrier aircraft and certain of the larger general aviation aircraft. Additionally, funds should be made available to provide ground installations where appropriate.

PILOT WARNING INDICATOR

There is considerable activity within the aviation community to develop a pilot warning indicator (PWI) to provide the pilot with sufficient information to improve his ability to see and avoid other aircraft in his vicinity. It was the consensus of the participants at the midair collision hearing that a PWI is needed to prevent collision accidents.

The distinction should be made between a CAS and PWI. The former provides the pilot with information regarding an aircraft which is on a collision course and what action should be taken to avoid the potential collision. The PWI, on the other hand, only provides the pilot with the intelligence that another aircraft is within a defined airspace around his airplane. It may also provide him with certain bearing information.

There have been a number of systems conceived to warn the pilot of another aircraft intruding into his airspace. The information provided to the pilot varies with the sophistication of the equipment, from merely an aural or visual warning that an aircraft is within a specific distance, to providing the azimuth of the intruding aircraft and whether it is higher, lower, or at the same level. The various proposals cover cooperative and noncooperative systems utilizing many different techniques, i.e., infrared radiation, transceivers, and radars.

Two Government agencies, FAA and NASA, are actively evaluating PWI systems. The Army, on the other hand, has a program under way to install a PWI system in 285 TH-13T (Bell 47) helicopters utilized in training at Fort Rucker. They are also considering a similar installation in their fixed-wing aircraft. The Army system consists of a transceiver which merely warns the pilot that another aircraft is within a specified airspace around him. A modification of this system has been developed to provide the pilot with the azimuth of the intruding aircraft, although the Army has no plans to modify the present system. The Army anticipates evaluating a collision warning device which will also advise the pilot of the range and closure rate of the intruding aircraft.

NASA is now evaluating two systems of PWI. One system detects infrared radiation from a Xenon lamp installed in another aircraft. The second system involves radio frequency techniques. Each of these systems can display to the pilot the azimuth of the other aircraft. Each is a cooperative system, since its operation depends on the installation and operation of suitable equipment in both aircraft. Flight tests for these two systems were scheduled by NASA for April and May of 1970.

The FAA has a number of contracts from which information is to be developed to assist in writing the ultimate specifications for a PWI system. These contracts are for human factors and analytical studies of the collision problem and the warning systems. Additionally, the visual flight rules are being studied to determine where improvements are required.

The FAA also has a contract with a private corporation to collect collision data through utilization of photographic techniques in actual flights and flight simulators. The purpose of this contract is to assess the many variables in the midair collision problem by flight-test simulation and evaluation of near collision and collision data. From these analyses, the contractor would develop specifications for a family of PWI systems.

From subsequent discussions and an overall view of the activities in the PWI program, the Safety Board has come to the conclusion that there is no agency giving overall direction to a PWI program. Although COPAG (Collision Prevention Advisory Group) on which manufacturers, users and government agencies are all represented, may make decisions as to how to proceed and who should take the action, its decisions and recommendations are not binding on any agency or organization.

The Safety Board believes that the aforementioned activities of NASA in evaluating PWI systems should be expedited.

Although much meaningful information may be forthcoming from the FAA studies, the Safety Board believes that an acceptable set of characteristics for a PWI system is presently available. A group of the industry users, National Business Aircraft Association, Air Line Pilots Association, and Aircraft Owners and Pilots Association have jointly developed the following set of PWI characteristics:

VFR Operation, Cooperative acceptable; Noncooperative desired
Operation in multiaircraft environment (terminal area)
Altitude-Sea level to 10,000 feet (minimum)
Visual with aural alert display
Azimuth Coverage (relative to aircraft heading)

Nose: 0° ± 60° (minimum) Desire 360°
Tail: 180° ± 15° (minimum) Desire 360°

Azimuth Display - 45° segments acceptable (15° segments desired)
Elevation Coverage (relative to level flight) ± 10° minimum

Elevation Display to show intruder above, below or own altitude
Range: 95% of target at 1 nm or less
95% of target at 3 nm or less with provisions for the pilot to reduce the range to 1 nm maximum

It is recommended that the FAA sponsor developmental contracts for PWI systems utilizing various technological methods in order to evaluate the practicality of each. Following the evaluation, it is recommended that minimum standards be adopted to require a compatible PWI system in all aircraft.

STANDARDIZED TRAFFIC PATTERNS

During the hearing, several witnesses recommended the establishment of standard traffic patterns at airports as a means of reducing the midair collision potential. A review of the applicable provisions of Part 91 of the Federal Aviation Regulations and the Airman's Information Manual has led the Safety Board to conclude that, as suggested during the hearing, there is considerable merit in the establishment of standard traffic patterns.

Lack of uniformity in airport traffic patterns, in the Board's opinion, can create confusion on the part of pilots; however, a hard-and-fast rule applicable to all airport traffic patterns is impractical. Since there are difficulties inherent in establishing traffic pattern criteria applicable to both controlled and uncontrolled airports, the Board recommends that a Government/Industry meeting be convened for the purpose of discussing the factors involved in establishing standard traffic patterns and initiating action leading to their creation.

On January 30, 1970, the Safety Board transmitted to the Administrator of the Federal Aviation Administration the foregoing recommendation. The FAA, on February 12, 1970, responded that they share the Board's concern and have reopened their study of airport traffic pattern criteria. They indicated that they were contacting the user organizations on an informal basis, but would consider convening the suggested Government/Industry meeting. A copy of this exchange of correspondence is included in Appendix 2.

FLIGHTCREW TRAINING PROGRAM

Although the Safety Board supports the development of a Collision Avoidance System, a Pilot Warning Indicator, and an improved Air Traffic Control System, there are a number of avenues which can be taken without a substantial expenditure of funds or extensive developmental programs. One of these is the establishment of a mandatory flightcrew training program to enhance the pilot's ability to detect other aircraft which might be on a collision course.

The Safety Board's review of its collision data indicates that most midair collisions occur in bright daylight at uncontrolled airports between general aviation aircraft. The primary reason for these accidents is the failure of the pilot(s) to see the other aircraft in sufficient time to determine the existence of a potential collision and to take evasive action. The failure to "see and avoid" is not limited to the general aviation pilot but has also been attributed to the air transport rated pilot.

During the Board's hearing, one witness theorized that the failure to scan properly for traffic resulted from the pilot's dependence on the air traffic control system to inform him not only that traffic was in his vicinity, but where to look for it. Effective scanning techniques were developed and taught to military pilots during the Second World War. The incentive to scan and watch for other aircraft was certainly necessary for self-protection. Studies by the McDonnell-Douglas Aircraft Company have shown, through training in "time sharing" scanning techniques, very large gains can be achieved in the pilot's ability to detect target aircraft. Also, there was a definite extension of the mean time during which the pilot was looking outside the aircraft. Although these studies were made assuming a single pilot is aboard the aircraft, the Board believes that the gains will be greater in a multipiloted aircraft.

On January 30, 1970, the Safety Board recommended to the FAA that a requirement be added to the Federal Aviation Regulations for ground training of pilots in the proper scan patterns to optimize the probability of detecting other aircraft and to increase the effective time the pilot is looking out of the cockpit. Also, it was recommended that a requirement for the adaptation of visual training aids for outside target detection be added to the simulators in use or being developed.

The Board also recommended that scan patterns and target detection be included in the training programs for licensing and upgrading private pilots. Also recommended was the expeditious development of simple training aids to be made available to the private pilot through fixed-base operators and other appropriate outlets. Through an exchange of letters, our letter of January 30, FAA reply dated February 9, 1970, our letter dated April 3, and their reply dated April 13, 1970, all four of which are included in Appendix 2, the FAA rejected the recommendation for regulatory action, since the recommended training aids are not yet available. The FAA believes that a voluntary program is more appropriate than a mandatory one.

It is the Board's opinion that there is no need to wait for the development of suitable training aids and that the training syllabus for pilots should be amended to include scanning techniques. When suitable training aids are developed to the satisfaction of the Administrator, they can be used to augment the training.

TERMINAL AREA NOTICE CHARTS

The Airman's Information Manual contains a terminal area chart for the Chicago area on which is depicted the most commonly used thoroughfares of the IFR traffic into and out of O'Hare, thus affording the small aircraft operator or VFR operator, information on the location of the heavy traffic concentrations. Such information permits the VFR pilot to avoid these areas. One witness, during the hearing, in drawing the Board's attention to this chart, indicated that it may very well be one of the reasons there have been no collisions between small and large aircraft in the Chicago area.

The Safety Board considered that this type of valuable information could be provided to pilots operating in other areas of the country and thereby ease the collision potential between the large and small airplane. Accordingly, on January 30, 1970, the Board recommended that the FAA expedite the development of similar charts for other areas. The FAA advised on February 9, 1970, that a program was under way to prepare similar graphic notices for most, if not all, of the 22 large hub airports, plus selected medium hub terminals. Copies of this correspondence are contained in Appendix 2.

VISUAL DETECTION OF AIRCRAFT ON A COLLISION COURSE

There are many factors which affect the pilot's ability to detect visually another aircraft which might be on a collision course with him. One of these previously discussed is the use of proper scanning techniques and time sharing of pilots' attention between the inside and outside of the cockpit. (See Flightcrew Training Program, supra.)

Both Parts 23 and 25 of the Federal Aviation Regulations contain visibility requirements for pilot compartments applicable to small and large airplanes, respectively. Although worded differently, the regulations require essentially that the pilot's view be sufficiently extensive, clear, and undistorted for safe operation of the airplane. In applying the provisions of Part 25, the FAA utilizes the policies contained in Civil Aeronautics Manual 4b, Section 4b.351-3, in which the recommended annular vision available to the pilot is enumerated. These criteria, although not mandatory in application, are utilized to determine the equivalency of the actual configuration.

Although the Safety Board is of the opinion that as much unobstructed vision as possible should be provided for the pilot, there are certain other factors which need be considered in cockpit window design, such as pressurization strength, birdproofing, heating, and location of essential instrumentation. The Board is gratified to see that steps are being taken by the FAA to increase the unobstructed visual area in future aircraft, as reported by Mr. Shaffer during our hearing.

From time to time in the past, various paint configurations have been utilized to increase the conspicuity of aircraft. Many of these have proved useful, but have not been generally adopted by the aircraft operators. These paint schemes have a tendency to deteriorate and require refurbishing at frequent intervals.

During the hearing, there were a considerable number of witnesses who recommended the installation of white strobe lights on all aircraft to be operable both during the day and night. Certainly, the night conspicuity of an airplane would be increased with such a light installed. The Board believes that an increase in conspicuity would also result during daylight hours. In addition, such lights could emit infrared radiation which could be detected by one of the proposed systems for a pilot warning indicator.

The FAA recently published Advance Notice of Proposed Rule Making 70-7, in which the Administration solicited views with respect to requiring the installation of white strobe lights on all aircraft. The Board supported the installation of these lights in our letter to the Administrator dated March 26, 1970. Enclosed with our letter was a list of excerpts from the hearing testimony which support the installation of the white strobe anticollision lights. A copy of our letter is included in Appendix 2.

AREA NAVIGATION

There is a considerable potential for lessening the exposure of aircraft to midair collisions through the application of area navigation (RNAV) equipment, techniques, and procedures in the airspace system. This conclusion is based on the premise that, by reducing the number of aircraft traversing a given volume of airspace, the exposure rate will be similarly reduced. In addition to reducing en route congestion, utilization of the RNAV system would permit efficient use of the total airspace, both by the aircraft operator and the air traffic controller.

During the hearing, this system was described in detail. It has been only in the past few years that the state of the art in microelectronics and integrated circuits has been applied to area navigation airborne hardware, permitting this equipment to be within the economic reach of the operators of at least multiengine aircraft. Cockpit displays provide continuous track guidance and distance to or from a preselected waypoint based on inputs from VORTAC. These stations need not be along the intended track but are generally off the RNAV route.

In later model RNAV equipment, slant range correction capability is available. In addition, vertical guidance is now available in this equipment. This capability permits a continuous display relating to aircraft altitude and distance from a preselected point in space or on the ground, thereby permitting a desired climb or descent profile to that point.

The Federal Aviation Administration promulgated Advisory Circular 90-45, dated August 18, 1969, which contains the method for approval of RNAV navigational systems for use in the U. S. National Airspace System. This, of course, is a first step in developing an RNAV capability. The FAA indicated that they had, at the time of the hearing, published in the Airman's Information Manual low- and high-altitude dual RNAV routes between:

Los Angeles	-	Chicago
Houston	-	Dallas
San Francisco	-	Chicago
Atlanta	-	Pinehurst, N. C.
Atlanta	-	Knoxville
New York	-	Chicago
Kansas City	-	Minneapolis

Since the hearing, the FAA has become increasingly active in the establishment and implementation of procedures and programs for RNAV application in the National Airspace System. It published a Handbook 7110.18, dated February 27, 1970, titled Air Traffic Control Service for Area Navigation Equipped Aircraft Operating in the U. S. National Airspace System. This handbook provides the airway planner with the technical criteria necessary for the development of area navigation routes. On March 2, 1970, the FAA issued Notice N 7110.149 which provides the air

traffic controller with the procedures and separation criteria applicable to area navigation equipped aircraft.

On May 7, 1970, the Air Traffic Service of the FAA promulgated internally their Area Navigation Program through Notice N 7110.162 in which they described their long range and interim plans of RNAV routes. By November 1, 1970, they will present to industry a nationwide en route and terminal area navigational plan. In the interim, the FAA will establish RNAV routes where recommended.

The Safety Board believes that the application of RNAV techniques will aid materially in the reduction of the midair collision potential. The increased capability of providing off-airway navigation, more efficient terminal area procedures, and instrument approaches to runways without local landing aids will be feasible with RNAV systems without procurement or installation of any additional ground-based hardware. We support the FAA's program to implement the required procurement, procedural and regulatory actions at as early a date as possible for a full RNAV system.

CIVIL AVIATION MIDAIR COLLISIONS - 1968-69

Since its establishment, the Safety Board has emphasized its efforts to the field of accident prevention. The Board's aviation staff is continually investigating and analyzing accidents and near accidents with the view of isolating factors which, if eliminated, would have prevented the hazardous condition in the first instance.

The midair collision problem in 1968 was viewed with the intent to determine what could be done by the aviation community and the Federal Government to reduce the number of collisions and the potential for such accidents. The Board, therefore, examined the midair collisions which occurred during 1968 and, in July 1969, published its report. (This report can be procured from the Government Clearing House.)

The study showed that, during calandar 1968, there were 38 midair collisions involving 76 aircraft, a 46-percent increase in the number of midair collisions over the 1967 figure. In every 1968 midair collision accident, a general aviation aircraft was involved. In three cases, an air carrier was involved with a general aviation aircraft. In one case, a military aircraft was involved with a general aviation aircraft. In the remaining 34 instances, the collisions were between two general aviation aircraft.

Twenty-four of the 38 collisions resulted in 71 fatalities -- all occupants of general aviation aircraft. The 1968 fatality figure is 55 percent lower than the 1967 midair collision fatality figure. There were no fatalities in the air carrier aircraft in 1968, but in 1967 the three air carrier aircraft accounted for most of the fatalities. There were three air carrier aircraft involved in 1967 midair collisions and three in 1968 midair collisions.

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Most of the 1968 midair collision accidents occurred at or near an uncontrolled airport, below 5,000 feet, in VFR weather during the summer months and on the weekend.

The traffic in the airspace involved in the 1968 midair collision accidents was not congested, and the closure rate between the aircraft involved was well below the cruise speed of the aircraft involved.

The air traffic control system was a factor in approximately 20 percent of the collisions, as was dual instruction. However, the majority of the midair collision accidents in 1968 occurred at uncontrolled airports in low-density traffic. The major problem in the midair collision accidents was the failure of the pilot to adhere to the "see and be seen" concept -- a concept which, at least in high-density terminal areas, may be on its way to becoming outmoded, unsafe, and incompatible with saturated operating environments.

Subsequent to the hearing, a review of the 1969 midair collision accidents indicated that there were 28 collisions involving 56 aircraft, a 26-percent decrease from the 1968 figure of 38. In every 1969 midair collision accident, a general aviation aircraft was involved. As in the two previous years, three cases involved an air carrier aircraft with a general aviation aircraft. In one case, a military aircraft was involved with a general aviation aircraft. In the remaining 24 accidents, the collisions were between two general aviation aircraft.

Twelve of the 28 midair collision accidents were fatal. The resulting 120 fatalities include 82 air carrier occupants and 38 general aviation occupants. Twenty-three of the 56 aircraft involved were destroyed, 23 were damaged substantially.

The 1968 report contains a number of recommendations to the aviation community which would be equally appropriate after reviewing the 1969 collision accidents. The main thrust of these recommendations is to increase the awareness of the pilot of the midair collision threat and for him to prepare himself to reduce the potential of his involvement in a collision situation. The pilots should renew their emphasis on well-disciplined, good, and precise flying techniques and habits, and should compensate for the inherent design restrictions to vision on the aircraft being flown.

On July 23, 1969, the Board sent to the Administrator of the Federal Aviation Administration a letter containing a fourteen-part recommendation which resulted from, and were contained in, the study. A copy of the Board's letter and the Administrator's reply are contained in Appendix 2.

We do not intend to discuss each of the fourteen recommendations herein, but will enumerate our thoughts on this exchange of correspondence.

In general, the FAA agrees with and will take action on most of the proposals forwarded in our letter. In many instances, they propose issuing the information in the form of an Advisory Circular. The Board, of course,

agrees that such action might be helpful, but questions the effectiveness of using this method to disseminate information to the rank-and-file pilot. The man who needs the education and has to be alerted to the problem of the midair collision potential will probably never see the Advisory Circular. We believe that a better method of information dissemination could be utilized. It was noted that the FAA was developing a film for the purpose of educating pilots, but this is a slow process and a one-shot type of approach. The Board believes that any educational program must be a continual one with constant reminder to drive the lesson home.

The recommendations concerning improved traffic flow, climb and descent corridors, standard traffic patterns, information on traffic flow at high-density airports, increased conspicuity, strobe lighting, collision avoidance systems, and pilot training for scanning have all been previously discussed in detail in this report.

PRIMARY RADAR TARGET ENHANCEMENT

The Safety Board, over the past few years, has been concerned over reports of air traffic controllers' inability to detect small aircraft by means of radar. Three recent accidents have brought the problem into sharp focus. Each involved a collision between a high-performance transport category aircraft and a small general aviation aircraft operating in Air Traffic Control radar-equipped terminal areas.

In two accidents, there was no radar detection of the small aircraft, while in the other, the aircraft was detected and subsequently lost. In each case, the general aviation aircraft presented a marginal radar cross-sectional target to the antenna. Aircraft exhibiting less than 2 square meters of cross-section will, many times, not present a usable radar target. In addition to the problem of a small radar cross-section, detection of these aircraft was further complicated by their being operated tangential to the radar.

A radar set, equipped with a moving target indicator (MTI) circuit, eliminates return from nonmoving targets, thereby eliminating ground clutter from the radarscope. When the controller is using the MTI provision, the target return will be eliminated when the aircraft flies in a path perpendicular to the radar signal, since it, in effect, remains the same distance from the antenna during successive radar pulses. Because of this lack of change in distance, the target is represented as a stationary one and, thereby, its return is eliminated from the radarscope.

Since suitable passive radar reflectors are available to increase the small aircraft's radar cross-section and since reflectors can be designed to eliminate the tangetial effect, the Board, on January 30, 1970, recommended that Parts 21 and 23 of the Federal Aviation Regulations be amended to require all small aircraft (12,500 pounds or under) to possess a radar cross-section suitable for primary target detection by FAA radar at ranges up to 125 to 150 miles. The cross-section augmentation was recommended by use of passive reflectors. Additionally, it was recommended that the regulations require

a minimum level of radar cross-section for presently certificated aircraft before permitting them to operate in certain expanded radar service environments, such as the high-density areas indicated in the FAA's recent rulemaking proposals.

In response to the Board's recommendations, the FAA, on February 11, 1970, indicated that it was working with industry to develop methods and devices to enhance radar detection of light aircraft. The Safety Board, on April 28, was briefed by six companies which presented their concepts and methodologies of augmenting the radar response of small aircraft. Many pointed out that flight tests have been conducted with satisfactory results. From these discussions, the Board is convinced that, within the present state of the art, passive means of radar reflective enhancement are available. However, the FAA in their letter dated August 13, 1970, expressed the view that no practical passive device is available to fulfill the goals sought by the Safety Board. Copies of the correspondence on this subject are included in Appendix 2.

Although the FAA indicated that it will expedite its research and development efforts in this matter, the Safety Board believes that effective devices are available and renews its recommendations of January 30 for amendment of Parts 21 and 23 of the Federal Aviation Regulations. The regulations should include requirements for suitable radar cross-sections on small aircraft and require a minimum radar cross-sectional area on presently certificated aircraft before operating in certain expanded radar service environments and high-density terminal areas.

III. CONCLUSIONS AND FINDINGS

Following a detailed review of the testimony presented at the hearing, as well as the data submitted by various organizations and individuals, the Safety Board has concluded that no one solution is available to the aviation community which will result in the elimination of all midair collisions. Even though there is not a single solution, the Board believes much can be done today to reduce or eliminate the collision potential.

It is the Board's opinion that this potential can be substantially reduced by:

1. Pilot education and awareness of the collision potential.

2. The development and implementation of the collision avoidance systems for transport category aircraft.

3. A pilot warning indicator for all aircraft or a device for small aircraft compatible with the collision avoidance system.

4. The development of standard traffic patterns for all airports.

5. The establishment of standards for operation into high-density areas.

6. The separation of high- and low-performance aircraft within terminal areas.

7. The development of pilot scanning techniques for implementation into pilot training programs.

8. The implementation of an area navigation system throughout the U. S. National airspace system.

9. The implementation of a program to increase the conspicuity of aircraft.

10. The expansion of the automation program for the ATC system.

IV. RECOMMENDATIONS

As a result of its deliberations, the Safety Board recommends that the Federal Aviation Administration: 3/

1. Evaluate the pilot qualifications and minimum airborne equipment necessary for safe operations into high-density terminal areas with a view toward increasing the minimum standards for each. (See page 3)

2. Accelerate the program to provide separation between high- and low-performance aircraft in high-density terminal areas. (See page 3)

3. Encourage the expeditious development of a collision avoidance system for installation in air carrier aircraft and larger general aviation aircraft. (See page 5)

4. Make funds available for the ground equipment which may be necessary for support of CAS systems. (See page 5)

5. Sponsor developmental contracts for pilot warning indicator (PWI) systems utilizing various technological methods in order to evaluate the practicability of each. (See page 6)

6. Develop regulations to require the installation of CAS and PWI systems when they become available from the activities of 3 and 5 supra. (See page 6)

7. Consider convening a special Government/Industry meeting for the purpose of discussing the factors involved in establishing standard traffic patterns and initiating action leading to their creation. (See page 8)

3/ For the convenience of the reader, page numbers referring to the Board's views on the subject follow each recommendation.

8. Amend the pilot training requirements in the Federal Aviation Regulations to require the addition of scanning techniques to the training syllabus. (See page 8)

9. Require suitable training aids be used to augment the syllabus when such aids are developed. (See page 8)

10. Promulgate regulations to require the installation of white anticollision lights on all aircraft as soon as possible (see ANPRM 70-7). (See page 11)

11. Accelerate its efforts in developing certification, procedural, and rulemaking processes involved in implementing a full area navigation (RNAV) system for utilization throughout the U. S. National airspace system. (See page 12)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

November 12, 1970

APPENDIX 1

SUMMATION OF WRITTEN AND ORAL TESTIMONY CONTAINED IN THE RECORD OF THE NATIONAL TRANSPORTATION SAFETY BOARD'S HEARING INTO THE PROBLEM OF MIDAIR COLLISION ACCIDENTS

NOVEMBER 4 THROUGH 10, 1969

APPENDIX 1

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I. INTRODUCTION

During the hearing into the midair collision problem, 28 witnesses representing aviation organizations, governmental agencies, and individuals testified before the Safety Board. Many of these witnesses also submitted written statements and documentation. Additionally, 12 letters were received containing views on the collision problem.

