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HUMAN ENGINEERING LABORATORY IDENTIFICATION FRIEND OR FOE TEST --ETC(U)

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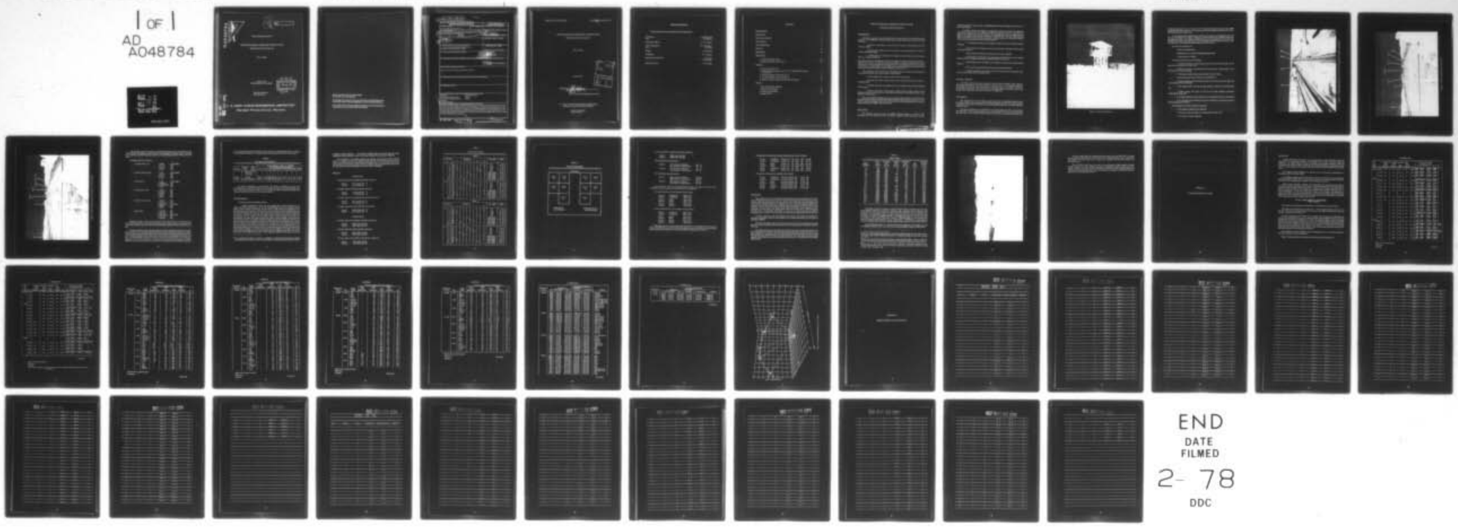

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HUMAN ENGINEERING LABORATORY IDENTIFICATION FRIEND OR FOE TEST (HELIFF)

John A. Barnes

October 1977
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U. S. ARMY HUMAN ENGINEERING LABORATORY
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This study tested the ability of qualified helicopter gunners to detect and to identify moving tactical vehicles of the United States and its allies and the Warsaw Pact countries as either friend or foe. The gunners observed the vehicles from a tower which simulated a gunship in the hover position. The data shows the mean time and mean range differences between the detection and the identification of the moving tactical vehicles both with the use of 10-power optics and with unaided vision. The percentage of correct identifications is also given.

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HUMAN ENGINEERING LABORATORY IDENTIFICATION

FRIEND OR FOE TEST (HELIFF)

BACKGROUND

Detection, recognition, and identification form a natural hierarchy of visual functions with detection and identification requiring, respectively, the least and the most, amount of target resolution.

a. Detection is the discovery of the presence or existence of something that has been previously hidden.

b. Recognition is being aware that the object or objects detected are of a class that could be identified as targets.

c. Identification is the verification of an object as a specific type and class. Example: Object is a US Army M-60 tank.

The relative position of Identification Friend or Foe (IFF) in the above-mentioned hierarchy is generally not clear but, in instances where good intelligence information is available, IFF may be made as early as when the target has been recognized. IFF can be defined as the visual perception of an object or an organizational unit of objects to the extent that the observer has accumulated sufficient information to assign it a specific designation of friend or foe.

The introduction of the IFF function was brought about by concern of several aspects of air-to-ground encounters with combat vehicles. These include:

a. Certain single enemy vehicles are similar to US Army vehicles.

b. Viewed from certain aspects, specific enemy vehicles and US Army vehicles are indistinguishable.

c. Friendly forces may be equipped with a mix of vehicles, some closely resembling enemy vehicles.

d. Before committing a weapon against a suspected enemy target, a gunner should attempt to decrease his uncertainty by examining other vehicles in the immediate vicinity of the suspicious looking vehicle.

There were available reasonable amounts of valid data which allowed us to state what the expected low-level and/or nap-of-the-earth target detection ranges should have been, but we felt that the actual firing ranges would be much shorter when the observer/gunner was forced to determine whether the target was a friend or a foe.

OBJECTIVES

The objectives of this test were: (a) establish threshold ranges; i.e., maximum range distributions at which detection and IFF of vehicular targets can be performed given virtually unlimited observation time; and (b) to establish detection and IFF response time distributions given a fixed range.

A complete response with regard to the objective would have required the assessing of many sensors under a variety of conditions. Factors such as dust, snow, rain, and fog which degrade the performance of sensors unequally and also geographic variations ranging from the desert to the jungle would have had to have been considered. Since the cost to test all sensors under all conditions would have been prohibitive, a modular approach to testing was followed. The current test was restricted to the following conditions:

1. Two daylight conditions were considered: unaided vision and a simulated airborne TOW sight.

2. The subjects were located in a tower which simulated a helicopter in hover during the pop-up maneuver.

3. Only operational helicopter pilot/observers were used as subjects.

4. Each target unit observed by the test subjects contained three or more operable military vehicles. All vehicles were uniquely identifiable and were in motion.

5. One background for the targets was considered; open area with trees beyond the roadways.

6. The test was conducted between mid morning and mid afternoon.

7. Weather conditions under which the test was conducted were those under which nap-of-the-earth flight could be conducted safely.

TACTICAL CONCEPT

The tactical concept of the test was one in which an airborne observer was to observe a ground unit operating in a close combat situation. The close proximity of the ground combatants had enabled the friendly units to provide the helicopter pilots with explicit information concerning the target area. The search therefore was concentrated, the approach direction was known, and the helicopter was able to operate from a vantage point.

TEST DESIGN

The effectiveness of the available sensors when used by qualified observers under controlled conditions was measured. A 6-meter tower (Figure 1) was used in the test to simulate the gunship pop-up position. The subjects were qualified pilot/observers all currently assigned to operational units.

The test was divided into two experiments: a threshold range experiment and a response time experiment. Each of these experiments were further divided into two parts: unaided vision and aided vision. In the threshold range experiment, the vehicles of the target units moved along

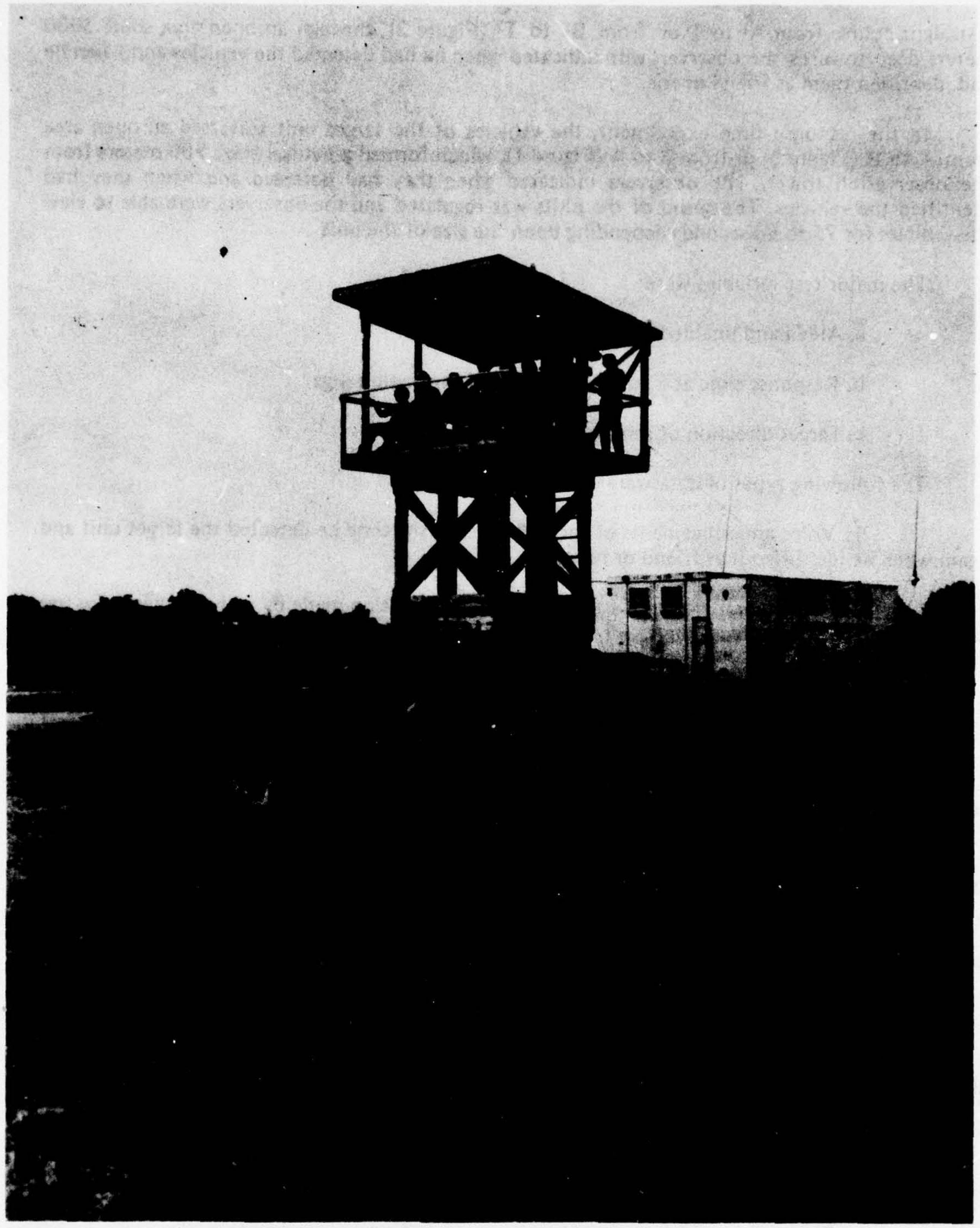


Figure 1. Tower and control van.

a straight course from A' to T or from B' to T' (Figure 2), through an open area some 3000 meters deep towards the observer, who indicated when he had detected the vehicles and when he had identified them as friend or foe.

In the response time experiment, the vehicles of the target unit traversed an open area from A to B (Figure 3) or from B to A (Figure 4), which formed a natural stage 900 meters from the observation tower. The observers indicated when they had detected and when they had identified the vehicles. The speed of the units was regulated and the observers were able to view the vehicles for 75 to 90 seconds depending upon the size of the unit.

The major test variables were:

a. Aided and unaided vision.

b. Response time at a constant range and threshold range.

c. Target direction of motion.

The following types of data were collected:

1. Voice announcements of each observer at the time he detected the target unit and again when he identified it as friend or foe.

2. Paper tape records of each transmission initiation made by a given subject for use as a backup to the voice recordings.

