MARINE SEARCH AND ATTACK BATTALION, PHASE I (1977-1982) STUDY

MARSAS WAR GAMES. VOLUME III.

INDIVIDUAL GAME ANALYSIS AND SUPPORTING ANNEXES

MARINE CORPS DEVELOPMENT AND EDUCATION COMMAND

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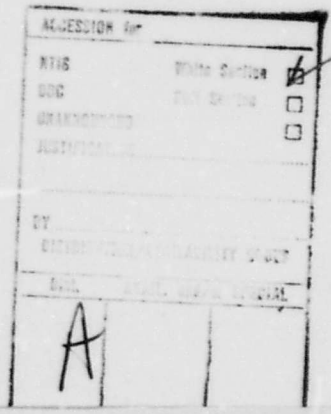

ANNEX E

ANALYSIS AND FINDINGS

War Game MARCAS I (MAU in the night defense)

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I. FINDINGS

Objective 1. To evaluate the relative capability of the two candidate forces to perform the functions of combat surveillance, target acquisition, target location, and target designation.

Findings.

1. Air surveillance provides a major contribution to the detection capability of Models I and III. However it is much more valuable for Model I, accounting for 2/3 of the detections as compared to 30 percent for Model III.

2. Conversely, radar and EO devices contribute much more to the detection capability of Model III than to that of Model I, and 50 percent of the detections, Model III, were made by radar/EO equipment as compared to 10 percent, Model I.

3. The value of air and unattended ground sensors in providing early, long range warning was demonstrated in both Models I and III.

4. The high rate of target element detections, Model III, highlights the need to examine in detail the company/battalion communications and target intelligence processing systems under very active conditions.

5. In addition to high rate of detection, in Model III the search capability was heavily overloaded with multiple detections and with simultaneous detections of the same targets by two or more STA devices. Further tests or experiments are needed to establish the dimensions of the communications and target intelligence processing problems which are posed.

6. While a certain amount of overlap and back-up should be provided for in STA coverage, there was probably too much overlap of medium range radars, Model III. Four radars were positioned along a one-kilometer front, covering much the same area, tending to oversaturate the system with multiple, identical detections.

7. The value of radar/EO devices having similar range capability and operating together was highlighted in Model III in the combination of long range radar/long range EO device. Such was not the case with the medium range radar/medium range EO device, the latter having less range capability than its companion radar.

8. The organic STA capability given Model III resulted in a significantly greater number of detections made earlier and at greater range than those made in Model I.

Objective 2. To evaluate the relative capability of the two candidate forces to engage enemy forces utilizing supporting arms.

Findings

There is a need to furnish supporting arms (air, naval gunfire, artillery) with an effective antimechanized attack capability in order to capitalize on the STA capability provided. The search capability greatly exceeded the attack capability in terms of taking the Red mechanized, mobile force under effective fire.

Objective 3. To evaluate the relative capability of the two candidate forces to engage the enemy in close combat utilizing direct fire weapons organic to the infantry battalion.

Findings

Results are inconclusive regarding the relative capability or Models I and III to engage the enemy in close combat. Model I inflicted 50 percent more losses on Red in close combat than did Model III, however Model III at 89 percent strength of Model I has a firepower potential of 10.8, versus 4.5 Model I.

Objective 4. To evaluate the relative capability of the two candidate forces to accomplish the assigned mission.

Findings

Results are inconclusive concerning the relative capability of Models I and III to accomplish the assigned missions. Red was attacking in close combat at the conclusion of each game. However firepower ratios at the start of ground combat favor Model III over Model I (Red/Blue 3.12/1, Model III; 5.3/1 Model I).

II. SUMMARY ANALYSIS

Objective 1. To evaluate the relative capability of the two candidate forces to perform the functions of combat surveillance, target acquisition, target location, and target designation.

A summary comparison of the Model I and III forces is shown below:

	I	III	Remarks
1. Target Elements	53	53	
Detected	51	51	III 8.6% more than I
Attacked	35	38	
2. Detections*	406	986	III 2.4 times greater than I
Air	267/66%	285/29%	
Radar	36/ 9%	283/29%	
E/O	4/ 1%	265/27%	
Sensor	17/ 4%	40/ 4%	
Ground	82/20%	113/11%	

Air accounts for 2/3 of the detections in Model I, less than 1/3 in Model III. Radar/EO account for 10% in Model I, and over five times this percentage (56%) in Model III.

3. Mean range, device to target (km).** See MOE 1, Section III for detailed data.

	I	III
PPS/15	2.2	
NOD	1.6	
Long range radar (LRR)		4.2
Medium range radar (MRR)		3.7
Long range EO devices		4.2

4. Longest range, device to target (km)

	I	III
PPS/15	2.8	
NOD	1.6	
LRR		6.8
MRR		4.9
LREO		5.8

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* Detections refer to target elements, throughout.

** Target refers to target element, throughout.

5. Mean range detected target to Blue (km). See Ch 2, Section III for detailed data.

	I	III
FPS/15	2.5	
NOD	1.9	
LRR		4.0
MRR		3.5
LREO		4.0
Air	8.2	8.5
Sensor	7.8	7.3

Air and sensors picked up targets at over twice the range of STA devices in Model III, and at over three times the range of these devices in Model I, providing valuable early warning.

6. Longest range, detected target to Blue (km)

	I	III
FPS/15 (forward OP)	4.2	
NOD (forward OP)	1.9	
LRR		5.2
MRR		4.0
LREO		5.2

7. Target detections over time, radar and E/O device

Hour	I	III	Increase factor (III over I)
2	4	34	8.5
3	0	129	Indeterminate
4	32	385	12
5	4	0	0
	40	548	13.7

Rate of detection, over the five-hour game period was, 8 per hour, Model I, 110 per hour Model III. However no radar or E/O detections were made in the first and fifth hours in Model III; thus the rate for the three-hour period preceding close combat (5th hour) was 183/hr or 3/minute. No false alarms or reports were played in the game, but even without these reports the multiple detection and reporting of targets poses a problem for communications and intelligence processing.

8. Multiple target detections

	Mean Detections Per Target		Number of Targets Detected	
	I	III	I	III
Hour				
1	2.8	2.1	51	44
2	2.9	3.7	44	48
3	1.0	5.3	3	44
4	2.8	10.2	42	44
5	1.1	1.0	40	34
Mean	2.1	4.5		

Of the 53 possible target elements, 51 were detected in each game. The above table indicates, by hour, the average number of multiple detections per target. Thus Model III averaged twice as many detections, per target, as did Model I. Note in particular the fourth hour when 44 target elements were each detected an average of 10 times in Model III. The great overload on the communications and target intelligence processing system is highlighted.

9. Simultaneous detections, identical targets

Combination	LRR	IREO	MRR	MREO	GROUND	AIR	PPS/15
A		2					
B			2				
C			2		1		
D	2	1					
E	2	2					
F	2	2	1				
G	2	2	2				
H	2	2	3				
I*					1	1	
J*							2

* Model I; all others, Model III

The table above indicates the combination of devices detecting identical targets, using only the fourth hour of play in each game. The table below indicates the number of simultaneous detections on the same target credited to each combination.

A	B	C	D	E	F	G	H	I	J
20	20	3	12	18	2	7	18	1	5

Thus, above, combination H detected the same target, at the same time, on 18 occasions. Crediting the LRR/LREO with a team operation (acts as a unit) we have five pieces of STA equipment making identical detections 18 times. The saturation effect is obvious, with attendant target processing delays. Model I, with less equipment and with less performance capability, obviously does not pose this problem of target intelligence processing.

10. Target engagements (Initial and subsequent strikes)

	Model I	Model III
Target elements	53	53
Engaged	35	38
%	66	72
Total attacks	46	64
Time of attack (hrs)		
1	2	3
2	6	9
3	3	14
4	6	4
5	29	34
	46	64

In each game 51 of 53 possible target elements were detected within the first hour and one-half, by air. Subsequently 35 (Model I) and 38 (Model III) of these targets were attacked over a five-hour period by infantry units or by supporting arms (air, NGF, artillery). Most attacks occurred in the fifth hour (63%, Model I, 53%, Model III). Note however that in the first three hours Model III effected over twice as many attacks as Model I (26/11). Overall, Model III effected 40 percent more attacks than did Model I. Increase in attacks cannot be attributed solely to the increase in detections since Blue experience with Model I did play a part.

11. Range of engagements (km)

	Model I Nr attks/mean range	Model III Nr attks/mean range
Air	13/5.5	23/6.3
NGF	4/1.5	10/1.7
Arty	9/1.5	8/2.5

Model III achieved more target attacks at greater range than did Model I. The principal difference occurred in air attacks, where Model III achieved 1.8 times as many as did Model I. Mean ranges between I and III do not differ significantly.

12. Target movement toward Blue before being engaged

On I: After initial detection, Model I targets moved an average of 4.1 kilometers closer to Blue positions than did Model III targets. Model I targets began to be hit after they had moved about 10 kilometers. Model III had hit 60 percent of its targets prior to their moving this same distance. Model III did engage targets to greater range than did Model I.

Objective 2. To evaluate the relative capability of the two candidate forces to engage enemy forces utilizing supporting arms.

This comparison has been touched on under objective one, related to the ability to detect and designate targets. Additional comparisons are given below.

Target attacks per hour (Initial strikes only)

	I Hour						III Hour					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Air	2	5	1	4	1	13	2	8	11	1	1	23
NGF		1		1	2	4		1	2	1	6	10
Arty			2		7	9			1	2	5	8
						26						41

Model III achieved 1.6 times as many attacks by supporting arms as did Model I, the biggest differences occurring in air and NGF support. By the end of the third hour (one hour before close combat) 2.3 times as many attacks had occurred in Model III, compared to Model I. Blue experience with Model I accounts for much of this increase in combat action, coupled with the great increase in detection capability of Model III.

Objective 3

To evaluate the relative capability of the two candidate forces to engage the enemy in close combat, utilizing direct fire weapons organic to the infantry battalion.

Loss ratio, Red to Blue, from organic firepower

	I		III	
	R	B	R	B
Strength, start close combat	1521	1869	1458	1779
Loss, ground combat	8[illegible]	36	60	42
Percent loss	6%	2%	4%	2%
Loss ratio	3/1		2/1	

In the Model I iteration close combat was assessed in two separate but simultaneous battles; in Model III, force disposition was such that the

confrontation could be assessed in one battle. Close combat assessment was terminated after one hour in the case of Model I and 1/2 hour in the case of Model III. Game results, with respect to number of Red casualties inflicted during close combat, tend to suggest that Model I dominated Model III. In fact, however, the opposite is true. Against Model I Red had a probability of success of 0.93; but, against Model III had only 0.55 probability of sucess due to the superior firepower scores of Model III (2.4 times greater than Model I). In determining the battle outcome the random number drawn for Model III had Red winning; but, in the Model I iteration a random number in the rare event category was drawn and Red did not win in one of the two battles. This rare event coupled with the shorter time of close combat assessment for Model III accounts for the greater number of casualties inflicted by Model I.

Objective 4. To evaluate the relative capability of the two candidate forces to accomplish the assigned mission.

1. Casualty Ratio, Red to Blue, as a function of Range.

Casualty Ratio Red to Blue	Red to Blue (Center of Mass) (km) 2-3	4-5	6-7	10	Total
I R/B	158/108	27/4		18/0	203/112
III R/B	96/83		96/0	17/0	209/83

Both games ended with Red attacking in close combat with a favorable force ratio. However in Model I the ratio, Red to Blue, was 5.3/1; in Model III 1.12/1. In Model I Blue inflicted 22 percent of total Red casualties prior to close-in fighting; in Model III Blue inflicted 52 percent of total Red casualties prior to close-in fighting. Model III employed more air in the attack throughout the game, resulting in heavier Red losses sooner and at greater range than in Model I. Two factors contributed to this greater air play, Model III: learning by Blue forces from the first Model I game, and greater STA capability confirming detections earlier and at greater range than in Model I.

2. Casualty Ratio, Red to Blue, as a function of time.

The table below shows a break-out of casualties over time. Note that essentially all Blue casualties occurred in the final two hours. The bulk of these casualties were caused by artillery/rocket and it was not until the fourth hour that Red had closed to the point that Blue was within artillery/rocket range. The reason for the wide variance in Blue casualties in the fourth hour was that the Red artillery which was fired on expected Blue positions was, by chance, not as effective in the Model III iteration.

Casualty Ratio Red to Blue	Time (Hours)					
	1	2	3	4	5	Total
I R/B	18/0	23/0	4/4	18/43	140/65	203/112
III R/B	17/0	43/0	53/0	14/13	82/70	209/83

3. Rate of Advance. Red achieved the same rate of advance in each game, averaging almost 4 kilometers per hour, for five hours.

III. DETAILED ANALYSIS

Objective I. To evaluate the relative capability of the two candidate forces to perform the functions of combat surveillance, target acquisition, target location, and target designation.

MOE 1. The number of initial (first time each target element is detected) and subsequent target detections as a function of the distance between the target and the source of the detection.

Model I

Table E-1. Range of PPS/15 Detections (km)
(Nr/range)

1.0-1.9	2.0-2.9	Total
6/1.5	5/2.1	
1/1.9	3/2.3	
	4/2.4	
	12/2.5	
	1/2.7	
	4/2.8	
7	29	36

Table E-2. Range of NOD Detections (km)
(Nr/range)

1.0-1.9	Total
4/1.6	4

Table E-3. Range of Sensor Detection (km)
(Nr/range)

0.0- .9	Total
17/.3	17

Table E-4. Range of Patrol/OP Detections (km)
(Nr/range)

0.0- .9	1.0-1.9	10.0-10.9	Total
7/ .9	10/1.5	1/10.7	18

Table E-5 Range of Infantry Detections (km)
(Nr/range)

1.0-1.9	Total
24/1.0	
18/1.1	
12/1.3	
10/1.5	
64	64

Model III

Table E-6. Range of Long Range Radar (LRR) Detections (km)
(Nr/range)

2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	Total
3/2.9	3/3.0	21/4.0	10/5.0	1/6.8	
	4/3.2	17/4.2	1/5.2		
	21/3.4	4/4.4	10/5.3		
	12/3.6	17/4.5	5/5.9		
	12/3.8	10/4.6			
		5/4.9			
3	52	74	26	1	156

Table E-7. Range of Medium Range Radar (MRR) Detections
(Nr/range)

2.0-2.9	3.0-3.9	4.0-4.9	Total
3/2.3	23/3.0	13/4.2	
3/2.7	31/3.4	7/4.3	
	13/3.8	10/4.4	
	10/3.9	9/4.5	
		5/4.9	
6	77	44	127

Table E-8. Range of Long Range Electro/Optical Device (LREO) Detections (km)
(Nr/range)

2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	Total
5/2.9	3/3.0	21/4.0	10/5.0	1/6.8	
	16/3.2	19/4.2	1/5.2		
	31/3.4	17/4.3	20/5.3		
	5/3.5	19/4.4	5/5.9		
	21/3.6	17/4.5			
	12/3.8	27/4.6			
		15/4.9			
5	88	135	36	1	265

Table E-9. Range of Sensor Detections (km)
(Nr/range)

.1- .9	Total
40/.1	40

Table E-10. Range of Patrol/OP Detections (km)
(Nr/range)

.1- .9	1.0-1.9	Total
23/.1	6/1.5	
2/.3		
12/.6		
37	6	43

Table E-11. Range of Infantry Detections (km)
(Nr/range)

1.0-1.9	Total
66/1.1	
4/1.5	
70	70

Table E-12. Mean Detection Ranges (km) Models I and III, Radars and Night Vision Devices

	I	III
Total detections (radar and EO)	40	548
Mean range, PPS/15 (36 detections)	2.2	
Mean range, NOD (4 detections)	1.6	
Mean range, LRR (156 detections)		4.2
Mean range, MRR (127 detections)		3.7
Mean range, LRFO (265 detections)		4.2

DISCUSSION. Of the eight STA platoon radars available in Model I, Blue attached four to one company (Company A) and one to each of the other three companies. One NOD was attached to each of the companies. Company A moved three of the radars to three prominent terrain features, used as outpost positions, from two to three kilometers northwest of the main defensive positions. Four radars accounted for all of the PPS/15 detections during the game period.

Of the four LRR and LREO devices available in Model III, Blue placed one of each in support of each of the three forward companies. He retained one team under battalion control, and established an observation post (OP) with it, combined with a force reconnaissance team. The observation post was located three kilometers northwest of the main defensive position. This OP was withdrawn before any detections were made, due to the Red closure rate. The LRR supporting A and B companies made all of the long range radar detections during game play. In addition, three of the MRR (one with Company A and two with Company B) made all of the medium range radar detections.

The LREO devices teamed with their radars to make subsequent detections, and in addition were used for tracking independently.

The MREO devices made no detections or identifications in this game, there being no hand-off from MRR to MREO because of the shorter range of the latter, and because of ground visual pick-up under battlefield illumination conditions.

Aircraft slant ranges to targets were not plotted, primary attention being given to detections by ground means. However all ranges from targets to Blue positions were recorded and are discussed under MOE 2.

Given the characteristics of the surveillance devices employed in Models I and III it is not surprising that Model III detections were made at much greater ranges than those of Model I. Tables E-1 to E-12 and Figure E-1 above give range distribution for all devices. In particular Table E-12 indicates that the mean range of detection for Model III is about twice that of Model I.

Radar and EO device performance are extremely sensitive to terrain line-of-sight limitations. The Blue defensive position was selected so as to maximize line-of-sight visibility. Model I radars have a maximum range of three kilometers; all of the Model I sightings equalled or exceeded one half of this range. Model III LRR have a 10-kilometer maximum range; only 17 percent $(\frac{27}{156})$ of LRR sightings equalled or exceeded one half of this range. Model III MRR have a five kilometer maximum range; 98 percent of MRR sightings exceeded one half of this range $(\frac{124}{127})$.

Total detections by radars or EO devices in Model III are greater than those of Model I by greater than a factor of 13 (13.7).

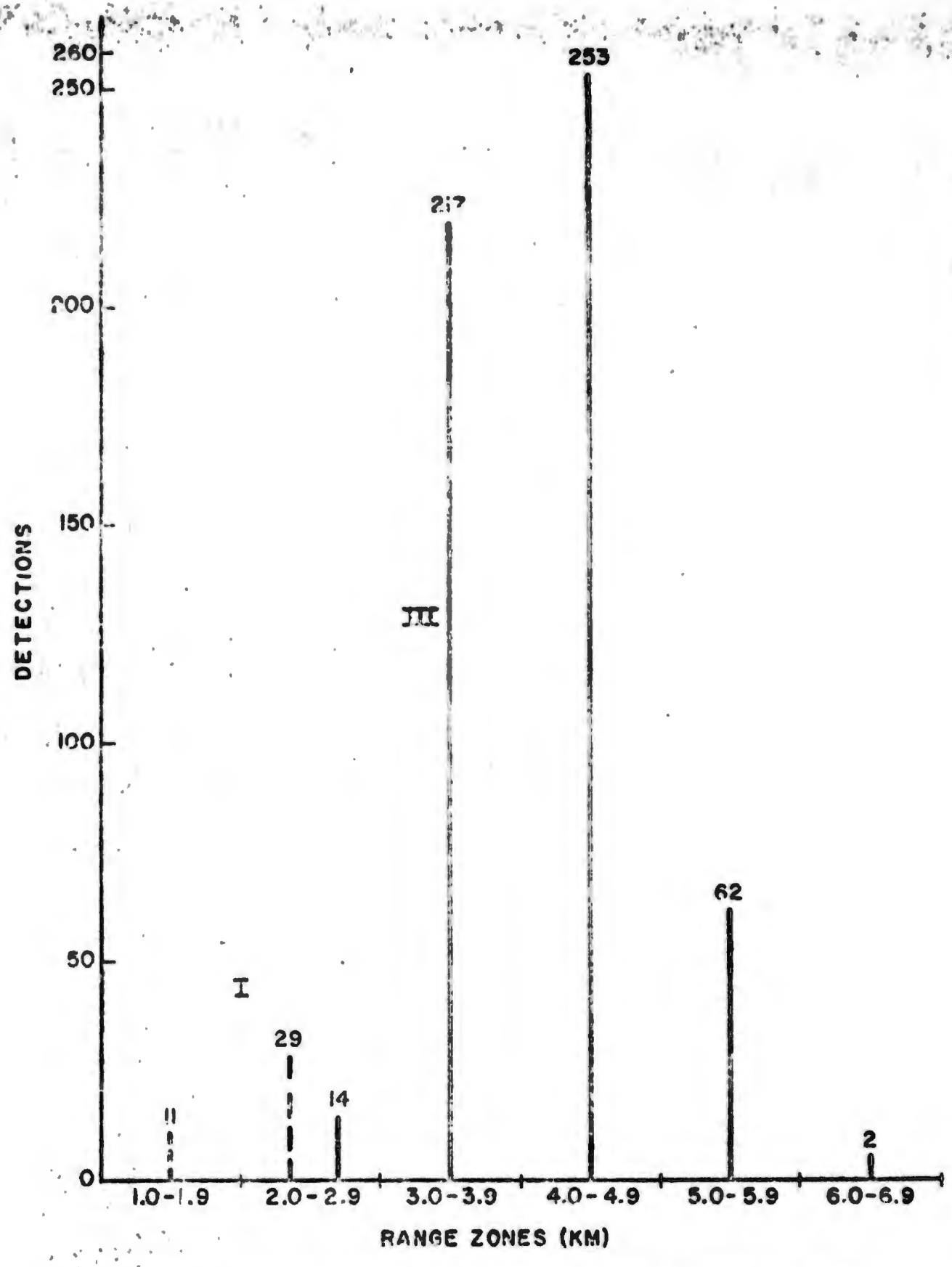


FIGURE E-1. RANGE FROM DEVICE TO TARGET, MODELS I AND III, PLOTTED BY 1 KILOMETER RANGE ZONE. RADAR AND NIGHT VISION DEVICES ARE SHOWN.

MOE 2. The number of initial and subsequent target detections as a function of the distance between the target and the center of mass of the Blue infantry platoon closest to the target.