There were over 1,000 pages of testimony taken and, during the five-day hearing, hundreds of pages of written statements and letters were received by the Board. These were all placed into the public record and are available in the Safety Board's Washington Office for perusal by interested parties. Copies of the testimony taken at the Board's hearing may be purchased from the Hoover Reporting Company, Inc., 320 Massachusetts Avenue, N. E., Washington, D. C. 20002. Exhibits entered in evidence at the hearing will be reproduced commercially upon request to the Board and at your expense; copies so prepared would be mailed and billed direct to you from the local business firm holding the current contract for commercial reproduction of the Board's public records.

Study of the docket by those who are in a position to contribute to the elimination of the midair collision problem is highly recommended. The docket contains many suggestions and recommendations by responsible individuals and associations which would improve the overall safety in aviation. The Board has not addressed itself to each of these suggestions and recommendations in its report. It will, however, take these into consideration in its future safety activities.

The first witness to appear at the hearing was the Honorable John A. Volpe, Secretary, Department of Transportation. Secretary Volpe's remarks are hereinafter quoted:

> I simply welcome this opportunity to come here this morning to join the National Transportation Safety Board in taking a close, probing look at a matter that is of great concern to everyone who travels. The Office of the Secretary of Transportation will watch the proceedings here with keen interest and will be most cooperative in assisting in any way that we can.
>
> The prevention of midair collisions is -- to a very real extent -- the full-time job of some 19,000 skilled employees in our Federal Aviation Administration's air traffic control service. It is also a major preoccupation of our research and development specialists. The matter of maintaining separation in the airspace -- and, after all, the "maintenance of separation" is the same as saying the "prevention of collision" -- is also a primary concern to our FAA flight inspection pilots. It is also a major purpose behind the establishment of some 4,000 navigational aid facilities and the people who operate them.

In the broadest sense, all Federal Aviation Administration personnel contribute in one way or another to the massive efforts of preventing collisions between aircraft. Yet, at the same time, there is nobody in the entire Department who can in any way claim to have all the answers to the problem.

The matter is of such seriousness that we welcome any positive contribution from any source -- any suggestion that will give us any additional measure of safety in the air. And we compliment the Board on the hearing they are holding at this time.

Mr. Jack Shaffer, our Federal Aviation Administrator, will testify later in this hearing and report to you on his continuing efforts to lessen this hazard. I know, personally, of his constant and deep concern about this problem. It is never far from his mind or mine either. And I should like to emphasize that his approach and the approach of all his people is not confined only to actual maintenance of separation through air traffic control operations. They are trying from every angle -- better training of pilots, improved weather reporting and on through hundreds of other efforts. And all this work is lessening the possibility of midair collisions. We are succeeding.

None of us can stand still, however. We shall soon be seeing the advent of the high capacity jet air carriers -- airplanes capable of carrying as many as 500 passengers at once. The air carrier fleet itself is expanding and the general aviation fleet is expanding even more rapidly. Within this general aviation fleet, it must be pointed out, are appearing growing numbers of high performance jet aircraft. There is on top of this an increasing average daily utilization of many of these aircraft. This increase of activity, finally, tends to occur in a limited number of busy areas.

At the same time -- and this, I think -- is the key to the problem -- the number of facilities and personnel supporting these operations have not kept pace. There is, today, not enough of just about everything.

There are two major approaches to this dilemma. One is to restrict or limit operations. And we are doing this. We have installed a quota system at our five busiest terminals and this has been effective.

But this approach satisfies nobody. It is a stop-gap solution at best.

The only proper approach to this problem is to expand our airport capacity and our air traffic and navigation system. And this is what we are seeking in the proposed "Aviation Facilities

Expansion Act of 1969." This measure, if passed, will give us the personnel and the tools to control air traffic efficiently and safely. No other single proposal or recommendation will do as much to minimize the hazard of midair collisions as the passage of this legislation.

This is our major effort. With the adoption of this measure, we can move and expand and improve our air traffic control system. We can bring in more people; we can add much-needed automated equipment; we can help with the construction of 900 new airports and the expansion of over 2,700 existing airports. All of these will mean a very significant lessening of the danger of midair collisions. There is no other action that will do as much.

As I noted earlier, however, we are not standing still. We are seeking improvement. We are interested in any measure that promises even the slightest increment of safety.

I and my staff will, then, be following the testimony at this hearing with close attention. I assure you, moreover, I, personally, shall study the recommendations that emerge.

Of all the challenges that became mine with the acceptance of my office, none has concerned me more than this task of minimizing the hazard of aircraft collision in flight.

In closing, Mr. Chairman and members of the Board, let me assure you of my complete support and cooperation with your hearing.

We will do everything we can to help in any way we can.

And we thank you this morning for this opportunity to place these comments in the record.

During the hearing, the Board was honored to have the Honorable Vance Hartke, United States Senator from the State of Indiana, testify. Senator Hartke's statement is hereinafter quoted:

Thank you, Governor Reed, members of the Board.

First, let me congratulate the Board upon holding these hearings and upon the fine work you are doing in this field and upon the work you anticipate doing in the field of automobile safety.

In this age when air transportation is not merely a pastime for daredevils, but the mode of travel for millions of Americans, the

question of air safety cannot be considered lightly. Responsibility for the protection of lives of people who use the airlines of the United States cannot be evaded.

The terrible collision in September near Indianapolis should outrage the conscience of many Americans, because lives were lost senselessly and unnecessarily. This disaster was not the act of a higher force, but the result of human error and human negligence. The evidence that has been gathered about that accident allows but one chilling conclusion, that it need not have happened.

There is nothing that we can do for the victims of the vicious apathy that led to that crash, for they have died in vain. But at long last, let us finally resolve that the Federal Aviation Administration and the aviation industry will adopt the appropriate measures that will prevent another such accident from occurring.

Certainly the Indianapolis crash is not the first time that we were made aware of the fact that the safety procedures of air transportation are inadequate to the realities of modern passenger aviation. There was recognition that drastic new procedures were in order after the disaster over the Grand Canyon in 1956, after the collision over New York in 1960, after the various sorts of unnecessary accidents that have caused the deaths of thousands during this decade.

The issue of air safety has not suffered from want of study. We are all familiar with the plethora of plans, ideas and proposals that have been developed over the years. But the fatal factor in this issue has been the lack of decisive action. The question that has to be answered is no longer what can be done, but when will it be done.

As the Supreme Court indicated last week, "all deliberate speed" is not fast enough for the American people.

Action with all deliberate speed is not fast enough when the air traffic over our airports is so great that each flight is a tragedy waiting to happen. And "all deliberate speed" is not fast enough when the nation is about to see the introduction of the giant 747 into the congested air lanes of the United States.

If we do not take action immediately, the innocent public can be certain that the horrifying story of Indianapolis will be replayed again and again -- perhaps over Chicago, perhaps over Boston, perhaps over Miami, perhaps over Washington -- perhaps, and possibly, over any city in the United States. And as we delay, our negligence assumes the proportion of gross criminality.

Today I propose that the goal that we should set for ourselves is nothing less than 100 percent air traffic safety. That means no accidents and no fatalities. And the deadline that I set for the attainment of that goal is: As soon as it is physically possible to accomplish.

We have the ability to act and we have means to enforce our laws. What is lacking is only the desire to enact them.

II. SUMMATION OF WITNESS STATEMENTS

Following is a summation of the written and oral testimony of all of the witnesses who testified during the hearing with the exception of Secretary Volpe and Senator Hartke, whose verbatim testimony was included in the previous section:

FEDERAL AVIATION ADMINISTRATION

Mr. John H. Shaffer, Administrator, represented the Federal Aviation Administration. He was accompanied by Mr. Cliff W. Walker, Deputy Associate Administrator for Operations; Mr. William M. Flener, Director, Air Traffic Service; and Mr. James F. Rudolph, Director, Flight Standards Service. Mr. Shaffer stated that the midair collision hazard in the U. S. airspace is a matter of deep concern to the FAA. One of the principal missions of the FAA, he said, is the prevention of collisions between aircraft and the protection of persons and property on the ground.

Faced with this mission, the FAA treats the midair collision hazard very seriously. Unfortunately, the potential exposure of aircraft to collision hazard can grow faster than the growth of aviation. FAA realizes that, in the absence of actions to reduce the collision hazard, the risk will increase geometrically as more flights are added to the Nation's airspace.

To put the collision hazard in its proper perspective, Mr. Shaffer stated that last year U. S. certificated route and supplemental carriers flew 2.3 billion miles and were involved in two midair collisions involving fatalities. Considering all flights of all categories, the National Airspace System last year accommodated some 130 million flights. There were 38 midair collisions. He pointed out that the Air Traffic Control system handled some 60 million flights without a single midair collision between two controlled flights, attesting to the ATC effectiveness.

He reviewed the midair collision studies and near midair collision studies of the past, noting that there are no basic conflicts between the recommendations of the FAA study and those contained in the NTSB midair collision report of 1968. The essence of all but five of the NTSB's 14 recommendations can be found in the 20 recommendations of the FAA study.

In the FAA formal paper, some 29 activities of the Administration were listed which had been accomplished to reduce the midair collision hazard. Mr. Shaffer reviewed some of these actions:

(1) Secondary Radar Beacon Systems -- 1959-69

All 89 en route air traffic control radar systems have secondary radar beacon capability. All but 6 of 118 terminal radar systems have this capability. Utility of this equipment is dependent upon installation of radar beacon transponders in aircraft.

(2) Area Positive Control (APC) -- 1959

To overcome the limitations of see-and-avoid with high-speed aircraft, Positive Air Traffic Control was established on a trial basis between altitudes of 17,000 and 22,000 feet on three airways linking New York and Washington with Los Angeles and San Francisco and two airways between Washington and Chicago. The experiment proved effective and the system was expanded to cover almost the entire 48 contiguous states by 1965. Except for rare instances of equipment malfunction, pilot error, or air traffic control system errors, near midair collisions have been almost eliminated in APC airspace.

(3) Developed and Installed Alphanumerics in Air Traffic System -- 1964-69

In the currently manually operated system, controllers are required to retain correct identity of the moving aircraft target on their radar displays. They must tag this aircraft target with a marker containing the aircraft's identification and altitude and move the marker to correspond to flight progress strips alongside the radar display. The automated alphanumerics systems perform these tedious chores automatically, faster, and more accurately.

(4) Congestion Rule -- 1968

This rule designated five high-density traffic airports and set limits on the number of hourly operations (takeoffs and landings) which would be permitted. Airports involved were John F. Kennedy, LaGuardia, Newark, O'Hare, and Washington National. This rule expired December 1969. FAA currently is evaluating effectiveness of the rule. A byproduct of the rule was a reduction of the number of "unknown" aircraft operating at these five terminal areas.

(5) Area Navigation Advisory Circular -- 1969

The Advisory Circular provides the aviation community with the standards for approval of the airborne equipment, accuracy requirements,

protected airspace criteria, traffic control procedures, and flightcrew training requirements for area navigation. Eight ways in which area navigation could reduce the midair collision hazard were enumerated.

In regard to FAA's present activities to prevent midair collisions, Mr. Shaffer stated that they are now concentrating on the operation of the Air Traffic Control System. The present ATC system is an elaborate and good midair collision prevention device. In instrument flight conditions, the system shoulders the burden of preventing midair collisions. He thought that, in visual flight situations, the human eye is still by far the best collision prevention device known and is why the see-and-avoid concept of separation is still with us. Efforts are being made through training and education to improve scanning techniques and visual detection of target aircraft.

Of great concern to the FAA is the automation effort to relieve controllers of present bookkeeping and clerical functions and to provide them with more and better data on flight progress. This makes it possible for the controller to devote most of his time to the pure control aspects of his job. Eventually, automation will provide controllers and pilots with warnings of potential traffic conflicts and with suggested alternatives for resolving such conflicts.

In FAA's formal paper, some 18 activities were listed which are now being conducted by the Administration to reduce the midair collision problem. A few of these were discussed by Mr. Shaffer:

(1) Automation of Air Traffic Control Facilities -- 1961-69

Automation will give the controller the assistance he needs to cope with future growth in air traffic by increasing the capability and efficiency of the system and by relieving the controller of many routine, repetitive tasks better performed by machine. Twenty domestic FAA Air Route Traffic Control Centers will be semiautomated in two separate phases. During the first phase, computers and computer update equipment designed to provide the centers with an automated flight data processing capability will be installed. The second phase will bring automatic radar tracking into the system. The schedule calls for a full-stage A en route operational environment for all 20 centers during 1974. Sixty-two of the highest activity terminals will be semiautomated to some degree by 1972.

(2) Collision Avoidance System

Three mainstreams of development are under way:

(a) The determination of the unaided visual capabilities of the pilot which will lead to recommendations for standardization of aircraft exterior marking and lighting.

(b) Simple pilot warning instruments (PWI).

(c) Collision avoidance system (CAS) which is directed toward establishing performance criteria, system characteristics, and implementing plans to meet the needs of civil/military users.

(3) Terminal Control Areas

A new plan for the control of traffic in the 22 large hub terminal areas was recently published in a Notice of Proposed Rule Making. It designates positive control airspace around busy terminal areas in which all air traffic activity is controlled. Minimum standards for flight in these terminal control areas are also proposed.

(4) Recruiting and Training More Controllers

In addition to the increase of 1,372 positions in 1968, FAA was authorized 1,375 positions for air route traffic control centers and 645 for terminal facilities in 1969. The current request for 1970 is for 2,800 positions; 1,467 for centers and 1,333 for terminals. The Administration is now engaged in a recruiting program and comprehensive training curriculum at Oklahoma City.

The formal FAA paper contains a brief discussion of the following 17 future plans of action:

(1) New guidance to general aviation inspectors.
(2) Sophistication of area navigation equipment.
(3) Improve conspicuity of airports and landing direction indicators.
(4) Improve clear view between runways and along runways.
(5) Develop reliever-type general aviation airports to reduce congestion at larger airports.
(6) Electronic collision avoidance system (CAS).
(7) Pilot warning instrument (PWI).
(8) Increased airport/airways capacity program.
(9) Cockpit design/visibility.
(10) Lower APC in high-density areas.
(11) Movie on midair collision problem.
(12) Increased use of simulators for training and transfer of flight training away from terminal areas, etc.
(13) Collision avoidance training.
(14) Aircraft conspicuity by smoke discharge.
(15) Revise private pilot exam.
(16) Improvement of static pressure systems.
(17) Film on pilot vision.

With respect to resources, Mr. Shaffer stated that we have come to the present state of affairs in aviation because we did not prepare ourselves for the demands now being placed on the system. We do not have enough resources -- trained controllers, enough control equipment, the right cockpit equipment, enough airports or runways, etc.

There are two basic reasons for our being in this situation. First, aviation has grown far beyond anyone's forecasts. Secondly, the fact that we simply have not been provided the resources to cope with increasing demand to reduce further the midair collision hazard.

The following is a list of FAA's recommendations as to what others could do to alleviate the midair collision situation:

(1) Voluntary use of remote airports.
(2) Carry out recommendations of NTSB Midair Collision and FAA Near Midair Collision reports.
(3) Development of collision avoidance training devices.
(4) Pilot responsibility for the safety of the flight by providing separation in VFR conditions.

Mr. Shaffer indicated that the single biggest assist others can give themselves, as well as FAA, is to get behind the Aviation Facilities Expansion Act of 1969. Today's aviation problems are more fiscal than technical. New airport/airways legislation, along the lines of the Expansion Act, is required to relieve the midair collision hazard.

There was considerable discussion of the FAA views concerning their terminal area control (TAC) concept and the corridor concept. The FAA indicated that the proposed TAC published so far did not include the corridor concept, but that future rulemaking would combine both concepts. They plan to first complete the TAC for the 22 major hub airports and similar types of control areas for the additional 97 airports with radar. Following these determinations, the remaining air carrier airports in the system will be subject to a true simple corridor concept.

In discussing the CAS and PWI systems, the FAA indicated that by 1972 the ground station specifications will be completed. The FAA is working very closely with the industry in this area so that these specifications can be drawn up simultaneously with the airborne equipment. The Administration's goal is to have the best collision avoidance system or warning indicator developed at a price which would permit its installation on all aircraft, including general aviation aircraft. The spokesmen indicated that, in 1970, the state of the art would permit the FAA to make a firm recommendation of a pilot warning indicator system. They were looking into the strobe light infrared system for PWI.

The FAA agreed that standard patterns at all airports was an excellent idea. They noted, however, that the number of airports around a city creates a problem, particularly in the utilization of airspace; so FAA allowed the airport operators to have as much freedom as possible in establishing their own traffic patterns.

AIR TRANSPORT ASSOCIATION

General Clifton E. Von Kann, Vice President, Operations and Engineering, represented the Air Transport Association. General Von Kann was accompanied by Mr. Frank White, Manager of Communications and Data Processing, and Mr. Andrew E. Pitas, Manager, Terminal Air Traffic Control.

General Von Kann indicated that, over the past 31 years, there had been just 12 midair collisions involving U. S. air carrier aircraft in which fatal injuries had been sustained by passengers. Of these, only four had occurred in the last 10 years. In view of the large number of daily airline flights, over 14,000 each day, the collision problem, in the ATA's opinion, represented a relatively low risk; however, the airlines continue to stress the urgency of solving the midair collision problem.

Three fundamental points evolved from early ATA studies of the near miss problem: (1) see-and-avoid alone does not offer the degree of protection which the airline passenger deserves; (2) for ATC to provide separation between air carrier aircraft and others, the position of the others must be known; and (3) the ATC system should be backed up by an independent noninterfering collision avoidance system.

General Von Kann discussed a number of recommendations for reducing the airlines' exposure to midair collisions. The ATA believes that there is no single solution which would eliminate this type of accident. They thought that the collision potential could be reduced by implementing all of their recommendations. They believe that positive control should be expanded by lowering the present floor from 24,000 feet to 18,000 feet over the 48 contiguous States and by further lowering the floor to 10,000 feet in the area bounded by Washington, New York, and Chicago, as well as the area between Los Angeles and San Francisco. Additionally, positive control should be extended to the ground in higher density terminal areas.

The airlines consider that it is not necessary for all aircraft to be flown under Instrument Flight Rules (IFR) in positive control areas if separation between aircraft can be accomplished by other means. For example, the expanded radar coverage in the Atlanta area has provided additional protection. The ATA believes that controlled airspace should be designated in those portions of the airspace where the airline aircraft must operate. The present uncontrolled airports into which air carriers operate should have designated control zones. ATA believes that control towers should be in operation at all air carrier airports.

The air carriers recommended that the cloud proximity rules and flight visibility rules be reviewed and increased in recognition of the increased performance of modern aircraft. The ATA specifically recommended that a 5-mile visibility be available for Visual Flight Rules (VFR) operations, but had no quantitative value for the recommended change in the cloud proximity rules.

The ATA considers that the FAA's Notice of Proposed Rule Making regarding terminal control areas has considerable merit. They believe that sufficient airspace should be available to permit radar vectoring for proper spacing for landing. Corridors from these areas for both letdown and climbout to controlled high altitude airspace would be beneficial. They considered that, at certain airports, VFR corridors might be better than IFR corridors. In any case, they believed that each airport should be considered individually to determine the best method of partitioning the airspace. They recommended that, in areas of high traffic density, commonly used IFR routes should be published and charts made available to all pilots operating within the area.

The ATA concurred in the suggestion contained in the FAA Near Midair Collision Report that the use of area navigation would relieve the congestion of traffic over VOR stations. To reduce the exposure to midair collisions, the ATA recommended that the FAA have an adequate number of properly trained controllers, that maximum use of automation be expedited, that more control towers be provided, and that more towers be equipped with radar.

Additionally, the ATA recommended that more towers and centers be equipped with radar beacon alphanumeric systems; video recording equipment for ATC radar be installed, altitude encoded transponders be installed on aircraft after a certain date by all users of certain airspace, more stringent pilot qualifications and training for those using major terminal areas, and flight and communication equipment be required for aircraft using such terminal areas.

General Von Kann briefly reviewed the status of the collision avoidance system development over the past 14 years. The system uses time-frequency technology in its application. The system being developed and, at the time of the hearing, being flight tested, is a cooperative one, i.e., both aircraft must be similarly equipped to provide the desired protection from collision potential. The manufacturers of the presently developed equipment are endeavoring to produce the CAS at a cost of $8,500 per installation. This, ATA admits, is too high for most general aviation aircraft, but hopes that a much less expensive, compatible system can be developed for that segment of the industry.

The ATA did not think that all general aviation aircraft should be equipped with transponders, but a great deal of thought should be given to requiring them on such aircraft operating in congested airspace. They expressed the hope that the air traffic control system would someday be completely automated to alleviate the traffic saturation which can occur when operating the system manually.

In addition to the foregoing recommendations, the ATA entered a statement on the two- vs. three-man flightcrew complement. During the hearing, no other organization commented on this problem; however, the Air Line Pilots Association, following the hearing, submitted their thoughts on this question. Since these statements are in the Board's public files, and since the question is as large as the midair collision problem alone, no attempt will be made in this report to evaluate the flightcrew complement question.

NATIONAL AIR TRANSPORTATION CONFERENCE

The National Air Transportation Conference (NATC) was represented by Mr. Joseph M. Fugere, Chairman of their Safety Committee, and Mr. Martin Macy, a member of that committee.

Mr. Fugere explained that, due to NATC's small size and funds limitations, the primary thrust of their organization in the field of collision prevention is crew training. Their Safety Committee has undertaken an information exchange program on crew training and operational problems, as well as a safety inspection program.

NATC, just prior to the Board's hearing held a 2-day seminar attended by the chief pilots of commuter airlines. During the seminar, these pilots discussed prime causes of midair collisions and positive steps that might be taken to improve the situation. From these discussions, Mr. Fugere made the point that the younger pilots were relying too much on radar for traffic separation; that too much paperwork was completed in the cockpit, although steps were being taken by some operators to eliminate paperwork in terminal areas; and that segregation of traffic by performance, separate control facilities at airports, and clean windshields would all reduce the midair collision problem.

In discussing FAA's Notice of Proposed Rule Making 69-41, "Terminal Control Areas," Mr. Fugere indicated that the proposed system would work a considerable hardship on the general aviation fleet and would do little to reduce the chance of midair collisions in high density areas. NATC thought that the defined control area would be difficult for the general aviation pilot to recognize and that in circumnavigating the area, the pilot could be in the control area without knowing it. NATC recommended that traffic be separated based on aircraft performance. Segregation of the traffic could best be accomplished by designating corridors for descent and climbout. They thought that separate facilities, runway and traffic patterns should be designated for high- and low-performance aircraft.

Increased radar coverage is not the answer to the midair collision problem according to NATC. In fact, they expressed the view that the air traffic control system is being used to provide separation of IFR traffic from VFR traffic, a purpose for which it was not designed. They thought that consideration should be given to requiring all traffic to be flown under visual flight rules under certain altitudes when the visibility is good.

NATC believes that there is a definite need for a well promoted educational program in all high-density areas to inform pilots on a continuing basis where the heavy traffic patterns are located. Mr. Fugere suggested that a three-dimensional trainer could be developed to apprise pilots of traffic flows and from where other aircraft are likely to come. The trainers could be taken around to airports and flight schools in the high-density areas.

Mr. Macy expressed the view that inexperienced pilots should be kept out of high-density areas. He did not think that pilots need an ATR or 10,000 hours experience, but he would not object if they were required to be instrument rated.

Mr. Fugere endorsed the proposal for standardization of traffic patterns. He also proposed the installation of a compass rose around the altimeter, then flying with the large hand of the altimeter on the aircraft's heading, thereby giving altitude separation to traffic.

