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Determination of the Daytime Conspicuity of a Small Airplane in a Terminal Area

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DETERMINATION OF THE DAYTIME CONSPICUITY OF A SMALL AIRPLANE IN A TERMINAL AREA*

SUMMARY

The average detection distance for a small single-engine aircraft was determined in a terminal area during daytime VFR conditions. Pilots were exposed to actual midair collision situations by having another normally painted and equipped airplane approach on various collision courses. The separation distance between the two aircraft was recorded at the time the subject pilot detected the approaching airplane. Also, the pilot's reactions and performance were recorded as the two aircraft continued to converge.

Twenty-five private and business pilots volunteered their services for the study. Each pilot was required to fly three collision courses for a total of 75 test flights. Each collision course consisted of a different terminal area maneuver. The three maneuvers were departure and climb-out, straight-in approach, and a right turn-in approach. During each maneuver, the target airplane was on a 90° converging course with the subject pilot's airplane, requiring a 45° left visual angle for the subject to detect the approaching target.

Subject pilots were oriented and briefed in such a manner that they were uninformed as to the true purpose of the flights and were unaware that they were flying collision courses with another airplane. Normal workload conditions which exist in the cockpit when aircraft are flying in a terminal area were duplicated for each collision course.

Eleven pilots failed to detect the target aircraft when flying the departure and climb maneuver. The average detection distance for the 14 pilots who detected the target aircraft was 0.85 mile. Ten pilots failed to detect the target aircraft when flying the straight-in approach maneuver and five pilots failed to detect the target aircraft when flying the right turn-in approach. The average detection distances for the 15 pilots who detected the target aircraft while flying the straight-in approach and for the 19 pilots who detected the target aircraft while flying the right turn-in approach were 1.3 miles and 1.05 miles, respectively. The average detection distances for the informed observers who knew the exact angle of approach of the target aircraft were 2.8 miles, 4.0 miles, and 4.3 miles, respectively, for the departure and climb, straight-in approach, and right turn-in approach.

The results of these studies indicate the average performance that might be expected of private pilots flying small single-engine airplanes in a terminal area under normal VFR conditions. The pilots' performance may be improved if better search habits and cockpit procedures are developed by each individual, however, due to the workload in the cockpit, they cannot be expected to detect an aircraft at threshold (the greatest distance that the aircraft can be detected and identified as such with the naked eye). The results also indicate the need for improving aircraft conspicuity and the need for a proximity warning device to help the pilot detect other aircraft visually. There is an indication that pilots are unable to recognize impending collision situations in flight, by the aspect of an approaching aircraft at the time of detection, until the two airplanes have reached dangerous proximity to each other. This may be due to the small area presented by a small private-type airplane. The average separation distance at the time of detection was greater for the straight-in approach and the turn-in approach maneuvers, when both aircraft were flying straight and level prior to the convergence point, than for the departure and climb maneuvers when the two aircraft had some vertical separation. This may indicate that altitude separation at the time of detection adds to an already confusing situation with which pilots are either unfamiliar or incapable of recognizing as dangerous.

INTRODUCTION

The aviation industry has become cognizant of the growing midair collision problem arising from both increased air traffic and increased aircraft speeds. Realizing the magnitude

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*Manuscript submitted for publication January 1959

of the problem as early as 1948, the Technical Development Center (TDC) began investigating the various factors associated with midair collisions This was done to assemble sufficient data to be used as a basis for recommendations and as a yardstick to measure the effectiveness of developments aimed at reducing this hazard

A majority of the investigations and studies have concerned visual avoidance of aircraft and have resulted in establishing a portion of the technical knowledge associated with the related problems [1,2,3] A recent study of past midair collisions[4] revealed that 88 per cent of the collisions involved either approaches from the side sectors or one airplane overtaking another from the rear sector with relatively moderate rates of closure, such that improved visibility from the cockpits and better scanning habits of the pilots might have been significant

Consideration of visual collision avoidance must recognize human limitations that affect the pilots' ability to see and analyze a collision situation The same study cited above also indicated that 90 per cent of past midair collisions occurred within 5 miles of an airport during daylight hours when visibility was good, and that small private-type aircraft were involved in the majority of those collisions Therefore, the study reported herein was designed to uncover and investigate some of the problems associated with detecting and avoiding small single-engine aircraft in a terminal area Thus, a more complete technical basis would be available for evaluating aids to conspicuity, and proximity warning or anticollision devices in terminal area conditions These records can now be used to form a basis or yardstick for determining the extent that aids or devices may improve conspicuity of aircraft under similar conditions

METHOD AND PROCEDURE

Two Beechcraft four-place Bonanza airplanes were used for the flights in this study One airplane (hereafter referred to as the subject aircraft) was piloted by the subject pilot The second airplane (hereafter referred to as the target aircraft) was flown by a pilot who was fully aware of the purpose of the tests and had practiced intercepting the subject aircraft during preliminary trial flights. Both aircraft were normally painted and equipped. The target aircraft, Fig 1, was painted to represent the scheme normally used by similar aircraft so as not to appear obvious to the subject It was painted white on the top half of the fuselage and gray on the lower half with a red separating color sweep along each side The tail was white with gray stabilizer tips and the wings were gray with white tips. The numerals on both fuselage and wings were red

Twenty-five subject pilots volunteered to donate their time for this study Subjects were both male and female, and their normal daily occupations were varied The subjects were briefed in such a manner that they were uninformed as to the true purpose of the flight and unaware that they would be flying collision courses A diagram of the corridors that each subject was instructed to fly and the VFR reference map used by the subjects are shown in Figs. 2 and 3, respectively The orientation sheet given to each pilot prior to the flight is shown in Appendix I The subject was accompanied by a copilot who was aware of the collision courses and was ready to take over control of the airplane should the occasion demand

An observer, whose primary responsibility was to record the data on each flight, also accompanied the subject and was instrumental in establishing the threshold or maximum range at which an airplane of this type could be detected Three different TDC engineers served as observers on the 25 flights The observers, knowing the exact direction from which

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[1]Wayne D Howell and Thomas M Edwards, "Determination of Some Geometric Relationships Pertaining to Collision Flight Paths," Technical Development Report No 259, June 1955

