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6 A REVIEW OF INDIVIDUAL PERFORMANCE IN AIR-TO-GROUND TARGET DETECTION AND IDENTIFICATION STUDIES

10 John A. Barnes

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This document is a review of the individual performances of the skilled aviators who participated in the US Army Human Engineering Laboratory Target Acquisition, Camouflage Application and Identification Friend or Foe tests and the Modern Army Selected Systems Evaluation Test, Evaluation, and Review Cobra/Tow Follow-On Evaluation. It highlights the individual performance differences in target detection and identification slant range and time and in eye fixations and scanning behavior against stationary and moving, camouflaged and uncamouflaged armor.

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August 1978

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A REVIEW OF INDIVIDUAL PERFORMANCE IN AIR-TO-GROUND TARGET DETECTION AND IDENTIFICATION STUDIES

INTRODUCTION

The US Army aviator has been the subject of many investigations to determine how the numerous flight tasks are accomplished. The US Army Human Engineering Laboratory (USAHEL) has investigated this performance of the air-to-ground target detection and identification tasks in several studies. The results of these studies, as in almost all of the literature, tell the reader how the group performed; how the individuals performed in general. This report covers in some detail the individual subject's performance from the nap-of-the-earth (NOE) flights of the Helicopter Acquisition Tests (HELHAT)[1], all of the flights of the Camouflage Applications Test (HELCAT)[2], all of the flights of the Identification Friend or Foe Tests (HELIFF)[3], and the Cobra/Tow Follow-On Evaluation (OT-131)[4].

It is a rare happening when a subject exceeds all other subjects in all phases of the performance of a complicated task. The better subjects excel in several areas of the total task but even the lowest scoring subject has, in some facet of the total task, scored well. We have attempted to determine why there was this difference in performance among subjects that were well trained and, in general, very experienced. In HELCAT and HELIFF we have, by the use of eye-movement measuring devices, determined how the individual searches for targets and how long he looks at them before he recognizes them as targets. We have, from these records of visual activity, been able to speculate about the causes of apparent differences in target detection performance.

We have checked, in HELIFF, the effect on the subject's performance of different seating positions in the test towers. In HELHAT we flew them in front and rear seats of the AH-1 and in the left seat of the OH-58 to check the effect of the different crew positions on their target detection performance. We also checked the detection performance of a two-man OH-58 crew against that of the left seat only.

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[1]Barnes, J.A. Human Engineering Laboratory helicopter acquisition test. Technical Memorandum 20-74, US Army Human Engineering Laboratory, Aberdeen Proving Ground, MD, September 1974.

[2]Barnes, J.A., & Doss, N.W. Human Engineering Laboratory camouflage applications test (HELCAT) observer performance. Technical Memorandum 32-76, US Army Human Engineering Laboratory, Aberdeen Proving Ground, MD, November 1976.

[3]Barnes, J.A. Human Engineering Laboratory identification friend or foe test. Technical Memorandum 30-77, US Army Human Engineering Laboratory, Aberdeen Proving Ground, MD, October 1977.

[4]Napier, W.R., Colston, R.C., McDonald, J.P., Robinson, R.N., & Swartz, A.J. Cobra/tow follow-on evaluation. MASSTER Test Report No. OT-131, Modern Army Selected Systems Test, Evaluation, and Review, Fort Hood, TX, December 1974.

The pilot/observer subjects have searched for a wide variety of military targets ranging in size from a rocket launcher to bridges, but generally the targets have been armored vehicles. These targets have been camouflaged and uncamouflaged, blended with the background and in open fields, and moving and stationary. They have used low-level tactics, nap-of-the-earth tactics, and pop-up tactics to attempt to detect these targets while performing route reconnaissances, 'S' pattern searches, and inplace searches. They have searched during the day, both with and without optical aids, and at night, with and without night vision devices.

Finally, we have looked into their personal statistics to determine their age, length of service, date of graduation from rotary wing flight training, total amount of rotary wing flight time, and rotary wing combat flight time.

SUMMARY OF RESULTS

One of the most interesting findings of this micro look into individual subject's performance came from the HELCAT and HELIFF eye-movement records. These data showed a considerable difference in the target detection times recorded by the different subjects. Yet, the eye fixations indicated that there was a spread of only a few seconds between the actual visual detections of the targets. The large differences in recorded detection times seemed to be due to each individual's decision making process as shown by the amount of time they spent fixating on the target before reporting the detection.

We have statistically determined the major factors that affect the pilot/observer's detection performance against stationary targets. Twenty-five factors were investigated and six were found to be significant; they were the relative bearing between the aircraft and the target, the aircraft's height above the ground, the size of the target, the contrast between the target and its ground, the distance to the target, and the ambient light available. When moving targets are considered, there are the additional factors of movement and any smoke or dust that is generated. Thus, if one is high enough above the ground and the moving target is well illuminated and contrasts greatly with the ground, there will be no trouble in detecting it at extended ranges within the visual capabilities of the eye. We did find that there is little difference in the amount of time individuals spent fixating on any one item during a search for targets until they find the target; the time was ½ second and ± ¼ second.

The personal statistics of our subjects were correlated with their performance data to determine if any of these would be predictors of target detection performance. There was no correlation between performance in any of these factors. This indicates that the training programs were such that our pilot/observers are at comparable skill levels across subjects and across tactical units. We did find that the mean age of our pilot/observer population is remaining constant, that is, the mean age of our subjects has changed as the year of the test has changed. For example, the mean age for the 1976 test was 30; the mean age for the 1972 test was 26.

We found that the night vision goggles were a necessary item for night target detection. They appeared to be more effective when used with a stationary aircraft as in the pop-up maneuver then when used on the move as in the route reconnaissance work; our subjects only made one detection in 20 trials without the goggles and 13 detections with them.

The identification of targets as friend or foe (IFF) phase of the testing produced one perfect score and 19 of lesser accuracy. The perfect score was tempered by some short observer-to-target ranges; the minimum range was 466 meters. There was a problem of previous misinformation that hampered the subjects who had participated in Reforger 1976. They said that they had been instructed that all of our allies would have US equipment; therefore, if it was not recognized as US, it was enemy and should be fired upon. Without this bias it is possible that these individuals might have had better IFF scores. We can only surmise that these instructions were meant for the exercise only, but were misunderstood by the individuals and applied to all situations. The overall mean IFF score was 75 percent correct identification.

TEST ANALYSES

The criterion used for the analyses in this report was to compare each of the subject's performance with the group mean performance for that task and to develop "Delta" values as deviations from that mean for each subject. If the subject's performance fell within a given range about the mean, less than ± 1 second for time measures or ± 33 meters for distance measures, it was considered to be average, if it exceeded this range it was considered to be good and if it was less than this range it was considered to be poor; ± 10 percent of the mean above-the-ground-level (AGL) was considered to be average AGL.

HELHAT

The first of the current USAHEL air-to-ground target detection studies was HELHAT which was flown partially at the Naval Weapons Center, China Lake, California, and partly at Aberdeen Proving Ground, Maryland. The final phase of the Aberdeen Proving Ground work, the NOE flights, were the source of the data for the analysis. The other flights of HELHAT were flown at altitudes of 100 to 300 feet AGL, altitudes which due to changes in tactics are no longer considered tactically valid. The NOE portion of HELHAT consisted of six, two-man crews who flew an OH-58 along a 7-mile length of roadway on an "S"-type (500 meters on either side of the route) reconnaissance mission. All of the crewmen were combat veterans and had volunteered to fly the test. The AGL flown varied from 5 to 35 feet depending upon the ground cover and the pilot's discretion. The instructions were to fly as low as possible without compromising safety.

The flights lasted approximately 40 minutes and there were six targets available to be found by the crews (Figure 1). Navigation proved to be the most difficult problem in this test; Crews 4, 5 and 6 became disoriented. Only Crew 5 was able to reestablish its position and reach the end point of the route. The other two crews had to be directed back to the range by the control helicopter. In addition to becoming disoriented, Crew 6 did not locate any of the targets so its overall performance rating was Poor. Crew 5 did an average job of navigation; a good job of locating targets (finding 5 of the 6 targets); their scores on the targets; i.e., the slant range to the target were average but the AGL flown was higher than the mean so they scored Poor on AGL. Crew 5 had an overall score of Average. Crew 4 became disoriented, thus scored poorly on navigation; they found less than the mean number of targets, so they scored Poor on that phase; the AGL flown was higher than average, therefore they scored Poor on AGL; their slant range scores on the targets were Good. Crew 4 had an overall score of Poor. Crew 3 flew the course without problems for a rating of Good; they found half of the targets which gave them a rating of Poor; the AGL they flew was high for a Poor score; their slant range scores on the targets were Good. Crew 3 had an overall rating of Average. Crew 2 flew the course completely for a rating of

Figure 1. HELHAT nap-of-the-earth route.

good; they found all but one of the targets for a rating of Good; the AGL flown was Average; the slant range scores were less than the mean for a rating of Poor. Crew 2 had an overall rating of Good. Crew 1 flew the complete course for a rating of Good; they found an average number of targets; they flew the lowest AGL for a rating of Good; their slant range scores were less than the mean for a rating of Poor. Crew 1 had an overall rating of Good.

Table 1 gives the scores and AGLs for each crew on each of the targets and Table 2 gives the ratings for the crews. One problem of NOE flight that was well illustrated by these crews' performances was that of intervisibility, the visibility or lack thereof between objects. Although Crew 1 and Crew 2 flew at the lowest AGL, they had Poor ratings on their slant range scores. This was an illustration of the intervisiblity function of AGL; the lower a crew flies, the more numerous are the obstacles that are in its visual path to the targets, thus the probability increases that the number of detections and the detection ranges are less than those of equally skilled crews flying at a higher AGL.

The NOE subjects were from the 1/9 Cavalry and the 7/17 Cavalry of the 1st Cavalry Division.

TABLE 1

HELHAT NOE Flights

	SR 15	AGL 15	SR 14	AGL 14	SR 13	AGL 13	SR 12	AGL 12	SR 11	AGL 11	SR 10	AGL 10	TGTS
Crew 1													
Score	520	5	120	10			470	5			640	5	4
Delta	150	-19	-115	-16			-332	-20			-298	-18	
Crew 2													
Score	160	30	370	30	350	25	770	25	220	20			5
Delta	-210	6	135	4	103	- 2	- 32	0	- 50	0			
Crew 3													
Score							780	30	320	20	1050	30	3
Delta							- 22	5	50	0	112	7	
Crew 4													
Score	460	30	230	30			1425	30					3
Delta	90	6	5	4			623	5					
Crew 5													
Score	340	30	220	35	145	30	565	35			1125	35	5
Delta	- 30	6	- 15	9	-103	3	-237	10			187	12	
Crew 6													
Score													0
Delta													
MEAN	370	24	235	26	248	27	802	25	270	20	938	23	4

SR- Slant range.

TABLE 2

Crew Ratings

Crew	Score	AGL	Route	Targets	Overall
1	P	G	G	A	G
2	A	A	G	G	G
3	G	P	G	P	A
4	G	P	P	P	P
5	A	P	A	G	A
6	P	P	P	P	P

G- Good
A- Average
P- Poor

HELCAT

The second of the air-to-ground detection studies was a more complex study. HELCAT investigated the pilot/observer's ability to detect camouflaged targets during NOE flight and from the pop-up maneuver under normal day conditions and at night, with and without, the aid of the AN/PVS-5 night vision goggles. During half of the day flights, the subjects wore an eye-movement measuring device so that their dwell times and search patterns could be recorded. There were a total of 80 detection trials in this study.

The 10 subjects who participated in this study were members of the 82d Airborne Division; all were current in the AH-1 helicopter and 9 of the 10 had combat experience. All of the flights were flown in an OH-58 helicopter bv a pilot assigned to Aberdeen Proving Ground. This arrangement eliminated any navigation problem and provided a measure of consistency in the flights. The flight route is shown in Figure 2. The night flights were the most difficult for the pilot/observers as the sky was overcast and there was no moon. There were no detections of the camouflaged tank during the night NOE route reconnaissance flights when the AN/PVS-5 goggles were not used; only one subject found the tank during the night pop-up maneuver without the use of the goggles. The results when wearing the AN/PVS-5 goggles were much better (Tables 3 and 4).

Table 3 indicates that 70 percent of the subjects were successful in finding the tank when they were wearing the goggles during the night NOE route reconnaissance flights. The detection ranges recorded are quite respectable, the mean range falls between the mean ranges achieved on the two daylight runs shown in Tables 5 and 6. The mean AGL for the night route reconnaissance flights were somewhat higher than those for the day flights in the interest of flight safety. Subjects 2, 3 and 6 had overall ratings of Good with Subject 6 being the best performer. Subjects 10, 1 and 7 had overall ratings of Poor with Subject 8 being the better performer.

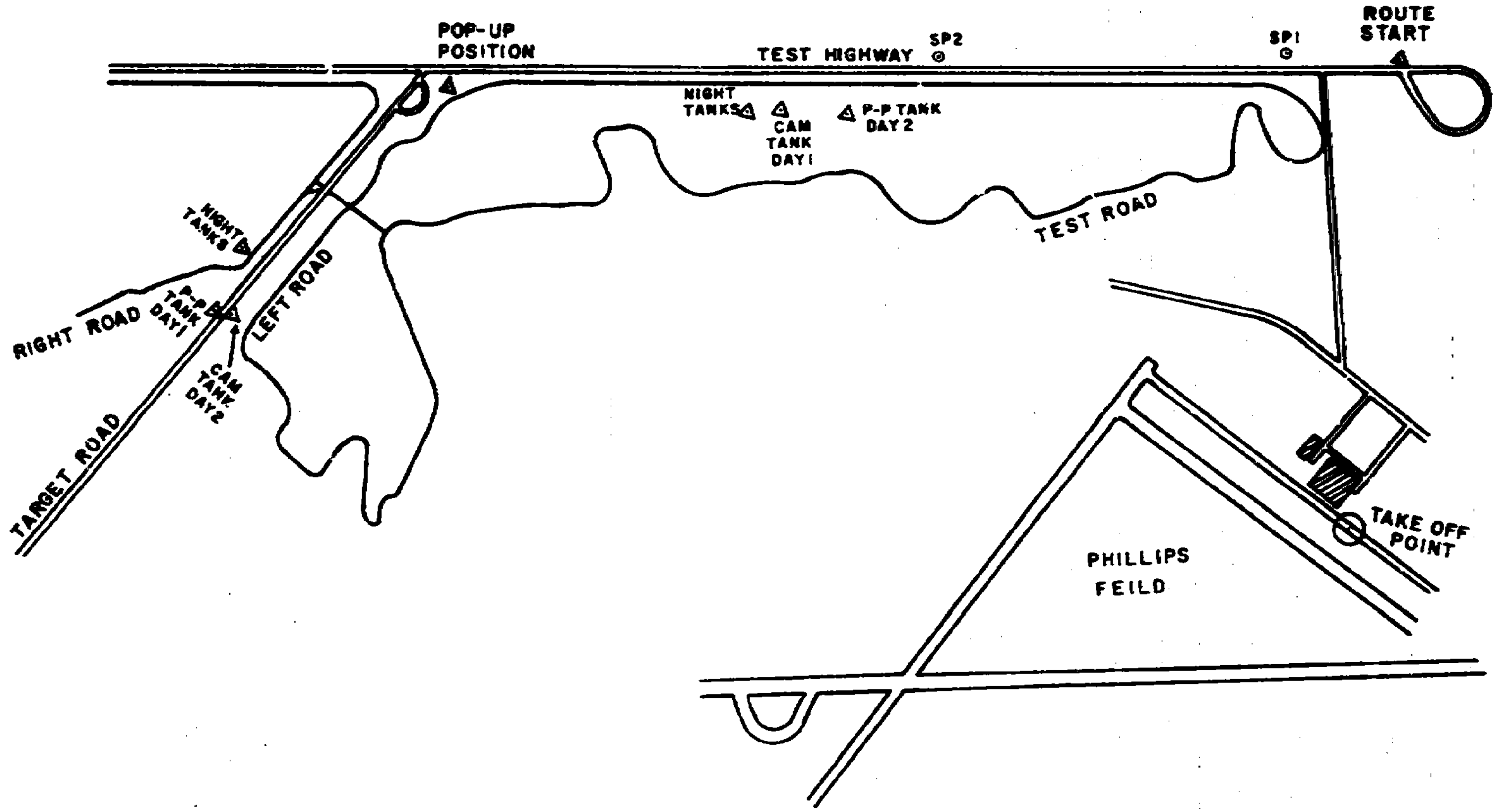

Figure 2. HELCAT flight route.

TABLE 3

Night NOE Route Reconnaissance

Subject	Range	AGL	Delta Range	Delta AGL	Range Rate	AGL Rate	Overall
1	740	70	208	11	G	P	A
2	640	60	108	1	G	A	G
3	635	60	103	1	G	A	G
4					P		P
5					P		P
6	827	35	295	-24	G	G	G
7	134	50	-398	- 9	P	G	A
8	140	85	-392	26	P	P	P
9					P		P
10	611	55	79	- 4	A	A	A
MEAN	532	59					

TABLE 4

Night Pop-Up Flights

Subject	Time	AGL	Delta Time	Delta AGL	Time Rate	AGL Rate	Overall
1					P		P
2					P		P
3	30.0	90	-60.8	33	G	P	A
4	105.0	48	14.2	-10	P	G	A
5					P		P
6	85.0	60	- 5.8	2	G	A	G
7	85.0	56	- 5.8	- 2	G	A	G
8					P		P
9	95.0	45	4.2	-13	P	G	A
10	145.0	46	54.2	-12	P	G	A
MEAN	90.8	58					

TABLE 5

Day NOE Route Reconnaissance-Camouflaged Tank

Subject	Range	AGL	Delta Range	Delta AGL	Range Rate	AGL Rate	Overall
1	474	65	159	25	G	P	A
2	303	35	- 12	- 5	A	G	G
3	378	15	63	-25	A	G	G
4	183	45	-132	5	P	P	P
5	112	33	-203	- 7	P	G	A
6	281	29	- 34	-11	A	G	G
7	183	78	-132	38	P	P	P
8					P		P
9					P		P
10	604	27	289	-13	G	G	G
MEAN	315	41					

TABLE 6

Day NOE Route Reconnaissance-Pattern-Painted Tank

Subject	Range	AGL	Delta Range	Delta AGL	Range Rate	AGL Rate	Overall
1	1138	30	428	2	G	A	G
2	970	28	260	0	G	A	G
3	437	40	-273	12	P	P	P
4	456	30	-254	2	P	A	P
5	456	25	-254	- 3	P	G	A
6	446	25	-264	- 3	P	G	A
7	482	20	-228	- 8	P	G	A
8	859	35	149	7	G	P	A
9	518	25	-192	- 3	P	G	A
10	1335	20	625	- 8	G	G	G
MEAN	710	28					

Although Subject 1 did not make a detection when using the AN/PVS-5 goggles during the night pop-up flights, he did detect the tank without the goggles with a detection time of 30 seconds and an AGL of 90 feet. Subjects 6 and 7 had overall ratings of Good with almost identical performances. Subjects 3, 4, 9 and 10 had ratings of Average with Subject 3 having the shortest detection time of all the subjects in Table 4 but also at the highest AGL. Subjects 1, 2, 5 and 8 did not detect the tank and all were rated as Poor. The mean night pop-up detection time was also between the times for the two-day trials shown in Tables 7 and 8. The mean night pop-up AGL was the same as the mean night route reconnaissance AGL and 33 percent lower than the mean day pop-up AGLs.

The day flights of HELCAT provided 40 target detection trials for the 10 subjects. Table 5 shows the results of the day route reconnaissance flights against the draped camouflaged tank, generally referred to as the camouflaged tank, and Table 6 shows the results of those against the pattern-painted tank. The results of the day pop-up maneuvers against the camouflaged tank are shown in Table 7 and those for the pattern-painted tank are shown in Table 8.

The effectiveness of the draped type camouflage is reflected in the 400 meter mean detection difference shown in Tables 5 and 6. Performance of the individual subjects was somewhat more varied against the pattern-painted tanks. Table 6 shows a detection range spread of 889 meters and Table 5 shows a spread of 492 meters for the eight subjects who found the tank. The AGLs that were flown against the camouflaged tank reflect some deviation from the desired 20-30 foot AGL; these were the result of trying to avoid causing alarm to the construction vehicles that were using the road (route) at the time. The best performance for the day NOE route reconnaissance was achieved by Subject 10; Subjects 2, 1 and 6 were the next best followed by Subjects 3, 5, 7, 8, 4 and 9. When the night flights are considered the order becomes Subjects 2, 10, 6, 3, 1, 5, 7, 8, 4 and 9.