3. Visibility and ambient light values during the period of testing.

4. Sun elevation and azimuth values for the testing period.

5. Target to background and foreground measures were taken during each target unit run to determine the contrast ratios.

6. The range controller recorded the target position at regular intervals during each run.

7. Motion pictures were taken of each run to provide qualitative information concerning the target units.

8. A subject experience profile questionnaire was completed on each of the subjects.

9. An informal observer debriefing was used to determine the subjects opinions of the test and equipment validity.

The evaluation to the data included the following:

a. The range at the target unit was detected.

b. The time at which the target unit was identified as friend or foe.

c. The number of correct responses.

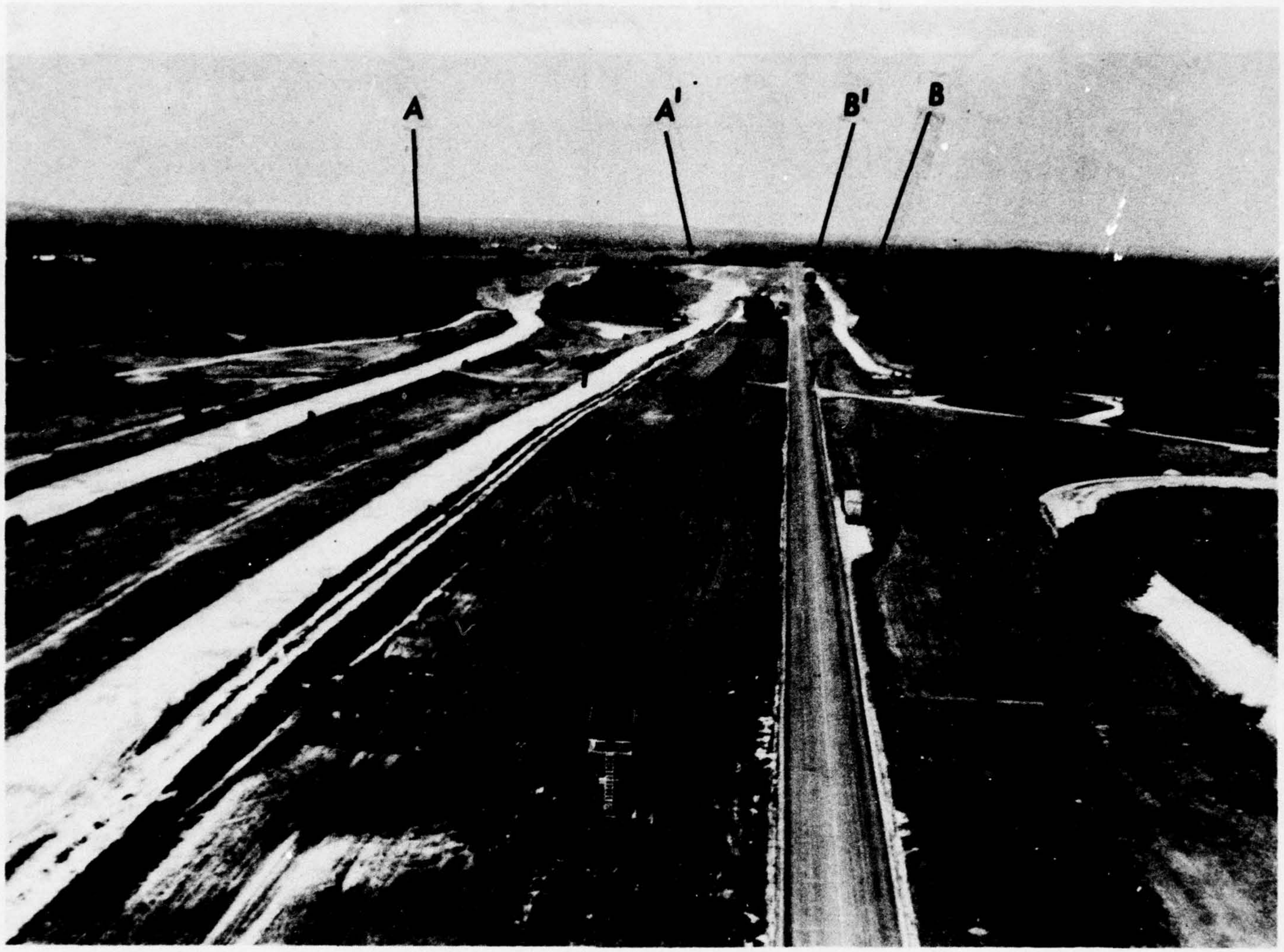


Figure 2. Threshold range courses, A' to T, B' to T'; response time courses A to B, B to A.

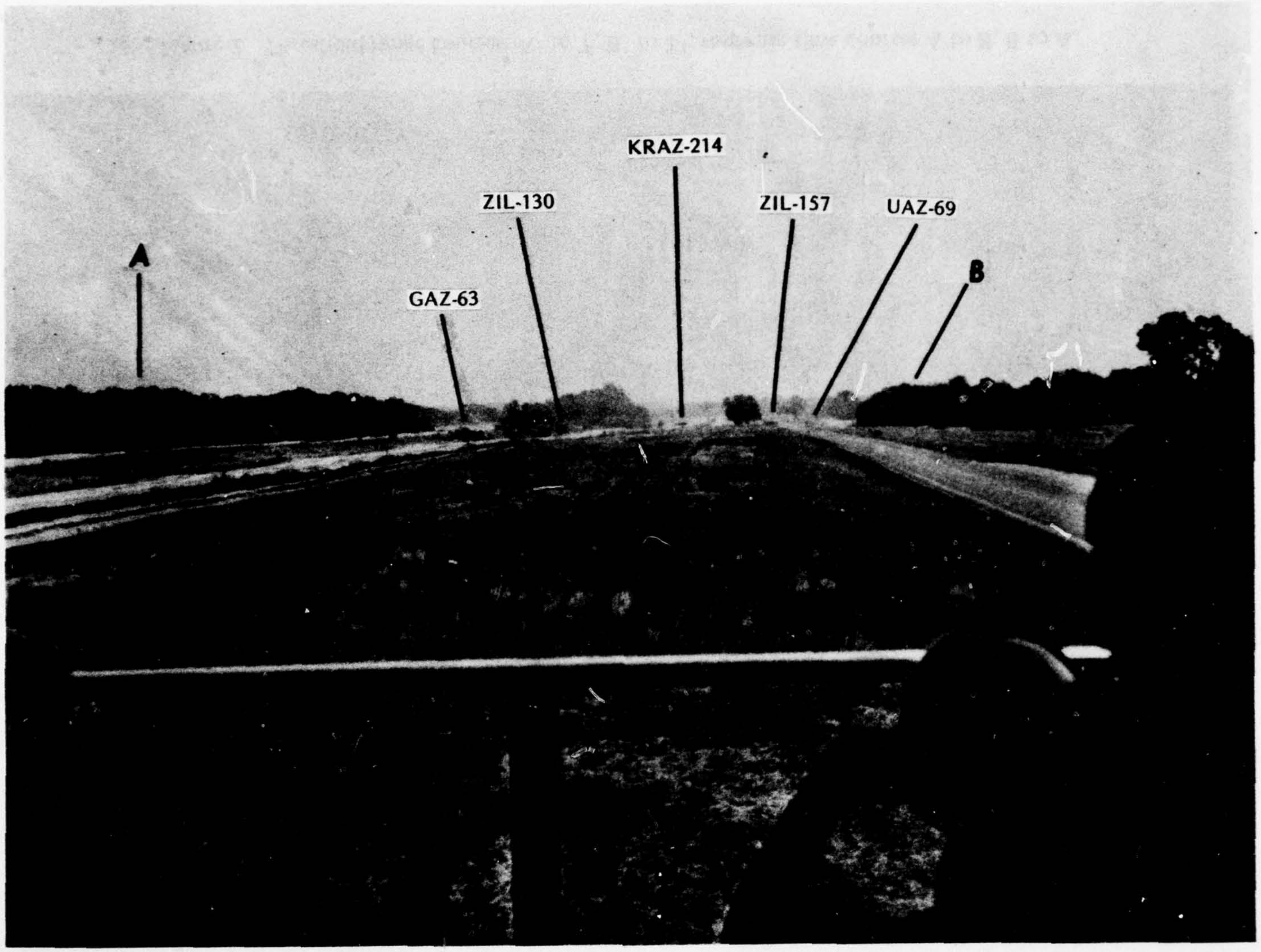


Figure 3. Test run response time course A to B.

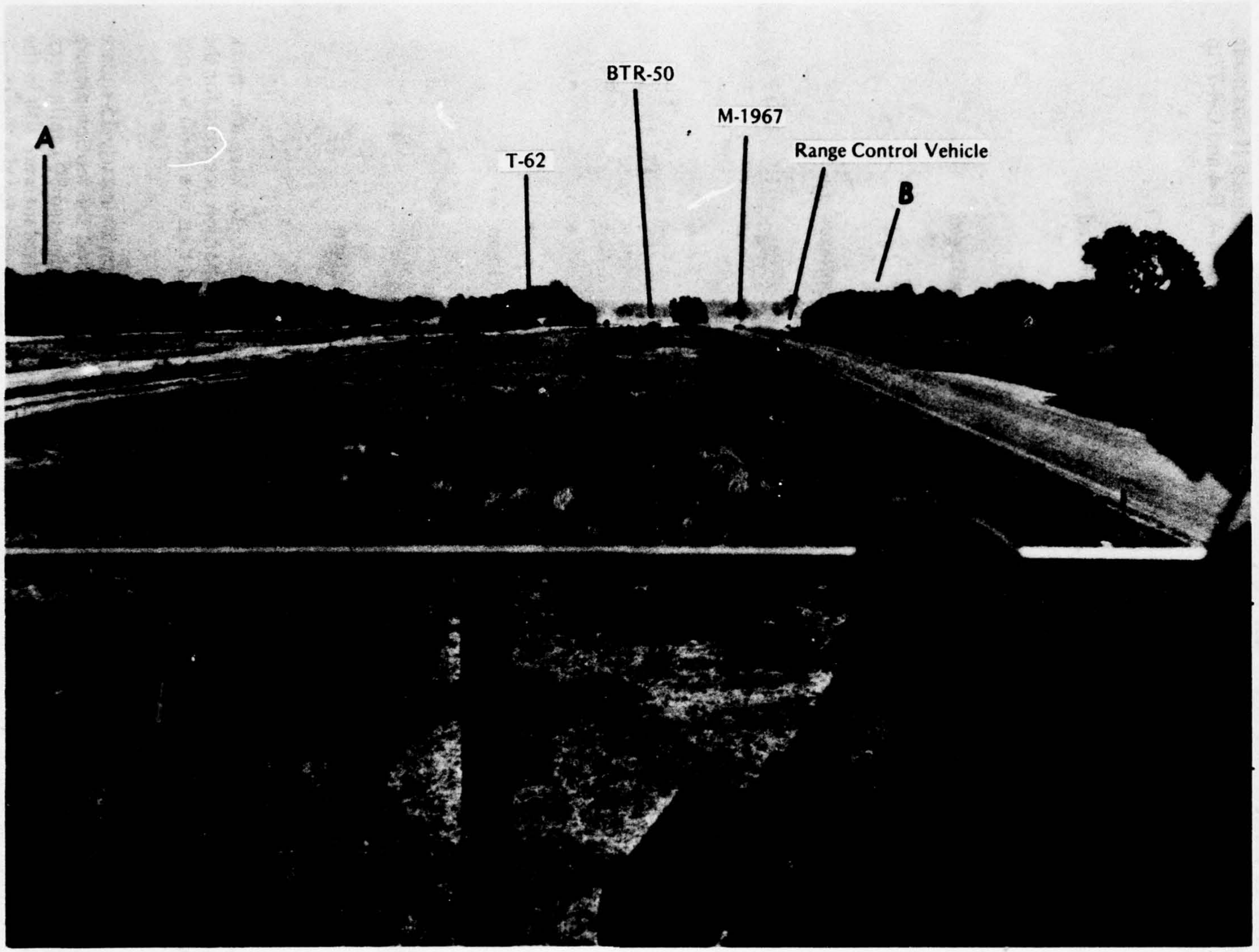


Figure 4. Test run response time course B to A (T-59 is missing).