Model I

Table E-13. Range from Nearest Blue Position of Air Detected Target Elements (km)

(Nr/range)

2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	8.0-8.9	9.0-9.9	13.0-13.9	14.0-14.9
13/2.9	34/3.0	1/4.0	42/5.1	6/8.8	26/9.7	17/13.1	10/14.0*
	1/3.2	21/4.6	17/5.3			(9 *	6/14.2*
	21/3.7					initial)	26/14.4
13	56	22	59	6	26	17	42

16.0-16.9
26/16.8*

Total: 267

*51 total initial detections, of 53 target elements.

Table E-14. Range from Nearest Blue Position of Radar Detected Target Elements (km)

(Nr/range)

1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	Total
4/1.4	1/2.1	1/3.6	4/4.0	
6/1.5	1/2.3		1/4.2	
	6/2.4			
	2/2.5			
	3/2.6			
	1/2.8			
	6/2.9			
10	20	1	5	36

Table E-15. Range from nearest Blue Position of NOD and Sensor Detected Target Elements (km)

NOD	4	1.9 km
Sensor	17	7.8 km

Table E-16. Range from Nearest Blue Positions of Patrol/OP Detected Target Elements (km)

10 at 2.1 km
7 at 2.7 km
1 at 10.7 km
18

Table E-17. Range from Nearest Blue Position of Infantry-Detected Target Elements (km)

(Nr/range)

0.0- .9	1.0-1.9	Total
18/ .5	20/1.0	
	9/1.1	
	12/1.3	
	5/1.5	
18	46	64

Model III

Table E-18. Range from Nearest Blue Position of Air Detected Target Elements (km)

(Nr/range)

2.0-2.9	3.0-3.9	4.0-4.9	7.0-7.9	8.0-8.9	9.0-9.9
6/2.3	6/3.3	38/4.3	6/7.4	25/8.0	6/9.0
		21/4.4	25/7.8		17/9.5
		21/4.6			18/9.8
6	6	80	31	25	41

10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9
2/10.8	17/11.0	6/12.4	9/13.9	2/14.2
	6/11.3	18/12.9		18/14.8
	18/11.7			
2	41	24	9	20

Total: 285

Table E-19. Range from Nearest Blue Position of LRR Detected Target Elements (km)

(Nr/range)

2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	Total
6/2.9	8/3.2	34/4.2	10/5.0	
	42/3.4	20/4.6	2/5.2	
	20/3.6	10/4.9		
	4/3.8			
6	74	64	12	156

Table E-20. Range from Nearest Blue Position of MRR Detected Target Elements (km)

(Nr/range)

2.0-2.9	3.0-3.9	4.0-4.9	Total
3/2.3	46/3.0	28/4.2	
3/2.7	31/3.4	3/4.4	
	8/3.8	5/4.9	
6	85	36	127

Table E-21. Range from Nearest Blue Position of LREO Detected Target Elements (km)

(Nr/range)

2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	Total
10/2.9	20/3.2	34/4.2	10/5.0	
	42/3.4	34/4.3	2/5.2	
	49/3.6	20/4.4		
	4/3.8	20/4.6		
		20/4.9		
10	115	128	12	265

Table E-22. Range from Nearest Blue Position of Sensor Detected Target Elements (km)

(Nr/range)

7.0-7.9	Total
17/7.2	
17/7.3	
6/7.4	
40	40

Table E-23. Range from Nearest Blue Positions of Patrol/OP Detected Target Elements (km)

(Nr/range)

2.0-2.9	3.0-3.9	5.0-5.9	13.0-13.9	Total
6/2.4	17/3.0	6/5.3	2/13.7	
6/2.6	6/3.9			
12	23	6	2	43

Table E-24. Range from Nearest Blue Position of Infantry Detected Target Elements (km)

(Nr/range)

0.0- .9	1.0-1.9	Total
22/ .5	7/1.0	
2/ .7	36/1.1	
3/ .8		
27	43	70

Table E-25. Mean Target Range to Blue, Air Detected Targets, Models I and III

	I	III
Total detections	267	285
Mean range (km)	8.2	8.5

Table E-26. Mean Target Range to Blue, Models I and III, with Radars and Night Vision Devices

	I	III
Total detections	40	548
Mean range PPS/15 targets (36 detections)	2.5	
Mean range NOD targets (4 detections)	1.9	
Mean range LRR targets (156 detections)		4.0
Mean range MRR targets (127 detections)		3.5
Mean range LREO targets (265 detections)		4.0

DISCUSSION. (Tables E-13 to E-26; Figures E-2, E-3). The same level of air support was available to Blue in both Models I and III - four A6A, six A4M, and 4 AV8A. However, more aircraft missions were flown in the second game (Model III) than in the first game (22 versus 11). One reason can probably be attributed to the experience gained by Blue from the first game. Another reason, however, is that a considerable number of ground detections occurred beginning in the second hour of play with Model III, undoubtedly causing Blue to increase his long range attack effort. In any event the increase in air detections was less than 10 percent in Model III, over Model I (285 in III, 267 in I).

When considering the proportion of air detections to radar and EO detections, the importance of air to the Model I effort is emphasized. In Model I, air accounted for 87 percent of combined air, radar, and NOD detections (267/307). In Model III air accounted for 34 percent of combined air, radar, and EO device detections. Obviously when air support is limited, for whatever reason, the importance of the ground STA capability becomes quite evident.

The use of aircraft allows for greater detection ranges, and early warning. Mean range of air detections was over eight km for Models I and III, three times greater than the Model I radars, and over twice as great as the Model III radars and EO devices. Center of mass of the 53 Red target elements moved from 21.6 kilometers from Blue to approximately 2 kilometers in the 5 hours of game play. Leading Red elements were 18 kilometers distant at game time, the game starting with their forward movement. One third of the air detected targets were greater than 10 km (LRR maximum range) from the Blue positions.

The most common detection range zone of radar targets, Blue, Model I, was between 2.0-2.9 kilometers, 56 percent of target detections being within that zone. The most common range zone for the LRR was 3.0-3.9 km (47 percent detections); for MRR 3.0-3.9 km (67 percent); for the LREO 4.0-4.9 km (48 percent). The LRR and the LREO detected targets farthest from the Blue position - two each at 5.2 km.

When comparing detection ranges from Blue as a function of design ranges of the equipment - in this particular terrain against this particular mechanized threat - we find:

PPS/15 - through forward positioning detected 6 targets at greater than 3 km from Blue, 5 being at 4 km or greater.

LRR - all targets were within approximately 50 percent of design range (up to 5.2 km).

MRR - 28 percent of the targets were within 80 percent of design range (5 km) (between 4.0-4.9 km, with 5 at 4.9 km).

LREO - all targets were within approximately 50 percent of design range (up to 5.2 km).

The MREO made no detections during the game, being range limited when compared to the MRR (3 km versus 5 km). Only 5 percent of the MRR targets were located at less than 3 kms from the Blue positions.

NUMBER OF DETECTED TARGETS
100
90
80
70
60
50
40
30
20
10
LEGEND:

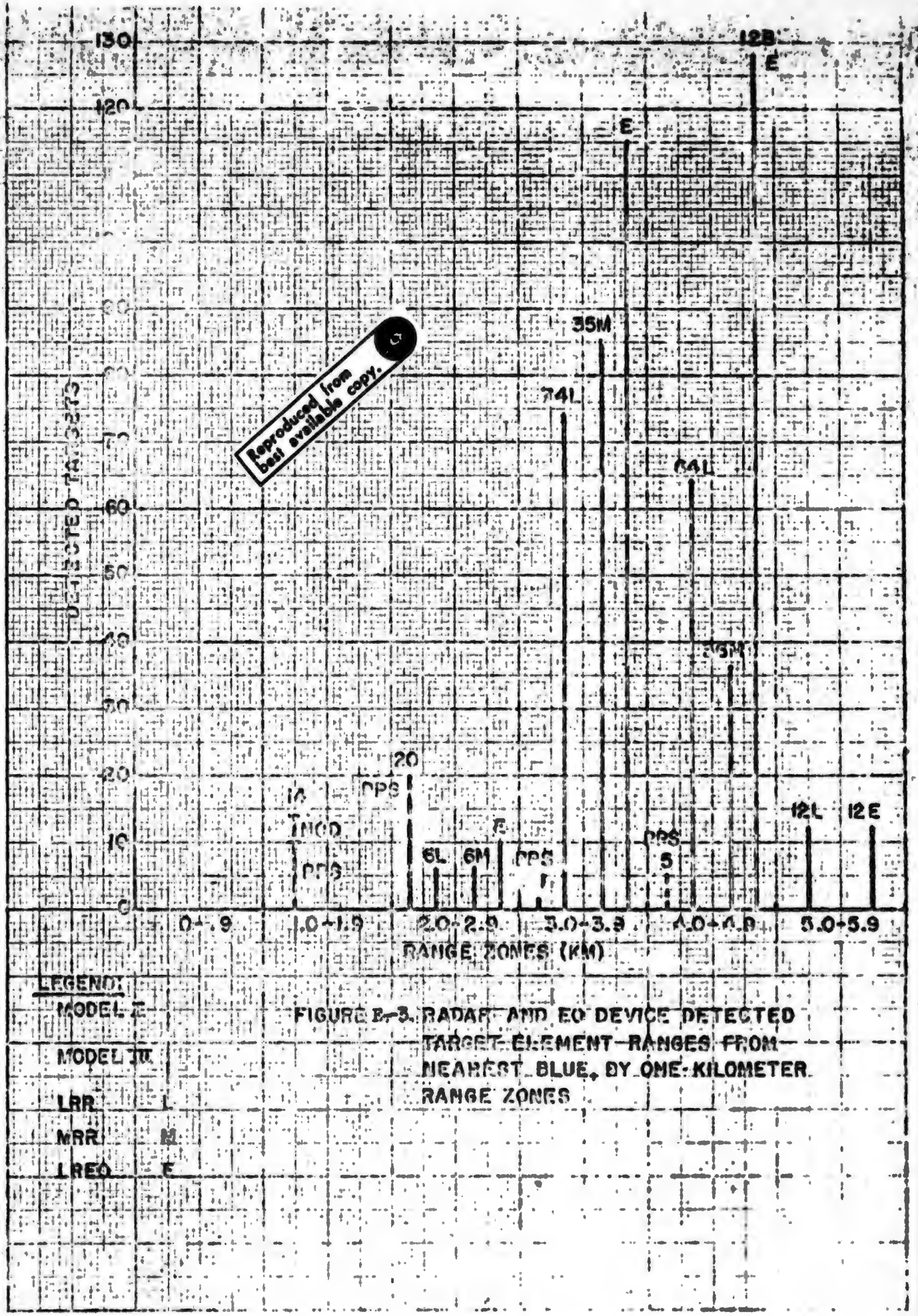


FIGURE E-3. RADAR AND EO DEVICE DETECTED TARGET ELEMENT RANGES FROM NEAREST BLUE, BY ONE-KILOMETER RANGE ZONES

MOE 3. The number of initial and subsequent target detections made during each hour of game play.

Model I and III

Table E-27. Hourly Detection by Aircraft

Model	Hours 1	2	3	4	5	Total
I	111 (51 initial)	107	2	47	0	267
III	91 (44 initial)	102 (7 initial)	86	6	0	285

Table E-28. Hourly Detections by Radars

Model		Hours 1	2	3	4	5	Total
I	PPS/15		4		28	4	36
III	LRR		12	30	114		156
	MAR			15	112		127

Table E-29. Hourly Detections by EO Devices

Model		Hours 1	2	3	4	5	Total
I	NOD				4		4
III	LREO		22	84	159		265
	MREO						0

Table E-30. Hourly Detections by Sensors

Model	I	17 in the second hour
	III	40 in the second hour

Table E-31. Hourly Detections by Ground Visual Means

Model	Hours 1	2	3	4	5	Total
I			1	40	41	82
III	2		16	59	34	113

Table E-32. Recapitulation, Hourly Detections

Model I

Time (hrs)	Source PPS	NOD	Sensor	Ground	Air	Total
1					111	111
2	4		17		107	128
3				1	2	3
4	28	4		40	47	119
5	4			41	0	45
Total	36	4	17	82	267	406

Model III

Time (hrs)	Source LRR	MRR	LREO	Sensor	Grd	Air	Total
1					2	91	93
2	12		22	40		102	176
3	30	15	84		18	86	233
4	114	112	159		59	6	450
5					34		34
Total	156	127	265	40	113	285	986

DISCUSSION. (Tables E-27 to E-33). Of the 53 possible target elements to be detected, 51 were detected by air in Model I in the first hour; in Model III 44 were detected in the first hour, and 7 in the second. No initial detections were made by ground elements in either game.

Over the five hour game period there were 2.4 times as many detections made by Model III than by Model I (986 to 406). By far the greatest increase occurred in radar and EO device detections, with many detections made earlier in Model III. Thus

Table E-33. Hourly Comparisons, Radar/EO Device, Models I and III.

	I	III	Increase Factor
Detections, second hour	4	34	8.5
Detections, third hour	0	129	Indeterminate
Detections, fourth hour	32	385	12
Detections, fifth hour	4	0	0
Total	40	548	13.7

In the detection figures above, detections are credited separately to individual LRR and LREO. If we assume that they operate as a system, producing single detections, then the above increase factors become:

	III	Factor		III	Factor		III	Factor
2d hour:	22	5.5	3d hour:	99	Ind.	4th hour:	271	8.5

	III	Factor
Total:	392	9.6+

Table E-33a. Number of Targets Detected by Detection Sources, Singly or in Combination, Within Each Hour

Model I

Detection Source \ Hour	1	2	3	4	5
Air	51	27	2	10	
Air/sensor		13			
Air/sensor/radar		4			
Air/NOD/radar				3	
Air/radar				5	
Air/ground/radar				5	
Air/ground				7	
NOD/radar				1	
Radar				1	
Ground/radar				8	4
Ground			1	2	36
	51	44	3	42	40

Using Table E-32, detections per target average:

Hour	1	2	3	4	5
Mean	2.8	2.9	1	2.9	1.1

MODEL III

Detection Sources \ Hour	1	2	3	4	5
Air	42	20	21		
Air/sensor		23			
Air/LRFO			7		
Air/LRR/LREO		5	3		
Air/LRR/MRR/LREO			7		
Air/ground	2		6	6	
LRR/MRR/LREO				2	
Ground/LRR/MRR/LREO				19	
Ground/MRR				3	
Ground				14	34
	44	48	44	44	34

Using Table E-32, detections per target average:

Hour	1	2	3	4	5
Mean	2.1	3.7	5.3	10.2	1

Table E-33a, above, gives an indication of how various devices contributed to overall target detection. In the third hour, Model III, the combination of STA devices with air detected 44 of 53 possible target elements, as compared to 3 for Model I. Referring to Table E-32, hourly detection, we arrive at frequency of detection, each target, shown for each model above. Note in particular the multiple detections indicated for the third and fourth hours, Model III. The game could not address this problem - namely the saturation effect produced by the actual reporting and processing of the information portrayed by the devices.

Another aspect of multiple detection occurs when identical targets are indicated at the same time by two or more detection sources. The question arises as to whether it is in fact the same target; precise location and later identification must of course be given by the operator to the processing center. Time delays are implicit here, but could not be addressed in the game. Teble E-33b, below, indicates how frequently single, identical targets were detected simultaneously within each hour by two or more sources. For example, in Model I, fourth hour, two radars detected identical targets at the same time on five occasions. Note for Model III how the problem is compounded when for example in the fourth hour 5 devices (2 LRR/2 LREO/3 MRR) detected identical targets on 18 occasions (counting each pair of LRR and LREO as one detection system).

Table E-33b. Number of Times Identical Targets Were Detected Simultaneously by Multiple Detection Sources, Each Hour

Model I

4th Hour		5th Hour
Ground/Air	2 PPS/15	2 Ground
1	5	1

Model III

2nd Hour	3rd Hour
Air/Unattended ground sensor	2 LREO
6	20
2 LREO	2 LREO/1 MRR
5	5
2 LRR/2LREO	2 LRR/2 LREO
5	10
	2 LRR/2 LREO/1 MRR
	5

4th Hour		
2 MRR	2 LRR/1 LREO	2 LRR/2 LREO/2 MRR
20	12	7
2 LREO	2 LRR/2 LREO	2 LRR/2 LREO/3 MRR
20	18	18
2 MRR/Ground		2 LRR/2 LREO/1 MRR
3		2

MOE 4. The cumulative number of initial and subsequent target element detections as a function of time.

DISCUSSION.

Referring to Figure E-4, air detections were made at the rate of 53 target elements per hour, Model I, 57 per hour, Model III, and in each of the first four hours.

Referring to Figure E-5, the dramatic buildup in Model III detections - radar and EO device - over Model I detection is quite evident. Rate of detection was 8 per hour, Model I, 110 per hour, Model III. No detections were made in the first hour and no detections in the fifth hour for Model III, ground visual means being employed. Thus all Model III detections - radar and EO device - were made in a three hour period, this rate being 1.83 per hour, or 3 per minute. This statistic emphasizes the point of multiple detections and reports being made during this very active period, with implications for communications and intelligence processing becoming quite evident. The game play and rules could not address this problem, but it is an obvious one.

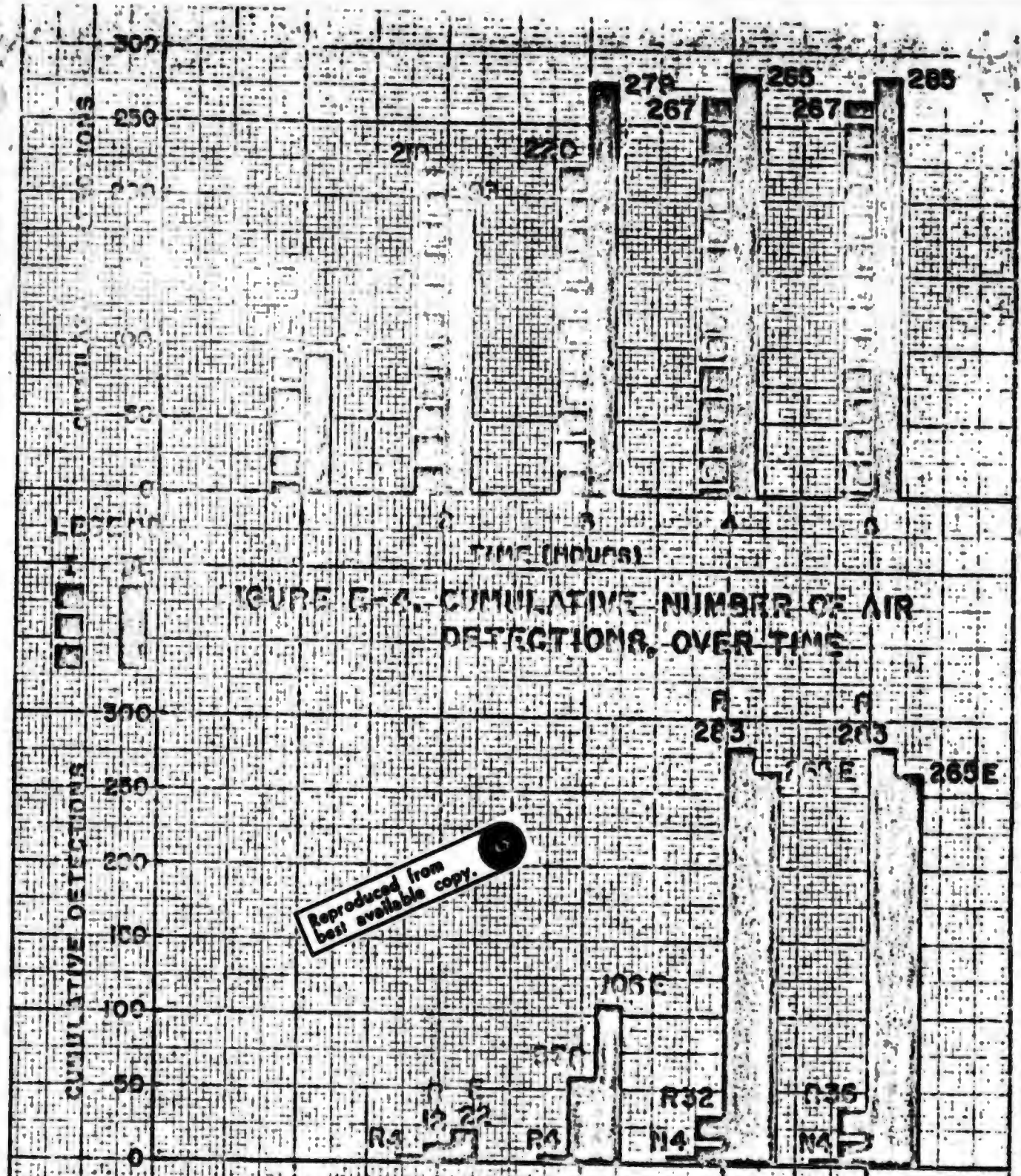
MOE 5. The number of targets being tracked at the end of each hour.

Table E-34. Tracked Targets per hour

Tracked Targets	Time (hours) 1	2	3	4	5
Model I				34[a]	40[b]
III		5[c]	23[d]	38[e]	34[f]

a. Twenty-three by infantry units, 3 by patrols, 5 by radar, 3 by NOD.
b. All by infantry units.
c. All tracked by 2 LRR's and 2 LREO's.
d. Ten tracked by LREO's alone; 7 by MRR and LREO's; 6 by OP/patrol.
e. Thirty-six by infantry platoons; 2 by LREO.
f. All by infantry units.

Model III STA equipment allowed for earlier tracking (beginning with the second hour) of enemy targets, and shows a steady buildup over time. In Model I tracking occurred beginning in the fourth hour, just prior to close combat.



MOE 6. The percent of targets within specified zones being tracked at the end of each hour. Zones will be established as a function of distance from a trace of the forward Blue platoons.