The day pop-up maneuver times are given in Table 7 for the camouflaged tank and in Table 8 for the pattern-painted tank. There were 19 attempts made at the pop-up maneuver, the aircraft experienced a transmission failure indication just prior to the last attempt so that trial is not recorded.

TABLE 7

Day Pop-Up Flights-Camouflaged Tank

Subject	Time	AGL	Delta Time	Delta AGL	Time Rate	AGL Rate	Overall
1					P		P
2					P		P
3	w				P		P
4	w				P		P
5					P		P
6	45.0	92	-51.7	1	G	A	G
7					P		P
8	90.0	90	- 6.7	-1	G	A	G
9	155.0	92	58.7	1	P	A	P
10	*						
MEAN	96.7	91					

w- Wrong target
*- Aircraft down

TABLE 8

Day Pop-Up Flights-Pattern-Painted Tank

Subject	Time	AGL	Delta Time	Delta AGL	Time Rate	AGL Rate	Overall
1	26.0	90	-23.4	0	G	A	G
2	34.5	95	-14.9	5	G	A	G
3	29.0	78	-20.4	-12	G	G	G
4	20.5	90	-28.9	0	G	A	G
5	22.0	87	-27.4	- 3	G	A	G
6	w				P		P
7	86.0	87	36.6	- 3	P	A	P
8	150.0	95	100.6	5	P	A	P
9	40.0	97	- 9.4	7	G	A	G
10	50.0	90	.6	0	A	A	A
MEAN	49.4	90					

w- Wrong target

The majority of the subjects were not able to locate the camouflaged tank (Table 7). The tank was extremely well hidden and was actually an outstanding performance on the part of the subjects that did locate it. The overall ranking for the day pop-up maneuver were Subjects 6, 9, 8, 10, 1, 2, 3, 4, 5 and 7.

The overall ratings for each of the subjects for the complete experiment are shown in Table 9. These data indicate that the best overall performance in all phases of the air-to-ground target detection task against the two types of camouflaged tanks was achieved by Subject 10. Subject 6 was a close second followed by Subject 2, Subjects 1 and 3 were rated as Average and the remaining subjects were Poor.

Several other measures of these subjects' performances were made; the one considered most likely to have shown the difference in their success at the target detection task was the recording of their eye movements and fixation points during one of the day route reconnaissance trials and one of the day pop-up trials. Table 10 provides the mean single glance dwell/fixation time of each subject and the maximum dwell time, the time spent looking at the target before an indication was made that it was a target. Table 10 lists the subjects in the order of overall HELCAT rating to enable the reader to easily see the obvious differences in subject eye/search behavior.

Subject 10 had an average single glance dwell time even though he obviously made up his mind much faster than any of the other subjects; a full 3 seconds faster than the mean time. His search technique was to make a short, narrow, left-to-right scan of an area about 550 meters ahead of the start point of the route and them move his attention to a point about 1,000 meters further down the route and repeated the narrow scans. Seven of the other eight subjects used similar search strategy for the route reconnaissance. Subject 9 was the only subject who followed the search technique recommended in US Army Field Manual 1-80, Aerial Observer Techniques and Procedures.

TABLE 9

HELCAT Overall Ratings

Subject	Day Route Reconnaissance CAM	Day Route Reconnaissance P-P	Night Route Reconnaissance	Day Pop-Up CAM	Day Pop-Up P-P	Night Pop-Up	Overall
1	A	G	A	P	G	P	A
2	G	G	G	P	G	P	G
3	G	P	P	P	G	A	A
4	P	P	P	P	G	A	P
5	A	A	P	P	G	P	P
6	G	A	G	G	P	G	G
7	P	A	A	P	P	G	P
8	P	A	P	G	P	P	P
9	P	A	P	P	G	A	P
10	G	G	A	*	A	A	G

*- Aircraft down; no chance to score in this area.
CAM- Camouflaged tank.
P-P- Pattern-painted tank.

TABLE 10

Eye Movement Dwell Times (Seconds)

Subject	Route Reconnaissance Single Glance	Route Reconnaissance Maximum Dwell	Pop-Up Single Glance	Pop-Up Maximum Dwell
10	.50	2.25	*	*
6	.75	4.63	.50	4.00 w
2	.50	5.50	.50	
3	.50	6.25	.50	5.00
1	.75	6.50	.25	3.00
4	.50	4.50	.50	8.00 w
8	x	x	.75	13.25
5	.75	4.00	.75	
7	.50	5.25	.50	
9	.75	8.00	.50	8.75
MEAN	.61	5.21	.53	7.00

*- Aircraft down
w- Wrong target
x- No dwell times recorded

The following are summaries of each observer's search scheme during the eye movement recorded route reconnaissance and pop-up trials:

Observer 1. Started his route reconnaissance with an out-and-back search to a point about 500 meters from the start of the route; for future use we will call this point SP 1. He then began a left-to-right scan from this point; the scan encompassed a sector of 30 degrees to either side of the point; completing this he moved to a new scan point, a tree approximately 1000 meters further down the route. For future use we will call this SP 2. From this point he scanned a 30- to 45-degree sector to the left of the tree, single-glance times of 1/2 to 3/4 seconds, and on the third scan he located the target. Detection range was 474 meters. Each of the last two scans was closer to the arc on which the target was located than was the previous scan. The observer's pop-up scan was slightly different, as the aircraft cleared the screening trees he was scanning to the left of the Target Road (TR), and when the aircraft was at altitude he picked a scan point about 500 meters down the TR and made three 45-degree sector scans of the area to the left of TR; completing this he moved his scan down TR and located the target. Search time was 26 seconds; range 867 meters.

Observer 2. He scanned the left and right sides of the route from the start point to SP 1 and then went to SP 1 and began a systematic 15 to 20 degree left sector scan which progressed down the route at 50-meter intervals with single-glance times of 1/2 second.

He detected the target at a range of 970 meters.

During the climb on pop-up one he scanned about 300 meters down TR and continued out to 600 meters on achieving hover, and returned along the right side of TR and then back out along the left side of the road. He next checked the Left Road (LR) and the Right Road (RR) and back out TR to the target area, he repeated this pattern several times with single-glance times of 3/4 second. His final scan was a check of TR from the target area back to 300 meters from the aircraft.

The second pop-up began with a scan down TR to the target area and back, and a repeat on reaching hover, and a check of LR and RR; single-glance times were 1/2 second. He then initiated a 10-degree left-and-right sector scan along TR from the target area to the aircraft and back, which he repeated four times.

The third pop-up featured a close-in scan of the area to the left on climb out, followed by a scan down LR. Once at hover he went to the target area and then over to LR at 700 meters. He then went back onto TR and searched to the aircraft and out again to the point ending on LR. Single-glance time was 3/4 second. No detection was made.

Observer 3. At the start of the trial he immediately went out to SP 1 and made two scans to the left and right of the route, followed by a scan to the area just beyond SP 1 and one more 15-degree sector scan to the left. He then directed his attention to a point approximately 500 meters further down the route and made three 30-degree scans to the left of the route with single-glance times of 1/4 to 1/2 second. He next moved out to SP 2 and made a 45-degree left-sector scan; on the return scan he paused for 3/4 second in the target area but continued the scan back to SP 2, and then immediately went back to the target. The detection range was 378 meters.

The pop-up trial started with the observer picking a scan point about 400 meters down TR as soon as the aircraft reached altitude, and he made a 45-degree sector scan to the left and a 30-degree sector scan to the right. He then came back to TR and moved his gaze out to the target area and saw the target. The pop-up search time was 29 seconds, range was 866 meters.

Observer 4. He scanned an area to the left of the route between the start point and SP 1, then moved out to SP 1 and started a 10- to 15-degree left-sector scan with single-glance times of 1/2 second. This scan pattern was sytematically moved forward about 50 meters at the completion of each cycle until about 100 meters prior to SP 2, at which time he found the target. The detection range was 456 meters.

On pop-up one he scanned close-in and to the left on climb and then went to a point 150 meters ahead of the aircraft between the Left Road (LR) and the TR; from here he went out to 300 meters to a point 10 degrees right of the RR and scanned left to a point 30 degrees left of LR. He then scanned the left side of TR out to the 600-meter point and repeated this tactic on LR and RR. This was followed by a 30-degree sector scan of an area to the right of RR and a check of both sides of TR and LR to about 300 meters. He ended pop-up one looking at a clump of trees about 250 meters down LR.

Pop-up two search was begun the same as the first one was, but upon reaching altitude he went to the clump of trees and decided that it contained the target; it did not. The total search time was 88.5 seconds.

Observer 5. He went to SP 1 at the start of the route reconnaissance and scanned a 15-degree sector to the left of the route three times with a single-glance time of 1/2 to 3/4 second. He then moved out to a point halfway to SP 2 and made three more left-sector scans and then back to a large tree near the route and spent several seconds in the immediate area. He next moved out to SP 2 and made 12 fast 30-degree left-sector scans before he saw the target. Detection range was 456 meters.

During the climb on pop-up one he scanned the area close in and to the left of the pop-up position and upon reaching hover he looked down the TR about 300 meters, glancing slowly to the left and to the right with single-glance times of 3/4 second; he next scanned the right side of the road back to the aircraft. He repeated this procedure going out to 600 meters followed by the same type of scan on the LR.

He started pop-up two in the same manner as the first and on reaching hover he went out to the target area and scanned to the left and to the right along RR back to the aircraft. Then he went out LR to the target area in the same manner and back to the aircraft; this pattern was repeated twice with single-glance times of 3/4 second. Next he repeated this scan on the TR and the RR.

Pop-up three began with a scan to 300 meters down the TR which was extended to 500 meters, at hover, to a point on the left of the LR and then back to 100 meters from the aircraft. His next scan went out to 600 meters on the TR with a single-glance time of 1/4 second followed by the same scan on the RR with a return to the target area and a scan of the TR back to the aircraft. The final scan of the search was of a 30-degree sector to the left of the LR at a range of 500 meters; this was repeated three times. No detection was made.

Observer 6. Upon departure he set up an out-and-back scan of the initial portion of the route and then went to SP 1 and made four 20-degree left-sector scans with single-glance times of 1/2 to 3/4 second. He then came back to SP 1 and spent 3 to 4 seconds in the immediate area before he moved his scan point 100 meters further down the route and made two 20-degree sector scans to the left where he saw something near the end of the second scan and actuated the event switch but did not announce a detection. He moved his scan point further down the route and did a 10-degree sector scan to the left; following this he moved to SP 2 and made another 10-degree sector scan to the left and saw the target. The detection range was 281 meters.

On clearing the screening trees on pop-up one he started a 30-degree sector scan to the left from a point 300 meters down the TR. He repeated this twice and next made a 10-degree right-sector scan followed by two 10-degree left-sector scans after which he indicated he had detected the target. This was a false detection; it occurred at 36 seconds after start of the pop-up.

Observer 7. He scanned the woods to the left of the route at 150-meter intervals out to SP 1 where he widened his sector to 45 degrees and continued the 150-meter pattern interval using a 1/2 second single-glance time. The target was located before the scan front reached SP 2. Detection range was 482 meters.

On pop-up one climb he scanned a 20-degree sector left of the pop-up position and then inspected a clump of trees 100 meters in front of the position. At hover he scanned out the TR to 400 meters, made a quick scan of the LR and then to the RR where he made a 30-degree right-sector scan with single-glance time of 1/4 second. He then returned to the LR and back to the aircraft from which he initiated two 20-degree left-sector scans at a range of 400 meters followed by a 45-degree left-sector scan from a point on the TR at 500 meters.

As soon as the aircraft cleared the screening trees on pop-up two he started a 20-degree left-sector scan at a range of 400 meters; returning to the TR he spent several seconds inspecting the immediate area. From this point he made two more 20-degree left-sector scans and three 40-degree right-sector scans followed by a final 30-degree left-sector scan.

When the aircraft reached altitude on the third pop-up he scanned down the LR 500 meters, made a 15-degree left-sector scan, came back to the aircraft and went out again on the TR; single-glance time was 3/4 second. He next spent several seconds looking left and right of the TR at 600 meters and then made a 45-degree right-sector scan. No detection was made.

Observer 8. There was no fixation mark visible on this trial, as the observer accidentially moved the source light prior to the start point. On pop-up one he chose a scan point 400 meters down the TR and 30 meters from the road; from here he made a 15-degree left-and-right-sector scan followed by a 30-degree and a 45-degree left-and-right-sector scan ending with a final 15-degree scan.

At the start of the second pop-up he spent several seconds inspecting an area near the pop-up position and then moved out the TR to the target area and repeated the scan behavior of the first pop-up.

For the third pop-up he went out to the target area on the TR and scanned a 30-degree sector to the left and then back to the aircraft on the TR; he went back to the target area, repeated the 30-degree scan and saw the target as he returned to the TR. The total search time was 150 seconds; detection range was 857 meters.

Observer 9. He went out to SP 1 at the start of the route and scanned a 30-degree left sector and then came back along the route to the aircraft. He next moved out to the road intersection across from SP 1 and spent several seconds in this area before he initiated a 10-degree left-sector scan at 100-meter intervals towards SP 2 with a single-glance time of 3/4 second. He continued this pattern until he saw the target. Detection range was 518 meters.

The initial scan on pop-up one was a clump of trees 100 meters out from the pop-up position; from here he went 300 meters down the LR and back, then the same thing on the TR with a single-glance time of 1/2 second. Next he scanned a 30-degree left sector at 400 meters on the LR followed by a scan out to 600 meters on the TR and back to the aircraft with a left-right zigzag pattern along the TR; this was repeated three times. The final scan was out the TR to 700 meters with a 5-degree left-right-sector scan at this point.

He began the second pop-up in the same manner as the first and went from the clump of trees to a point 400 meters out on the RR and made a 20-degree right-sector scan. He returned to the TR and went out to 700 meters, then to the LR, back to the TR and back in to 400 meters and then out to 700 meters again; he repeated this four times.

He scanned close in on the TR during climb on the third pop-up and then went out to 300 meters and scanned back and out on the LR and RR. He then went back to the TR at 400 meters, spent several seconds in this area at 3/4 second single-glance time and then went out to the target area and found the target. The total search time was 155 seconds; detection range was 857 meters.

Observer 10. At the start of the route he went out well beyond SP 1 about 10 degrees to the left of the route and then back to SP 1. He then made three passes out to SP 2 at 100 meters to the left of the route and found the target; single-glance time was 1/2 second. Detection range was 1335 meters.

No pop-up was flown as the aircraft engine failed shortly after the route detection.

HELIFF

The Identification Friend or Foe study, Part I, was designed to determine how long it would take a helicopter gunship crewman at hover AGL to identify, as friend or foe, a group of moving armored vehicles or a moving convoy of trucks at a fixed range of 900 meters. HELIFF, Part II, tested the subjects to ascertain at what range they could make the same determination against the same vehicles.

Twenty aircrewmen currently assigned to gunship duty participated as subjects in this study; each subject was presented 10 time trials, 5 without visual aids and 5 using 10-power optics to simulate the missile sight optics, and 10 range trials, 5 with and 5 without the optics. The series of trials were equally divided between groups of armored vehicles and truck convoys. The vehicles presented to the subjects were actual vehicles used by the United States, Israel and Soviet allies.

The subjects were tested in groups of 10, an 18-foot tower was used to simulate a gunship at hover, each man wore his flight helmet and had his microphone and headset connected to an individual circuit of the data recorder. After each trial, the subjects would move, in a predetermined order, to another position in the tower so that for each series of 10 trials they had one trial in each of the 10 positions. The individual performance data show the subject's performance deviations form the mean value for each trial and for the seat/position he was occupying for that trial. The first group of 10 aircrewmen were from the 1/17 Cavalry and their individual performance tables are shown in Appendix A. The second group of 10 aircrewmen was made up of men from the 2/17 Cavalry, the 4/9 Cavalry and the 77th Armed Helicopter Battalion; their individual performance tables are shown in Appendix B.

Figure 3 is an aerial view of the test courses used in HELIFF and the tower. The individual performance information from Appendix A has been summarized in Table 11. These values enable the reader to consider each of the subject's performance in every facet of the Detection (DET) and Identification Friend or Foe (IFF) tasks and arrive at an overall rating for his performance in relation to that of his peers in the group.

TABLE 11

Group 1 Overall Performance

		NORMAL					OPTICS							
SUBJECT		RUN DET	RUN IFF	SEAT DET	SEAT IFF	MISS IFF	RUN DET	RUN IFF	SEAT DET	SEAT IFF	MISS IFF	OVERALL RATE	OVERALL MISS	FINAL RATING
1	Time	G	G	P	P	2	G	P	G	P	1	A	3	
	Range	G	P	G	P	2	G	P	G	A	2	A	4	A
2	Time	P	P	P	P	1	P	A	P	A	0	P	1	
	Range	G	P	A	P	2	P	P	G	P	3	P	5	P
3	Time	P	G	A	A	2	G	P	G	A	1	A	3	
	Range	P	P	P	P	4	G	P	G	G	2	P	6	A
4	Time	G	G	G	P	0	G	G	G	G	0	G	0	
	Range	G	G	G	P	0	G	A	G	A	1	G	1	G
5	Time	G	G	G	G	2	G	G	G	G	0	G	2	
	Range	G	G	G	P	0	G	G	G	G	1	G	1	G
6	Time	P	P	P	P	4	G	P	P	P	3	P	7	
	Range	P	P	A	P	2	G	P	A	P	0	P	2	P
7	Time	G	P	G	G	0	A	P	G	P	0	G	0	
	Range	G	P	G	P	0	G	P	G	A	0	G	0	G
8	Time	G	G	A	G	2	G	G	G	G	1	G	3	
	Range	A	G	P	A	1	G	P	A	P	0	A	1	G
9	Time	G	G	G	G	0	G	G	G	G	2	G	2	
	Range	G	G	G	A	1	G	G	G	G	0	G	1	G
10	Time	G	G	G	G	2	G	G	G	G	1	G	3	
	Range	P	P	P	P	3	P	A	G	G	1	P	4	A

G- Good
A- Average
P- Poor

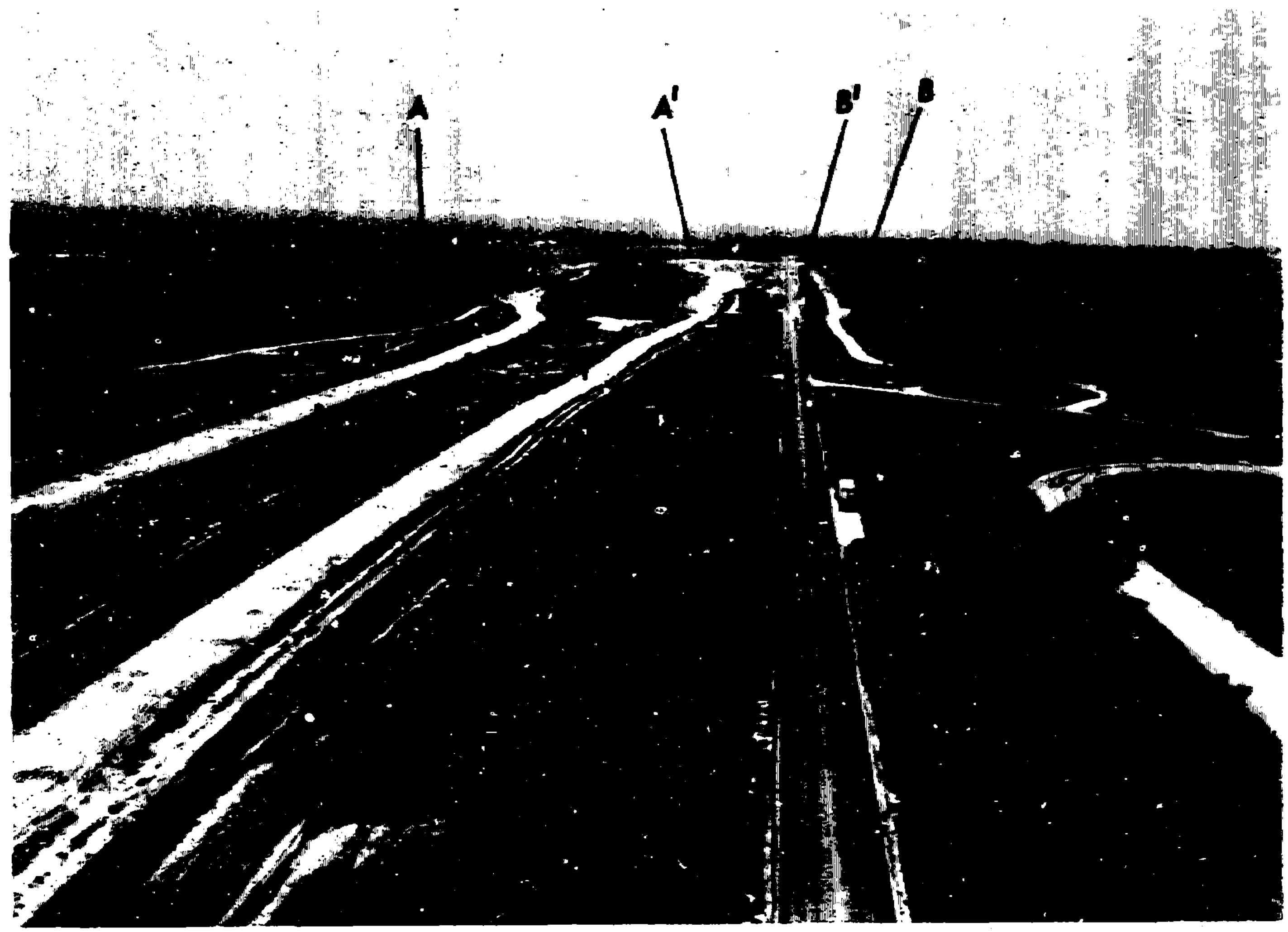

Figure 3. Threshold range courses, A' to T, B' to T'; response time courses A to B, B to A.