The 20 subjects used in the test were qualified pilot/observers and were divided into two groups. Group I was made up of men from B, C, and D Troops 1/17 Cavalry. Group II was made up of men from A and B Troops 2/17 Cavalry, C Troop 4/9 Cavalry, and A-4, B-4 and C-4-77th AHB.

The target units were as follows:

a. Friend, Armor, US;	1. M-60	Camouflaged
	2. M-113	OD
	3. M-113	OD
	4. M-60	OD
b. Friend, Armor, Israel;	1. T-62	Camouflaged
	2. M-113	OD
	3. M-113	OD
	4. T-59	OD
c. Foe, Armor;	1. T-62	Camouflaged
	2. BTR-50	OD
	3. PRCM-1976	OD
	4. T-59	OD
d. Friend, Truck, US;	1. M-151	OD
	2. M-109	OD
	3. M-813	OD
	4. M-34	OD
	5. M-34	OD
e. Friend, Truck, Israel;	1. M-151	OD
	2. ZIL-157	OD
	3. KRAZ-214	Dark Green
	4. M-813	OD
	5. M-34	OD
f. Foe, Truck;	1. UAZ-69	OD
	2. ZIL-157	OD
	3. KRAZ-214	Dark Green
	4. ZIL-130	OD
	5. GAZ-63	OD

During the Group I time runs, the ZIL-157 truck would not start. To keep the truck convoy size the same for all trials, the M-109 was not used. A similar condition occurred for the last five of the Group II time runs when the T-59 had clutch problems and thus one M-60 was not used.

The 6-meter tower had an observation platform which contained approximately 15-square meters of floor space. This space was utilized for the 10 test positions and the motion picture camera position. Four of the test positions were at floor level, four were elevated 30 centimeters, and two were 60 centimeters from floor level. The test director and his assistant were also in the tower. A diesel generator located at the base of the tower provided power for the electronic equipment in the control van and also a noise level that screened the noise made by the armored vehicles. The noise level and make up was similar to that encountered in the observer's position of the current gunship at hover[1] (Table 1). The control van, located behind the tower, contained the experimenter's station, the 14-channel audio recording equipment, and the control radios.

TABLE 1

AH-1 Cabin Noise Comparison

Airspeed	Canopy Type	Mike Position	dBA	Sound Pressure Levels in Decibels — Octave Band Center Frequencies 31.5	63	125	250	500	1000	2000	4000	8000
	Slightly Curved[1] (AH-1S)											
Hover		Copilot	89.5	102	103	100	92	87	80	77	76	68
Tower		Subject Position 4	83.0	50	88	81	82	80	77	76	74	69

All subject transmissions, all experimenter test director transmissions, and all radio transmissions were recorded. The target units were under the control of the vehicle manager, who was in radio contact with the control van at all times. The vehicle positions during tests were relayed by radio to the control van by the range controller.

TEST PROCEDURE

A typical test session proceeded as follows:

Subjects ascended the tower and were assigned their position according to the subject number they had been given at the start of the test. When they were in position, the test director and his assistant would insure that the subject's flight helmets were plugged into the recording jacks at each position. In the meantime, the experimenter was in contact by radio with the vehicle manager to insure that the proper target unit was in place with all vehicles operational. He was also in contact by radio with the range controller. When the test director notified the experimenter that the subjects and the motion picture camera operator were ready, the experimenter would alert the range controller and notify the vehicle manager to send the target unit onto the course. As the subjects detected the target unit, they would announce the fact into their microphone and it would be recorded on the tape channel for that position; they would do the same when they had identified the target unit as friend or foe. The range controller would follow the target unit's course and announce on his radio when the unit passed each of the prepositioned range markers along the course; his transmissions were recorded on the same tape as the subject responses. At the end of each test run, the vehicles of the target unit would proceed to their holding area in the woods (there were two holding areas used for each of two major tests). The subjects would move to their scheduled position for the next run and the

[1] Cox, C., Edwards, B., Gaffey, T., Gibson, E., & Norman, L. AH-1S cabin noise levels with slightly curved glass. Bell Helicopter Textron, Inter-office Memo, 3 November 1976, Fort Worth, Texas.

procedure would be repeated. The position schedule (Table 2) was such that each of the subjects sat at each position for each of the visual conditions for one test run (Table 3).

The first group of 10 subjects was given the response time tests first, while the second group of 10 subjects was given the threshold range tests first. The first five of the test runs of each of the major tests were accomplished with unaided vision. The remaining five runs were accomplished with the subjects using a hand-held 10-power monocular which had a field of view that was within one half of one degree of that of the airborne TOW sight.

RESULTS

Response Time

The mean values of the unaided-eye detection time were:

Group I	16.5 seconds, SD 9
Group II	10.1 seconds, SD 9

The mean values of the optics detection time were:

Group I	9.2 seconds, SD 9
Group II	11.7 seconds, SD 8

The mean values of the unaided-eye *identification time were:*

Group I	36.1 seconds, SD 21
Group II	22.8 seconds, SD 13

The mean values of the optics identification time were:

Group I	32.5 seconds, SD 19
Group II	24.3 seconds, SD 13

Threshold Range

The mean values of the unaided-eye detection range were:

Group I	2280 meters, SD 394
Group II	2226 meters, SD 497

The mean values of the optics detection range were:

Group I	2445 meters, SD 273
Group II	2450 meters, SD 263

The mean values of the unaided-eye identification range were:

Group I	1163 meters, SD 591
Group II	835 meters, SD 401

TABLE 2

HELIFF Test Procedure

GROUP I

DAY	RUN	POSITION 1	2	3	4	5	6	7	8	9	10	EYE MARK	ROUTE
1	1	S1	2	3	4	5	6	7	8	9	10	S-2	A to B
	2	S10	1	7	3	4	5	6	2	8	9	S-1	B to A
	3	S9	10	6	7	3	4	5	1	2	8	S-10	A to B
	4	S8	9	5	6	7	3	4	10	1	2	S-9	B to A
	5	S2	8	4	5	6	7	3	9	10	1	S-8	A to B
	6	S6	7	8	9	10	1	2	3	4	5	TOW SIGHT	B to A
	7	S5	6	2	8	9	10	1	7	3	4	TOW SIGHT	A to B
	8	S4	5	1	2	8	9	10	6	7	3	TOW SIGHT	A to B
	9	S3	4	10	1	2	8	9	5	6	7	TOW SIGHT	B to A
	10	S7	3	9	10	1	2	8	4	5	6	TOW SIGHT	B to A
2	1	S6	7	8	9	10	1	2	3	4	5	S-7	A' to T
	2	S5	6	2	8	9	10	1	7	3	4	S-6	B' to T'
	3	S4	5	1	2	8	9	10	6	7	3	S-5	A' to T
	4	S3	4	10	1	2	8	9	5	6	7	S-4	B' to T'
	5	S7	3	9	10	1	2	8	4	5	6	S-3	A' to T
	6	S1	2	3	4	5	6	7	8	9	10	TOW SIGHT	A' to T
	7	S10	1	7	3	4	5	6	2	8	9	TOW SIGHT	B' to T'
	8	S9	10	6	7	3	4	5	1	2	8	TOW SIGHT	A' to T
	9	S8	9	5	6	7	3	4	10	1	2	TOW SIGHT	B' to T'
	10	S2	8	4	5	6	7	3	9	10	1	TOW SIGHT	A' to T

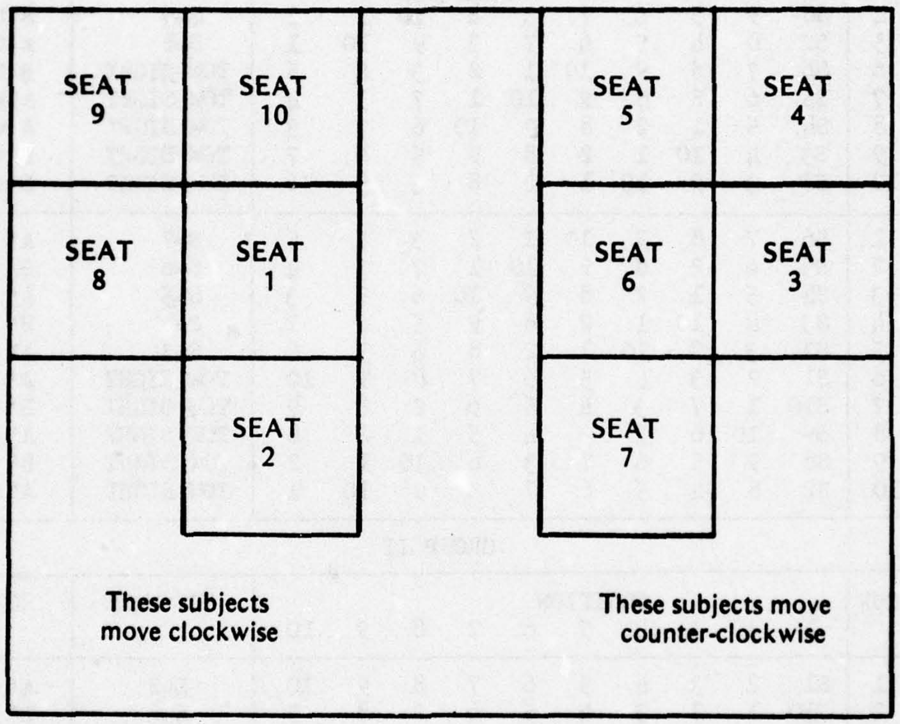
GROUP II

DAY	RUN	POSITION 1	2	3	4	5	6	7	8	9	10	EYE MARK	ROUTE
1	1	S1	2	3	4	5	6	7	8	9	10	S-2	A' to T
	2	S10	1	7	3	4	5	6	2	8	9	S-1	B' to T'
	3	S9	10	6	7	3	4	5	1	2	8	S-10	A' to T
	4	S8	9	5	6	7	3	4	10	1	2	S-9	B' to T'
	5	S2	8	4	5	6	7	3	9	10	1	S-8	A' to T
	6	S6	7	8	9	10	1	2	3	4	5	TOW SIGHT	A' to T
	7	S5	6	2	8	9	10	1	7	3	4	TOW SIGHT	B' to T'
	8	S4	5	1	2	8	9	10	6	7	3	TOW SIGHT	A' to T
	9	S3	4	10	1	2	8	9	5	6	7	TOW SIGHT	B' to T'
	10	S7	3	9	10	1	2	8	4	5	6	TOW SIGHT	A' to T
2	1	S6	7	8	9	10	1	2	3	4	5	S-7	A to B
	2	S5	6	2	8	9	10	1	7	3	4	S-6	B to A
	3	S4	5	1	2	8	9	10	6	7	3	S-5	A to B
	4	S3	4	10	1	2	8	9	5	6	7	S-4	B to A
	5	S7	3	9	10	1	2	8	4	5	6	S-3	A to B
	6	S1	2	3	4	5	6	7	8	9	10	TOW SIGHT	B to A
	7	S10	1	7	3	4	5	6	7	8	9	TOW SIGHT	A to B
	8	S9	10	6	7	3	4	5	1	2	8	TOW SIGHT	A to B
	9	S8	9	5	6	7	3	4	10	1	2	TOW SIGHT	B to A
	10	S2	8	4	5	6	7	3	9	10	1	TOW SIGHT	B to A

TABLE 3

Subject Seating Diagram

Test Course



The mean values of the optics identification range were:

Group I	1803 meters, SD 430
Group II	2000 meters, SD 466

The overall mean time values were:

Group I	12.7 seconds for detection,	SD 9
	34.2 seconds for identification,	SD 20
Group II	10.9 seconds for detection,	SD 8
	23.5 seconds for identification,	SD 13

The overall mean range values were:

Group I	2363 meters for detection,	SD 349
	1487 meters for identification,	SD 607
Group II	2338 meters for detection,	SD 413
	1453 meters for identification	SD 730

Quick detection times and long identification ranges are excellent, but when IFF is necessary it is the correctness of the identification that is paramount.

