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HUMAN ENGINEERING LAB ABERDEEN PROVING GROUND MD

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COMPARISON TEST BETWEEN TWO MOVING TARGET SIGHTING PROCEDURES F--ETC(U)

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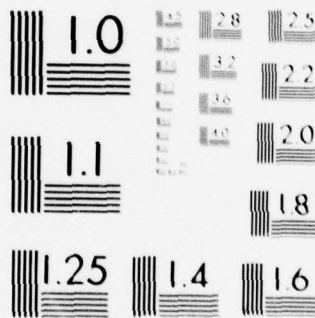
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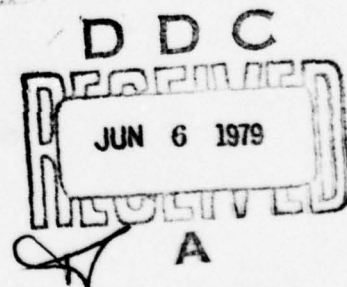
Technical Note 3-79

COMPARISON TEST BETWEEN TWO MOVING TARGET SIGHTING
PROCEDURES FOR VIPER

Dominick J. Giordano
Chauncey E. Wilson

March 1979
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COMPARISON TEST BETWEEN TWO MOVING TARGET SIGHTING
PROCEDURES FOR VIPER

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CONTENTS

INTRODUCTION	3
METHOD	3
RESULTS	34
DISCUSSION	50
CONCLUSIONS	52
RECOMMENDATION	52
REFERENCES	53

APPENDIXES

A. USAIS Wording and Layout for VIPER Sighting Instructions	54
B. Subject Briefing and Outline of Testing Procedure	56
C. Subjects' Comments - Initial and Final Questionnaire	60

FIGURES

1. "S" Sighting Procedure for Moving Targets	7
2. "T" Sighting Procedure for Moving Targets	8
3. Front Sight Overlay	9
4. "S" Procedure Practice Test	10
5. "S" Procedure Test	12
6. "T" Procedure Practice Test	16
7. "T" Procedure Test	22
8. Personal History Questionnaire	36
9. Sighting Procedure Rating Questionnaire	37
10. Sighting Procedure Comparison Questionnaire	38

TABLES

1. Subjects' Personal History Summary	4
2. Chronology of Testing	5
3. Training and Testing Times	35
4. Sight Picture Alignment Errors for S-T Sequence	40
5. Sight Picture Alignment Errors for T-S Sequence	42
6. Summary of Sight Picture Alignment Errors	44
7. Frequency of Errors By Target Orientation and Aspect Angle	44
8. Data for Sight Pictures That Could Be Classified Correctly in Either of Two Speed Categories—Subjects 001 Through 006	45
9. Data for Sight Pictures That Could Be Classified Correctly in Either of Two Speed Categories—Subjects 007 Through 012	46
10. Error Frequency for "T" Procedure Initial Sight Picture	48
11. Sighting Procedure Subjective Ratings/Initial Sight Procedure Rating Summary	49
12. Sight Comparison Questionnaire Summary	51

COMPARISON TEST BETWEEN TWO MOVING TARGET SIGHTING PROCEDURES FOR VIPER

INTRODUCTION

Background

Two different types of procedures have been proposed to engage moving targets with VIPER. The first was developed by the US Army Human Engineering Laboratory (HEL) in conjunction with the US Army Infantry School (USAIS), the VIPER contractor and the VIPER Project Manager, and is similar to the procedure developed for the M72A2 Light Antitank Weapon (2). The second was developed by the USAIS and differs markedly from the first procedure as well as from the procedures used with other free-flight antitank weapons (e.g., M72A2, US Army recoilless rifles, Swedish Miniman and Carl Gustaf and Soviet RPG-7).

The major difference between the two procedures is the first is based on estimation of crossing speed and the second is based on estimation of a one-second time interval. For that reason we will refer to the HEL procedure as the "S" (speed) procedure, and the USAIS procedure as the "T" (timing) procedure.

Purpose

The purpose of this experiment was to measure and compare the ability of soldiers to learn, remember and use two different types of procedures for engaging moving targets with VIPER.

METHOD

Subjects

The subjects were nine enlisted men and three enlisted women who were on temporary duty at Aberdeen Proving Ground as test subjects in a bulk ammunition loading study (HELFAST). All subjects were recent BCS graduates and had ammunition supply MOS's. Background characteristics of the test subjects, including available GT scores, are shown in Table 1.

Test Area and Dates

All testing was conducted at the HEL, Aberdeen Proving Ground, MD (APG), during the period 5 December through 18 December 1978. Test dates and times for each subject are shown in Table 2.

TABLE 1

Subjects' Personal History Summary

SUBJECT #	SEX	AGE	RANK	TIME IN GRADE (MONTHS)	TIME IN SERVICE (MONTHS)	PRIMARY MOS	SECONDARY MOS	PREVIOUS FIRING EXPERIENCE						APTITUDE SCORES			M72 LAW BCT TRAINING	YEAR	M72 LAW AIT TRAINING	YEAR
								M72	M16	M60	RATING	YEAR	RATING	GRENDE	YEAR	RATING	GT	GN	MM	
001	M	18	E-2	3.5	3.5	55B10	---	78	SS	78	SS	78	MM	78	EX	EX	---	---	---	---
002	F	21	E-1	6	6	55B	---	78	SS	78	SS	78	MM	78	EX	EX	108	93	70	78
003	F	24	E-2	4	4	76V10	---	---	---	---	---	---	---	---	---	---	100	90	91	---
004	M	17	E-3	3	3	55B	---	---	---	---	---	---	---	---	---	---	113	99	84	---
005	M	18	E-1	4	4	55B10	---	78	MM	78	MM	78	MM	78	SS	SS	---	---	---	78
006	M	18	E-1	4	4	76V	---	---	---	---	---	---	---	---	---	---	---	---	---	---
007	M	18	E-1	3	3	55B	---	78	MM	78	MM	78	MM	78	SS	SS	88	90	97	78
008	F	26	E-1	4	4	76V	---	---	---	---	---	---	---	---	---	---	108	90	73	78
009	M	24	E-1	3	3	55B	---	---	---	---	---	---	---	---	---	---	90	93	78	---
010	M	18	E-1	4.5	4.5	62F	---	---	---	---	---	---	---	---	---	---	118	119	115	78
011	M	23	E-1	4	4	76V	---	---	---	---	---	---	---	---	---	---	103	82	74	78
012	M	18	E-1	3	3	76V	---	---	---	---	---	---	---	---	---	---	85	87	87	---

RANK	SEX		MOS	
E-1	M	9	55B	6
E-2	F	3	62F	1
E-3		1	76V	5

Average Age = 20.35 years

Average Time in Grade = 3.8 months

TABLE 2
Chronology of Testing

Subject	Start Training and Testing		Start Retest		Time Difference In Hours
	Time	Date	Time	Date	
001	0900	5 Dec 78	1305	8 Dec 78	76.08
002	0900	5 Dec 78	0830	8 Dec 78	71.50
003	1000	5 Dec 78	1313	7 Dec 78	51.22
004	1000	5 Dec 78	0830	7 Dec 78	46.50
005	1115	5 Dec 78	1313	7 Dec 78	49.97
006	1115	5 Dec 78	1313	7 Dec 78	49.97
007	0830	12 Dec 78	1300	14 Dec 78	52.50
008	0830	12 Dec 78	1300	14 Dec 78	52.50
009	1000	12 Dec 78	1345	14 Dec 78	51.75
010	1000	12 Dec 78	1445	15 Dec 78	76.75
011	1000	12 Dec 78	1530	15 Dec 78	77.50
012	1400	15 Dec 78	1300	18 Dec 78	71.00

Equipment

Sighting Procedures

"S" and "T" sighting procedures are shown in Figures 1 and 2, respectively. Figure 2 was developed using almost the exact wording provided by the Infantry School for these procedures (the actual wording is shown in Appendix A). Sight pictures to accompany the verbal description of the "T" sighting procedure were developed and are shown in Figure 2. (Because sight pictures to accompany the verbal description of the "T" sighting procedure had not been developed, we developed the ones shown in Figure 2.)

Sight Picture Test

Practice and actual tests for both sighting procedures required that the subject align a mock-up front sight on sketches of tank targets. The front sight mock-up, shown in Figure 3, was an approximately 2:1 enlargement of the actual VIPER front sight (66mm between outside edges compared to 34mm for the actual VIPER front sight).

The sight mock-up had two holes located below the end posts. Subjects indicated their sight alignment by placing a felt-tipped pen through both holes on the sight after they had aligned the sight on the target.