The numerical values for MISS IFF have the following values: under the Normal and Optics headings values of 1 and 2 are Good, 3 is Average and 4 and 5 are Poor; under the OVERALL heading 0, 1, 2, and 3 are Good; 4, 5, and 6 are Average; and 7, 8, 9, and 10 are Poor. The schema for the letter ratings is as follows: G+P = A, G+A = G, P+A = P. This group of subjects produced the only perfect MISS IFF score, Subject 7, but his scores in some of the categories were Poor; Subject 9 had the best scores in all categories except the MISS IFF. The ranking of this group is: Subjects 7, 4, 9, 5, 8, 1, 10, 3, 2 and 6.

Table 12 is a summary of the individual performance information from Appendix B.

TABLE 12

Group 2 Overall Performance

SUBJECT		NORMAL RUN DET	NORMAL RUN IFF	NORMAL SEAT DET	NORMAL SEAT IFF	NORMAL MISS IFF	OPTICS RUN DET	OPTICS RUN IFF	OPTICS SEAT DET	OPTICS SEAT IFF	OPTICS MISS IFF	OVERALL RATE	OVERALL MISS	FINAL RATING
1	Time	A	A	G	G	1	P	P	P	P	2	A	3	
	Range	P	P	A	P	0	G	P	A	P	3	P	3	A
2	Time	G	A	G	G	0	P	P	A	A	1	G	1	
	Range	G	G	G	G	1	A	P	A	P	0	G	1	G
3	Time	P	P	P	P	2	P	P	P	P	0	P	2	
	Range	G	G	G	G	0	A	P	G	P	2	G	2	A
4	Time	G	G	G	G	0	G	G	G	G	1	G	1	
	Range	A	P	P	P	1	G	G	G	G	2	A	3	G
5	Time	G	P	P	P	0	G	P	G	A	2	A	2	
	Range	G	P	G	G	1	A	P	A	P	2	A	3	A
6	Time	G	G	G	G	1	G	G	P	G	1	G	2	
	Range	P	G	P	G	1	G	G	G	P	1	G	2	G
7	Time	G	G	G	G	1	G	G	G	P	2	G	3	
	Range	G	P	G	P	1	G	G	G	G	1	G	2	G
8	Time	P	P	P	P	1	P	P	A	P	2	P	3	
	Range	P	P	P	P	2	P	G	P	P	2	P	4	P
9	Time	G	P	G	G	0	G	P	G	A	2	G	2	
	Range	G	P	G	P	1	G	P	G	P	2	A	3	G
10	Time	A	P	G	P	1	A	P	A	P	2	P	3	
	Range	G	G	G	G	0	G	P	G	P	2	G	2	A

G- Good
A- Average
P- Poor

The best performance from the Group 2 subjects was by Subject 2 followed in order by Subjects 6, 4, 7, 9, 5, 3, 10, 1 and 8. The men from this group misidentified 15 groups of vehicles out of the 100 that were presented to them under the Normal category and 32 groups of vehicles out of the 100 under the Optics category. It would appear that when they could see the vehicles in greater detail they made more identity mistakes. The men from Group 1 performed in a more expected manner, misidentifying 30 groups under the Normal category and 19 under the Optics. There was a difference in the past experience of the two groups of subjects in that many of the Group 2 subjects had participated in Reforger in Europe and had expressed the philosophy that if one of the vehicles in a group was recognized as a non-US vehicle, the whole group was then classified as "FOE" because "all of our allies will be using US equipment." This, of course, was a false assumption and led to errors when the Israeli armor groups and truck convoys were presented as they were made up of a mix of US and Soviet vehicles. This type of thinking could lead to some costly battlefield errors because much of the armor of our allies bears a close resemblance to Soviet armor; for example, the Soviet wheeled Armored Personnel Carrier BTR-60 is the same type of vehicle used by many of our European allies. The US has no wheeled vehicles of this type. The use of optics, a very lightweight power, wide angle, hand-held monocular which simulated those of the TOW sight, helped. All of the subjects in Group 1, except for Subject 9 who made one error without the optics and two with them, made the same number or fewer errors when using the optics. The story was somewhat different for Group 2, no one made fewer errors; three subjects made the same number of errors while the rest made a greater number of IFF errors when using the optics. It was quite obvious from listening to the data tapes that the error increase experienced by Group 2 was induced by the philosophy mentioned above; as soon as one vehicle was recognized as Soviet, the fire command would be given.

An attempt was made to obtain eye movement data from each of the subjects of the HELIFF test but the difficulties encountered when a reduction in the size and intensity of the fixation indication marker to compensate for the extended ranges caused the loss of most of the data. The Eye Mark system with the 60° field of view optics is not designed for ranges greater than 200 to 300 meters. At these distances, the effect of the wide-angle optics reduced the size of the targets while the fixation indication marker size remained constant; this produced a giant marker and a small target. The eye movement data from the ranging runs of Subjects 1, 2, 8 and 10 of Group 2 was obtained.

TABLE 13

Eye Movement Dwell Times
(Seconds)

Subject	Run	Performance DET	Performance IFF	Single Glance	Maximum Dwell
1	2	A	P	1/2	1
2	1	G	G	1/2	4
8	5	P	P*	3/4	5
10	3	G	A	3/4	22

* Wrong IFF.

Subject 1 was presented a friendly truck convoy to identify, the convoy was proceeding from Point B' to T' at a rate of 12.76 mph along a paved roadway (Figure 3) to the right of the open area used for the tank route. He began his search by glancing to the left of the convoy route and then back to the convoy route and generally directed his attention to the approaching trucks. He called his direction of the vehicles when they were at a range of 2,067 meters but there was no particular visual behavior to indicate this determination, his single glances averaged approximately 1/2 second with a few as long as 1 second. He continued to visually follow the truck convoy as it approached the turning point at T' but never fixated on any one item. He gave his IFF call as the vehicles were turning at point T', the range was 466 meters.

Subject 2 had a friendly armored group to identify, the group was proceeding from Point A' to T' at a speed of 10.4 mph across an open area. The four vehicles were in a staggered echelon formation to prevent the dust from obscuring any of them from the view of the subjects. Subject 2 began his search by scanning to the left of the tank route prior to his initial detection at a range of 2,516 meters. After the detection, he generally followed the vehicles progress towards his position with occasional glances to the far right of the course. He identified the armored group at a range of 949 meters and had a maximum dwell time of 4 seconds. His visual behavior following the IFF was very interesting, he fixated on the vehicles for a period of 10 seconds where prior fixations had been approximately 1/2 second. As the vehicles made a turn to the right at a range of 900 meters to proceed to the road to Point T', he visually followed each individual vehicle for 4 to 5 seconds as if to verify his identification. Usually the subjects would identify the vehicles and then proceed to look elsewhere. This behavior was identifiable even when the fixation marker was not visible because as the subject's head moved, the scene shifted on the data film.

Subject 8 had an enemy armor group to identify. This group also moved from Point A' to T' and proceeded at a rate of 12.6 mph. He began the run by searching to the right of the armored vehicle route and just before he announced his detection of the group, he made a large head movement to the left and concentrated his attention on the route. The detection range was 1,603 meters and he had fixated for 5 seconds on the vehicles before he called the detection. His single glance dwell times were 3/4 seconds on the average. He continued to follow the group until they made the turn at Point T' where he incorrectly identified them at a range of 456 meters. This was a poor performance overall and there was no apparent reason for the amount of time spent searching to the right of the vehicle route as this was the last run in a series of five runs made in the test period.

Subject 10 was presented a friendly armor group to identify. It proceeded from Point A' to T' at a rate of 10.97 mph. He detected the vehicles 14 seconds after they had departed for a detection range of 2,650 meters. After the detection announcement, he continued to scan the area around Point A' for 45 seconds. Before he returned his attention to the vehicles, he spent several seconds looking at the area immediately in front of the tower and then at the truck convoy route. He finally identified the group as they crossed the road between Points A' and B' at a range of 830 meters. He had fixated on the column for 22 seconds prior to making the IFF. His average single glance dwell time had been 3/4 second during the run. After making the IFF, he no longer followed the vehicles' progress to Point T'.

This limited sample from Group 2 contains data on the subjects with the best and the poorest overall performance ratings and on two subjects who were rated as low average.

A comparison of the tactics used by Subject 2 and those used by Subjects 8 and 10 reveal some probable causes for the differences in performance. Subject 8 had a group of vehicles, armor, that was moving slightly faster than the armor group did for Subject 2, but the obvious difference in their performance was attention to the task at hand, or so it seems. Subject 8 was late in his detection call because he was searching in the wrong area. He had experienced four previous runs in this session; yet he was searching in the area of B' where the truck convoys originated and spent an excessive amount of time looking there before he turned his attention to the A' area. From that point until he finally did make an incorrect identification of the column at a slant range of 466 meters, he did watch their progress down the course in a proper manner. Subject 10 had a group that proceeded at approximately the same speed as that of Subject 2. He detected the group at maximum range but while waiting for the group to get close enough to positively identify, he wasted valuable time looking at the area immediately in front of the tower and at the convoy route. If he had been concentrating on the tank route, it is highly possible that he would have seen the silhouette of the tanks and armored personnel carriers when they crested high points in the course as they proceeded towards him and would have been able to identify them much sooner; his was a reasonable performance that could have been an outstanding one.

The subjects that contributed to this data base were all considered by the US Army to be fully trained. They were assigned to operational tactical units and were performing in tactical jobs; in short, they were from top quality units that would be our first line defense. There was a considerable difference in the flight experience of these subjects, as will be shown in the following tables, but they were all at a high level of competence in their assignment.

Unfortunately, the individual data from the HELHAT study had been put onto computer cards for use in the statistical program and the original data sheets had been destroyed. Therefore, only the amount of combat flight experience of the more experienced member of the NOE flight crews is available. It is as follows:

Crew 1	500 hours
Crew 2	1500 hours
Crew 3	500 hours
Crew 4	1900 hours
Crew 5	500 hours
Crew 6	900 hours

All of the pilots were Chief Warrant Officers, Grade 2, except for the pilot of Crew 4 who was a Captain. All of the observers were CW-2s.

The best overall NOE performance from HELHAT was accomplished by Crews 1 and 2. Crew 2 found more targets but flew at a higher AGL than did Crew 1; this increased the intervisibility for Crew 2 which would have enabled it to increase its probability of detecting targets, but it would also have increased its possibility of being detected and hit by the enemy. The poorest performance was that of Crew 6; they found no targets before they became disoriented and were unable to complete the 7-mile long route. Crew 4 also became lost but they did find three of the targets before they strayed off of the route. Crew 4 had the most combat experience followed by Crews 2 and 6; thus, the most experienced crews had one of the best and also the poorest scores of the NOE test. This would seem to indicate that some experience is good but that the amount of experience does not insure good performance. No mention has been made of motivation because these 12 men volunteered to fly this test; in fact, they had asked that the NOE portion be added to the HELHAT test as it was not a part of the original plan.

The HELCAT Subject Profile (Table 14) provides a good statistical view of the subjects.

TABLE 14

HELCAT Subject Profile

Subject	Total Time	Combat Time	Flight School	Age	Service (Months)	Rank
1	2600	1800	1969	26	90	CW-2
2	1788	521	1971	24	72	CW-2
3	3525	1498	1969	34	219	CW-2
4	1430	952	1968	31	115	CPT
5	352	0	1975	26	42	WO-1
6	1400	434	1971	26	72	CW-2
7	1600	1000	1969	32	168	CPT
8	2800	1343	1969	31	157	CW-2
9	1000	300	1972	25	72	CW-2
10	2800	1112	1970	27	84	CW-2
MEAN	1930	896	1970	28	109	

Subjects 2, 6 and 10 were the best overall performers and as in HELHAT all had had combat experience. The poorest performances were by Subjects 4 and 8, who also had combat experience. Subject 5 had no combat experience, very low flight time and his overall performance was Poor but two of the six categories of performance were Average and one was Good. Subject 1 had the most combat experience and his overall performance was Average with two of the six categories scored as Poor. Subject 3 who had the most total flight time was also an Average with three of the six categories scored as Poor; he also had the most time in service and was the oldest of the test subjects. Subject 2 was the youngest subject; Subject 4 was the first of the group to complete rotary wing flight school and Subject 5 was the last. This whole group of subjects was very cooperative and worked hard to make the study a success.

The HELIFF Group 1 Subject Profile (Table 15) shows that Subject 7, who had the best overall performance rating, had had combat experience and that Subject 6, who had the poorest overall rating, had not. Both had the same amount of total flight time even though there was a 6-year difference in the date that they completed rotary wing flight training. Subject 4 was the youngest of the group, one of the last to complete rotary wing flight training and one of those with the least amount of total flight time and no combat time; he had the next to the best overall performance rating. Subjects 1 and 2 were the oldest of the group; Subject 1 was the first to complete rotary wing flight school, had next to the most combat time and the most service time, and his overall performance was Average. Subject 2 had the most total flight time and was high in combat time but his overall performance was next to the poorest.

The Group 2 Subject Profile (Table 16) shows that Subject 2, who had the best overall performance rating, had combat experience as did Subject 8 who had the poorest rating. Both completed rotary wing flight training in 1969, had approximately the same amount of total flight time and were approximately 30 years of age.

TABLE 15

HELIFF Subject Profile

Group 1

Subject	Total Time	Combat Time	Flight School	Service (Months)	Age	Rank
1	1500	700	1969	120	35	WO-1
2	2700	600	1970	96	35	CW-2
3	1200	0	1975	96	26	CW-2
4	600	0	1975	36	23	WO-1
5	1020	400	1969	108	29	CW-2
6	1150	0	1975	36	30	CW-2
7	1200	450	1969	108	34	CW-2
8	1600	760	1970	96	27	CW-2
9	600	0	1975	84	25	WO-1
10	1400	0	1972	72	32	CW-2
MEAN	1297	291	1972	85	30	

TABLE 16

HELIFF Subject Profile

Group 2

Subject	Total Time	Combat Time	Flight School	Service (Months)	Age	Rank
1	1500	0	1972	72	26	CW-2
2	2425	776	1969	108	28	CW-3
3	3900	1000	1969	108	30	CW-2
4	3300	1300	1969	108	33	CW-2
5	2535	1003	1968	120	41	CW-3
6	2500	850	1969	108	27	CW-2
7	1900	800	1971	84	26	CW-2
8	2550	1825	1969	108	31	CW-2
9	780	0	1975	36	25	CW-2
10	2800	1130	1969	108	31	CW-2
MEAN	2419	868	1970	96	30	

The major difference was that Subject 8 had 1000 hours more combat time than did Subject 2. Subject 5, with an overall performance rating of Average, was the oldest, the first to complete rotary wing flight training and had the most time in service. Subject 9, with a rating of Good, was the youngest, the last to complete rotary wing flight training and had the least flight and service time.

There are some group differences shown in Tables 15 and 16; Group 2 had almost twice as much total flight time and three times the combat time of Group 1, yet both had the same mean age and completion of rotary wing flight training date and similar total service times. The group correct IFF scores from the HELIFF study were:

Group 1	Overall	Time	79% correct
Group 2	Overall	Time	76% correct
Group 1	Overall	Range	70% correct
Group 2	Overall	Range	74% correct

The group scores for detection were:

Group 1	Mean Detection Time	12.7 seconds
Group 2	Mean Detection Time	10.9 seconds
Group 1	Mean Detection Range	2,363 meters
Group 2	Mean Detection Range	2,338 meters

The group scores for IFF were:

Group 1	Mean IFF Time	34.2 seconds
Group 2	Mean IFF Time	23.5 seconds
Group 1	Mean IFF Range	1,487 meters
Group 2	Mean IFF Range	1,453 meters

The above group scores indicate that although there was a considerable difference in the flight experience level of the two groups, the only major group difference in performance was in the Mean IFF Time where Group 2 was much quicker than Group 1 but at the cost of 3 percent IFF error. Group 1 had a 30-meter advantage over Group 2 in the ranging tests but at the cost of a 4 percent IFF error. Both groups had an overall IFF score of 75 percent correct identifications which seems to indicate that the training has been able to compensate for a large measure of experience.

In the summer of 1974 a study was conducted at Fort Hood, Texas, that was entitled, Cobra/Tow Follow-On Evaluation (OT-131). This study, by another Army agency, followed a format similar to that of the USAHEL studies. The 18 subjects were all members of the 7/17 Cavalry, a unit that had furnished subjects for HELHAT and HELIFF. All were CW-2s except Subject 2.2 (Table 17), who was a Captain and Subject 6.1 who was a WO-1. The major task of the study was the live firing of a wire guided missile at a moving tank from the hover position of the pop-up maneuver. The target was "handed-off" to the gunship by a scout which eliminated the IFF requirement and considerably hastened the detection process. All of the subjects were qualified in the AH-1Q but none had any experience in the AH-1Q. They were all given training in the AH-1Q prior to the live fire tests and each fired five missiles. The original report gives a wealth of information on the training and the individual results but we will only look at the final item; the live fire test results and how each subject performed in the areas that made up the missile fire to impact sequence.

TABLE 17

OT-131 Ratings

SUBJECT	DET	ACQ	L	RM	ACL	RNG	TSP	EXP	D-A	A-F	SCORE	OVERALL
1.1	G	G	G	G	G	A	G	P	P	A	G	G
1.2	G	G	G	G	G	A	P	G	G	P	G	G
2.1	G	G	G	G	P	G	A	G	P	G	G	G
2.2	G	G	G	G	G	A	A	G	P	G	A	G
3.1	P	A	P	P	P	G	P	P	G	P	G	P
3.2	G	G	G	P	P	P	G	P	G	P	G	G
4.1	G	G	G	G	G	A	A	G	G	A	A	G
4.2	G	G	G	G	P	A	P	G	G	G	P	G
5.1	G	G	G	G	G	A	A	G	A	P	G	G
5.2	G	G	G	G	G	A	A	G	G	A	G	G
6.1	P	P	P	A	P	P	A	G	G	G	G	A
6.2	P	P	P	P	P	A	A	P	P	P	A	P
7.1	G	P	P	P	A	A	G	P	P	G	A	A
7.2	P	P	P	P	A	A	A	G	P	A	G	P
8.1	P	P	G	G	P	A	A	G	G	G	A	G
8.2	P	A	G	G	G	P	G	G	A	G	P	G

ACQ,	Acquire target
L,	Launch missile
RM,	Remask
ACL,	Height above ground cover/mask
RNG,	Launching range
TSP,	Target speed
EXP,	Total exposed time
D-A,	Detection to acquisition
A-F,	Acquisition to missile fire

The mean values for the items listed in Table 17 were as follows:

Detection	25.3 seconds
Acquisition	31.1 seconds
Launch	41.5 seconds
Remask	81.3 seconds
HCL	49.3 feet
Range	2397.0 meters
Target Speed	7.9 mph
Exposure	56.0 seconds
D-A	5.8 seconds
A-F	10.4 seconds

As stated above, each subject fired five missiles; data values for each category of the five firing sequences were the basis for the subject's performance rating.

Subject 5.2 had the best overall performance rating followed in order by Subjects 4.1, 2.2, 5.1, 1.2, 2.1, 1.1, 4.2, 8.2, 8.1, 3.2, 6.1, 7.1, 7.2, 3.1 and 6.2. Subject 2.1 had flown in the low level HELHAT tests in 1972 and 1973 but had not participated in the NOE tests.

The profile of these subjects is given in Table 18 and contains the same information as the previous profile tables except for total service time.