For the time series of runs the subjects scored as follows:

Group I	Unaided-eye	80% correct
Group II	Unaided-eye	84% correct
Group I	Optics	78% correct
Group II	Optics	68% correct
Group I	Overall	79% correct
Group II	Overall	76% correct

For the range series of runs, the subjects scored as follows:

Group I	Unaided-eye	68% correct
Group II	Unaided-eye	82% correct
Group I	Optics	72% correct
Group II	Optics	66% correct
Group I	Overall	70% correct
Group II	Overall	74% correct

These figures show an overall correct identification rate of 75 percent for both of the test groups. These subjects came from 10 different organizations at three different forts and should be representative of the population of US Army gunship pilot/gunners now on duty.

A breakdown of these errors by friend, US and Israel, and foe is as follows:

Group I	Unaided-eye	Friend, U S	11%	Israel	6%	Foe	8%
Group II	Unaided-eye	Friend, U S	3%	Israel	12%	Foe	2%
Group I	Optics	Friend, U S	3%	Israel	18%	Foe	2%
Group II	Optics	Friend, U S	1%	Israel	31%	Foe	1%
Overall	Unaided-eye	Friend, U S	7%	Israel	9%	Foe	5%
Overall	Optics	Friend, U S	2%	Israel	25%	Foe	2%

A breakdown of the errors by vehicle type is as follows:

Group I	Unaided-eye	Armored Vehicles	12%	Trucks	13%
Group II	Unaided-eye	Armored Vehicles	15%	Trucks	2%
Group I	Optics	Armored Vehicles	6%	Trucks	17%
Group II	Optics	Armored Vehicles	14%	Trucks	19%
Overall	Unaided	Armored Vehicles	14%	Trucks	7%
Overall	Optics	Armored Vehicles	10%	Trucks	18%

DISCUSSION

Each subject had a total of 20 chances to identify groups of moving vehicles as a friend or a foe; of these chances, seven were US Army vehicles, seven were enemy vehicles, and six were a mixture of US and enemy vehicles such as is used by one of our allies. Ten of the subjects were from units that had participated in the Reforger exercise in 1976. These subjects seemed to be reluctant to accept the fact that they would encounter US equipment mixed with that of other countries. This was expressed during the informal debriefing sessions and was apparent in their IFF scores; if it was a mix, it was almost always called foe. At some time in their training they had been given to understand, intentionally or not, that our allies would only be using US equipment; thus if it wasn't US, it was enemy. The other group of subjects did not have this bias.

A subject experience profile was compiled from information furnished by the subjects so that some comparisons could be made between their actual performance and their level of experience (Table 4).

The mean and median score for IFF errors was five; four of the seven pilots who had less than five errors had combat experience as did four of the seven pilots who scored more than five IFF errors.

Five pilots from Group I had fewer than five IFF errors and four had more than five. Two pilots from Group II had fewer than five errors and three had more than five IFF errors. It was also interesting to note that the two pilots who gave the most correct IFFs and the two pilots that gave the most wrong IFFs had no combat experience; their total flight experience ranged between 500 and 600 hours of helicopter flight time and all were 1975 graduates from helicopter flight training.

TABLE 4

Subject Profile

Subject Number	Total Time (Hours)	Helicopter Time (Hours)	Combat Time (Hours)	Instrument Time (Hours)	Age (Years)	Helicopter Rating (Year)
I-9	600	600	0	60	25	1975
I-4	600	500	0	80	23	1975
I-7	1200	1200	0	150	34	1969
I-8	1600	1600	760	100	27	1970
I-10	1400	1400	0	140	32	1972
I-5	1020	1000	400	75	29	1969
I-1	1500	1500	700	30	35	1969
I-2	2700	2400	600	220	35	1970
I-6	1150	550	0	50	30	1975
I-3	1200	600	0	100	26	1975
II-5	2535	2500	1003	100	41	1968
II-9	780	780	0	150	25	1975
II-7	1900	1900	800	75	26	1971
II-1	1500	1500	0	50	26	1972
II-3	3900	3900	1000	125	30	1969
II-4	3300	3300	1300	100	33	1969
II-10	2800	2800	1130	100	31	1969
II-6	2500	2500	850	200	27	1969
II-8	2550	1700	975	75	31	1969
II-2	2425	2300	776	200	28	1969

The results of this test continue to illustrate what has been a repeated result of the US Army Human Engineering Laboratory helicopter target acquisition tests conducted since 1972.[2,3,4] This test was the first that has divided the observer's task into detection and identification. The detection ranges are similar to those of the other tests for the same flight conditions. The 1976 test[4] against stationary camouflaged M-60 tanks in the same area of the test range at a slant range of 800 meters with the observers (Figure 5), in an actual pop-up maneuver showed a mean detection time of 50.9 seconds. This difference in mean detection times, 13.3 against 50.9, shows the advantage target movement gives to the helicopter observer.

A nap-of-the-earth detection range test was also flown against the camouflaged tank. The mean detection range was 753 meters. The current test mean detection range was 2253 meters.

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

[3]Barnes, J.A. Use of the tank main gun for defense against helicopter attack. Technical Memorandum 14-76, US Army Human Engineering Laboratory, Aberdeen Proving Ground, MD, April 1976.

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

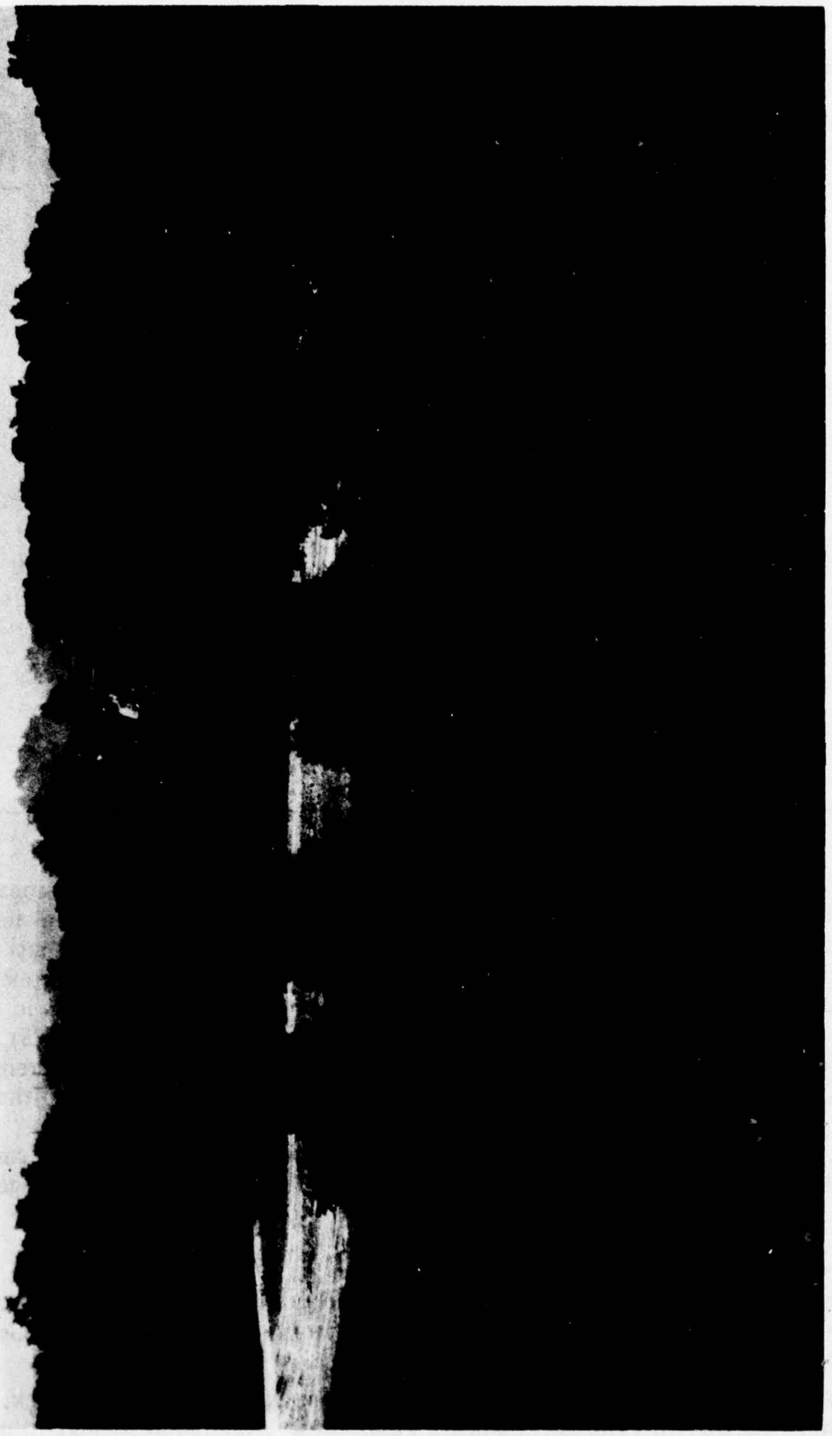


Figure 5. Helicopter at hover during a tactical pop-up maneuver.

The use of optics improved the mean detection range by less than 200 meters. This same type of result was indicated in the 1975[3] tests in which a stabilized optics system was used by the helicopter and was found to be of little use in detection but was very helpful as an identification aid.

The 1972-1973 tests[2] were low level route reconnaissance flights against stationary military vehicles in flat, well foliated areas and in mountainous, sparsely covered areas. They showed a maximum detection range of an M-48 tank at 2320 meters with a helicopter altitude of 340 feet and a maximum detection range of 610 meters at an altitude of 220 feet; both of these figures are for the mountainous terrain.

APPENDIX A

LIGHT AND CONTRAST VALUES

PROCEDURE

Ambient light levels (footcandles) were measured using a model 1960 Spectra Pritchard photometer. The photometer detector unit, equipped with a cosine corrected integrating attachment, was aimed vertically upward; this placed the photometer reference surface in a horizontal plane. Under the above conditions, the measured illumination represented the light levels in a horizontal plane, which resulted from light incident from the hemisphere (sky) directly above.

Sky brightness (footcandles/ster) was derived from the illumination measurements by dividing the latter by the factor π (Pi).

Sky brightness measurements (footlamberts) taken in conjunction with the target array versus background readings, used to compute target contrast, were measured directly by using a photometer which was aimed at the portion of the sky relevant to the test.

Target contrast (dynamic contrast) was determined from luminance (foot lambert) measurements taken on the target vehicles and their associated backgrounds. These measurements were taken while the vehicles were proceeding in a target array and along a course specified in a time/run schedule for this test. The targets were measured while in motion, when they were in view, simultaneously, of the light measurements group and the observers participating in an adjunct test phase of this test. The photometer was aimed at the targets, along a line-of-sight parallel to that of the observers, and after the last target was measured, background readings were taken. Target contrast was calculated by the equation:

$$\text{Contrast} = \frac{\text{High Luminance - Low Luminance}}{\text{High Luminance}}$$

Illumination levels measured are representative of the light levels at the test location.