NATIONAL AVIATION TRADES ASSOCIATION

The National Aviation Trades Association (NATA) was represented by its president, Mr. Frank Kingston Smith. Mr. Smith gave the Association's understanding of the facts, conditions, and circumstances concerning the September 1969 midair collision involving a DC-9 and a Piper Cherokee near Indianapolis. He decried the mass communications media for acting as judge, jury, and executioner in placing the blame on the operator of the light aircraft and also deplored emotional statements of certain Congressmen relative to the dangers of midair collisions and the initiation of legislation designed to drive "private airplanes" out of the skies. He stated that "no high-speed airline jet should ever be allowed to 'wander around' anywhere at low altitudes." He indicated that his definition for that "wandering around" means "not under radar control." He said that even in uncomplicated airplanes under instrument conditions, it is possible that the pilot would not look out the window for long periods of time. NATA complained about mass communications media feeding misleading information to the public and arousing them against general aviation -- blaming it for every collision -- thus making it easy to obtain repressive legislation. Mr. Smith also accused FAA of encouraging the airlines and treating general aviation as a "marginal nuisance that is to be phased out and allowed into the big cities only under the most stringent regulations -- all in the name of safety."

Mr. Smith indicated that it is a false view to contend that the 532 airports served by the certificated carriers are "crowded and congested" and that large numbers ("thousands") of air carrier jets are operating while the general aviation segment is an untrained, unequipped and unregulated group. He cited statistical data on numbers of airports and numbers of aircraft (airline fleet and general aviation aircraft), stating that officially released figures can be used to distort the truth.

NATA criticized FAA's Near Midair Collision Study as being unscientific, for using fictional figures and objectionable, misleading terms such as: "positive control" and "control," "IFR Aircraft and VFR Aircraft," and "IFR/VFR Mix." NATA believes that operating aircraft of extremely disparate performance in the same airspace is hazardous and that air traffic at major terminals should be segregated by performance. NATA, therefore, recommends the establishment of approach/departure corridors. They believe that radar is not the answer under Visual Meteorological Conditions (VMC), nor is it the complete answer under Instrument Meteorological Conditions (IMC) and that transponders are of great assistance to ATC, but are not a total solution to the problem. They considered that under VMC the vast majority of general aviation could operate without burdening the ATC system. For advocates of "positive-control-is-the-only-answer," NATA stated that the Near Midair Collision Study shows 56 cases of near midair collisions when both aircraft were IFR and were technically under "positive control."

NATA pointed out that "general aviation" is not really descriptive of anything and states that many aircraft of the "general aviation fleet" are the same type used by the certificated carriers and that the carriers also operate light aircraft for various purposes.

NATA believes that neither the Near Midair Collision Study nor the NTSB 1968 Collision Report bears out the press, public, and Congressional conclusions that "the air is crowded" and that "little airplanes have been running into big airplanes."

NATA provided its analysis of the NTSB report on the 38 midair collisions in 1968, including the fact that 124,928 general aviation aircraft were not involved in collisions, and objecting to news media's focusing on the 38 accidents (an increase of 46 percent over 1967) instead of the few collisions which occurred compared to the overall fleet. They also pointed out that none of the 38 collisions occurred over large cities such as New York, Chicago, Boston, etc., and that only one involved private pilots or pleasure flights.

NATA concluded that "any midair is serious to the people involved, but the midair collision hazard is not an unreasonable risk of high incidence nor commonplace."

NATA recommends that:

1. FAA institute promptly a program of approach/departure corridors so that large and small aircraft can be kept apart without the requirement for constant voice communications via already crowded radio circuits. None of these corridors need be utilized under actual instrument meteorological conditions, since everyone is under the ATC System.

2. The term "positive control" be eliminated and the term "positive separation" be substituted therefor. The charting of approach/departure corridors would enable light aircraft pilots to avoid the paths of large jets, which is desired by all pilots. Under VMC, it would create a condition of "positive separation" without loading the already saturated radio communications frequencies. Under actual IMC, the entire operation would be under radar/voice Instrument Flight Rules as a matter of existing law and regulation.

3. There be a central information source within the NTSB to supply facts to the press -- which wants to know what happened and why. They are entitled to know, and absent such a source of official information -- however fragmentary -- the press can have a field day on hunches, guesses, and opinions.

NATIONAL BUSINESS AIRCRAFT ASSOCIATION

The National Business Aircraft Association (NBAA) was represented by the Assistant Director, Technical and Safety, Mr. Frederick M. McIntosh, and the Assistant Senior Director, Operations, Mr. John P. Woods.

Mr. McIntosh stated that the NBAA membership is comprised of 800 companies utilizing approximately 2,300 aircraft, of which 382 are turboprop aircraft and 427 turbojet aircraft.

The NBAA actively participates in such safety projects as the Collision Prevention Advisory Group (COPAG), the Flight Information Advisory Committee (FIAC), local and regional Air Traffic Control Advisory Committees, and provides expertise in certain accident investigations in the operational and maintenance areas.

The NBAA believes that the midair collision problems should be divided in two, namely: aircraft proximity and separation methods in the utilization of the airspace.

As far as aircraft proximity is concerned, the NBAA considers that although CAS, PWI, ground radar, corridors, positive control, and use of strobe lighting are all useful methods, no single system or technique can

provide the answer. The ultimate action to avert collision must be made by the pilots of the aircraft involved, requiring either visual sighting or advisories from ground controllers based on radar detection. Since all recent collisions involving commercial carriers have occurred when they were under direct control of the ground environment and under reasonable visibility conditions, it is the contention of the NBAA that enhancement of aircraft conspicuity through the use of condenser discharge lighting should be made mandatory immediately. This type of lighting should have a minimum infrared (IR) content so that a Proximity Warning Indicator based on IR sensing could be developed in the near future.

The NBAA is concerned about the possibility that the developing collision avoidance system will be made a prerequisite to flight in certain already restricted airspace. Because of the high cost of this system, less than 3 percent of the total aircraft flying today would be so equipped. They questioned the priority assigned this system when only 3 percent of the Nation's air fleet will be able to afford it. NBAA acknowledges that the FAA has a contract for a compatible system, and urges a high priority Government supported development of a PWI system utilizing NASA's Doppler system or optical radar techniques.

Concerning the problem of separation methods in the airspace, the NBAA believes that a system operating beyond its capacity is inherently less safe than a system operating within its capacity. They stated that recent proposals, placing greatly increased portions of total air traffic under positive control, are not in the interest of safety since the volume of existing traffic, the mix of controlled and uncontrolled aircraft, and the imprecision of radar data displays are already severe limitations to the system. The NBAA believes that the solutions to the midair collision problem could be categorized as long-term, high-cost, medium-term, medium-cost, and short-term, low-cost options.

They consider the long-term, high-cost option included automation of ATC data display, some of the controller's functions, and voice communications. They urged decisive leadership in this area to reduce the required lead time. They considered the medium-term, medium-cost option to be an improved display of navigational data, such as an area navigation system (RNAV) capability. The NBAA urged the FAA to recognize the benefits to be derived from giving the pilot the capability of choice in en route navigation. This would relieve the ATC system from individual aircraft control in order to put more emphasis on the monitoring of traffic flow. The short-term, low-cost option proposes to segregate air traffic by aircraft performance characteristics in high volume terminal areas in two separate flows of traffic, thereby reducing the probability of conflict. Additionally, high performance aircraft should be kept at a much higher altitude in the terminal area than they are at present. It was also proposed that a minimum airborne equipment list be specified for each aircraft entering these high-density terminal areas. Such lists should be

kept to the minimum to directly improve the probability of traffic conflicts. Finally, the NBAA feels that pilot proficiency is directly related to safety. To that end, the NBAA proposes that the aviation industry be given a greater role in policing its own training and other activities, and that the pilots be given a greater role in the operation of the ATC system.

Mr. McIntosh then outlined the NBAA's safety program. They publish a Standards Manual covering all aspects of corporate and business aviation, including management, training, and maintenance. All aspects are supported by technical committees made up of professional pilots and aviation managers. The NBAA stresses two pilot operations and has established safety award programs. They recommend recurrent training by outside organizations, especially in the areas of IFR operations, emergency procedures, and teamwork.

Mr. Woods stated that the NBAA hesitates to be too specific in their thinking as to what the general aviation pilot should do, but they feel that recurrent training would not be too much of a burden and might be of significant benefit.

The NBAA is of the opinion that further application of positive control should be effected only with due consideration for the capacity of the ATC system to handle more traffic. Their representatives stated that the application of the FAA-proposed terminal control area concept was not too much different than the corridor concept. Each needed a certain amount of airspace around the terminal for maneuvering the aircraft. From this airspace, fingers would extend out and up as corridors. They did not think that the general aviation pilot would have too much difficulty in keeping out of these control areas.

AIRCRAFT OWNERS AND PILOTS ASSOCIATION

The Aircraft Owners and Pilots Association (AOPA) was represented by Mr. Victor J. Kayne, Vice President, Policy and Technical Planning, accompanied by Mr. Ralph Nelson, Executive Vice President of the AOPA Air Safety Foundation and Vice President of AOPA for Safety and Training, and Mr. Roys C. Jones, Director of AOPA Air Traffic Control Department.

The major thrust of the presentation of AOPA indicates "an entirely new approach must be made to return responsibility to the cockpit and to remove the liability for prevention of collisions from the controller to a large extent."

1. In the opinion of AOPA, the only difference in an aircraft operating under Special VFR (SVFR) in controlled airspace and operating under standard VFR outside controlled airspace is that air traffic control provides standard IFR separation between the SVFR operation and all others in controlled airspace. The SVFR

operation is, therefore, safer from a collision standpoint than is a standard VFR operation outside of the controlled airspace.

Many airports plagued with recurring low visibility situations, such as Van Nuys, California, the second busiest airport in the United States, could and does make frequent use of SVFR. At such places, it is frequently possible for SVFR operations to be conducted independently and concurrently with the IFR operations.

2. Many years ago, AOPA became alarmed because of the limited range of visibility from the cockpits of many aircraft, and in 1956, petitioned the Civil Aeronautics Board to amend the Civil Air Regulations to provide specific measurable visibility standards with respect to outside vision for both transport category and small, fixed-wing airplanes.

3. The first AOPA recommendation to the FAA for establishment of corridors for high-performance aircraft was in January 1962. In the opinion of AOPA, this could be accomplished without additional expenditures for equipment either on the ground or in the air and would not require the installation of transponders. AOPA indicated that, in conjunction with the Air Line Pilots Association, it made a proposal for corridors which, in its opinion, would be safer than terminal area control as proposed by the FAA. AOPA protested the implementation of terminal control proposed in NPRM 69-41.

4. They recommended that FAA give a high priority for research to improve the conspicuity of aircraft. The use of high-visibility paint would be beneficial.

5. The AOPA has recommended to FAA that the availability of radar advisories for all aircraft be increased. At the present time, AOPA stated, the VFR traffic is usually refused radar advisory service even though the general aviation fleet now has more than 19,000 transponders on board.

6. In 1959, the AOPA recommended that short parallel runways be installed at major airports so that maximum utility could be obtained from facilities at the airports, while allowing general aviation and the heavier airline aircraft to operate in separate, nonconflicting traffic patterns.

7. For some time, AOPA has emphasized the need for the development of a simple PWI that would alert a pilot to the presence of another aircraft in his vicinity. They stated that, in many midair collisions, it has been rather obvious that one pilot was not looking for traffic and the other pilot was not in a position to see the airplane bearing down on him. The CAS being developed by the ATA will not be suitable for widespread use in general aviation.

8. For many years, the Civil Air Regulations had a provision requiring pilots to maintain a watch for other traffic. This was dropped by the FAA during a recodification of the Regulations. AOPA brought this to the attention of the FAA and it was later reinstated in the current regulations. However, the duties imposed on some pilots, notably those in scheduled airline service, by their FAA-approved Flight Manuals, leave them little time to maintain the required watch for other traffic. This is a matter that requires renewed emphasis in training and educational programs and is one that is being actively pursued in various pilot proficiency training programs.

9. One of AOPA's recommendations that the FAA has adopted concerns the speed limit below 10,000 feet. AOPA believes that renewed emphasis on adherence to speed limits is needed. Their corridor concept would impose no speed limit within the corridors, except as required for ATC spacing. Outside the corridors, the speed limit would be observed.

10. Under the FAA, the requirement for standard traffic patterns has disappeared and is gradually being replaced by individual traffic rules for various airports around the country. AOPA believes that, for a general aviation pilot who operates on cross-country flights into many different areas nonstandard traffic patterns impose an almost impossible burden to look up the individual rules for each airport. AOPA recommends that the essential details of the patterns, such as altitudes (m.s.l.) and direction (right or left) be published in Airport Directory, Part 2, of the Airmans Information Manual (AIM) and the AOPA Annual Airport Directory. Also, consideration should be given to standardizing of left-hand rectangular patterns with arriving downwind and base legs at 800 feet above ground level for low-performance aircraft and 1,500 feet a.g.l. (above ground level) for high-performance aircraft. Arriving aircraft should enter the pattern at not less than a 30° angle and at traffic pattern altitude so as to avoid letting down on an aircraft already in the pattern.

They believe that departing aircraft should proceed straight out without turns to a minimum of 800 feet a.g.l. before proceeding on course. Student flights shooting practice landings and takeoffs should attain an altitude of 800 feet a.g.l. after takeoff before making appropriate turns to enter the arriving pattern.

11. The AOPA Safety and Training Division has developed a flight training clinic and air safety seminar program that covers the entire United States. This program was established because AOPA believed that there was a need for a continual upgrading and maintaining of pilot proficiency as an essential element of any safety program. AOPA considers that, if a system of training is

developed that has the major emphasis on collision avoidance in the cockpit, or at least provides the pilot with the means of avoiding a collision when another pilot on the ground system blunders, then we will be a long step ahead in the matter of reducing midair collisions.

NATIONAL PILOTS ASSOCIATION

The National Pilots Association (NPA) was represented by Mr. William H. Ottley, Executive Director. After briefly discussing the midair collision problem, Mr. Ottley indicated that this organization, through monthly and special bulletins, their affiliated magazine, Flying, and through seminars, has repeatedly stressed the importance of compliance with air traffic procedures, the upgrading of pilot proficiency, and the upgrading of aircraft to be accommodated properly in the air traffic system as now constituted.

Their mission is to educate their members and to offer helpful guidance to all users of the airspace so as to promote harmonious and safe use of this airspace. Mr. Ottley then enumerated the following:

1. Two of the eight recommendations submitted to the FAA on February 7, 1968, by NPA and six other organizations they consider pertinent to the midair collision problem.

(a) That FAA establish, in collaboration with appropriate aviation industry representatives, such reasonable requirements for aircraft equipment and pilot proficiency as will ensure that all airplanes using high-density terminal areas will be able to operate efficiently in their part of the ATC system.

(b) That FAA's ATC terminal area procedures be designed to keep turbojets as high as practical until they are clost to the airport and that jet arrival and departure paths for different wind conditions be shown on charts used for VFR flying and keyed to ATIS (Air Terminal Information Service).

2. Approach and departure corridors should be established at all airports where high performance jet aircraft operate. All aircraft within the corridor should be under positive control. The corridors should be published on all WAC and sectional charts.

3. Air carrier crews should be required to have completed a review of all cockpit checklists before entering designated terminal areas. Administrative paper work and communications not essential to the safe operation of their aircraft should likewise be eliminated.

4. Air carrier aircraft operating in terminal areas in VFR conditions should be required to have a designated observer whose sole duty would be to observe other aircraft.

5. That each high-density area be studied and only such restrictions as are necessary be applied to each area.

6. No restrictions should be made which would tend to eliminate permanently any class of aircraft from any airport; however, all pilots and equipment should meet the requirement of the system established for that airport, route, or facility.

7. ATIS should be expanded and its transmitters should be located at strategic points along various approach paths to the airports and at some distance from the airports.

8. ATC arrival and departure procedures should minimize the number of frequency changes demanded of the aircraft.

9. NPA supports a joint and noncompetitive program between FAA and NASA in developing a PWI system. They believe an infrared detection from a strobe light emission would provide an ideal solution.

Mr. Ottley indicated that there should be separate runways and separate traffic patterns for general aviation aircraft. NPA would like separate but equal facilities.

They thought a study should be made on why the air traffic controllers bring transport category aircraft down low, far from the airport. They believe that the aircraft should be held at high altitudes until they are close to the airport and then brought down more rapidly.

He thought that some sort of proficiency check or test should be required to qualify a pilot to operate in high-density terminal areas, and that information should be provided to enable him to operate safely and efficiently in these terminal areas.

AIR LINE PILOTS ASSOCIATION

The Air Line Pilots Association (ALPA) was represented by Mr. Ted Linnert, Director, Engineering and Air Safety Department; Captain Clyde Muirheid, Chairman, ALPA/ATC Committee; Captain Carl L. Smith, Chairman, ALPA/CAS Committee; and Captain Robert A. Patterson, Washington Area Safety Chairman.

The ALPA considers that the growth of air traffic and the recent history of collisions indicate the problem is immediate, but many potential solutions are still in the future because of technical and economic considerations.

ALPA strongly supports the development of an effective collision avoidance system. They also support efforts to ease the controller's workload and provide him with improved traffic control hardware. The

comingling of uncontrolled traffic in the same airspace as traffic on ATC clearances is considered to be a critical problem by ALPA. They indicated that ATC radar was designed principally to provide separation of IFR traffic and only supplementally is used as a collision avoidance device in the mix of VFR-IFR traffic. They thought that radar has definite limitations for this purpose and that the crewmember's eyes are the only collision avoidance system continuously available today in the VFR-IFR traffic mixture.

They considered the "see and be seen" concept of collision avoidance to be outdated with serious limitations. Restrictions to visibility include smoke and haze which restrict vision, flight into the sun, insect smears on the windshields, obstructions by aircraft structure, and contrast of target aircraft against the background (conspicuity). Nevertheless, they believed that, until fully effective countermeasures are provided, collision avoidance by vigilance of the flightcrews must be emphasized and enhanced where possible in view of the continued growth of traffic in our already crowded skies.

ALPA has continually pressed for positive control in expanded portions of the airspace, a more effective air traffic control system through improved equipment in ATC facilities, improved equipment in all aircraft which operate within the system, more sophisticated automation in FAA Air Route Traffic Control Centers and Terminal Area facilities, and an increased controlled airspace in the vicinity of airports.

ALPA has repeatedly recommended that the Instrument Flight Rules be applied to aircraft as much as possible and that all aircraft which operate within the ATC System be equipped with adequate navigation and communications equipment.

ALPA concluded that the following items would minimize the number of midair collisions:

1. Elimination of uncontrolled traffic from en route altitudes and corridors in the vicinity of airports.

2. Provide adequate radar coverage, capable of displaying the altitude of the aircraft, as soon as possible at all airports in which airlines operate.

3. Expedite development of an airborne collision warning device.

4. Provide a control tower at all airports served by air carrier aircraft.

5. Expedite a massive airport construction and modernization program for both air carrier and general aviation.

6. Improve FAA's safety standards for airports and related facilities.

7. Increase the weather requirements for VFR to 1,500 feet ceiling and 5 miles visibility.

8. Require all aircraft operating above 10,000 feet to be transponder equipped.

9. Require all aircraft operating above 10,000 feet to be on IFR flight plans.

10. Expedite a program to educate the inexperienced pilots as to the location of high-density airways and airports and the dangers of operating in these areas.

11. Require a three-pilot crew.

12. Improved anticollision lighting such as strobe lights.

Following the Indianapolis, Indiana, midair collision on September 9, 1969, the Air Line Pilots Association and the Aircraft Owners and Pilots Association jointly presented a plan to the FAA known as the High Performance Aircraft Corridor Plan. The plan contemplates the designation of at least two corridors at each airport served by a significant number of high-performance aircraft. It proposes an increase in the size of the airport traffic area to provide more maneuvering room for the large high-performance aircraft. The expanded airport traffic area would encompass a 7 1/2 mile radius from the airport reference point, and would extend from the surface to 3,000 feet above the airport elevation.

At the edge of the airport traffic area, designated High Performance Aircraft Corridors would extend from 1,500 feet a.g.l. to 5,000 feet a.g.l. with a width of 2 miles. The corridor would expand in width to 10 miles at a distance of 45 miles from the airport, where 8,000 feet of vertical airspace would be available from 10,000 feet a.g.l. to 18,000 feet a.g.l.

The corridor design would permit aircraft to pass either over or under, thus facilitating efficient use of all of the airspace in terminal areas.

ALPA does not believe that the FAA's proposed TAC will do the job and that it unnecessarily restricts a lot of airspace for the use of general aviation VFR traffic. Additionally, there are cases where the normal traffic flow patterns would have to be in and out of the control area before entry into a path which will be protected to the runway.

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ALPA is concerned with the mixing of the traffic operating under the ATC system and the VFR traffic in the same environment. Additionally, they thought that the intermix of aircraft with different performance capabilities flying in the same traffic patterns could create an additional workload both for the controller and the pilot and was a potentially dangerous situation.

ALPA believes that controllers give the pilots all the traffic advisories they can. However, the controllers do not see all the traffic because of the limits of their radar equipment and, even if they see the traffic, frequency congestion in radio communication may prevent the controller from advising the pilots.

It was ALPA's view that there is a definite requirement that the pilot have available to him a device that will warn him when another aircraft becomes a threat. Because of the deficiencies in the ATC system, including its radar equipment, the device to alert a pilot of a possible hazard must be completely independent of ground facilities and personnel. The Association is convinced that the development of a fully cooperative system must also be supplemented by the development of an adequate but more simplified system, suitable for use by the vast numbers and types of aircraft of the General Aviation community. It is ALPA's opinion that consideration must be given <u>now</u> to the development of a light plane warning system.

ALPA has taken the position that the immediate development of a time/frequency system is properly the first step in the solution to the problem of traffic congestion and midair collisions, and, to this end full support is given to the present program. At the same time, however, they say more attention must be focused on the greater problem encompassing the total aviation community and research must be encouraged toward the development of an additional but simplified system whereby light aircraft can be equipped to participate (at least to a minimal degree) in the collision prevention procedure. Such systems are generally classed as "Proximity Warning Indicators" (PWI). They thought that, unless the CAS and PWI are completely compatible, the air carrier aircraft would have to carry both to be completely protected.

Establishing human reaction time for the pilot to take evasive action to prevent a collision is the first factor which has to be determined before the scientists and designers can produce a practical PWI. ALPA claimed that approximately 10 seconds warning time was sufficient for the pilot(s) to prevent a collision during VFR conditions, provided the pilot(s) were alerted by an aural sound and an azimuth pointer to show at a glance where to look for the traffic conflict.

ALPA indicated that a NASA ad hoc committee in 1966 drew up and submitted the following PWI design objectives:

PWI EQUIPMENT
CHARACTERISTICS
(Best Estimate)

DESIGN OBJECTIVES:

1.	Self-contained (Quasi-passive)	
2.	Azimuth Accuracy (Relative to Heading)	- ±15°min. - ±10° desired
3.	Elevation Accuracy (Relative to Self)	- ±5°
4.	Azimuth Coverage	- 360° (ideal) ±70° (min.) ±120°(desired)
5.	Elevation Coverage	- ±10°
6.	Range of Detection	- 1.0 n. mile minimum

ALPA presented its analysis of 5 years of midair collisions.

Assuming CAS or PWI are available and installed, ALPA pointed out that they should be regarded only as emergency devices and in no case a substitute for a reliable and adequate ATC and airport system.

To show the very urgent need of improving the ATC and airport system, they indicated that, at this time, the records show that the number of registered general aviation airplanes outnumber airline airplanes by a ratio of 50 to 1. Well supported studies show that by 1980 general aviation airplanes will outnumber airline airplanes by approximately a ratio of 75 to 1.