TABLE 18

OT-131 Subject Profile

Subject	Total Time	Combat Time	Flight School	Age	Rank
1.1	1100	636	1971	23	CW-2
1.2	1151	681	1971	24	CW-2
2.1	2277	1358	1969	25	CW-2
2.2	1006	534	1971	28	CPT
3.1	890	467	1971	28	CW-2
3.2	1121	524	1971	24	CW-2
4.1	1216	702	1973	24	CW-2
4.2	925	403	1972	23	CW-2
5.1	2092	1582	1970	25	CW-2
5.2	622	274	1972	32	CW-2
6.1	540	0	1972	23	WO-1
6.2	1076	556	1971	30	CW-2
7.1	1362	729	1971	27	CW-2
7.2	903	459	1972	27	CW-2
8.1	1290	808	1971	24	CW-2
8.2	1428	537	1971	25	CW-2
MEAN	1187	640	1971	26	

The OT-131 subject numbering system was such that Subjects 1.1 and 1.2 flew as a crew, when one man had the missile firing task to accomplish, the other handled the rest of the flight duties.

Subject 5.2 was the oldest subject participating in the test but he was a rather recent graduate of rotary wing flight school and had the lowest amount of total flight time of any of the subjects who had combat flight time; he also was low time man in this category excluding Subject 6.1 who had no combat time. Subject 1.1 was the youngest man and ranked seventh overall. Subjects 2.1 and 5.1 had the most total and combat flight time, they were the same age but Subject 2.1 had completed rotary wing flight training approximately 1 year earlier; they ranked sixth and fourth respectively. Subjects 5.2 and 6.1 had the least amount of combat and total flight time, they both completed rotary wing flight training the same year but Subject 5.2 was the oldest subject and 6.1 was one of the youngest; they ranked first and twelfth respectively.

DISCUSSION

The results of HELCAT, HELHAT, and OT-131 give a good indication of what can be expected of aircrews performing the pop-up maneuver against armor on the fringes of an armor engagement. When the armor is stationary and conventional camouflage is used, it should take 49 seconds to locate the armor at slant ranges of 800 to 1,000 meters when the helicopter is 60 feet above the masking cover (ACL); HELCAT was the source of this information. When single units of armor are moving across the aircrew's field of vision at mean slant ranges of 2,400 meters, the aircrew should detect the armor in 25 seconds from an ACL of 49 feet given they had had a "hand off" from a scout. This information was from OT-131.

There are several documents in the literature that state that 950 ± 50 meters is the maximum distance at which an object the size of a tank can be recognized with the unaided eye. We have also found this to be a fact experimentally and thus target and course placements in HELCAT andHELIFF, when indicated by the nature of the test, were governed by this information.

Small groups of armor; three to four vehicles, and small vehicle convoys; four to five vehicles, were detected in 12 seconds when crossing the field of view of the aircrews at slant ranges of approximately 1,000 meters. When the off angle of the approach was changed from 90° to 20° and the slant range increased to approximately 3,000 meters, the detections were made in 60 seconds. The ACL was 18 feet for both test conditions. This information was from HELIFF.

The aircrewmen's performance in the studies reviewed herein have been subjected to a number of statistical procedures such as Step-Wise Multiple Regressions, Analyses of Variance, Differences Between Means and Rank Correlation tests. The results of these procedures have not provided an absolutely clear explanation of the elements of excellence or lack thereof in the target detection and identification tasks.

The HELHAT study data which encompassed 831 low altitude (100 to 200 feet ACL) and 20 NOE target detections accomplished by a total of 53 aircrewmen of the 7/17 and 1/9 Cavalry flying at the Naval Weapons Center and Aberdeen Proving Ground, was analyzed using the multiple regression technique. The low altitude data indicated that the observer's sighting angle, the aircraft AGL, the aircraft heading, the target's relative bearing, the target's range from the aircraft, its size and conspicuity and the available ambient light were the significant factors in the aircrewman's success in detecting targets. The linear equation used in the procedure contained 25 of the variables that were measured in the HELHAT studies. The analysis of the NOE data indicated that the significant factors were the size of the target, its heading, its range from the aircraft and the available ambient light.

The HELCAT route reconnaissance detections were given the same statistical treatment and the same significant factors were evident with some minor differences. In HELCAT, the aircraft heading and target size were constant, thus were dropped out and the aircraft speed and the observer's combat experience were added as factors. These men were from the 1/17 Cavalry. The data from the 871 target detections indicate that, at the .05 level of confidence, the major factors that affect the aircrewman's ability to detect stationary targets during route reconnaissance are:

1. The relative bearing between the target and aircraft headings.

2. The height of the aircraft above the ground (AGL).

3. The distance between the aircraft and the target.

4. The size of the target.

5. The amount of contrast between the target and its background and foreground.

6. The ambient light available.

The individual eye movement data provides an interesting insight to one reason why apparently equally qualified subjects differ considerably in their target detection reporting times. The data from HELCAT and HELIFF showed little difference in single glance dwell times and in generally the search tactics were similar; the item that seemed to separate the excellent performer from the average performer was a simple matter of the time spent making up one's mind and reporting the detection. The actual detection times were close but there were extra seconds spent looking at the target prior to reporting it.

Rank correlation coefficients were computed from the data on the subjects of HELIFF, HELCAT and OT-131 to determine if there was any correlation between their overall performance rankings and their total amount of flight time, amount of combat flight time, and age. There was no evidence of correlation between any of these factors and the performance of the subject. It must be remembered that these were not naive subjects; they were well trained members of our "first line" US Army Air Cavalry units and the data and results reflect this. The performance differences that have been exhibited by these subjects have been, in general, the differences that can be expected between the members of a trained group. The additional stimulant of actual combat might well change the performance of many of the subjects and we do know from the Subject Profile tables that the majority of the subjects had flown many hours of combat and successfully so; they are still flying. We also have evidence that a small lapse in attention, such as documented from the eye motion data of HELIFF Subject 8, had a disastrous effect on his detection performance, yet he was combat experienced and we doubt that he had many lapses of attention during his 1,825 hours of combat flying. The data that has been reported upon is based on 1,018 air-to-ground target detections by 109 US Army pilot/observers. The route reconnaissance detections were 831 low level, 38 NOE, and 7 night vision detections for a total of 876. The pop-up detections were 135 day and 7 night vision detections for a total of 142.

The probability curves prepared from the detection and identification data of the HELCAT and HELIFF studies graphically show the impact movement and camouflage had on detection ranges and times. They also show the effects moving and stationary aircraft had on these measures. The graphs show that individual subjects do excede the mean detection and identification times and slant ranges but only in a random manner. We have included the curves of the best, the most variable and the poorest performing subjects in each category that has been graphed.

The data from the HELCAT NOE route reconnaissance flights are shown in Figure 4. The curve for the pattern-painted tank shows that there was one chance in 10 of detecting the stationary tank at slant ranges greater than 1200 meters. There was a 50 percent chance of detecting the tank at slant ranges of greater than 600 meters. The proper application of draped camouflage to the tank caused these slant ranges to drop to 550 and 250 meters respectively.

The slant range detection data from HELIFF Group I (Figure 5) shows the delta deviations from the group mean slant range detection. The graph indicates that a pilot performing a 6-meter AGL pop-up maneuver should have one chance in 10 of detecting a small (four to five vehicles) armored group at a slant range of greater than 2700 meters. There was a 50 percent chance of detecting the group at ranges greater than 2450 meters. Subject 1 was the best performer; Subject 10 was the most variable and the poorest performer.

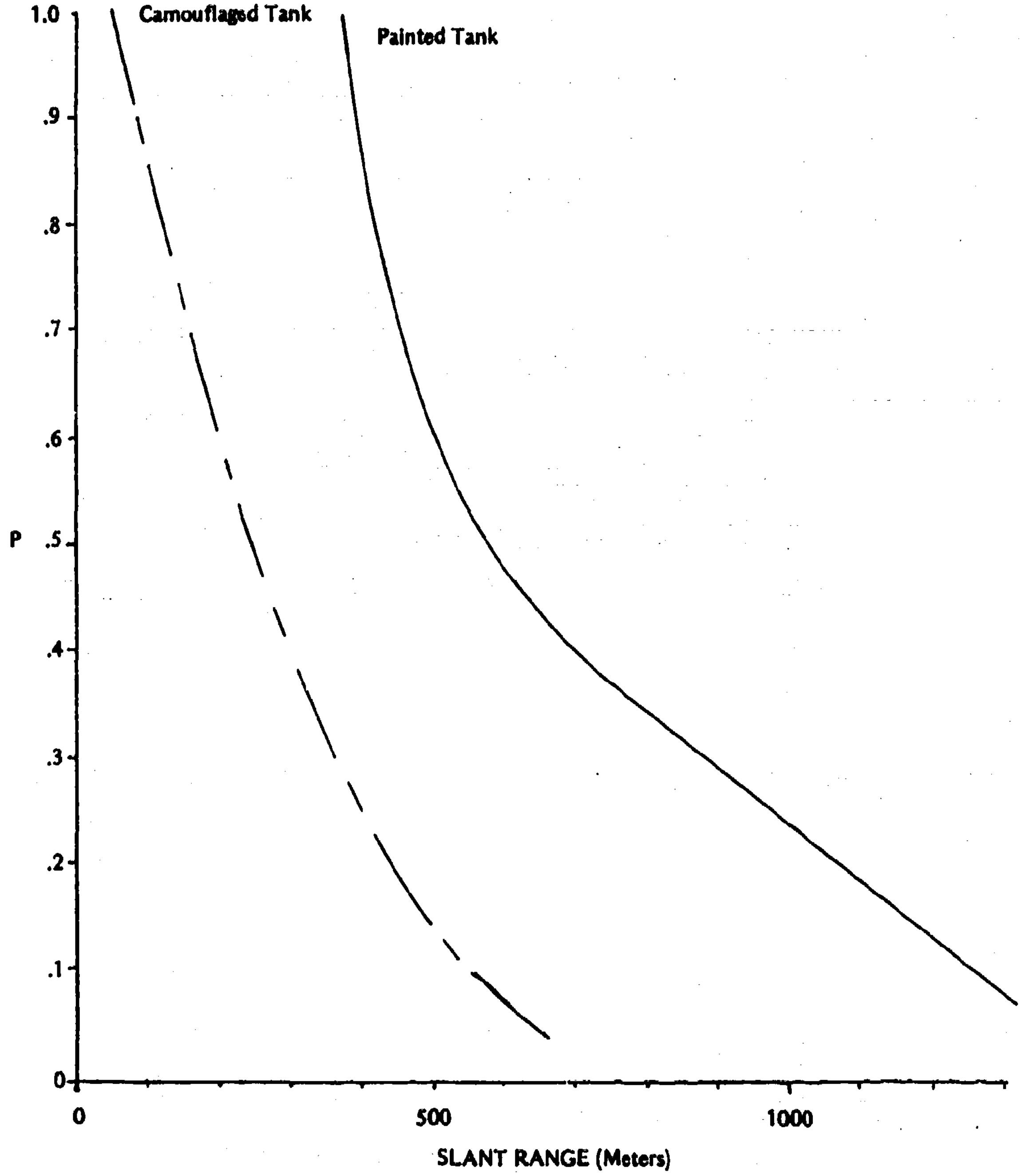

Figure 4. HELCAT; Probability of detection versus slant range.

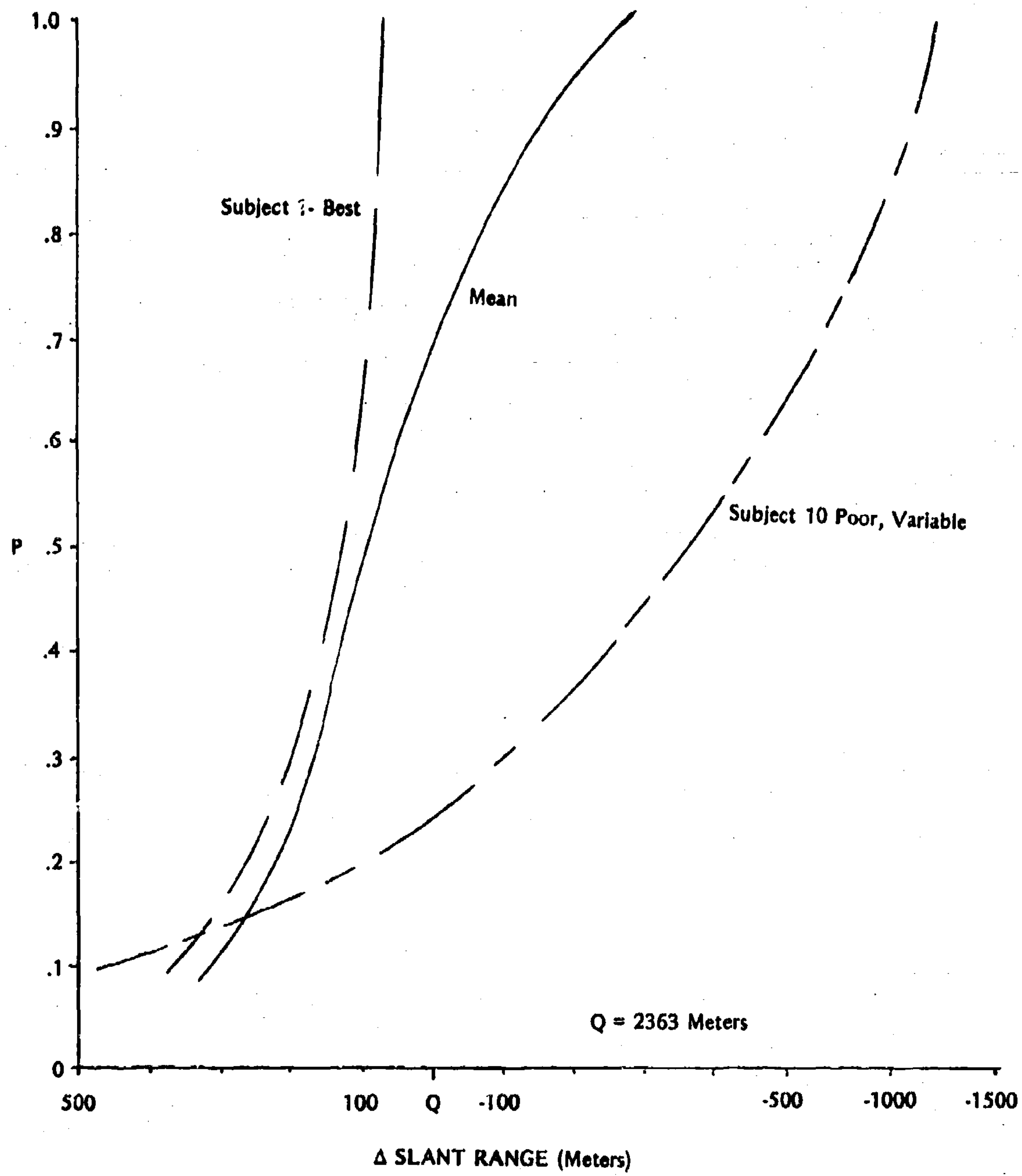

Figure 5. HELIFF, Group I; Probability of detection versus Δ slant range.

The HELIFF Group II data (Figure 6) for the same conditions indicates a one in 10 chance of detecting the moving group of vehicles at slant ranges in excess of 2660 meters and a 50 percent chance at ranges greater than 2400 meters. From these two groups of data, it is reasonable to conclude that a pilot performing a 6-meter AGL pop-up maneuver has a 50 percent chance of detecting a small group of moving armor at a slant range of greater than 2400 meters and a 10 percent chance of detecting the group at a slant range greater than 2700 meters.

The requirement to identify the vehicle group as friend or foe made some drastic changes in the slant ranges. The HELIFF Group I identification curves (Figure 7) show the 10 percent chance level at a slant range greater than 1887 meters and the 50 percent chance level at a slant range greater than 1550 meters. Subject 9 was the best performer, Subject 8 was the most variable, Subject 6 was the poorest performer and Subject 7 was the only subject who identified all groups correctly.

The HELIFF Group II identification curves (Figure 8) show that these subjects had a 10 percent chance of identifying the groups at slant ranges greater than 1900 meters and a 50 percent chance of identifying the groups at slant ranges greater than 1500 meters. Subject 4 was the best performer of Group II, Subject 2 was the most variable and Subject 1 was the poorest performer.

There were only three subjects in Group I who did not appear on one of the graphs in one of the three performance categories. The same was true for the Group II subjects. This indicates that no one subject was all good or all poor. From this we should be able to conclude that on any given day the Army can expect 10 percent of its gunship crewmen, when at hover at 6-meters AGL, to be able to detect small groups of moving armor at slant ranges of greater than 2700 meters and to be able to identify them as friend or foe at slant ranges of greater than 1900 meters. The Army can expect 50 percent of its gunship crewmen to be able to detect the vehicles at slant ranges greater than 2400 meters and to identify them at slant ranges greater than 1500 meters.

The HELCAT detection time curves (Figure 9) show that the gunship crewman during a pop-up maneuver has a 10 percent chance of detecting a tank at a slant range of greater than 900 meters in 10 seconds and a 50 percent chance of detecting it in 40 seconds. When draped camouflage is applied to the tank, the 10 percent time becomes 65 seconds and the 50 percent time becomes 175 seconds.

HELIFF study investigated the detection and identification times also. The subjects' position was the same as for the ranging tests but the vehicle groups operated at a slant range of 900 meters. The Group I curves (Figure 10) show that there was one chance in 10 of detecting the moving armor groups in less than 4.3 seconds and a 50 percent chance of detecting the group in less than 6 seconds. The Group I performances showed that Subject 5 was the best, Subject 9 was the most variable and Subject 2 the poorest.

The Group II curves (Figure 11) indicate that there was a 10 percent chance of detecting the target in less than 3 seconds and a 50 percent chance of detecting the group in less than 6.1 seconds. Subject 7 was the best performer, Subject 5 the most variable and Subject 3 was the poorest performer.

The additional task of identifying the targets as friend or foe required more time just as it had required shorter slant ranges in the ranging portion of HELIFF. The Group I graph (Figure 12) shows that these subjects had a 10 percent chance of identifying the moving armor groups in less than 14.2 seconds and that the interval increased to 32.5 seconds for a 50 percent chance of identification. Subject 5 was the best performer, Subject 10 was the most variable and Subject 6

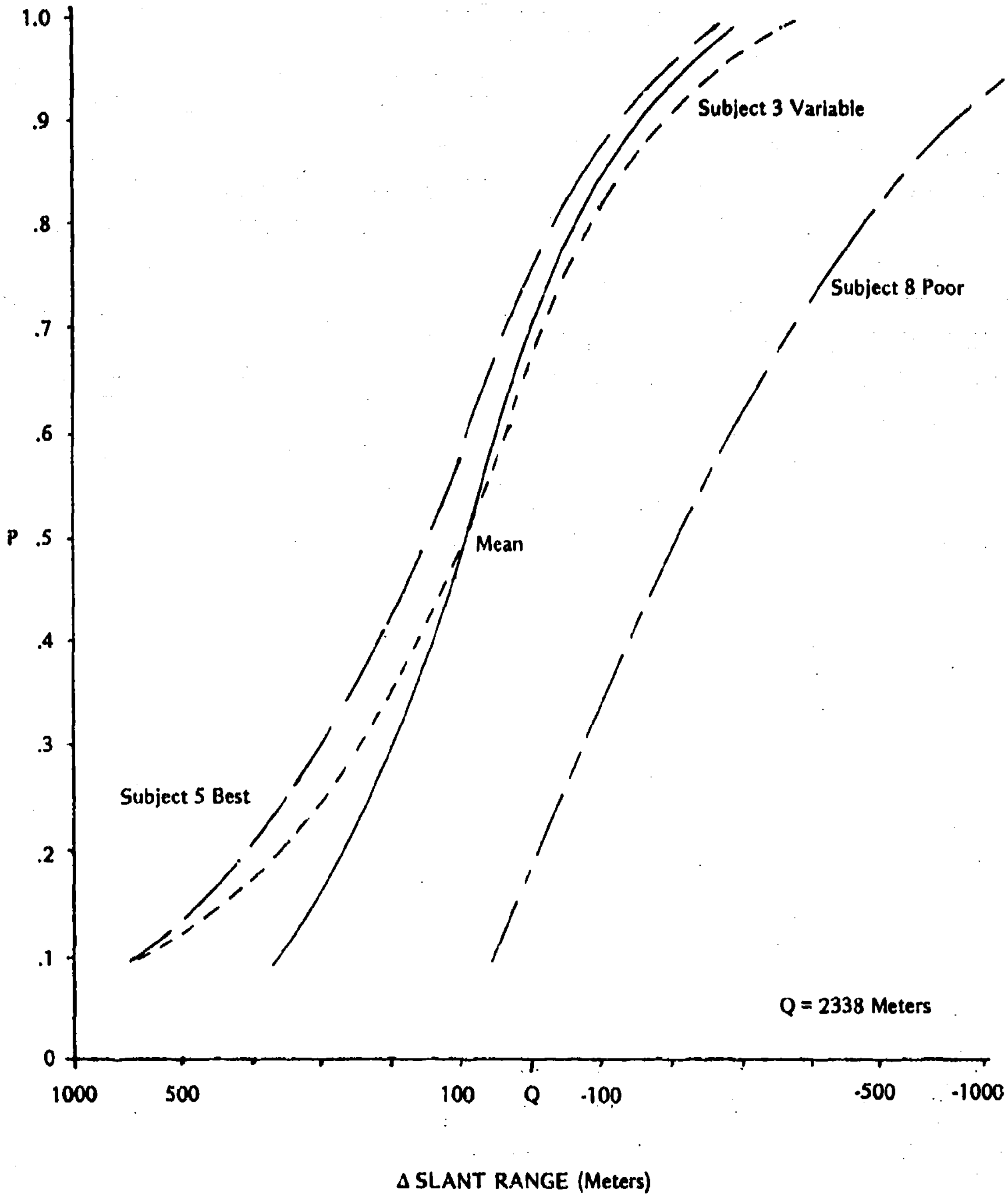

Figure 6. HELIFF, Group II; Probability of detection versus Δ slant range.