Sky brightness (footcandle/ster) is representative of the average brightness of the sky at the test site. This data was calculated rather than measured, since direct measurement would only measure a small portion of the sky (2^{o}).

Contrast measurements were taken while the target was in motion and proceeding in an array along a preselected test course. This posed a problem when preceding along a dirt road. The leading vehicle would stir up enough dust or smoke to completely engulf, in a mist of suspended particles, the other following vehicle(s). As a result, the contrast readings eventually calculated from these data would seem to be scattered without any correlation among several measurements taken on the same vehicle or other vehicle in the group. It is felt, however, that these measurements do, indeed portray the conditions of the test and should correlate closely with the visual data collected in the visible region of spectrum.

The illumination and sky brightness data were representative of the conditions existing at the test site for the time of year and season.

Figure 1A illustrates the sun's azimuth and altitude during the testing periods.

LUMINANCE DATA

Date of Test (1977)	Time	Luminance of the Field, Footlamberts x 10^2 Trees In Near Background	Trees In Far Background	Road Surface	Grass In The Foreground	Sky	Luminance of the Targets Footlamberts x 10^2				
23 May	1510	2.05	6.85	14.7[a]	5.64	20.0	M60 3.15	M113 3.72	M113 3.05	M60 3.24	
	1522	2.70	8.37	16.2[a]	7.22	20.8	T62 4.78	M113 4.20	M113 3.14	T59 3.66	
	1535	1.82	8.62	9.25[a]	4.13	17.50	T62 2.39	M1967 3.51	BTR50 2.34	T59 3.74	
24 May	0920	2.11	5.30	8.27[a]	4.94	16.45	UAZ69 2.41	KRAZ214 1.41	ZIL130 1.82	GAZ63 2.43	
	1035	3.53	12.16	10.04[a]	7.09	23.1	JEEP Lost	5-TON 4.00	6x6 3.06	6x6 3.10	
	1050	3.08	8.50	12.64[a]	7.63	23.2	T62 3.43	M1967 4.30	BTR50 2.92	T59 2.66	
	1100	2.66	6.81	11.11[a]	5.60	21.0	UAZ69 3.33	KRAZ214 1.45	ZIL130 1.83	GAZ63 2.97	
	1110	–	–	–	–	–	T62 Lost	M113 Lost	M113 Lost	T59 Lost	
	1115	2.78	9.61	14.30[a]	7.13	22.0	M60 3.14	M113 2.68	M113 2.90	M60 2.18	
	1125	3.61	8.52	17.64[a]	7.34	23.4	JEEP 3.22	KRAZ214 1.83	5-TON 2.19	6x6 2.71	
	1355	–	5.82	19.70[b]	9.63	22.7	T62 8.80	T59 9.70	BMP-A 2.85	BTR50 2.41	
	1433	–	5.46	8.25[c]	7.48	22.5	JEEP 6.09	5-TON 4.23	6x6 3.60	6x6 3.34	
	1450	–	3.53	6.79[b]	6.79	21.2	T62 7.29	T59 8.30	M113 7.50	M113 6.99	
	1515	–	3.49	8.24[c]	6.69	18.19	UAZ69 3.27	KRAZ214 3.15	ZIL130 3.60	GAZ63 3.90	
	1530	–	4.86	13.54[b]	5.62	17.07	M60 3.40	M60 3.70	M113 6.32	M113 7.18	
25 May	0920	–	1.64	3.80[b]	2.38	7.13	T62 1.96	T59 1.50	M113 1.39	M113 1.47	
	0940	–	2.01	6.72[c]	3.58	9.22	JEEP 1.35	ShopVan 1.55	5-TON 1.51	6x6 1.32	6x6 1.27
	0955	–	2.30	6.89[b]	3.85	10.40	M60 3.00	M60 2.45	M113 2.89	M113 2.85	
	1013	–	3.31	9.24[c]	5.73	14.6	JEEP 2.20	ZIL157 3.90	KRAZ214 2.20	5-TON 2.11	6x6 2.09
	1039	–	2.07	7.19[b]	3.75	15.9	T62 3.27	T59 4.57	BMP-A 3.28	BTR50 3.17	
	1335	–	2.59	4.91[b]	3.23	9.48	T62 3.18	T59 2.50	BMP-A 2.53	BTR50 1.90	

[a]Mixture of clay, gravel and sand.
[b]Bare earth.
[c]Macadam.

(Continued)

LUMINANCE DATA

Date of Test (1977)	Time	Luminance of the Field, Footlamberts x 10^2 Trees In Near Background	Trees In Far Background	Road Surface	Grass In The Foreground	Sky	Luminance of the Targets Footlamberts x 10^2 JEEP	ShopVan	5-TON	6x6	6x6
25 May	1351	--	3.09	8.72[c]	3.48	13.30	2.14	2.02	1.76	1.66	1.58
	1419		2.07	5.30[b]	3.44	13.30	T62 / 2.80	T59 / 2.79	M113 / 2.40	M113 / 2.28	
	1439		2.14	11.20[c]	4.05	17.70	UAZ69 / 2.51	ZIL157 / 3.04	KRAZ214 / 2.20	ZIL130 / 2.18	GAZ63 / 2.40
	1458	--	2.00	7.08[b]	4.70	17.00	M60 / 3.52	M60 / 2.77	M113 / 3.36	M113 / 4.46	
26 May[d]	0936	--	3.40	14.20[b]	7.17	21.9	T62 / 5.71	T59 / 7.12	M113 / 5.34	M113 / 5.21	
	0958		3.36	10.30[c]	6.65	21.3	JEEP / 2.05	ShopVan / 2.57	5-TON / 1.46	6x6 / 1.40	6x6 / 1.50
	1016		3.36	17.40[b]	6.50	20.7	M60 / 8.20	M60 / 6.08	M113 / 7.93	M113 / 8.22	
	1036	--	3.33	10.30[c]	6.65	20.0	JEEP / 2.40	ShopVan / 3.20	KRAZ214 / 2.20	5-TON / 1.70	6x6 / 1.60
	1053	--	3.20	20.9[b]	6.40	19.10	T62 / 7.90	T59 / 11.00	BMP-A / 7.50	BTR50 / 7.24	
	1335	2.30	7.42	15.12[a]	7.84	18.75	M60 / 7.34	M113 / 7.30	M113 / 10.60	M60 / 8.90	
	1345	2.21	8.27	16.26[a]	7.36	12.33	T62 / 8.50	M113 / 10.53	M113 / 9.90	T59 / 9.80	
	1355	2.35	7.33	16.17[a]	7.86	14.40	T62 / 7.90	M1967 / 10.00	BTR50 / 8.90	T59 / 11.60	
	1455	3.39	7.25	17.30[a]	8.34	19.00	UAZ69 / 6.80	ZIL157 / 8.30	KRAZ214 / 6.90	ZIL130 / 7.59	GAZ63 / 12.16
	1505	3.39	7.25	17.30[a]	8.34	19.00	JEEP / 6.90	ShopVan / 4.19	5-TON / 8.96	6x6 / 10.16	6x6 / 12.08
27 May[d]	--	--	--	--	-	-	T62 / Lost	M1967 / Lost	BTR50 / Lost	T59 / Lost	
	0950	1.72	5.20	7.99[a]	6.01	22.9	UAZ69 / 2.30	ZIL157 / 2.99	KRAZ214 / 3.62	ZIL130 / 5.90	GAZ63 / 7.70
	0957	2.11	4.42	7.18[a]	6.52	22.7	T62 / 2.90	M113 / 1.70	M113 / 1.42		
	1002	2.38	5.58	7.02[a]	6.41	21.5	M60 / 3.70	M113 / 5.71	M113 / 9.97		
	1007	2.88	5.40	7.12[a]	6.65	22.2	JEEP / 3.20	ZIL157 / 4.18	KRAZ214 / 5.91	5-TON / 5.19	6x6 / 9.60

(Concluded)

[a]Mixture of clay, gravel and sand.

[b]Bare earth.

[c]Macadam

[d]Note: 26 and 27 May only: The cumulative dust cloud is responsible for the high readings obtained on the trailing vehicles.

CONTRAST

Date of Test (1977)	Time	Target Vehicle	Contrast of Target Vehicle With Respect To: Trees In Near Background	Trees In Far Background	Road Surface	Grass In The Foreground	Sky
23 May	1510	M60	.34	.54	.79[a]	.44	.84
		M113	.44	.46	.75[a]	.34	.81
		M113	.33	.55	.79[a]	.46	.85
		M60	.37	.53	.78[a]	.43	.84
	1522	T62	.44	.43	.70[a]	.34	.77
		M113	.36	.50	.74[a]	.42	.80
		M113	.14	.62	.81[a]	.57	.85
		T59	.26	.56	.77	.49	.82
	1535	T62	.24	.72	.74[a]	.42	.86
		M1967	.48	.59	.62[a]	.15	.80
		BTR 50	.22	.73	.75[a]	.43	.87
		T59	.51	.57	.60[a]	.09	.79
24 May	0920	UAZ 69	.12	.55	.71[a]	.51	.85
		KRAZ 214	.33	.73	.83[a]	.71	.91
		ZIL 130	.14	.66	.78[a]	.63	.89
		GAZ 63	.13	.54	.71[a]	.51	.85
	1035	JEEP	Lost	Lost	Lost	Lost	Lost
		5-TON	.12	.67	.60[a]	.44	.83
		6 x 6	.13	.75	.70[a]	.57	.87
		6 x 6	.12	.75	.69[a]	.56	.87
	1050	T62	.10	.59	.73[a]	.55	.85
		M1967	.28	.49	.66[a]	.44	.81
		BTR 50	.05	.66	.77[a]	.62	.87
		T59	.14	.69	.79[a]	.65	.89
	1100	UAZ 69	.20	.51	.70[a]	.41	.84
		KRAZ 214	.45	.79	.87[a]	.74	.93
		ZIL 130	.31	.73	.88[a]	.67	.91
		GAZ 63	.10	.56	.73[a]	.47	.86
	1110	T62	Lost	Lost	Lost	Lost	Lost
		M113	Lost	Lost	Lost	Lost	Lost
		M113	Lost	Lost	Lost	Lost	Lost
		T59	Lost	Lost	Lost	Lost	Lost
	1115	M60	.11	.67	.78[a]	.56	.86
		M113	.04	.72	.81[a]	.62	.88
		M113	.04	.70	.80[a]	.59	.87
		M60	.22	.77	.85[a]	.69	.90
	1125	JEEP	.11	.62	.82[a]	.56	.86
		KRAZ 214	.49	.79	.90[a]	.75	.92
		5-TON	.39	.74	.88[a]	.70	.91
		6 x 6	.25	.68	.85[a]	.63	.88
	1355	T62	–	.34	.55[b]	.09	.61
		T59	–	.40	.51[b]	.01	.57
		BMP-A	–	.51	.86[b]	.70	.87
		BTR 50	–	.59	.88[b]	.75	.89

[a]Mixture of clay, gravel and sand.
[b]Bare earth.