Table E-35. Tracked Targets, by Zone, Per Hour

Model I

	Time (hrs) 1		2		3		4		5	
Zone (km)	Tgts	Tkd	Tgts	Tkd	Tgts	Tkd	Tgts	Tkd	Tgts	Tkd
0-3							17	17	37	37
3-6			26	0	26	0	26	17	5	3
6-9			16	0	16	0	1		2	0
9-12	29	0	7	0	7	0	7		5	0
12-15	22	0	0	0	0	0			2	0
>15	2	0	4	0	4	0	2		2	0
	53	0	53	0	53	0	53	34	53	40

Model III

	Time (hrs) 1		2		3		4		5	
Zone (km)	Tgts	Tkd	Tgts	Tkd	Tgts	Tkd	Tgts	Tkd	Tgts	Tkd
0-3							17	17	33	31
3-6					14	9	25	21	9	3
6-9			15	5	30	14	2	0	2	0
9-12	5	0	34	0	5	0	5	0	5	0
12-15	28	0	2	0	2	0	2	0	2	0
>15	20	0	2	0	2	0	2	0	2	0
	53	0	53	5	53	23	53	38	53	34

Table E-35a. Percent Targets Tracked Each Hour (53 targets total)

	Hour				
Model	1	2	3	4	5
I	0	0	0	64	75
III	0	9	40	71	64

Target Density

Model I

1st hour - all 53 target elements were beyond the range of ground visual, radar, or night vision devices.

2d hour - 27 target elements were within range of one radar, positioned on a forward observation post. Four were detected, none was tracked. Terrain defilade was the principal reason for lack of detection by Blue.

3d hour - no change. Red in attack position.

4d hour - forty-three targets were within radar range. Four radars detected 22 of these targets, one radar providing duplicate coverage of five targets and one NOD providing duplicate coverage of three targets. At the end of the hour, of the 34 target elements being tracked, radars were tracking five, the NOD 3, and infantry units 26 (including three by forward patrols). Radar and NOD coverage complemented ground visual coverage by tracking targets at greater range, and by handing off targets after initial detection.

5th hour - all targets tracked by infantry units within 1300 meters.

Model III

1st hour - of the 53 target elements, 33 were within long range radar range but were not detected, due to terrain masking.

2d hour - of the 53 target elements, 51 were within long range radar range. Five were detected by two long range radars and two long range EO devices, and were being tracked at the end of the hour. No targets were within medium radar range.

3d hour - of the 53 target elements, 48 were within long range radar range and 23 were being tracked at the end of the hour - 17 by two long range EO devices, and six by a forward observation post. Thirty-five targets were within medium radar range, two within medium EO device range; seven of these targets had been detected by radar, duplicating the long range coverage, and were being tracked by the MRR at the end of the hour.

4th hour - of the 53 target elements, 38 had been detected and were being tracked at the end of the hour. Forty-nine were within long range radar range, and 21 of these were detected by two radars and two EO devices; two were being tracked by EO devices at the end of the hour, ground units tracking the other 19.

Forty-two targets were within MRR range, 22 being detected during the hour by three radars combined. Nineteen of these were also detected

by long range devices. All were being tracked by infantry units at the end of the hour.

Ground units were tracking all 17 targets in the 1-3 km zone and 19 of 25 in the 3-6 km zone at the end of the hour. Two LREO were tracking an additional two targets.

5th hour - during this hour of close combat all detections (34) were made by infantry units, and accounted for 34 target elements, all within 1 kilometer of the forward Blue positions.

MOE 7. The mean and median distances between targets being tracked and the trace of the forward Blue platoons at the end of each hour.

Table E-36. Distance of Tracked Targets from Blue, Each Hour

	Time (hours)									
	1		2		3		4		5	
Distance (km)	I	III	I	III	I	III	I	III	I	III
0- .9							2/ .9		18/ .5	22/ .5
										2/ .7
										3/ .8
1.0-1.9							10/1.1	36/1.1	16/1.0	7/1.0
							5/1.3		6/1.3	
							5/1.5			
							3/1.9			
2.0-2.9					6/2.6		2/2.4	2/2.9		
							4/2.6			
							2/2.7			
							1/2.8			
3.0-3.9										
4.0-4.9			5/4.9		17/4.3					
mean distance			4.9		3.9		1.6	1.2	.8	.6
median distance			4.9		4.3		1.4	1.1	1.0	.5
mode			4.9		4.3		1.1	1.1	.5	.5

DISCUSSION. Table E-36 indicates that in Model I the greatest range of tracked targets from Blue was 2.8 km, and tracking took place within one hour of close combat. Model III achieved a 75 percent increase in range, (4.9 versus 2.8) using the maximum Model I range, and comparing it to the initial tracking range of Model III. When mean ranges are compared for the first hour of tracking for each model (second for Model III, fourth for Model I), Model III achieves three times the range of Model I (4.9 versus 1.6). Model III also was tracking targets approximately three hours before close combat, compared to one hour for Model I. The reason that Model III tracked targets earlier is the greater range capability of the Model III radars. Note that the target elements tracked by Model III prior to the fourth hour were beyond the range of the Model I radar.

MOE 8. The percent of initial and subsequent detections as a function of the detection source (visual, radar, night vision, ground and airborne sensors).

Table E-37. Detections by Source, Each Hour, Model I

	Source						
Time (hrs)	PPS	NOD	Sensor	Ground	Air		Total
1					111		111
2	4		17		107	(51 initial)	128
3				1	2		3
4	28	4		40	47		119
5	4			41	0		45
Total	36	4	17	82	267		406
Percent	9	1	4	20	66		100

Table E-38 Detections by Source, Each Hour, Model III

	Source								
Time (hrs)	LRR	MRR	LREO	MREO	Sensor	Ground	Air		Total
1						2	91	(44 initial)	98
2	12		22		40		102	(7 initial)	176
3	30	15	84			18	86		233
4	114	112	159			59	6		450
5						34			34
Total	156	127	265	0	40	113	285		986
Percent	16	13	27	0	4	11	29		100

DISCUSSION. (Table E-37, E-38). Model I achieved 41 percent of the detections made in Model III. Two thirds of Model I detections were made by air reconnaissance. Air accounted for only 30 percent of Model III detections, emphasizing the great increase in ground detections in Model III, air effort being approximately the same in each game. Model I, using its radars and NODs, achieved only 7 percent of the detections made by radars and EO devices in Model III (40/548). Note the importance of the sensors in providing early warning in each game - in each case during the second hour. In Model I, 17 target elements were detected by one string, and in Model III, 23 were detected by two strings, 17 being detected twice (40 total detections).

Figure E-6 graphically portrays how the air, ground, and STA systems complement each other over time. In each case the major contribution in the first two hours is by air. In the third and fourth hours the STA equipment makes its major contribution. Finally, ground visual means build up in the fourth and fifth hours, making almost the sole contribution in the close combat phase of the last hour. The major contribution of the Model III STA equipment is evident.

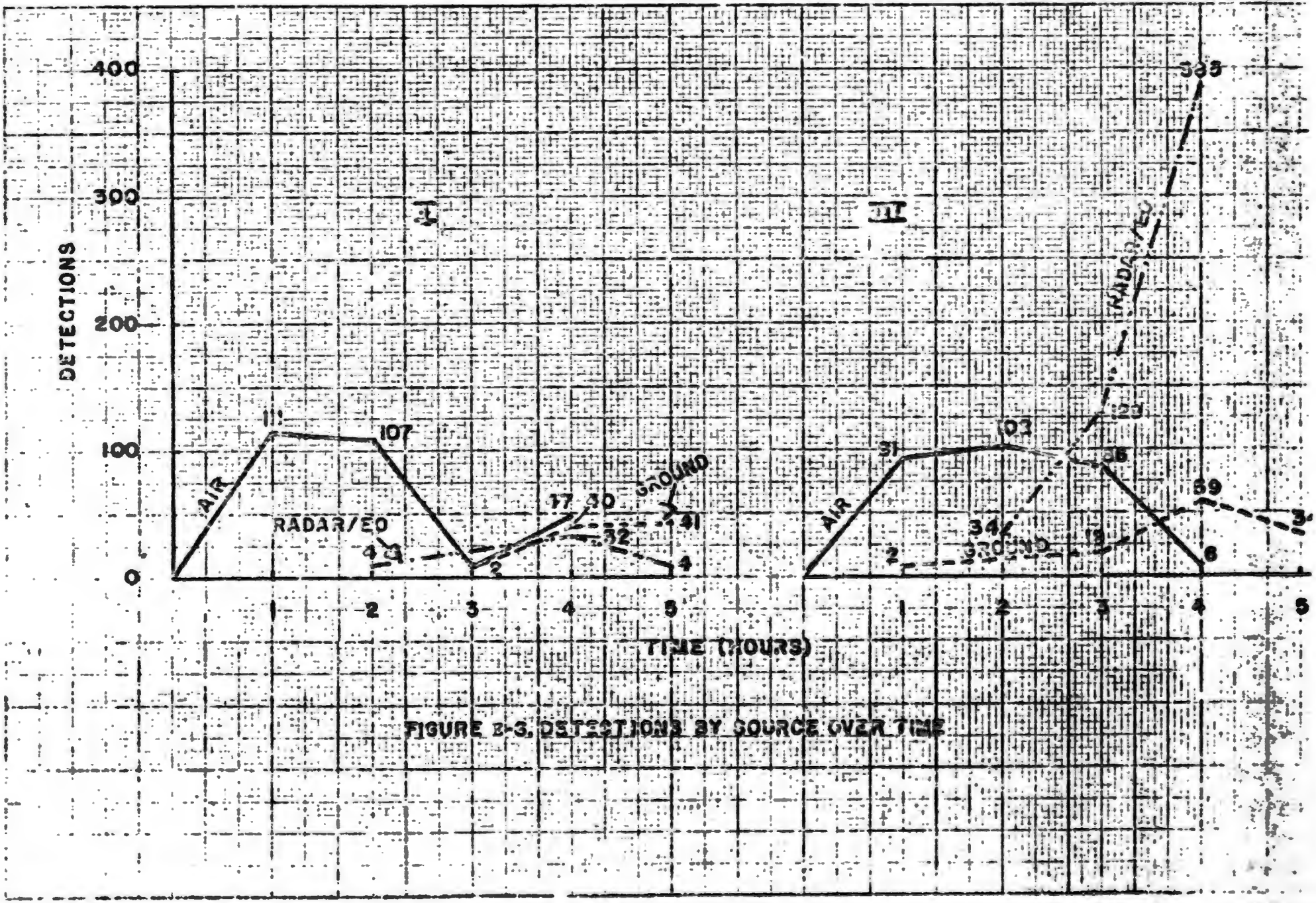


FIGURE E-3. DETECTIONS BY SOURCE OVER TIME

MOE 9. The mean and the median of the difference between the reported and the actual target locations for all targets tracked at the end of each hour.

Assessment model was not sufficiently precise to permit valid comparisons.

MOE 10. The number and percent of square meters within the area of possible coverage to which line of sight (LOS) exists from those STA devices making detections of targets during game play, computed at the initial STA device location and orientation.

DISCUSSION. Model I: Using the digitized terrain printouts furnished by remote terminal from NWL it was determined that the eight Model I PPS/15 radars achieved 26 percent of total possible area coverage. Total area under surveillance was 56 square kilometers, with 14.6 square kilometers visible. Total area was computed on a non-duplicative basis. That is, areas covered by two or more radars are counted only once.

Model III: Total area under radar surveillance was 165 square kilometers, with 42 percent visible (69 square kilometers). Model III achieved five times the area covered by Model I.

MOE 11. The additional area covered by unattended ground sensors.

DISCUSSION. In both Models I and III there were seven sensor strings deployed in the area of attack. Each has an average radius of coverage of 300 meters. Total area covered is two square kilometers.

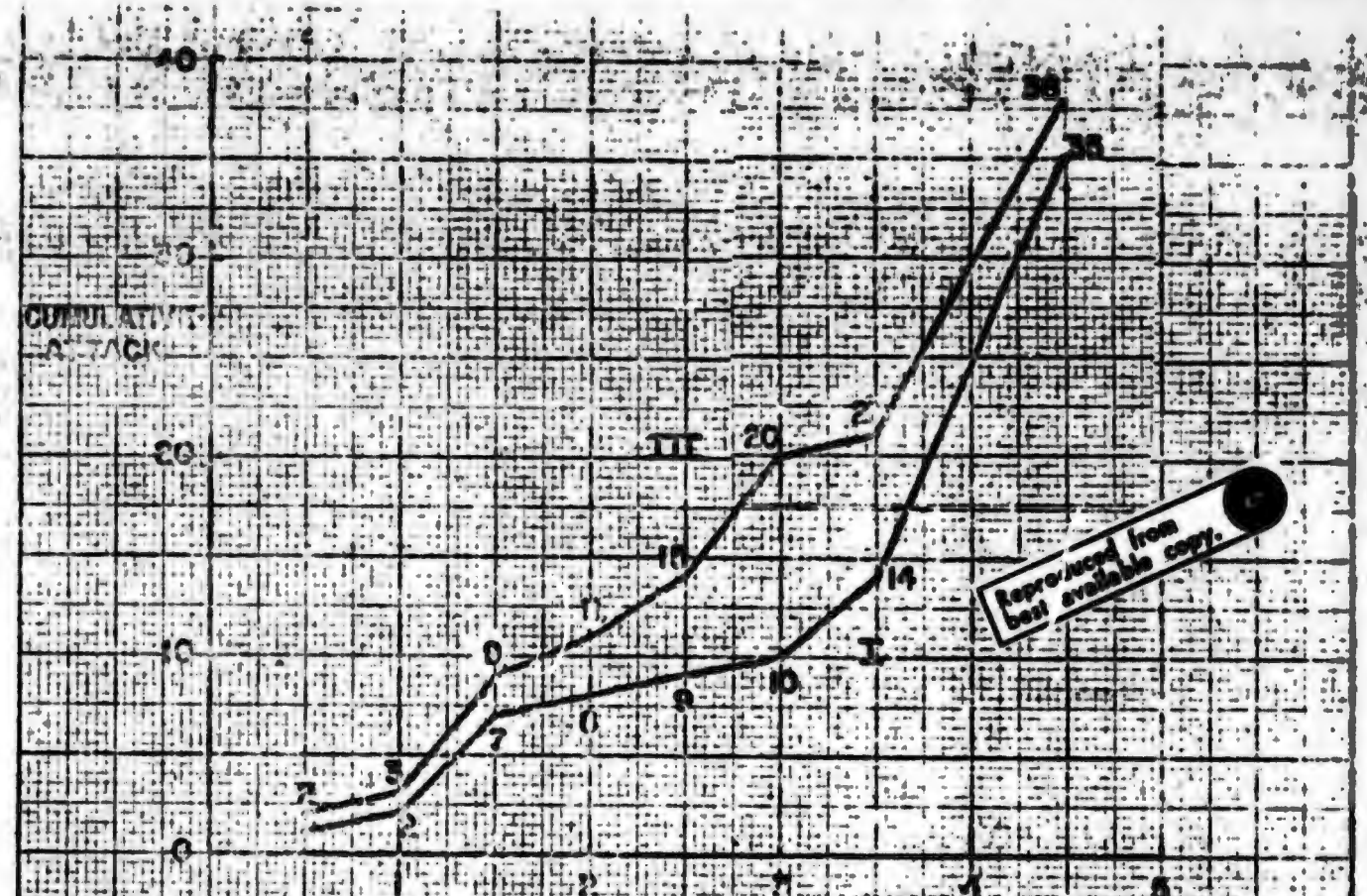
MDE 12. The time from initial target detection to target engagement (first round fired or release of ordnance by air) by target type and by type detection device.

Table E-39. Time from Initial Target Detection to Target Attack, Models I and III, One-Half Hour Periods

	ELAPSED TIME									
	1		2		3		4		5	
(mins)	00-30	31-60	00-30	31-60	00-30	31-60	00-30	31-60	00-30	31-60
Target Attacks										
I	1	1	5	1	1	1	4	0	21	
III	2	1	6	2	4	5	1	0	17	

Total		Rate	
I	III	I	III
35	38	7.8 per hr	8.4 per hr

DISCUSSION. There were a total of 53 target elements in the enemy order of battle. Fifty-one of these were picked up initially by air in the first hour, in Model I, and in the first hour and a half in Model III. Subsequently, as indicated in Table E-39, 35 (68%) of these targets were hit during game play in Model I; 38 (75%) were hit during game play in Model III. Although the table indicates a rate, also indicated by the slope of the lines of Figure E-7, the hour for most frequent attack was the fifth in each game. Forty-one percent of the Blue target attacks were made in this hour in Model I, 33 percent in Model III, indicating more targets hit earlier by Model III. In fact, during the second and third hours, 23 percent of the targets were attacked in Model I, and double this percentage in Model III (45 percent).



TARGET ATTACKS		1		2		3		4		5		TOTAL	RATE (PER HR)
		00-30	31-60	00-30	31-60	00-30	31-60	00-30	31-60	00-30	31-60		
	I							4	0	21		35	7.0
	III	2	1	6	2	4	5	1	0	17		38	8.4

FIGURE E-7. CUMULATIVE TARGET ATTACK, MODELS I AND III (1/2 HOUR INCREMENTS)

Table E-40. Targets (initial), Detection Sources, and Attack Means, Model I

Hour	Target	Detection Source	Attack By	Target Posture
1	Mec Inf Plat	Air	Air	Moving
	Tk Plat	Air	Air	Moving
2	Mec Co Hq	Air	NGF	Moving
	Mec Bn Hq	Air	Air	Moving
	Mec Inf Plat	Air	Air	Moving
	Tk Plat	Air	Air	Moving
	Mort Btry	Air	Air	Moving
	Mec Bn Hq	Air	Air	Moving
3	Arty Btry	Air	Arty	Stationary
	AA Sec	Air	Arty	Firing
4	Tk Plat	Radar	Grd	Moving
	Mec Inf Plat	Air	Air	Moving
	AT Plat	Air	Air	Moving
	Tk Co Hq	Air	Air	Moving
5	2 Mec Inf Plats	Radar	Arty	Moving
	Mec Co Hq	Radar	Grd	Moving
	9 Mec Inf Plat	Grd	Grd	Moving
	2 Mec Inf Plat	Grd	Arty	Moving
	Mec Inf Plat	Grd	NGF	Moving
	Mec Bn Hq	Grd	Air	Moving
	2 Mec Rcn Plat	Grd	Grd	Moving
	2 Tk Plat	Grd	Grd	Moving
	AT Plat	Grd	Grd	Moving

Total: 35 target elements 35 attacks

Table E-41. Targets (initial), Detection Sources and Attack Means, Model III

Hour	Target	Detection Source	Attack By	Target Posture
1	2 Mec Inf Plat	Air	Air	Moving
	Mec Rcn Plat	Grd	Mines	Moving
2	Tk Plat	Air	Air	Moving
	6 Mec Inf Plat	Air	Air	Moving
	Rkt Sec	Air	Air	Moving
3	Mec Co Hq	2 LRR/EO	NGF	Moving
	3 Mec Inf Plat	Air	Air	Moving
	Tk Plat	Air	Air	Moving
	Mort Btry	2 LRR/EO	Air	Moving
		Air		
	Mec Inf Plat	2 LRR/EO	Air	Moving
		1 MRR		
		Air		
	Tk Plat	2 LRR/EO	Air	Moving
		Air		

Hour	Target	Detection Source	Attack By	Target Posture
	Mec Inf Plat	Grd Rcn Air	Air	Moving
4	Mec Bn Hq	2 LRR/EO 1 MRR	NGF	Moving
5	2 Mec Inf Plat	Grd	Arty	Moving
	Mec Co Hq	Grd	Arty	Moving
	Mec Bn Hq	Grd	Arty	Moving
	2 Mec Inf Plat	Grd	NGF	Moving
	Mec Co Hq	Grd	NGF	Moving
	Mec Co Hq	Grd	Air (Hel)	Moving
	2 Mec Co Hq	Grd	Grd	Moving
	Tk Co Hq	Grd	Grd	Moving
	3 Tk Plat	Grd	Grd	Moving
	Mec Rcn Plat	Grd	Grd	Moving
	2 AT Plat	Grd	Grd	Moving
	Total: 38 target elements		38 attacks	

Tables E-40 and E-41 above indicate the nature of the targets, detection sources, and method of attack of these targets, Models I and III. As indicated earlier the threat consisted of two Red mechanized infantry battalions, with a preponderance of tracked vehicles. In all cases except 2 in Model I, targets were moving when attacked. As might be expected, the preponderance of targets were mechanized infantry platoons (17/35 Model I, 17/38 Model III), platoon-size units making up target elements in the games. Note the multiple detection of individual target elements in Model III, beginning in the third hour, with subsequent attack by air (4 cases) and NGF (2 cases). In Model I, radar detected four target elements, resulting in two artillery and two ground attacks; two detections were made in the fourth hour, and two in the fifth.

Table E-42. Recapitulation, Initial Target Attacks, by Source of Attack, Over Time

Number and Source of Attacks, Model I

Time (hours)	Air	Artillery	NGF	Ground	Total
1	2				2
2	5		1		6
3		2			2
4	3			1	4
5	1	4	1	15	21
Total:	11	6	2	16	35
Percent:	31	17	6	46	100

Model III

Time (houre)	Air	Artillery	NGF	Ground	Total
1	2			1	3
2	8				8
3	8		1		9
4			1		1
5	1	4	3	9	17
Total:	19	4	5	10	38
Percent:	50	11	13	26	100

Table E-42 sums up the attacks by source over time. Note in Model III air accounts for 50 percent of the attacks, versus 31 percent in Model I.

MOE 13. The time from initial and subsequent target detection to target engagement (first round fired or release of ordnance by air) by target type and by detection device.

Where Tables E-40 and E-41 for MOE 12 indicate initial target detection source, and subsequent strike, Tables E-43 and E-44 below indicate additional strikes made on initial targets, in other words multiple strikes on the same target.