[2]Thomas M Edwards and Wayne D. Howell, "Recommendations on Cockpit-Visibility Standards for Transport-Type Aircraft," Technical Development Report No. 275, February 1956

[3]Wayne D Howell, "Determination of Daytime Conspicuity of Transport Aircraft," Technical Development Report No 304, May 1957

[4]R Byron Fisher and Wayne D Howell, "An Investigation of Some Parameters Related to Midair Collisions of Aircraft," Technical Development Report No 322, October 1957

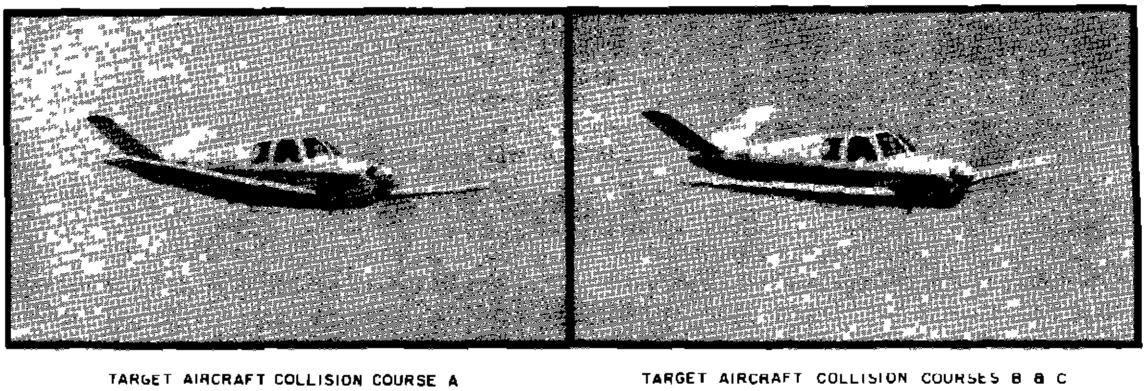

Fig. 1 Profile View of Target Aircraft Just Prior to Collision Point

the target would approach, were trained to fixate their vision in the area where the target first would become visible and to record the corresponding check point when the target airplane first was detected

The three collision courses used for this study are shown in Figs 4, 5, and 6, and all flights were made during VFR conditions The average rate of closure for the two aircraft on course A was 186.5 mph and for courses B and C, 197.5 mph The visual angle from the subject airplane to the target airplane normally remains constant if both aircraft fly straight collision courses and maintain constant speeds To maintain a constant visual angle between the aircraft, each airplane was flown over clearly defined ground check points and the pilot of the target airplane varied the speed of his craft to coincide with the progress of the subject airplane To keep the subject uninformed during the flight, the copilot carried on all necessary radio communication with the pilot of the target airplane and the airport traffic controllers.

A typical record sheet showing the data recorded for each flight is shown in Fig 7. Environmental conditions such as the weather, reported visibility, and the time of day were recorded, as well as a time history of the flight and the type of maneuver, if any, chosen by the subject to avoid a possible collision.

The procedure used with each subject starting with collision course A, Fig. 4, was as follows