The tests for the "S" procedure (Figures 4 and 5) depicted tank targets at four different aspect angles from head-on to side-on and moving either left or right or right to left. The crossing speed (horizontal component of the actual target speed) was written above each target.

The tests for the "T" procedures (Figures 6 and 7) showed the sight picture gunners would get after they aligned the center post on the front of the target and counted "one thousand one". To the right of this sight picture was the target on which the subject was to align the sight based on the previous sight picture. These sight pictures were scaled so that the angular distance between the outside sight posts represented the distance a 15 mph target would move in one second. Target size, aspect, direction and speed (as indicated by the location of the sight with respect to the target) were similar to ones used in the "S" procedure tests.

Procedure

The subjects were trained and tested in the use of both sighting procedures: "S" procedure first and "T" procedure second for subjects 001 through 006; and "T" procedure first and "S" procedure second for subjects 007 through 012. The two different test sequences are identified as S-T (S procedure followed by T procedure) for subjects 001 through 006 and T-S for subjects 007 through 012.

Subjects 001 through 006 were tested during the first test week, and subjects 007 through 012 were tested during the second test week.

One to three subjects at a time were tested on an "as available" basis (when they were not participating in the other experiment). They were given a briefing on the purpose of the experiment, a description of the VIPER weapon and an opportunity to handle and simulate firing with an inert weapon. The testing procedure was then outlined (see Appendix B for the complete subject briefing and test procedure outline).

VIPER SIGHT RULES

FIRST ESTIMATE VEHICLE CROSSING SPEED AND THE REQUIRED LEAD.
THEN AIM AT THE CENTER OF THE TARGET AS SHOWN IN THE FIGURES.

SIGHT PICTURE FOR TARGET MOVING:
LEFT TO RIGHT RIGHT TO LEFT

SPEED

LEAD

SLOW

0 TO 5 MPH (2M/S)

CENTER POST



MEDIUM

5 TO 10 MPH (2 TO 4M/S)

SPLIT THE DIFFERENCE BETWEEN
CENTER POST AND LEAD POST



FAST

10 TO 20 MPH (4 TO 8M/S)

LEAD POST



Figure 1. "S" Sighting Procedure for moving targets.

VIPER SIGHT RULES

TARGET MOVING
LEFT TO RIGHT RIGHT TO LEFT

1. Place center post on leading edge of target

2. Count one thousand one

3. Determine lead from new sight picture

TARGET MOVING
LEFT TO RIGHT RIGHT TO LEFT

a. If center post is forward of center of mass,

Then place center post center of mass

b. If center post is past center of mass,
still on target

Then move center post to leading
edge of target

c. If center post is off the target

Then move lead post to center of mass
of target

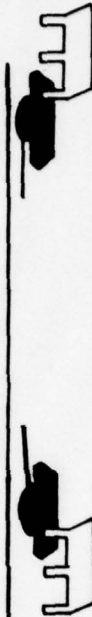
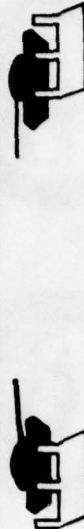
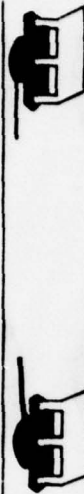


Figure 2. "T" Sighting Procedure for moving targets.

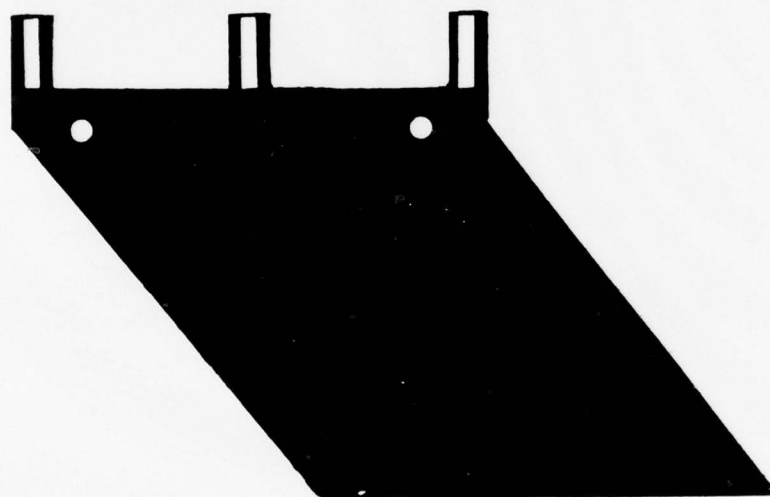


Figure 3. Front sight overlay.

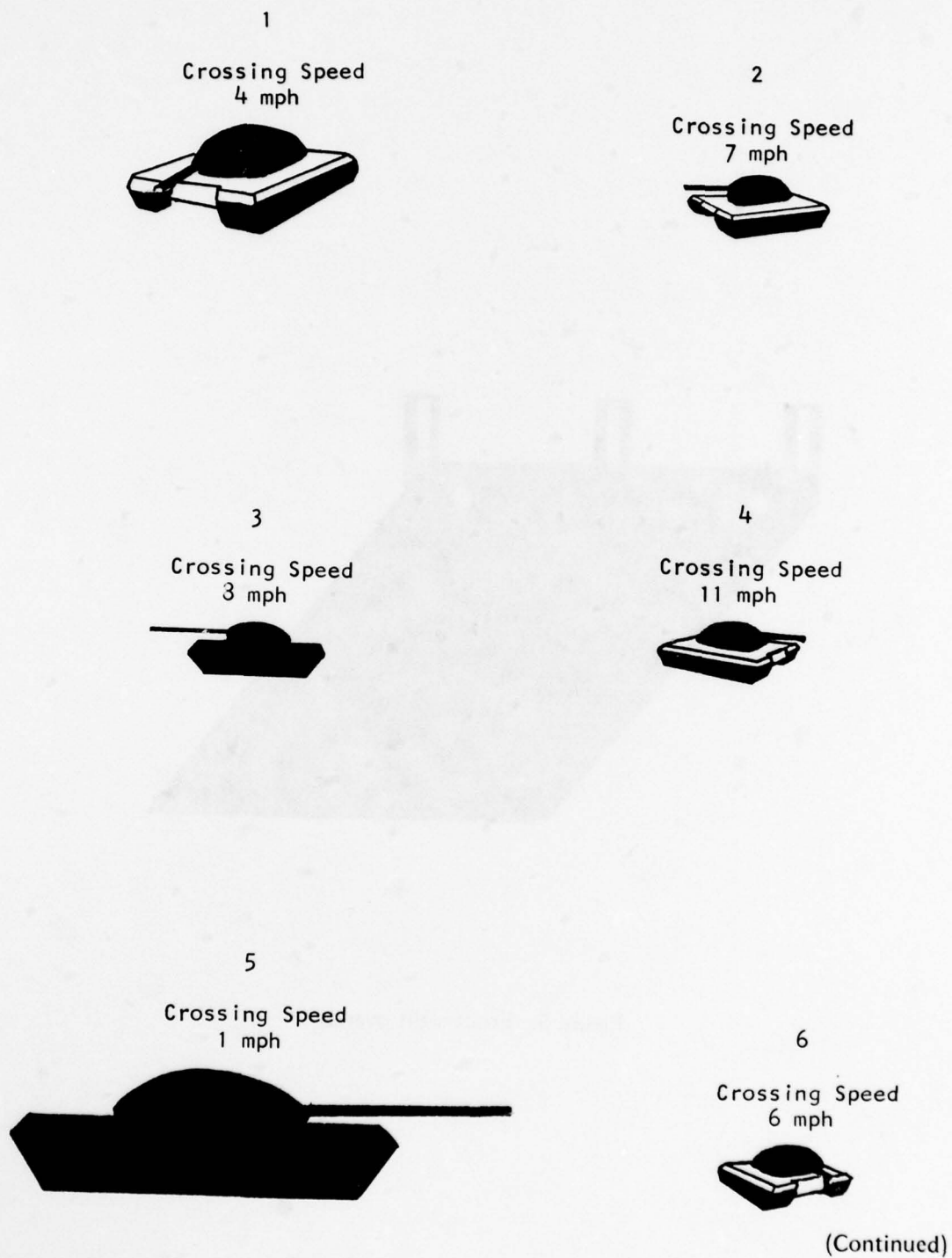


Figure 4. "S" Procedure Practice Test.