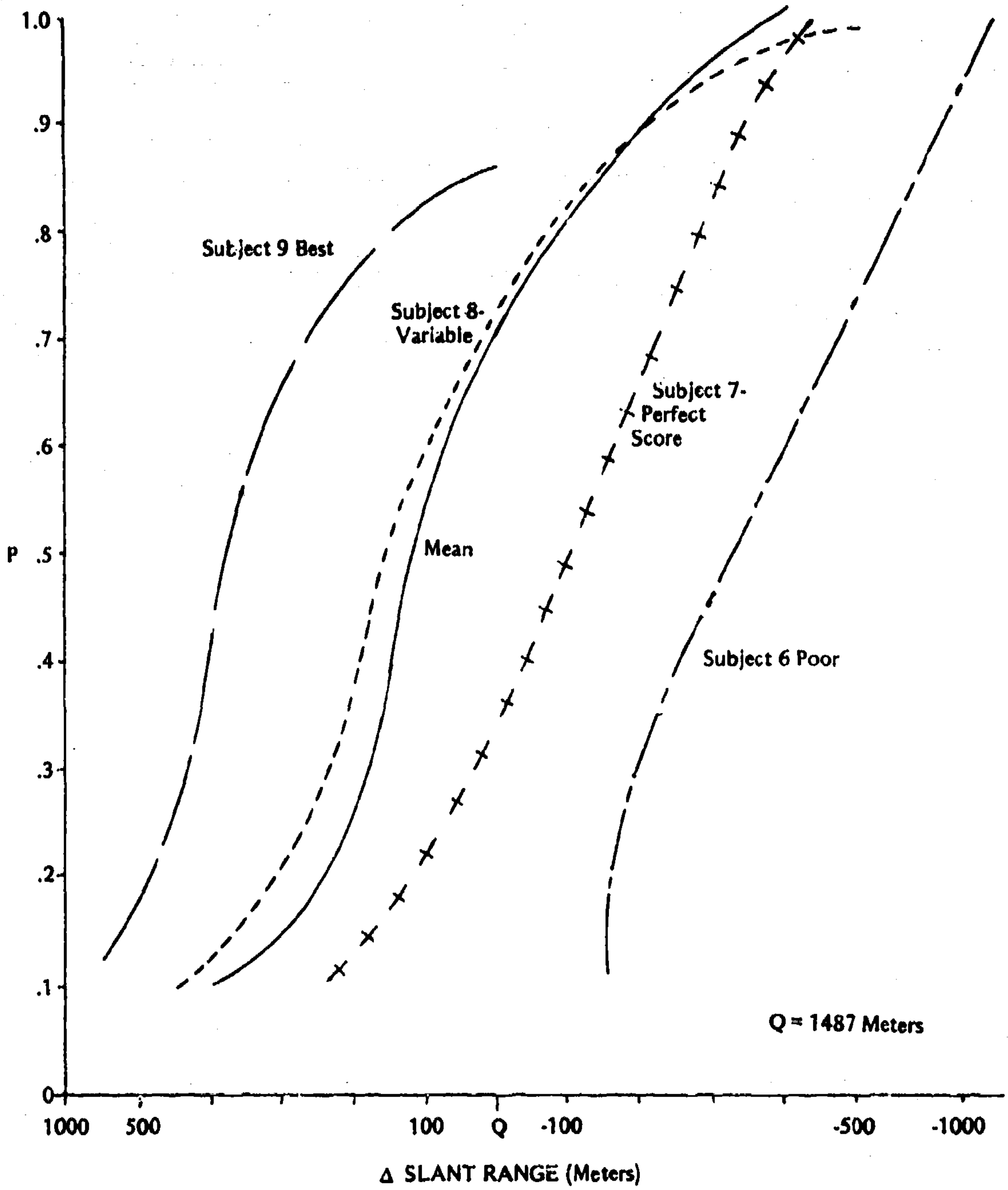

Figure 7. HELIFF, Group I; Probability of identification versus Δ slant range.

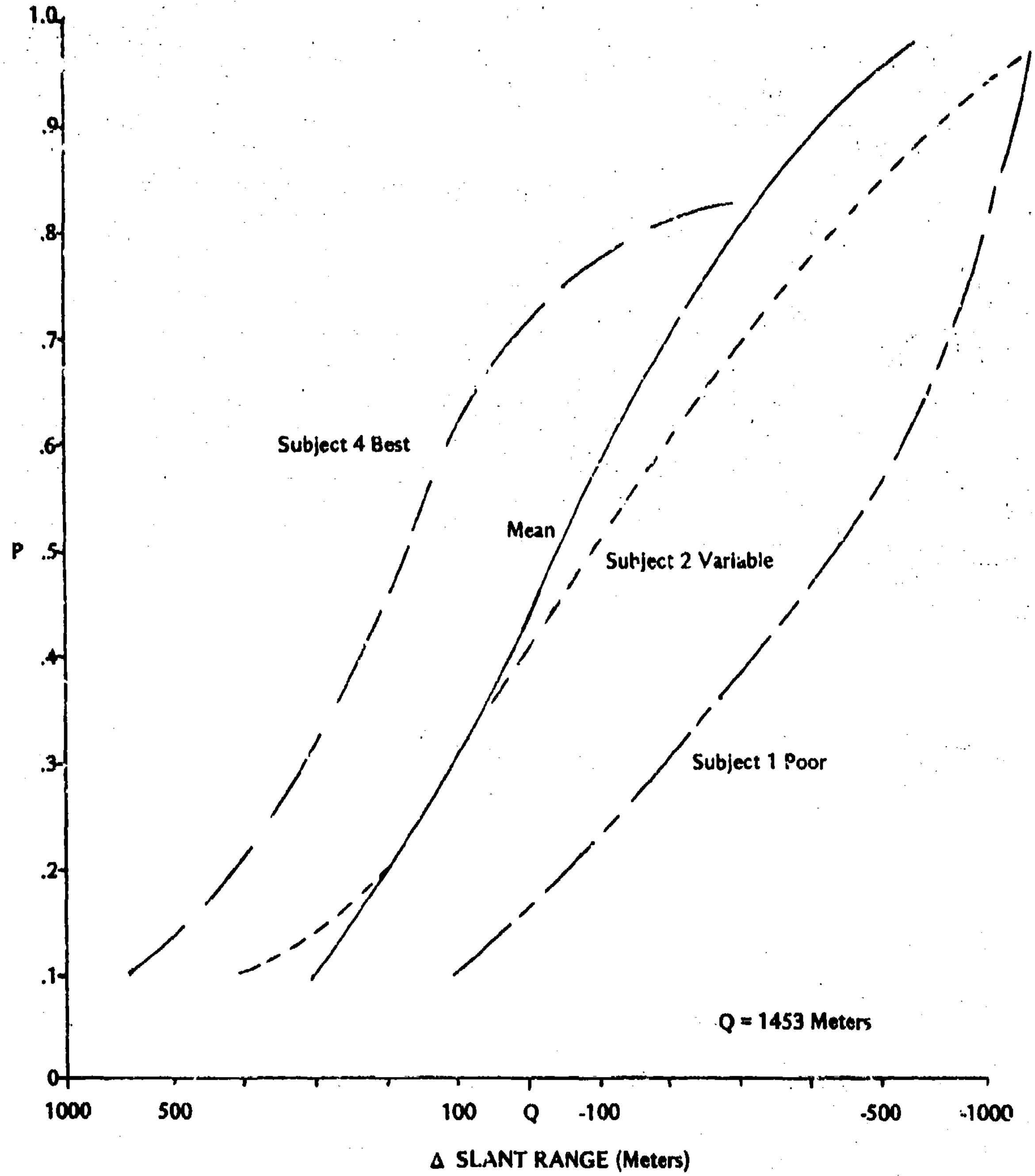

Figure 8. HELIFF, Group II; Probability of identification versus Δ slant range.

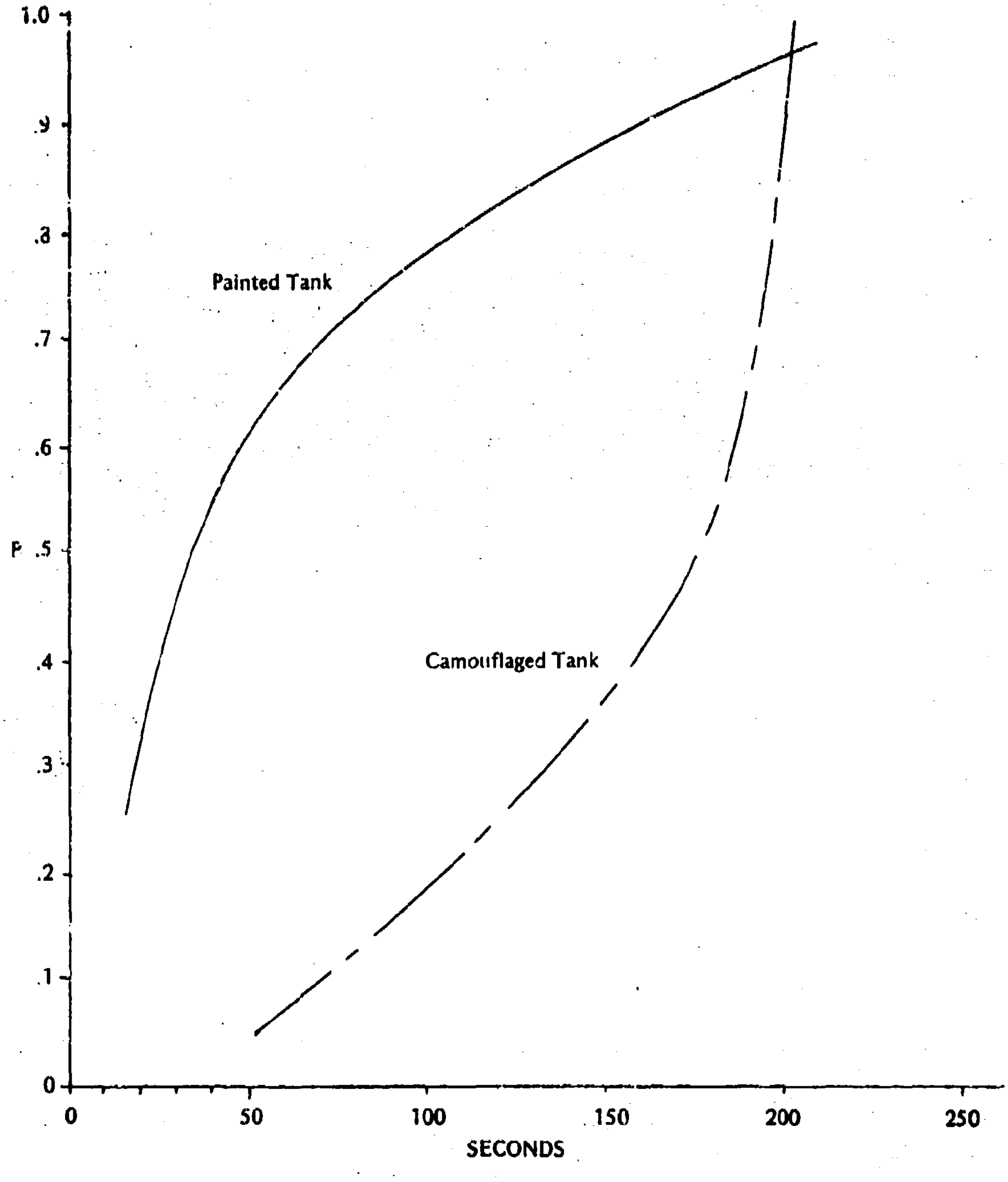

Figure 9. HELCAT; Probability of detection versus time.

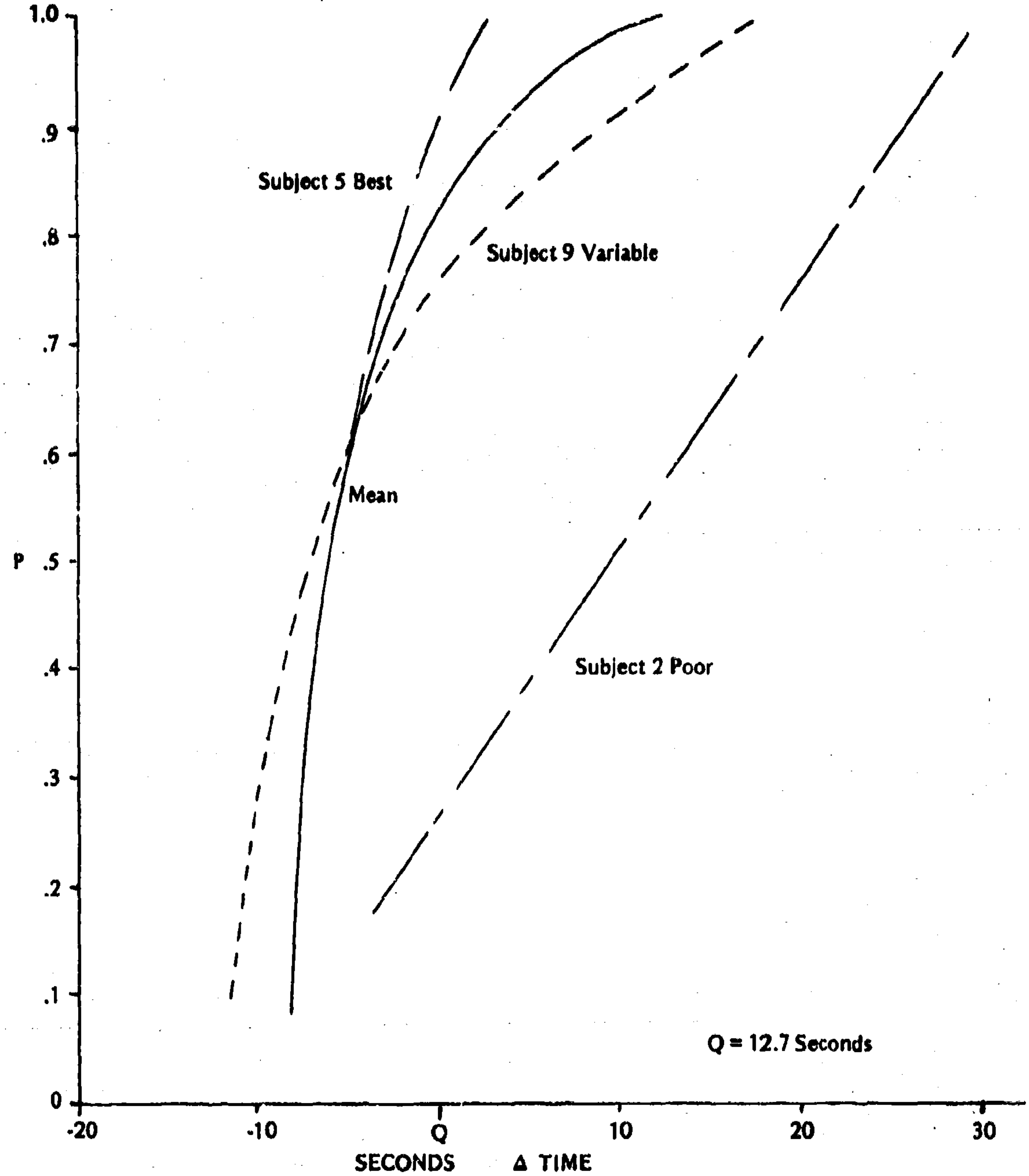

Figure 10. HELIFF, Group I; Probability of detection versus Δ time.

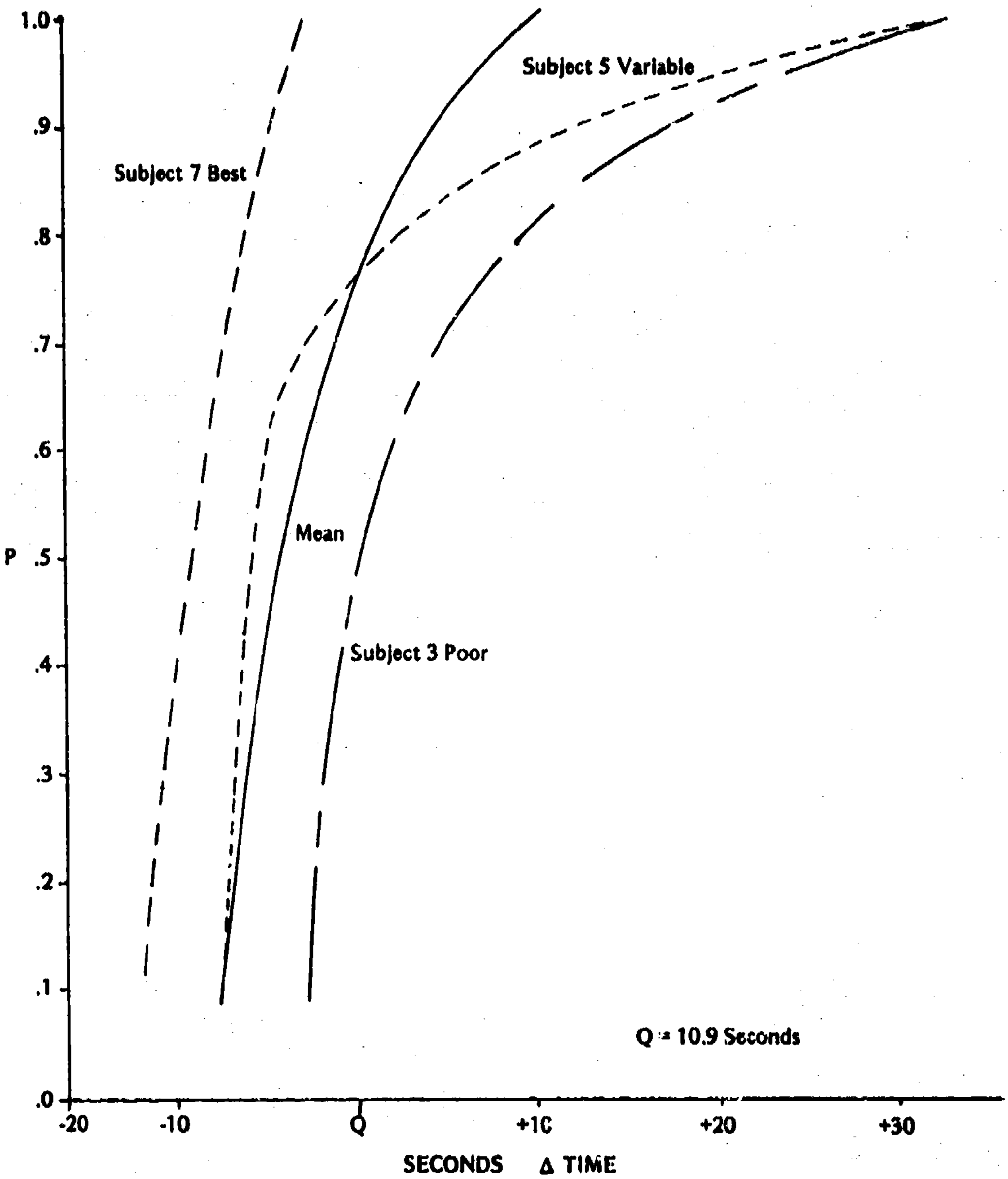

Figure 11. HELIFF, Group II; Probability of detection versus Δ time.