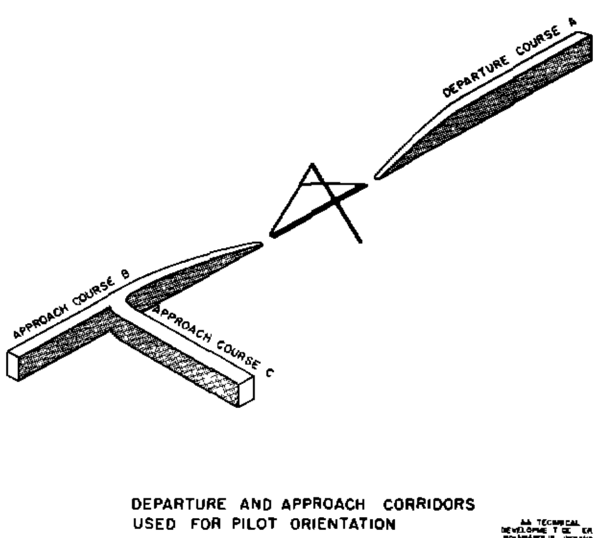

Fig 2 Departure and Approach Corridors Used for Pilot Orientation

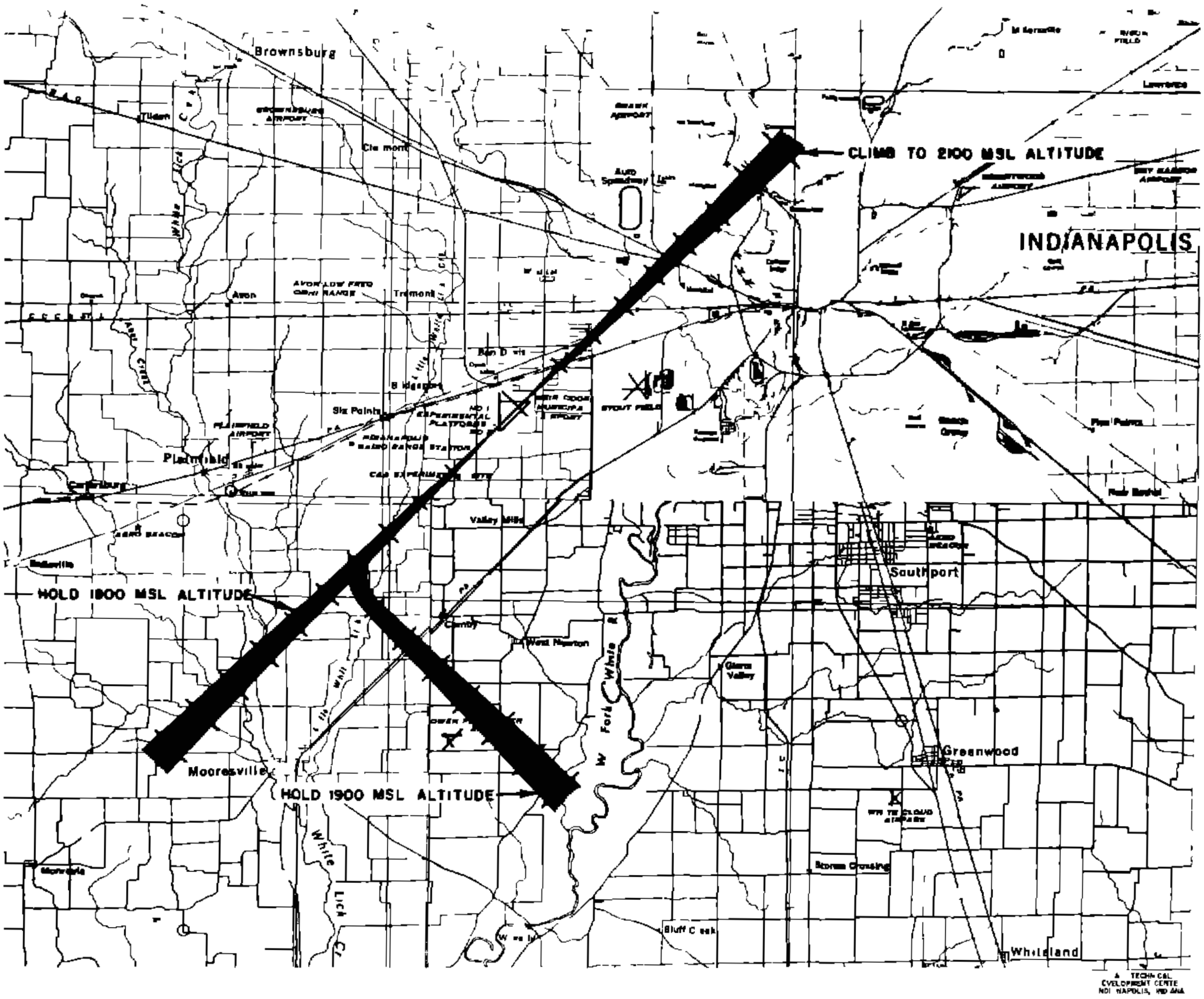

Fig. 3 Subject Pilots' Reference Map

1 The subject pilot was requested to read thoroughly the orientation sheet and study the map, and then was given an oral briefing before each flight Then he was taken to the airplane to fly the three collision courses, A, B, and C, in sequence.

2 The subject was given control of the aircraft from takeoff through landing, but the copilot handled all radio communications Earphones were used by the copilot so that the subject pilot could not hear any of the communications

3 The subject was instructed by the copilot to take off and fly for a few minutes to get acquainted with the feel of the airplane He then was asked to fly a holding pattern until clearance was obtained from the control tower for the start of course A, either by making a low pass over the runway or by a touch-and-go procedure A low pass over the runway was used to simulate the takeoff, if time was limited While the subject aircraft was taking off and flying to its holding position, the target aircraft flew to its starting point

4 The copilot of the subject aircraft coordinated the flights by calling off check points to the pilot of the target aircraft by radio The target aircraft speed was controlled so that it would arrive over each preselected check point at the prescribed time.

5. The observer in the subject aircraft recorded the ground check points that each aircraft was over at the time he detected the target The separation distance then was computed from this information