In response to the Board's request, ALPA submitted the following additional information:

The ALPA/UAL study of United Air Lines Boeing 737 and 727 operations produced data relating to the midair collision problem which had never before been measured or examined in actual airline operation. This study, according to ALPA, showed considerable new evidence. Following are a few examples:

1. For each 100 targets called to the attention of the crew by ATC, only 43 were detected.

2. Of the three-man crew B-727 and B-737 airplanes, these ATC called targets were first seen by the third crewmember in 24 and 25 percent of the incidents, respectively.

3. For each 100 targets warned by ATC and seen by the crews of the three-man B-727 and B-737, there was an average of 71 and 80 additional targets, respectively, which were detected by the crews for which no ATC warning was given.

4. On the B-727 and B-737, these unwarned targets were first seen by the third crewmember in 41 and 43 percent of the incidents, respectively.

5. On the B-737, there was a 37 percent increase in the number of non-ATC-warned traffic detections of the three-man crew over the two-man crew operation on the same airplane type.

There were other differences showing a positive improvement in traffic detections for three-man crews over two-man operations.

ALLIED PILOTS ASSOCIATION

The Allied Pilots Association (APA) was represented by Captain Theodore MacEachen. In its prepared paper, APA indicated that it considers the midair collision hazard to be the most serious problem facing the aviation industry today, when aircraft flying in the same airspace are permitted to fly under two different sets of flight rules. The Association felt that the hazard inherent in the dual-rule system must be corrected as rapidly as possible, giving the maximum protection to the public carriers with the minimum adverse affect on VFR flights. It recognized that it is impossible to control every aircraft movement, but is possible and desirable, however, to separate the controlled traffic from the uncontrolled and offer reasonable protection to the traveling public.

Captain MacEachen strongly advocated the FAA's "Terminal Control Areas" proposal. However, he would, in addition, require that the terminal protected airspace reach the positive control airspace, so that no gap exists. If the terminal and en route airspace do not meet, the resulting gap will attract a significant portion of the same VFR traffic that had previously operated at lower altitudes. APA would be satisfied with arrival and departure corridors at some airports which do not have a large volume of traffic.

Another very important step for the Administration to take, in APA's opinion, is to recognize the importance of clearing departure aircraft up high as quickly as possible and, at the same time, allow inbounds to remain at, or above, 10,000 feet until the aircraft's operating characteristics dictate descent.

The Allied Pilots Association recommended:

1. Segregation of controlled and uncontrolled traffic in the vicinity of all high-density terminals from the ground up to positive control airspace.

2. A requirement that all aircraft operating in the designated terminal areas be equipped with at least a two-way radio and a transponder beacon.

3. A requirement that all aircraft operating in designated areas obtain an ATC clearance prior to such operation.

4. The elimination of VFR flying by airline aircraft, except for training flights, which should remain in designated airspace for air work maneuvers.

5. The establishment of suitable routes in high-density areas for through traffic not using the control system.

6. The elimination of Special VFR.

7. The designation of arrival and departure corridors at terminals where traffic is less dense for use by controlled traffic only.

APA believes that the 250-knot speed limitation for arriving aircraft in the terminal area should be maintained, but if departure corridors are designated and aircraft within them properly separated, then there should be no speed limitation for those aircraft.

Captain MacEachen indicated that his personal opinion was that the VFR visibility minimum should be 5 miles. He also thought that strobe lights are very effective at night but do not help much during the day.

AIR TRAFFIC CONTROL ASSOCIATION

The Air Traffic Control Association (ATCA) was represented by Mr. George W. Kriske, Executive Director.

The Association believes there is no single revolutionary step, as a practical measure, that can be implemented without causing an adverse impact on the national aviation system and on economy. However, it believes that a number of actions, taken in concert, should contribute substantially to reduce the potential of midair collisions. It recommended that strong efforts be made to pursue these measures without delay, where resources are presently available.

ATCA made five basic recommendations to the Board which, in ATCA's opinion, would reduce the midair collision potential. It recommended:

1. The designation of additional controlled airspace. It considered that the FAA's TAC proposal would place an additional burden on all categories of aircraft operation into and out of the affected terminals. ATCA thought that rulemaking should substantially reduce the potential for unknown traffic in terminal areas at major airports.

2. The conduct of an intensive educational campaign by FAA in pilot training to emphasize the various air-ground communications facilities, radio navigational aids, radar traffic and weather advisory service, preflight and in-flight briefing, and flight planning service. During his training, the pilot should also be given information of the expanded radar services and the advantages and limitations of radar. The pilots should be tested on the foregoing subjects to obtain their certificates.

3. Improved dissemination of information through improved aeronautical publications and charts. Mr. Kriske stated that, if the Terminal Control Area rule is adopted, it would have to be indicated on the charts in an easily understood fashion or general aviation pilots would be seriously limited in their ability to understand and comply with the required in-flight procedures. He specifically recommended that the Airmans Information Manual be amended to include frequencies to be used by transiting aircraft and to require pilots to contact terminal radar facilities for advisory service.

4. Providing control zones and airport traffic control towers at all qualifying airports, provide airport surveillance radar (ASR) equipment and additional air traffic controller staffing at some 38 airports which qualify for this service, install daylight (BRITE) radar displays at all nonapproach control towers where the equipment could be remoted from the ASR site serving the approach control facility which has jurisdiction over the terminal area, designate area navigation routes between major terminals, and develop and conduct a vigorous and comprehensive pilot educational program on the critical nature of the midair collision problem.

5. Immediate attention be given to enhance ATC radar detection of smaller type general aviation aircraft. Primary targets are often not received at all, or, in some cases, only weak and intermittent returns are obtained.

It was ATCA's view that transponder equipment, to provide secondary radar targets from all categories of general aviation aircraft, is not

practical due to cost, normal usage of the aircraft, and the radar clutter that would occur if all aircraft operating under VFR were using the equipment. Primary radar target enhancement, on the other hand, might be a reasonable alternative for many types of general aviation aircraft that do not operate in the IFR system. This would be true, particularly, if such enhancement could be accomplished by employing current state of the art devices or techniques and if expense could be kept at a nominal level.

The ATCA concurred in the FAA-proposed terminal area control rules. They believe that a simple corridor system would not provide sufficient airspace around the terminal areas to permit the controller to vector aircraft for sequencing the traffic. The Association does not object to a daytime special VFR clearance; however, it recommended that a sliding scale of ceiling and visibility be established for such clearances, ranging from 500 feet in 3 miles, 600 feet in 2 miles, to 700 feet in 1 mile. Standard patterns at uncontrolled airports should be required by Federal Aviation Regulations according to ATCA.

NATIONAL ASSOCIATION OF GOVERNMENT EMPLOYEES

Mr. Stanley Lyman, Vice President for FAA Affairs, represented the National Association of Government Employees (NAGE). Mr. Lyman stated that the midair collision problem encompasses inadequate staffing, system-wide inefficiency, managerial deficiencies, and totally inadequate radar and communications equipment.

In February 1967, NAGE conducted a survey of air traffic controller locals throughout the country with emphasis on those centers controlling the Boston-New York-Washington air corridor. This survey indicated an average of 25 incidents per week wherein two aircraft nearly collided in flight in this northeast corridor. An updated estimate by NAGE made in October 1969 indicated 50 such incidents occurring per day.

Mr. Lyman described two proposals which have been submitted to the FAA for consideration. Both of these proposals are designed to ease the controller's workload, expedite the flow of traffic, and, thus make for a safer operation. FAA regional supervisory personnel have ignored these proposals, according to NAGE.

The first proposal suggested that delays be reduced by eliminating control by the New York Air Route Traffic Control Center of all air traffic arriving and departing the New York area in the air corridor to Boston or the overseas air routes.

Mr. Lyman explained that expanding the southern control area of the Boston Air Route Traffic Control Center from its present boundary would extend the Boston Center's coverage of air traffic to within range of

the FAA's common IFR room, which provides radar and communication service to the three major New York airports -- Kennedy, LaGuardia, and Newark. In his opinion, such a reconfiguration would free certain of those New York Center controllers handling this traffic for assignment to other undermanned sectors controlled by the facility, such as those responsible for traffic to and from the Philadelphia and Washington areas.

It has been estimated by the New York controllers that peak traffic delays could be reduced by as much as 40 percent if it were adopted. More importantly, NAGE believes, it would provide a safer environment.

The second proposal is quote similar in that it involves realignment of the control area boundaries in the Florida area between the Jacksonville and Miami ARTCC.

Reference was made in Mr. Lyman's statement to an "Unsatisfactory Condition Report" submitted to FAA officials with respect to the newly installed ASR-5 radar at the Oakland Bay, California, terminal radar control (TRACON) facility. The subject report cited numerous problems encountered with the equipment since its commissioning, charging that it had been accepted in a "marginal" condition. It was also noted at the time the system was accepted that it would not function properly with the radar antenna located at its present site.

Several photographs of the presentation of the ASR-5 radar system involved were submitted by NAGE to illustrate graphically the problem. NAGE indicated that the FAA has not corrected the situation.

PROFESSIONAL AIR TRAFFIC CONTROLLERS ORGANIZATION

The Professional Air Traffic Controllers Organization (PATCO) was represented by Mr. James Hays, the president of the organization. Mr. Hays, in his written statement, referred to the known limitations of primary radar in respect to its inability to detect all targets in a given area on a repeatable basis, as well as to the problem of insufficient response time available to pilots of high-performance aircraft in which to execute an evasive maneuver to avoid a midair collision, once the threat is identified. PATCO's recommendations were: that radar flight inspections should be made without notice and without tuning or adjustment of the radar equipment until the flight check is completed; that all flight check reports should be made required reading for controllers and be made available to pilots; that controllers should be made aware of the location of student pilot practice areas; and that the location of such areas be coordinated with the appropriate ATC facility.

In his testimony before the Board, Mr. Hays stated that immunity with respect to the reporting of near midair collisions has not been extended to air traffic controllers, as indicated by the fact that report of only four near midair collisions have been received from controllers.

He also indicated his organization's support of the principle of segregating high-performance aircraft from other in congested areas as an aid in lessening the midair collision potential.

Mr. Hays had various other comments and recommendations:

1. There are more airplanes flying in the (ATC) system than the air traffic controllers can accommodate safely.

2. Improved training programs, along with new and improved equipment are required for controllers.

3. Student pilots should be required to visit traffic control facilities prior to obtaining a private pilot certificate.

4. Controller applicants should be appropriately screened through psychological testing to weed out personnel not adaptable to the demands of the profession.

5. Training aids and procedures for controllers should be updated.

FLIGHT SAFETY FOUNDATION

General F. L. Vidal, executive vice president, and Mr. W. Bartholomew, head, Engineering Section, represented the Flight Safety Foundation (FSF). FSF considers expeditious solution of the midair collision problem to be of greatest urgency, the problem being further complicated every year by increasing numbers of sophisticated, larger, faster airplanes.

General Vidal indicated that, in 1961, FSF's Project SCAN (System of Collection and Analysis of Near-Collision Reports) proved the enormity of the problem and, as a result, there was a decline in near misses reported. Subsequent complacency has been accompanied by an increase in near misses, requiring remedial measures. As indicated in SCAN and the FAA Report of Near Midair Collisions in 1968, the majority of near misses involve flights between either VFR/VFR aircraft or VFR/IFR.

FSF indicated that pilot error and ATC error have caused both near and actual midair collisions. Remedial action revolves around positive control of aircraft. This control would require an audio and/or automatic communication among all traffic and en route and terminal area air traffic control. Cockpit visibility is another aspect of the problem. Because of human eye physiology, human reaction time, and high-closing speeds of aircraft, pilots do not have adequate time to assess hazards and take evasive action. Consideration must be given to an airborne Collision Avoidance System. Improved altimeters are also required.

Despite progress in secondary radar, automatic altitude reporting and automated display, FSF believes that ATC is not and never will be infallible.

Mixing VFR (unknown) with controlled (known) traffic is dangerous and the mix of traffic in a control zone, area, or airway must cease. Even VFR traffic must be controlled. General Vidal stated that currently radar is used to augment the basic nonradar system of ATC. If traffic can be observed and identified on the scope, it can be radar controlled, and identification is assured by transponder. If contact is lost, control reverts to basic nonradar system. The ATC system, while inadequate, is a marvel of performance.

Two courses can be taken to reduce the probability of midair collisions: (1) insure separation by automating ATC and, (2) provide the pilot with an airborne anti-collision device.

FSF recommended specifically that:

1. ATC exercise positive control of all aircraft operating in any controlled airspace.

2. Positive control be accomplished through communication with every aircraft with the applicable control facility.

3. ATC provide timely traffic information to all aircraft involved.

4. All aircraft, operating under ATC supervision, be equipped with adequate communications equipment and transponders to meet the above requirements.

5. General aviation aircraft provide the maximum in pilot visibility, especially lateral, vertical and rearward. Employment of mirrors (as aids) should be instituted by the manufacturers.

FSF also recommended that, upon certification of the required special equipment:

1. All aircraft operating under ATC control be equipped with collision avoidance systems and more accurate altimetry.

2. The ATC system be automated to the degree that puts the computer on line with the controller to assist in directing and organizing traffic flow, especially through the capability of the computer to forecast collision tracks well in advance, as well as to permit pilots to maintain their separation through use of a CAS.

FSF has submitted a proposal to the FAA to determine the common denominator of midair collisions.

On the subject of other anticollision aids, such as strobe lights and conspicuous aircraft paint, FSF favors any items that are economical

and practical. FSF supported the FAA approach of positive control, as well as area navigation systems.

RADIO TECHNICAL COMMISSION FOR AERONAUTICS

Mr. Alexander W. Wuerker, chairman, representing the Radio Technical Commission for Aeronautics (RTCA), stated that the purpose of any air traffic control system is to provide for safe, efficient use of the airspace by all classes of users. He included prevention of collisions and assurance of minimum delay to the user in such systems.

Mr. Wuerker explained that by "Air Traffic System" is meant traffic control, navigation, communications, weather data dissemination, airports, regulations, operating procedures, and other factors involved in the safe and efficient utilization of the airspace.

Participation in the air traffic system -- either as a pilot, aircraft operator, or controller -- is becoming more difficult because of increasing operational complexity. Complexity is being reflected in rules, in airspace utilization, navigational charts, and ATC procedures and clearances. He stated that every effort must be made in writing rules and procedures and in utilization of equipment to simplify participation in the system. He thought complexity in airspace nomenclature should be investigated.

Mr. Wuerker emphasized the matter of workload on the pilot as well as workload on the controller. The pilot's problems include: complying with the navigational and communication requirements of the ATC system, complicated language of ATC clearances, maintaining visual separation, frequency change on communications and navigation equipment, and transponder code changes, all added to the task of flying the aircraft.

With respect to the controller, as traffic mounts, he faces added procedures and circumstances which make his task increasingly difficult.

Many of these problems are associated with the need for automatic devices to aid both the pilot and controller. Areas in which automation will be most effective are those which concern communications, flight data processing, conflict prediction and resolution, sequencing, automatic tracking, and an adequate controller display system.

Mr. Wuerker pointed out the need for the development of an acceptable world-wide airborne CAS and PWI independent of the ATC system.

RTCA was of the opinion that the CAS was not intended to be a substitute for a ground-based air traffic control system, nor should that system be designed to rely on the airborne CAS for separation of aircraft. The best solution to the problem of potential midair collision is a fail-safe air traffic control system under the jurisdiction of a central agency exercising control from ground facilities. The CAS must not be dependent upon the air traffic system.

Mr. Wuerker refers to several documents published by RTCA. The intent of one such document published in 1967 on "long range planning for the air traffic system," was to be helpful to the Federal Aviation Administration and others by providing suggested guidelines leading toward the system of the future. Its findings also should serve to promote international understanding of user needs.

This report, SC-104, was presented in two parts. Part I states the purpose of an air traffic system and lists the needs of the controller and the pilot. Part II analyzes future problems and pinpoints basic operational requirements to achieve many of the objectives of the first part.

Mr. Wuerker stated that all of the efforts of RTCA are directed essentially toward improved safety and efficiency of aeronautical operations. At the present time, RTCA has 16 special committees at work on various problems which include updating minimum performance standards for airborne electronic equipment, development of minimum operational characteristics of airborne electronic systems, development of a new approach and landing system and space communications, as well as the development of uniform minimum performance standards for emergency position indicating radio beacons for downed aircraft.

DEPARTMENT OF DEFENSE

The Department of Defense (DOD) was represented by Mr. John W. Klotz, assistant director, DOD Research and Engineering, who was assisted by Mr. Emery Sellers, air traffic control specialist, Office of Air Force Operations, and Mr. W. D. D. Jones, air safety specialist, Office of Director, Army Aviation.

The combined DOD air fleet is about 30,000 aircraft with a wide diversity of performance characteristics, including light observation aircraft, helicopters, high-performance fighters, and military transports. In support of its fleet of aircraft, DOD operates numerous airports, control centers, and navigational aids.

The Department of Defense shares in the national concern for safety in the airspace and has worked very closely with the FAA in this area.

The three areas which were the theme of Mr. Klotz's presentation were an extension of the concept of area positive control; the use of the radar beacon for providing identity and altitude information to the controllers; and the necessity for adequate resources to achieve our national goals for air traffic control.

Mr. Klotz reviewed the history of the national plans for radar and beacon surveillance starting with the establishment of a Project Beacon

Task Force in 1961 and the recommendations generated by the task force. He then gave the present status of semiautomatic alphanumeric systems for air traffic control including the National Airspace Utilization System Stage A at Jacksonville, the SAGE facility at Malstrom Air Force Base, the ARTS system at Atlanta and the TPX-42, a much simplified version of the ARTS III system. Several hundred of the TPX-42 systems are being procured for installation in military terminals.

Mr. Klotz expressed the view that if transponders were installed on all aircraft, the aircraft target could be seen by the controller but a new problem would be created. The controller's radar displays would become cluttered with a greater number of beacon signals. However, if the aircraft were also equipped with automatic altitude reporting, individual controllers could select different altitude layers for monitoring and thereby remove unneeded signals from their displays.

Mr. Klotz stated that, considering the new technology applicable to collision avoidance, the modernization of their aircraft fleet and ground facilities, and the experience gained in operating radar beacon systems, the DOD believes that further extension of the concept of area positive control with radar and beacon monitoring, is the only way to prevent a further deterioration in national air traffic control over the next 5 to 7 years.

The DOD recommended extension of positive controlled airspace, but stated that a major acquisition of new automated facilities would be required.

To support further the DOD cooperative effort to assist the Federal Aviation Administration in achieving our national goals for the safe and efficient utilization of the airspace, DOD strongly endorses the following:

1. Adoption of procedures to separate controlled and uncontrolled traffic in dense terminal areas.

2. Application of adequate funds and management resources to expedite and expand the NAS/ARTS/TPX-42 ground installation program.

3. Expediting installation of higher levels of automation to relieve air traffic controller workload.

4. Initiation by FAA of an aggressive program to provide adequate equipment on flight inspection aircraft to monitor beaconry signals on a national scale in order to isolate causes of reported or apparent submarginal system performance.

5. Installation of identity and altitude beaconry equipment on all new general aviation aircraft.

6. Development of a program to retrofit progressively with beaconry equipment those classes of general aviation aircraft which generate the greatest potential conflict with IFR operations.

7. Initiation of an FAA program to monitor beacon altimetry performance on the airways by cross-checking with altitude information derived from a special ground radar designed for this function.

8. Development of a proximity warning indicator feature on a low-cost transponder for general aviation aircraft that will alert the pilots and ground controller when minimum clearance criteria are exceeded.

Considering the new technology applicable to collision avoidance, DOD's current investment in modernizing its air fleet and ground facilities, and its experience in operating with the radar beacon system, the DOD believes that a further extension of the concept of area positive control, with radar and beacon monitoring, is the only way to prevent a further deterioration in national air traffic control over the next 5 to 7 years.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Henry L. Anderton, chief, Microwave and Optics Branch, Office of Advanced Research and Technology, represented the National Aeronautics and Space Administration (NASA).

Mr. Anderton stated that NASA regards the aircraft collision problem as one of the most important specific difficulties facing the continuing expansion of aeronautical services in the United States. The continuing increase in air passenger and cargo transportation and the increasing number of general aviation aircraft will further increase the risk of collision. This threat merits the individual attention of qualified research activities as well as operational and rulemaking authorities in both industry and government. The final solution, he said, will undoubtedly involve a combination of improved traffic control and airport and airspace planning. In the meantime, some stopgap measures, such as collision avoidance devices, pilot warning indicators, and greatly restricted use of airspace will be required to protect lives and expensive equipment.

Mr. Anderton explained that NASA's direct involvement in the collision avoidance problem has dealt almost entirely with the development of pilot warning devices. However, he pointed out that NASA also works in many other areas which indirectly have an influence on the problem.

One of the pilot warning systems under development by NASA uses an optical technique which operates in the infrared part of the spectrum and depends upon detection by one aircraft of the radiation from a Xenon lamp installed on other aircraft.

A second type of PWI equipment is being developed by Langley Research Center, using radio frequency techniques. This equipment uses random coding and Doppler signals to derive range and range rate from the signals returned from other aircraft. This information is then processed to determine which aircraft are hazards, and data on these are displayed to the pilot with azimuth information derived from a directional antenna. Three harmonically related frequencies are used jointly by all aircraft and, again, equipment is required in all aircraft.

Mr. Anderton indicated that, in any PWI system, probably the weakest link will be the pilot. All pilots, including those in the smallest and simplest aircraft, are heavily loaded with work during much of the process of flying. There is a possibility that a properly operating PWI device will have such a high alarm rate that the pilot will either ignore it, turn down its threshold, or turn it off. However, even if this turns out to be the case, the stakes are so high that we cannot afford to delay or stop the development of this PWI equipment which could save lives.

BUTLER NATIONAL CORPORATION

Butler National Corporation was represented by Mr. Glen A. Gilbert, Consultant. Mr. Gilbert indicated that Butler National Corporation was a private avionics manufacturer engaged in the research and development in the field of area navigation (RNAV) for aircraft. He indicated that the corporation had successfully built and demonstrated a three-dimensional system (3D RNAV). The Butler system uses the existing VOR/DME navigational facilities to determine the flightpath of the aircraft. No additional ground facilities need be established for a workable system.

The FAA published Aviation Circular AC 90-45 on August 18, 1969, which has set the stage for the introduction of the RNAV concept into the National Air Space System. Mr. Gilbert pointed out that two actions are necessary to implement fully this system; namely, the FAA must set up system procedures for navigation off routes and traffic patterns in terminal areas, and, in addition, the operators must implement the program by installing the necessary equipment in their aircraft.

The 3D RNAV equipment is now available. Utilization of this equipment would provide a means to restructure the airspace with "overpasses," and "underpasses," and "corridors" to permit segregation of different classes of air traffic. When aircraft are so equipped, according to Butler, the controller can more effectively realize his role of regulating the flow of traffic and monitoring traffic movements for collision avoidance.

Mr. Gilbert enumerated several elements that could be introduced into our National Air Space System to help reduce midair collisions with the help of 3D RNAV capability:

(1) Major airports should have the capability to handle separate flows of traffic on an independent, simultaneous basis during IFR, as well as VFR, weather conditions.

(2) Descent corridors from controlled airspace for high performance aircraft can be established in which the high-performance aircraft are exposed to the lower airspace for a minimal period of time. Both descent and ascent corridors should be considered as "protected airspace" and only suitably equipped aircraft of specified speed characteristics should be permitted to enter.

(3) Similarly, protected corridors can be established for non-high-performance aircraft (STOL, helicopter, commuter, piston-powered, general aviation, etc.).

(4) The nearly 2,000 airports with a 3,000-foot or longer hard surface runway not utilized today under instrument conditions, could be utilized with RNAV with a resultant decongestion of air traffic at major airports.

(5) The information provided the pilot would enable him to reduce the possibility of overshooting approaches, permitting him to be more attendant to other aircraft in the traffic pattern -- thereby reducing the midair collision hazard.