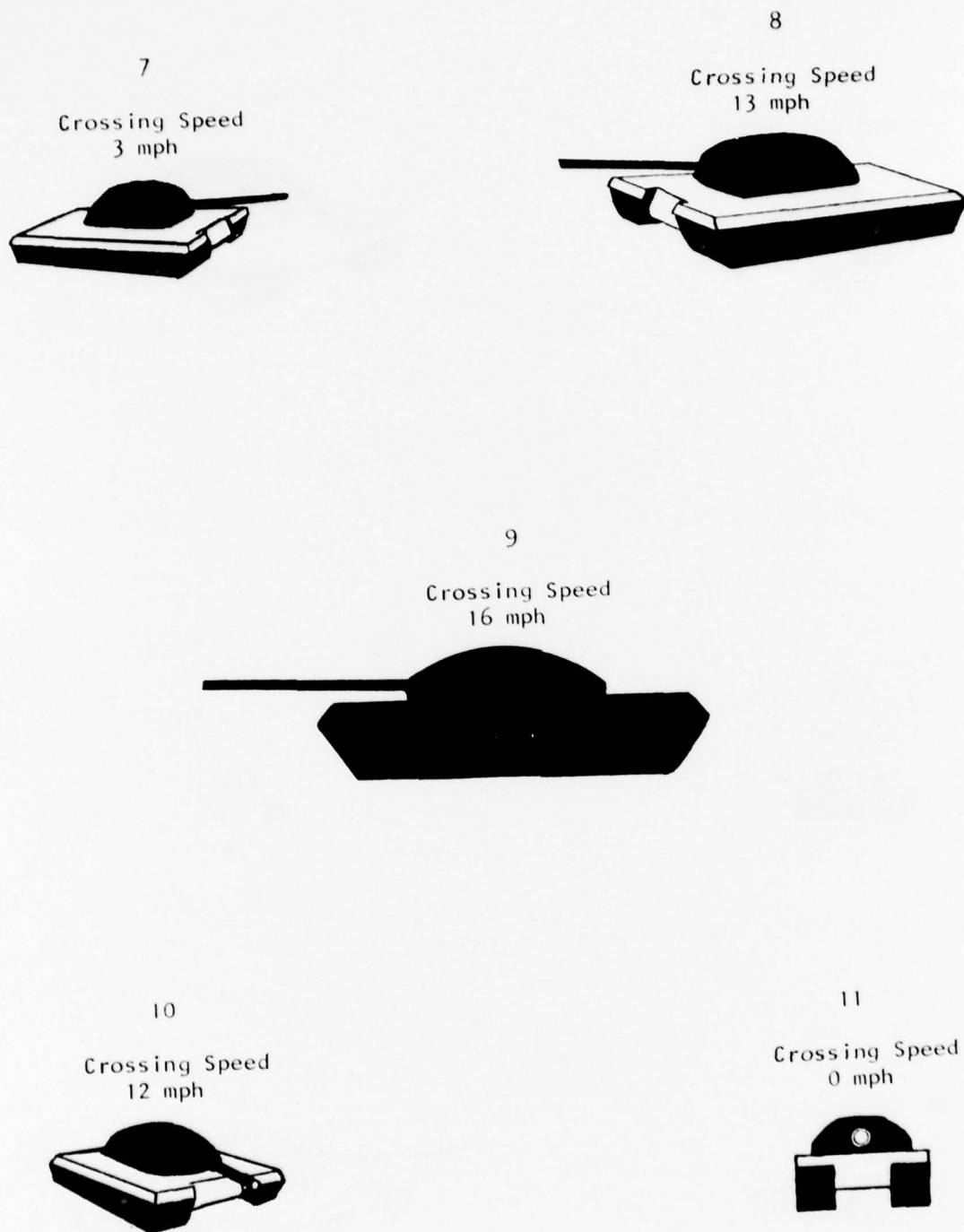


Figure 4. "S" Procedure Practice Test. (Concluded)

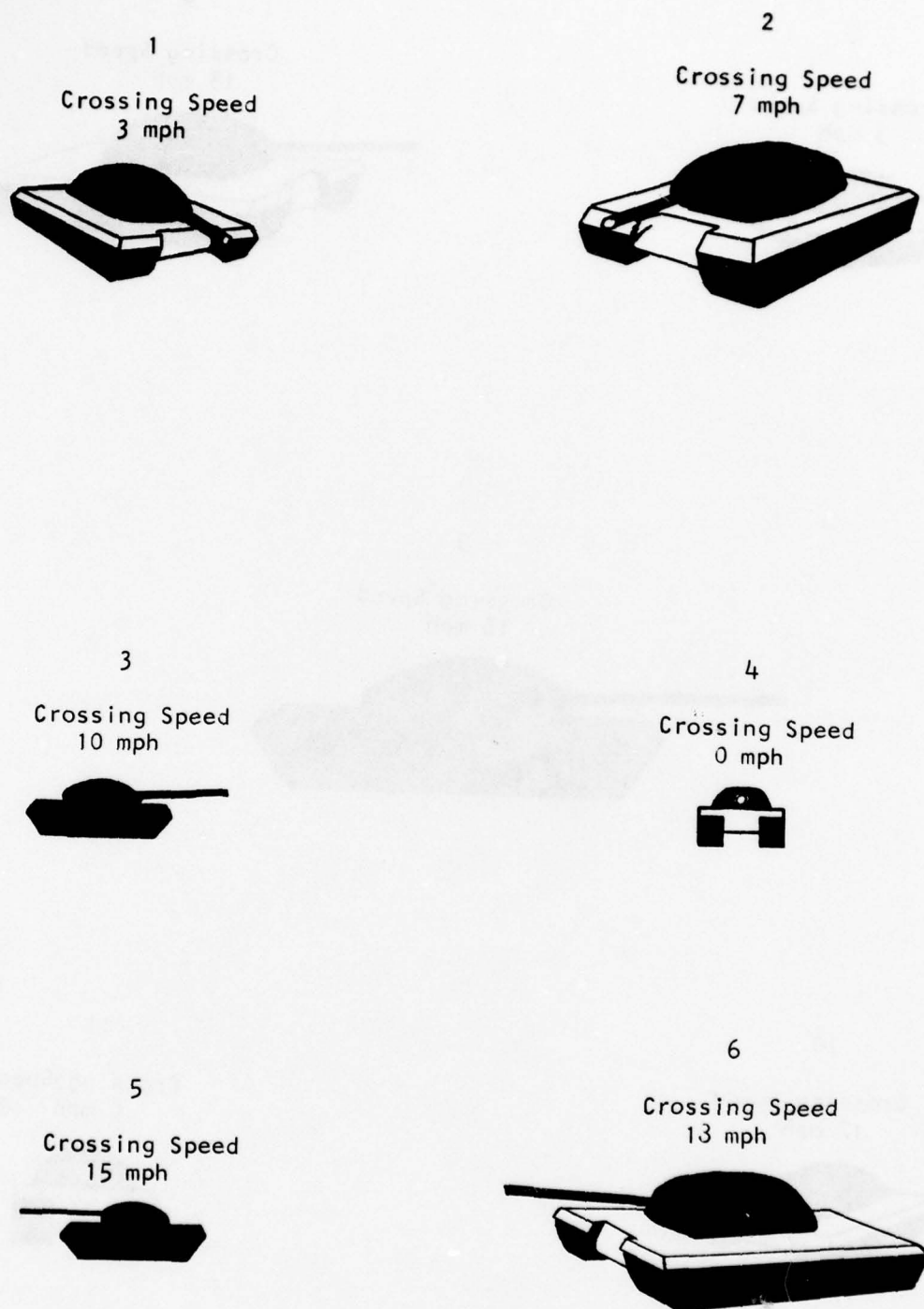


Figure 5. "S" Procedure Test.

(Continued)

7
Crossing Speed
0 mph



8
Crossing Speed
12 mph



9
Crossing Speed
5 mph



10
Crossing Speed
10 mph



11
Crossing Speed
11 mph



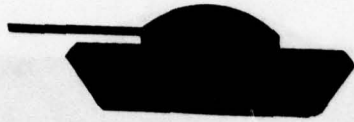
12
Crossing Speed
5 mph



Figure 5. "S" Procedure Test. (Continued)

13

Crossing Speed
5 mph



14

Crossing Speed
0 mph



15

Crossing Speed
0 mph



16

Crossing Speed
10 mph



17

Crossing Speed
20 mph



18

Crossing Speed
0 mph



Figure 5. "S" Procedure Test. (Continued)

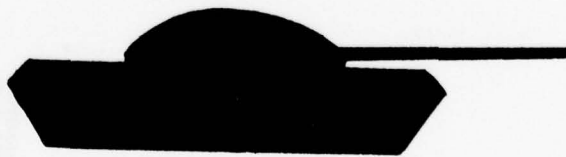
19

Crossing Speed
15 mph



20

Crossing Speed
0 mph



21

Crossing Speed
13 mph



Figure 5. "S" Procedure Test. (Concluded)

MARK THE PROPER INITIAL SIGHT POSITION BY USING THE SIGHT POST OVERLAY.