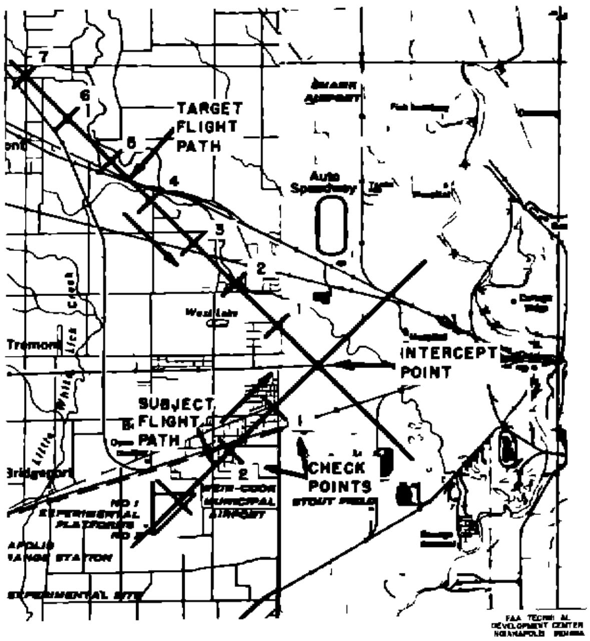

Fig. 4 Collision Course A

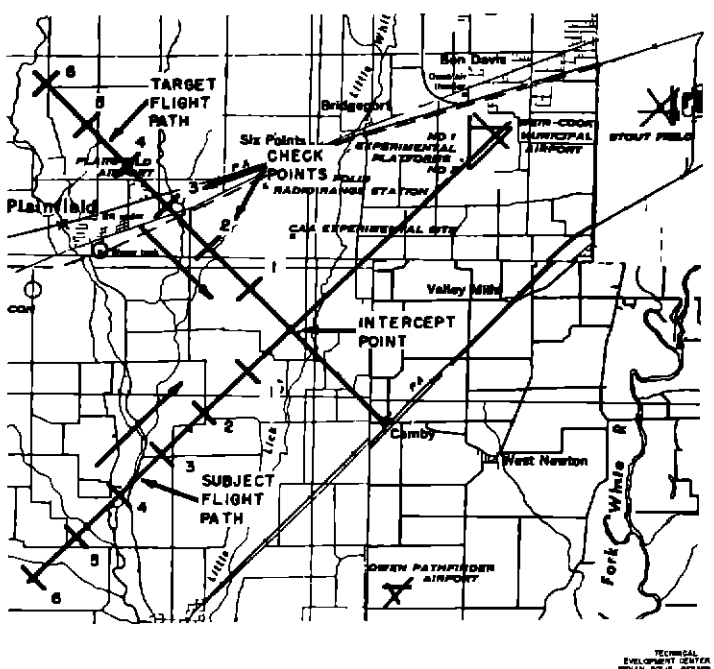

Fig 5 Collision Course B

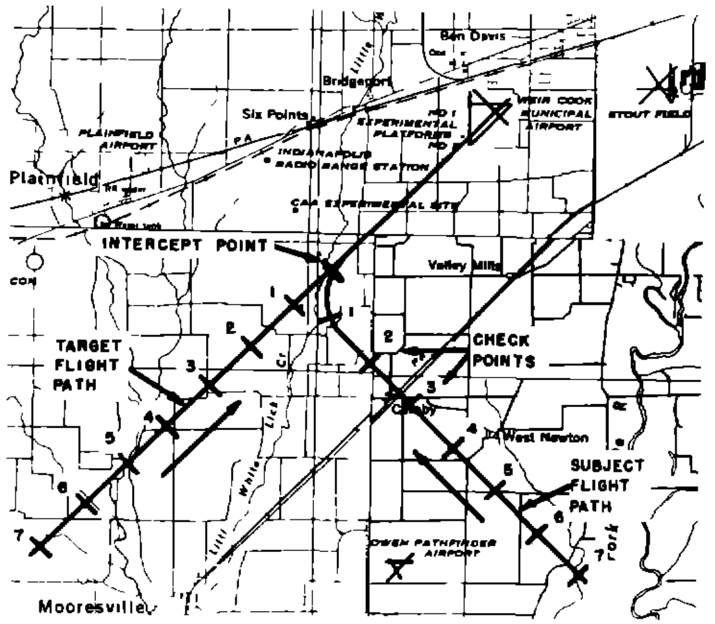

Fig. 6 Collision Course C

6. When the subject pilot detected the target aircraft, the observer started a stop watch and recorded the ground check points over which each aircraft was flying so that the separation distance and the distance to the collision point could be computed.

7. When the pilot made an evasive maneuver to prevent collision, the time on the stop watch, the check point at which the avoidance maneuver was made, and the type of evasive action taken by the pilot all were recorded. The watch was stopped when the target aircraft reported passing the collision point, and the time to collision was recorded.

8 If the subject pilot took no evasive action, the pilot in the target aircraft started a climb sufficient to miss the subject aircraft This ended the test run.

The same procedure was followed for the straight-in approach, course B, Fig. 5, and the right turn-in approach, course C, Fig. 6, except that no low pass or touch-and-go was made over the runway for these two maneuvers

DISCUSSION OF RESULTS

The data recorded for each subject pilot for the three collision courses and the observers' detection distances are shown in Tables I, II, and III Comparisons of the observer and subject pilot detection distances for each course are shown in Figs 8, 9, and 10, and the averages of all detections for the three courses are shown in Fig. 11 These data are discussed below

Collision Course A - Table I.

The average detection separation distance of the two aircraft for the 25 pilots on course A was 0 47 mile, or an average of 9 5 seconds prior to a collision point. A total of 11 pilots did not detect the target aircraft on this course and therefore made no attempt to take evasive action. The average separation distance for the 14 pilots who did detect the target was 0 85 mile One subject, D, detected the approaching aircraft at the maximum separation distance that was recorded, yet the subject failed to recognize the approach of the target aircraft as dangerous, ignored its position from that point on, and did not make an avoidance maneuver as the two aircraft converged on the point of collision The average detection separation distance for the observers, who were aware of the target position with respect to the subject aircraft, was 2.82 miles, or six times greater than the average for all the pilots This was due mainly to the fact that they knew where to look It is believed that the difference

DAYTIME STUDY

Subject Q Date FEBRUARY 15, 1958 Time 10 00 A M

Course A				Weather
Check Point	1	Time	32	Clear ✓
Maneuver Point	1/2	Time	18	Lt Haze
Maneuver	RIGHT TURN			Overcast
Observer Check Point	2	Target Check Point	2 1/2	
Course B				
Check Point	0	Time	0	Light
Maneuver Point	0	Time	0	Bright Sunlight ✓
Maneuver	NONE			Dim Sunlight
Observer Check Point	3	Target Check Point	3	No Sun
Course C				
Check Point	1/2	Time	12	Visibility 15+
Maneuver Point	1/4	Time	6	
Maneuver	RIGHT TURN DESCENT			
Observer Check Point	2 1/2	Target Check Point	2 1/2	

REMARKS

Fig. 7 Typical Flight Record

in detection range was influenced by the mental and motor tasks of the pilot in the cockpit which the observer did not perform Also, the subjects were not prone to scan in a vertical direction On course A, the subject aircraft was climbing to the altitude at which the target aircraft was flying The fact that 14 of the 25 pilots made no attempt to avoid a collision after detection and that 8 of the 11 who did initiate action waited until the aircraft were within 6 seconds or less of the collision point is alarming and reflects either an inability to make a quick decision for self-preservation or an inability to recognize a hazardous collision condition, or both

Collision Course B - Table II

The average detection distance for the 25 pilots on course B was 0.78 mile, an average of 14 6 seconds prior to the point of collision, or approximately double the distance for course A. A total of ten pilots missed detecting the target on this course, one less than for course A, although both aircraft were on straight and level flight up to the point of collision. The average detection distance for the 15 detections was 1 3 miles The average detection range for the observers on this course was 4 0 miles, or more than five times as great as the average for all pilots, again reflecting the effect of "informed scanning" and the difference in workloads The observer's range for this course is 40 per cent greater than for course A It should be noted in this connection that both aircraft were at the same altitude in course B which was not