Table E-43. Multiple Strikes on Targets, by Strike Source, Model I

Time (hours)	Target (Ln Nr)	Previously Hit	Present Hit
3	Tk Plat (39)	Air, 2d hr	Air
4	Tk Co Hq (37)	Air, 4th hr	Air
	Mec Inf Plat (30)	Air, 1st hr	NGF
5	Mec Inf Plat (31)	Grd, 5th hr	NGF
	Mec Inf Plat (30)	Air, 1st & 4th hr	Arty
	Mec Bn Hq (02)	Air, 5th hr	Arty
	Mec Inf Plat (26)	Air, 1st hr	Grd
	Mec Inf Plat (30)	Air, 1st hr NGF, 4th hr Arty, 5th hr	Grd
	AT Plat (19)	Air, 4th hr	Grd
	Tk Plat (40)	Grd, 4th hr	Grd
	Mec Inf Plat	Grd, 4th hr	Arty

Total additional attacks: 11

Table E-44. Multiple Strikes on Targets, by Strike Source, Model III

Time (hours)	Target (Ln Nr)	Previously Hit	Present Hit
2	Mec Rcn Plat (45)	Grd, 1st hr	NGF
3	Mec Rcn Plat (45)	Grd, 1st hr NGF, 2d hr	Arty
	Mec Inf Plat (30)	Air, 2d hr	NGF
	Mec Inf Plat (31)	Air, 2d hr	Air
	Mort Btry (44)	Air, 3d hr	Air
	Mec Inf Plat (5)	Air, 2d hr	Air
4	Mec Inf Plat (6)	Air, 3d hr	Arty
	Mec Inf Plat (5)	Air, 2d hr Air, 3d hr	Air
	Mort Btry (44)	Air, 3d hr Air, 3d hr	Arty
5	Mec Bn Hq (24)	NGF, 4th hr	Arty
	Mec Inf Plat (9)	Air, 2d hr	NGF
	Mec Inf Plat (26)	Air, 1st hr	NGF
	Mec Co Hq (29)	Arty, 3d hr	NGF

Time (hours)	Target (Ln Nr)	Previously Hit	Present Hit
	Mec Inf Plat (8)	Air, 2d hr	Grd
	Mec Inf Plat (4)	Air, 2d hr	Grd
	Mec Inf Plat (5)	Air, 2d hr	Grd
		Air, 3d hr	
		Air, 4th hr	
	Mec Inf Plat (6)	Air, 3d hr	Grd
		Arty, 4th hr	
	Mec Rcn Plat (45)	Grd, 1st hr	Grd
		NGF, 2d hr	
		Arty, 3d hr	
	Mec Inf Plat (34)	Air, 3d hr	Grd
	Mec Inf Plat (35)	Air, 3d hr	Grd
	Mec Inf Plat (36)	Air, 3d hr	Grd
	Mec Inf Plat (30)	Air, 2d hr	Grd
		NGF, 3d hr	
	Mec Inf Plat (31)	Air, 2d hr	Grd
		Air, 3d hr	
	Mec Inf Plat (32)	Air, 3d hr	Grd
	Mec Inf Plat (27)	Air, 1st hr	Grd
	Tk Plat (40)	Air, 3d hr	Grd

Total additional attacks: 26

DISCUSSION. (Tables E-44, E-45). Model I had 35 hits on 35 separate target elements, plus 11 additional attacks, for a total of 46 target attacks. In Model III, 38 target elements were hit at least once, with 26 additional attacks made, for a total of 64. Model I achieved 72 percent of the attacks made in Model III.

Reaction time - detection to target attack - is indicated below for supporting arms (air, NGF, artillery) for the total attacks made by Models I and III.

Table E-45. Time from Detection to Attack, Model I, by Type Supporting Arms

Time Detection to Attack* (min)	Supporting Arm Air	NGF	Artillery
0-5	11		
5-10		2	2
10-15		1	4
15-20		1	1
25-30			1
35-40			1
45-50	2		
Total:	13	4	9

* 19 target elements hit at least once.

Note: Air — 10 attacks, 2 mins each
1 attack, 3 min
1 attack, 47 min
1 attack, 49 min

NGF — 2 attacks, 15 min ea
1 attack, 16 min
1 attack, 27 min

Arty — 2 attacks, 9 min ea
1 attack, 13 min
3 attacks, 14 min ea
1 attack, 19 min
1 attack, 26 min
1 attack, 39 min

Air: mean 9.15 min
mode 2 min

Artillery: mean 17.4 min
mode 14 min

NGF: mean 18.3 min
mode 15 min

Table E-46. Time from Detection to Attack, Model III by Type Supporting Arm

Time Detection to Attack* (min)	Supporting Arm Air	NGF	Artillery
0-5	18		
6-10	2	1	4
11-15		7	4
16-20	2	1	
31-35	1		
36-40		1	
	23	10	8

Note: Air — 13 attacks, 2 min ea
1 attack, 3 min
4 attacks, 4 min ea
1 attack, 6 min
1 attack, 8 min
2 attacks, 20 min ea
1 attack, 31 min

NGF — 1 attack, 9 min
7 attacks, 15 min ea
1 attack, 19 min
1 attack, 37 min

Arty — 4 attacks, 9 min ea
4 attacks, 14 min ea

* 28 target elements hit at least once.

Air: mean 5.7 min
mode 2 min

NGF: mean 17.0 min

Arty: mean 11.5 min

MOE 14. The number of targets engaged by type supporting arm as a function of target range from the closest point of the trace of the center of mass of the forward Blue infantry platoons at time of initial target engagement.

Table E-47. Range of attack, by Type Supporting Arm, Models I and III

Model I (19 target elements)

Target Range (km)	Supporting Arm		
	Air	Arty	NGF
0 - .9		4 (.5)	2 (.5, .95)
1 - 1.9	1 (1.0)	3 (2-1.0) (1-1.3)	1 (1.0)
2.0-2.9	1 (2.9)		
3.0-3.9	4 (3-3.0) (1-3.2)	1 (3.4)	1 (3.7)
4.0-4.9	1 (4.0)	1 (4.6)	
5.0-5.9	4 (5.1)		
13.0-13.1	1 (13.1)		
16.0-16.9	1 (16.8)		
Total:	13	9	4
Mean range:	5.5	1.5	1.5

Model III (28 target elements)

Target Range (km)	Supporting Arm		
	Air	Arty	NGF
0 - .9	1 (.5)	3 (.5)	6 (.5)
1.0-1.9		2 (1.1)	
2.0-2.9	1 (2.3)	2 (2.4) (2.9)	
3.0-3.9	2 (3.3)		1 (3.4)
4.0-4.9	9 (6-4.4 (3-4.6)	1 (4.6)	2 (4.6)
7.0-7.9	4 (7.8)		
9.0-9.9	4 (2-9.0 (2-9.5)		1 (9.4)
12.0-12.9	1 (12.9)		
13.0-13.9	1 (13.9)		
Total	23	8	10
Mean range:	6.3	1.7	2.5

DISCUSSION

Model III did achieve more target attacks at greater ranges by supporting arms. Principal difference occurred in air attacks, where Model III achieved 1.8 times as many as occurred in Model I. Note however that the mean ranges differ for air by only 800 meters, for artillery by 200 meters, and for NGF by 1000 meters. Figure E-8 graphically portrays the data.

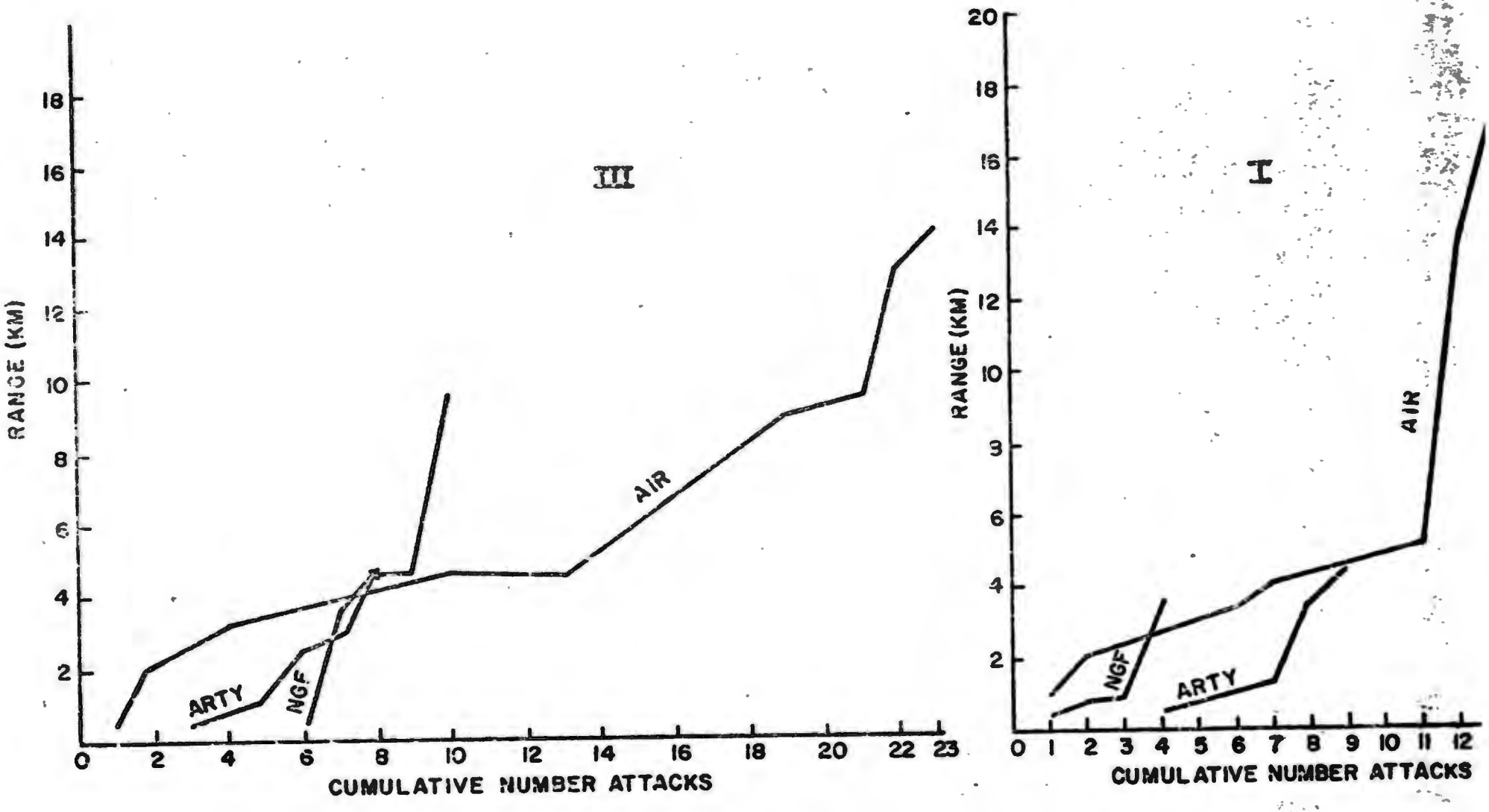
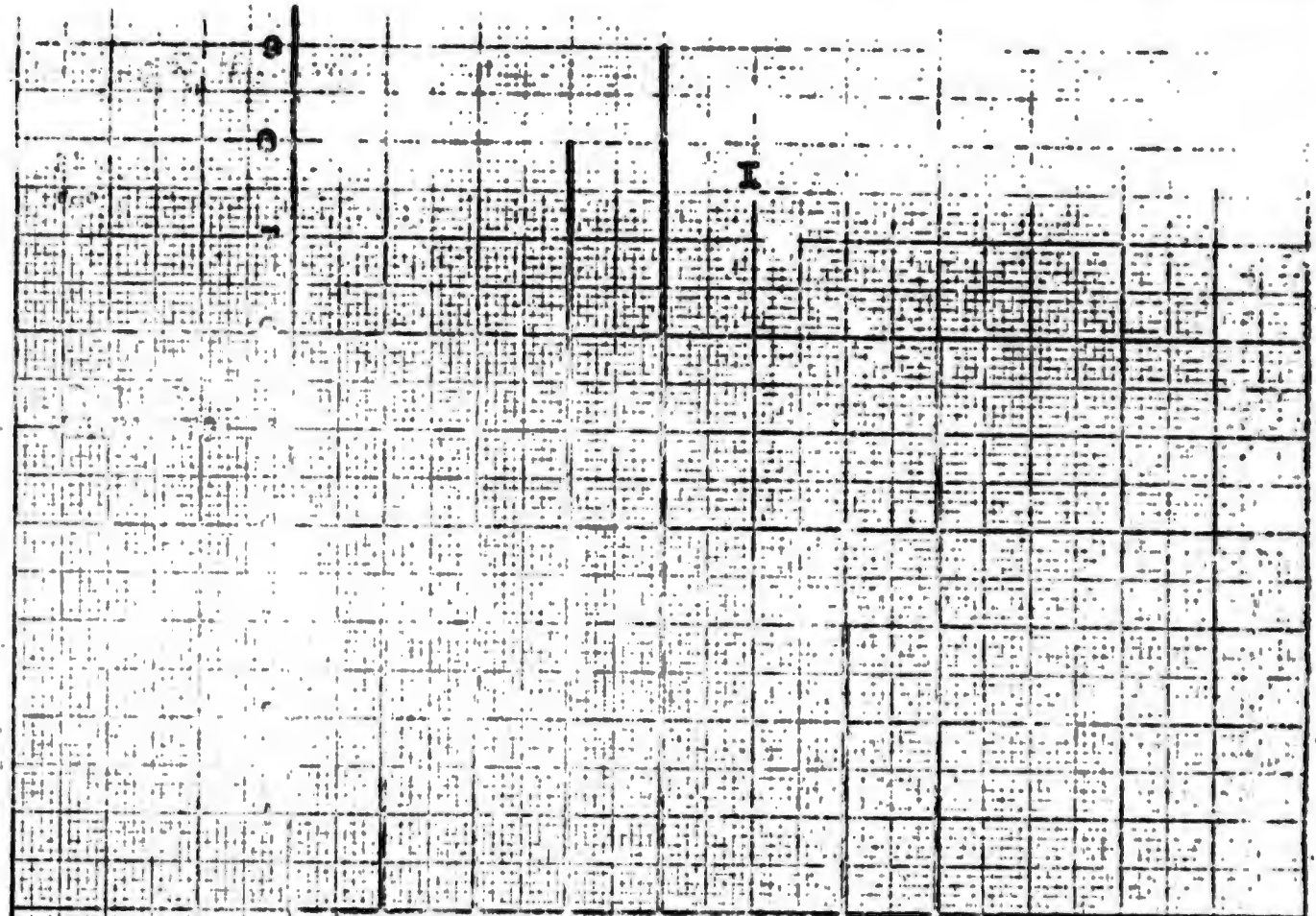


FIGURE E-3. CUMULATIVE ATTACKS, BY RANGE TO BLUE POSITIONS

MOE 15. The change of target range from the trace of the forward Blue platoons from time of initial detection to time of engagement by range zone at time of initial detection.

Figures E-9 and E-10 below indicate for Models I and III how far target elements travelled toward Blue before being hit, measured from initial detection range. On the average Model I targets moved 4.1 kilometers closer to Blue positions than did Model III targets, before being hit. Model I targets began to be hit after they had moved about 10 kilometers. Model III hits were more evenly spaced over range, and in fact almost 60 percent (22/38) had been hit before they had moved from 300 to less than 10 kilometers. Model III engaged targets earlier to a significant degree than did Model I.



MEAN DISTANCE TRAVELLED TOWARD BLUE 13.0 KM (DETECTION TO ATTACK)

FIGURE E-9. DISTANCE TRAVELLED TOWARD BLUE AFTER DETECTION AND UNTIL HIT

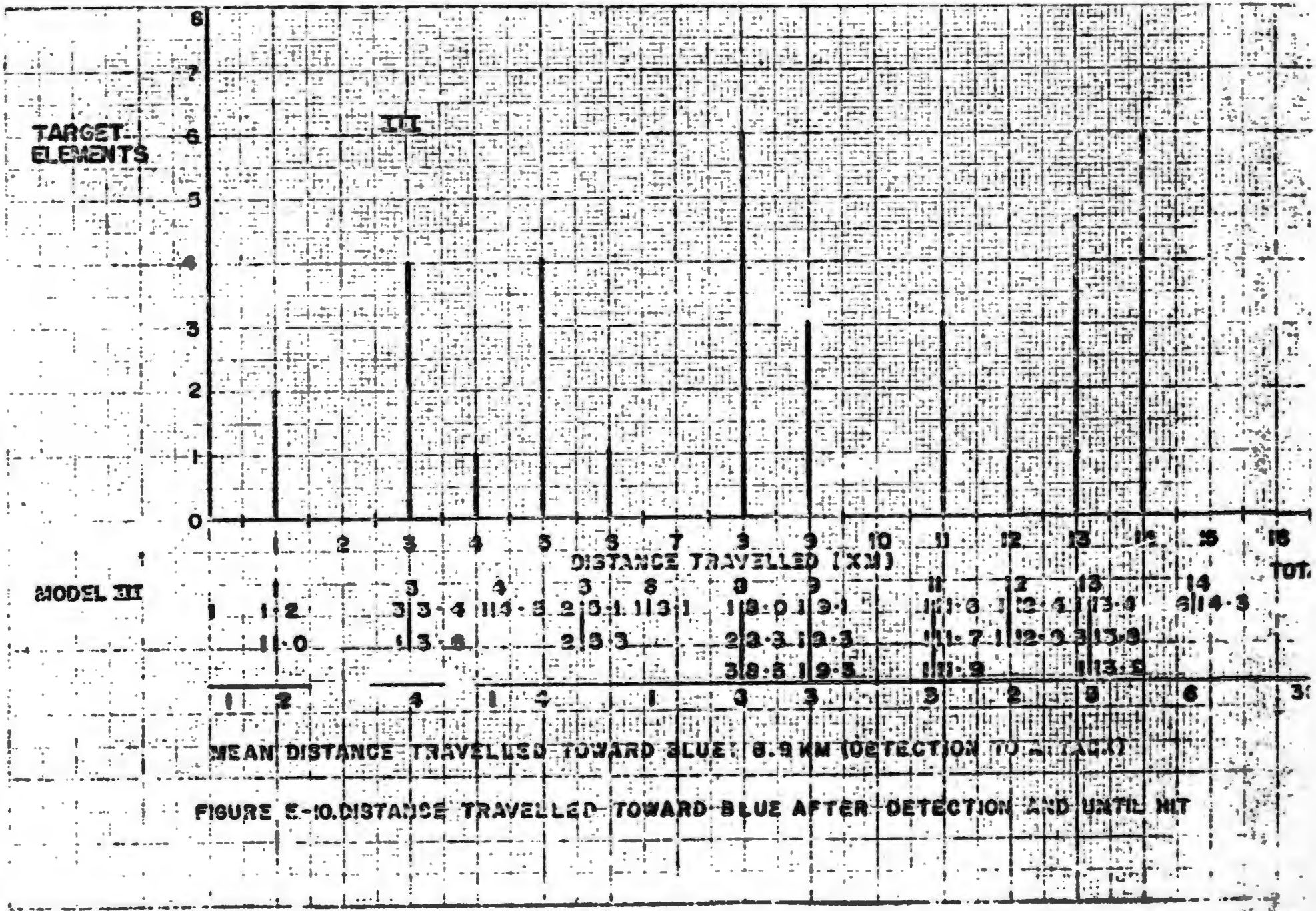


FIGURE E-10. DISTANCE TRAVELLED TOWARD BLUE AFTER DETECTION AND UNTIL HIT

MOE 16. The difference between the total number of detections and number of target engagements, by type supporting arm (air, NGF, artillery, mortar) as a function of range from the trace of the forward Blue platoons.

In Model I the ratio between total attacks by supporting arms and total detections was 26/406, or 6 percent. In Model III this ratio was 4 percent (41/986). In either case, detection capability was much greater than capability to respond with supporting arms. Figures E-11 and E-12 below give the comparison of detections and attacks for each model. Model III did achieve more attacks spread over a greater range than did Model I. The tables below give detailed breakouts of detection and attack ranges.