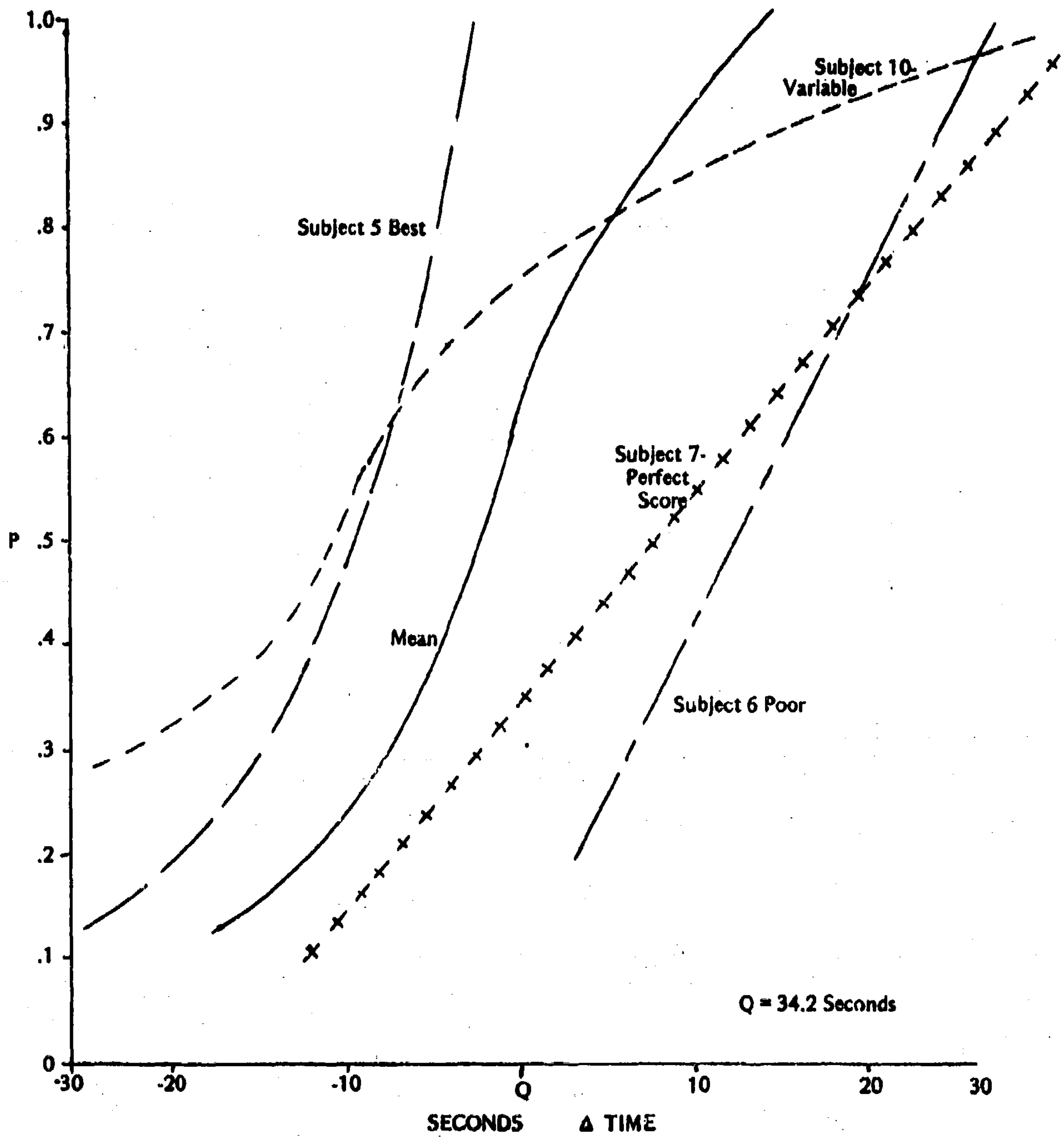

Figure 12. HELIFF, Group I; Probability of identification versus Δ. time.

was the poorest performer. Subject 7, as in the ranging, had a perfect identification score, his 10 percent score was 22.5 seconds and his 50 percent score was 42.5 seconds. His detection time curve fell along the mean detection time curve; his identification time curve fell to the positive side of the mean curve by approximately 1C seconds.

The Group II performance curves (Figure 13) are somewhat different. These subjects had a 10 percent chance of identifying the target in less than 15.1 seconds but the time interval only increased to 21.8 seconds for the 50 percent chance of identification. The Group II identification error rate was 3 percent greater than that of Group I which may have been attributable to the faster identification times.

Regression curves for the detection to impact, acquisition to impact, and missile flight to impact times from the OT-131 study are shown in Figure 14. These curves show how long it takes for a gunner to impact a wire guided missile onto a moving tank. This graph shows that the detection to impact time was essentially constant and exclusive of the slant range to the target; it varied only about a second as the slant range varied 2000 meters. The cause is shown clearly by the distance between the acquisition and missile flight time curves; the acquisition to firing time increases as the slant range decreases because as the angular velocity of the target increases the time necessary to acquire a lock-on increases.

Combining this information with that of the detection and identification studies, we find that with the gunship helicopter crew, operating in accordance with current tactics using normal and optically aided vision, can be expected to detect, identify and impact a wire guided missile as follows:

Moving Armored Vehicle

Slant Range, 1000 meters; 10% chance in less than 43 seconds
Slant Range, 1000 meters; 50% chance in less than 60 seconds

Stationary Armored Vehicle

Slant Range, 1000 meters; 10% chance in less than 39 seconds
Slant Range, 1000 meters; 50% chance in less than 69 seconds

Draped Camouflaged Stationary Armored Vehicle

Slant Range, 1000 meters; 10% chance in less than 94 seconds
Slant Range, 1000 meters; 50% chance in less than 204 seconds

These figures are for ideal conditions in a one-on-one situation with nothing to distract the gunship crewman from his task of locating, identifying and impacting a round on the target. They show that we are hard pressed to get off one missile per minute at a slant range of 1000 meters. The time will not improve as the slant range increases to 1500 meters, the distance at which there is a 50 percent chance of target identification. If the gunships are free to fire at any target they detect, the slant range is increased to 2400 meters for the 50 percent chance of detection; decreasing the chance to 10 percent increases the slant range to 2700 meters.

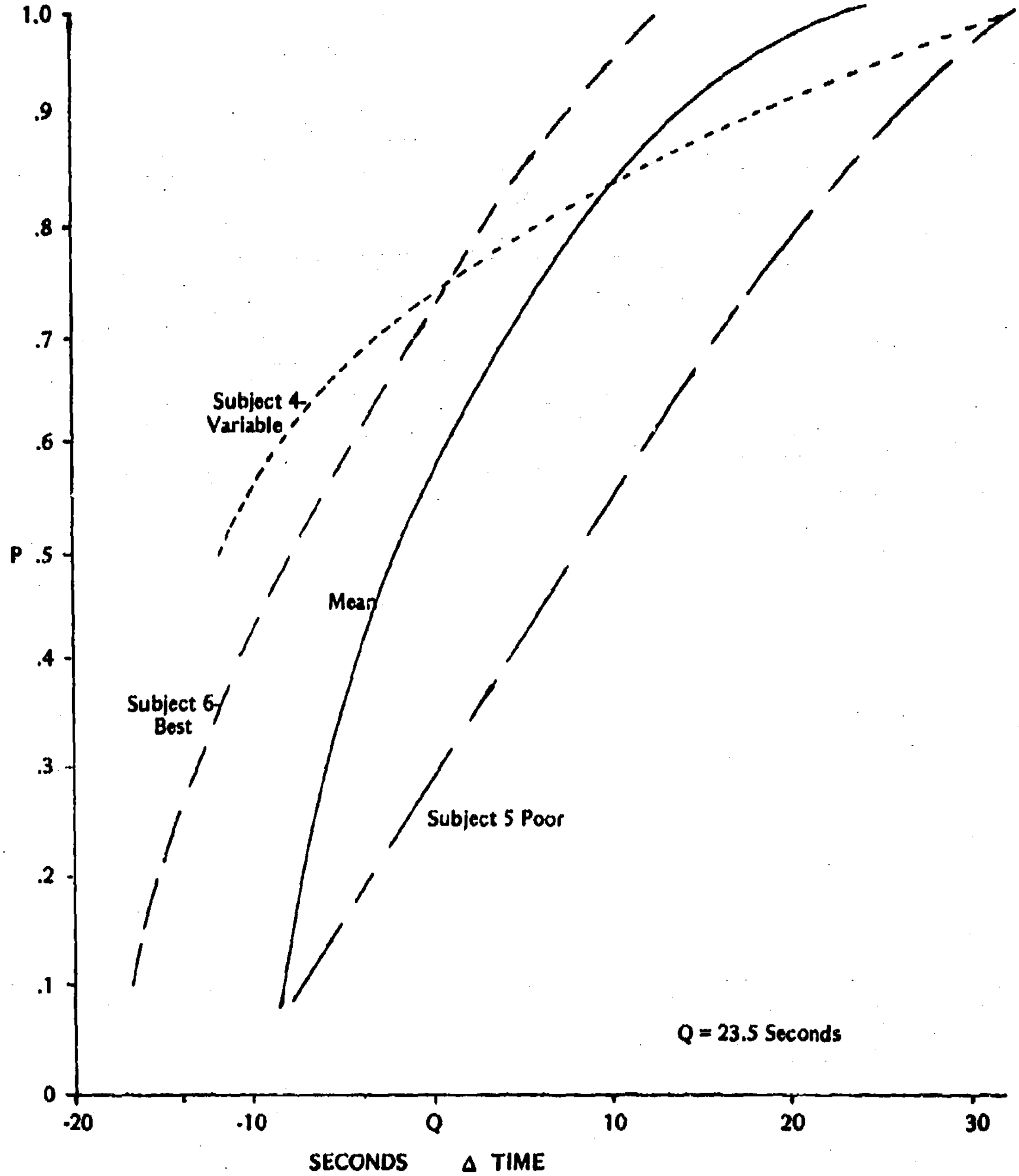

Figure 13. HELIFF, Group II; Probability of identification versus Δ time.

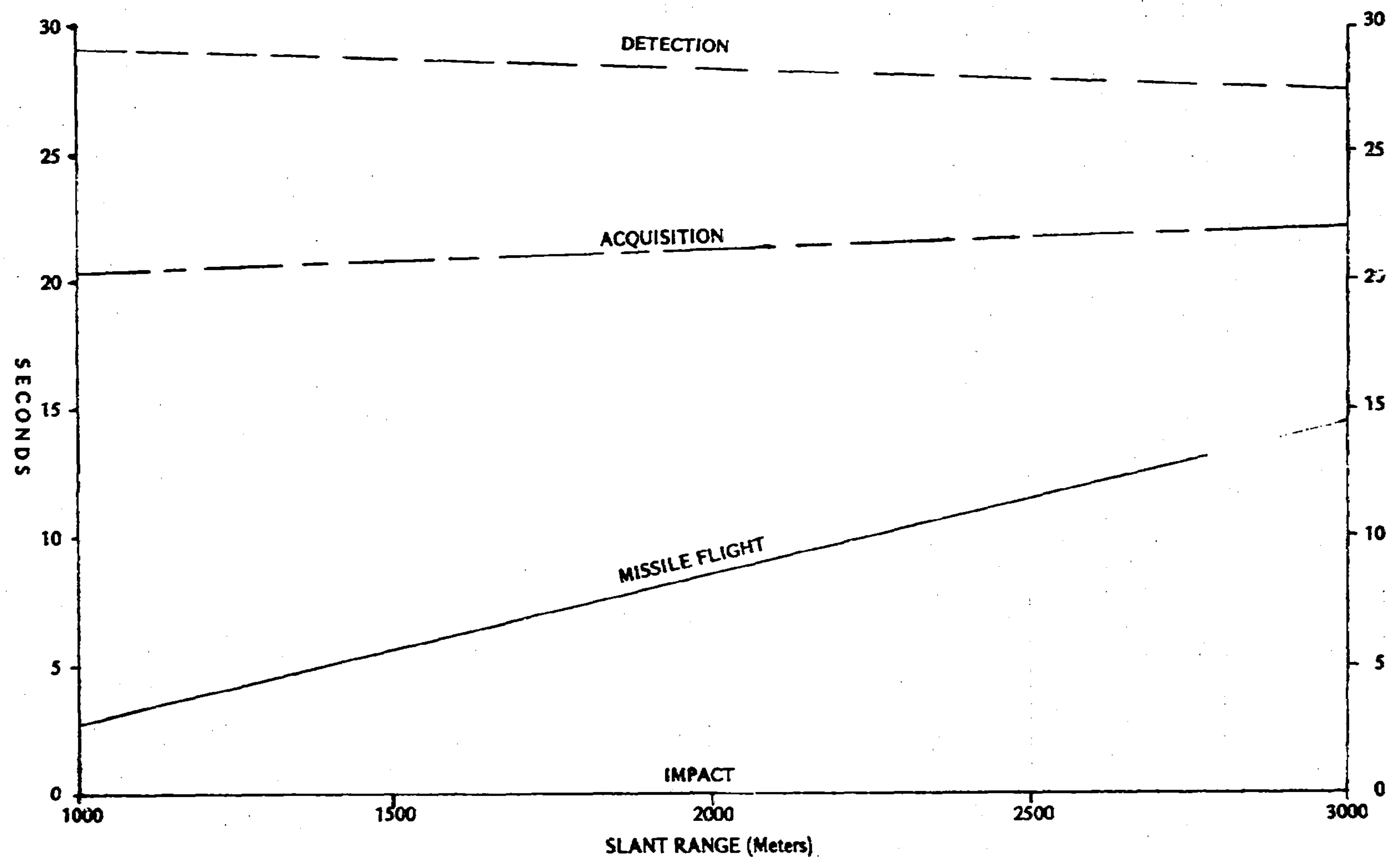

Figure 14. OT-131 regression curves; missile time to impact versus slant range.

We, in the Army community, must realize that using the current tactics, gunships as they are now configured, cannot regularly fire effective missiles at ranges greater than those listed above. The cold facts are that half of the time the gunships are able to impact one missile on a moving target at a slant range of 1000 meters in as fast as 1 minute; 10 percent of the time they can do it in as fast as 40 seconds. The remaining 50 percent of the time it will take the gunship longer than 1 minute to impact one missile on a moving tank at a slant range of 1000 meters.

APPENDIX A

SUBJECT'S PERFORMANCE
GROUP 1

SUBJECT'S PERFORMANCES

The following tables show in detail each of the subject's performance compared to the experiment mean value for that particular test run and for the position in which the subject was seated during the test run.

The delta values listed were obtained by the use of the following equation: Subject Score-Mean Score = Delta Value. A Good rating for the time experiments would consist of a negative delta value; for the range experiments a Good rating would result from a positive delta value.

The performance ratings were Good (G) for any delta value exceeded the Average (A) rating and Poor (P) for any delta value that did not. Average performance ratings were those delta values that were less than ± 1 second of the mean time value and those that were less than ± 100 feet of the mean range value.

Each table shows the delta value range and median for the five runs of that phase of the experiment and a performance rating for the runs. The table also gives the detection and IFF performance ratings for each run and for each seat occupied by the subject. There are four tables for each subject; unaided vision detection and IFF times, aided vision detection and IFF times, unaided vision detection and IFF ranges, and aided vision detection and IFF ranges.

SUBJECT 1

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	.4	-7.9	-2.7	5.7	1.9	13.6	.4	A
Delta Run IFF	26.7	-16.7*	7.4	-6.4	-2.6	43.4	-2.6	A
SEAT NUMBER	6	7	3	4	5			
Delta Seat Detect.	-.1	0	-5.0	10.2	-3.5	15.2	-.1	G
Delta Seat IFF	21.3	-11.8*	-.9	-1.0	-4.2	33.1	-1.0	G
SUBJECT PERFORMANCE								
Seat Detection	A	A	G	P	G			
Seat IFF	P	E	A	G	G		1 Error	
Run Detection	A	G	G	P	P			
Run IFF	P	E	P	G	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	6.4	7.3	13.3	4.2	2.6	10.7	6.4	P
Delta Run IFF	-.5	3.5	16.4*	4.2	-6.1*	22.5	3.5	P
SEAT NUMBER	1	2	8	9	10			
Delta Seat Detect.	10.0	2.7	7.3	-2.4	1.0	12.4	2.7	P
Delta Seat IFF	6.4	-3.3	25.6*	-3.3	-13.2*	38.8	-3.3	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	P	G	P			
Seat IFF	P	G	E	G	E		2 Errors	
Run Detection	P	P	P	P	P			
Run IFF	A	P	E	P	E			

SUBJECT 1

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-38	-21	-84	-95	55	150	-38	P
Delta Run IFF	-118	-573	-407	-330	-419	455	-407	P
SEAT NUMBER	1	2	8	9	10			
Delta Seat Detect.	51	-19	-15	-320	441	761	-15	A
Delta Seat IFF	-442	-169	-206	-290	-91	351	-206	P
SUBJECT PERFORMANCE								
Seat Detection	G	A	A	P	G			
Seat IFF	P	P	P	P	P			
Run Detection	P	A	P	P	G			
Run IFF	P	P	P	P	P			

0 Errors

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	81	324	-139	175	-306	630	81	G
Delta Run IFF	325*	-330*	-65	593*	256	923	256	P
SEAT NUMBER	6	7	3	4	5			
Delta Seat Detect.	348	10	-8	-50	-185	533	-8	A
Delta Seat IFF	360*	-627*	265	-2*	221	997	221	P
SUBJECT PERFORMANCE								
Seat Detection	G	A	A	P	P			
Seat IFF	E	E	G	E	G			
Run Detection	G	G	P	G	P			
Run IFF	E	E	P	E	G			

3 Errors

SUBJECT 2

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-1.1	-8.5	-1.8	5.5	2.8	14.0	-1.1	G
Delta Run IFF	-9.3	-.6	-10.4	4.0	7.4	17.8	-.6	A
SEAT NUMBER	7	3	4	5	6			
Delta Seat Detect.	-.9	-1.4	-3.1	6.7	-.2	9.8	-.9	G
Delta Seat IFF	-10.0	-1.5	-10.3	5.7	-4.3	16.0	-4.3	G
SUBJECT PERFORMANCE								
Seat Detection	A	G	G	P	A			
Seat IFF	G	G	G	P	G		0 Errors	
Run Detection	G	G	G	P	P			
Run IFF	G	A	G	P	P			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	16.8	2.7	-5.2	-4.4	5.7	22.0	2.7	P
Delta Run IFF	14.9	-6.9	5.0	7.8	-3.0*	19.9	5.0	P
SEAT NUMBER	2	8	9	10	1			
Delta Seat Detect.	19.4	.9	-8.7	-12.7	1.5	32.1	.9	A
Delta Seat IFF	12.6	-10.2	15.7	-3.5	-2.1*	25.9	-2.1	A
SUBJECT PERFORMANCE								
Seat Detection	P	A	G	G	P			
Seat IFF	P	G	P	G	E		1 Error	
Run Detection	P	P	G	G	P			
Run IFF	P	G	P	P	E			

SUBJECT 2

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	184	248	67	-82	133	330	133	G
Delta Run IFF	365	232	237*	-196	141	561	232	G
SEAT NUMBER	2	8	9	10	1			
Delta Seat Detect.	430	34	458	-528	477	1005	430	G
Delta Seat IFF	314	599	354*	43	118	556	314	G
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	P	G			
Seat IFF	G	G	E	G	G			
Run Detection	G	G	G	P	G			
Run IFF	G	G	E	P	G			

1 Error

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	82	241	-51	-15	-468	709	82	A
Delta Run IFF	-413	540	23	-483	-76	1023	23	P
SEAT NUMBER	7	3	4	5	6			
Delta Seat Detect.	114	-29	155	-160	-281	436	-29	A
Delta Seat IFF	-360	-54	203	-670	-774	907		P
SUBJECT PERFORMANCE								
Seat Detection	G	A	G	P	P			
Seat IFF	P	P	G	P	P			
Run Detection	G	G	P	A	P			
Run IFF	P	G	A	P	P			

0 Errors

SUBJECT 3

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	.2	32.9	2.3	7.9	1.2	32.7	2.3	P
Delta Run IFF	-11.9*	22.3*	6.0	-4.2	-6.2	24.2	-4.2	P
SEAT NUMBER	3	9	10	1	2			
Delta Seat Detect.	2.2	34.6	1.0	2.3	-.4	35.0	2.2	P
Delta Seat IFF	-16.3*	29.2*	5.3	-1.1	.6	45.5	.6	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	P	P	A			
Seat IFF	E	E	P	G	A		2 Errors	
Run Detection	A	P	P	P	P			
Run IFF	E	E	P	G	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	1.0	1.4	-.5	3.1	4.6	8.6	1.4	P
Delta Run IFF	1.3	.1	9.8	11.2	-4.1	15.3	1.3	P
SEAT NUMBER	3	4	5	6	7			
Delta Seat Detect.	14.2	5.1	-4.0	6.3	8.0	18.2	6.3	P
Delta Seat IFF	9.4	-2.3	17.0	-4.8	4.3	21.8	4.3	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	P	P			
Seat IFF	P	G	P	G	P		0 Errors	
Run Detection	P	P	A	P	P			
Run IFF	P	A	P	P	G			