TABLE 1

OBSERVER DETECTION AND PILOT PERFORMANCE IN TERMINAL AREAS
COLLISION COURSE A - DEPARTURE AND CLIMB

SUBJECT	DETECTION SEPARATION DISTANCE (MILES) OBSERVER	DETECTION SEPARATION DISTANCE (MILES) SUBJECT	DETECTION TIME (SEC) PRIOR TO COLLISION	DETECTION TIME (SEC) PRIOR TO EVASION	MANEUVER POINT TO COLLISION POINT DISTANCE (MI)	MANEUVER POINT TO COLLISION POINT TIME (SEC)	EVASIVE MANEUVER	VISIBILITY	SKY
A	*	0	0	0	0	0	NONE	15 LT HAZE	CLEAR
B	3 25	0	0	0	0	0	NONE	10 LT HAZE	SCATTERED
C	3 8	0	0	0	0	0	NONE	10 LT HAZE	SCATTERED
D	*	2 20	43	0	0	0	NONE	15 LT HAZE	SCATTERED
E	*	0	0	0	0	0	NONE	15 LT HAZE	SCATTERED
F	1 3	.15	3	1	05	2	DESCENT	15 LT HAZE	SCATTERED
G	2 6	1 25	25	21	10	4	DESCENT	15	OVERCAST
H	3 25	0	0	0	0	0	NONE	15	OVERCAST
I	*	2 20	43	39	10	4	DESCENT	15	OVERCAST
J	3 25	0	0	0	0	0	NONE	15	BROKEN
K	*	0	0	0	0	0	NONE	15	BROKEN
L	2 6	80	16	10	20	6	RT TURN	15	SCATTERED
M	2 25	1 6	32	18	45	14	DESCENT	15	SCATTERED
N	3 25	35	7	2	15	5	DESCENT	12 LT HAZE	CLEAR
O	3 25	75	15 5	5 5	30	10	RT DESCENT	12 LT HAZE	CLEAR
P	*	1 00	20 5	14 5	20	6	DESCENT	15 LT HAZE	CLEAR
R	3 25	75	15	5	30	10	DESCENT	15 LT HAZE	BROKEN
S	2 6	0	0	0	0	0	NONE	15 LT HAZE	SCATTERED
T	3 25	5	10	5	15	5	DESCENT	15 LT HAZE	SCATTERED
U	*	0	0	0	0	0	NONE	12 LT HAZE	CLEAR
V	*	10	2	0	05	2	DESCENT	12 LT HAZE	CLEAR
W	*	0	0	0	0	0	NONE	12 LT HAZE	CLEAR
X	1 65	1	2	0	0	0	NONE	12 LT HAZE	CLEAR
Y	*	1	2	0	0	0	NONE	12 LT HAZE	CLEAR
Z	*	0	0	0	0	0	NONE	15 LT HAZE	CLEAR
AVERAGES	2 82	47	9 5	4 8	08	2 7	FOR ALL SUBJECTS		
		85	16 8	8 6	15	6 2	FOR ALL DETECTIONS		

*NO OBSERVER MEASUREMENTS MADE ON THESE FLIGHTS

NOTE
MINIMUM VISIBILITY 10 MILES
MAXIMUM VISIBILITY UNLIMITED

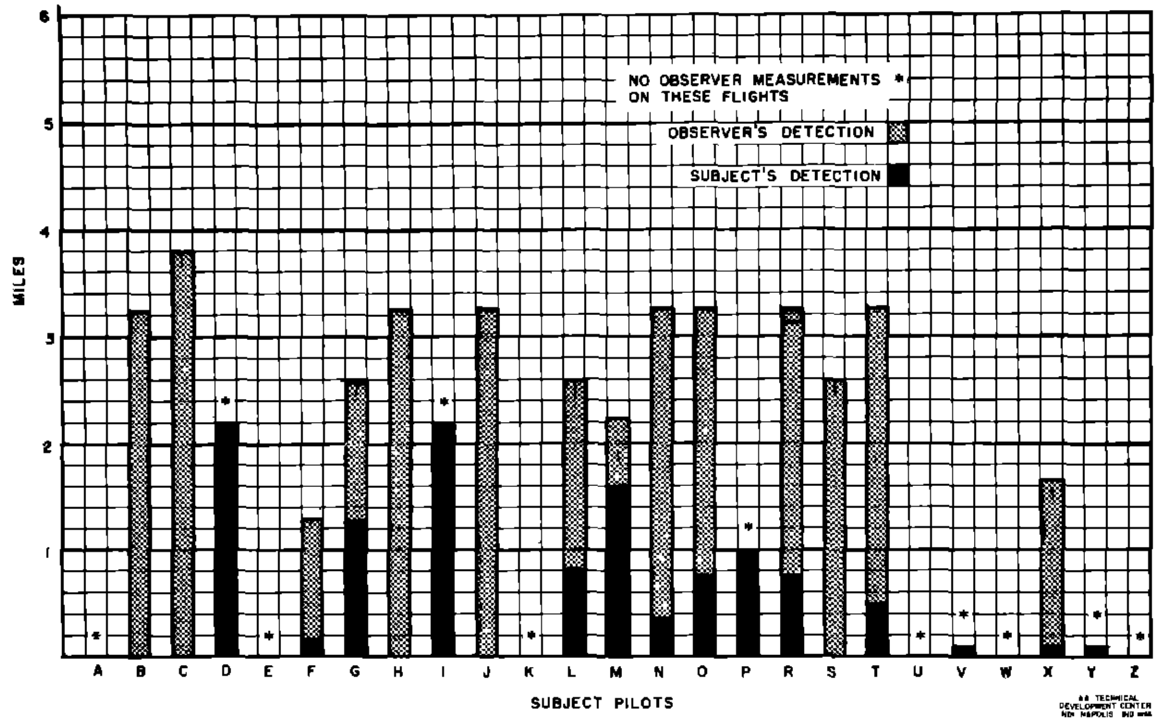

Fig 8 Observer and Subject Detection Distance - Collision Course A Departure and Climb

the case in course A Of the 13 pilots who initiated an avoidance maneuver on course B, 9 waited until 6 seconds or less remained to avoid the collision When this is compared with the eight late recognitions on course A, there is further indication that a hazardous collision situation cannot be recognized nor a decision reached readily even when both aircraft are at the same altitude

Collision Course C - Table III

The average detection separation for all pilots on course C was 0 84 mile, or an average of 15 3 seconds prior to collision This reflects the performance of 24 pilots since one of the passes on course C had to deviate because of conflicting traffic The average detection separation for the 19 detections was 1 05 miles. There were only five missed detections on this course, which may indicate more alertness by reason of the two previous experiences, or an awareness that radio communication increased for the copilot prior to a previous near-collision experience It also is possible that early pilot training, to always scan or "clear" an area before making a turn, was influential in the increase in number of detections for this course, since a turn was necessary and since the majority of the detections were at close range. However, with the added number of detections, there still was no decrease in the number of pilots who failed to initiate action until 6 seconds or less prior to the point of collision This may be explained by the changing aspect of the subject aircraft as it turned relative to the target, adding a factor of difficulty to decision time The observer's average detection range for this course was 4 3 miles. This was approximately the same as course B, indicating that about 4 miles is a valid detection range for aircraft of this size on straight and level flight The records of performance for subjects F, L, and X were deleted when they indicated they became aware of the true intent of the flight during this run However, the performance of subject X does not indicate an improvement in detection, regardless of his awareness, as he did not spot the target aircraft until 13 seconds before the collision point