Table E-47a. Range of Detection (km), Model I

Range (Detections)	1	2	3	4	5	7
	3 .95	8 2.1	34 3.0	5 4.0	42 5.1	17 7.8
	17 1.00	1 2.3	1 3.2	1 4.2	17 5.3	
	9 1.10	6 2.4	1 3.6	21 4.6		
	18 .50	2 2.5	21 3.7			
	12 1.30	3 2.6				
	4 1.40	3 2.7				
	11 1.50	8 2.8				
	4 1.90	19 2.9				
	78	50	57	27	59	17

Range (Detections)	8	9	10	13	14	16
	6 8.8	26 9.7	1 10.7	17 13.1	10 14.0	26 16.8
					6 14.2	
					26 14.4	
	6	26	1	17	42	26

Total: 406

Table E-47b. Range of Attacks (km) Model I (19 target elements)

Supporting Arm (Range)	1	2	3	4	5	13	16	Total
Air	1	1	4	1	4	1	1	13
NGF	3		1					4
Artillery	7		1	1				9
								26

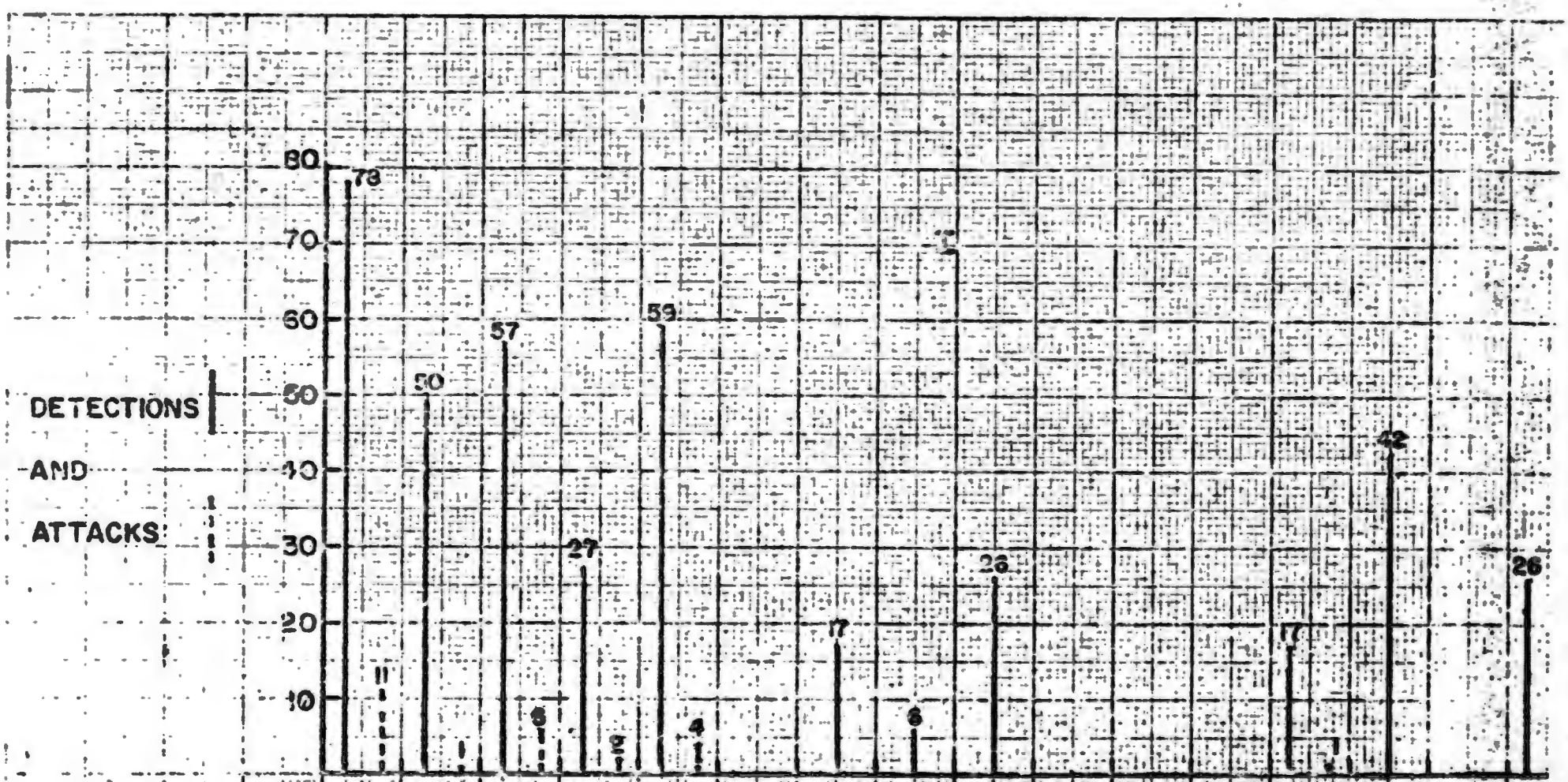


FIGURE E-11. DETECTIONS AND ATTACKS, MODEL I

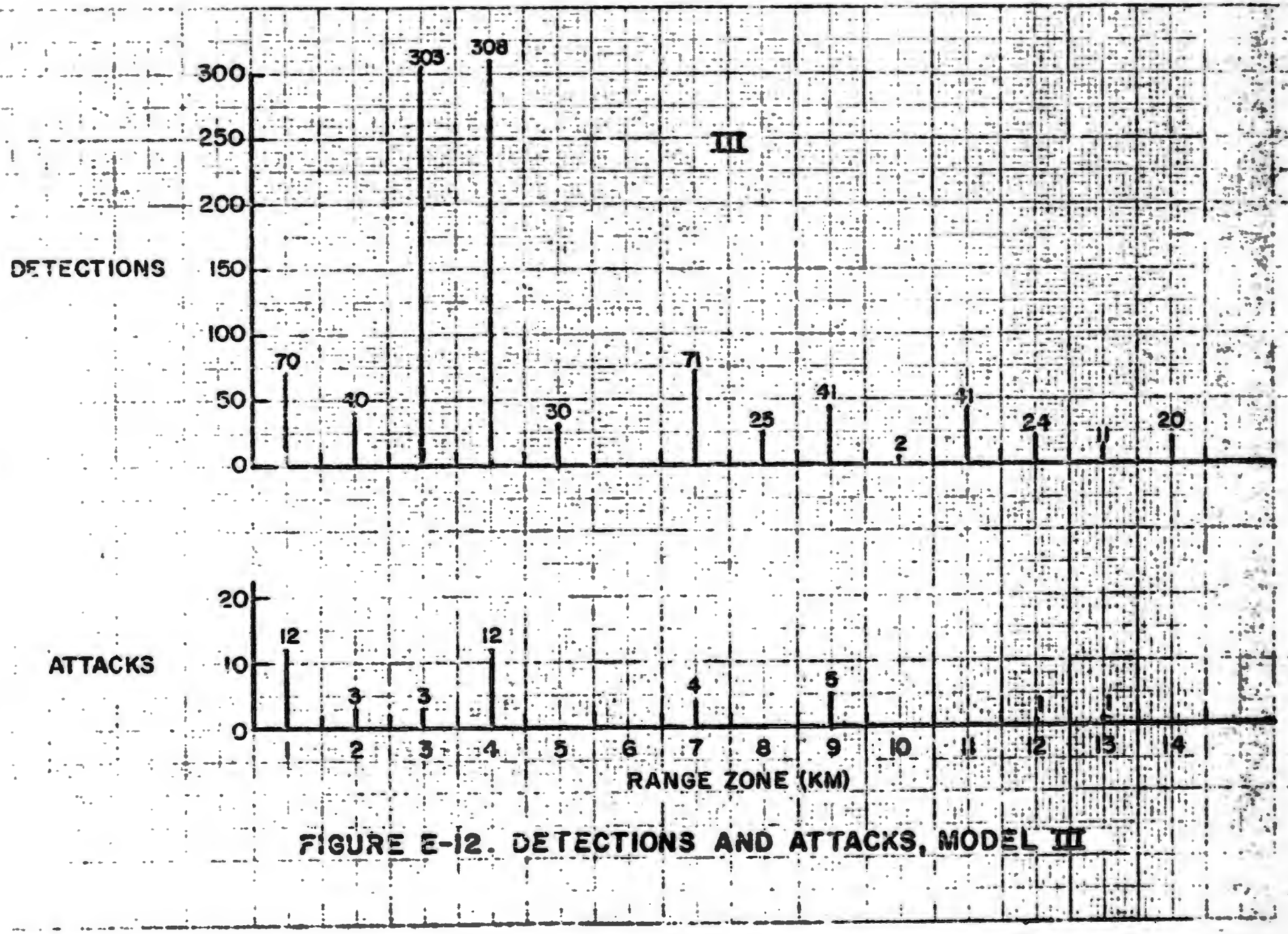


FIGURE E-12. DETECTIONS AND ATTACKS, MODEL III

Table E-47c. Range of Detection (km), Model III

Detections \ Range	1	2	3	4	5	7
	22 .5	9 2.3	63 3.0	96 4.2	20 5.0	17 7.2
	2 .7	6 2.4	28 3.2	72 4.3	4 5.2	17 7.3
	3 .8	6 2.6	6 3.3	44 4.4	6 5.3	12 7.4
	7 1.0	3 2.7	115 3.4	61 4.6		25 7.8
	36 1.1	16 2.9	69 3.6	35 4.9		
			16 3.8			
			6 3.9			
	70	40	303	308	30	71

8	9	10	11	12	13
25 8.0	6 9.0	2 10.8	17 11.0	6 12.4	9 13.9
	17 9.5		6 11.3	18 12.9	2 13.7
	18 9.8		18 11.7		
25	41	2	41	24	11

14	Total
2 14.2	986
18 14.8	
20	

Table E-47d. Range of Attacks, Model III (28 target elements)

Supporting Arm \ Range	1	2	3	4	7	9	12	13	Total
Air	1	1	2	9	4	4	1	1	23
NGF	6		1	2		1			10
Artillery	5	2		1					8
									41

OBJECTIVE 2. To evaluate the relative capability of the two candidate forces to engage enemy forces utilizing supporting arms.

MOE 17. Discussed under MOE 13.

MOE 18. The number of targets engaged by type supporting arm (air, NGF, artillery, mortar) as a function of time.

Figure E-13 below indicates graphically the comparison of the supporting arms contribution for Models I and III. Model III achieved 1.6 times as many attacks as did Model I, the biggest differences being in air and NGF support. By the end of the third hour 2.3 times as many attacks had occurred in Model III, compared to Model I. Nineteen target elements were hit at least once, Model I, and 28 were hit at least once in Model III, by supporting arms.

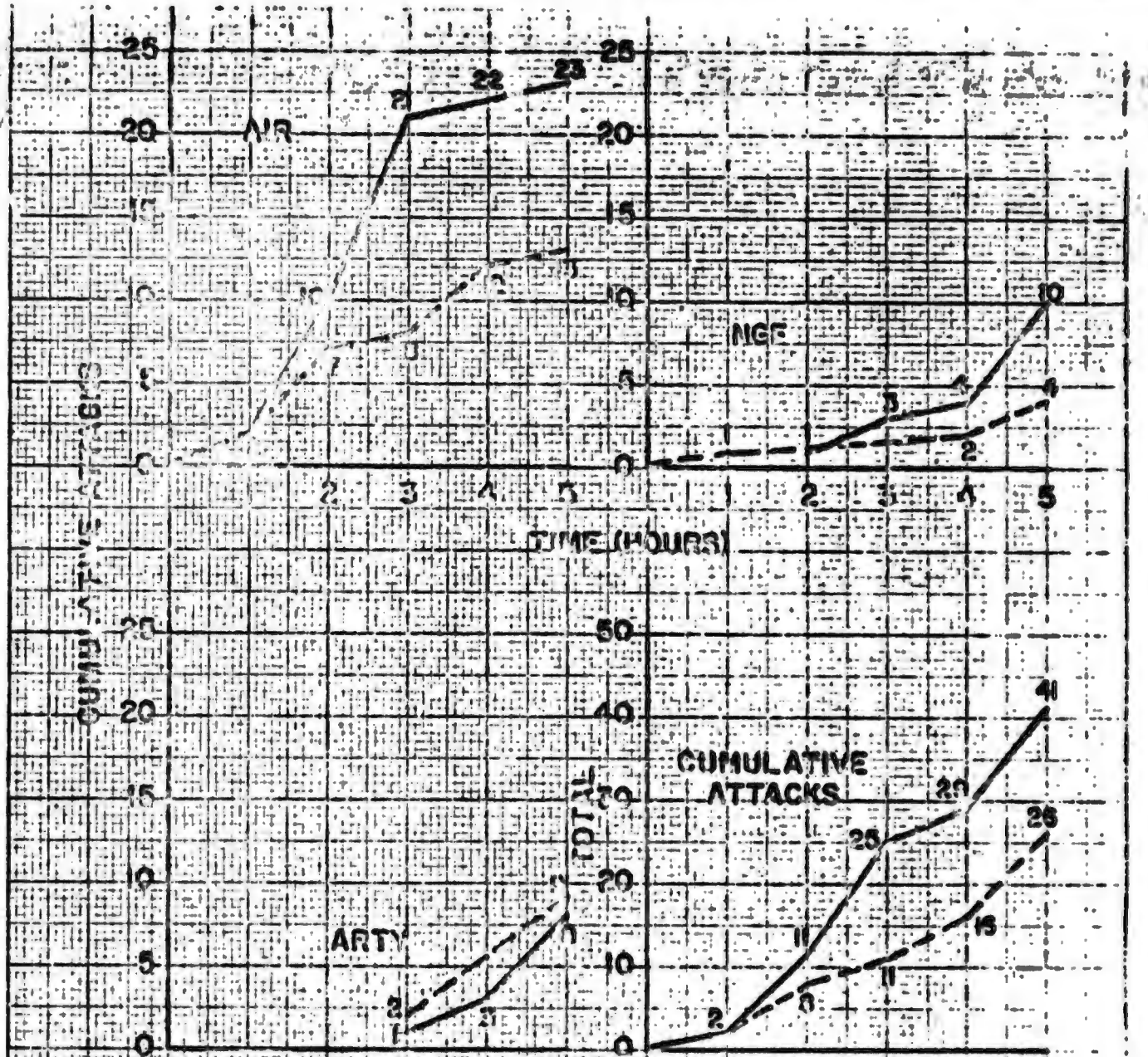


FIGURE E-13. TARGETS ENGAGED BY SUPPORTING ARMS, OVER TIME

MOE 19. The number of Red casualties and type of equipment lost as a function of time.

Figure E-14 below indicates the Red and Blue losses over time. Results are quite close for both models. The greatly increased STA capability of Model III did not result in a similar increase in Red losses, 203 in Model I, 209 in Model III. However 2.5 times as many losses were inflicted earlier on Red, in Model III, than in Model I, prior to close combat in the fifth hour.

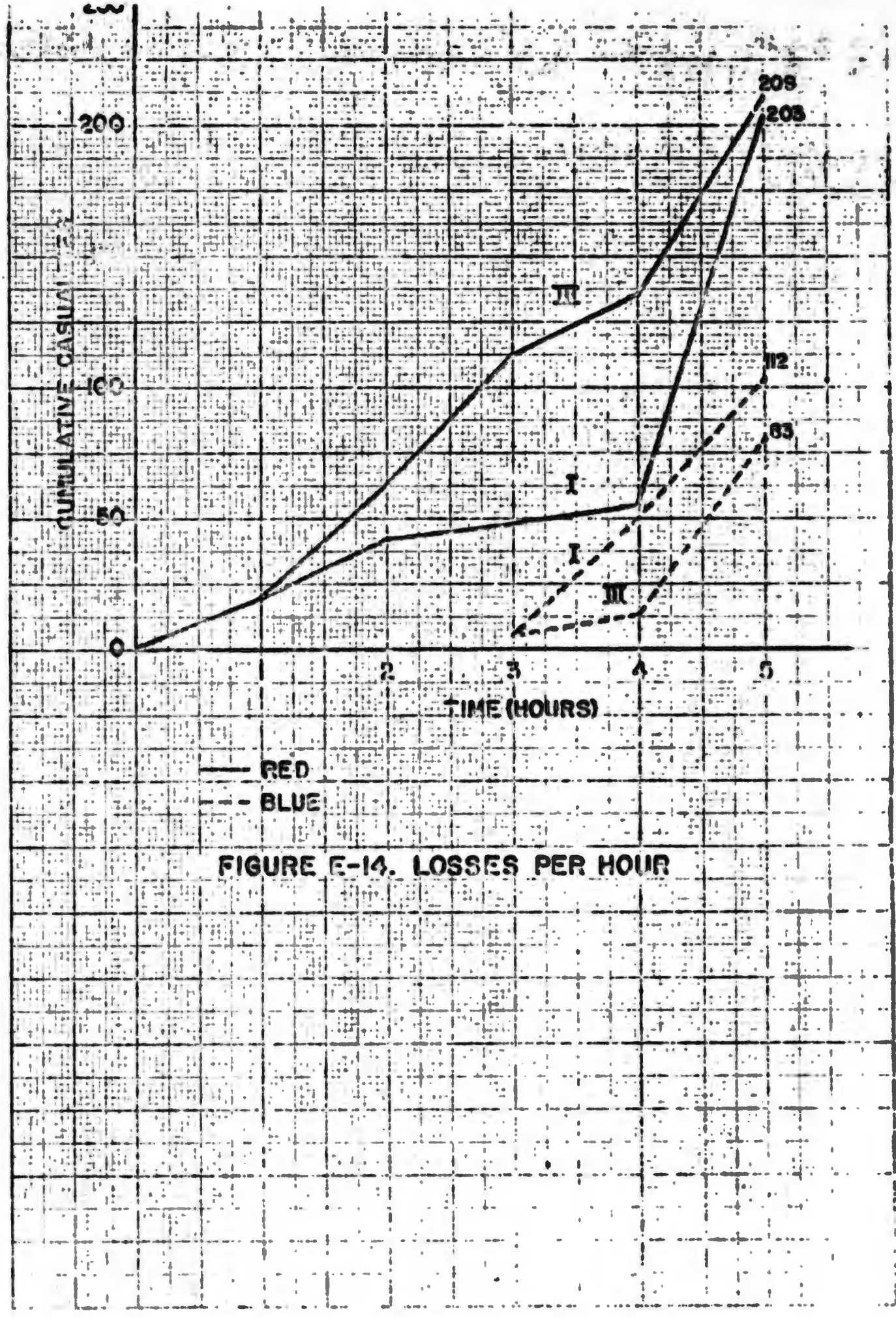


FIGURE E-14. LOSSES PER HOUR

MOE 20. The number of Red casualties and type of equipment lost as a function of the distance from the trace of the forward Blue platoons.

Table E-48 below indicates the number of Red casualties by range to the closest Blue positions. No great differences are discernible, with totals being almost the same - 203 in Model I, 209 in Model III. However in Model I more casualties, 73 percent, were inflicted at close range, up to 1.1 kilometers, than in Model III, where 39 percent were inflicted.

In Model I, half of the APC losses occurred within 2 kilometers of Blue; no APC losses occurred at this close range in Model III, all being fairly well distributed out to 14 kilometers. And in Model III Red APC losses were almost double those in Model I (19 to 10). (See Table E-49).

Model	One Kilometer Zones 0.0	1	2	3	4	5	6	7	8
I	10/.3 14/.9 8/.95 32	93/1.0 23/1.1 116		10/3.0 4/3.2 14		17/5.1 17			6/8.8 6

(cont below)

Model	9	10	11	12	13	14	15	16	Total
I				2/12.7 2	4/13.1 4			12/16.8 12	203

Model	0.0	1	2	3	4	5	6	7	8
III	26/.5 15/.8 6/.9 47	28/1.0 7/1.1 35	8/2.4 4/2.9 12	8/3.3 2/3.4 10	29/4.4 16/4.6 45			23/7.8 23	

(cont below)

Model	9	10	11	12	13	14	15	16	Total
III	8/9.0 12/9.5 20		1/11.7 1	8/12.9 8	8/13.9 8				209

Table E-48. Red Casualties by Range to Blue

Table E-49. Red Equipment Losses, by Range to Blue

Range (km)	Tk		APC		BRDM		Trk		Arty	
	I	III	I	III	I	III	I	III	I	III
0.0- .9										
1.0-1.9	11	12	5		3	6	2			
2.0-2.9				1						
3.0-3.9	2		1	2	1			1		
4.0-4.9		2		6				2		2
5.0-5.9							4		1	
6.0-6.9										
7.0-7.9		1		2				1		1
8.0-8.9			1							
9.0-9.9				4						
10.0-10.9										
11.0-11.9										
12.0-12.9				2						
13.0-13.9	1			2	1					
16.0-16.9			3							
Total	14	15	10	19	5	6	6	4	1	3

MOE 21. The number of rounds respectively of mortar, artillery, and NGF expended per Red casualty, and per unit and type of equipment lost.

Table E-50 below shows NGF and artillery rounds per casualty. Mortars were incorporated in the firepower calculations for Models I and III, reflected in force ratios in ground combat. There are wide variances in game results between the Models in terms of rounds per casualty. But, these differences could not be traced to differences in STA performance. Rather, they stem from differences in target engagement decisions in the two iterations and the stochastic nature of casualty assessment. There are no significant findings to be reported in comparing Models I and III, using rounds per casualty or per type equipment lost as a measure.

Table E-50. NGF and Artillery Rounds per Casualty, Models I and III.

Model I

NGF and Artillery - rds/casualty

Hour	NGF Rds	Casualties	Hour	Arty Rds	Casualties
2	80	0			0
4	60	0	3	15	0
5	120	8	5	300	38
	260	8		315	38

32.5 rds/casualty

8.3 rds/casualty

Model III

Hour	NGF Rds	Casualties	Hour	Arty Rds	Casualties
2	30	0			
3	90	0	3	60	0
4	960	2	4	284	12
5	180	9	5	150	13
	1260	11		494	25

114.5 rds/casualty

19.8 rds/casualty

Objective 3. To evaluate the relative capability of the two candidate forces to engage the enemy in close combat utilizing direct fire weapons organic to the infantry battalion.

MOE 22. A comparison of the full strength firepower available to the Model I and Model III battalions (small arms firepower scores, antiarmor effectiveness, mortar effectiveness).

Discussion. Although the Model I battalion had fourteen percent more strength than the Model III battalion (1231/1080) the firepower score for Model I was 4.52, for the Model III battalion, 10.82. Differences were primarily due to the incorporation of the small automatic weapon in Model III (equivalent to the M60 machine gun) and to the incorporation of 12 improved 81mm mortars, 6200 meters range, versus 8 mortars, 4500 meters range Model I.

Antitank firepower was also increased in Model III with 12 DRAGON trackers and 4 106mm recoilless rifles, versus 8 106mm recoilless rifles in Model I. The DRAGON achieves about a 35 percent increase in hit probability over the 106mm recoilless rifle at 1000 meters.

MOE 23. The ratio of the percentage of Red losses to the percentage of Blue losses from commencement of close combat to termination of close combat, attributable to organic firepower, as a function of strength at the time of commencement of close combat.

The loss ratio is reflected in the table below.

Table E-51. Loss Ratio, Red to Blue, from Organic Firepower

	Model I		Model III	
	Red	Blue	Red	Blue
Strength, start close combat:	1521	1869	1458	1779
Loss, ground combat:	89	36	60	42
Percent loss:	(89/1521)	(36/1869)	(60/1458)	(42/1779)
	6%	2%	4%	2%
Loss Ratio:	6/2 = 3/1 red/blue		4/2 = 2/1 red/blue	

Discussion. At the start of the close combat phase - beginning of the 5th hour of combat in each game - leading Red elements were between 1.0 and 1.1 kilometers from Blue positions. Red total losses were approximately the same in each game (203, Model I; 209, Model III). In the Model I iteration close combat was assessed in two separate but simultaneous battles; in Model III, force disposition was such that the confrontation could be assessed in one battle. Close combat assessment was terminated after one hour in the case of Model I and 1/2 hour in the case of Model III. Game results, with respect to number of Red casualties inflicted during close combat, tend to suggest that Model I dominated Model III. In fact, however, the opposite is true. Against Model I Red had a probability of success of 0.93; but, against Model III had only 0.55 probability of success due to the superior firepower scores of Model III (2.4 times greater than Model I). In determining the battle outcome the random number drawn for Model III had Red winning; but, in the Model I iteration a random number in the rare event category was drawn and Red did not win in one of the two battles. This rare event coupled with the shorter time of close combat assessment for Model III accounts for the greater number of casualties inflicted by Model I.