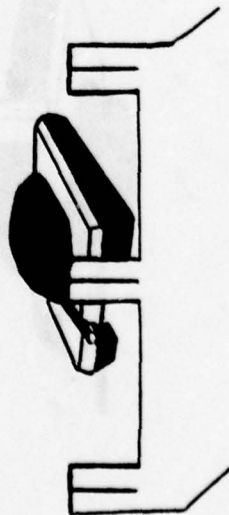


(Continued)

Figure 6. "T" Procedure Practice Test.

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

1



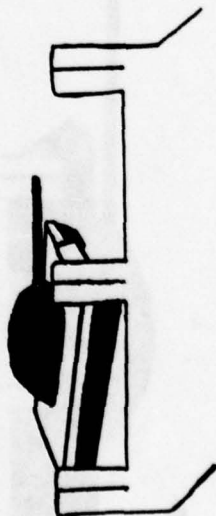
2



Figure 6. "T" Procedure Practice Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

3



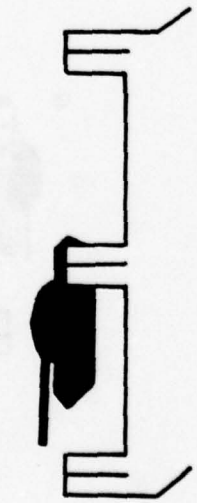
4



Figure 6. "T" Procedure Practice Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

5



6



Figure 6. "T" Procedure Practice Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

7



8

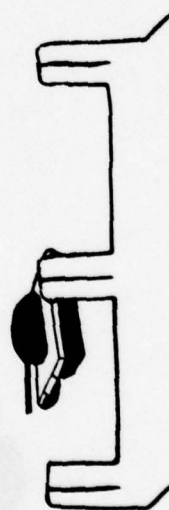


Figure 6. "T" Procedure Practice Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

9



21

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

10

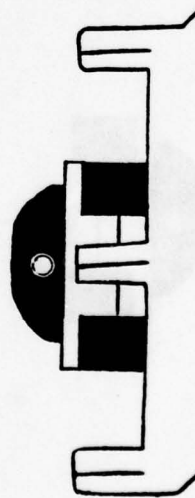
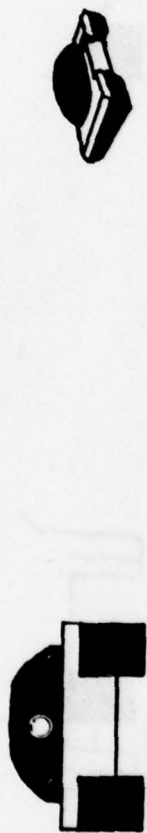


Figure 6. "T" Procedure Practice Test. (Concluded)

MARK THE PROPER INITIAL SIGHT POSITION BY USING THE SIGHT POST OVERLAY.



(Continued)

Figure 7. "T" Procedure Test.

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

1



2

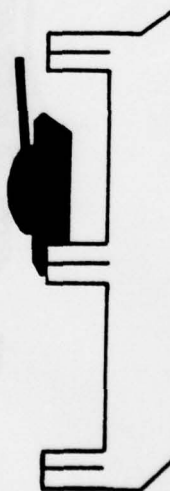


Figure 7. "T" Procedure Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

3



4

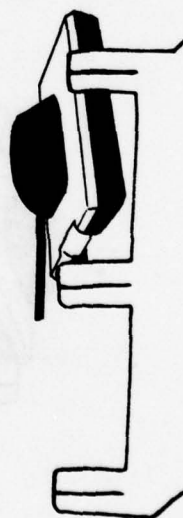


Figure 7. "T" Procedure Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

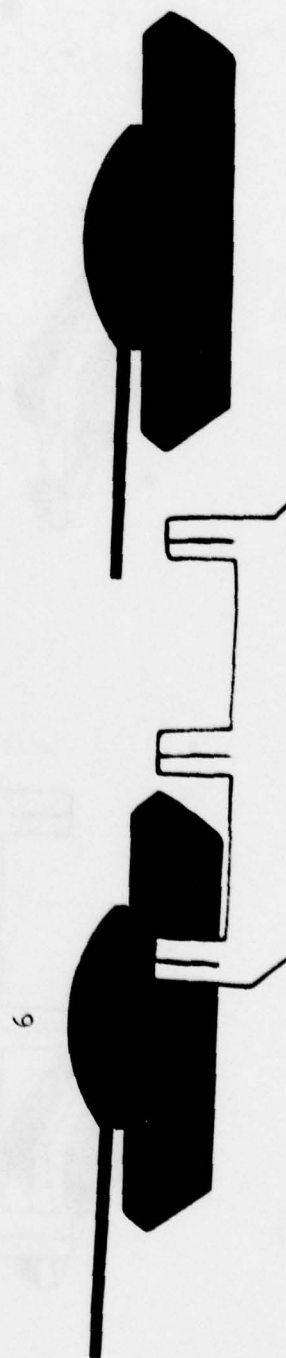


Figure 7. "T" Procedure Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

7



8



Figure 7. "T" Procedure Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

9



10



Figure 7. "T" Procedure Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

11



12



Figure 7. "T" Procedure Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

13



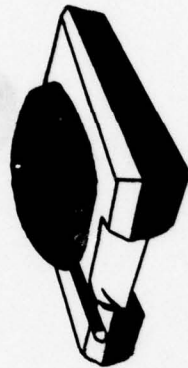
14



Figure 7. "T" Procedure Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

15



16

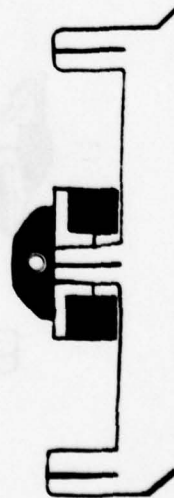


Figure 7. "T" Procedure Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

17



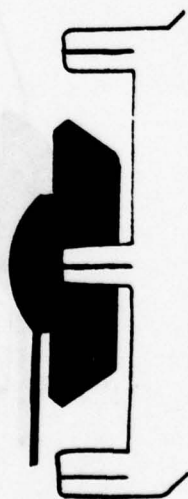
18



Figure 7. "T" Procedure Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

19



20



Figure 7. "T" Procedure Test. (Continued)

If the illustration on the left is the sight picture that you get after your initial sight picture, what lead should you apply? Indicate your answer by using the sight post overlay and the illustration on the right.

21

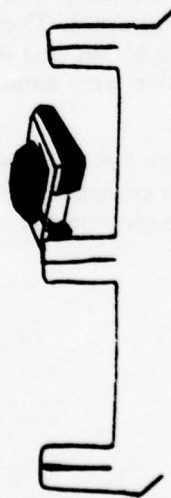


Figure 7. "T" Procedure Test. (Concluded)

Each subject was given a copy of the sighting procedure (Figure 1 or 2). The procedure was explained slowly and carefully by an instructor. Using a 3:1 enlargement of the front post and 8" x 12" color photographs of an M60 tank as a training aid, the instructor showed the subjects how to align the front sight on the target for various assumed target crossing speeds for the "S" procedure, and initial and subsequent sight pictures for the "T" procedure.

The subjects were then asked individually to describe the sighting procedure in their own words and to demonstrate with the training aid their ability to use the procedures. This training was continued until the instructor judged that they knew how to use the sighting procedure correctly. Thus, the training time varied among the test sessions (Table 3).

When this aspect of training was completed, the practice test was administered. The subjects were seated so that one subject could not view the other's work. They were told to align the sight on each target for the condition specified—indicated speed for "S" procedure and subsequent sight picture for the "T" procedure. The test for the "T" procedure had two parts. In the first part, the subject indicated the initial sight picture; and in the second part, the subject indicated the final sight picture. Sample practice tests are shown in Figure 4 for the "S" test and in Figure 6 for the "T" test.

When the practice test was finished, the instructor checked the answers with each subject by placing the front sight overlay on the target. When errors were noted, the instructor showed the subject the correct sight picture.