SUBJECT 3

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	211	282	257	507	133	274	257	G
Delta Run IFF	-39	-308	752	954	205	1268	205	G
SEAT NUMBER	3	4	5	6	7			
Delta Seat Detect.	123	79	256	124	487	408	124	G
Delta Seat IFF	-406	71	406	699	145	1105	145	G
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	G	G			
Seat IFF	P	G	G	G	G	0 Errors		
Run Detection	G	G	G	G	G			
Run IFF	P	P	G	G	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-19	-338	66	-205	68	406	-19	A
Delta Run IFF	-261*	-187	-156	-166*	123	384	-166	P
SEAT NUMBER	8	9	10	1	2			
Delta Seat Detect.	214	-464	139	-449	150	678	139	G
Delta Seat IFF	-283*	-310	528	-214*	206	838	-214	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	P	G			
Seat IFF	E	P	G	E	G	2 Errors		
Run Detection	A	P	G	P	G			
Run IFF	E	P	P	E	G			

SUBJECT 4

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	1.7	-7.2	-.9	-3.7	-4.1	8.9	-3.7	G
Delta Run IFF	-11.0	-8.6	-13.5	-13.6	-8.5	5.1	-11.0	G
SEAT NUMBER	9	10	1	2	8			
Delta Seat Detect.	-4.3	1.7	-12.3	1.3	-4.6	14.0	-4.3	G
Delta Seat IFF	-9.7	-1.9	-15.7	-3.5	-12.7	13.8	-9.7	G
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	P	G			
Seat IFF	G	G	G	G	G			
Run Detection	P	G	A	G	G			
Run IFF	G	G	G	G	G			

0 Error

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-5.5	-10.2	-3.8	-3.4	-10.1	6.8	-5.5	G
Delta Run IFF	-2.5	7.9	34.4	-13.4	-5.6*	47.8	-2.5	G
SEAT NUMBER	4	5	6	7	3			
Delta Seat Detect.	5.4	-9.5	-2.5	-6.7	-4.7	14.9	-4.7	G
Delta Seat IFF	-.4	2.6	36.6	-9.2	-3.5*	45.8	-.4	G
SUBJECT PERFORMANCE								
Seat Detection	P	G	G	G	G			
Seat IFF	A	P	P	G	E			
Run Detection	G	G	G	G	G			
Run IFF	G	P	P	G	E			

1 Error

SUBJECT 4

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-91	240	-213	-5	117	331	-5	A
Delta Run IFF	-118	1134	-298*	-116	451	1432	-116	P
SEAT NUMBER	4	5	6	7	3			
Delta Seat Detect.	-50	-44	20	-483	284	767	-44	P
Delta Seat IFF	-194	945	-476*	-265	385	1421	-194	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	A	P	G			
Seat IFF	P	G	E	P	G		1 Error	
Run Detection	P	G	P	A	G			
Run IFF	P	G	E	P	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-325	422	66	226	98	747	98	G
Delta Run IFF	-331*	424	101	-340*	358	764	101	G
SEAT NUMBER	9	10	1	2	8			
Delta Seat Detect.	-105	94	39	12	251	356	39	G
Delta Seat IFF	-104*	184	828	-409*	278	1237	184	G
SUBJECT PERFORMANCE								
Seat Detection	P	G	G	A	G			
Seat IFF	E	G	G	E	G		2 Errors	
Run Detection	P	G	G	G	G			
Run IFF	E	G	G	E	G			

SUBJECT 5

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-2.0	33.0	1.8	-2.7	-1.7	35.7	-1.7	G
Delta Run IFF	18.1	34.1	-9.8	34.1	-2.8	43.9	18.1	P
SEAT NUMBER	10	1	2	8	9			
Delta Seat Detect.	-.8	31.0	1.0	3.4	-10.2	41.2	1.0	P
Delta Seat IFF	19.2	39.3	-5.0	33.2	-1.3	44.3	19.2	P
SUBJECT PERFORMANCE								
Seat Detection	A	P	P	P	G			
Seat IFF	P	P	G	P	G	0 Errors		
Run Detection	G	P	P	G	G			
Run IFF	P	P	G	P	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	3.5	-6.6	-2.1	-3.1	-.9	10.1	-2.1	G
Delta Run IFF	.1	9.8	-20.4*	.7	32.4*	52.8	.7	P
SEAT NUMBER	5	6	7	3	4			
Delta Seat Detect.	11.4	-1.1	-2.3	-4.4	2.2	15.8	-1.1	G
Delta Seat IFF	-.7	-.5	2.0*	-1.4	28.5*	29.9	-.7	A
SUBJECT PERFORMANCE								
Seat Detection	P	G	G	G	P			
Seat IFF	A	A	E	G	E	2 Errors		
Run Detection	P	G	G	G	A			
Run IFF	A	P	E	A	E			

SUBJECT 5

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	210	283	215	804	133	671	215	G
Delta Run IFF	-118	232	354	386*	-419	805	232	P
SEAT NUMBER	5	6	7	3	4			
Delta Seat Detect.	170	2333	353	-161	429	590	233	G
Delta Seat IFF	-753	220	282	231*	194	1035	220	G
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	P	G			
Seat IFF	P	G	G	E	G			
Run Detection	G	G	G	G	G			
Run IFF	P	G	G	E	P			

1 Error

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	68	-16	-49	-385	119	504	-16	A
Delta Run IFF	-596*	-546[1]	2	-212*	686	1282	-212	P
SEAT NUMBER	10	1	2	8	9			
Delta Seat Detect.	86	-230	23	-528	259	787	23	A
Delta Seat IFF	-486*	-743	708	-444*	-508	1451	-486	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	A	P	G			
Seat IFF	E	P	G	E	P			
Run Detection	G	A	P	P	G			
Run IFF	E	P	A	E	G			

2 Errors

SUBJECT 6

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	4.0	-8.4	-2.9	-8.2	.5	12.4	-2.9	G
Delta Run IFF	-8.7	-7.4*	4.5	-19.3	-14.9	23.8	-8.7	G
SEAT NUMBER	1	2	8	9	10			
Delta Seat Detect.	-5.7	.2	-2.6	-10.1	-.8	12.3	-2.6	G
Delta Seat IFF	-9.1	4.8*	-1.7	-14.5	-13.6	19.3	-9.1	G
SUBJECT PERFORMANCE								
Seat Detection	G	A	G	G	A			
Seat IFF	G	E	G	G	G		1 Error	
Run Detection	P	G	G	G	A			
Run IFF	G	E	P	G	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-9.4	-1.8	-4.1	-4.4	12.0	21.4	-4.1	G
Delta Run IFF	-1.8	-11.*	-10.0*	-.6	10.6	22.0	-1.8	G
SEAT NUMBER	6	7	3	4	5			
Delta Seat Detect.	3 3	2 2	-2.3	-8.0	12.1	20.1	2.2	P
Delta Seat IFF	-7.6	-1.5	6.1*	-8.7	3.3	14.8	-1.5	G
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	G	P			
Seat IFF	G	G	E	G	P		1 Error	
Run Detection	G	G	G	G	P			
Run IFF	G	G	E	G	P			

SUBJECT 6

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-1144	-495	-421	-315	20	1164	-421	P
Delta Run IFF	-118	221	-34*	233	481	599	221	G
SEAT NUMBER	6	7	3	4	5			
Delta Seat Detect.	-950	-640	470	-851	235	1185	-640	P
Delta Seat IFF	-585	315	-112*	369	147	632	147	G
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	P	G			
Seat IFF	P	G	E	G	G	1 Error		
Run Detection	P	P	P	P	A			
Run IFF	P	G	E	G	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	121	-403	66	123	108	526	108	G
Delta Run IFF	-86	-546	41	110*	364	910	41	G
SEAT NUMBER	1	2	8	9	10			
Delta Seat Detect.	253	-587	99	-33	46	840	46	G
Delta Seat IFF	67	-746	584	136*	-303	1348	67	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	A	G			
Seat IFF	G	P	G	E	P	1 Error		
Run Detection	G.	P	G	G	G			
Run IFF	P	P	G	E	G			

SUBJECT 7

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-2.9	-7.9	-2.4	-7.0	-3.2	5.5	-3.2	G
Delta Run IFF	-3.4	-3.5*	-3.1	-13.8	-12.7	10.7	-3.5	G
SEAT NUMBER	2	8	9	10	1			
Delta Seat Detect.	-2.0	1.8	-10.2	-1.7	-15.4	17.2	-2.0	G
Delta Seat IFF	3.2	-2.3*	-3.6	-9.2	-13.3	16.4	-3.6	G
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	G	G			
Seat IFF	P	E	G	G	G		1 Error	
Run Detection	G	G	G	G	G			
Run IFF	G	E	G	G	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-12.5	-8.9	-4.3	-3.4	-11.1	9.1	-8.9	G
Delta Run IFF	-10.1	-14.4	-27.1*	-11.6	-11.8*	17.0	-11.8	G
SEAT NUMBER	7	3	4	5	6			
Delta Seat Detect.	-5.0	-2.9	-4.8	-10.0	-6.2	7.1	-5.0	G
Delta Seat IFF	4.3	-10.8	-17.0*	-22.6	-23.6*	27.9	-17.0	P
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	G	G			
Seat IFF	P	G	E	G	E		2 Errors	
Run Detection	G	G	G	G	G			
Run IFF	G	G	E	G	E			

SUBJECT 7

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	182	257	314	-1	123	315	182	G
Delta Run IFF	-118	-186	-266*	-330	308	638	-186	P
SEAT NUMBER	7	3	4	5	6			
Delta Seat Detect.	281	-75	394	-618	572	1190	281	G
Delta Seat IFF	-479	2	-53*	-753	142	895	-53	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	P	G			
Seat IFF	P	A	E	P	G	1 Error		
Run Detection	G	G	G	A	G			
Run IFF	P	P	E	P	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	93	-177	66	-8	122	270	66	G
Delta Run IFF	128*	244	-15	169	42	259	128	G
SEAT NUMBER	2	8	9	10	1			
Delta Seat Detect.	255	-290	155	-366	174	621	155	G
Delta Seat IFF	260*	-137	786	78	62	923	78	G
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	P	G			
Seat IFF	E	P	G	G	G	1 Error		
Run Detection	G	P	G	A	G			
Run IFF	E	G	A	G	G			

SUBJECT 8

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	1.6	-10.7	9.3	0	2.6	20.0	1.6	P
Delta Run IFF	1.6*	.8	6.7	23.4	17.1	24.2	6.7	P
SEAT NUMBER	3	4	5	6	7			
Delta Seat Detect.	1.0	-2.6	4.7	3.6	.3	7.3	1.0	P
Delta Seat IFF	-4.9*	8.3	3.1	15.0	16.6	21.5	8.3	P
SUBJECT PERFORMANCE								
Seat Detection	P	G	P	P	A			
Seat IFF	E	P	P	P	P	1 Error		
Run Detection	P	G	P	A	P			
Run IFF	E	A	P	P	P			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	2.2	5.3	6.3	8.0	0	5.8	5.3	P
Delta Run IFF	9.7	-.3	12.5*	3.8	-2.8*	15.3	3.8	P
SEAT NUMBER	8	9	10	1	2			
Delta Seat Detect.	7.6	6.0	.3	-2.9	-5.2	12.8	.3	A
Delta Seat IFF	10.9	-2.1	21.7*	.5	-11.1*	32.8	.5	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	A	G	G			
Seat IFF	P	G	E	A	E	2 Errors		
Run Detection	P	P	P	P	A			
Run IFF	P	A	E	P	E			

SUBJECT 8

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	79	-1553	-66	-645	-984	1632	-645	P
Delta Run IFF	43	-573	-246*	-8	-419*	616	-246	P
SEAT NUMBER	8	9	10	1	2			
Delta Seat Detect.	109	-1425	490	-1133	-483	1915	-483	P
Delta Seat IFF	-45[1]	-290	70*	-120[1]	-169*	360	-120	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	P	P			
Seat IFF	P	P	E	P	E	2 Errors		
Run Detection	G	P	P	P	P			
Run IFF	G	P	E	A	E			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-115	-177	-26	-413	7	420	-115	P
Delta Run IFF	303*	295	48	-212*	441	653	295	G
SEAT NUMBER	3	4	5	6	7			
Delta Seat Detect.	-39	-372	230	-522	-41	752	-41	P
Delta Seat IFF	59*	-449	636	-378*	445	1085	59	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	P	P			
Seat IFF	E	P	G	E	G	2 Errors		
Run Detection	P	P	A	P	A			
Run IFF	E	G	G	E	G			

SUBJECT 9

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-1.3	-9.0	-1.9	-1.4	1.4	10.4	-1.4	G
Delta Run IFF	3.4	-7.7	7.5	-.1	20.4	28.1	3.4	P
SEAT NUMBER	4	5	6	7	3			
Delta Seat Detect.	-.9	-3.9	-4.1	2.9	-1.7	7.0	-1.7	G
Delta Seat IFF	-1.5	-4.2	-6.2	2.7	14.1	20.3	-1.5	G
SUBJECT PERFORMANCE								
Seat Detection	A	G	G	P	G			
Seat IFF	G	G	G	P	P	0 Errors		
Run Detection	G	G	G	G	P			
Run IFF	P	G	P	A	P			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-2.6	5.0	-3.1	.1	-2.9	8.1	-2.6	G
Delta Run IFF	-9.5	5.1	-28.0*	.9	-10.0*	33.1	-9.5	P
SEAT NUMBER	9	10	1	2	8			
Delta Seat Detect.	5.3	4.0	-10.9	-11.8	-5.3	17.1	-5.3	G
Delta Seat IFF	-6.8	-.5	-13.1*	-11.6	-14.8*	14.5	-11.6	A
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	G	G			
Seat IFF	G	A	E	G	E	2 Errors		
Run Detection	G	P	G	A	G			
Run IFF	G	P	E	A	E			

SUBJECT 9

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	193	350	249	-162	133	512	193	G
Delta Run IFF	178	-573	-47*	-330	-419	751	-330	P
SEAT NUMBER	9	10	1	2	8			
Delta Seat Detect.	545	237	377	-493	418	1038	377	G
Delta Seat IFF	6	-91	-82*	-169	-206	212	-91	P
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	P	G			
Seat IFF	A	P	E	P	P		1 Error	
Run Detection	G	G	G	P	G			
Run IFF	G	P	E	P	P			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-61	-16	66	239	146	300	65	G
Delta Run IFF	532*	-256	14	190*	119	788	119	P
SEAT NUMBER	4	5	6	7	3			
Delta Seat Detect.	90	-161	388	-105	142	549	90	G
Delta Seat IFF	138*	-592	749	42*	-174	1341	42	P
SUBJECT PERFORMANCE								
Seat Detection	G	[illegible]	G	P	G			
Seat IFF	E	P	A	E	P		2 Errors	
Run Detection	P	A	G	G	G			
Run IFF	E	P	G	E	G			

SUBJECT 10

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-.8	-6.6	-.9	3.7	-1.6	10.6	-.9	A
Delta Run IFF	1.1	-13.1*	5.0	-4.0	2.6	18.1	1.1	P
SEAT NUMBER	5	6	7	3	4			
Delta Seat Detect.	-3.7	-4.9	-2.4	7.2	-3.7	12.1	-3.7	G
Delta Seat IFF	.7	-19.4*	2.5	-7.0	4.7	24.1	.7	P
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	P	G			
Seat IFF	A	E	P	G	P		1 Error	
Run Detection	A	G	A	P	G			
Run IFF	G		P	G	P			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	.2	5.7	3.7	-1.4	-.1	7.1	.2	A
Delta Run IFF	-1.3	6.1*	7.8	-2.6	0*	10.4	0	P
SEAT NUMBER	10	1	2	8	9			
Delta Seat Detect.	6.4	2.1	-5.1	-10.0	0	16.4	0	A
Delta Seat IFF	-2.4	8.5*	13.5	-11.6	-3.3*	25.1	-2.4	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	G	A			
Seat IFF	G	E	P	G	E		2 Errors	
Run Detection	A	P	P	G	A			
Run IFF	G	E	P	G	E			

SUBJECT 10

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	210	385	279	-1	133	386	210	G
Delta Run IFF	43	393	-43	-264	93	657	43	G
SEAT NUMBER	10	1	2	8	9			
Delta Seat Detect.	341	230	564	-548	740	1288	341	G
Delta Seat IFF	70	524	195	-140	222	664	195	G
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	P	G			
Seat IFF	G	G	G	P	G		0 Errors	
Run Detection	G	G	G	A	G			
Run IFF	G	G	P	P	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	76	145	-64	236	108	300	108	G
Delta Run IFF	392*	359	-125	350*	551	676	359	P
SEAT NUMBER	5	6	7	3	4			
Delta Seat Detect.	277	66	23	-64	179	341	66	G
Delta Seat IFF	392*	44	502	-95*	108	597	108	P[1]
SUBJECT PERFORMANCE								
Seat Detection	G	G	A	P	G			
Seat IFF	E	G	G	E	G		2 Errors	
Run Detection	G	G	P	G	G			
Run IFF	E	G[1]	P	E	G			

APPENDIX B

SUBJECT'S PERFORMANCE

GROUP 2

SUBJECT'S PERFORMANCES

The following tables show in detail each of the subject's performance compared to the experiment mean value for that particular test run and for the position in which the subject was seated during the test run.

The delta values listed were obtained by the use of the following equation: Subject Score-Mean Score = Delta Value. A Good rating for the time experiments would consist of a negative delta value; for the range experiments a Good rating would result from a positive delta value.

The performance ratings were Good (G) for any delta value exceeded the Average (A) rating and Poor (P) for any delta value that did not. Average performance ratings were those delta values that were less than ± 1 second of the mean time value and those that were less than ± 100 feet of the mean range value.

Each table shows the delta value range and median for the five runs of that phase of the experiment and a performance rating for the runs. The table also gives the detection and IFF performance ratings for each run and for each seat occupied by the subject. There are four tables for each subject; unaided vision detection and IFF times, aided vision detection and IFF times, unaided vision detection and IFF ranges, and aided vision detection and IFF ranges.