TABLE II

OBSERVER DETECTION AND PILOT PERFORMANCE IN TERMINAL AREAS
COLLISION COURSE B - STRAIGHT-IN APPROACH

SUBJECT	DETECTION SEPARATION DISTANCE (MILES)		DETECTION TIME (SEC) PRIOR TO		MANEUVER POINT TO COLLISION POINT		EVASIVE MANEUVER	VISIBILITY	SKY
	OBSERVER	SUBJECT	COLLISION	EVASION	DISTANCE (MI)	TIME (SEC)			
A	*	0	0	0	0	0	NONE	15 LT HAZE	CLEAR
B	2 8	40	8	6	05	2	RT TURN	10 LT HAZE	SCATTERED
C	4 2	35	7	4	10	3	DESCENT	10 LT HAZE	SCATTERED
D	*	1 05	20	7	5	13	RT TURN	15 LT HAZE	SCATTERED
E	*	0	0	0	0	0	NONE	15 LT HAZE	SCATTERED
F	4 2	1 30	24	20	15	4	RT TURN	15 LT HAZE	SCATTERED
G	3 5	0	0	0	0	0	NONE	15	OVERCAST
H	2 8	15	3	0	0	0	NONE	15	OVERCAST
I	4 6	70	13	9	15	4	RT TURN	15	OVERCAST
J	4 6	2 85	53	50	10	3	DESCENT	15	BROKEN
K	4 9	0	0	0	0	0	NONE	15	BROKEN
L	4 6	1 40	26	18	30	8	RT TURN	15	SCATTERED
M	4 9	10	2	0	0	0	DESCENT	15	SCATTERED
N	4 2	2 55	47	41	25	6	DESCENT	12 LT HAZE	CLEAR
O	4 2	1 10	20	14	25	6	L T DESCENT	12 LT HAZE	CLEAR
P	3 5	1 20	22	18	15	4	CLIMB	15 LT HAZE	CLEAR
R	3 5	1 40	26	19	25	7	DESCENT	15 LT HAZE	BROKEN
S	4 2	2 35	44	40	15	4	DESCENT	15 LT HAZE	SCATTERED
T	3 9	0	0	0	0	0	NONE	15 LT HAZE	SCATTERED
U	4 2	0	0	0	0	0	NONE	12 LT HAZE	CLEAR
V	3 5	2 65	49	36	5	13	R T DESCENT	12 LT HAZE	CLEAR
W	*	0	0	0	0	0	NONE	12 LT HAZE	CLEAR
X	2 8	0	0	0	0	0	NONE	12 LT HAZE	CLEAR
Y	4 2	0	0	0	0	0	NONE	12 LT HAZE	CLEAR
Z	*	0	0	0	0	0	NONE	15 LT HAZE	CLEAR
AVERAGES	4 0	78	14 6	11 3	12	3 08	FOR ALL SUBJECTS		
		1 30	24 5	20 2	23	6 2	FOR ALL DETECTIONS		

*NO OBSERVER MEASUREMENTS MADE ON THESE FLIGHTS

NOTE

MINIMUM VISIBILITY 10 MILES
MAXIMUM VISIBILITY UNLIMITED

TABLE III

OBSERVER DETECTION AND PILOT PERFORMANCE IN TERMINAL AREAS
COLLISION COURSE C - RIGHT TURN-IN APPROACH

SUBJECT	DETECTION SEPARATION DISTANCE (MILES) OBSERVER	DETECTION SEPARATION DISTANCE (MILES) SUBJECT	DETECTION TIME (SEC) PRIOR TO COLLISION	DETECTION TIME (SEC) PRIOR TO EVASION	MANEUVER POINT TO COLLISION POINT DISTANCE (MI)	MANEUVER POINT TO COLLISION POINT TIME (SEC)	EVASIVE MANEUVER	VISIBILITY	SKY
A	*	0	0	0	0	0	NONE	15 LT HAZE	CLEAR
B	*	85	16	10	25	6	RT TURN	10 LT HAZE	SCATTERED
C	3 5	6	11	5	25	6	RT TURN	10 LT HAZE	SCATTERED
D	*	7	13	6	25	7	STRAIGHT	15 LT HAZE	SCATTERED
E	*	7	13	4 5	30	8 5	RT TURN	15 LT HAZE	SCATTERED
F[1]	4 2	1 4	26					15 LT HAZE	SCATTERED
G	*	45	8	4	15	4	STRAIGHT	15	OVERCAST
H	BAD PASS - NO DETECTION								
I	4 2	0	0	0	0	0	NONE	15	OVERCAST
J	4 6	80	15	12 5	10	2 5	RT TURN	15	BROKEN
K	4 6	6	11	8	10	3	RT TURN	15	BROKEN
L[1]	5 7	2 80	51					15	SCATTERED
M	5 7	1 4	26	17	35	9	RT TURN	15	SCATTERED
N	4 2	0	0	0	0	0	NONE	12 LT HAZE	CLEAR
O	4 6	2 80	51	36	6	15	LT DESCENT	12 LT HAZE	CLEAR
P	4 2	6	11	6	20	5	R T (VIOLENT)	15 LT HAZE	CLEAR
R	4 2	1 15	21	11	40	10	DESCENT	15 LT HAZE	BROKEN
S	4 2	7	12	5	25	7	DESCENT	15 LT HAZE	SCATTERED
T	4 6	0	0	0	0	0	NONE	15 LT HAZE	SCATTERED
U	3 9	0	0	0	0	0	NONE	12 LT HAZE	CLEAR
V	4 2	7	12	8	15	4	RT TURN	12 LT HAZE	CLEAR
W	3 5	1 35	24 5	11 5	5	13	RT TURN	12 LT HAZE	CLEAR
X[1]	3 5	7	13					12 LT HAZE	CLEAR
Y	4 2	1 60	29	16	5	13	RT TURN	12 LT HAZE	CLEAR
Z	*	20	4	1	10	3	RT TURN	15 LT HAZE	CLEAR
AVERAGES	4 3	84	15 3	6 7	18	4 8	FOR ALL SUBJECTS		
		1 05	19 3	10 1	25	7 2	FOR ALL DETECTIONS		