MOE 24. The ratio of Red losses to Blue losses from the commencement to termination of close combat, attributable to organic firepower, as a function of strength at time of commencement of close combat.

Table E-52. Loss Ratio, Red/Blue, Close Combat

Model I		Model III	
$\frac{\text{Red Loss}}{\text{Blue Loss}}$	$\frac{89}{36} = \frac{2.5}{1}$	$\frac{60}{42} = \frac{1.4}{1}$	

Discussion. As noted under MOE 23 above Red losses were 50 percent greater in close combat (5th hour) in Model I than in Model III. Total Red losses to Blue organic firepower were $\frac{95}{203}$ (.47), Model I and $\frac{61}{209}$ (.29). All other Red losses were attributable to supporting arms in each game - 53 percent, Model I and 71 percent Model III.

MOE 25. The number of times Blue attacked successfully or Red attacked unsuccessfully relative to the total number of ground combat assessments.

Discussion. There were two ground combat assessments, Model I, and one, Model III. Red was successful in one in Model I, one in Model III, and was within 300 to 500 meters of Blue at the end of the fifth hour.

MOE 26. Probability of Red success at start of close combat.

Discussion. Probability of success is a function of force ratio, based on firepower scores. In Model I, force ratio was $\frac{5.3}{1}\left\{\begin{matrix}(R)\\(B)\end{matrix}\right.$ with probability of Red success .93. In Model III force ratio was $\frac{1.12}{1}\left\{\begin{matrix}(R)\\(B)\end{matrix}\right.$, with probability of Red success .55.
Thus, Model III clearly dominates Model I in close combat potential. The reason is the superior firepower scores of Model III, accruing primarily from the improved 81mm mortar and the squad automatic weapon.

Objective 4. To evaluate the relative capability of the two candiate forces to accomplish the assigned mission.

MOE 27. Ratio of Red casualties, and type equipment lost, to Blue casualties and equipment lost, as a function of distance from a trace of the forward Blue platoons.

Discussion. Table E-53 below indicates casualty ratios, Red to Blue, as a function of center of mass distance Red to Blue, over time. Essentially the data bear out the point previously made that Model III, with greater organic, close-in firepower available than Model I, was in a more favorable position to withstand Red attack when the game ended. Red at this point had only a marginal force-ratio superiority 1.2/1 Model III, versus 5.3/1 Model I. In Model III the Red force had been attrited more severely throughout the game, whereas in Model I major attrition occurred in the last hour.

In both games, 80 percent of Red tank losses occurred within two kilometers of Blue (Table E-49). Losses were approximately the same for Red in each game (14, 15). Blue lost all tanks, (5), Model I, three tanks, Model III. Red APC losses however show a difference in Blue effectiveness. In Model I, Blue destroyed 10 APC's; in Model III, Blue destroyed 19 APC's. Also, in Model III all APC's were destroyed at greater than two kilometers range from Blue; in Model I only five APC's were similarly destroyed (see Table E-49).

Table E-53. Casualty Ratio, Red to Blue, as Function of Range

Model I

Time (hrs)	Distance Red Center of Mass to Blue (km)	Casualties (R/B)	Ratio (R/B)
1	11.5	18/0	Indeterminate
2	4.7	23/0	Indeterminate
3	4.7	4/4	1/1
4	2.5	18/43	.4/1
5	2.0	140/65	2.2/1

Model III

Time (hrs)	Red from Blue (km)	Casualties (R/B)	Ratio (R/B)
1	15	17/0	Indeterminate
2	6.5	43/0	Indeterminate
3	6.3	53/0	Indeterminate
4	2.8	14/13	1.1/1
5	2.0	82/70	1.2/1

MOE 28. Ratio as above, as a function of time.

Discussion. Table E-54 below indicates loss ratios over time.

Table E-54. Ratio of Losses Over Time

	Time (hrs)									
	1		2		3		4		5	
	I	III	I	III	I	III	I	III	I	III
Red Loss	18	17	23	43	4	53	18	14	140	82
Blue Loss	0	0	0	0	4	00	43	13	65	70
Ratio	Indeterminate				1	Ind.	.4	1.1	2.2	1.2

MOE 29. Rate of Red advance toward its objective.

Discussion. Table E-55, below, indicates Red rate of advance toward Blue. In each game Red began his deployment of two mechanized battalions from march column during the first hour, then achieved his fastest movement during the second hour during the move to attack positions. Movement slowed as Red closed on the Blue force (4th and 5th hours) after leaving his attack positions. Center of mass of Red at the start was 21.6 kilometers from Blue. Overall rate was 3.9 kilometers per hour, Models I and III.

Table E-55. Rate of Advance, Red Toward Blue (km/hr)

Center of Mass Movement	Time (hours)				
	1	2	3	4	5
I	5.4	11.5	0	2.2	.5
III	6.6	8.5	.2	3.5	.8

ANNEX F

ANALYSIS AND FINDINGS

War Game MARSAS II (Bn in the night attack)

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I. FINDINGS

1. Nature of Game. This game pitted a Marine infantry battalion against a one-battalion mechanized force. Prior to game start the Blue battalion had been pursuing the withdrawing Red force and had stopped on an interim objective to reorganize to continue the attack. Game play began at 2000 hrs as Red broke contact and commenced his withdrawal to his next defensive position, some five kilometers distant from the Blue battalion. One hour later Blue commenced a dismounted attack with three companies abreast. Within six hours Blue closed on the Red position and close combat commenced. Ambient illumination was quarter moon and rainfall did not occur. The game ended at the end of the sixth hour for Model III and the seventh hour for Model I: an additional hour of close combat was included in the Model I iteration.

2. Findings:

a. Objective 1. The relative capability of Models I and III to perform the functions of combat surveillance, target acquisition, target location and target designation.

Model III demonstrated a greater capability to detect targets. Two measures capture the essence of the comparative performance: (1) Surveillance Coverage (2) Percentage of total targets detected as a function of time.

(1) Surveillance Coverage. The table below displays the marked difference in coverage that accrued to Model III from the greater radar capability. It should be noted that neither battalion employed all their radar assets (III used 5 of 16; I used 2 of 8). The reason was lack of need for coverage of the rear and the narrow battalion width in attack posture. Also, due to the narrow width, Blue learned in the first iteration (Model III) that only two medium range radars were needed. The real advantage accruing to Model III, then, was the longer ranges of its radars, not the number available.

MODEL	RADARS USED		AREA UNDER SURVEILLANCE (KM^2)	PERCENT VISIBLE	AREA COVERED (KM^2)
	MRR	LRR			
I	2	-	14	19%	2.7
III	3	2	157	29%	45.5

Table F-1

(2) Percentage of Targets Detected. The table below gives the percentage of targets detected until close combat commenced. Game resolution was at platoon level; 25 platoons constituted the Red Force. Model III was superior in every period, especially the first and fifth hours. It is also

significant to note that this greater performance is directly attributable to the new radars and E/O devices of Model III. Table F-26 of Section III reveals that the radars of Model III detected 11 more targets than Model I (13 vs 2) and E/O devices 4 more (8 vs 4).

PERCENTAGE of TARGET ELEMENTS DETECTED

Table F-2

MODEL \ HOUR	1	2	3	4	5	6
I	48	24	12	04	0	04
III	92	28	24	24	40	-

b. Objective 2. The relative capability of the two Models to engage enemy forces utilizing supporting arms.

There does not appear to be any significant difference in supporting arms performance that is correlated with STA performance. Rather, the differences that do exist in the performance measures dealing with target engagement (Measures 12-18 of Section 2) can be traced to varying Blue tactics between the two iterations. And, it could not be reasoned that these changes should have occurred based on different nature of the Models only. If, however, artillery were more effective against fleeting mechanized columns (as determined by the LFWG model) Model III would have probably dominated in target engagement performance.

c. Objective 3. The relative capability of the two Models to engage the enemy in close combat.

Model III was superior to Model I in close combat performance. Model III had a probability of 0.5 to succeed compared to 0.3 for Model I. But, this increased margin is primarily due to the superior firepower scores of Model III and not STA system comparative performance. It should be noted, however, that Model III was able to apply 72% of its remaining force against Red in the first battle while Model I applied only 32% of its remaining force (see para 17, Section 2). The reason was that Model III was able to detect and thus fix all Red companies while Model I had not fixed one of Red companies prior to close combat. An additional hour of close combat was included in the Model I iterations to allow all forces to engage.

d. Objective 4. The relative capability of the two Models to accomplish the assigned mission.

At end game the Red to Blue casualty ratio slightly favored Model I (0.8 to 0.7). However, had the game continued, Model III would have undoubtedly dominated Model I because of its superior fire power score. (See para 17, Section 2).

II. PERFORMANCE MEASURES

1. Measure #1. The number of target detections as a function of distance between the target and the source of detection.

The table below gives total data. See Table F-28 for breakdown by sensor. Air detections are not included since it was infeasible to measure the sensor range.

DETECTIONS VS SENSOR RANGE

Table F-3

RANGE / MODEL	$0 \leq R \leq 1$	$1 < R < 2$	$2 < R \leq 3$	$3 < R \leq 4$	$4 < R \leq 5$	Σ
I	2	6	0	0	0	8
III	2	11	4	5	1	23

COMMENT: In each case the greatest number of detections occurred within the range band 1-2 km. However, Model III also made a significant number of detections beyond this band while Model I did not. This is directly attributable to the longer range capability of Model III radars.

2. Measure #2. The number of target detections as a function of the distance between the target and the center of mass of the Blue infantry platoon closest to the target.

The table below gives total data. See Table F-27, for breakdown by sensor. Air detections are included in this measure.

DETECTIONS VS RANGE to BLUE

Table F-4

RANGE / MODEL	$0 \leq R \leq 1$	$1 < R \leq 2$	$2 < R \leq 3$	$3 < R \leq 4$	$4 < R \leq 5$	Σ
I	0	7	3	3	1	14
III	1	17	1	6	2	27

COMMENT: Again, the greatest number is at the 1-2 band. However, Model I does make a significant number of detections beyond that band, primarily due to the inclusion of air in this measure.

3. Measure # 3. The number of target detections made during each hour of game play.

The table below gives total data. See Table F-26, for breakdown by sensor.

DETECTIONS VS TIME
Table F-5

MODEL \ HOUR	1	2	3	4	5	6	Σ
I	7/40/12	2/3/6	3/6/3	1/1/1	0	1/1/1	14/51
III	12/86/23	4/4/7	2/4/6	7/14/6	2/9/10	-	27/137
%* I	48	24	12	04	0	04	-
III	92	28	24	24	40	-	-

Table Entry = #Detections/#target elements detected/#different elements

* Entry is percentage of total population of target elements that were detected during hour.

COMMENT: Model III is clearly superior to Model I, not only in the number of detections but, also, in the percent of target elements detected.

4. Measure # 4. The cumulative number of target detections as a function of time.

The table below gives total data, see Table F-30 for breakdown.

CUMULATIVE DETECTIONS VS TIME
Table F-6

MODEL \ TIME	T≤1	T≤2	T≤3	T≤4	T≤5	T≤6
I	7	9	12	13	13	14
III	12	16	18	25	27	-

5. Measure # 5. The number of target elements being tracked at the end of each hour.

MODEL \ HOUR	1	2	3	4	5
I	4	2	1	0	0
III	6	7	5	8	1

Table F-7

6. Measure # 6. The percent of target elements within specified zones being tracked at the end of each hour. Zones will be established as a function of distance from trace of forward Blue platoons.

TARGET ELEMENT DISTRIBUTION

RANGE / HOUR	0≤R≤3		3<R≤6		6<R≤9	
	I	III	I	III	I	III
1	4	4	20	20	1	1
2	5	5	9	19	1	1
3	7	7	18	18	0	0
4	20	20	5	5	0	0
5	22	25	3	0	0	0

Table F-8

PERCENT of ELEMENTS TRACKED

HOUR / MODEL	1			2			3			4			5		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
I	100	0	0	40	0	0	14	0	0	0	0	0	0	0	0
III	100	10	0	40	26	0	57	05	0	40	0	0	04	0	0

Table F-9

A: 0≤R≤3
B: 3<R≤6
C: 6<R≤9

7. Measure # 7. The mean and median distances between targets being tracked and a trace of forward Blue platoons at the end of each hour.

Model I: 3 data points; $\bar{x}$ = 1.7 km, median = 1.5
Model III: 12 data points; $\bar{x}$ = 2.5 km, median = 2.4

8. Measure # 8. The percent of detections as a function of the detection source.

Table F-10

SENSOR / MODEL	MRR	LRR	MREO	LREO	AR	AV	GV
I	14	-	29	-	21	21	15
III	37	11	15	15	11	04	07

COMMENT: Consistent with Game 1 we note that air accounts for a higher proportion of detections in Model I than III.

9. Measure # 9. The mean and median of the difference between the reported and actual target locations for all targets tracked at the end of each hour.

Assessment model was not sufficiently precise to permit valid comparisons.

10. Measure # 10. Area under surveillance by STA devices and percent visible.

MODEL	RADARS USED		AREA UNDER SURVEILLANCE (km^2)	PERCENT VISIBLE	AREA COVERED (km^2)
	MRR	LRR			
I	2	-	14	19%	2.7
III	3	2	157	29%	45.5

Table F-11

COMMENT: This marked difference in area covered is the basic reason for the greater detection capability of Model III shown in previous measures.

11. Measure # 11. Additional area covered by unattended ground sensors.

MODEL	# STRINGS	TOTAL # SENSORS
I	2	8
III	2	8

Table F-12

COMMENT: The UGS were aerially - emplanted to the rear the Red battalion to detect reinforcements. No detections were made.

12. Measures 12-18 consider aspects of target engagements by supporting arms and are best dealt with in a combined fashion.

The tables below summarize the more detailed information of Table F-35 Section III.

NUMBER of STRIKES

ARM / MODEL	ARTY	NGF	AIR
I	6	6	3
III	9	10	9

MEAN ELAPSED TIME: DETECTION to STRIKE (Min)

ARM / MODEL	ARTY	NGF	AIR
I	23	24	24
III	47	48	22

Table F-14

COMMENT: The time disparities between the Models are not correlated with either communication processing times or weapon response times. Rather, they reflect the decision not to fire immediately on fleeting targets.

STRIKES by HOUR

ARM \ HOUR	1	2	3	4	5	6	7
ARTY I	1	1	0	0	0/1*	1/1*	1
ARTY III	2	0	2	1	2	2	-
NGF I	1	1	0	0	0/1*	1/1*	1
NGF III	2	1	2	1	2	2	-
AIR I	1	1	0	0	0	0	1
AIR III	1	2	2	2	1	1	-

Table F-15

* Second number is preparation fires

13. Measure # 19. The number of Red casualties as a function of time.

The tables below give aggregations. See Table F-36 for breakdown by supporting arms.

RED PERSONNEL CASUALTIES

MODEL \ HOUR	1	2	3	4	5	6	7	Σ
I	10	11	0	17	6	22	25	91
III	12	12	15	11	13	25	-	88

Table F-16

COMMENT: Greater number of casualties caused by Model I attributable to longer combat time.

RED MATERIEL LOSS

MODEL \ HOUR	1	2	3	4	5	6	7	Σ
I	1/0/1	1/0/0	0	0	0	0/1/0	1*	2/1/1
III	1/0/0	3/0/0	2/0/1	1/1/0	0/1/1	2/0/0	-	9/2/2

Table F-17

ENTRY: APC/Wheeled Vehicle/Tank
*: Artillery Cannon
COMMENT: All losses caused by Air

14. Measure # 20. The number of Red casualties as a function of separation distance between Red and Blue.

CUMULATIVE RED CASUALTIES VS SEPARATION DIST

MODEL \ DIST (km)	4	3	2	1	0
I	21	21	38	44	91
III	24	39	50	63	88

Table F-18

COMMENT: No significant difference that is correllated with STA performance.

RED MATERIEL LOSS

MODEL \ DIST	4	3	2	1	0
I	2/0/1	2/0/1	2/0/1	2/0/1	2/1/1*
III	4/0/0	6/0/1	7/1/1	7/2/2	9/2/2

Table F-19

ENTRY: APC/Wheeled Vehicle/Tank * ARTY Cannon

15. Measure # 21. The number of rounds respectively of mortar, artillery and NGF expended per Red casualty.

RED PERSONNEL CASUALTIES

ARM	# CASUALTIES	# ROUNDS	ROUNDS/CAS
ARTY I	20	380	19
III	15	600	40
NGF I	7	860	123
III	27	1170	43

Table F-20

COMMENT: The differences here could not be traced to differences in STA performance; but rather, to differences in target engagement decisions in the two iterations and the stochastic nature of casualty assessment.

16. Measure # 22. A comparison of the full strength firepower available to the Model I and III battalions.

MODEL	FIREPOWER SCORE	III/I
I	4.52	2.4
III	10.82	

COMMENT: Although Model I had 13% more strength than Model III (1231/1090), the firepower score for Model III is 2.4 times greater than I. This significant increase is primarily due to the incorporation of the small automatic weapon in Model III (equivalent to the M60 machine gun) and to the incorporation of 12 improved 81mm mortars, 6200 meters range, versus 8 mortars, 4500 meters range, in Model I.

17. Measures 23-26. These measures deal with aspects of close combat that are covered in the following tables.

GAME II

CLOSE COMBAT RECORD

	MODEL		FORCE REMAINING INFANTRY *	FORCE APPLIED **	FIRE POWER SCORE	FORCE RATIO B/R	PROBABILITY OF SUCCESS
Battle 1	I	R	405/88%	155/38%	6.19	.33	.30
		B	1152/94%	363/32%	2.03		
	III	R	381/83%	304/80%	11.98	1.0	.50
		B	992/92%	711/72%	12.34		
Battle 2	I	R	399/87%	151/38%	6.14	.33	.30
		B	1123/91%	343/31%	2.03		
Battle 3	I	R	399/87%	399/100%	7.13	.56	.30
		B	1112/90%	1112/100%	4.0		

* Percent of Game Strength

** Percent of Remaining Force

Table F-22

COMMENT: Model I was involved in two hours of combat while Model III was involved in only one hour. The reason was that when close combat commenced Model I had not yet fixed one of the Red companies; Model III, on the other hand, had fixed all Red companies.

18. Measures 27 and 28. Ratio of Red to Blue casualties as a function of time and separation distance.

RATIO of PERSONNEL CASUALTIES (R/B)
vs TIME

MODEL \ HOUR	1	2	3	4	5	6	7	Σ
I	1.0	0.9	0	*	0.5	0.8	1.4	0.8
III	0.3	0.4	1.0	*	1.3	0.5	-	0.7

Table F-23

*: Indeterminate, divisor is zero.

COMMENT: Model I shows a slight margin over III. However, if close combat had continued until culmination, Model III would have probably surpassed Model I because of higher firepower score.

19. Rate of Blue advance toward objective.

SEPARATION DISTANCE vs TIME

MODEL \ HOUR	1	2	3	4	5	6
I	4.7	4,7	3.6	2.5	1.4	CLOSE
III	4.7	4.7	3.6	3.3	2.2	COMBAT

Table F-24

DISTANCE ADVANCED vs TIME

MODEL \ HOUR	1	2	3	4	5	6	7
I	0	1.1	1.1	1.1	1.4	0.5*	0.1*
III	0	1.1	0.3	1.1	2.2	0.2*	--

Table F-25

* Close Combat

COMMENT: The difference in advance rate was caused by a tactics change in the two iterations. In the third hour Model I by-passed a combat outpost while Model III did not. The greater advance rate in the fifth hour by Model III was occasioned by the use of illuminating flares.

TABLE F-26

DETECTION RECORD

SENSOR \ HOUR		1	2	3	4	5	6	TOTAL
MRR	I	2/12/12	0	0	0	0	0	2/12/12
	III	4/29/23	3/3/2	0	3/6/6	0		10/38/31
LRR	I	-	-	-	-	-	-	-
	III	2/17/17	0	0	1/2/2	0	-	3/19/19
MREO	I	2/12/12	1/2/2	1/2/2	0	0	0	4/16/16
	III	1/6/6	0	1/2/2	2/4/4	0	-	4/12/12
LREO	I	-	-	-	-	-	-	-
	III	3/19/17	0	0	1/2/2	0	-	4/21/19
AR	I	2/12/12	0	1/2/2	0	0	0	3/14/14
	III	1/11/11	0	0	0	2/9/9	-	3/20/20
AV	I	0	1/1/1	0	1/1/1	0	1/1/1	3/3/3
	III	0	0	1/2/2	0	0		1/2/2
GV	I	1/4/4	0	1/2/2	0	0	0	2/6/6
	III	1/4/4	1/1/1	0	0	0	-	2/5/5
TOTAL*	I	7/40/12	2/3/6	3/6/3	1/1/1	0	1/1/1	14/51
	III	12/86/23	4/4/7	2/4/6	7/14/6	2/9/10	-	27/117
%**	I	48	24	12	04	0	04	-
	III	92	28	24	24	40	-	

TABLE ENTRIES: No. Detections/total No. target elements/No. different target elements

*: No. of different target elements are derived from the detections made during the hour and the carry over target elements that were being tracked at the end of preceding hour.