After a 10-15 minute break, the subjects completed a personal history questionnaire. A sample questionnaire is shown in Figure 8. Then, the initial sighting test was administered. The conduct of this test and actual test questions were similar to the practice test. A sample test is shown in Figure 5 (or Figure 7). The time to complete the test was measured. At the end of the test, the instructor checked the answers with each test subject as was done in the practice test. Next, the subjects completed the questionnaire shown in Figure 9 which asked them to rate the sighting procedure with respect to various performance measures.

Each pair of subjects was retested on the same questions 2 to 3 days later (times between the test and retest sessions are shown in Table 3). The subjects were then briefed (see Appendix B) and trained on the second set of procedures. They were given a practice test (Figure 4 or Figure 6) and a 15-minute break, followed by the test on the second sighting procedure (Figure 5 or Figure 7). Training and testing used here were similar to the training and testing used for the first sighting procedure.

When both subjects had finished the test, they were asked to complete the questionnaire shown in Figure 10 which asked them to compare the first and second sighting procedures with respect to the same performance measures given in the previous questionnaire (Figure 9).

RESULTS

Training and Testing Times

S-T Sequence

Subjects 001 through 006 were trained and tested first on the "S" procedure and then retested 2 to 3 days later. The mean time between the test and retest sessions was 58 hours. Following the retest, these subjects were trained and tested on the "T" procedure. Training, test and retest times were obtained during both sessions (see Table 3). The mean time required to

TABLE 3
Training and Testing Times
(Minutes)

Subject	S PROCEDURE			T PROCEDURE		
	Training	Test	Retest	Training	Test	Retest ^a
001	33	9	5	34	13	14
002	33	8	8	40	15	16
003	37	13	7	38	19	18
004	37	10	8	40	15	15
005	30	8	6	40	13	13
006	30	9	7	38	19	19
Mean	33	10	7	38	16	16
S.D.	3	2	1	2	3	3

Subject	S PROCEDURE			T PROCEDURE		
	Training ^a	Test ^a		Training	Test ^a	Retest ^a
007	25	11		47	15	14
008	25	15		47	13	16
009	30	13		50	17	18
010	20	7		50	16	15
011	28	20		50	16	13
012	22	15		43	18	20
Mean	25	14		48	16	16
S.D.	4	4		3	2	3
Combined	29	12		43	16	
S.D.	5	4		6	2	

^aTimes were estimated.

PERSONAL HISTORY

SUBJECT NO. _____

1. Name: _____ 2. Age: _____ 3. Rank: _____

4. Time in Grade: _____ 5. Time in Service: _____

6. Primary MOS: _____ 7. Secondary MOS: _____

8. How many months have you been in positions calling for your Primary MOS:
Total? _____

9. Previous Experience:

Have you qualified with:

<u>Weapon</u>	<u>Yes/No</u>	<u>Year</u>	<u>Rating (Expert, S. S., etc.)</u>
M72 LAW?	_____	_____	_____
M16 Rifle?	_____	_____	_____
M60 Machinegun?	_____	_____	_____
Other (name each)?			
_____	_____	_____	_____
_____	_____	_____	_____

10. Did you receive training with the M72 LAW in BCT? _____ What Year? _____
AIT? _____ What Year? _____

11. Have you ever participated in other experiments with shoulder-fired weapons
that required aiming at targets? _____ If so, give details (when,
what weapon, etc.). _____

Figure 8. Personal history questionnaire.

Sighting Procedure = _____

NAME: _____ SUBJECT NO: _____ DATE: _____

What is your impression of the sight rules with respect to the following
(circle one answer for each question):

1. Learning them?

	<u>Very</u>	<u>Somewhat</u>	<u>Neutral</u>	<u>Somewhat</u>	<u>Very</u>
Easy	1	2	3	4	5 Difficult

2. Remembering them?

	<u>Very</u>	<u>Somewhat</u>	<u>Neutral</u>	<u>Somewhat</u>	<u>Very</u>
Easy	1	2	3	4	5 Difficult

3. Using them?

	<u>Very</u>	<u>Somewhat</u>	<u>Neutral</u>	<u>Somewhat</u>	<u>Very</u>
Easy	1	2	3	4	5 Difficult

4. How quickly could you determine and then apply lead to the targets?

	<u>Very</u>	<u>Somewhat</u>	<u>Neutral</u>	<u>Somewhat</u>	<u>Very</u>
Fast	1	2	3	4	5 Slow

5. How accurately could you determine and then apply lead to the targets?

	<u>Very</u>	<u>Somewhat</u>	<u>Neutral</u>	<u>Somewhat</u>	<u>Very</u>
Accurate	1	2	3	4	5 Not Accurate

6. Do you think this procedure would give good performance with the VIPER
weapon system?

Yes

No

WHY? _____

Figure 9. Sighting Procedure Rating Questionnaire

SIGHTING PROCEDURE FINAL QUESTIONNAIRE
(#1 = _____; #2 = _____)

NAME: _____ SUBJECT NO: _____ DATE: _____

Compare the two types of sight rules with respect to the following
(check one answer for each question):

1. Learning them?

#1			#2	
<u>Much</u> <u>Easier</u>	<u>Somewhat</u> <u>Easier</u>	<u>No</u> <u>Difference</u>	<u>Somewhat</u> <u>Easier</u>	<u>Much</u> <u>Easier</u>
_____	_____	_____	_____	_____

2. Remembering them?

#1			#2	
<u>Much</u> <u>Easier</u>	<u>Somewhat</u> <u>Easier</u>	<u>No</u> <u>Difference</u>	<u>Somewhat</u> <u>Easier</u>	<u>Much</u> <u>Easier</u>
_____	_____	_____	_____	_____

3. Using them?

#1			#2	
<u>Much</u> <u>Easier</u>	<u>Somewhat</u> <u>Easier</u>	<u>No</u> <u>Difference</u>	<u>Somewhat</u> <u>Easier</u>	<u>Much</u> <u>Easier</u>
_____	_____	_____	_____	_____

4. Quickness in determining and applying lead to the targets?

#1			#2	
<u>Much</u> <u>Faster</u>	<u>Somewhat</u> <u>Faster</u>	<u>No</u> <u>Difference</u>	<u>Somewhat</u> <u>Faster</u>	<u>Much</u> <u>Faster</u>
_____	_____	_____	_____	_____

5. Accuracy in determining and applying lead to the targets?

#1			#2	
<u>Much More</u> <u>Accurate</u>	<u>More</u> <u>Accurate</u>	<u>No</u> <u>Difference</u>	<u>Much More</u> <u>Accurate</u>	<u>More</u> <u>Accurate</u>
_____	_____	_____	_____	_____

6. Which procedure would give better performance with the VIPER Weapon System?

#1	#2
Why? _____	

Figure 10. Sighting procedure comparison questionnaire.

teach the subjects to use the "T" procedure was 38 minutes, significantly longer ($p < .005$, $t = 3.28$) than the time required to train the subject to use the "S" procedure, 33 minutes. Time required to complete the "T" procedure initial test was significantly greater ($p < .005$, $t = 4.78$) than the time required to complete the "S" initial test—15.7 minutes versus 9.5 minutes.

T-S Sequence

Subjects 007 through 012 were first trained, tested and retested on the "T" procedure and subsequently trained and tested on the "S" procedure. Subject availability in the T-S test sequence was constrained because of the bulk ammunition study requirements mentioned earlier. As a result, "T" test, retest and "S" training and test times had to be estimated (Table 3). The mean time between the test and retest session was 64 hours. As we found in the S-T sequence, "T" procedure training took significantly longer ($t = 12.69$, $p < .001$) than the "S" procedure training—48 minutes versus 25 minutes.

Sight Alignment Errors

Fewer errors were made in the test on the "S" procedure than in the test on the "T" procedure (Tables 4 through 6). Subjects trained first in the "T" procedure and then in the "S" procedure had almost four times more errors in the "T" procedure initial test than in the "S" procedure initial test (29 versus 8). Those trained first in the "S" procedure had more than five times the number of errors in the "T" procedure initial test than in the "S" procedure initial test (45 versus 8). When retested (different subjects for each procedure), subjects who used the "T" procedure made almost twice as many errors as subjects who used the "S" procedure (35 versus 19). All these differences are significant by the χ^2 test at $p < .05$.

Subject 11 had many more errors than all of the others—13 out of 21 questions. If we assume this subject's performance was atypical and delete errors for the worst subject in each retest (subjects 5 and 11), the total of errors for the two retests are 22 and 13, respectively, for "T" versus "S", still close to two-to-one.

All of the subjects performed better in the initial test than in the practice test. Although the number of errors found on the initial test is larger in some cases than the number of errors on the practice test, the average number of errors is smaller. Performance degraded between the initial test and the retest. For the "S" procedure, the number of errors increased from 8 to 19 and for the "T" procedure from 29 to 35 (Table 6).