*NO OBSERVER MEASUREMENTS MADE ON THESE FLIGHTS

[1] PERFORMANCE NOT RECORDED BECAUSE OF SUBJECT BECOMING AWARE OF PURPOSE

NOTE
MINIMUM VISIBILITY 10 MILES
MAXIMUM VISIBILITY UNLIMITED

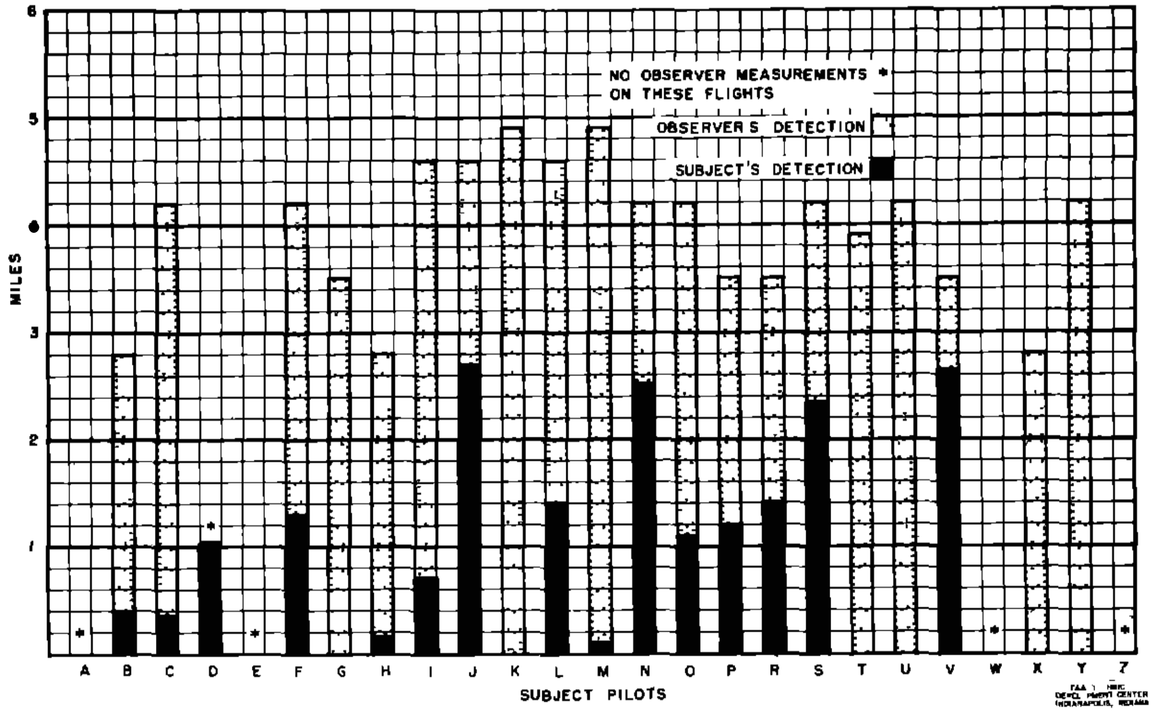

Fig. 9 Observer and Subject Detection Distance - Collision Course B Straight-In Approach

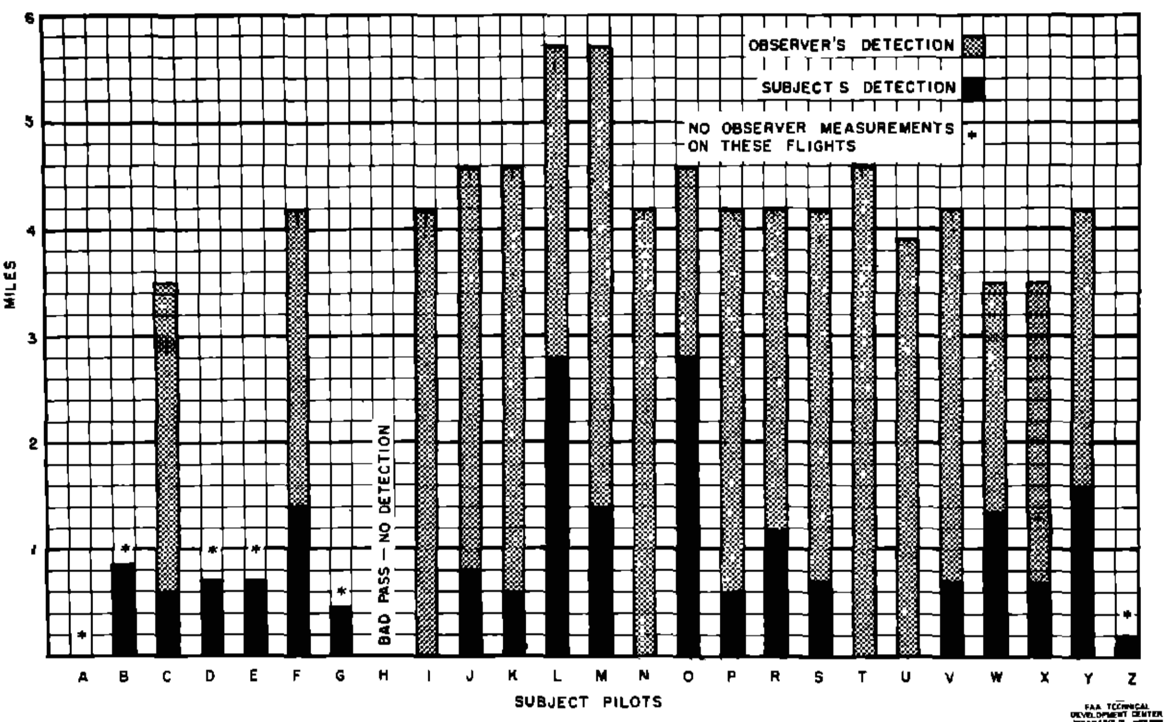

Fig 10 Observer and Subject Detection Distance - Collision Course C Right Turn-In Approach