**: Entries-$\frac{\text{No. different tgt elements detected}}{\text{Total No. of tgt elements (25)}}$

TABLE F-27

DETECTIONS VS RANGE TO CLOSEST BLUE UNIT

SENSOR \ RANGE (km)		$0<R\leq 1$	$1<R\leq 2$	$2<R\leq 3$	$3<R\leq 4$	$4<R\leq 5$	TOTAL	%
MRR	I	0	2	0	0	0	2	15
	III	1	5	0	4	0	10	37
LRR	I	-	-	-	-	-	-	-
	III	0	2	0	1	0	3[1]	11
MREO	I	0	4	0	0	0	4	28
	III	0	4	0	0	0	4	15
LREO	I	-	-	-	-	-	-	-
	III	0	2	1	1	0	4	15
AR	I	0	0	1	2	0	3	21
	III	0	3	0	0	0	3	11
AV	I	0	1	1	1	0	3	21
	III	0	1	0	0	0	1	04
GV	I	0	0	1	0	1	2	15
	III	0	0	0	0	2	2	07
TOTAL	I	0	7	3	3	1	14	-
	III	1	17	1	6	2	27	
%	I	0	50	21	21	08	-	-
	III	04	63	04	22	07		

TABLE F-28

DETECTIONS VS SENSOR RANGE

SENSOR \ RANGE (km)		0<R≤1	1<R≤2	2<R≤3	3<R≤4	4<R≤5	TOTAL
MRR	I	0	2	0	-	-	2
	III	0	5	1	3	1	10
LRR	I						
	III	0	1	1	1	0	3
MREO	I	0	4	0	-	-	4
	III	0	4	0	0	0	4
LREO	I						
	III	0	1	2	1	0	4
GV	I	2	0	0	0	0	2
	III	2	0	0	0	0	2
TOTAL	I	2	6	0	0	0	8
	III	2	11	4	5	1	23
%	I	25	75	0	0	0	-
	III	09	48	17	22	04	

TABLE F-29

DETECTIONS VS TIME

SENSOR \ HOUR		1	2	3	4	5	6	TOTAL
MRR	I	2	0	0	0	0	0	2
	III	4	3	0	3	0	-	10
LRR	I	-	-	-	-	-	-	-
	III	2	0	0	1	0	-	3
MREO	I	2	1	1	0	0	0	4
	III	1	0	1	2	0	-	4
LREO	I	-	-	-	-	-	-	-
	III	3	0	0	1	0	-	4
AR	I	2	0	1	0	0	0	3
	III	1	0	0	0	2	-	3
AV	I	0	1	0	1	0	1	3
	III	0	0	1	0	0	-	1
GV	I	1	0	1	0	0	0	2
	III	1	1	0	0	0	-	2
TOTAL	I	7	2	3	1	0	1	14
	III	12	4	2	7	2	-	27

TABLE F-30

CUMULATIVE DETECTIONS VS TIME

SENSOR \ TIME (HRS)		T≤1	T≤2	T≤3	T≤4	T≤5	T≤6
MRR	I	2	2	2	2	2	2
	III	4	7	7	10	10	
LRR	I	-	-	-	-	-	-
	III	2	2	2	3	3	-
MREO	I	2	3	4	4	4	4
	III	1	1	2	4	4	-
LREO	I	-	-	-	-	-	-
	III	3	3	3	4	4	-
AR	I	2	2	3	3	3	3
	III	1	1	1	1	3	-
AV	I	0	1	1	2	2	3
	III	0	0	1	1	1	-
GV	I	1	1	2	2	2	2
	III	1	2	2	2	2	-
TOTAL	I	7	9	12	13	13	14
	III	12	16	18	25	27	-

TABLE F-31

% DETECTIONS VS SENSOR

SENSOR \ HOUR		1	2	3	4	5	6	TOTAL
MRR	I	29	0	0	0	0	0	14
	III	33	75	0	47	0	-	37
LRR	I	-	-	-	-	-	-	-
	III	17	0	0	12	0	-	11
MREO	I	29	50	33	0	0	0	29
	III	09	0	50	29	0	-	15
LREO	I	-	-	-	-	-	-	-
	III	25	0	0	12	0	-	15
AR	I	29	0	33	0	0	0	21
	III	08	0	0	0	100	-	11
AV	I	0	50	0	100	0	100	21
	III	0	0	50	0	0	-	04
GV	I	13	0	34	0	0	0	15
	III	08	25	0	0	0	-	07

TABLE F-32

AIRCRAFT RECORD

ACFT \ HOUR		1	2	3	4	5	6	7	TOTAL
A6	I	2/1/1/14	0/0/1/0	0/0/1/0	1/0/1/28	0/1/0/0	1/0/1/0	0/0/1/0	4/2/-/42
	III	2/1/1/28	0/0/1/0	1/2/0/0	1/0/1/0	0/0/1/0	0/0/0/28	-	4/3/-/56
A4	I	4/0/4/0	0/1/0/32	2/0/2/0	0/0/0/20	0/0/0/0	2/0/2/0	2/0/2/20	10/1/-/72
	III	4/0/4/0	0/0/0/40	2/1/0/20	2/1/0/20	1/0/0/10	0/0/0/0	-	9/2/-/90
AV8	I	0/0/0/0	0/0/0/0	4/0/4/0	0/0/4/16	0/0/0/0	0/0/0/0	2/1/0/0	6/1/-/16
	III	2/0/2/0	0/0/0/16	2/0/0/16	0/0/0/0	1/1/0/8	0/0/0/0	-	5/1/-/40
F4	I	0/0/0/0	0/0/0/0	0/0/0/0	2/0/2/0	2/0/2/0	0/1/0/0	0/0/0/0	4/1/-/0
	III	0/0/0/0	0/0/0/0	0/0/0/0	0/0/0/0	0/0/0/0	0/0/0/0	-	0/0/-/0
AH1	I	0/0/0/0	2/0/2/0	0/0/2/0	0/0/0/0	1/0/1/0	0/0/0/0	0/0/0/0	3/0/-/0
	III	0/0/0/0	0/0/0/0	0/0/0/0	2/0/2/0	0/0/0/38	0/0/0/0	-	2/0/-/38
EA6	I	1/0/1/-	0/0/1/-	1/0/2/-	0/0/1/-	0/0/1/-	0/0/1/-	1/0/1-	3/0/-/-
	III	1/0/1/-	0/0/1/-	1/0/1/-	0/0/1/-	0/0/1/-	1/0/1/-	-	3/0/-/-
UH1	I	0/0/0/-	0/0/0/-	0/0/0/-	0/0/0/-	1/0/1/-	0/0/0/-	0/0/0/-	1/0/-/-
	III	0/0/0/-	0/0/0/-	0/0/0/-	0/0/0/-	0/0/0/-	0/0/0/-	-	0/0/-/-
Σ	I	7/1/6/14	2/1/4/7	7/0/11/0	3/0/8/64	4/1/5/0	3/1/4/0	5/1/4/20	31/5/-/130
	III	9/1/8/28	0/0/2/56	6/3/1/36	5/1/4/20	2/1/2/56	1/0/1/28	-	23/6/-/224

TABLE ENTRY: ACFT Launched/ACFT Loss/on station end of hour/weapons delivered

TARGET ENGAGEMENT RECORD

This record consists of three parts: Target Description, Model I; Target Description, Model III; Target Engagements, Models I and III.

TARGET DESCRIPTION (MODEL I)

TARGET NUMBER	RELATIONSHIP	# ELEMENT	COMPOSITION
1	Basic	6	Inf Co rein with Tank Plt
3	Basic	6	Inf Co rein with Tank Plt
5	=1	6	Inf Co rein with Tank Plt
7	⊃3	4	Inf Co (-)
9	⊃7	1	Inf Plt
10	⊃5	2	Inf Plt and Tank Co

TABLE F-33

TABLE EXPLANATION:

1. Target #: Excepting basic targets, only those targets that were hit are listed.

2. Relationship: This column gives the interrelationship of targets. Basic targets are mutually exclusive and exhaust all target elements that comprise the set of targets. (⊃means a subset of).

TARGET DESCRIPTION (MODEL III)

TARGET NUMBER	RELATIONSHIP	# ELEMENTS	COMPOSITION
1	Basic	6	Inf Co reinforced with Tank Plt
8	Basic	5	Inf Co reinforced with Tank Plt
10	Basic	11	Bn Hqs, Inf Co, Tank Co (-), AT Plt
5	=1	6	Inf Co reinforced with Tank Plt
9	>8	4	Inf Co (-)
12	>1	2	Inf Plt and Tank Plt
18	>8	3	Inf Co (-)
19	=12	2	Inf Plt and Tank Plt
21	=19	2	Inf Plt and Tank Plt
22	>10	2	Inf Plt and Tank Plt
31	=21	2	Inf Plt and Tank Plt
32	=22	2	Inf Plt and Tank Plt
35	>10	5	Inf Co (-), Tank Co (-), Eng Plt
36	>1	4	Inf Co (-), Tank Plt
37	>10	5	Inf Co (-), Tank Plt, AT Plt, Eng Plt

TABLE F-34

TARGET ENGAGEMENTS

MODEL	INITIAL STRIKES (TGT #)	SENSOR	ELAPSED TIME (MINUTES)			NUMBER OF REPEAT STRIKES			SUBSEQUENT STRIKES (TGT #)	SENSOR	ELAPSED TIME (MINUTES)			NUMBER OF REPEAT STRIKES		
			ARTY	NGF	AIR	ARTY	NGF	AIR			ARTY	NGF	AIR	ARTY	NGF	AIR
I	5	MRR/EO	-	-	11	-	-	-	9	AV	-	-	03	-	-	-
	7	MRR/EO	45	49	-	-	-	-	10	MREO	14	14	-	-	-	-
	16	AV	10	10	58	-	-	-								
III	5	RA	-	-	11	-	-	-	19	AV	-	-	01	-	-	-
	9	MRR	49	49	-	-	1	-	18	AV	-	-	02	-	-	-
	12	LRR/EO MRR	19	19	-	-	-	-	21	AV	77	81	0	-	-	-
	22	LRR/EO MRR	126	130	139	-	-	-	31	AV	24	-	-	-	-	-
									32	AV	-	-	15	-	-	-
									35	AV	-	09	0	-	-	-
									36	AV	15	20	-	1	1	-
									37	AV	20	25	06	1	1	1

TABLE F-35

Initial Strikes are the first time a target complex is hit.
Subsequent Strikes are strikes on subsets of the initial target elements.

TABLE F-36
CASUALTY RECORD

SOURCE \ HOUR			1	2	3	4	5	6	7	Σ
I	ARTY	R	1/60	2/60	0/0	0/0	1/60	16/150	0/50	20/380
		B	10/60	12/120	32/120	0/0	13/90	18/120	0/0	85/510
	NGF	R	2/60	1/120	0/0	0/0	2/120	2/360	0/200	7/860
		B	—	—	—	—	—	—	—	—
	AIR	R	7/14	8/32	0/0	17/64	0/0	0/0	19/20	51/130
		B	—	—	—	—	—	—	—	—
	GC	R	0	0	0	0	0	4/-	6/-	10/-
		B	0	0	0	0	0	11/-	18/-	29/-
	OTHER	R	0	0	0	0	3/-	0	0	3/-
		B	0	0	0	0	0	0	0	0
III	ARTY	R	4/120	0/0	2/120	3/60	3/120	3/180	—	15/600
		B	36/60	27/150	15/120	0/120	10/180	32/270	—	126/900
	NGF	R	4/150	3/60	4/240	3/120	4/240	9/360	—	27/1170
		B	—	—	—	—	—	—	—	—
	AIR	R	4/28	9/56	9/36	5/20	6/36	6/28	—	39/224
		B	—	—	—	—	—	—	—	—
	GC	R	0	0	0	0	0	7/-	—	7/-
		B	0	0	0	0	0	8/-	—	8/-
	OTHER	R	0	0	0	0	0	0	—	0
		B	0	0	0	0	0	0	—	0
Σ	I	R	10/134	11/212	0/0	17/64	6/180	22/510	25/270	91/1370
		B	10/60	12/120	32/120	0/0	13/90	29/120	18/0	114/510
	III	R	12/293	12/116	15/396	11/200	13/416	25/559	—	88/1994
		B	36/60	27/150	15/120	0/120	10/180	46/270	—	134/900

TABLE ENTRY: # CASUALTIES / # RDS

ANNEX G

ANALYSIS AND FINDINGS

War Game MARSAS III (Bn in the Day Attack)

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I. FINDINGS

1. Nature of Game. This game had the Blue battalion inserted on the flank of a MAB front to cut-off a withdrawing Red mechanized battalion. The Blue battalion closed into position at 1000 hours and spent the next hour organizing for an attack. The attack was launched on schedule at 1100 hours with two companies abreast, dismounted, and one compnay mounted in LVTs, reinforced with a tank platoon. The reinforced company would synchronize its movement with the dismounted companies and attack around the right flank. The Blue battalion advanced steadily, temporarily stopping between the second and third hours at an intermediate objective, and closed with Red within six hours after having advanced some seven kilometers. The advance rate was reduced by 50% during the fifth hour due to heavy rain. Two hours of close combat (6th and 7th hours)were played prior to end game. Note: since no activity of consequence occurred between 1000-1100 hours, the first hour for all tables of this Annex is 1100-1200.

2. Findings:

a. Objective 1. The relative capability of Models I and III to perform the functions of combat surveillance, target acquisition, target location and target designation.

There appeared to be no significant difference in the performance of the STA systems between Models I and III. Excluding air and ground visual detections, only two detections were made by Model III and none by Model I. The performance of the STA systems in this game leads to two conclusions:

(1) There appears to be no significant difference in the utility of the Model I and III STA systems under the conditions that existed during this game; i.e., (1) bulk of the targets stationary, (2) periods of heavy rain.

(2) The utility of either STA system (Model I or III) reaches a minimum under the above conditions since radar performance is severely degraded.

b. Objective 2. The relative capability of the two Models to engage enemy forces utilizing supporting arms.

Since the performance of both STA systems was minimal no significant difference in target engagement performance could be attributed to STA performance. The slight differences that did occur, generally favoring Model III, are attributable to the stochastic nature of warfare.

c. Objective 3. The relative capability of the two Models to engage the enemy in close combat.

Model III dominated in close combat, entering close combat with a probability of success of 0.55 compared to 0.30 for Model I. The reason, of course, is the greater firepower scores of Model III.

d. Objective 4. The relative capability of the two Models to accomplish the assigned mission.

Again, Model III dominated because of superior firepower scores.

II. PERFORMANCE MEASURES

1. Measure # 1. The number of target detections as a function of distance between the target and the source of detection.

The table below gives total data. See Table G-26, for breakdown by sensor. Air detections are not included since it was infeasible to measure the sensor range.

DETECTIONS VS SENSOR RANGE

RANGE / MODEL	$0 \leq R \leq 1$	$1 < R \leq 2$	$2 < R \leq 3$	$3 < R \leq 4$	$4 < R \leq 5$	$R > 5$	Σ
I	2	2	0	0	0	0	4
III	2	4	0	0	2	0	8

Table G-1

2. Measure # 2. The number of target detections as a function of the distance between the target and the center of mass of the Blue infantry platoon closest to the target.

The table below gives total data. See Table G-25, for breakdown by sensor. Air detections are included in this measure.

DETECTIONS VS RANGE TO BLUE

RANGE / MODEL	$0 \leq R \leq 1$	$1 < R \leq 2$	$2 < R \leq 3$	$3 < R \leq 4$	$4 < R \leq 5$	$5 < R \leq 6$	$6 < R \leq 7$	$7 < R \leq 8$	$8 < R \leq 9$	$R > 10$	Σ
I	2	2	0	0	3	1	0	0	1	1	10
III	2	4	0	0	4	1	1	0	1	1	14

Table G-2

3. Measure # 3. The number of target detections made during each hour of game play.

The table below gives total data. See Table G-27, for breakdown by sensor.

DETECTIONS VS TIME

HOUR / MODEL	1	2	3	4	5	6	Σ
I	2/38/29	2/5/5	0/0/5	2/9/9	0/0/0	4/32/31	10/84
III	3/43/33	3/7/5	0/0/0	2/9/9	0/0/0	6/38/31	14/97
%* I	78	13	13	24	0	84	-
III	89	13	0	24	0	84	-

Table G-3

Table Entry: # Detections/# target elements detected/# different elements

* Entry is percentage of total population of target elements that were detected during hour.

4. Measure # 4. The cumulative number of target detections as a function of time.

Table below gives total data, see Table G-27 for breakdown.

CUMULATIVE DETECTIONS VS TIME

TIME / MODEL	T≤1	T≤2	T≤3	T≤4	T≤5	T≤6
I	2	4	4	6	6	10
III	3	5	6	8	8	14

Table G-4

5. Measure # 5. The number of target elements being tracked at the end of each hour.

HOUR / MODEL	1	2	3	4	5
I	0	5	0	0	0
III	5	0	0	0	0

Table G-5

6. Measure # 6. The percent of target elements within specified zones being tracked at the end of each hour. Zones will be established as a function of distance from trace of forward Blue platoons.

TARGET ELEMENT DISTRIBUTION

RANGE (km) / HOUR	0≤R≤3		3<R≤6		6<R≤9		9<R≤12		12<R≤15	
	I	III	I	III	I	III	I	III	I	III
1	0	0	12	12	23	23	1	1	1	1
2	4	3	20	18	12	15	1	1	0	0
3	8	8	26	26	2	2	1	1	0	0
4	18	19	17	16	2	2	0	0	0	0
5	31	31	4	5	2	1	0	0	0	0
6	35	35	1	1	1	1	0	0	0	0

Table G-6

PERCENT OF ELEMENTS TRACKED

HOUR / MODEL	1					2				
	A	B	C	D	E	A	B	C	D	E
I	0	0	0	0	0	0	25	0	0	0
III	0	42	0	0	0	0	0	0	0	0

Table G-7

7. Measure # 7. The mean and median distances between targets being tracked and a trace of the forward Blue platoons at the end of each hour.

There is only one data point for each Model:

Model I - 5.3 KM (Air Sensor)

Model III - 1.2 KM (LREO)

8. Measure # 8. The percent of detections as a function of the detection source.

SENSOR / MODEL	MRR	LRR	MREO	LREO	AR	AV	GV
I	0	-	0	-	40	20	40
III	0	0	0	14	29	14	43

Table G-8

9. Measure # 9. The mean and median of the difference between the reported and actual target locations for all targets tracked at the end of each hour.

Assessment Model was not sufficiently precise to permit valid comparisons.

10. Measure # 10. Area under surveillance by STA devices and percent visible.

RADAR COVERAGE

MODEL	RADARS USED		AREA UNDER SURVEILLANCE (km^2)	PERCENT VISIBLE	AREA COVERED (km^2)
	MRR	LRR			
I	2	-	14	70	9.8
III	2	2	102	46	46.4

Table G-9

11. Measure # 11. Additional area covered by unattended ground sensors.

MODEL	# STRINGS	TOTAL # SENSORS
I	18	78
III	18	78

Table G-10

12. Measures 12 - 18. Consider aspects of target engagements by supporting arms and are best dealt with in a combined fashion. The tables below summarize the more detailed information of Table G-30.

NUMBER OF STRIKES

MODEL \ ARM	ARTY	NGF	AIR
I	7	7	7
III	4	8	5

Table G-11

Mean Elapsed Time: Detection to Strike (Min)

MODEL \ ARM	ARTY	NGF	AIR
I	09	15	13
III*	26/11	34/14	25

Table G-12

*The larger times for ARTY and NGF include strikes that were deliberately delayed. The lower times exclude these delays.

STRIKES BY HOUR

ARM \ HOUR		1	2	3	4	5	6
ARTY	I	0	0	0	2	2	3
	III	0	1	0	1	0	2
NGF	I	0	0	0	2	2	3
	III	0	1	0	1	2	4
AIR	I	2	2	0	2	0	1
	III	2	1	0	0	2	0

Table G-13

13. Measure # 19. The number of Red casualties as a function of time. The tables below give aggregations. See Table G-33 for breakout by supporting arms.

RED PERSONNEL CASUALTIES

MODEL \ HOUR	1	2	3	4	5	6	7	Σ
I	12	16	0	25	8	37	12	110
III	11	30	0	12	13	48	7	121

Table G-14

RED MATERIEL LOSS

MODEL \ HOUR	1	2	3	4	5	6	Σ
I	3/1	2	0	5	0	2/2	12/4
III	2/1	2/1/1	0	0	1	0	5/2/1

Table G-15

Entry: Armored Personnel Carrier/Wheeled Vehicle/Tank

Note: All losses caused by Air

14. Measure # 20. The number of Red casualties as a function of separation distance between Red and Blue.

CUMULATIVE RED CASUALTIES VS SEPARATION DIST

DIST (km) / MODEL	5	3	2	1	0
I	12	28	28	53	110
III	11	41	41	53	121

Table G-16

RED MATERIEL LOSS

DIST (km) / MODEL	5	3	2	1	0
I	3/1	5/1	5/1	10/1	12/4
III	2/1	4/2/1	4/2/1	4/2/1	5/2/1

Table G-17

Entry: APC/Wheeled Vehicle/Tank

15. Measure # 21. The number of rounds respectively of mortar, artillery and NGF expended per Red casualty.

RED PERSONNEL CASUALTIES

ARM		# CASUALTIES	# ROUNDS	ROUNDS/CASUALTY
ARTY	I	18	330	18.3
	III	17	270	15.9
NGF	I	18	840	46.7
	III	34	1114	32.8

Table G-18

16. Measure # 22. A comparison of the full strength firepower available to the Model I and III battalions.

MODEL	FIREPOWER SCORE	III/I
I	4.52	2.4
III	10.82	

Table G-19

COMMENT: Although Model I had 13% more strength than Model III (1231/1090), the firepower score for Model III is 2.4 times greater than I. This significant increase is primarily due to the incorporation of the small automatic weapon in Model III (equivalent to the M60 machine gun) and to the incorporation of 12 improved 81mm mortars, 6200 meters range, versus 8 mortars, 4500 meters range, in Model I.

17. Measures 23-26. These measures deal with aspects of close combat that are covered in the following tables.

CLOSE COMBAT RECORD

BATTLE	MODEL		FORCE REMAINING INFANTRY*	FORCE APPLIED **	FIREPOWER SCORE	FORCE RATIO B/R	PROBABILITY OF BLUE SUCCESS
1	I	R	346/69%	346/100%	12.2	0.5	.30
		B	1120/91%	1120/100%	6.6		
	III	R	321/64%	321/100%	11.6	1.2	.55
		B	945/88%	945/100%	14.2		
2	I	R	323/65%	323/100%	12.2	0.5	.30
		B	1078/88%	1078/100%	6.2		
	III	R	309/62%	309/100%	11.3	1.2	.55
		B	927/86%	97/100%	13.6		

Table G-20

* Percent of Start Game Strength
** Percent of Remaining Force

18. Measure # 27 and 28. Ratio of Red to Blue casualties as a function of time and separation distance.

RATIO OF PERSONNEL CASUALTIES (R/B) VS TIME

MODEL \ HOUR	1	2	3	4	5	6	7	Σ
I	I	0.4	0	I	I	0.4	0.4	0.6
III	I	1.5	0	0.9	I	0.6	0.7	0.8

Table G-21

I: Undeterminate, denominator is zero.