Both groups of subjects made a total of eight errors when tested (initially) on the "S" procedure. For the "T" procedure, the first group of subjects (S-T sequence) had more errors, both in the practice test and the initial test, than subjects in the second group (T-S sequence).

Error frequencies for different target orientations (left to right versus right to left) and aspect angles (0° , 30° , 60° , 90°) are listed in Table 7. There appears to be no consistent pattern of errors for either target orientation or aspect angle.

Targets That Could Be Classified Correctly in Either of Two Speed Categories

Six of the 21 targets in both the "S" and "T" tests could be classified correctly as either of two speeds: three could be either slow or medium and three could be either medium or fast. The subjects' responses on this part of the test are shown in Tables 8 and 9 for the first and second groups of subjects, respectively. Results for initial test and retest combined are shown in Part D of the tables.

TABLE 4

Sight Picture Alignment Errors for S-T Sequence
(Subjects 001 Through 006)

A. "S" Procedure Practice Test												
Sight Picture #	1	2	3	4	5	6	7	8	9	10	11	TOTAL
Target Speed	S	M	M	F	S	M	S	F	F	F	S	
Subject #												
001									C	C		2
002						C		M	C			2
003				M		(M)		(M)		(E)		4
004				(M)		(M)				S		3
005	M			M	C		C		C	M		7
006	C	F	F			C	C	M				6
												24
B. "S" Procedure Initial Test												
Sight Picture #	1	2	3	4	5	6	7	8	9	10	11	TOTAL
Target Speed	S	M	M-F	S	F	F	S	F	S-M	M-F	F	
Subject #												
001											M	2
002												1
003												1
004											M	2
005												0
006								F				2
												8
C. "S" Procedure Retest												
Sight Picture #	1	2	3	4	5	6	7	8	9	10	11	TOTAL
Target Speed	S	M	M-F	S	F	F	S	F	S-M	M-F	F	
Subject #												
001						M				S	S	6
002												0
003												1
004					M				F		M	6
005									F			3
006								S				3
												19

(Continued)

TABLE 4 (Continued)

[illegible]

NOTE:

Error Code:

"S". "W" or "F" = Sight was aligned on target for the indicated speed.

⑤ Sight was aligned on target as if it were moving in direction opposite to the one indicated.

C = Sight was off center of target a distance greater than the width of the front post.

(Concluded)

TABLE 5
Sight Picture Alignment Errors for T-S Sequence
(Subjects 007 Through 012)

A. "T" Procedure Practice Test														
Sight Picture #		1	2	3	4	5	6	7	8	9	10	11		
Target Speed		S	S	S	F	M	F	S	M	-	M	S		
Subject #														
007														
008		M	(M)	(M)						-	S			
009		M	M	C			M			-	(M)			
010		M	M	M	C	F	C	M	F					
011		M	M	M	C	C	S		(M)			M		
012		M	M	M	C	C				-				
TOTAL		1 3 4 7 8 3 26												

B. "T" Procedure Initial Test																								
Sight Picture #		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
Target Speed		S	M-F	F	S	F	F	M-F	S	F	M-F	S	S-M	S-M	F	M	S	F	F	S-M	S	S		
Subject #																								
007																								
008		M		M											M		S							
009			S					S		S					S		M					M		
010				M					F						S									
011		C	C			M								S		S	S	S						
012					M	S			F							S	M							
TOTAL		4 3 8 2 7 5 29																						

C. "T" Procedure Retest																								
Sight Picture #		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
Target Speed		S	M-F	F	S	F	F	M-F	S	F	M-F	S	S-M	S-M	F	M	S	F	F	S-M	S	S		
Subject #																								
007																								
008			M	C	M										M			M						
009								S			C				C		S				M			
010															S									
011		F		M	M	C	C	C	C	S	C			F	M							M		
012					C	S		S							M	S								
TOTAL		4 7 5 1 13 5 29																						

(Continued)

TABLE 5 (Continued)

Sight Picture Alignment Errors for T-S Sequence
(Subjects 007 Through 012)

D. "S" Procedure Practice Test														TOTAL										
Sight Picture #		1		2		3		4		5		6			7		8		9		10		11	
Target Speed		S		M		M		F		S		S			M		S		F		F		S	
Subject #																								
007																								0
008																								0
009																								0
010																								1
011																								0
012																								4
																								2
																								7

NOTE:

Error Code:

"S", "M" or "F" = Sight was aligned on target for the indicated speed.

⑤ ④ or ③ = Sight was aligned on target as if it were moving in direction opposite to the one indicated.

C = Sight was off center of target a distance greater than the width of the front post.

(Concluded)

TABLE 6

Summary of Sight Picture Alignment Errors

ERROR FREQUENCY				
	<u>"S" Test</u>		<u>"T" Test</u>	
	<u>S-T Sequence</u>	<u>T-S Sequence</u>	<u>T-S Sequence</u>	<u>S-T Sequence</u>
Practice	24	7	26	37
Initial Test	8	8	29	45
Retest	19	N/A	35	N/A

TABLE 7

Frequency of Errors By Target Orientation and Aspect Angle

<u>SUBJECTS 001 - 006</u>							
	<u>TARGET ORIENTATION</u>		<u>ASPECT ANGLE</u>				
	<u>LEFT TO RIGHT</u>	<u>RIGHT TO LEFT</u>	<u>0°</u>	<u>30°</u>	<u>60°</u>	<u>90°</u>	
Initial "S" Test	4	4	0	1	7	0	
Retest	6	13	1	4	10	4	
Initial "T" Test	21	24	0	11	16	18	

<u>SUBJECTS 007 - 012</u>							
	<u>TARGET ORIENTATION</u>		<u>ASPECT ANGLE</u>				
	<u>LEFT TO RIGHT</u>	<u>RIGHT TO LEFT</u>	<u>0°</u>	<u>30°</u>	<u>60°</u>	<u>90°</u>	
Initial "T" Test	17	12	0	9	11	9	
Retest	19	15	1	10	14	10	
Initial "S" Test	3	5	0	1	4	3	

TABLE 8

Data for Sight Pictures That Could Be Classified Correctly in Either of
Two Speed Categories—Subjects 001 Through 006

A. "S" Initial Test

SPEED	SIGHT PICTURE NUMBER					
	3 M-F	9 S-M	10 M-F	12 S-M	13 S-M	16 M-F
<u>SUBJECT</u>						
001	M	S	M	S	S	M
002	F	S	F	S	S	F
003	F	S	F	S	S	F
004	M	S	M	S	S	M
005	M	S	F	S	M	M
006	F	(F)	F	S	S	F

B. "S" Retest

SPEED	SIGHT PICTURE NUMBER					
	3 M-F	9 S-M	10 M-F	12 S-M	13 S-M	16 M-F
<u>SUBJECT</u>						
001	M	S	(S)	S	S	(S)
002	F	S	F	S	S	F
003	F	S	F	M	S	F
004	M	(F)	M	S	S	(C)
005	F	(F)	F	M	(F)	F
006	F	M	M	S	S	F

C. "T" Initial Test

SPEED	SIGHT PICTURE NUMBER					
	2 M-F	7 M-F	10 M-F	12 S-M	13 S-M	19 S-M
<u>SUBJECT</u>						
001	M	M	M	S	S	S
002	M	M	M	M	M	(F)
003	M	(S)	M	S	M	M
004	(S)	(S)	(S)	M	M	(C)
005	M	(S)	M	(C)	M	(F)
006	M	F	M	M	M	M

D. "S" Test Summary (Initial and Retest)

S-M Sight Pictures: S = 28

M = 4

Errors = 4

M-F Sight Pictures: M = 12

F = 21

Errors = 3

NOTE: S = Slow; M = Medium; F = Fast; C = Sight was off center of target a distance greater than the width of the front post.
Circled letters indicate sight picture alignment error.