Butler is presently planning to introduce the time factor into their system thereby enabling a pilot to arrive over a particular point at a specific altitude and at a particular time. They recommend that the FAA continue to give the highest possible priority to establishing terminal area and approach procedures and ascent/descent corridors for different classes of aircraft.

Mr. Gilbert stated that their system would cost $20,000 to $25,000 an airborne package. Their two-dimensional system for general aviation would be about $5,000 per aircraft. Other manufacturers hope to produce a system for about $3,000 per aircraft.

MR. E. KING STODOLA, REEVES INSTRUMENT DIVISION, DYNAMICS CORPORATION OF AMERICA, REPRESENTING HIMSELF

It is Mr. Stodola's opinion, based on his years of professional experience in the field of electronics engineering, that the mechanized collision avoidance and proximity warning systems are years away from general use and, therefore, the present primary "instrumentation" for traffic separation and collision avoidance is visual observation, pilot

judgment, and pilot action. However, he stated that the visual techniques in collision avoidance have not been fully exploited. He believes that most pilots have not been given adequate training in visual traffic observation and proper collision avoidance action and that there is a lack of published information on the subject.

To offer some relief in this area, Mr. Stodola presented to the Board a quantitative analysis approach for determining critical collision angles between two aircraft, particularly aircraft of different speeds, and a method to determine and recognize the "collision danger cone" area; also, how best to interrupt the collision course path using the aforementioned information. He recommended that the method he presented be developed more fully and that it be presented in a practical form to all pilots.

Mr. Stodola also pointed out that evaluation of separation distance by pilots, and actual visual detection in good weather, is much more complex than simply measuring the meteorological visibility. He illustrated the point by the use of color photos and scale diagrams that unrestricted meteorological visibility may actually inhibit the ability of a pilot to detect another aircraft in his path or to estimate the distance between the two aircraft. For example, a photo taken from a descending aircraft of another aircraft 1,500 feet in front of and slightly below it, gave a view of the other aircraft against ground objects 7 miles away, making it difficult to see and, in particular, to make a reasonable estimate of separation distance.

Mr. Stodola recommended that a system, with a set of specific procedures as outlined in his presentation, be developed for visual traffic observation and collision avoidance and that the system be incorporated into a widely distributed manual and, also, that the system be included in air carrier procedures and checks.

GENERAL AIRCRAFT CORPORATION

Dr. Lynn L. Bollinger, chairman of General Aircraft Corporation, discussed the potentials of short takeoff and landing (STOL) on the problem of midair collisions.

Dr. Bollinger related the fact that Federal authorities, in general, concerned with aviation appropriations, need to be made aware that the current STOL state of the art has already been proven in service to be capable of contributing immediately in a very substantial way to the relief of air congestion and to the decrease of collision hazards.

Today's airspace congestion, it was explained, with its attendant collision hazards was not only foreseeable but was foreseen, and corrective action initiated years ago by NASA in cooperation with outside advisors.

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Dr. Bollinger explained that immediately available STOL capabilities, which can be added to existing light aircraft designs by any and all manufacturers, afford the most practicable way of reducing to an easily manageable level the current excessively high risks of collision between light aircraft and heavy transports. With the exception of some executive-type aircraft which have airline-type avionics and pilots, all light aircraft in congested areas should be segregated into helicopter equivalent flight patterns below and between heavy aircraft traffic. Advanced, but well proven, STOL technology makes this possible.

Dr. Bollinger related the experience gained in the Boston area during the late forties where 10 STOL airports were built. Two problems had to be, and were, overcome during these operations. One was the objectionable noise in residential areas, which was solved by applying then known techniques of noise suppression. The other more difficult problem was one of control at low speeds in confined areas where invisible airflow and eddies of potentially dangerous magnitude were found to be generated by the wind around city structures. The NASA research resulted in the production of design data needed to eliminate those loss-of-control hazards.

Dr. Bollinger pointed out that U. S. STOL aircraft were successfully using the helicopter approach patterns and landing areas both at LaGuardia and Washington National Airport. The ability of such aircraft to operate on peripheral STOL strips and to operate, along with helicopters, in otherwise unused low-altitude airspace, eliminated all conflict with heavy traffic and all risks of collision with jets. Self-supporting STOL short haul air service was, at that time, demonstrated as feasible. These operations were conducted for several years but could serve no useful commercial purpose in the absence of Federal standards to permit such activities to be expanded elsewhere.

Dr. Bollinger pointed out that the bulk of the U. S. aviation industry still has no STOL vehicles ready for service that incorporate the control features found necessary by NASA. The airframe manufacturers oppose regulatory action to establish operational characteristics for STOL aircraft, since neither their present aircraft nor the foreign STOL aircraft would meet these requirements.

Dr. Bollinger suggested that the Federal Government discontinue seeking industry consensus on STOL regulations and adopt the pattern of regulations recently adopted by the California Aeronautical Commission. The State of California has recently defined two types of STOL aircraft and set up a regulatory framework to facilitate their use. The more conventional older STOL types which lack stability-and-control augmentation require 1,800-foot landing strips, and no climbing or descending turns are permitted below 500 feet. The stability-and-control augmented STOL requires 1,000-foot and 600-foot strips for commercial and private operations, respectively. Short radius turns are permitted for these aircraft.

Dr. Bollinger pointed out that the advantage of the STOL aircraft is to permit the separation of small aircraft and air carrier type of aircraft. The procedures he suggests will not eliminate the two slow airplanes from hitting each other while approaching for landing. They will, however, minimize this possibility and will, at least, protect the flying public from light airplanes.

MCDONNELL-DOUGLAS ASTRONAUTICS COMPANY

Mr. Anatole Browde, Director, CNI Program, represented the McDonnell-Douglas Astronautics Company. Mr. Browde explained that McDonnell-Douglas has developed a collision avoidance system which has been in operation on their company aircraft since 1965. In the planning stage many different types of systems were investigated, such as infrared devices, conspicuity enhancers, and active radar. After 2 years of study, they determined that none was satisfactory to handle aircraft of varying velocity and in all flight attitudes. They settled on a time resynchronization technique which they called EROS, "Eliminate Range Zero System."

This system, it was explained, provides identification of each member (those aircraft which have the system installed) and provides sufficient information to the computer of the other member to determine parameters of range, range rate, and position in space. Each member is provided a time slot within a 3-minute period for transmission. Except while transmitting, each member is listening to the transmissions of the other members. The system is capable of permitting 2,000 members to transmit within the 3-minute time period.

The EROS system warns the pilot when a collision situation exists and advises him of the action to be taken. The aircraft are considered on co-altitudes if their flight levels are within 700 feet of one another. If they are within 30 seconds of a collision, the pilots will be warned by an indicator in the cockpit to fly up or down or to remain level. The command to remain level would be given only when three aircraft are involved.

In addition, the pilot is given a warning when another aircraft is either above or below him, from 700 feet to 3,200 feet. No action need be taken in this case. Another feature is an audible warning when any other aircraft is within one-half mile.

The entire system is dependent on precise timing. The aircraft's timing mechanism is set by ground stations or resynchronized by other aircraft while in flight. This system would require three ground stations, Los Angeles, Chicago, and New York. These ground stations would cost about $30,000 each.

A study, sponsored by NASA Electronic Research Center, is being conducted by McDonnell-Douglas to provide a system that is compatible with the air transport system that is suitable for general aviation. The

present system provides full protection between equipped air carrier aircraft. The concept is to install a less expensive system on general aviation aircraft to protect it from air carrier aircraft and a second stage installation which would protect a general aviation aircraft from another general aviation aircraft similarly equipped.

Initially, these aircraft could be provided with the capability of transmitting in the specified time slot so the air carrier aircraft could detect and avoid the smaller aircraft. This feature would cost about $1,500. In the next phase, a receiver-transmitter module could be added to provide full protection. The equipment would provide a distance measuring capability to indicate the distance from ground stations. Additionally, a method of identification would be provided to enhance tracking by ATC.

Mr. Browde explained that air traffic controllers could utilize this collision avoidance system to advantage. The exact position of each equipped aircraft could be displayed in X-Y coordinates on a radarscope. Digital information of altitude, identity, and range could be displayed to the controller. Since range information is being calculated, an additional display could be given the pilot to inform him of the separation between his aircraft and others, thereby assisting him in station keeping for sequencing for landing.

Mr. Browde indicated that, in his opinion, RNAV is the most valuable tool and needs exploration, regardless of what happens to the collision avoidance case. He also recommended that concerted effort be made to get a better digital output altimeter and that it be accomplished at a cost that general aviation could afford.

NATIONAL ASSOCIATION OF AIR TRAFFIC SPECIALISTS

The National Association of Air Traffic Specialists (NAATS) was represented by Mr. William R. Kraham, Executive Director and General Counsel.

NAATS represents a majority of the controllers in the FAA's Flight Service Stations (FSS). These controllers are generally the only ones with whom pilots have direct personal contact through weather briefings and flight planning. Weather information and airport advisories are also provided for an increasing number of air carrier aircraft and they handle all military flights. Mr. Kraham indicated that the controllers serve as operations office for the majority of pilots flying approximately 125,000 general aviation aircraft. In 1968, FSS specialists accounted for more than 50 percent of those saved out of 4,000 assists provided to pilots of aircraft in distress.

NAATS provided their summary of the Safety Board's report on 1968 midair collisions, indicating that the major problem in all the collisions

was the failure of the pilots to "see and be seen," that serious consideration must be given to the fact that the "see and be seen" problem does exist in uncongested airspace, and that the occurrence of the majority of these collisions at or near uncontrolled airports raises serious questions regarding existing concentrations of monitoring and facility effort throughout the air traffic system.

Following the report of the Indianapolis collision, NAATS released a statement, in part as follows: "The immediate and widespread public assumption that the fault for the recent tragic air accident in Indiana rests with the pilot of the small aircraft involved is the logical result of over-exposure of the public to the publicity attendant to the current crisis in air traffic congestion at major airports in the country."

NAATS believes that concern should be focused on the common practice of using radar control to expedite arrivals of large transport aircraft by making "en route" penetrations off airways under radar surveillance, using transponder beacon for position identification of the jet transport during this transitional period.

Mr. Kraham indicated that the use of "positive control" to eliminate collisions is unrealistic and physically impossible due to the shortage of facilities and controllers. Such control would require four times as many controllers. NAATS recommended the establishment of approach and departure corridors for large high-speed aircraft operating out of FAA controlled airports. The military has demonstrated that corridor control is safe, efficient, and reliable for all types of aircraft. NAATS also recommended increased efforts in education and training to assure a greater awareness of the potential of midair collisions. Regarding training flights, mandatory notification to the local or nearest air traffic facility was recommended.

Mr. Kraham recommended the establishment and publication of standard entry, departure, and go-around procedures. Also recommended was the immediate examination of a need for monitoring and control capability at more active uncontrolled airports. NAATS recommended determining the feasibility of a requirement for the installation of high-intensity white lights (flashing) on all aircraft, and moving forward with implementation of proximity warning systems on the ground until such time as airborne collision avoidance systems become capable of practical implementation and use.

MR. JACK BRECKMAN, ELECTRONICS ENGINEER REPRESENTING HIMSELF

Mr. Breckman discussed a technique for collision avoidance which he called SECANT-B, for exchanging signals in very dense air traffic. He stated that this technique was not subject to the usual interference problems which had plagued previous interrogator transponder systems.

He described SECANT-B then as a system, which consists of a remitter (compound of the words "receiver" and "transmitter") and a COMET (the full system, standing for "Complete Estimation of Traffic") and a CADET ("close aircraft detector," Mr. Breckman's version of a PWI). The minimally equipped aircraft carries a remitter, thus permitting its presence to be known to COMET-carrying aircraft, such as air transports, as well as those general aviation aircraft equipped with CADET.

He explained that the remitter requires only the electric current supplied by a flashlight battery to operate and, in the event of a crash-landing, it becomes a locator beacon. He also suggests that the remitter may be used in lieu of the present-day transponder.

The COMET display equipment is a 6-inch PPI (Plan Position Indicator) scope on which only the potential intruders into the subject aircraft's flight profile are displayed in terms of range, relative bearing, and height difference. The resultant data correlation provides the pilot/viewer with an airborne traffic monitoring system, wherein he may alter his own aircraft's course to resolve a potential threat, while remaining within the separation envelope provided by the ground-based ATC system.

There is, at present, no hardware built to test the system described above.

The remainder of Mr. Breckman's testimony concerned itself with the application of the technique/system aforedescribed in the total air traffic movement scheme, and some specialized applications for remitters in obstruction marking, course guidance, etc.

In addition to describing his SECANT-B system, Mr. Breckman spent considerable time discussing the faults of the time/frequency CAS sponsored by the ATA and monitored by the FAA. A few of his main contentions were the false alarm which is given in high-density areas. He alluded to an unpublished FAA report that in the Atlanta area some 700 false alarms per hour were reported. He considered that a system which permits only vertical maneuvers to separate potential collision targets was unsatisfactory. According to Mr. Breckman, the CAS sponsored by the ATA is a command system requiring the pilot to react immediately to avoid a collision but such systems should provide the pilot with additional intelligence of the developing situation. He pointed out that his system provides the pilot with the developing situation. One additional fault in the CAS system, as reported by Mr. Breckman, is its susceptibility to sabotage from a ground signal which could give false signals to the aircraft.

INTERNATIONAL FLYING FARMERS

Mr. A. Martin Macy, Washington legislative representative, was the spokesman for the International Flying Farmers (IFF). He indicated that there are two primary factors that can affect midair collision or the

avoidance of midair collisions. One is training and/or education on the part of the pilot. He stated that this training should result in the pilot's looking out of the cockpit; he should know what he is looking for and how to avoid something if he does see it. The other factor concerns the air traffic control procedures. In Mr. Macy's opinion, the FAA, which has all of the authority for establishing these procedures, is not doing what it could do to improve them. Efforts to segregate the relatively high-speed traffic from operating to and from major hub airports from the relatively low-speed traffic operation in and out, or in the vicinity of these airports has so far been only moderately successful.

IFF does not believe that additional radar or computers will solve the midair collision problem. They believe that in good VFR weather all aircraft flying below 5,000 or 10,000 feet should be under VFR. The ATC system was developed to separate IFR from other IFR traffic; in utilizing this system to separate IFR from VFR traffic in good VFR conditions, we are asking the system to do something for which it was not designed.

The IFF is a strong advocate of establishing corridors at airports for the descent to landing and climbout for high speed aircraft. Mr. Macy stated that, although many organizations had recommended their establishment, the FAA had failed to conduct a testing of such a system, either during actual operations at a few airports or by simulating such systems at their NAFEC facility. He was opposed to the establishment of the terminal control area as proposed by the FAA, believing that those with low density of jet aircraft traffic could be better served by a corridor system.

Mr. Macy discussed the training and retraining of pilots. His organization adopted a program to give annual check rides to their pilots on a voluntary basis to increase their proficiency. The program did not accomplish what was expected since only 10 to 15 percent of IFF pilots participated. The FAA, it was pointed out, issued an NPRM proposing annual proficiency check rides. Since FAA did not have enough inspectors to conduct the necessary checks, IFF opposed the proposal.

IFF was opposed to the proposal to install transponders in all aircraft because, in their opinion, the controllers could not distinguish between targets if all had transponders in high-density areas. Mr. Macy indicated that the pilot should exercise more responsibility -- not leave it up to Big Brother on the ground.

MR. LEONARD J. KMIECEK TESTIFYING FOR HIMSELF

Mr. Kmiecek stated that he, working with FAA personnel and other airspace users through the FAA Traffic Advisory Committee, developed a terminal area notice chart for the Chicago area. The chart indicated the most commonly used paths of IFR traffic into and out of O'Hare International Airport. The chart has been in existence since 1965, and

was distributed to local airports at that time. It is currently printed on the back of the Chicago local chart and published in the Airmans Information Manual.

Mr. Kmiecek was of the opinion that the aforementioned chart may well be one of the reasons that there have been no collisions between small and large aircraft in the Chicago area and suggested that this type of information is invaluable to the VFR pilot. Mr. Kmiecek expressed the view that most pilots would like to know much more about collision avoidance. He said that there is lack of information and very little training on collision avoidance. He also suggested that the FAA gather and publish information on the subject and make it available to all pilots. Additionally, he suggested that collision avoidance training be given to all pilots at the very outset of their pilot training.

Mr. Kmiecek stated that less emphasis should be placed on establishing the responsibility for a collision, and more emphasis be placed on developing methods to reduce the collision potential.

Mr. Kmiecek prefers, and believes that most pilots share his preference for, the safety corridor concept over the TAC concept proposed by the FAA. To illustrate his point, Mr. Kmiecek stated that in the Chicago area there are five small airports, three of which have over 1,000 aircraft, relatively close to O'Hare Airport. He indicated that the proposed terminal area control will cram this large number of general aviation aircraft from these five smaller airports into a narrow slice of airspace and, in Mr. Kmiecek's view, will increase the potential of midair collision accidents.

MR. FRANK MCDERMOTT, TRANSPORTATION CONSULTANT REPRESENTING HIMSELF

Mr. McDermott suggested that the present system of air traffic control should be sharply upgraded. He felt that the Safety Board should conduct a study into the FAA Air Traffic Control program, paying close attention to current developments. He was highly critical of present schemes of automation being used by the FAA in air traffic control without its having first been tested as a genuine useful aid. He cited the Jacksonville Center, pointing up the fallacies and inadequacies of the automated system at that facility. He pointed out the Safety Board's limited manpower with ATC experience. He felt that the Board should have more people on the staff to cope with the multiple duties which we should undertake rather than delegate those duties to the FAA. Because of NTSB's limited staff, Mr. McDermott thought it has to depend too much on the FAA.

Mr. McDermott felt that it would be in keeping with our statuatory duties to audit the whole FAA/ATC system and report as necessary our findings to Congress and to the President.

MR. DONALD BAIN REPRESENTING HIMSELF

Mr. Bain indicated that he had conducted research into the conflict between scheduled air carriers and private aviation and that, from this point of view, he would discuss the midair collision problem.

After discussing his opinion of the philosophy of rulemaking, Mr. Bain indicated that, even though 80 percent of general aviation accidents are attributed to pilot error, FAA has done nothing to upgrade private pilot training or institute a revalidation program. There has also been no program of license classification (pilots wishing to operate in congested areas need higher degree of training). He also pointed to the lack of regulations relative to prohibiting private pilots from drinking prior to flight and advocated imposing rules on all pilots relative to drinking.

Mr. Bain indicated he was in favor of FAA's plan to institute positive control at certain U. S. airports and that it should have been done long ago.

Mr. Bain took exception to "many specific areas of regulation or lack of regulation," indicating that these are a result of "prevailing philosophy" which must change before any meaningful solutions can be found to aviation's problems. He pointed to the March 9, 1967, accident at Urbana, Ohio, and the Board's report of that accident, criticizing the "see and be seen" philosophy as one which is no longer useful or practical, and criticizing the system of first-come-first-served. He advocated that the FAA take positive action to upgrade the Federal Aviation Regulations.

Mr. Bain recognized that all elements of aviation cannot enjoy equal freedom of the skies and recommended a system of priorities until the system is able to cope more efficiently with increasing numbers of aircraft and the mix of various types of operations. The highest priority should be given to the people using the nation's scheduled airlines.

Mr. Bain presented the following proposals:

1. FAA should act as an independent agency of experts, not as a regulatory agency.

2. Ban planes and pilots unable to function within the ATC system.

3. Bring all possible pressure to bear to improve the control system, thereby permitting more participants to enter this field.

4. Restructure the pilot training program. Minimum required hours are too low. Testing should be given back to FAA. Tighten up the testing.

5. Institute a pilot certificate revalidation program.

6. Eliminate "see and be seen," as well as "first-come-first-served" and the airplane/automobile analogy.

III. SUMMATION OF WRITTEN COMMENTS

In addition to those who appeared as witnesses at the hearing, a number of organizations and individuals submitted written comments to the Board in which they made recommendations for solutions to the midair collision problem. Following is a summation of these comments:

MR. RICHARD H. SANDERS

Mr. Richard H. Sanders, a pilot and an engineer, after listening to the testimony given at the hearing, indicated that there was no panacea for the short-term solution to the midair collision problem, but that improvement to the efficiency and safety of the present system is possible and necessary.

To improve the present system, Mr. Sanders made several recommendations as follows:

1. See and Avoid

   (a) All aircraft equipped with rotating red beacons and/or strobe lights have the lights turned on during both day and night flights.

   (b) Augment the visual sighting capability of the crew by use of mirrors or closed circuit television.

   (c) Standard traffic patterns be established at uncontrolled airports where feasible.

   (d) Include instruction in the theory and practice of collision avoidance in the early stages of training of student pilots.

   (e) Provide the airman with pictorial information on heavy traffic routes at high-density airports similar to the one depicting the Chicago area.

   (f) The corridor concept be adopted in preference to the terminal control area concept.

   (g) The July 25 near miss between BOAC and TWA aircraft over the Atlantic should be studied for both positive and negative factor in visual sighting.

2. Mixed Traffic in High-Density Areas

   (a) "Thumbnail" traffic pictures should be provided to pilots in instances where the controller's workload is too great to give more thorough radar traffic advisories.

(b) Implement methods to enhance primary radar target..

(c) Discreet codes be assigned to VFR aircraft for each 1,000 feet cruising altitude and one each for climbing, descending, and practice maneuvers involving changes in altitude and direction.

3. Flights Into Unfamiliar Areas

(a) Improvement in pilot information is needed. The itinerant pilot has considerable difficulty in strange areas due to the poorly conceived presentation of material.

(b) Develop a code word that would indicate to the controller that the pilot is unfamiliar with the area. This suggestion would, in Mr. Sanders' view, minimize misunderstandings, confusion, and contribute to fewer "say agains," which help tie up the frequencies.

4. Altimetry

Pilots of VFR and IFR flights should change their altimeter setting between fixes to reflect the setting appropriate to the next fix. At the time of reporting over a fix, the ground controller should supply the setting for the next fix. If the VFR pilot does not use the full IFR report, he should at least give routing or destination.

5. Aircraft Proximity Indicators

That development of a relatively inexpensive proximity indicator be expedited.

MR. G. SCOTT ADAMS, JR.

Mr. G. Scott Adams, Jr., a professional engineer working as a general aviation pilot, former military pilot, and a citizen vitally concerned with air safety, objected to the practice of the U. S. Air Force's flying high-speed aircraft at low levels over a major portion of Texas.

Mr. Adams pointed out that the FAA "Near Midair Collision Report of 1968" listed, in declining order of gravity, 10 major problems and that the first cited was the see-and-be-seen rule in which 21 percent of the 1,128 near midair collisions fall. The seventh listed problem was "High-speed aircraft encountering low-speed aircraft."

Mr. Adams stated that it was inconceivable to him that, contrary to studied safety recommendations, the Air Force would so arbitrarily usurp such a large portion of active airspace. Also, that the situation is grossly contrary to the maintenance of even basic flight safety and is lacking any stated or apparent justification.

Mr. Adams thinks that, at the very least, a much smaller affected area, better defined, and some reasonable time block limitations should be specified. He also requested that the NTSB assist in rectifying the Air Force's hazardous flight operation conditions of random, low level, high-speed jet flights in already busy and unsophisticated airspace.

SUPERVISORY AIR TRAFFIC CONTROL ORGANIZATION

Mr. Paul Plummer, president of the Supervisory Air Traffic Control Organization (SATCO), indicated that the causes of midair collision resolve into the overcrowding of the airspace and the resultant air traffic control problems.

The control of aircraft, both in the airways and at the terminals, is, in Mr. Plummer's view, at a critical point. The solutions to this problem involve new radar systems, airborne warning devices, and, most importantly, people.

In SATCO's view, improvement of the Air Traffic Control System is the first step in solving the midair collision problem. This, they think, could be greatly improved by strengthening the position of the first line Air Traffic Control supervisor.