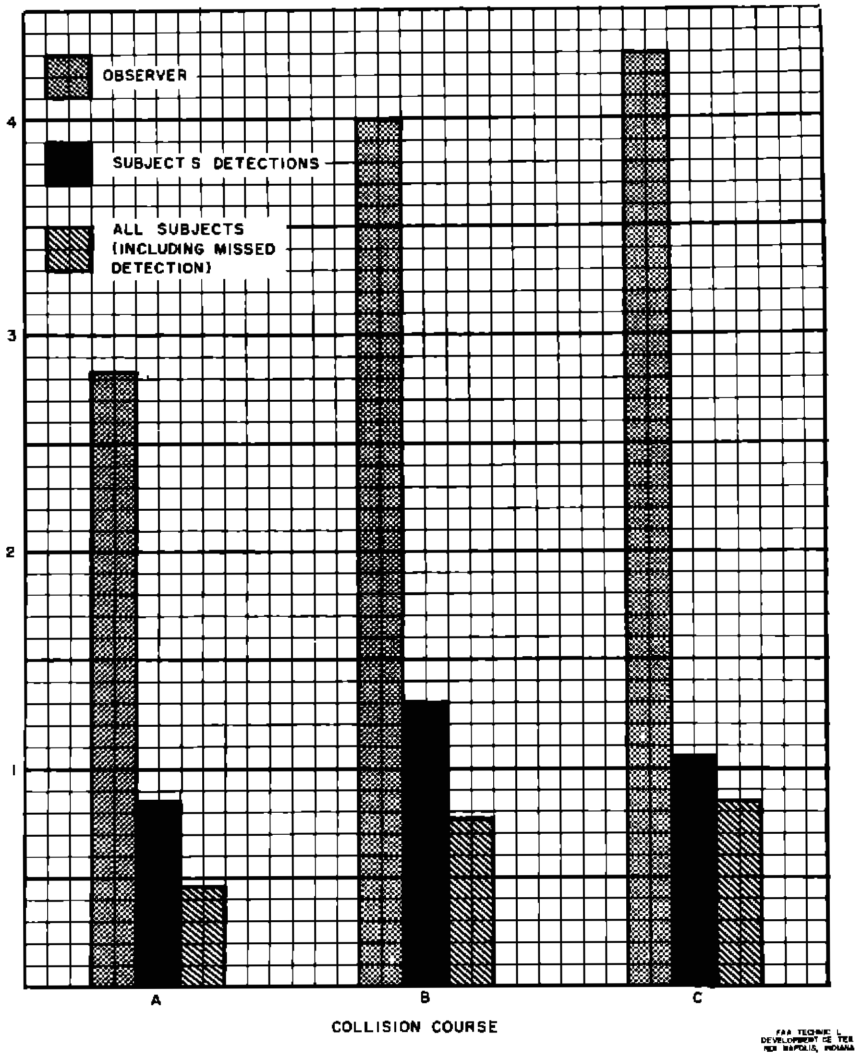

Fig. 11 Average Detection Distance

The responses, as shown in Tables I, II, and III, are not to be construed as representative of all pilots However, in view of the large number of pilots participating in this study, and the number of courses flown, the results indicate that the probability of one pilot not seeing another airplane on a collision course in the terminal area is one out of every three times This is revealed by the large number of missed detections, namely, 26 misses in 75 collision courses flown. The results also indicate that, of the number of times the target airplane was detected, 33 per cent of the detections were too late for the evasive action to be effective

The tables also disclose the type of maneuver that each pilot chose For collision course A, a descending maneuver was used by 10 of the 11 pilots who took evasive action For course B, 8 of the 13 pilots chose a descending maneuver, and for course C, 3 pilots descended during evasion One possible explanation for 91 per cent of the pilots choosing a descending maneuver on course A may be the influence of seeing the target approaching on a possible collision course from a higher altitude at the time of decision

CONCLUSIONS

From the results obtained by all of the tests, the following can be concluded

1 Aircraft of the size used in this study normally could be detected in a terminal area at distances up to 4 miles in daytime VFR conditions with a minimum of 10 miles visibility

2 With normal VFR cockpit duties and when not forewarned of an impending collision situation, pilots could not be expected to detect an airplane of the size used in this study at distances greater than 2 8 miles in a terminal area.

3 The pilots did not detect other aircraft as readily during takeoff and climb as they did during straight and level flight, nor did pilots recognize a hazardous condition as readily under such conditions

4 When the pilots made a decision that an evasive maneuver was necessary for self-preservation, more pilots chose a descending maneuver than any other action

5 For every three hazardous situations, two subject pilots detected and avoided the impending collision

6 The pilots did not recognize a hazardous collision situation in flight by the aspect of the approaching aircraft alone, until both aircraft were in dangerous proximity to each other

APPENDIX I

ORIENTATION FOR PILOTS

The personnel at the CAA Technical Development Center wish to express their appreciation for the time and effort you have so generously volunteered to help promote Aviation Safety Your name will not be disclosed in any respect concerning this flight without your permission

In the future it may be necessary to have established approach lanes or courses for all aircraft entering the terminal area These lanes may be of varied configurations and will have to be followed during VFR as well as IFR flying To study the feasibility of such a proposal, three courses, two approach and one takeoff, have been outlined for initial investigation at Weir Cook Airport

You, as the pilot, will be expected to fly your airplane along the trial courses to determine how well a departure or approach lane can be followed for VFR flights Maps showing the three lanes are attached A copilot will accompany you and he will act as an instructor on these flights The copilot will be in communication with the control tower and he will relay any clearances and flight instructions, relieving you of radio responsibility. Please point out all aircraft you detect in the area and take any appropriate action necessary as four eyes watching are better than two A CAA observer also will be aboard to judge and record the feasibility of using an airport procedure such as this The CAA observer will gladly answer any questions you may have about the operation

Thank you