TABLE 9

Data for Sight Pictures That Could Be Classified Correctly in Either of
Two Speed Categories—Subjects 007 Through 012

A. "T" Initial Test

SPEED	SIGHT PICTURE NUMBER					
	2	7	10	12	13	19
SUBJECT	M-F	M-F	M-F	S-M	S-M	S-M
007	M	M	M	S	S	M
008	F	F	F	M	M	M
009	(S)	(S)	(S)	S	M	S
010	F	M	M	S	S	S
011	(C)	M	M	S	S	S
012	M	M	M	S	S	S

B. "T" Retest

SPEED	SIGHT PICTURE NUMBER					
	2	7	10	12	13	19
SUBJECT	M-F	M-F	M-F	S-M	S-M	S-M
007	M	M	M	S	S	S
008	(C)	M	F	S	S	S
009	M	(S)	(S)	S	(C)	S
010	M	M	M	S	M	S
011	F	(C)	(C)	S	(F)	S
012	M	(S)	M	S	(S)	S

C. "S" Initial Test

SPEED	SIGHT PICTURE NUMBER					
	3	9	10	12	13	16
SUBJECT	M-F	S-M	M-F	S-M	S-M	M-F
007	M	S	M	S	S	F
008	F	M	F	M	M	M
009	(M)	S	M	S	S	M
010	F	S	M	M	S	F
011	M	S	(C)	S	S	(C)
012	F	S	F	S	S	F

D. "T" Test Summary (Initial and Retest)

S-M Sight Pictures: S = 27

M = 6

Errors = 3

M-F Sight Pictures: M = 20

F = 6

Errors = 10

NOTE: S = Slow; M = Medium; F = Fast; C = Sight was off center of target a distance greater than the width of the front post.
Circled letters indicate sight picture alignment error.

For targets that could be classified as either slow or medium, about 85 percent (ignoring errors) were classified as slow in both "S" and "T" tests; 95 percent binomial confidence limits are .76 to .99 for "S" procedure and .69 to .95 for the "T" procedure.

For targets that could be correctly classified as medium or fast, more than half were classified as fast for the "S" sighting procedure (95 percent binomial confidence limits are .47 to .80) and less than half were classified as fast (95 percent binomial confidence limits are .07 to .39) for the "T" procedure. The subjects' responses on this portion of both tests differ significantly ($\chi^2 = 7.9$, $p < .005$).

Initial Sight Picture Sub-Test ("T" Procedure)

In the first part of the "T" procedure test, the gunner had to align the sight on the target to obtain the correct initial sight picture. There were three sight pictures on the practice test and five sight pictures on the actual test. One of the sight pictures in each test showed a head-on tank. The correct initial sight picture for this target was the center post on the middle of the target; for the others, it was center post on the front edge of the target. (The "S" procedure test, unlike the "T" procedure test, did not require an initial sight picture determination.

The error frequency for the initial sight pictures is listed in Table 10. No errors were made in aligning the sight on the head-on target. For targets at other aspect angles, five subjects made no errors, while half of the subjects had one or more errors on each test. Most of the errors were in aligning the center post on the middle of the target instead of the front edge.

Subjects' Ratings and Comparison of Sighting Procedures

Immediately after the initial test on the first sighting procedure, the subjects rated the procedure with respect to various performance measures (Figure 9). Five-point rating scales were used with lower numbers representing better performance. Subjects 001 through 006 evaluated the "S" procedure and subjects 007 through 012 evaluated the "T" procedure. The results are summarized in Table 11.

Subjects who evaluated the "S" procedures (Table 11a), in general, found them either "very" or "somewhat" easy to learn and remember, easy and quick to use, and accurate, with an average rating of 1.8 across all subjects and performance measures. All but one subject believed the "S" procedure would give good performance with VIPER as indicated by a "yes" answer to question 6. The one subject who answered "no" surprisingly enough rated the "S" procedure "very" good with respect to four out of the five questions. This leads us to believe the subject either misunderstood the question or circled the wrong answer.

The average rating for the "T" procedure was 2.4, somewhat worse than the "S" procedure. However, all of the subjects believed the "T" procedure would yield good performance with VIPER.

It must be emphasized that the subjects were not given any baseline in the first questionnaire from which to measure and rate performance with either of the sighting procedures. The questionnaire was oriented towards obtaining the subjects' initial reactions to the procedures (also the training and testing) and stimulating their thoughts about performance measures prior to receiving and filling out the sight comparison questionnaire.

TABLE 10

Error Frequency for "T" Procedure Initial Sight Picture

A. Sequence S-T

<u>Subject</u>	<u>Practice</u>	<u>Test</u>
001	0	0
002	2	1
003	0	0
004	0	0
005	1	3
006	<u>0</u>	<u>0</u>
TOTAL	3	5

B. Sequence T-S

<u>Subject</u>	<u>Practice</u>	<u>Test</u>
007	0	0
008	0	1
009	2	3
010	0	0
011	2	4
012	<u>2</u>	<u>1</u>
TOTAL	6	9

TABLE 11

Sighting Procedure Subjective Ratings/Initial Sight Procedure Rating
Summary

A. "S" Procedures

QUESTION #	SUBJECT #					
	<u>001</u>	<u>002</u>	<u>003</u>	<u>004</u>	<u>005</u>	<u>006</u>
1	2	1	1	1	3	1
2	1	1	1	1	1	1
3	2	1	2	1	1	1
4	3	1	2	3	1	2
5	3	2	2	1	1	2
TOTAL	11	6	8	7	7	7
6 ^a	Y	Y	Y	N	Y	Y

B. "T" Procedures

QUESTION #	SUBJECT #					
	<u>007</u>	<u>008</u>	<u>009</u>	<u>010</u>	<u>011</u>	<u>012</u>
1	1	2	2	3	3	2
2	1	2	2	1	4	1
3	1	3	2	3	5	1
4	1	2	1	3	3	1
5	1	2	2	3	1	1
TOTAL	5	11	9	13	16	6
6 ^a	Y	Y	Y	Y	Y	Y

^aFor question 6, Y = Yes; N = No.

Immediately after testing, the subjects compared the two sighting procedures (Figure 10) with respect to the same performance measures used in the first questionnaire. For subjects 001 through 006, sighting procedure number 1 was the "S" procedure and sighting procedure number 2 was the "T" procedure; for subjects 007 through 012, the numbering was reversed.

Results of the comparison questionnaire are given in Table 12. In order to combine data for all subjects, data from subjects 007 through 012 were converted from "T" versus "S" to "S" versus "T" as described in the note in Table 12. Therefore, for all of the data in that table, a "1" would indicate "S" is better than "T" and a "5" would indicate "T" is better than "S".

The "S" procedure was rated much better than the "T" procedure by most of the subjects and for most of the performance measures. Only one of the twelve subjects preferred the "T" procedure over the "S" procedure (question 6). The average rating over all questions (1 through 5) and subjects was 1.5; i.e., the "S" procedure was between "somewhat" better and "much" better than the "T" procedure. Subjects' comments about the two types of sighting procedures (see Appendix C) generally indicate that the "S" procedure was easier to use than the "T" procedure.

DISCUSSION

While the experimental procedures and the results are straight forward, they could be challenged from three aspects. First, the experiment was conducted by the agency that developed and advocates the sighting procedure that yielded the better results. On the other hand, we believed that the design and conduct of the experiment was unbiased. Although the USAIS and VIPER PMO were invited to observe or participate in the experiment, they did not do so. Second, the subjects were not infantry soldiers. However, the subjects were recent BCS graduates and in the future, all soldiers will be trained in BCS to use the VIPER. From previous testing experience, we believe the subjects' performances were similar to that which one would expect from infantry soldiers. Third, in the experiment we did not measure the soldiers' ability to estimate either target speed ("S" procedure) or maintain weapon alignment while counting "one-thousand one" and viewing the new relationship between target and sight ("T" procedure). There are data, however, which indicate that the magnitudes of errors associated with estimating speed and time intervals are similar (4, 5).

Although there were about 2 days between testing and retesting on each sighting procedure, the subjects' performances were degraded. It is believed that for longer time periods between training and use of either procedure, a greater performance decrement would be measured. This finding reinforces the HEL recommendation (5) that the VIPER weapon have a decal which illustrates the sighting procedure so that soldiers can refresh themselves quickly on how to use the weapon.

A decal was developed for the "S" procedure (4) and is similar to the sight pictures shown in Figure 1. Although the USAIS has stated that a sight picture decal is required on VIPER (8), a decal illustrating the "T" procedure has not been developed to date and we cannot envision one that would provide a clear description of the "T" procedure, be legible, and still fit on the weapon.

TABLE 12

Sight Comparison Questionnaire Summary

QUESTION #	SUBJECT #												TOTAL	MEAN
	001	002	003	004	005	006	007	008	009	010	011	012		
1	1	1	1	1	1	1	3	1	1	2	2	1	16	1.3
2	3	1	1	1	1	1	3	1	1	1	2	3	19	1.6
3	1	1	1	1	1	1	3	1	1	1	1	1	14	1.2
4	1	1	1	1	3	1	3	1	1	3	2	3	21	1.8
5	1	1	1	2	1	2	5	1	1	3	2	1	21	1.8
TOTAL	7	5	5	6	7	6	17	5	5	10	9	9	91	1.5
6	S	S	S	S	S	S	T	S	S	S	S	S	11S;	1T

NOTE: Subjects 001 through 006 were trained first with "S" procedures and then with "T" procedures. The opposite was done with subjects 007 through 012. Data from subjects 007 through 012 were converted from "T" versus "S" to "S" versus "T" by reversing ratings, e.g., 1 = 5 and 5 = 1.