(Continued)

CONTRAST

Date of Test (1977)	Time	Target Vehicle	Contrast of Target Vehicle With Respect To: Trees In Near Background	Trees In Far Background	Road Surface	Grass In The Foreground	Sky
24 May	1433	JEEP	–	.10	.26[c]	.19	.73
		5-TON	–	.23	.49[c]	.43	.81
		6 x 6	–	.34	.56[c]	.52	.84
		6 x 6	–	.39	.60[c]	.55	.85
	1450	T62	–	.52	.07[b]	.07	.66
		T59	–	.57	.18[b]	.18	.61
		M113	–	.53	.09[b]	.09	.65
		M113	–	.49	.03[b]	.03	.67
	1515	UAZ 69	–	.06	.60[c]	.51	.82
		KRAZ 214	–	.10	.62[c]	.53	.83
		ZIL 130	–	.03	.56[c]	.46	.80
		GAZ 63	–	.11	.53[c]	.42	.79
	1530	M60	–	.30	.75[b]	.40	.80
		M60	–	.24	.73[b]	.34	.78
		M113	–	.23	.53[b]	.11	.63
		M113	–	.32	.47[b]	.22	.58
25 May	0920	T62	–	.16	.48[b]	.18	.73
		T59	–	.09	.61[b]	.37	.79
		M113	–	.15	.63[b]	.42	.81
		M113	–	.10	.61[b]	.38	.79
	0940	JEEP	–	.33	.80[c]	.62	.85
		Shop Van	–	.23	.77[c]	.57	.83
		5-TON	–	.25	.78[c]	.58	.84
		6 x 6	–	.34	.80[c]	.63	.86
		6 x 6	–	.37	.81[c]	.65	.86
	0955	M60	–	.23	.56[b]	.22	.71
		M60	–	.06	.64[b]	.36	.76
		M113	–	.20	.58[b]	.25	.72
		M113	–	.19	.59[b]	.26	.73
	1013	JEEP	–	.34	.76[c]	.57	.85
		ZIL 157	–	.15	.58[c]	.24	.73
		KRAZ 214	–	.34	.76[c]	.57	.85
		5-TON	–	.36	.77[c]	.59	.86
		6 x 6	–	.37	.77[c]	.59	.86
	1039	T62	–	.37	.55[b]	.13	.79
		T59	–	.55	.36[b]	.18	.71
		BMP-A	–	.37	.54[b]	.13	.79
		BTR 50	–	.35	.56[b]	.15	.80
	1335	T62	–	.19	.35[b]	.02	.66
		T59	–	.04	.49[b]	.23	.74
		BMP-A	–	.02	.48[b]	.22	.73
		BTR 50	–	.27	.61[b]	.41	.80
	1351	JEEP	–	.31	.75[c]	.39	.84
		Shop Van	–	.35	.77[c]	.42	.85
		5-TON	–	.43	.80[c]	.49	.87
		6 x 6	–	.46	.81[c]	.52	.88
		6 x 6	–	.49	.82[c]	.55	.88

[a]Mixture of clay, gravel and sand.

[b]Bare earth.

[c]Macadam

(Continued)

CONTRAST

Date of Test (1977)	Time	Target Vehicle	Contrast of Target Vehicle With Respect To: Trees In Near Background	Trees In Far Background	Road Surface	Grass In The Foreground	Sky
25 May	1419	T62	–	.26	.47[b]	.19	.79
		T59	–	.26	.47[b]	.19	.79
		M113	–	.14	.55[b]	.30	.82
		M113	–	.09	.57[b]	.34	.83
	1439	UAZ 69	–	.15	.78[c]	.38	.86
		ZIL 157	–	.30	.73[c]	.25	.83
		KRAZ 214	–	.03	.80[c]	.46	.88
		ZIL 130	–	.02	.81[c]	.46	.88
		GAZ 63	–	.11	.79[c]	.41	.86
	1458	M60	–	.43	.50[b]	.25	.79
		M60	–	.28	.61[b]	.41	.84
		M113	–	.40	.53[b]	.29	.80
		M113	–	.55	.37[b]	.05	.74
26 May	0936	T62	–	.40	.60[b]	.20	.74
		T59	–	.52	.50[b]	.01	.67
		M113	–	.36	.62[b]	.26	.76
		M113	–	.35	.63[b]	.27	.76
	0958	JEEP	–	.39	.80[c]	.69	.90
		Shop Van	–	.24	.75[c]	.61	.88
		5-TON	–	.57	.86[c]	.78	.93
		6 x 6	–	.58	.86[c]	.79	.93
		6 x 6	–	.55	.85[c]	.77	.93
	1016	M60	–	.59	.53[b]	.21	.60
		M60	–	.45	.65[b]	.06	.71
		M113	–	.58	.54[b]	.18	.62
		M113	–	.59	.53[b]	.21	.60
	1036	JEEP	–	.28	.77[c]	.64	.88
		Shop Van	–	.04	.69[c]	.52	.84
		KRAZ 214	–	.34	.79[c]	.67	.89
		5-TON	–	.49	.83[c]	.74	.92
		6 x 6	–	.52	.84[c]	.76	.92
	1053	T62	–	.59	.62[b]	.19	.59
		T59	–	.71	.47[b]	.42	.42
		BMP-A	–	.57	.64[b]	.15	.61
		BTR 50	–	.56	.65[b]	.12	.62
	1335	M60	.69	.01	.51[a]	.06	.61
		M113	.68	.02	.52[a]	.07	.61
		M113	.78	.30	.30[a]	.26	.43
		M60	.74	.17	.41[a]	.12	.53
	1345	T62	.74	.03	.48[a]	.13	.31
		M113	.79	.21	.35[a]	.30	.15
		M113	.78	.16	.39[a]	.26	.20
		T59	.77	.16	.40[a]	.25	.21

[a]Mixture of clay, gravel and sand.

[b]Bare earth.

[c]Macadam

(Continued)

CONTRAST

Date of Test (1977)	Time	Target Vehicle	Contrast of Target Vehicle With Respect To: Trees In Near Background	Trees In Far Background	Road Surface	Grass In The Foreground	Sky
26 May	1355	T62	.70	.07	.51[a]	.01	.45
		M1967	.77	.27	.38[a]	.21	.31
		BTR 50	.74	.18	.45[a]	.12	.38
		T59	.80	.37	.28[a]	.32	.19
	1455	UAZ 69	.50	.06	.61[a]	.18	.64
		ZIL 157	.59	.13	.52[a]	.00	.56
		KRAZ 214	.51	.05	.60[a]	.17	.64
		ZIL 130	.55	.04	.56[a]	.09	.60
		GAZ 63	.72	.40	.30[a]	.31	.36
	1505	JEEP	.51	.05	.60[a]	.17	.64
		Shop Van	.19	.42	.76[a]	.50	.78
		5-TON	.62	.19	.48[a]	.07	.53
		6 x 6	.67	.29	.41[a]	.18	.47
		6 x 6	.72	.40	.30[a]	.31	.36
27 May	0925	T62	Lost	Lost	Lost	Lost	Lost
		M1967	Lost	Lost	Lost	Lost	Lost
		BTR 50	Lost	Lost	Lost	Lost	Lost
		T59	Lost	Lost	Lost	Lost	Lost
	0950	UAZ 69	.25	.56	.71[a]	.62	.90
		ZIL 157	.42	.43	.63[a]	.50	.87
		KRAZ 214	.52	.30	.55[a]	.40	.84
		ZIL 130	.71	.12	.26[a]	.02	.74
		GAZ 63	.78	.32	.04[a]	.22	.66
	0957	T62	.27	.34	.60[a]	.56	.87
		M113	.19	.62	.76[a]	.74	.93
		M113	.33	.68	.80[a]	.78	.94
	1002	M60	.36	.34	.47[a]	.42	.88
		M113	.58	.02	.19[a]	.11	.73
		M113	.76	.44	.30[a]	.36	.54
	1007	JEEP	.10	.41	.55[a]	.52	.86
		ZIL 157	.31	.23	.41[a]	.37	.81
		KRAZ 214	.51	.09	.17[a]	.11	.73
		5-TON	.45	.04	.27[a]	.22	.77
		6 x 6	.70	.44	.26[a]	.31	.56

[a]Mixture of clay, gravel and sand.
[b]Bare earth.
[c]Macadam

(Concluded)

ILLUMINATION

Date of Test (1977)	Time	Illumination Foot Candle	Illumination Lux	Calculated Sky Brightness Foot Candle Steradian	Calculated Sky Brightness Lux/Steradian	Remarks
23 May	0900	2.9×10^3	31.2×10^3	0.922×10^3	9.93×10^3	Overcast
	0930	2.9×10^3	31.2×10^3	0.922×10^3	9.93×10^3	Overcast
	1000	4.3×10^3	46.3×10^3	1.37×10^3	14.7×10^3	Partial cloud
	1030	3.0×10^3	32.3×10^3	0.956×10^3	10.3×10^3	Overcast
	1100	7.4×10^3	79.6×10^3	2.36×10^3	25.3×10^3	Sun thru light cloud
	1130	8.6×10^3	92.5×10^3	2.74×10^3	29.4×10^3	Sun thru light cloud
	1300	8.8×10^3	94.7×10^3	2.80×10^3	30.1×10^3	Sun thru light cloud
	1330	6.4×10^3	68.9×10^3	2.04×10^3	21.9×10^3	Slight overcast
	1400	5.8×10^3	62.4×10^3	1.85×10^3	19.9×10^3	Slight overcast
	1430	5.8×10^3	62.4×10^3	1.85×10^3	19.9×10^3	Slight overcast
	1500	3.8×10^3	40.9×10^3	1.21×10^3	13.0×10^3	Cloudy
	1530	4.3×10^3	46.3×10^3	1.37×10^3	14.7×10^3	Cloudy
24 May	0830	1.85×10^3	19.9×10^3	0.588×10^3	6.33×10^3	Overcast
	0900	2.45×10^3	26.4×10^3	0.780×10^3	8.40×10^3	Overcast
	0930	3.80×10^3	40.9×10^3	1.21×10^3	13.0×10^3	Some clear sky
	1000	3.40×10^3	36.6×10^3	1.09×10^3	11.7×10^3	Some clear sky
	1030	5.90×10^3	63.5×10^3	1.88×10^3	20.2×10^3	Some clear sky
	1100	5.40×10^3	58.1×10^3	1.72×10^3	18.5×10^3	Slight overcast
	1130	9.20×10^3	99.0×10^3	2.94×10^3	31.5×10^3	Bright sun
	1300	5.7×10^3	61.3×10^3	1.92×10^3	19.5×10^3	Sky overcast
	1330	4.5×10^3	48.4×10^3	1.43×10^3	15.4×10^3	Sky overcast
	1400	6.5×10^3	69.9×10^3	2.06×10^3	22.2×10^3	Light overcast
	1430	4.6×10^3	49.5×10^3	1.46×10^3	15.8×10^3	Overcast
	1500	3.8×10^3	40.9×10^3	1.21×10^3	13.0×10^3	Overcast
	1530	3.5×10^3	37.7×10^3	1.11×10^3	12.0×10^3	Overcast
25 May	0830	7.6×10^2	8.18×10^3	2.42×10^2	2.60×10^3	Very light shower
	0900	7.4×10^2	7.96×10^3	2.36×10^2	2.53×10^3	Shower
	0930	2.1×10^3	22.6×10^3	0.668×10^3	7.19×10^3	Overcast
	1000	2.7×10^3	29.1×10^3	0.858×10^3	9.26×10^3	Overcast
	1030	2.5×10^3	26.9×10^3	0.796×10^3	8.56×10^3	Overcast
	1100	2.8×10^3	30.1×10^3	0.892×10^3	9.58×10^3	Light shower
	1130	2.0×10^3	21.5×10^3	0.636×10^3	6.84×10^3	Light shower
	1300	2.75×10^3	29.6×10^3	0.876×10^3	9.42×10^3	Rain
	1330	2.1×10^3	22.6×10^3	0.668×10^3	7.19×10^3	Rain
	1400	2.45×10^3	26.4×10^3	0.780×10^3	8.40×10^3	Rain
	1430	2.45×10^3	26.4×10^3	0.780×10^3	8.40×10^3	Overcast
	1500	3.2×10^3	34.4×10^3	1.02×10^3	10.9×10^3	Overcast
26 May	0830	4.0×10^3	43.0×10^3	1.27×10^3	13.7×10^3	Clear
	0900	4.55×10^3	49.0×10^3	1.45×10^3	15.6×10^3	Clear
	0930	5.4×10^3	58.1×10^3	1.72×10^3	18.5×10^3	Clear
	1000	6.0×10^3	64.6×10^3	1.91×10^3	20.6×10^3	Clear
	1030	6.7×10^3	72.1×10^3	2.14×10^3	23.0×10^3	Clear
	1050	7.4×10^3	79.6×10^3	2.36×10^3	25.3×10^3	Clear
	1120	7.7×10^3	82.9×10^3	2.46×10^3	26.4×10^3	Clear
	1300	8.65×10^3	93.1×10^3	2.74×10^3	29.6×10^3	Clear
	1330	8.8×10^3	94.7×10^3	2.80×10^3	30.1×10^3	High light clouds
	1400	8.5×10^3	91.5×10^3	2.70×10^3	29.1×10^3	High light clouds
	1430	8.3×10^3	89.3×10^3	2.64×10^3	28.4×10^3	Haze
	1500	8.0×10^3	86.1×10^3	2.54×10^3	27.4×10^3	Clear