MR. JOHN A. MARGWARTH

Mr. Margwarth of Mission Hills, California, suggested that a collision avoidance system, consisting of a low-cost transmitter and receiver, be installed in as many airplanes as possible. The object of the system is to alert the pilots by audio and/or visual indication that another aircraft is nearby.

The system suggested by Mr. Margwarth would be effective in areas of normally light air traffic where pilots might not be especially alert to other aircraft. The system could incorporate a cutout switch for the receiver when flight is conducted in congested areas.

MR. THOMAS O'R GALLAGHER

Mr. Thomas Gallagher, chief flight instructor, McIntyre Aviation, Inc., New York, submitted a paper on his views and recommendations on the midair collision problem. His recommendations and suggestions follow:

1. Revise the Flight Test Guides for various licenses by including "Vigilance" with the objective to determine whether the applicant maintains careful watch for other aircraft. Failure to do so would be disqualifying.

2. Designate a special frequency for broadcasting position at uncontrolled airports.

3. That the value of the visual reporting points be reexamined to assure clarity for itinerant pilots.

4. That the value of the use of a written checklist be reexamined. Perhaps a tape recorder could be used when a pilot cannot afford to take his eyes off traffic in the busy traffic pattern.

5. That traffic pattern and standard entry and departure points be defined at all airports.

6. That an automatic wind tee be required at uncontrolled public airports. The tee would not swing facing the wind, but would include a spring-loaded ratchet to restrict its face-swinging feature.

7. That pilots be reminded to check the accuracy of their compasses and the setting of their heading indicators by placing small signs in the runup areas reading, for example, "Runway 6 Magnetic Heading on this Runway 057."

8. That FAA inspector, controllers, and Flight Service Station specialists have the authority to inspect a pilot's license. This power would be used for the purpose of assuring that the pilot is rated for the type of operation in which he intends to engage.

9. That controllers have the authority to refuse a clearance for takeoff in the interests of safety.

10. That ATC be provided with radar weather capability.

11. That aircraft be equipped with a warning light and buzzer to indicate when any one of several systems is in need of attention.

12. That aircraft control positions be standardized.

13. That the location and depiction of the instrument be standardized.

14. That the IFR requirements for Part 135 be tightened to require an Instrument Rating and current IFR experience for all air taxi pilots. Also, that Part 135 permit single-engine, single-pilot IFR operations.

15. That recurrent pilot proficiency checks be made mandatory every two or three years.

16. That the quality of the reception from ATIS be improved.

17. That FAA expedite the installation of high-intensity white flashing lights.

In addition to the above recommendations, Mr. Gallagher believes that:

1. The "rules of the road" need to be revised.

2. The proposal to exclude the noninstrument-rated pilot from the High Density airports seems reasonable but could be tempered by adding "unless he has demonstrated his ability to operate at that airport."

3. The Flight Test Guides for both the private and commercial licenses specify that an approach and landing at an unfamiliar airport, when practicable, will be included. It would be even better, in Mr. Gallagher's view, if an unfamiliar controlled airport were specified.

4. More SID's, STAR's, and Preferred Routes would reduce the amount of verbage and the probability of misunderstanding. DME on the ILS would also relieve the controller of the burden of giving position information, besides making the approach safer with continuous information.

5. Wires on approaches to airports may contribute only in a small way to the collision problem, but they contribute significantly to the total accident toll, and action should be taken to remove them.

6. Clarify Control Zone restrictions for the benefit of controllers.

COMMONWEALTH SCIENTIFIC CORPORATION

Mr. George R. Thompson, of the Commonwealth Scientific Corporation, wrote to the Board that his company has been developing a product that may help reduce the midair collision problem. This product is a coating which, when applied to the surface of the aircraft, will enhance both its optical and radar reflective characteristics. Mr. Thompson estimates that the efficiency of the reflected surface would be increased by a factor of several thousand over the reflective properties on existing surfaces. He estimates the cost to be a few dollars per square foot.

CESSNA AIRCRAFT COMPANY

The Cessna Aircraft Company, Wichita, Kansas, completed an in-depth study of the FAA proposal for control areas, and of the alternative proposals by the AOPA, ALPA, and other organizations for improved air traffic separation. Based on this study, Cessna issued a policy statement. The policy statement was sent to the National Transportation Safety Board for consideration at the hearing.

In comparing the FAA plan for terminal control areas with the AOPA/ALPA plan for high-performance corridors, the Cessna study noted the following similarities:

1. Both plans provide for additional controlled airspace in which to ensure separation of high-performance aircraft under positive control from uncontrolled traffic.

2. Both plans recognize the need for additional maneuvering room in the immediate vicinity of the terminal. The main difference in this area is whether this space around the terminal is under "positive control."

3. Both plans will carefully consider local conditions in determining the exact shape and position of controlled airspace.

The Cessna study also noted several significant differences between the plans. The differences are:

1. The FAA plan would require radar beacon transponders for all aircraft entering the terminal control area, except during published times. The AOPA/ALPA plan would not require transponders, since the airport traffic area would function as at present. It was Cessna's view that, if VFR weather exists, or if a satisfactory radar return is received from the aircraft, there should be no reason for exclusion of the aircraft from the terminal area just because it was not equipped with a transponder.

2. The FAA plan calls for all pilots operating in the terminal control area to have at least a private pilot certificate. Any pilot requesting and receiving an ATC clearance should be able to follow the instructions given him. However, there is no reason to believe that a pilot will be better able to operate in a terminal control area simply because he has a private pilot certificate. Such a restriction would reduce the number of training operations in the terminal area; however, Cessna pointed out that many flight schools have been moving from high-density terminals to outlying airports on their own initiative. Many airports, such as Tulsa, Phoenix, Oakland, Austin, and, in the near future, Wichita, have these separate provisions for general aviation operations. Separate communications frequencies for the general aviation runways have been established at airports, such as Phoenix. It was Cessna's suggestion that the appropriateness of flight training at specific airports be an individual rather than a blanket decision.

3. The provision that VFR operations in the terminal control area require a cloud ceiling of at least 1,500 feet must be reconsidered. Cessna thought that the long and successful history of VFR operations with a minimum ceiling of 1,000 feet demonstrates that higher ceilings are not a prerequisite to safety.

INSTRUMENT SYSTEMS CORPORATION

The Instrument Systems Corporation (ISC) of New York, presented a brief paper containing its position on the midair collision problem.

ISC is presently under contract to the United States Naval Air Systems Command to develop and build a flight test feasibility model of an aircraft collision avoidance system. This is a nontime-frequency system which utilizes an interrogator-transponder technique and is applicable to commercial and private aircraft as well as military aircraft.

Instrument Systems Corporations Aircraft Collision Avoidance System is designed to determine the threat of a real collision (with a minimum of false alarms), provide audio and visual alarm to the pilot, and provide him with concise information enabling him to make a safe avoidance maneuver in the available time.

After a detailed description of the system and its operation, ISC indicated that they are building a feasibility model. A flight test model was to be delivered in January 1970. They stated that there are various areas in which work remains in order to fully meet the civil aviation requirements imposed. Some of these areas are as follows:

a. Develop a special purpose processor.
b. Reduce system cost.
c. Decide on best pilot indicators from several alternatives.
d. Determine location and number of antennas required by various type of aircraft.
e. Analyze various correlation techniques.
f. Evaluate the system in a simulated high-density environment.

It is ISC's opinion that a major effort must be directed to developing an ACAS that will meet the requirements of:

a. Reliability.
b. Low false alarm rate.
c. Small size and weight.
d. Low cost, especially for small aircraft installations.

As far as ISC is concerned, this translates into a requirement for thorough investigation into systems other than the ATA-supported time-frequency system.

LITCHFORD SYSTEMS

Mr. George B. Litchford, of the Litchford Systems, suggested a Proximity Warning Indicator for general aviation which utilizes the signals transmitted by transponders which could provide a pilot alert to

the presence of another transponder-equipped aircraft in the vicinity. Each transponder would carry an additional simple receiver, which would listen for about 100 microseconds for replies of other nearby aircraft to interrogation from ground secondary radar. Limited "listen-in" period, coupled with narrow radar beam, limits replies to only those aircraft which are nearby. This feature could also provide an audible warning to the controller that two aircraft are close to each other.

Since all of the aircraft, in Mr. Litchford's view, seem destined to carry transponders, and the suggested system is fully compatible with the transponder and FAA ground displays, he suggests it is the direction to go. Further, it is expected that the add-on cost would only be $400 to $500 at most.

Mr. Litchford offered the above system as a means of reducing the midair collision problem.

ELECTRONIC INDUSTRIES ASSOCIATION

Mr. George D. Butler, president of the Electronic Industries Association (EIA), stated that he and his association are very much concerned with the entire problem to increase the effectiveness of air traffic control systems and that, if this is done, considerable improvements will result in many safety areas including that of midair collisions. He further stated that in July 1969, the Air Traffic Control Committee of EIA submitted its recommendations on the subject of Air Traffic Control to the Secretary of Transportation.

The aforementioned recommendations, in Mr. Butler's views, are pertinent to the hearing.

The recommendations are the result of a suggestion by the Secretary of Transportation to the Electronic Industries Association that a committee be established to review the air traffic control system planning in the United States and make recommendations for a traffic control system for 1980. The committee made the following findings:

1. The ATC system is of vital importance to the United States, contributing to its economy, culture, and security.

2. The population growth and the expanding role of aviation have generated increased air traffic at a rate which is causing increasing degrees of saturation of air traffic facilities and decreasing aviation utility.

3. It is in the urgent national interest to expand and improve the air traffic control system to permit increased air traffic with improved safety and efficiency.

414-710 O - 71 - 6

4. Systems engineering and planning must be utilized on a continuing basis to design a satisfactory ATC system.

5. Responsibility and authority for the design and operation of the system must not be divided. The burden and authority should be placed on the FAA.

6. The FAA, then, needs major systems capability in order that the ATC system can grow and keep pace with the demand. There is, therefore, a need for:

a. A continuing and perpetuating systems engineering organization (long range concept and plans for the total system).

b. A research agency off line from the day-to-day operations but under the guidance of the systems engineering organization.

c. An operating organization that implements and operates the system utilizing the output of the research organization in accord with the plan of the systems organization.

7. After drawing an analogy between the ATC system and U. S. telephone system that, while expanding, must continue to provide service, they indicated that the systems engineering organization should formulate the plan for new equipment implementation, should guide the research and development, and should be directly responsible for the test and evaluation of hardware.

8. The air traffic control system need not be built around new and untried ideas.

9. The FAA should continue to improve their contracting operation by simplification, elimination of unnecessary and onerous detailed specifications, and should work with the electronics industry, not only to improve its own contracting efficiency, but to provide greater capability within the industry to supply major elements of the system which could be used by the military or by other countries.

10. One of the major problems of the recent past has been inconsistent and insufficient funding for an ATC Development Program. The committee considers that the recent estimates by the FAA of approximately $250 million a year funding needs for new equipment and facilities should be considered a minimum level.

The Air Traffic Control Committee of Electronic Industries Association believes that, if we are to cope with the monumental growth of air traffic now forecast, the establishment of this systems engineering/management organization within the FAA is urgent.

AEROSPACE INDUSTRIES ASSOCIATION

The Aerospace Industries Association (AIA) submitted a statement for entry into the midair collision hearing record. A summary of the statement follows:

> The Aerospace Industries Association is the national trade association of companies engaged in the research, development, and manufacturing of aerospace systems including aircraft, missiles, astronautical vehicles, and their propulsion and control units. The AIA has had a basic goal -- the promotion of aviation safety.
>
> In AIA's opinion, a safe system is composed of three elements: (1) the aircraft, (2) the aircrew, and (3) the air traffic control system. The failure of any one of these elements can lead to a collision. The member companies of AIA are primarily concerned with, and are constantly working to improve the inherent safety of, the vehicle and the interrelationship between the vehicle and crew to enable the aircrew to perform more safely its function. However, because of the complex relationships that exist among the aircraft, the aircrew, and the air traffic control system, the basic problem of midair collisions is obviously not one capable of unilateral solution on the part of any one element of the system, such as the vehicle manufacturers.

The AIA stated that these hearings will serve a most valuable function and could enable NTSB to make a major contribution toward the solution of this problem. To date, both adequate priority and a central focal point to define the basic objectives and technical parameters of a system to prevent collisions have been lacking. A central point for a coordinated effort, particularly, is necessary and must be established.

AIA pointed out that industry will continue its active support and development of aircraft improvements in conjunction with the operators and Government agencies to provide an air transportation system as safe as it is humanly possible to make it.

CITIZENS FOR AVIATION SAFETY

On May 6, 1970, the Citizens for Aviation Safety (CFAS) submitted a statement for the record in which it took exception to a recent amendment to the FAA's Air Traffic Procedures Manual. CFAS pointed out that, as a result of a midair collision near Carmel, New York, on November 12, 1965, the provision, Merging Target Procedures, was introduced and was included in the manual. CFAS stated that, on April 1, 1970, the FAA amended the manual for both terminal and en route traffic control so that there was no longer a requirement for a controller to inform an air carrier aircraft, not known to be separated by the required increments of altitude if it was indicated on the radarscope, that the air carrier aircraft was going to merge with another target.

CFAS compared the merging target procedure to another pair of eyes in the cockpit. The procedure, in their opinion, was cost-free and did not place an unacceptable burden on the existing air traffic procedure. They recommended that the Air Traffic Procedures Manual retain the Merging Target Procedures as a separate and independent section, rather than place it under the "Additional Services" section of the manual.

APPENDIX 2

RECOMMENDATION CORRESPONDENCE BETWEEN THE BOARD

AND THE FAA ON THE MIDAIR COLLISION PROBLEM

APPENDIX 2

TABLE OF CONTENTS

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

January 30, 1970

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Washington, D. C. 20590

Dear Mr. Shaffer:

During the Board's public hearing on the midair collision problem, several witnesses expressed a need for standardizing traffic patterns at airports as one means of reducing the midair collision potential. It was pointed out that the present trend is toward establishing special traffic rules at an increasing number of airports scattered throughout the country. This lack of uniformity creates confusion among general aviation pilots by requiring them to remain constantly current as to the many rule changes that occur at some of the airports into which they operate. It was further stated that a reduction in the number of exceptions required, by unusual airport conditions, would lessen pilot confusion and improve the safety of terminal area operations.

The Board believes that the suggestion relating to standard traffic patterns has considerable merit. This is particularly true in view of the increasing number of airports utilizing special traffic patterns, the limited procedures specified in Part 91 of the Federal Aviation Regulations, and limited guidance material provided in the Airman's Information Manual. However, the Board is well aware of the difficulties inherent in establishing a traffic pattern criteria that can be applied to most of the many U. S. civil airports, both controlled and uncontrolled.

Accordingly, we recommend that you consider convening a special Government/Industry meeting in the near future for the purpose of discussing the factors involved in establishing standard traffic patterns and initiating action leading to their creation.

Sincerely yours,

John H. Reed

John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

12 FEB 1970

Honorable John H. Reed, Chairman
National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

The views expressed in your letter of 30 January 1970 regarding standard airport traffic patterns are appreciated.

We share your concern for minimizing the midair collision potential around airports. Following our analysis of the near-collision data collected in 1968, we reopened our study of airport traffic pattern criteria which had been more or less placed in abeyance after receipt of public reaction to Advance Notice of Proposed Rule Making 63-8. The requirements expressed by users in response to the Notice were so diverse, conflicting and uncompromising as to indicate the infeasibility of proceeding with an arbitrary rule at that time.

In our further study of the matter, we have been in contact with user organizations on an informal basis. We should like to proceed in this manner for the time being, although we shall certainly give consideration to your recommendation that a Government/Industry meeting be convened in order to develop criteria which will bring about the requisite improvement in safety.

Sincerely,

D. D. Thomas

D. D. Thomas
Acting Administrator

2 Enclosures:
ANPRM 63-8
Withdrawal of ANPRM 63-8

UNITED STATES OF AMERICA
FEDERAL AVIATION AGENCY
AIR TRAFFIC SERVICE

(14 CFR Part 60)

(Notice 63-8 ; Docket No. 1620)

ADVANCE NOTICE OF PROPOSED RULE MAKING

Operation on and in the Vicinity of Airports Without a Control Tower

The Federal Aviation Agency is considering an amendment to § 60.18 of the Civil Air Regulations relating to the standardizing of traffic pattern flight procedures at "uncontrolled airports"—those airports at which a tower is not available to provide airport traffic control service.

Section 60.18(c) of the Civil Air Regulations at present contains provisions dealing with communication requirements, the direction of turns when landing, and compliance with established traffic patterns when departing. It appears necessary, however, to determine whether these are adequate to provide for safety without additional provisions concerning such elements as traffic pattern entry procedures, traffic pattern altitude and speed requirements, use of specific runways, crosswind operations, and avoidance of traffic patterns by en route aircraft. These present some fairly complex problems and participation by all interested persons is desired at an early stage to assist the Agency in developing such changes in the regulation as it considers necessary, in the manner most informative to interested persons.

For this purpose, the Agency invites comments and suggestions from interested persons. All communications should be in duplicate and mailed not later than May 2, 1963 to the Docket Section of the Federal Aviation Agency, Room A-103, 1711 New York Avenue NW., Washington 25, D.C. Because of the large number of comments which this notice should bring, the Agency will be unable to acknowledge their receipt, but all comments will be considered in the development of the proposed rule. All comments submitted will be available in the Docket Section for examination by interested persons at any time.

This notice is being issued pursuant to a policy, recently adopted by the Agency, concerning the issuance of "Advance Notices of Proposed Rule Making" in certain cases when it has been determined that the resources of the Agency and reasonable inquiry outside the Agency are not likely to provide a sufficient basis to identify and select all tentative or alternate courses of action upon which rule-making action might be undertaken, or when it would be helpful to invite early public participation. The subject matter of this notice involves the situation contemplated by this policy. If it is determined to proceed further, after considering the matter in the light of available information and comments received in response to this notice, a further notice of proposed rule making will be issued.

The Agency has previously prescribed regulations to standardize traffic pattern flight procedures at airports with towers providing airport traffic control service. The notice of proposed rule making preceding those regulations discussed the need for standardization at uncontrolled airports and stated that the matter would be further considered in a future proposal. Some of the comments received in response to that notice contained suggestions and comments with respect to uncontrolled airports. These have been evaluated by the Agency. Together with Agency consideration of other information, they have resulted in developing a number of items which could be considered as the elements of standard traffic pattern flight procedures. These are:

1. Traffic Pattern Components.
2. Traffic Pattern Entry Procedures.
3. Traffic Pattern Altitudes.
4. Aircraft Speed.
5. Calmwind, Crosswind, and Downwind Operations.
6. En Route Operations.
7. Straight-in Approaches.
8. Right-of-way.
9. Departure Procedures.
10. Communications.

This list, of course, is not exclusive and comments are not restricted to those items if any person believes that the list should be amended in any way.

1. *Traffic pattern components.* It is probable that any standardization would necessitate establishment of a standard traffic pattern to be used at all uncontrolled airports to which it can be adapted. Lack of standardization in this respect could so seriously impair the effectiveness of any other uniform procedures as to make them inadequate for the purposes intended. It is contemplated that a standard traffic pattern—with either left or right turns, as appropriate—would encircle the landing runway and would consist of the following:

a. Upwind leg: A flight path in the direction of landing, parallel to the landing runway, and a sufficient distance from the landing runway to permit observance of other traffic operating on the airport.

b. Crosswind leg: A flight path perpendicular to the direction of landing and upwind of the landing runway.

c. Downwind leg: A flight path opposite to the direction of landing, parallel to the landing runway, and a sufficient distance from the landing runway to permit a normal turn to the base leg and a subsequent normal turn to the final approach.

d. Base leg: A flight path perpendicular to the direction of landing and sufficiently downwind of the approach end of the landing runway to permit at least a 1,000 foot final approach after completion of a normal turn on final.

e. Final approach: A flight path in the direction of landing wherein an aircraft is in line with the landing runway and descending toward the runway threshold.

2. *Traffic pattern entry.* It has been a long established and common practice to enter traffic patterns on the upwind, downwind or crosswind leg at an angle of approximately 45°. Usage would indicate the desirability of establishing this type of entry as the uniform procedure. At the same time, the specific entry procedure may not be so necessary to safety that other entry procedures should not be permitted, particularly entries made straight-in on the upwind, downwind or crosswind leg, and this is being considered. Consideration of entry procedures necessitates also determination of the minimum extent of flight within the traffic pattern. It appears at the present time, that entry on the base leg or on the final approach leg should be prohibited. A turn of at least 180° within the traffic pattern is indi-

cated by present analysis.

3. *Traffic pattern altitudes.* Recommendations concerning traffic pattern altitudes have varied greatly. Their prescription would involve questions of providing latitude in both altitude and lateral dimension. For example, should small aircraft be permitted to operate low and close to the airport and large aircraft to operate higher and farther away? It might be desirable to have a "standard" light aircraft pattern at 600 feet with a separate circular pattern for large aircraft at 1,200 feet, since large aircraft cannot conform to a small aircraft rectangular pattern without violent maneuvers and steep banks which result in passenger discomfort and increased hazard. On the other hand, a standard altitude of 1,000 feet might be safer, since a traffic pattern which calls for slow aircraft (which are usually high wing) to fly below fast aircraft (which are usually low wing) could result in impairing the pilot's ability to see other aircraft in the pattern. It is possible with a single traffic pattern altitude that the smaller and lighter planes would normally fly a closer-in pattern than the larger and faster aircraft, thus providing a natural separation of the two kinds of traffic.

4. *Aircraft speed.* There has been considerable study of, and comment on, the subject of aircraft speed in traffic patterns and in the vicinity of uncontrolled airports. The basic question has yet to be answered conclusively, as has the question of specific speeds.

5. *Calmwind, crosswind, and downwind operations.* There have been numerous reports of incidents resulting from simultaneous operations on crossing runways, as well as from opposite direction operations on the same runway. Although the degree of hazard from such operations may vary according to location, it appears that any mixture of downwind, crosswind, and into-the-wind operations at the same airport increases the risk of collision between aircraft. It would also appear that any provision which would allow crosswind and downwind operations for training or for economic reasons would, for practical purposes, allow takeoff and landing in any direction, on any runway, at any time. It may be that landings and takeoffs should be permitted only in the direction indicated by the landing direction indicator at an airport so equipped; at other airports, landings and takeoffs should be made on or parallel to the runway most nearly aligned into the wind. Exceptions would have to be made in the interest of safety; for example, use of a longer runway should be permitted by certain aircraft due to safety considerations, even though wind direction might indicate use of a short runway.

6. *En route operations.* While segregation of en route traffic from landing and departing traffic at uncontrolled airports is undoubtedly desirable, strict avoidance of airport traffic patterns by en route aircraft would raise the minimum en route altitude for VFR flight to an unacceptable level in some areas. This disadvantage could be overcome by a "when possible" provision, but this would seriously weaken the effect of the rule. As an alternative, en route aircraft might be required to either avoid an airport traffic pattern or conform to it.

7. *Straight-in approaches.* The Agency has received many recommendations that the regulations be written to prohibit straight-in approaches at uncontrolled airports on the basis that they are hazardous and unnecessary. By circling the airport the pilot has an opportunity to sequence his aircraft with other traffic flying the pattern, to observe the field conditions, and to see and be seen by other traffic which may be approaching to land or preparing to take off. On the other hand, a straight-in approach reduces the flying time in the vicinity of an airport which is a factor contributing to safety and economy. If straight-in and pattern approaches are both permitted, an aircraft on a straight-in approach should be required to give way to other aircraft in the pattern when proper spacing and sequencing are required, and prior to starting a straight-in approach the pilot should be required to determine, either by visual means or by radio, which runway is in use.