SUBJECT 1

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	4.4	2.7	-4.6	5.6	-1.9	10.0	-1.9	G
Delta Run IFF	-2.8	-.1	-4.7*	-7.2	19.6*	26.8	-2.8	G
SEAT NUMBER	1	2	8	9	10			
Delta Seat Detect.	2.7	7.8	-14.8	-5.7	8.4	23.2	2.7	P
Delta Seat IFF	-13.7	5.6	-10.2*	-8.5	52.0*	65.7	-8.5	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	G	P			
Seat IFF	G	P	E	G	E	2 Errors		
Run Detection	P	P	G	G	G			
Run IFF	G	A	E	G	E			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-4.9	-8.6	-4.3	-3.2	-4.7	5.4	-4.7	G
Delta Run IFF	32.5	14.0	3.9	5.2	17.1*	31.1	14.0	P
SEAT NUMBER	6	7	3	4	5			
Delta Seat Detect.	-.3	-2.5	-7.5	-7.2	-8.1	7.8	-7.2	G
Delta Seat IFF	36.5	17.1	18.7	-4.1	23.5*	40.6	18.7	P
SUBJECT PERFORMANCE								
Seat Detection	A	G	G	G	G			
Seat IFF	P	P	P	G	E	1 Error		
Run Detection	G	G	G	G	G			
Run IFF	P	P	P	P	E			

SUBJECT 1

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	179	259	316	271	98	218	259	G
Delta Run IFF	-758		-615		-780	165	-758	P
SEAT NUMBER	6	7	3	4	5			
Delta Seat Detect.	450	-25	200	-39	272	489	200	G
Delta Seat IFF	-799		-333		-208	591	-333	P
SUBJECT PERFORMANCE								
Seat Detection	G	A	G	P	G			
Seat IFF	P		P		P			
Run Detection	G	G	G	G	G			
Run IFF	P		P		P			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	145	236	151	121	191	115	121	G
Delta Run IFF	211		-108	-568*	-289	779	-198	P
SEAT NUMBER	1	2	8	9	10			
Delta Seat Detect.	414	105	211	134	253	309	211	G
Delta Seat IFF	344		-82	-736*	93	1080	5.1	A
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	G	G			
Seat IFF	G		P	E	P		1 Error	
Run Detection	G	G	G	G	G			
Run IFF	G		P	E	G			

SUBJECT 2

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	1.7	18.5	4.9	7.2	1.4	17.1	4.9	P
Delta Run IFF	12.0	10.4		7.0	14.4	7.4	8.6	P
SEAT NUMBER	2	8	9	10	1			
Delta Seat Detect.	-2.7	20.5	-.2	4.2	18.3	23.2	4.2	P
Delta Seat IFF	-.3	10.4		3.3	48.5	48.8	6.8	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	A	P	P			
Seat IFF	A	P		P	P			
Run Detection	P	P	P	P	P			
Run IFF	P	P		P	P			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	12.1	21.3	29.6	23.7		17.5	22.5	P
Delta Run IFF	-11.6	0	-.3	13.2		24.8	-.15	A
SEAT NUMBER	7	3	4	5	6			
Delta Seat Detect.	13.4	23.9	26.0	15.3		12.6	19.6	P
Delta Seat IFF	-10.1	8.6	13.6	-2.4		23.7	3.1	A
SUBJECT PERFORMANCE								
Seat Detection	P	P	P	P				
Seat IFF	G	P	P	G				
Run Detection	P	P	P	P				
Run IFF	G	A	A	P				

SUBJECT 2

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	153	359	-1237	346	93	1596	153	G
Delta Run IFF	-340	-70*	-451*	-276	339	679	-276	P
SEAT NUMBER	7	3	4	5	6			
Delta Seat Detect.	253	-60	-1230	-4	497	1727	-4	A
Delta Seat IFF	-121	-577*	-73*	-598	710	1308	-121	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	P	A	G			
Seat IFF	P	E	P	E	G	2 Errors		
Run Detection	G	G	P	G	G			
Run IFF	P	E	P	E	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	110	118	-328	-25	-88	546	-25	P
Delta Run IFF	277*	16*	-83*	-687	-503	964	-83	P
SEAT NUMBER	2	8	9	10	1			
Delta Seat Detect.	37	34	199	-63	251	314	37	G
Delta Seat IFF	118*	-385*	254*	-780	-242	1034	-242	P
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	P	G			
Seat IFF	E	E	E	P	P	3 Errors		
Run Detection	G	G	P	P	P			
Run IFF	E	E	E	P	P			

SUBJECT 3

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	.8		4.9	3.2	2.0	4.1	2.6	P
Delta Run IFF	-4.7*			-2.4	-16.2	13.8	-4.7	G
SEAT NUMBER	3	4	5	6	7			
Delta Seat Detect.	-3.7		-.2	+2.2	13.4	17.1	1.0	A
Delta Seat IFF	-16.3*			-11.6	18.8	34.1	-11.6	A
SUBJECT PERFORMANCE								
Seat Detection	G		A	P	P			
Seat IFF	E			G	P		1 Error	
Run Detection	A		P	P	P			
Run IFF	E			G	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-.4	-8.2	-1.1	-1.0	-1.7	7.8	1.1	G
Delta Run IFF	-14.7	3.4	5.9	-5.6	40.9*	55.6	3.4	P
SEAT NUMBER	8	9	10	1	2			
Delta Seat Detect.	-6.4	-1.2	-2.3	-5.5	-6.1	5.2	-5.5	G
Delta Seat IFF	-15.1	4.0	15.3	-27.4	39.7*	54.8	4.0	A
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	G	G			
Seat IFF	G	P	P	G	E		1 Error	
Run Detection	A	G	G	G	G			
Run IFF	G	P	P	G	E			

SUBJECT 3

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	292	-309	-1237	-102	-51	1529	-102	P
Delta Run IFF	82*	-141*	-451*	218	-290*	669	-141	P
SEAT NUMBER	8	9	10	1	2			
Delta Seat Detect.	557	-245	-1230	-426	195	1787	-245	P
Delta Seat IFF	56*	-801*	-73*	-706	240*	1041	-73	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	F	P	G			
Seat IFF	E	E	E	P	E		4 Errors	
Run Detection	G	P	P	P	P			
Run IFF	E	E	E	G	E			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	67	198	42	123	-88	286	67	G
Delta Run IFF	196	829*	-165	510*	-503	1332	510	P
SEAT NUMBER	3	4	5	6	7			
Delta Seat Detect.	-65	-11	179	36	126	244	36	G
Delta Seat IFF	77	647*	71	436*	-242	889	77	G
SUBJECT PERFORMANCE								
Seat Detection	P	A	G	G	G			
Seat IFF	G	E	G	E	P		2 Errors	
Run Detection	G	G	G	G	P			
Run IFF	G	E	P	E	P			

SUBJECT 4

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-1.2	-10.3	5.3	-4.5	-6.6	9.1	-5.3	G
Delta Run IFF	-4.6	13.4	-8.5	8.6	-1.9	21.9	-1.9	G
SEAT NUMBER	4	5	6	7	3			
Delta Seat Detect.	-7.7	-3.6	-11.3	-6.4	4.5	7.7	-6.4	G
Delta Seat IFF	27.0	2.5	-29.3	7.5	32.5	61.8	2.5	P
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	G	P			
Seat IFF	G	P	G	P	P		0 Errors	
Run Detection	G	G	G	G	G			
Run IFF	G	P	G	P	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-2.3	-8.0	-3.8	-5.3	14.4	22.4	-3.8	G
Delta Run IFF	1.3	-14.1	-2.7	-10.9	-13.1	15.4	-10.9	G
SEAT NUMBER	9	10	1	2	8			
Delta Seat Detect.	-.1	-3.4	-7.9	-4.2	12.0	19.9	-3.4	G
Delta Seat IFF	-3.3	-10.9	-1.3	-34.1	-6.9	32.8	-6.9	G
SUBJECT PERFORMANCE								
Seat Detection	A	G	G	G	P			
Seat IFF	G	G	G	G	G[1]		0 Errors	
Run Detection	G	G	G	G	P			
Run IFF	P	G	G	G	G[1]			

SUBJECT 4

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	292	88	-206	353	134	559	134	G
Delta Run IFF	-355	-124	685	208	950	1305	208	G
SEAT NUMBER	9	10	1	2	8			
Delta Seat Detect.	740	-208	-213	75	825	1038	75	G
Delta Seat IFF	-358	-535	785	-156	1226	1761	-156	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	P	G	G		0 Errors	
Seat IFF	P	P	G	P	G			
Run Detection	G	G	P	G	G			
Run IFF	P	P	G	G	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	130	319	165	202	53	266	165	G
Delta Run IFF	-255	65	-246	254*	429	684	64	A
SEAT NUMBER	4	5	6	7	3			
Delta Seat Detect.	-21	312	194	120	-9	333	120	G
Delta Seat IFF	-168	-127	185	-118*	438	606	-118	A
SUBJECT PERFORMANCE								
Seat Detection	P	G	G	G	A			
Seat IFF	P	P	G	E	G		1 Error	
Run Detection	G	G	G	G	G			
Run IFF	P	G	P	E	G			

SUBJECT 5

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-.7		-5.4	.9	-3.2	6.3	-3.0	G
Delta Run IFF	-6.5		-7.3*	-7.0	-2.3	5.0	-6.7	G
SEAT NUMBER	5	6	7	3	4			
Delta Seat Detect.	-3.5		-12.3	-1.3	5.9	18.2	-2.4	G
Delta Seat IFF	-24.2		-16.0*	-2.4	20.3	44.5	-9.2	G
SUBJECT PERFORMANCE								
Seat Detection	G		G	G	P			
Seat IFF	G		E	G	P	1 Error		
Run Detection	A		G	A	G			
Run IFF	G		E	G	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-2.7	-8.4	-2.8	.6	-1.8	9.0	-2.7	G
Delta Run IFF	-5.2	-15.4	-29.3	1.7	-8.4	31.0	-8.4	G
SEAT NUMBER	10	1	2	8	9			
Delta Seat Detect.	-2.9	-6.7	-1.3	-6.8	4.0	10.8	-2.9	G
Delta Seat IFF	-3.6	-20.2	-29.3	-14.1	-6.4	26.7	-14.1	G
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	G	P			
Seat IFF	G	G	G	G	G	0 Errors		
Run Detection	G	G	G	A	G			
Run IFF	G	G	G	P	G			

SUBJECT 5

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-60	82	306	394	106	454	106	G
Delta Run IFF	489	74	152	-129	254	618	152	G
SEAT NUMBER	10	1	2	8	9			
Delta Seat Detect.	82	-228	345	261	680	908	261	G
Delta Seat IFF	635	-615	-502	-747	563	1382	-502	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	G	G			
Seat IFF	G	P	P	P	G		0 Errors	
Run Detection	P	G	G	G	G			
Run IFF	G	G	G	P	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	127	-322	88	176	144	498	127	G
Delta Run IFF	211	-164	7	505*	311	669	211	G
SEAT NUMBER	5	6	7	3	4			
Delta Seat Detect.	178	-437	122	14	63	615	63	G
Delta Seat IFF	289	-160	140	39*	526	686	140	G
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	A	G			
Seat IFF	G	P	G	E	G		1 Error	
Run Detection	G	P	G	G	G			
Run IFF	G	P	A	E	G			

SUBJECT 6

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	.5	5.7	5.5	18.8	+9.2	18.3	5.7	P
Delta Run IFF	16.0*	12.6	1	6.3*	25.2*	18.9	14.3	P
SEAT NUMBER	6	7	3	4				
Delta Seat Detect.	-1.8	11.0	1.7	14.6	22.0	23.8	11.0	P
Delta Seat IFF	-2.1*	9.4		-7.2*	52.5*	59.7	3.7	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	P	P	P			
Seat IFF	E	P		E	E	3 Errors		
Run Detection	A	P	P	P	P			
Run IFF	E	P		E	E			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	16.7	-3.8	-2.0	-1.5	6.9	20.5	-1.5	G
Delta Run IFF	27.9	10.3*	-.1*	11.3	4.8*	28.0	10.3	P
SEAT NUMBER	1	2	8	9	10			
Delta Seat Detect.	13.6	3.5	-9.0	-.7	10.3	22.6	3.5	P
Delta Seat IFF	21.5	4.1*	7.3*	-8.7	13.0*	30.2	7.3	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	A	P			
Seat IFF	P	E	E	G	E	3 Errors		
Run Detection	P	G	G	G	P			
Run IFF	P	E	E	P	E			

SUBJECT 6

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-513	-342	165	-66	79	678	-66	P
Delta Run IFF	-383	-201	-556*	-224*	-611	410	-383	P
SEAT NUMBER	1	2	8	9	10			
Delta Seat Detect.	-515	-606	349	-16	293	955	-16	A
Delta Seat IFF	-339	-640	-460*	-809*	-53	756	-460	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	A	G			
Seat IFF	P	P	E	E	P	2 Errors		
Run Detection	P	P	G	P	G			
Run IFF	P	P	E	E	P			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	106	107	38	174	-908	1082	106	G
Delta Run IFF	-1077	-131	-108	-957	-400	969	-400	P
SEAT NUMBER	6	7	3	4	5			
Delta Seat Detect.	49	-3	8	-7	-194	243	-3	A
Delta Seat IFF	-804	-425	-69	-1217	-787	1148	-787	P
SUBJECT PERFORMANCE								
Seat Detection	G	A	A	A	P			
Seat IFF	P	P	P	P	P	0 Errors		
Run Detection	G	G	G	G	P			
Run IFF	P	P	P	P	P			

SUBJECT 7

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-1.7	-2.8	-3.4	-6.6	-.4	6.2	-2.8	G
Delta Run IFF	1.5	-11.1	34.9	-6.2	12.2	46.0	1.5	P
SEAT NUMBER	7	3	4	5	6			
Delta Seat Detect.	-5.9	2.2	-12.6	-7.1	11.9	24.5	-5.9	G
Delta Seat IFF	-8.5	-14.9	13.8	-15.0	39.1	54.0	-8.5	G
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	G	A			
Seat IFF	G	G	P	G	P			
Run Detection	G	G	G	G	P			
Run IFF	P	G	P	G	P			

0 Errors

OPTIONS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-5.1	11.4	-3.3	.1	6.2	16.5	.1	A
Delta Run IFF	25.5	27.4	14.6	-.1	27.3	27.5	25.5	P
SEAT NUMBER	2	8	9	10	1			
Delta Seat Detect.	-2.6	10.2	-3.0	-1.5	6.7	13.2	-1.5	G
Delta Seat IFF	29.7	28.6	23.9	-13.9	27.5	43.6	27.5	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	G	P			
Seat IFF	P	P	P	G	P			
Run Detection	G	P	G	A	P			
Run IFF	P	P	P	A	P			

0 Errors

SUBJECT 7

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-30	-75	290	109	84	365	84	G
Delta Run IFF	-569	-201	-658	-78	7	665	-201	P
SEAT NUMBER	2	8	9	10	1			
Delta Seat Detect.	90	-194	657	-201	293	858	90	G
Delta Seat IFF	-451	-894	-529	-414	287	1181	-451	P
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	P	G			
Seat IFF	P	P	P	P	G		0 Errors	
Run Detection	A	P	G	G	G			
Run IFF	P	P	P	P	A			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-315	258	42	96	145	573	96	G
Delta Run IFF	50	-95	-33	232	-57	327	-33	P
SEAT NUMBER	7	3	4	5	6			
Delta Seat Detect.	-367	68	23	117	158	525	68	G
Delta Seat IFF	25	-483	212	-37	344	827	25	A
SUBJECT PERFORMANCE								
Seat Detection	P	G	A	G	G			
Seat IFF	A	P	G	P	G		0 Errors	
Run Detection	P	G	G	G	G			
Run IFF	G	P	P	G	P			

SUBJECT 8

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-1.4		10.6	-5.9	-2.3	16.5	-1.9	G
Delta Run IFF	4.2		-4.4	-7.0*	-10.8	15.0	-5.7	G
SEAT NUMBER	8	9	10	1	2			
Delta Seat Detect.	-8.9		2.6	-9.1	8.9	18.0	-3.2	A
Delta Seat IFF	-2.6		-17.7	-9.0*	21.9	39.6	-5.8	G
SUBJECT PERFORMANCE								
Seat Detection	G		P	G	P			
Seat IFF	G		G	E	P		1 Error	
Run Detection	G		P	G	G			
Run IFF	P		G	E	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-4.2	-5.0	-2.8	-4.2	-6.4	3.6	-4.2	G
Delta Run IFF	-12.0	14.0*	-8.5	.1	-21.0	35.	-8.5	G
SEAT NUMBER	3	4	5	6	7			
Delta Seat Detect.	-6.4	-2.8	-10.8	-1.0	-1.5	9.8	-2.8	G
Delta Seat IFF	-5.0	21.7*	-.9	-11.3	-12.9	34.6	-5.0	G
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	G	G			
Seat IFF	G	E	A	G	G		1 Error	
Run Detection	G	G	G	G	G			
Run IFF	G	E	G	A	G			

SUBJECT 8

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-191	-28	261	-257	69	518	-28	A
Delta Run IFF	968	213	-110*	206	-654	1622	206	G
SEAT NUMBER	3	4	5	6	7			
Delta Seat Detect.	-226	-324	228	-377	295	675	-226	P
Delta Seat IFF	1018	-40	272*	-316	-23	1334	-23	A
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	P	G			
Seat IFF	G	P	E	P	A		1 Error	
Run Detection	P	A	G	P	G			
Run IFF	G	G	E	G	P			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	52	-277	74	172	121	449	74	G
Delta Run IFF	179	-128	247	-408	-363	655	-128	P
SEAT NUMBER	8	9	10	1	2			
Delta Seat Detect.	26	-292	152	-169	118	444	26	A
Delta Seat IFF	47	-218	659	-386	-394	1053	-218	P
SUBJECT PERFORMANCE								
Seat Detection	A	P	G	P	G			
Seat IFF	G	P	G	P	P		0 Errors	
Run Detection	G	P	G	G	G			
Run IFF	G	P	G	P	P			

SUBJECT 9

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-1.4	-13.3	3.0	-2.1	5.6	18.9	-1.4	G
Delta Run IFF	-10.5	-16.6	-3.4	5.3	-34.8	40.1	-10.5	G
SEAT NUMBER	9	10	1	2	8			
Delta Seat Detect.	-3.8	-9.1	-5.6	-4.2	13.7	22.8	-4.2	G
Delta Seat IFF	-20.7	-22.4	-13.0	1.9	3.4	25.8	-13	G
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	G	P			
Seat IFF	G	G	G	P	P	0 Errors		
Run Detection	G	G	P	G	P			
Run IFF	G	G	G	P	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-4.8	17.4	-3.7	-3.9	-2.9	22.2	-3.7	G
Delta Run IFF	-18.8	5.0	-16.5*	-4.3	-16.6*	23.8	-16.5	G
SEAT NUMBER	4	5	6	7	3			
Delta Seat Detect.	-7.4	15.2	-.1	-4.0	-1.5	22.6	-1.5	G
Delta Seat IFF	-12.7	6.4	-4.7*	-18.2	-3.0*	24.6	-4.7	G
SUBJECT PERFORMANCE								
Seat Detection	G	P	A	G	G			
Seat IFF	G	P	E	G	E	2 Errors		
Run Detection	G	P	G	G	G			
Run IFF	G	P	E	G	E			

SUBJECT 9

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	131	-97	289	69	24	386	69	G
Delta Run IFF	381	346	1159*	-115	601	1274	381	G
SEAT NUMBER	4	5	6	7	3			
Delta Seat Detect.	219	-433	486	-229	115	919	115	G
Delta Seat IFF	685	-51	1350*	-378	1063	1728	685	A
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	P	A			
Seat IFF	G	P	E	P	G	1 Error		
Run Detection	G	P	G	G	G			
Run IFF	G	G	E	P	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	129	283	-140	-39	157	440	129	G
Delta Run IFF	256	-164	354	646	665	829	354	G
SEAT NUMBER	9	10	1	2	8			
Delta Seat Detect.	172	217	215	-142	201	359	201	G
Delta Seat IFF	435	-179	-355	140	661	1016	140	G
SUBJECT PERFORMANCE								
Seat Detection	G	G	G	P	G			
Seat IFF	G	P	P	G	G	0 Error		
Run Detection	G	G	P	P	G			
Run IFF	G	P	G	G	G			

SUBJECT 10

TIME RUNS

TIME (seconds)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-.7	-3.0	-2.7	-5.1	-3.6	4.4	-3.0	G
Delta Run IFF	-4.5	-8.6	-6.8	-3.2*	-5.5*	5.4	-5.5	G
SEAT NUMBER	10	1	2	8	9			
Delta Seat Detect.	-6.0	3.7	-9.8	-10.3	9.6	19.9	-6.0	G
Delta Seat IFF	-17.1	-12.7	-17.8	-1.1*	29.3*	47.1	-12.7	G
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	G	G			
Seat IFF	G	G	G	E	E		2 Errors	
Run Detection	A	G	G	G	P			
Run IFF	G	G	G	E	E			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-4.7	8.2	-5.5	-5.1	-9.8	18.0	-5.1	G
Delta Run IFF	-26.5	-26.3	33.3	-10.7	-31.3*	64.6	-26.3	G
SEAT NUMBER	5	6	7	3	4			
Delta Seat Detect.	-11.7	1.2	-5.2	-8.7	-8.8	12.9	-8.7	G
Delta Seat IFF	-26.7	-20.7	42.6	-19.1	-18.6*	69.3	-19.1	G
SUBJECT PERFORMANCE								
Seat Detection	G	P	G	G	G			
Seat IFF	G	G	P	G	E		1 Error	
Run Detection	G	P	G	G	G			
Run IFF	G	G	P	G	E			

SUBJECT 10

RANGE RUNS

RANGE (meters)

RUN NUMBER	1	2	3	4	5	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-311	65	-414	-1097	639	1162	-414	P
Delta Run IFF	486	108*	477*	191*	182	378	191	P
SEAT NUMBER	5	6	7	3	4			
Delta Seat Detect.	-163	-41	-395	-1530	-425	1489	-395	P
Delta Seat IFF	646[1]	-495*	928*	-241*	898	1423	646	P
SUBJECT PERFORMANCE								
Seat Detection	P	P	P	P	P			
Seat IFF	G[1]	E	E	E	G		3 Errors	
Run Detection	P	G	P	P	P			
Run IFF	G[1]	E	E	E	G			

OPTICS

RUN NUMBER	6	7	8	9	10	DELTA RANGE	DELTA MEDIAN	SUBJECT PERFORMANCE
Delta Run Detect.	-549	-920	-132	585	73	1505	-132	P
Delta Run IFF	-46	224	136	237*	-68	305	136	A
SEAT NUMBER	10	1	2	8	9			
Delta Seat Detect.	-557	-723	119	141	649	1372	119	G
Delta Seat IFF	208	-360	135	-242*	239	602	135	G
SUBJECT PERFORMANCE								
Seat Detection	P	P	G	G	G			
Seat IFF	G	P	G	E	G		1 Error	
Run Detection	P	P	P	G	G			
Run IFF	P	G	G	E	P			