(Continued)

ILLUMINATION

Date of Test (1977)	Time	Illumination		Calculated Sky Brightness		Remarks
		Foot Candle	Lux	Foot Candle Steradian	Lux/Steradian	
27 May	0830	3.8×10^3	40.9×10^3	1.21×10^3	13.0×10^3	Bright sun
	0900	4.6×10^3	49.5×10^3	1.46×10^3	15.8×10^3	Bright sun
	0930	5.4×10^3	58.1×10^3	1.72×10^3	18.5×10^3	Bright sun
	1000	6.1×10^3	65.6×10^3	1.94×10^3	20.9×10^3	Bright sun

(Concluded)

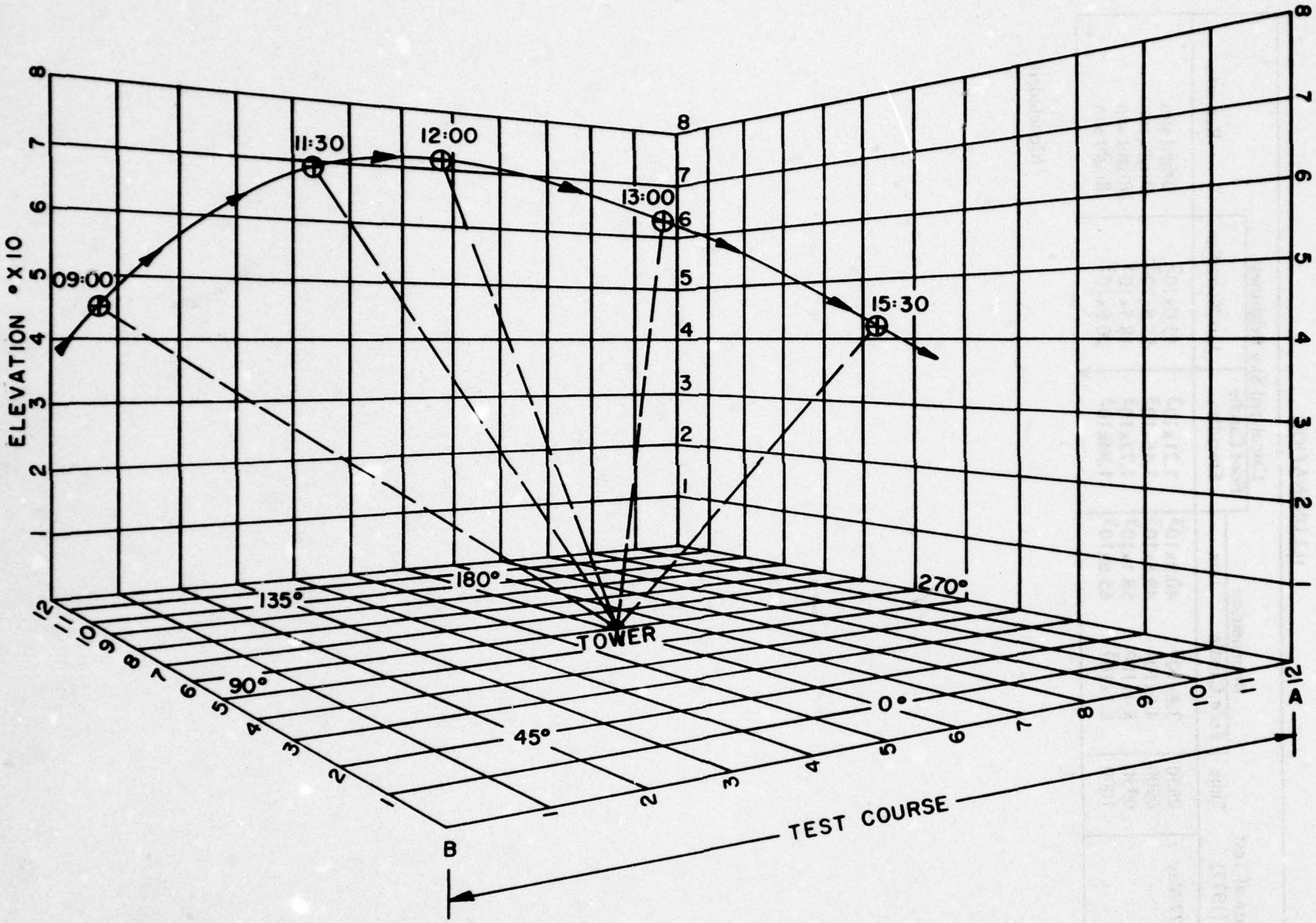


Figure 1A. Sun azimuth and elevation, May 23 - 27, 1977.

APPENDIX B

COMPUTER PRINT OUT OF RAW DATA

BEST AVAILABLE COPY

THRESHOLD RANGE DATA

RUN	GROUP	SEAT	DETECTION	IDENTIFICATION	SUBJECT
1	1	1	1915.0	841.0	6
1	1	2	2398.0	655.0	7
1	1	3	2237.0	2192.0	8
1	1	4	2559.0	1605.0	9
1	1	5	2117.0	1710.0	10
1	1	6	2607.0	466.0	1
1	1	7	2581.0	884.0	2
1	1	8	2720.0	1306.0	3
1	1	9	2720.0	869.0	4
1	1	10	2422.0	1713.0	5
2	1	1	2126.0	741.0	5
2	1	2	1702.0	466.0	6
2	1	3	2402.0	597.0	2
2	1	4	2016.0	880.0	8
2	1	5	1947.0	1013.0	9
2	1	6	2109.0	775.0	10
2	1	7	2303.0	0.0	1
2	1	8	1969.0	466.0	7
2	1	9	1735.0	526.0	3
2	1	10	2132.0	543.0	4
3	1	1	2141.0	2141.0	4
3	1	2	2653.0	1608.0	5
3	1	3	2663.0	841.0	1

3	1	4	1110.0	1005.0	2
3	1	5	2608.0	1346.0	8
3	1	6	2636.0	2615.0	9
3	1	7	1933.0	1933.0	10
3	1	8	2512.0	900.0	6
3	1	9	2637.0	798.0	7
3	1	10	2575.0	1375.0	3
4	1	1	1928.0	960.0	3
4	1	2	2383.0	950.0	4
4	1	3	933.0	933.0	10
4	1	4	2301.0	0.0	1
4	1	5	2376.0	466.0	2
4	1	6	1773.0	949.0	8
4	1	7	2099.0	627.0	9
4	1	8	2424.0	613.0	5
4	1	9	1946.0	518.0	6
4	1	10	2139.0	664.0	7
5	1	1	2638.0	1643.0	7
5	1	2	2503.0	1346.0	3
5	1	3	2578.0	2237.0	9
5	1	4	1915.0	1818.0	10
5	1	5	2652.0	856.0	1
5	1	6	2647.0	1375.0	2
5	1	7	2623.0	982.0	8
5	1	8	2688.0	2586.0	4
5	1	9	2660.0	1890.0	5
5	1	10	2633.0	1025.0	6
6	1	1	2576.0	2076.0	1
6	1	2	2541.0	2142.0	2

BEST AVAILABLE COPY

6	1	3	2498.0	2061.0	3
6	1	4	2561.0	1610.0	4
6	1	5	2558.0	2076.0	5
6	1	6	2537.0	788.0	6
6	1	7	2116.0	1915.0	7
6	1	8	2483.0	2044.0	8
6	1	9	2560.0	2120.0	9
6	1	10	1882.0	1819.0	10
7	1	1	1453.0	1372.0	10
7	1	2	2609.0	0.0	1
7	1	3	2631.0	1501.0	7
7	1	4	2571.0	2425.0	3
7	1	5	2692.0	1660.0	4
7	1	6	2051.0	1432.0	5
7	1	7	2480.0	1465.0	6
7	1	8	2491.0	1612.0	2
7	1	9	2096.0	1468.0	8
7	1	10	2656.0	1432.0	9
8	1	1	2377.0	2377.0	9
8	1	2	2385.0	2159.0	10
8	1	3	2555.0	1915.0	6
8	1	4	2559.0	1990.0	7
8	1	5	2559.0	1858.0	3
8	1	6	2682.0	1777.0	4
8	1	7	2605.0	2030.0	5
8	1	8	2668.0	1915.0	1
8	1	9	2189.0	1940.0	2
8	1	10	2591.0	2270.0	8

BEST AVAILABLE COPY

9	1	1	1993.0	1346.0	8
9	1	2	2362.0	2164.0	9
9	1	3	2577.0	2023.0	5
9	1	4	2575.0	561.0	6
9	1	5	2497.0	1750.0	7
9	1	6	2524.0	2028.0	3
9	1	7	2603.0	1772.0	4
9	1	8	1986.0	1755.0	10
9	1	9	2522.0	950.0	1
9	1	10	2376.0	831.0	2
10	1	1	2413.0	1490.0	2
10	1	2	2622.0	1630.0	8
10	1	3	2554.0	2422.0	4
10	1	4	2645.0	2304.0	5
10	1	5	1593.0	1593.0	6
10	1	6	2646.0	1936.0	7
10	1	7	2609.0	2267.0	3
10	1	8	2658.0	2658.0	9
10	1	9	2574.0	1925.0	10
10	1	10	2692.0	1704.0	1
1	2	1	2294.0	466.0	1
1	2	2	2516.0	949.0	2
1	2	3	2543.0	545.0	3
1	2	4	2241.0	466.0	4
1	2	5	2542.0	466.0	5
1	2	6	1188.0	466.0	6
1	2	7	2514.0	466.0	7
1	2	8	2411.0	627.0	8
1	2	9	2525.0	762.0	9