8. *Right-of-way.* There is general agreement that en route aircraft, or aircraft entering a traffic pattern, should be required to give way to aircraft operating in the pattern. There also appears to be general agreement that an aircraft making a straight-in approach should be required to give way to aircraft in the traffic pattern and that aircraft on final approach to land, or landing, should have the right of way over aircraft operating on the surface. One additional significant problem that must be considered in a traffic pattern proposal is that of right-of-way during crosswind or no-wind operations.

9. *Departure procedures.* Generally, the Agency considers that existing regulations relating to departure procedures are adequate in that they require pilots operating from an airport to conform to the traffic pattern established for that airport. Normally, a pilot has adequate opportunity to familiarize himself with the pattern before departure. However, in developing standard traffic patterns the adequacy of existing regulations regarding departure procedures must be considered, as well as the possible changes in departure procedures that may be required by proposed changes in approach and landing procedures.

10. *Communications.* Should there be any change in communications requirements? Where there is a unicom at an uncontrolled airport, it might be used to provide a form of airport advisory service. Even though the unicom might not be manned, if a pilot approaching the airport for landing were required to call on the unicom frequency, other aircraft in the area monitoring this frequency would receive the traffic information.

In order to simplify the classification and analysis of public comments on the various issues involved, and for convenience in the preparation of these comments, it is suggested that reference be made to the foregoing subjects by number.

Issued in Washington, D.C. on February 20, 1963.

D. D. THOMAS,
Director, Air Traffic Service.

(As published in the Federal Register; March 1, 1963)

[14 CFR Part 91 [New]]

[Reg. Docket No. 1620; Draft Release No. 63-8]

OPERATION ON AND IN VICINITY OF AIRPORTS WITHOUT CONTROL TOWER

Withdrawal of Advance Notice of Proposed Rule Making

On February 20, 1963, the Federal Aviation Agency published an advance notice of proposed rule making (14 CFR Part 60) concerning the operation of aircraft on or in the vicinity of airports without a control tower. The notice indicated that § 60.18(c) of the Civil Air Regulations [now recodified as Federal Aviation Regulation § 91.89 [New]] presently contains provisions dealing with communications requirements, the direction of turns when landing, and compliance with established traffic patterns when departing airports not having a control tower. The Agency believed it necessary to determine whether the present requirements of § 60.18(c) were adequate, or whether it was necessary for safety reasons to provide additional provisions such as traffic pattern entry procedures, traffic pattern altitude and speed requirements, use of specific runways, crosswind operations and avoidance of traffic patterns by en route aircraft. The public was invited to submit written comments and suggestions concerning this proposal. In addition, the Agency scheduled a series of informal conferences to be conducted during October and November 1963, at Philadelphia, Birmingham, Des Moines, Houston, Denver, Phoenix, Seattle, Oakland, Anchorage, and Honolulu, so that interested persons could express their opinions and make recommendations.

Many segments of the aviation industry responded through written comment to the advance notice. Because of the number and diversity of these comments, no effort will be made to individually treat them in this notice. The Agency also made a written record of the comments, opinions and recommendations expressed by persons who appeared at the various informal conferences.

After reviewing the comments and reconsidering all facets of this matter, it has been determined that at this time the present regulation is adequate and a more definitive traffic pattern rule would serve no useful purpose. A universally applicable standard traffic pattern rule would be excessively burdensome to aircraft operators. The complexities associated with catering to the diverse circumstances and situations at the large number of airports in the United States would constitute overregulation and provide little if any improvement in safety. The proposed rule change would therefore not be in the public interest.

In consideration of the foregoing, the advance notice of proposed rule making entitled "Operation on and in the Vicinity of Airports Without a Control Tower," and circulated as Notice 63-8, is hereby withdrawn.

This withdrawal shall become effective on publication in the FEDERAL REGISTER.

Issued in Washington, D.C., on October 1, 1964.

CLIFFORD P. BURTON,
Acting Director,
Air Traffic Service.

[F.R. Doc. 64-10215; Filed, Oct. 7, 1964; 8:46 a.m.]

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

January 30, 1970

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Washington, D. C. 20590

Dear Mr. Shaffer:

During the public hearing on the midair collision problem, our attention was directed to the absence of a training requirement for the proper method of time-sharing or scanning programs, both inside and outside the cockpit. The testimony of Mr. E. King Stodola (pages 791-815) was quite interesting in this regard. It is noted, also, that there are no visual training aids for external target detection and definition incorporated in the present simulators, nor has any requirement for a visual training aid of this type been laid down for the simulators that are now under development.

It is recognized that many devices and systems are now in the process of development; however, these devices are now in the embryonic stage and will take time to bring to fruition. Also, many of these devices are expensive and, in order to be effective, they would be required on all aircraft. This is not to suggest that development of these systems cease but, since we do not have the luxury of time, we must take steps to improve and utilize what is now available.

A study performed, by Gabriel and Burrows, at the Douglas Aircraft Division, Long Beach, California, February 1968, for the Naval Training Devices Center did show that through training for "time-sharing" of the pilots' attention, very large gains could be achieved in the probability of detection. Also, there was a definite extension of the mean time during which the pilot was looking outside of his aircraft. This study was performed on single-piloted aircraft. However, it can be hypothesized that the increases gained would be equal, if not greater, in multipiloted, air carrier aircraft.

It is recommended that a requirement be added to the present Federal Aviation Regulations for ground training of pilots in the proper scan patterns to optimize the probability of detecting other

aircraft and to increase the effective time the pilot's eyes are looking outside of the cockpit. Also, a requirement for the adaptation of visual training aids for outside target detection and definition should be added to the simulators now in use or being developed for future use.

It is recognized that the above steps are made toward the large commercial segment of the aviation industry and there is as great a need for a training program for the private pilot as for the airline pilot. Therefore, a program whereby scan patterns and target detection are included in the training program for licensing and upgrading of the private pilot is necessary. Also, action to expedite the development of visual training aids of a less exotic nature than those required for simulators should be given a high priority--these aids to be made available to the private pilots through fixed-base operators and other appropriate outlets.

Sincerely yours,

John H. Reed

John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

9 FEB 1970

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

This is in response to your letter of 30 January 1970, which recommended that a requirement be added to the present Federal Aviation Regulations for ground training of pilots in the proper scan patterns to optimize the probability of detecting other aircraft and to increase the effective time the pilot is looking outside the cockpit.

In this regard, you recommended that we establish a requirement for visual training aids for outside target detection to be adapted to simulators now in use and those being developed. You also recommended that we take action to expedite the development of less exotic visual training aids to be made available to private pilots through fixed based operators and other appropriate outlets.

You may be aware that in 1967, we looked into the U. S. Navy studies being conducted in a generalized flight simulator to improve visual time-sharing. Our contact with the U. S. Navy and the Douglas Aircraft Company indicated that further studies should be conducted to determine whether there should be a training requirement for air carrier and/or general aviation pilots in order to improve the collision avoidance situation.

The FAA NAFEC facility conducted a research study in 1968-69, Project 560-103-04X, under which four FAA certificated general aviation flight schools evaluated low cost collision avoidance ground training equipment in the development and/or improvement of pilot scan/search technique by time-sharing practice in a pilot ground trainer. The results of the study were positive and showed decided improvement in pilot scan and target detection abilities after ground training.

In November 1969, the FAA held a meeting to determine further action to be taken on the basis of the project results, and it was recommended that efforts be continued to improve ground training equipment and that the evaluation by flight training centers should be extended. The Flight Standards Service fully supports this effort and an Advisory Circular pertaining to collision avoidance training is in preparation.

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The NAFEC study final report is being reproduced to be furnished to all general aviation FAA certificated flight schools, together with a detailed engineering description, schematics and detailed parts list, sufficient for use by those flight schools that may desire to fabricate equipment for use with their pilot ground trainers.

United Air Lines has expressed interest in our endeavor and has asked that one collision avoidance ground training device kit be loaned for use at the UAL training center. They intend to evaluate the adaptability of such device on a pilot procedural trainer and a simulator to determine its applicability to pilot training. We hope that other air carriers will show a similar interest.

Regulatory action to set a training requirement is not appropriate at this time due to the incomplete stage of development of suitable devices. When more complete information has been obtained on the adaptability of collision avoidance scan pattern training devices to procedural trainers and simulators and on the feasibility of manufacturing reasonably low cost training devices for general aviation, we will be in a better position to consider regulatory action.

Sincerely,

D. D. Thomas

D. D. Thomas
Deputy Administrator

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

April 3, 1970

OFFICE OF
THE CHAIRMAN

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Washington, D. C. 20590

Dear Mr. Shaffer:

Your letter of February 9, 1970, in response to the Board's recommendation for regulatory action in ground training and training devices to improve pilot's scan patterns has been received and evaluated.

It is gratifying to note that further development is occurring in these areas. However, the present midair collision hazard is such that we can ill afford to wait for the optimum system. Your letter indicates that positive results were obtained during the evaluation of low cost devices for which specifications are now available. It was, also, noted that positive results were obtained in the Douglas tests. In our view, it is important to adopt now any practical system that will reduce the probability of midair collisions. This could be accomplished, even though it might be only an interim measure, by initiating appropriate regulatory action to require training in the detection of other aircraft. This would not hinder the development of more sophisticated systems, but would reassure the public that corrective measures are being taken without delay.

We recommend, therefore, that you reconsider your position and initiate regulatory action requiring ground training of pilots in the proper scan patterns to optimize the probability of detecting other aircraft. It is recommended further that the simulators, now

in use or being developed for future use, be required to possess the capability for visual training in outside target detection and definition. Needless to say, the latter requirement should be mandatory for all simulator training and checking that is anticipated for the future.

Sincerely yours,

John H. Reed

John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

13 APR 1970

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

This is in reply to your letter of 3 April 1970, recommending that the Federal Aviation Administration (FAA) reconsider its position stated in the letter of 9 February 1970, and initiate regulatory action requiring ground training of pilots in the proper scan patterns to optimize the probability of detecting other aircraft.

Your views are appreciated, however, we remain convinced that regulatory action to set such a training requirement is not appropriate at this time. It strikes us as impractical to set a requirement for the use of training equipment which is not generally available.

We believe it is more constructive to pursue the voluntary cooperation route which we embarked upon when arrangements were made to reprint and distribute the NAFEC study final report with the schematic and parts list for a "home built" training device to all of the general aviation FAA certificated flight schools.

The matter of encouraging the air carriers to incorporate collision avoidance training with flight crew simulator training is less clear-cut. United Air Lines, you will recall from our 9 February 1970 letter, expressed interest in obtaining one collision avoidance ground training device kit on loan. Unfortunately, United's B-727 simulator at Denver was destroyed by fire and it will be some time before United can evaluate the adaptability of this device.

Our Aircraft Development Service is currently making contact with other major U. S. air carriers for the purpose of evaluating the adaptability of a video device for collision avoidance scan pattern training to an aircraft simulator.

We believe that the foregoing summarizes why we do not consider it prudent now to impose regulatory requirements upon either the general aviation or air carrier industry.

Sincerely,

J. H. Shaffer
Administrator

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

January 30, 1970

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Washington, D. C. 20590

Dear Mr. Shaffer:

During the course of the public hearing on the midair collision problem, our attention was directed to the advantages inherent in the publication of Terminal Area Notice Charts in Part 3 of the Airman's Information Manual. Specifically, it was pointed out that such a chart, pertinent to the Chicago area, has been in existence since 1965. The chart is also printed on the back of the Chicago Area Local chart. It was developed by the FAA Traffic Advisory Committee in Chicago "to indicate to the operators of small or VFR aircraft the most commonly used thorofares of the IFR traffic into and out of O'Hare."

The designation of terminal control areas and corridors, in consonance with your recent Notice of Proposed Rulemaking 69-41, should not negate the value of Terminal Area Notice Charts similar to those presently in existence for the Chicago area.

In many terminal areas where a mixture of general aviation aircraft with air carrier and/or military aircraft is the rule, the development of charts depicting IFR and VFR corridors, similar to the Chicago area chart, would be most useful.

We recommend, therefore, that you review the Chicago Terminal Area Notice Chart in Part 3 of the Airman's Information Manual with a view toward expediting the development of similar charts for other terminal areas, wherever the mixture of traffic tapes warrants such action.

Sincerely yours,

John H. Reed

John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

9 February 1970

Honorable John H. Reed
Chairman
National Transportation Safety Board
Washington, D. C. 20591

Dear Mr. Chairman:

Thank you very much for the recommendation in your letter of 30 January 1970 concerning development of charts similar to the Chicago Terminal Area Notice now in the Airman's Information Manual (AIM).

We presently have a program underway to have graphic notices prepared, similar to the one published for the Chicago Terminal Area, covering terminal areas where there is a considerable mixture of air carrier/ military aircraft and general aviation aircraft. These areas should encompass most, if not all, of the 22 large hubs plus selected medium hubs.

In addition to their publication in the AIM, these graphic notices will be issued as Advisory Circulars and distributed free in the manner calculated to reach the widest possible aviation audience. Copies for free distribution will be obtainable from FAA field installations and will be provided as an accompaniment to the appropriate Sectional Charts; reproduction copies will be made available to aviation magazines and chart producers; and, where space is available, the notices will be reproduced on existing government charts.

We are confident that our approach, which is directly in line with your recommendation, will be most useful in enhancing safety.

Sincerely,

D. D. Thomas

D. D. Thomas
Deputy Administrator

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

March 26, 1970

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Department of Transportation
Washington, D. C. 20590

Dear Mr. Shaffer:

Reference is made to your Advance Notice of Proposed Rule Making 70-7 entitled "Anticollision Light Standards." The Board supports the earliest possible culmination of regulatory action designed to require the installation of white strobe lights on all aircraft and to require further that such anticollision lights be operated whenever the aircraft is being operated.

In this connection, your attention is invited to one of the recommendations contained in our letter to you of July 23, 1969. This recommendation was directed to the consideration of ". . . the establishment of requirements for the installation and day and night operation of high-intensity white flashing lights on all civil aircraft." We do not have a specific proposal with respect to the candlepower of such lights. Such lights are beneficial not only from the standpoint of their direct conspicuity, but also from their use in conjunction with "pilot warning indicators" (PWI).

We are enclosing herewith pertinent excerpts from the testimony received at our recent hearing on the midair collision problem in the interest of documenting the magnitude of government and industry support which already exists for the white strobe light requirement.

Sincerely yours,

John H. Reed

John H. Reed
Chairman

Enclosure

SUPPORT FOR WHITE STROBE ANTICOLLISION LIGHTS

EXCERPTS FROM THE TESTIMONY OBTAINED DURING THE BOARD'S PUBLIC HEARING ON THE MIDAIR COLLISION PROBLEM

1. NATIONAL PILOTS ASSOCIATION

Page 77 - "NPA supports a joint and noncompetitive program between FAA and NASA in developing a proximity warning indicator, preferably of the noncompatible type. A system employing the infrared detection from strobe light emission suggests itself as an ideal answer, especially since the strobe light in itself is of great value and low in cost."

2. AIRCRAFT OWNERS AND PILOTS ASSOCIATION

Page 156 - "There has been a lot of talk, for example, of high intensity beacons, strobe lights, if you will. Currently, we do have on most general aviation airplanes, without exception I think, except for some of the older ones, rotating beacons. But these are not always easy to see in the daytime. We think a high intensity static discharge light, for example, could replace this and be easier to see."

3. NATIONAL BUSINESS AIRCRAFT ASSOCIATION

Pages 251-252 - "It is our contention that immediate enhancement of aircraft sighting can be provided by the installation of condenser discharge lighting on all aircraft; this lighting to be used both day and night and be required to have a minimum infrared or IR content. The research and development of IR sensors by industry is long past the stage where usable hardware can be produced and marketed at a reasonable cost.

"The installation and continuous use of strobe lighting can be made mandatory immediately with compliance with the IR content to follow at some reasonable time. This installation would permit the operator of the aircraft the added prerogative of installing a sensing device that would extend his visual range at the time he needs it the most."

4. AIRLINE PILOTS ASSOCIATION

Page 343 - "I would say we would very much welcome strobe lights on all aircraft. We have seen demonstrations and certainly they stand out far better than anything you can get."

Page 344 - "There are some lights which do a good job. I saw fit to put one on my little airplane. It was $200.00 installed and the price has gone down since then. They do a good job for that money."

5. ALLIED PILOTS ASSOCIATION

Page 392 - "It is a delightful thing to have when you land at night--just beautiful--and I am always very happy to be able to turn on the strobe lights and let them flash away. I know when I saw other airplanes with a similar lighting system, companies using the same thing I could see them for a great distance. I didn't attempt to measure them, but it is really excellent.

"In the daytime, I can't really say I saw it made any difference. We operate with them day and night, and I can't say I observed any difference in the daytime."

6. AIR TRAFFIC CONTROL ASSOCIATION

Page 473 - "At night there isn't any question about it. You can see a guy for 50 miles and that is great. In the daytime, I am not so sure. There is some benefit I am sure of that but how much I really would have difficulty in putting a finger on it."

7. NATIONAL ASSOCIATION OF AIR TRAFFIC SPECIALISTS

Page 600 - "Determine immediately the feasibility of a requirement for installation of high-intensity white lights flashing, for both day and night operation on all aircraft in the system. I don't think this has to be elaborated. Everybody is in agreement that will work. It should be done."

8. FEDERAL AVIATION ADMINISTRATION

Page 652 - "We have had fifteen years of allowing most anyone to experiment with this, to get a better system on light conspicuity, and we are coming to a decision point next year."

Page 704 - "Somewhere we have to come up with something, after 14 years of trying, something a lot better. We have a lot of experimental types out there to pick from, and next summer I think is the year of decision on what a standard best lighting system in this country for airplanes will be."

9. DEPARTMENT OF DEFENSE

Page 737 - "At nighttime there is a definite advantage - in daytime there is a question as to what benefit it would be. At this state we haven't reached a firm position as to which one we would endorse."

10. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Pages 2 and 3 of Their Written Statement - "One of the pilot warning systems under development by NASA uses an optical technique which operates in the infrared part of the spectrum and depends upon detection by one aircraft of the radiation from a xenon lamp installed on other aircraft. This xenon flashing lamp is presently installed on many aircraft for conspicuity enhancement and delivers a brilliant white flash visible over long distances. The same light also gives off very strong radiation in the infrared range in several very narrow bands as shown in Figure 1."

COPY

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Washington, D. C. 20590

Office of
The Administrator

6 APR 1970

Honorable John H. Reed
Chairman, National Transportation
Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

Thank you for your useful comments and suggestions on our Advance Notice of Proposed Rule Making (Notice 70-7) concerning anticollision light standards. Your letter will be docketed and its contents will be given full consideration before we take our next regulatory step.

Sincerely,

/s/ J. H. Shaffer

J. H. Shaffer
Administrator

414-710 O - 71 - 8

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

July 23, 1969

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Department of Transportation
Washington, D. C. 20590

Dear Mr. Shaffer:

We are pleased to enclose herewith 10 copies of our recently completed special study, "Midair Collisions in U. S. Civil Aviation - 1968."

The study showed that, during calendar year 1968, there were 38 midair collisions involving 76 aircraft, a 46 percent increase in the number of midair collisions over the 1967 figure. In every 1968 midair collision accident, a general aviation aircraft was involved. In three cases, an air carrier was involved with a general aviation aircraft. In one case, a military aircraft was involved with a general aviation aircraft. In the remaining 34 instances, the collisions were between two general aviation aircraft.

Twenty-four of the 38 collisions resulted in 71 fatalities -- all occupants of general aviation aircraft. The 1968 fatality figure is 55 percent lower than the 1967 midair collision fatality figure. In 1967, the three air carrier aircraft involved in the collision accidents accounted for the vast majority of the fatalities.

Most of the 1968 midair collision accidents occurred at or near an uncontrolled airport, below 5,000 feet, in Visual Flight Rules (VFR) weather during the summer months and on the weekend.

The traffic in the airspace involved in the 1968 midair collision accidents was not congested and the closure rate between the aircraft involved was well below the cruise speed of the aircraft involved.

Honorable John H. Shaffer (2)

The air traffic control system was a factor in approximately 20 percent of the collisions, as was dual instruction. However, the majority of the midair collision accidents in 1968 occurred at uncontrolled airports. The major problem in the midair collision accidents was the failure of the pilot to adhere to the "see and be seen" concept--a concept that well may be, at least in high-density terminal areas, on its way to becoming outmoded, unsafe, and incompatible with saturated operating environments.

You will note that a number of recommendations are addressed to civil pilots and other elements of the aviation community. Notwithstanding, the Safety Board feels that additional measures should be taken by your Administration to further reduce the midair collision potential. We therefore recommend that the Federal Aviation Administration:

1. Undertake an educational program to make both pilots and controllers more aware of the midair collision problem, and to make pilots aware that most midair collisions occur at or near airports in clear weather and in daylight hours.

2. Establish a continuing program to assure indoctrination and continuing awareness on the part of all pilots to the midair collision potential and avoidance techniques (i.e., "see and be seen" concept, descent, turn, and climb maneuvering techniques, etc.).

3. Examine more stringently all pilot applicants for their external cockpit vigilance, with particular attention to pilots who are tested for flight instructor ratings.

4. Provide special warning and guidance to pilots who are required by the nature of their operations to fly in pairs.

5. Inform all certificated flight instructors of the high statistical significance of their involvement in midair collisions.

6. Encourage all instructor pilots to notify the control tower operator, at airports where a tower is manned, regarding first solo flights, and require the tower operator to advise other traffic in the pattern about such flights.

Honorable John H. Shaffer (3)

7. Conduct detailed traffic flow studies for all high-volume general aviation controlled airports with a view to improving the VFR traffic flow techniques of the ATC personnel.

8. Designate climb and descent corridors for high-performance aircraft at high-density airports.

9. Irrespective of the provisions contained in Part 91 of the Federal Aviation Regulations, establish standard entry, departure, and go-around procedures for each uncontrolled airport.

10. In cooperation with ESSA, develop and produce VFR approach and departure charts for selected airports with a high volume of traffic.

11. In addition to the requirements of Section 91.89 of Part 91 of the Federal Aviation Regulations, develop a requirement for the installation of surface pattern indicators (for day and night) at smaller airports which would define specific patterns, particularly the base leg and the final approach.

12. Reevaluate visual conspicuity standards for all civil aircraft.

13. Consider the establishment of requirements for the installation and day and night operation of high-intensity white flashing lights on all civil aircraft.

14. Support the expeditious development of low-cost Collision Avoidance Systems for all civil aircraft.

Please feel free to have members of your staff contact members of our Bureau of Aviation Safety for any further details.

Sincerely yours,

John H. Reed

John H. Reed
Chairman

Enclosures

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

9 SEP 1969

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

This is in response to the recommendations contained in your letter of 23 July 1969 concerning the midair collision problem.

Item 1. We concur with this recommendation and our efforts to make pilots and controllers aware of the midair collision problem have been and will continue as a major part of our educational programs. As an example a film titled "Strike" designed to present the facts of the midair collision problem and to show how operations can be more safely conducted in the complex airspace environment is in scripting with production scheduled for late fall. This film will be given wide distribution for presentations at safety meetings, clinics, seminars, aviation training schools, colleges and other educational institutions and on television.

Our safety efforts bearing on the problem are represented in numerous FAA publications such as advisory circulars, training manuals, flight test guides, Airman's Information Manuals, posters, etc. We plan continuous updating of publications when studies reveal areas where improvements can be made.

One of the principal functions of the Air Traffic Service is to prevent midair collision and controller training focuses on this most important safety factor throughout a controller's career. The FAA Near-Midair Collision Report of 1968 will be distributed in the near future and we are confident that this report will make controllers even more aware of the problem.

Item 2. We agree that indoctrination and continuing awareness of the midair collision potential should be stressed. In this regard, we plan to accentuate collision avoidance techniques beyond those presently covered in various FAA publications. This will be covered in an advisory circular on collision avoidance designed to reflect findings of both the FAA and NTSB studies. Our objective is to bring the aviation community's responsibilities to their attention continuously and to provide information which will promote and encourage flight practices which will reduce the probability of midair collisions.