Rating Code				
1	2	3	4	5
"S" Procedure	much easier	somewhat easier	no difference	somewhat easier
				much easier
				"T" procedure

Some of the targets could be classified at either of two speeds: slow or medium and medium or fast. It was assumed that for the "S" procedure, subjects would tend to classify fewer targets as medium compared to either slow or fast, since it is easier to align a sight post on a target than align an imaginary point half way between two posts on a target. This idea was proven in the results. For the "T" procedure, we assumed the subjects would classify half of the targets in either speed category. However, when given a choice between two speed categories, the subjects tended to choose the slower of the two and had a proportionally larger "slow" bias for medium/fast targets for the "T" procedure than the "S" procedure.

CONCLUSIONS

The test subjects could learn, use, and remember the "S" procedure better than the "T" procedure and also had an overwhelming preference for the "S" procedure.

RECOMMENDATION

The procedure for engaging moving targets developed by HEL ("S" procedure) should be adopted for use with VIPER.

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7. US Army Missile Readiness and Development Command. VIPER Program Manager, letter, DRCPM-VIE, subject: VIPER Sight Data, 26 October 1978.
8. US Army Infantry Center, letter, ATSH-I-V-A-S, subject: Engaging Moving Targets with VIPER, Ft. Benning, MA, 2 November 1978.

APPENDIX A

USAIS WORDING AND LAYOUT FOR VIPER SIGHTING INSTRUCTIONS

VIPER SIGHT RULES

(MOVING TARGETS - 250 METERS OR LESS)

- RANGE ESTIMATION
- WITHIN 200 METERS - NO SIGHT ADJUSTMENT
- OVER 200 METERS - SET REAR SIGHT
- PLACE CENTER POST ON LEADING EDGE OF TARGET
- COUNT - ONE THOUSAND ONE
- IF CENTER POST IS FORWARD OF CENTER OF MASS
- IF CENTER POST IS PAST CENTER OF MASS, STILL ON TARGET
- IF CENTER POST IS OFF THE TARGET
- PLACE CENTER POST CENTER OF MASS
- MOVE CENTER POST TO LEADING EDGE OF TARGET
- MOVE LEAD POST TO CENTER OF MASS OF TARGET
- FIRE
- FIRE

APPENDIX B

SUBJECT BRIEFING AND OUTLINE OF TESTING PROCEDURE

Initial Subject Briefing

"We are from another team at HEL, the Infantry Team, and with your cooperation will be conducting a small test today and later in the week. The purpose of this test will be to get your impression of a set of rules for firing at targets with a light antitank weapon that is being developed by the Army. We want to know how easy the rules are to learn, whether you can use them without any problems and whether you can remember them.

"We will start by showing you a mock-up of the weapon and giving a brief explanation of what it does. Then we will train you how to use the sight against moving and stationary targets. Following that we will test your ability to use the sight, and at the end of testing go over your answers with you to correct any errors. Then we will give you some additional training. We will do all of that today in the next couple of hours. Later this week, we will come back and give you another test to see how well you remember what you learned today."

Training and Test Procedure Sequence

1. Show and describe VIPER.
2. Hand out copy of sight procedures and give explanation.
3. Train subjects with sight overlay and target pictures - give individual attention.
4. Have subjects explain in their own words the rules for firing at targets.
5. Give subjects 15-minute break.
6. Subjects fill out background questionnaire.
7. Administer test—measure overall time to complete test.
8. Review answers with individual subjects and show and explain correct sight picture.
9. Thank subjects and remind them that they would be retested in a few days.

"S" PROCEDURE INSTRUCTIONS

Place the front sight overlay on each target so that you have the correct sight picture for the indicated target crossing speed and direction. . . in other words apply the required lead (if any) to hit the target.

"T" PROCEDURE INITIAL SIGHT PICTURE INSTRUCTIONS

Place the front sight overlay on each target so that you have the correct initial sight picture—that is the sight picture you use to determine the correct lead you must apply in order to hit the target.

"T" PROCEDURE FINAL SIGHT PICTURE INSTRUCTIONS

Pretend you obtained the correct initial sight picture, counted "one thousand one" and the target has moved to the position indicated in the sight pictures on the left. Based on the left hand sight picture what lead should be applied? Indicate the correct lead on the right hand sight pictures using your front sight overlay.

RETEST BRIEFING AND OUTLINE OF PROCEDURE FOR THE SECOND TRAINING AND TESTING SESSION

Retest Briefing

"Welcome back. As we said earlier, we will be retesting you on the firing procedures today. When we are done with the test, we will go on to some additional training, but let's get started on this test first.

"There is another set of rules for firing at targets that is different from the one learned earlier and were tested on. What we would like to do now is train you to use the other set of rules, test you as we did before and then ask you to compare the two sets of rules. Then we are finished."

Training and Retest Procedure Sequence

1. Hand out copy of sighting rules and give explanation.
2. Train subjects with sight overlay and target pictures - give individual attention.
3. Have subjects explain in their own words the rules for firing at targets.
4. Give subjects 15-minute break.
5. Administer test—measure overall time to complete test.
6. Review answers with individual subjects and show and explain correct sight picture.
7. Administer questionnaire comparing two sets of rules.
8. "That's all there is. Thank you for your cooperation."

APPENDIX C

SUBJECTS' COMMENTS - INITIAL AND FINAL

QUESTIONNAIRE

SUBJECTS' COMMENTS - INITIAL AND FINAL QUESTIONS

<u>SUBJECT #</u>	<u>QUESTIONNAIRE</u>	<u>ANSWER TO QUESTION #6</u>	<u>COMMENTS</u>
001	Initial	Yes	Because if you are a good shooter, you could hit a target every time.
	Final	"S"	Because "S" you would just aim and fire, but on "T" you have to aim two times.
002	Initial	Yes	It's easily learned.
	Final	"S"	"S" was easier understood; can be more easily and faster; takes less time.
003	Initial	Yes	The procedures were limited to three steps. Diagram pictures were helpful.
	Final	"S"	"T" in my opinion was complicated and too detailed to remember.
004	Initial	No	It helps you get a better shot on your target. Let's you be in control of the target.
	Final	"S"	On "S" it is easier to explain than "T". It is easy to remember.
005	Initial	Yes	Because on the sight and the mileage, the vehicle is going fast, slow or medium. I think that it's a better system.
	Final	"S"	It is much easier to learn the sights and speed.
006	Initial	Yes	Because each time you move the sight, it becomes centered again, and it would be a direct hit on the target, depending on the speed.
	Final	"S"	I think it's much easier to get a perfect sight picture on the target and a lot easier to hit the target.
007	Initial	Yes	Especially to the infantry soldier; he is one of the most important soldiers in the combat zone.
	Final	"T"	Cause the center post placement on the first one which makes easier for the person that is operating the weapon.

(Continued)

SUBJECTS' COMMENTS - INITIAL AND FINAL QUESTIONS (Continued)

<u>SUBJECT #</u>	<u>QUESTIONNAIRE</u>	<u>ANSWER TO QUESTION #6</u>	<u>COMMENTS</u>
008	Initial	Yes	Because the instructions are not hard to understand, and there are not too many instructions to remember.
	Final	"S"	Because it is easier to zero in on the target and less complicated instructions to remember.
009	Initial	Yes	Because the steps are very easy to learn. It would help people to understand the VIPER weapon system.
	Final	"S"	Because you have more time to line your target and it gives you the time to judge your target.
010	Initial	Yes	It is a good short range weapon. It would be useful in close quarters, like Vietnam, but not as useful in a desert (Middle East) situation because the tanks would spot you first. Should be put into circulation.
	Final	"S"	"S" was easier because you don't have to re-sight. You can estimate speeds and fire quicker.
011	Initial	Yes	Because to me, the VIPER weapon is needed soon or later depending on the future, the changing of the world. "Never can tell".
	Final	"S"	Because seem like to me, better understanding.
012	Initial	Yes	
	Final	"S"	More quicker and accurate to operate by determining the speed of vehicles.

NOTE: Sighting procedures were designated as No. 1 and No. 2 in the final questionnaire. The numbers have been changed to the equivalent sighting procedure, "S" or "T".

(Concluded)