BEST AVAILABLE COPY

1	2	10	2542.0	627.0	10
2	2	1	2473.0	1432.0	10
2	2	2	2067.0	466.0	1
2	2	3	2345.0	853.0	7
2	2	4	2370.0	731.0	3
2	2	5	2328.0	2173.0	4
2	2	6	2371.0	1271.0	5
2	2	7	1593.0	1260.0	6
2	2	8	2336.0	1271.0	2
2	2	9	555.0	466.0	8
2	2	10	2438.0	466.0	9
3	2	1	2620.0	826.0	9
3	2	2	2650.0	830.0	10
3	2	3	1950.0	839.0	6
3	2	4	2685.0	607.0	7
3	2	5	2628.0	1625.0	3
3	2	6	2158.0	575.0	4
3	2	7	2586.0	1227.0	5
3	2	8	2287.0	466.0	1
3	2	9	2438.0	1110.0	2
3	2	10	1711.0	627.0	8
4	2	1	1110.0	788.0	8
4	2	2	1593.0	466.0	9
4	2	3	2559.0	1182.0	5
4	2	4	1440.0	1029.0	6
4	2	5	1754.0	466.0	7
4	2	6	2262.0	1750.0	3
4	2	7	1750.0	680.0	4

BEST AVAILABLE COPY

4	2	8	1754.0	532.0	10
4	2	9	1660.0	466.0	1
4	2	10	1673.0	600.0	2
5	2	1	2720.0	1026.0	2
5	2	2	1603.0	466.0	8
5	2	3	2704.0	1336.0	4
5	2	4	2720.0	466.0	5
5	2	5	2607.0	1366.0	6
5	2	6	2710.0	1193.0	7
5	2	7	2720.0	1090.0	3
5	2	8	2720.0	466.0	9
5	2	9	2720.0	978.0	10
5	2	10	2642.0	466.0	1
6	2	1	2720.0	1920.0	6
6	2	2	2692.0	2134.0	7
6	2	3	2484.0	2309.0	8
6	2	4	2538.0	2538.0	9
6	2	5	2675.0	2398.0	10
6	2	6	2680.0	2331.0	1
6	2	7	2681.0	1593.0	2
6	2	8	2580.0	1754.0	3
6	2	9	2274.0	1675.0	4
6	2	10	2667.0	1410.0	5
7	2	1	2237.0	1110.0	5
7	2	2	1850.0	1110.0	6
7	2	3	2494.0	2196.0	2
7	2	4	2076.0	1951.0	8
7	2	5	2237.0	1400.0	9
7	2	6	2398.0	2015.0	10

BEST AVAILABLE COPY

7	2	7	2577.0	1326.0	1
7	2	8	2076.0	1900.0	7
7	2	9	1915.0	1469.0	3
7	2	10	2675.0	2080.0	4
8	2	1	2720.0	2681.0	4
8	2	2	2605.0	2582.0	5
8	2	3	2515.0	2515.0	1
8	2	4	2603.0	2603.0	2
8	2	5	2628.0	2628.0	8
8	2	6	2720.0	2720.0	9
8	2	7	2590.0	2455.0	10
8	2	8	2720.0	2621.0	6
8	2	9	2720.0	2565.0	7
8	2	10	2720.0	2424.0	3
9	2	1	2018.0	1639.0	3
9	2	2	2449.0	1465.0	4
9	2	3	2459.0	2155.0	10
9	2	4	2398.0	2398.0	1
9	2	5	2238.0	1322.0	2
9	2	6	1810.0	1593.0	8
9	2	7	2462.0	1995.0	9
9	2	8	1838.0	1593.0	5
9	2	9	2346.0	1915.0	6
9	2	10	2215.0	1974.0	7
10	2	1	2641.0	1915.0	7
10	2	2	2587.0	2080.0	3
10	2	3	2665.0	2076.0	9
10	2	4	2627.0	2508.0	10

BEST AVAILABLE COPY

10	2	5	2213.0	2213.0	1
10	2	6	2051.0	1197.0	2
10	2	7	2526.0	2398.0	8
10	2	8	2617.0	2315.0	4
10	2	9	2638.0	1271.0	5
10	2	10	2627.0	1593.0	6

RESPONSE TIME DATA

RUN	GROUP	SEAT	DETECTION	IDENTIFICATION	SUBJECT
1	1	1	16.2	20.0	1
1	1	2	13.5	34.8	2
1	1	3	12.6	18.1	3
1	1	4	10.6	18.2	4
1	1	5	11.1	16.3	5
1	1	6	12.3	38.8	6
1	1	7	10.1	24.3	7
1	1	8	10.4	27.0	8
1	1	9	10.4	12.3	9
1	1	10	11.1	18.3	10
2	1	1	21.0	21.0	10
2	1	2	24.0	29.5	1
2	1	3	18.5	18.5	7
2	1	4	0.0	0.0	3
2	1	5	11.0	43.0	4
2	1	6	0.0	0.0	5
2	1	7	27.0	42.2	6
2	1	8	39.8	40.0	2
2	1	9	0.0	0.0	8
2	1	10	8.0	13.0	9
3	1	1	12.1	20.7	9
3	1	2	6.4	17.3	10
3	1	3	14.6	0.0	6

3	1	4	5.7	59.0	7
3	1	5	6.7	24.6	3
3	1	6	3.8	15.6	4
3	1	7	3.7	16.8	5
3	1	8	4.5	19.4	1
3	1	9	14.0	0.0	2
3	1	10	19.7	19.7	8
4	1	1	8.2	24.7	8
4	1	2	12.0	37.0	9
4	1	3	15.0	31.0	5
4	1	4	32.9	38.0	6
4	1	5	7.5	25.5	7
4	1	6	17.3	29.3	3
4	1	7	9.6	40.3	4
4	1	8	9.0	28.5	10
4	1	9	8.5	24.5	1
4	1	10	21.3	38.7	2
5	1	1	28.8	82.2	2
5	1	2	25.1	57.0	8
5	1	3	20.8	65.9	4
5	1	4	24.2	65.5	5
5	1	5	36.6	93.0	6
5	1	6	27.0	80.0	7
5	1	7	29.4	51.6	3
5	1	8	33.0	33.0	9
5	1	9	23.8	62.3	10
5	1	10	25.5	87.4	1
6	1	1	24.7	60.4	6
6	1	2	2.9	60.0	7

6	1	3	3.8	20.5	8
6	1	4	3.2	13.7	9
6	1	5	3.3	6.0	10
6	1	6	3.1	65.0	1
6	1	7	20.1	20.9	2
6	1	8	7.6	17.8	3
6	1	9	5.7	33.8	4
6	1	10	5.3	27.3	5
7	1	1	4.4	18.7	5
7	1	2	9.0	44.4	6
7	1	3	34.1	34.1	2
7	1	4	7.8	48.1	8
7	1	5	30.2	39.1	9
7	1	6	4.6	7.8	10
7	1	7	4.2	29.5	1
7	1	8	24.2	61.5	7
7	1	9	4.6	37.5	3
7	1	10	4.8	20.0	4
8	1	1	3.2	37.6	4
8	1	2	4.2	11.0	5
8	1	3	2.7	44.2	1
8	1	4	36.6	40.0	2
8	1	5	4.2	31.8	8
8	1	6	3.3	23.8	9
8	1	7	1.5	73.6	10
8	1	8	5.0	40.2	6
8	1	9	3.7	54.9	7
8	1	10	5.9	46.2	3

BEST AVAILABLE COPY

9	1	1	5.6	11.5	3
9	1	2	1.3	6.2	4
9	1	3	1.5	6.4	10
9	1	4	3.4	22.3	1
9	1	5	30.3	30.3	2
9	1	6	2.4	17.2	8
9	1	7	2.7	12.8	9
9	1	8	7.2	18.8	5
9	1	9	5.1	28.4	6
9	1	10	6.7	17.0	7
10	1	1	17.8	66.4	7
10	1	2	9.9	80.0	3
10	1	3	8.7	22.5	9
10	1	4	1.8	7.8	10
10	1	5	6.9	56.2	1
10	1	6	0.0	0.0	2
10	1	7	5.2	18.1	8
10	1	8	26.0	26.0	4
10	1	9	9.8	30.7	5
10	1	10	18.5	43.9	6
1	2	1	12.6	12.6	6
1	2	2	5.7	17.9	7
1	2	3	10.2	22.9	8
1	2	4	7.3	17.9	9
1	2	5	7.8	22.4	10
1	2	6	9.0	48.0	1
1	2	7	7.5	12.0	2
1	2	8	8.8	9.4	3
1	2	9	10.3	10.3	4

BEST AVAILABLE COPY

1	2	10	6.6	39.4	5
2	2	1	49.3	61.0	5
2	2	2	7.9	19.5	6
2	2	3	7.8	26.3	2
2	2	4	5.6	27.7	8
2	2	5	7.3	19.2	9
2	2	6	9.7	13.8	10
2	2	7	8.4	10.2	1
2	2	8	8.4	23.4	7
2	2	9	49.2	49.2	3
2	2	10	9.1	18.3	4
3	2	1	6.0	6.0	4
3	2	2	8.7	9.7	5
3	2	3	4.2	26.9	1
3	2	4	5.1	9.1	2
3	2	5	16.2	26.2	8
3	2	6	5.0	27.0	9
3	2	7	6.0	24.5	10
3	2	8	4.0	24.0	6
3	2	9	4.5	16.4	7
3	2	10	9.2	25.5	3
4	2	1	20.6	20.6	3
4	2	2	9.0	11.2	4
4	2	3	16.4	20.8	10
4	2	4	18.4	18.4	1
4	2	5	18.2	28.8	2
4	2	6	12.7	48.2	8
4	2	7	11.3	24.7	9

4	2	8	10.0	58.9	5
4	2	9	4.5	5.5	6
4	2	10	5.7	11.0	7
5	2	1	2.9	8.5	7
5	2	2	7.3	15.3	3
5	2	3	7.5	41.9	9
5	2	4	4.5	24.1	10
5	2	5	8.0	18.9	1
5	2	6	8.9	28.9	2
5	2	7	8.7	38.6	8
5	2	8	2.0	13.0	4
5	2	9	4.4	18.7	5
5	2	10	6.6	6.6	6
6	2	1	26.3	26.3	1
6	2	2	36.7	41.7	2
6	2	3	20.9	28.1	3
6	2	4	14.4	24.3	4
6	2	5	23.4	26.9	5
6	2	6	10.5	25.0	6
6	2	7	7.4	16.7	7
6	2	8	22.1	36.5	8
6	2	9	17.3	17.3	9
6	2	10	20.1	25.5	10
7	2	1	18.4	28.4	10
7	2	2	20.0	25.8	1
7	2	3	3.8	7.9	7
7	2	4	14.1	22.4	3
7	2	5	2.5	30.2	4
7	2	6	6.1	32.1	5

7	2	7	10.9	10.9	6
7	2	8	15.4	15.4	2
7	2	9	18.0	22.0	8
7	2	10	17.7	27.4	9
8	2	1	5.4	6.8	9
8	2	2	12.2	42.6	10
8	2	3	4.4	24.8	6
8	2	4	4.2	7.7	7
8	2	5	8.0	44.6	3
8	2	6	4.7	69.2	4
8	2	7	6.4	14.4	5
8	2	8	21.8	51.2	1
8	2	9	3.3	39.8	2
8	2	10	14.8	47.3	8
9	2	1	13.4	20.4	8
9	2	2	5.5	17.5	9
9	2	3	2.3	17.3	5
9	2	4	1.0	16.0	6
9	2	5	2.0	5.0	7
9	2	6	13.5	27.8	3
9	2	7	2.0	3.2	4
9	2	8	4.0	14.0	10
9	2	9	9.6	20.8	1
9	2	10	1.0	24.4	2
10	2	1	17.8	17.8	2
10	2	2	12.1	18.0	8
10	2	3	2.0	15.2	4
10	2	4	11.2	53.2	5

10	2	5	24.1	31.4	6
10	2	6	1.0	9.0	7
10	2	7	16.7	16.7	3
10	2	8	9.2	10.8	9
10	2	9	12.0	20.8	10
10	2	10	14.7	14.7	1