Item 3. Certain of our flight test guides caution the applicant that attention will be given to the applicant's vigilance for other traffic and "clearing the area" before performing any maneuver which might result in a collision hazard. Others will be revised to include this. We have for some time directed pilot examiners to emphasize to both the applicant and flight instructor the proper relationship between cockpit vigilance and attention outside the aircraft as a part of pilot proficiency. Our Flight Training and Flight Instructor Handbook speaks to the importance of developing this practice early in training. We plan to stress this further in the proposed advisory circular on collision avoidance.

Item 4. The collision hazard involving two aircraft, which because of the nature of the operation requires flying in close proximity, is recognized. Pilots will be warned of the collision potential and of the necessity for arrangements between pilots to avoid flight conflicts in the proposed advisory circular on collision avoidance.

Item 5. All training material emphasizes the importance of vigilance and collision avoidance in flight training areas. We plan to summarize these in the proposed advisory circular on collision avoidance.

Item 6. We have encouraged the practice of student pilot identification to air traffic control facilities. Advisory Circular 90-8, "Radio Identification of Student Pilots" and the Airman's Information Manual encourages this procedure. We will also amplify the importance of this procedure in the proposed advisory circular on collision avoidance as well as encouraging flight instructors to notify the control tower prior to the initial solo flight of a student pilot. Until a determination is made concerning the controller's capability to absorb the additional workload and responsibility, we would be opposed to requiring a tower controller to advise all other traffic in the pattern that a particular flight is a student first solo. If the student is staying in the traffic pattern the controller would be routinely providing control and advisories. When a student pilot identifies himself in accordance with the General Operating Practices of Part I of the Airman's Information Manual the tower then provides such extra assistance and consideration as he may need.

Item 7. What is meant by "improving the VFR traffic control techniques by ATC personnel" is not quite clear to us. As is well known, such factors as noise considerations, adjacent airports, surrounding terrain, etc., can affect the traffic flow at individual airports as much as the control "techniques" in use. We agree,

however, that traffic flow studies should be conducted on a continuing basis with the publication of VFR ingress and egress routes and commonly used VFR checkpoints on appropriate aeronautical charts. (See comments on Item 10).

Item 8. At the present time we are working on a plan for selected high density terminals which will provide for the segregation and separation of traffic on a somewhat broader scale than would be possible under a corridor type concept. Although a final decision has not been made, we expect to issue an NPRM on our high density proposal for public comment in the near future. Meanwhile, we will continue to explore the feasibility of a corridor concept at lower activity locations.

Item 9. The FAA Near Midair Collision Report of 1968 has recommended establishment of traffic patterns at nontower airports. This recommendation is now under consideration. To further increase safety at nontower airports, Advisory Circular AC 90-42, Traffic Advisory Practices at Nontower Airports was issued. This circular establishes as good operating practice procedures for pilots to exchange traffic information when operating from nontower airports. The contents of this advisory circular are contained in the Airman's Information Manual.

Item 10. We plan to expand on the number of special maps published in the Airman's Information Manual. These maps are designed to provide information and guidance to pilots operating in high density traffic areas. They are prepared at the request of the regional offices of the FAA and show itinerant VFR routes, corridors, call-up and other related information. Source material used in the preparation of maps is obtained from the FAA field activities primarily concerned.

These data will also be shown, as appropriate, on large scale inserts of high density traffic terminal areas presently published on the new series of sectional aeronautical chart sheets and the local aeronautical chart series.

Item 11. The FAA has issued Advisory Circular AC 150/5340-5, "Segmented Circle Airport Marker System" which sets forth standards and practices recommended for airport marking. We assume your reference to "surface pattern indicator" to mean the same as "traffic pattern indicator" as used in the circular. We have specified that both traffic pattern indicators (L-shaped marker and amber light) are necessary for safety and regularity of air navigation.

The FAA encourages installation of these facilities at all airports and requires their installation at airports where Federal Aid to Airport funds are used.

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We have initiated a project for a Research and Development effort to develop an efficient, inexpensive and reliable landing direction indicator which will automatically or semi-automatically indicate the runway in use.

Item 12. After extensive research and study, consideration of exterior paint patterns was abandoned as not effective against all backgrounds and under various sighting conditions. What would increase conspicuity under one circumstance may camouflage an airplane under other circumstances. A proposed rule on this subject had to be withdrawn several years ago as completely unsupportable by factual data.

Item 13. Consideration has been given to requiring day and night operation of high-intensity white flashing lights and, to support regulatory changes to that end, research has been accelerated on this subject. The purpose of the several research projects currently underway is to provide specific information on the human factors aspects of the use of white flashing lights not provided by previous studies and to supplement subjective judgements with quantitative data. Petitions for rule making to make high-intensity white flashing lights a requirement have been received from companies which have a vested interest in such lights. They have been denied for lack of justification to change from existing requirements and lack of objective information to substantiate that a new improvement in safety would be provided by a requirement to display high-intensity white flashing lights. If the results of research now in progress provide the justification, action will be initiated to process an appropriate rule change.

Item 14. The FAA is actively cooperating with the ATA collision avoidance system program. Manpower and test facilities are being made available to test all new items of hardware which show any promise as CAS potential as well as proximity warning indicators. At least two new PWI devices have been promised to FAA about September of this year. As you know, infrared sensing of condenser discharge (strobe) lights is one of the techniques being investigated. In addition to research and development personnel, representatives from FAA's Legal, Air Traffic and Flight Standards Services are preparing to cope with problems associated with the introduction of collision avoidance system devices into civil air operations.

Your recommendations are sincerely appreciated. Action on our plans to minimize the probability of midair collisions will be taken as rapidly as possible.

Sincerely,

J. H. Shaffer
Administrator

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

January 30, 1970

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Washington, D. C. 20590

Dear Mr. Shaffer:

Recent investigations into the facts and circumstances concerning two midair collisions which occurred in radar terminal areas between large, high-performance air carrier aircraft and small general aviation aircraft have revealed, among other things, the following:

The small aircraft was not detected by the air traffic controllers on radar in one case, and was detected and subsequently lost from the radar in the other.

The small aircraft, with low radar cross sections, were operating in radar tangential effect during a portion of the controllers' available detection time. The radar cross sections of the small aircraft were considered marginal.

Safe and effective air traffic control expanded radar service cannot be provided unless aircraft possess adequate radar cross section to ensure that usable primary radar returns are received on the controller's display equipment.

Suitable passive radar reflectors are available for small aircraft which will increase the aircraft's radar cross sections, thereby enhancing their reflective capability to the desired level. Reflectors can be designed to eliminate the tangential effect.

The cost of the simple reflectors, with 2 square meters of reflective augmentation, is within the financial means of most operators who desire to use the available expanded radar service in terminal areas. The cost of reflectors with the capability of eliminating the tangential effect is somewhat greater.

We believe that it would be appropriate to modify Parts 21 and 23 of the Federal Aviation Regulations to require all aircraft under 12,500 pounds, manufactured after some appropriate date, to possess a radar cross section suitable for primary target detection by FAA radar at ranges up to 125-150 miles. This cross section augmentation should be accomplished during manufacture, using passive reflectors.

We also believe that the regulations should require a minimum level of radar cross section for present-day aircraft before permitting them to operate in certain expanded radar service environments such as the high-density areas indicated in your recent rule making proposals.

Sincerely yours,

John H. Reed

John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

11 February 1970

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

This is in reply to your letter of 30 January 1970 in which you recommended that the Federal Aviation Administration take regulatory action to require specific radar cross sections on light aircraft when operated within certain radar service environment.

We are actively working with industry to develop methods or devices to enhance radar detection of light aircraft. The evaluation of target enhancers is in addition to our transponder program.

We have no knowledge of suitable passive radar reflectors which are now available for small aircraft. To our knowledge, an acceptable application of passive reflectors has not been demonstrated on existing metal skin small aircraft. Your letter indicates you may have information that has not been made available to us. We would appreciate your informing us so that we may contact anyone with a promising proposal. We would like to use our facilities to test and evaluate active or passive radar enhancement devices.

As soon as an acceptable approach to radar target enhancement is found, we will be in a position to consider regulatory action making radar enhancement devices a requirement in addition to requirements for transponders under specific operation.

Sincerely,

G. S. Moore
Acting Administrator

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

March 19, 1970

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Department of Transportation
Washington, D. C. 20590

Dear Mr. Shaffer:

Thank you for your response dated February 11, 1970, to our recommendation concerning modification of the Federal Aviation Regulations to insure adequate radar cross section of aircraft weighing under 12,500 pounds.

We were pleased to learn that you are actively engaged in the development of "methods or devices to enhance radar detection." While we now have considerable data, we have decided to invite industry representatives to present a briefing, in the near future, on the state of the art. In that way we hope to be able to furnish you with more complete information concerning passive radar reflectors.

As soon as the date for this briefing has been established, we shall advise you and would welcome attendance by representatives of the Federal Aviation Administration.

Sincerely yours,

John H. Reed

John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

July 7, 1970

Honorable John H. Shaffer
Administrator
Federal Aviation Administration
Department of Transportation
Washington, D. C. 20590

Dear Mr. Shaffer:

In our letter of January 30, 1970, we recommended action designed to enhance aviation safety through the use of passive reflectors on small aircraft for the purpose of augmenting primary target returns on FAA radar.

Your response of February 11, 1970, stated that you had "no knowledge of suitable passive radar reflectors which are now available for small aircraft."

Consequently, we decided to convene an industry briefing on the subject and invited FAA representation at the briefing. You accepted the invitation by letter of April 3, 1970, and your representatives were in attendance at the briefing held at the Safety Board on April 28, 1970.

Based upon the presentations at the above-mentioned briefing, we have concluded that the state of the art has evolved to such a degree that due consideration should now be given to its practical application on an expedited basis. The various business concerns have indicated that they are capable of providing the necessary equipment to accomplish this end.

We feel a sense of urgency inasmuch as the circumstances which originally directed our attention to this matter remain unchanged. The potential for catastrophe through collision is still a reality within the ATC system. Small aircraft are difficult and sometimes impossible to detect with present day radar.

In our earlier recommendation dated January 30, 1970, it was suggested that action be taken modifying parts 21 and 23 of the Federal

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Aviation Regulations to require that all aircraft under 12,500 pounds, manufactured after some appropriate date, possess a radar cross section suitable for primary target detection. We now believe that a more appropriate regulatory approach would be to amend part 91 of the Federal Aviation Regulations to require that all aircraft have a minimum level of radar cross section in order to operate in radar service environments. Such action would make it possible for some operators, never operating in radar environments, to avoid the necessity of reflective augmentation. At the same time, it would achieve the goal of assuring adequate primary target returns on ATC radar at ranges of 125-150 miles.

Sincerely yours,

John H. Reed

John H. Reed
Chairman

COPY

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Washington, D.C. 20590

Office of
The Administrator

13 AUG 1970

Honorable John H. Reed
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

This is in reply to your letter of 7 July 1970 relative to the use of passive reflectors and acknowledges participation in the 28 April 1970 briefing to which you refer.

In a practical manner, there was no passive device presented at that briefing that would achieve your stated goal of adequate primary target returns on ATC radar at 125-150 miles range. We will expedite our R&D efforts in this matter hoping to develop a practical enhancement device.

In a related action to improve radar detection of small aircraft in terminal areas, FAR 91.90 as amended by Amendment 91-78, effective 25 June 1970, requires operable transponders on all airplanes operating VFR or IFR within the Group I designated terminal control areas. FAR 71 as amended by Amendment 71-6, effective 25 June 1970, defines the list of the nine Group I designated terminal control areas. The requirement for transponders was implemented at Atlanta effective 25 June 1970 and is scheduled for implementation at Washington, D. C., and Chicago O'Hare on 20 August 1970.

Sincerely,

/s/ K. M. Smith

K. M. Smith
Deputy Administrator

APPENDIX 3

HISTORICAL DEVELOPMENT OF THE "SEE AND BE SEEN" CONCEPT

APPENDIX 3

THE "SEE AND BE SEEN" CONCEPT

In the early development of aviation, aircraft were of necessity operated on a "see and be seen" basis. Federal regulations designed specifically to augment the "see and avoid" concept and minimize the midair collision potential were first issued in 1926 by the Secretary of Commerce. These were basically right-of-way rules, modeled after marine regulations, relating to movement of surface vessels on the water. They were based entirely on the premise that pilots would operate aircraft by visual reference to the ground and would be able to see and avoid other aircraft. For the most part, aircraft cruising speeds at that time were 100 miles per hour or less.

Early in 1930 it was recognized that the aircraft's ability to maneuver in three dimensions tended to present a collision potential that was not completely solvable by "see and be seen" procedures or the existing right-of-way rules. Accordingly, separation of aircraft in cruising flight was accomplished by the adoption of rules which required the use of discrete altitudes, based upon the direction of travel. By 1935 it was further recognized that pilots operating aircraft in restrictive meteorological conditions might not be able to see and avoid other aircraft. The Secretary of Commerce, therefore, authorized the airlines to establish a system of self-separation of airline aircraft operations in the vicinity of Cleveland, Ohio, Chicago, Illinois, and Newark, New Jersey.

In 1936, this was followed by Amendment No. 4 to Chapter 7 of Aeronautics Bulletin No. 7, which established Federal regulations governing all aircraft operations conducted by reference to instruments over designated airways. Aircraft cruising speeds had increased, by this time, to about 150 miles per hour. However, because passenger cabins were not pressurized, airline flights were operated at altitudes below 10,000 feet. Rates of descent were normally limited to about 500 feet per minute for passenger comfort. In the years immediately following passage of the Civil Aeronautics Act of 1938, considerable regulatory attention was given to the problems of providing separation between aircraft.

Rules relating to flight by visual means were expanded to prohibit flight within certain distances from clouds, and to prescribe minimum visibility conditions for flight in both controlled and noncontrolled airspace. However, the often expressed, fundamental basis of collision avoidance in VFR flight remained the "see and be seen" concept.

Doubts about the adequacy of the rules relating to "see and be seen" again appeared with the introduction into airline service in 1947 of such aircraft as the Lockheed Constellation, the Douglas DC-6, and others with pressurized cabins. Pressurization permitted high altitude operations and high rates of descent, without passenger discomfort. Operating speeds increased to approximately 250 miles per hour. These factors, and the continually growing numbers of aircraft in the U. S. civil fleet, prompted

recommendations from the airlines, the military, and the Civil Aeronautics Administration for increases in the VFR visibility minimums to 5 miles in controlled airspace, and for the expansion of positive air traffic control. Anticollision lights were installed on airline aircraft to provide increased safety in night time operations.

In June 1956 the adequacy of the "see and avoid" philosophy was brought into sharp focus by the catastrophic midair collision of two airline aircraft, both operating in visual meteorological conditions.

In an appearance before the Subcommittee on Transportation and Communications of the House Committee on Interstate and Foreign Commerce, on September 11, 1956, the Deputy Director of the Bureau of Safety Regulation of the CAB discussed the adequacy of "see and be seen" as follows:

> "For many years it has become increasingly apparent that conditions other than weather conditions are being encountered which directly affect aircraft separation and of which account must be taken in the continued development of the air traffic rules. For instance, it appears that under certain circumstances the rate of closure of very high-speed aircraft is such that the total time in which an aircraft may be visible to a pilot of another aircraft is so short that pilots cannot be expected to insure separation between aircraft irrespective to the weather conditions in which they are flying. It is also apparent that the density of air traffic, particularly in the vicinity of certain major air terminals, has approached or is approaching serious proportions. Obviously, the greater number of aircraft movements within a given airspace the more difficult it is for a pilot to separate himself adequately from other aircraft regardless of the vigilance exercised."

Subsequent to this testimony, on February 6, 1957, Amendment 60-2 to the Civil Air Regulations was adopted. This provided, among other things, for the designation at the discretion of the Administrator, of high density air traffic zones around certain airports. Aircraft were to be limited to indicated airspeeds not to exceed 180 miles per hour (160 knots). Communication with, or otherwise permission from, the control tower was also required prior to entering the control zone. This amendment specified further that aircraft operating in a control zone without an ATC clearance must not be flown VFR beneath the cloud ceiling when the ceiling was less than 1,000 feet; or closer than 500 feet vertically under, 1,000 feet vertically over, or 2,000 feet horizontally from any cloud formation.

On April 30, 1957, Amendment 60-5 to Part 60 became effective and modified the cruising altitude rules to provide a better safety margin between aircraft in cruising flight. This amendment contained the following caveat:

> "Since the cruising rules in effect in Part 60 will not provide for separation between IFR aircraft at certain assigned altitudes and VFR aircraft operated in accordance with VFR cruising altitude

rules, it remains the responsibility of all pilots operating in VFR weather conditions, even while cruising at an assigned altitude authorized by air traffic control, to maintain a vigilant watch so as to observe and avoid conflicting traffic."

Civil Air Regulation Draft Release No. 57-11, issued on May 23, 1957, contained an agenda for an air traffic conference to be held in June 1957. This agenda contained, among other things, proposals relating to weather minimums for VFR flight, the expansion of controlled airspace at high altitudes, and operations on, and within the vicinity of, airports. The agenda stated that the Bureau of Safety Regulations had received recommendations from the Civil Aeronautics Administration, the Army, the Navy, the Air Force, Air Transport Association, Air Traffic Controllers Association, and the Air Line Pilots Association advocating an increase in the minimum VFR criteria. These groups contended that the existing, prescribed minimums were inadequate in light of the high speeds of aircraft and the increasing volume of air traffic. Little attention was directed to the problems inherent in high descent rates, however, other than a recommendation by the Aircraft Owners and Pilots Association for a maximum rate of descent of 1,000 feet per minute at altitudes below 3,000 feet in all control zones around civil airports. This recommendation appears to have been dismissed from serious consideration, and other than its appearance as an agenda item, was not again mentioned in any subsequent regulatory action. Also largely ignored was the potential collision hazard inherent in a combination of high speed descent for IFR traffic and the operation of VFR flights only 500 feet below cloud formations.

The diminishing validity of the "see and avoid" method of collision avoidance was recognized, as is evidenced by the several recommendations by the aviation industry and the aforementioned Deputy Director's statement to the Congress. However, operational capability for positive control, as a solution to the problem, did not exist without severe restrictions on the amount of air traffic that could use the airspace. This was not considered acceptable.

Subsequent to the June 1957 conference, the CAB issued Civil Air Regulations Draft Release No. 57-27 proposing changes to the regulations based upon comments received in response to the conference notice, and the discussions at the conference. On September 11, 1958, Civil Air Regulation Amendment 60-11 was adopted. This amendment increased the visibility requirement to 5 miles only for those aircraft operating above 24,000 feet m.s.l. The minimum distance below clouds remained at 500 feet. In discussing the reasons for not adopting more of the previously proposed regulation, the preamble to the amendment stated:

"It was clear from the comment received on the draft release that the lines were drawn sharply on this highly controversial issue of appropriate VFR weather minimums. Briefly stated, the airmen from the professional segments of aviation concurred with the proposal, although some thought that it did not go far enough, while the

non-professional segments vigorously opposed any increases in the VFR minimums. Reasons given in support of the respective positions were essentially as received in earlier considerations of the problem, and which are detailed above. Persuasive arguments were advanced by the general aviation segment that no case could be made for the proposition that accidents would be reduced materially if VFR weather minimums were increased since accident statistics clearly showed that midair collisions were occurring in relatively clear weather. The Board has confirmed this through an extensive analysis of its civil accident and near collision statistics. One finding is particularly telling: 98 percent of all midair collisions in the past 10 years have occurred in weather conditions exceeding 3 miles in visibility - the other 2 percent have occurred in visibility conditions of about 3 miles.

The position of the proponents increased minimums, and the one pursued in the draft release, is, of course, valid. It is indisputable that some safety advantage would accrue were the minimums to be raised since fewer aircraft would be authorized to operate in given airspace and, accordingly, collision potential would be reduced.

The question which the Board must decide is how much safety will be increased by raising the VFR weather minimums and at what price to the users of the airspace. Based on the evidence available, the Board concludes and the Administrator agrees that the advantages to be gained by adopting the VFR weather minimums rules as proposed are not sufficient to justify the impairment of the public right of freedom of transit in air commerce through the navigable airspace of the United States. Accordingly, with the exception of the one-half-mile rule discussed below, established VFR weather minimums will not be changed. This conclusion should be construed only as a finding that under existing conditions raising the VFR minimums for acrobatic flight and in high density areas will not materially assist in the separation of traffic in VFR conditions under the "see and be seen" principle. It does not mean that other measures should not be taken to give greater effect to this principle."

In early 1958, critical attention was again focused on the adequacy of the "see and be seen" concept of air traffic separation by two catastrophic midair collisions, which occurred within 29 days of each other, between two military and two airline aircraft. In both accidents, all four aircraft involved were operating in VFR weather conditions. Subsequent to these accidents, Special Civil Air Regulation SR-424 was adopted. This regulation, on an experimental basis, authorized the establishment of positive air traffic control over designated routes at altitudes between 17,000 and 35,000 feet m.s.l. With this exception, the regulations continued to place the burden for collision avoidance in VFR weather conditions on the pilot. However, in a growing recognition that the visibility criterion alone was insufficient, other recommendations were received by the FAA. Among these recommendations was one by the Aircraft

Owners and Pilots Association in March 1959 that a speed restriction of 180 miles per hour be applied to all aircraft operating at altitudes of less than 2,000 feet above the ground, and that a maximum safe "see and be seen" speed be determined for en route operations.

The inadequacy of the "see and be seen" concept received further recognition in the 10 years between 1960 and 1970. Studies were conducted to determine the feasibility of devices in the cockpit to warn the pilots of potentially conflicting traffic. One such study 1/ concluded that a better chance of collision avoidance would be probable if the pilot were aware that potentially conflicting traffic was present, and knew approximately where to look for it. A distinction should be made here between a device described as a Pilot Warning Indicator (PWI) and a Collision Avoidance System (CAS). Early studies considered the feasibility of a PWI which would serve to alert a pilot to potentially conflicting traffic and identify the area in which he should look for the traffic. Most of the early proposals considered a "compatible" system in which detection was based upon the premise that all aircraft would be equipped with a receiver/transmitter. Later studies suggested that the detection capability should not be dependent upon transmitting capability of another aircraft, and that detection capability should be self-contained in each aircraft. This premise was expanded to include capability of the device to not only detect the presence of conflicting traffic, but to provide the pilot with instructions for the proper evasive maneuver, hence "Collision Avoidance System." This subject will be discussed in detail in the Board's forthcoming report on the Midair Collision Problem.

Further regulatory consideration of the midair collision problem in the past 10 years resulted in the lowering of the "floor" of the Continental Control Area 2/ to 14,500 feet m.s.l. Visibility minimums have been increased to 5 miles for VFR flights above 10,000 feet m.s.l. Above 10,000 feet, the minimum distance below clouds was increased to 1,000 feet, and the horizontal distance to 1 mile. However, as of September 19, 1969, with respect to VFR operations in controlled airspace below 10,000 feet, the regulations remained essentially as they were in 1956.

Speed restrictions since 1957 however, were increased from 160 knots in the high-density airports to 200 knots for turbine powered aircraft. A 250-knot maximum speed has been established for operations below 10,000 feet outside of airport air traffic areas. The Board believes that the original speed restriction of 160 knots was valid for the purpose of minimizing the collision potential at the busy terminal in 1957. The

1/ A Study of Requirements for a Pilot Warning Instrument for Visual Airborne Collision Avoidance - Sperry Gyroscope Company, December 1963.

2/ An area in which all aircraft must be operated in accordance with IFR procedures, regardless of the meteorological conditions.

subsequent allowable increase to 200 knots in the airport traffic area, and the 250-knot speed allowed outside these areas, can be related only to the operational characteristics of the jet aircraft. In the process, the ability to achieve safety through the "see and be seen" concept has been diminished.

U. S. GOVERNMENT PRINTING OFFICE : 1971 O - 414-710