19. Rate of Blue advance toward objective.

SEPARATION DISTANCE VS TIME

MODEL \ HOUR	1	2	3	4	5	6
I	7.1	4.9	3.2	2.1	1.0	CLOSE
III	7.1	4.9	3.2	2.1	1.0	COMBAT

Table G-22

DISTANCE ADVANCED VS TIME

MODEL \ HOUR	1	2	3	4	5	6	7
I	2.2	1.7	1.1	1.1	1.0	0*	0*
III	2.2	1.7	1.1	1.1	1.0	0*	0.5*

Table G-23

* Close Combat

DETECTION RECORD

Sensor \ Hour		1	2	3	4	5	6	Σ
MRR	I	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0
	III	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0
LRR	I	—	—	—	—	—	—	—
	III	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0
MREO	I	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0
	III	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0
LREO	I	—	—	—	—	—	—	
	III	1/5/5	1/5/5	0/0/0	0/0/0	0/0/0	0/0/0	2/10/10
AR	I	2/38/29	2/5/5	0/0/0	0/0/0	0/0/0	0/0/0	4/43/34
	III	2/38/29	2/2/1	0/0/0	0/0/0	0/0/0	0/0/0	4/40/30
AV	I	0/0/0	0/0/0	0/0/0	2/9/9	0/0/0	0/0/0	2/9/9
	III	0/0/0	0/0/0	0/0/0	2/9/9	0/0/0	0/0/0	2/9/9
GV	I	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	4/32/31	4/32/31
	III	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	6/38/31	6/38/31
Σ *	I	2/38/29	2/5/5	0/0/5	2/9/9	0/0/0	4/32/31	10/84
	III	3/43/33	3/7/5	0/0/0	2/9/9	0/0/0	6/38/31	14/97
% **		78	13	13	24	0	84	—
		89	13	0	24	0	84	—

Table G-24

Table Entries: # Detections/total # target elements/# different target elements

* # of different target elements are derived from detections made during the hour and the carry-over target elements that were being tracked at the end of preceding hour.

** Entry = $\frac{\text{\# different tgt elements detected}}{\text{total \# tgt elements (37)}}$

DETECTIONS VS RANGE TO CLOSEST BLUE UNIT

Sensor \ Range		0≤R≤1	1<R≤2	2<R≤3	3<R≤4	4<R≤5	5<R≤6	6<R≤7	7<R≤8	8<R≤10	R>10	Σ	%
MRR	I	0	0	0	-	-	-	-	-	-	-	0	0
	III	0	0	0	0	0	-	-	-	-	-	0	0
LRR	I	-	-	-	-	-	-	-	-	-	-	-	-
	III	0	0	0	0	0	0	0	0	0	-	0	0
MREO	I	0	0	-	-	-	-	-	-	-	-	0	0
	III	0	0	0	-	-	-	-	-	-	-	0	0
LREO	I	-	-	-	-	-	-	-	-	-	-	-	-
	III	0	0	0	0	2	0	0	0	0	0	2	14
AR	I	0	0	0	0	1	1	0	0	1	1	4	40
	III	0	0	0	0	0	1	1	0	1	1	4	29
AV	I	0	0	0	0	2	0	0	0	0	0	2	20
	III	0	0	0	0	2	0	0	0	0	0	2	14
GV	I	2	2	0	0	0	0	0	0	0	0	4	40
	III	2	4	0	0	0	0	0	0	0	0	6	43
Σ	I	2	2	0	0	3	1	0	0	1	1	10	-
	III	2	4	0	0	4	1	1	0	1	1	14	-
%	I	20	20	0	0	30	10	00	0	10	10	-	-
	III	14	29	0	0	29	07	07	0	07	07	-	-

Table G-25

DETECTIONS VS SENSOR RANGE

Sensor \ Range		0≤R≤1	1<R≤2	2<R≤3	3<R≤4	4<R≤5	5<R≤5	Σ
MRR	I	0	0	0	-	-	-	0
	III	0	0	0	0	0	-	0
LRR	I	-	-	-	-	-	-	-
	III	0	0	0	0	0	0	0
MREO	I	0	0	-	-	-	-	0
	III	0	0	0	-	-	-	0
LREO	I	-	-	-	-	-	-	-
	III	0	0	0	0	2	0	2
GV	I	2	2	0	0	0	0	4
	III	2	4	0	0	0	0	6
Σ	I	2	2	0	0	0	0	4
	III	2	4	0	0	2	0	8
%	I	50	50	0	0	0	0	-
	III	25	50	0	0	25	0	-

Table G-26

CUMULATIVE DETECTIONS VS TIME

Sensor \ Time		T≤1	T≤2	T≤3	T≤4	T≤5	T≤6
MRR	I	0	0	0	0	0	0
	III	0	0	0	0	0	0
LRR	I	-	-	-	-	-	-
	III	0	0	0	0	0	0
MREO	I	0	0	0	0	0	0
	III	0	0	0	0	0	0
LREO	I	-	-	-	-	-	-
	III	1	2	2	2	2	2
AR	I	2	4	4	4	4	4
	III	2	4	4	4	4	4
AV	I	0	0	0	2	2	2
	III	0	0	0	2	2	2
GV	I	0	0	0	0	0	4
	III	0	0	0	0	0	6
Σ	I	2	4	4	6	6	10
	III	3	6	6	8	8	14

Table G-27

PERCENT DETECTIONS VS SENSOR

Sensor \ Hour		1	2	3	4	5	6	Σ
MRR	I	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
LRR	I	-	-	-	-	-	-	-
	III	0	0	0	0	0	0	0
MREO	I	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
LREO	I	-	-	-	-	-	-	-
	III	33	33	0	0	0	0	14
AR	I	100	100	0	0	0	0	40
	III	67	57	0	0	0	0	29
AV	I	0	0	0	100	0	0	20
	III	0	0	0	100	0	0	14
GV	I	0	0	0	0	0	100	40
	III	0	0	0	0	0	100	43

Table G-28

AIRCRAFT RECORD

Acft \ Hour		1	2	3	4	5	6	7
A6	I	2/0/1/28	0/0/1/28	0/0/1/0	1/0/1/0	0/0/1/0	0/1/0/0	3/1/-/56
	III	2/1/1/28	0/0/0/20	1/0/1/0	0/1/0/0	0/0/0/0	1/0/0/28	4/2/-/76
A4	I	2/0/2/0	0/0/0/20	0/0/0/0	0/0/0/0	0/0/0/0	4/0/4/40	6/0/-/60
	III	2/0/2/0	0/0/0/20	0/0/0/0	2/0/2/0	0/0/0/20	4/0/4/40	8/0/-/80
AV8	I	0/0/0/0	0/0/0/0	0/0/0/0	3/0/3/24	0/0/0/0	0/0/0/0	3/0/-/24
	III	2/0/2/0	0/0/0/12	0/0/0/0	0/0/0/0	0/0/0/0	2/1/0/8	4/1/-/20
F4	I	2/0/2/0	0/0/0/12	0/0/0/0	3/0/3/18	0/0/0/0	0/0/0/0	5/0/-/30
	III	2/0/2/0	0/0/0/12	0/0/0/0	2/0/2/0	0/0/0/12	0/0/0/0	4/0/-/24
AH1	I	0/0/0/0	0/0/0/0	2/0/2/0	0/0/0/0	0/0/0/0	0/0/0/0	2/0/-/0
	III	0/0/0/0	2/0/2/0	0/0/2/0	0/0/0/0	0/0/0/0	0/0/0/0	2/0/-/0
EA6	I	1/0/1/-	0/0/1/-	1/0/1/-	0/0/1/-	0/0/1/-	0/0/1/-	2/0/-/-
	III	1/0/1/-	0/0/1/-	1/0/1/-	0/0/1/-	0/0/0/-	0/0/0/-	2/0/-/-
UH1	I	0/0/0/-	0/0/0/-	2/0/2/-	0/0/0/-	0/0/0/-	0/0/0/-	2/0/-/-
	III	0/0/0/-	2/0/2/-	0/0/2/-	0/0/0-	0/0/0-	0/0/0-	2/0/-/-
Σ	I	7/0/6/28	0/0/2/60	5/0/6/0	7/0/8/42	0/0/2/0	4/1/5/40	23/1/-/170
	III	9/1/8/28	4/0/5/64	2/0/5/0	4/1/5/0	0/0/0/32	7/1/0/76	26/3/-/200

Table Entry: Acft launched/Acft loss/on station end of hour/weapons delivered.

Table G-29

TARGET ENGAGEMENT RECORD

This record consists of three parts: Target Description, Model I; Target Description, Model III; Target Engagements, Models I and III.

TARGET DESCRIPTION (MODEL I)

Tgt#	Relationship	#Elements	Composition
2	Basic	29	Inf Bn(rein) less Inf Co and 1 tank plt
3	Basic	2	Inf Plt and tank plt
4	Basic	3	Inf Co (-)
1	⊃ 2	9	2 Inf Co and tank plt
7	⊃ 1	5	Inf Co and tank plt
8	⊃ 1	4	Inf Co
10	=7	5	Inf Co and tank plt
12	⊃ (2U3U4)	25	Inf Bn (-)

Table G-30

Table Explanation:

1. Target #: Excepting basic targets, only those targets that were hit are listed.

2. Relationship: This column gives the interrelationship of targets. Basic targets are mutually exclusive and exhaust all target elements that comprise the set of targets. (⊃ means a subset of; U means union)

TARGET DESCRIPTION (MODEL III)

Tgt#	Relationship	#Elements	Composition
2	Basic	29	Inf Bn(rein) less 1 Co. and 1 Tank Plt.
3	Basic	5	Inf Co and Tank Plt
1	⊃ 2	9	2 Inf Co and 1 Tank Plt
7	⊃ 1	4	Inf Co
8	⊃ 1	5	Inf Co and Tank Plt
11	=8	5	Inf Co and Tank Plt

Table G-31

TARGET ENGAGEMENT.

MODEL	INITIAL STRIKES (TGT #)	SENSOR	ELAPSED TIME (MINUTES)			NUMBER OF REPEAT STRIKES			SUBSEQUENT STRIKES (TGT #)	SENSOR	ELAPSED TIME (MINUTES)			NUMBER OF REPEAT STRIKES		
			ARTY	NGF	AIR	ARTY	NGF	AIR			ARTY	NGF	AIR	ARTY	NGF	AIR
I	1	RA	-	-	0	-	-	-	7	AV	9	14	34	1	1	-
	2	RA	-	-	0	-	-	-	8	AV	9	19	24	2	2	-
	3	RA	-	-	3	-	-	-	10	GV	9	14	-	-	-	-
	4	RA	-	-	5	-	-	-	12	GV	9	14	28	-	-	-
III	1	RA	-	-	2	-	-	-	7	AV	-	14	41	-	2	-
	2	RA	-	-	0	-	-	-	8	AV	9	51	33	-	1	-
	3	LREO	57	57	51	-	-	-	11	GV	13	14	-	1	1	-

Table G-32

Initial Strikes are the first time a target complex is hit.
Subsequent Strikes are strikes on subsets of the initial target elements.

CASUALTY RECORD

Source		Hour	1	2	3	4	5	6	7	Σ
I	Arty	R	0/0	0/0	0/0	6/120	4/60	8/150	-	18/330
		B	0/0	40/180	14/60	0/0	0/0	65/270	-	119/510
	NGF	R	0/0	0/0	0/0	6/360	4/120	8/360	-	18/840
		B	-	-	-	-	-	-	-	-
	Air	R	12/28	16/60	0/0	13/42	0/0	11/40	-	52/170
		B	0/0	0/0	0/0	0/0	0/0	0/0	-	0/0
	GC	R	-	-	-	-	-	4/-	12/-	16/-
		B	-	-	-	-	-	24/-	31/-	55/-
	Other	R	0/0	0/0	0/0	0/0	0/0	6/-	0/0	6/-
		B	0/0	0/0	0/0	0/0	0/0	8/-	0/0	8/-
III	Arty	R	0/0	4/60	0/0	6/90	0/0	7/120	-	17/270
		B	0/0	20/120	20/190	0/0	0/0	68/360	-	108/570
	NGF	R	0/0	8/200	0/0	6/200	6/234	14/480	-	34/1114
		B	-	-	-	-	-	-	-	-
	Air	R	11/28	18/64	0/0	0/0	7/32	17/76	-	53/200
		B	0/0	0/0	0/0	14/10	0/0	0/0	-	1?/10
	GC	R	-	-	-	-	-	2/-	7/-	9/-
		B	-	-	-	-	-	5/-	10/-	15/-
	Other	R	0/0	0/0	0/0	0/0	0/0	8/-	0	8/-
		B	0/0	0/0	0/0	0/0	0/0	9/-	0	9/-
Σ	I	R	12/28	16/60	0/0	25/522	8/180	37/550	12/-	110/1340
		B	0/0	40/180	14/60	0/0	0/0	97/270	31/-	182/510
	III	R	11/28	30/324	0/0	12/290	13/266	48/676	7/-	121/1584
		B	0/0	20/120	20/90	14/10	0/0	82/360	10/-	146/580

Table Entry: # Casualties/# Rds

Table G-33

ANNEX H

Analysis and Findings

War Game MARSAS IV (Bn in the Day Defense)

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I. FINDINGS

1. Nature of Game. This game had Blue in defense against a three-battalion Red Force. As part of a MAB, the Blue battalion was helicopter-landed into position to protect a flank of the MAB. Red reacted to this landing by implementing their Contingency Plan. And, according to plan, at 0600 hours (one hour after the first elements of Blue were landed) Red began moving their force to attack positions approximately 5 kilometers distant from Blue. This movement was made by wheeled vehicle in battalion increments. Two hours later at 0800 Red launched a dismounted attack with two battalions abreast and one battalion in reserve. The right flank assualt battalion was reinforced with two tank companies. Red closed with Blue some two hours later in the Model III iteration; three hours later in the Model I iteration. The reason for this difference is that the Red reserve had to be committed in Model III due to a higher casualty rate; thereby, slowing the attack. The reserve Red battalion was not committed during Model I game play. The attack carried the Red Force through a river bed that was obscured by fog; the fog extending some 500 meters on each side of the river. Ninety-two platoon-sized elements comprised the Red Force. The first hour of game play was involved with closing the Blue battalion into position and no activities of consequence occurred. Therefore, tables that follow start with the second hour, redesignated the first hour.

2. Findings:

a. Objective 1. The relative capability of Models I and III to perform the functions of combat surveillance, target acquisition, target location and target designation.

(1) There does not appear to be any significant difference in the performance of the STA systems of the two Models. Both Models detected the incremental movement of the Red Force from their assembly areas to their attack positions, detected them while in the attack position and kept Red under almost continuous surveillance during the movement to contact. Each Model registered a total of 37 discrete detections. It should be noted, however, that in the absence of air support and force reconnaissance, Model III would have dominated. By virtue of the significant range enhancement of the Model III long range radar over the Model I radar, Model III was able to detect the movement of Red from assembly to attack areas with ground radar as well as air and force recon, while Model I had to rely solely on these latter two assets. The significance of this is that the overall performance of the Model III STA system would not degrade as rapidly as the Model I system with increasing intensity of the enemy air defense environment.

(2) Electronic Warfare. When in a daylight defense, it does not appear that a reasonable threat against the radars and the communications system will significantly degrade the performance of either Model. However, Model I is less vulnerable to early enemy detection because its radar emissions do not extend as far as the Model III emissions. This was not a factor in this game as Red had fixed Blue prior to detection of the radars.

(a) Communication System. Since Blue had been in position sufficiently long to lay wire throughout the battalion all radio circuits had a wire backup except circuits with external agencies (principally air request and NGF) and circuits to outposts and reconnaissance teams (disruptions in wire communications due to combat activity were not played as this is beyond the level of resolution of the LFWG). Red did employ communications jamming frequently, but with little impact on the performance of either Model I or Model III battalions. Five detection reports were delayed from two to ten minutes in each Model, but the reports were of such a nature as not to cause any impact on the employment of supporting arms. The most significant impact of Red jamming was delaying the request for NGF. Request for NGF was delayed on one occasion in both Models for approximately 30 minutes.

(b) Radars. Red determined the direction to one of the Model I radars, but was unable to destroy/neutralize that radar. In Model III Red located two long range radars and, subsequently, jammed these radars. However, at the time these radars were jammed, Red was within the range of the medium range radars. The table following summarizes the EW activity.

	JAMMING		ESM			
MODEL	Detection Reports Delayed	Supporting Arms Delayed	Radios DF'ed	Radios Located	Radars DF'ed	Radars Located
I	5	1-NGF	1	1	1	0
III	5	1-NGF	1	1	2	2

Table H-1

b. Objective 2. The relative capability of the two Models to engage enemy forces utilizing supporting arms.

The game records suggest that there is a significant difference in the Models in terms of ammunition expended and casualties produced, with Model III the dominant force. However, these differences are not correlated with STA system performance. Instead, they stem from inconsistencies in game play. Consider the records:

BLUE AMMUNITION EXPENDED

Arm \ Hour	1	2	3	4	5	6
Arty*						
I	0	100	230	195/140	120	-
III	0	720	300/360	210/90	0	200/90
NGF						
I	0	200	300	300	360	-
III	0	400	400	300	800	500

* For double entry: 105mm/81 mm mortar

Table H-2

RED CASUALTIES

Model \ Hour	1	2	3	4	5	6	Σ
I	25	79	90	67	50	-	311
III	0	110	146	57	48	54	415

Table H-3

(1) First we note that Model I produced 25 casualties in the first hour while Model III inflicted none. The reason is that the aircraft that caused the casualties was, by chance, shot down in the Model III iteration before delivering its ordnance.

(2) In the second hour the Model III artillery fired seven times as many rounds as Model I and NGF fired twice as many, causing 39% more casualties. The explanation is game learning. In Model III (second iteration) the helicopter that was observing the deployment of the Red battalions into their attack positions was positioned outside small arms fire. Thus, the helicopter was able to survive the entire hour and adjust fire on the Red battalions. In Model I, this same helicopter was shot down early in the hour.

(3) In the next hour we observe the most significant difference between the two models in terms of producing casualties: the improved 81mm mortar. The Model I mortar could not strike Red at this range; but, the improved mortar could. And, the difference was significant: Model III produced a total of 146 casualties, 62% more than Model I; the mortars' contribution to this total was 79 casualties or 46%. By the end of the hour the cumulative casualties produced by Model III was sufficiently high to cause one of the Red battalions to become ineffective (by LFWG rules). The game result was that the reserve battalion was committed in the Model III iteration; it was not committed in Model I.

(4) Finally, we note that red casualties were much higher in this game than in the previous three. The reason is that Red was dismounted.

in this game in contrast to the other games, and supporting arms are significantly more effective against dismounted troops. It is interesting to note that of the total 415 casualties produced by Model III, 105 or 25% were contributed by the improved mortar. The comparative number for Model I is 28 or 9%.

c. Objective 3. The relative capability of the two Models to engage the enemy in close combat.

The close combat record shows a slight margin for Model III in the one close combat battle of the game. However, the margin would have been significantly greater in favor of Model III had there been time to extend game play to the point that Red committed his reserve battalion against Model I.

d. Objective 4. The relative capability of the two Models to accomplish the assigned mission.

At end game the Red to Blue casualty ratio was the same for both Models. However, had the game continued, Model III would have probably dominated Model I because of its greater firepower score.
(See Par. 17, Section II)

II. PERFORMANCE MEASURES

1. **Measure # 1.** The number of target detections as a function of distance between the target and the source of detection.

The table below gives total data. See Table H-28, for breakdown by sensor. Air detections are not included since it was infeasible to measure the sensor range.

DETECTIONS vs SENSOR RANGE

MODEL \ RANGE	0≤R≤1	1<R≤2	2<R≤3	3<R≤4	4<R≤5	5<R≤6	6<R≤7	7<R≤8	Σ
I	8	8	5	0	0	0	0	0	21
III	3	3	2	2	1	0	4	5	20

Table H-4

COMMENT: The LRR accounts for the detections at longer ranges. See para 2, Section I, for analysis of comparative performance.

2. **Measure # 2.** The number of target detections as a function of the distance between the target and the center of mass of the Blue infantry platoon closest to the target.

The table below gives total data. See Table H-27, for breakdown by sensor. Air detections are included in this measure.

DETECTIONS vs RANGE TO BLUE

MODEL \ RANGE	0≤R≤1	1<R≤2	2<R≤3	3<R≤4	4<R≤5	5<R≤6	6<R≤7	7<R≤8	8<R≤10	Σ
I	3	3	3	1	1	6	6	9	5	37
III	1	0	0	2	1	6	12	10	5	37

Table H-5

3. **Measure # 3.** The number of target detections made during each hour of game play.

The table below gives total data. See Table H-26, for breakdown by sensor.

DETECTIONS vs TIME

Table H-6

Model \ Hour	1	2	3	4	5	6	Σ
I	7/99/53	8/212/79	11/50/65	3/45/34	8/91/45		37/497
III	10/77/26	11/144/73	11/88/46	2/46/71	1/61/61	2/55/69	37/471
* I	58	86	71	37	49	-	-
% III	28	79	50	77	66	75	-

Table Entry: #Detections/#Target elements/#different elements
*Entry is percentage of total population of target elements that were detected during hour.

4. Measure # 4. The cumulative number of target detections as a function of time.

The table below gives total data, see Table H-29 for breakdown.

CUMULATIVE DETECTIONS vs TIME

Model \ Time	T≤1	T≤2	T≤3	T≤4	T≤5	T≤6
I	7	15	26	29	37	37
III	10	21	32	34	35	37

Table H-7

5. Measure # 5. The number of target elements being tracked at the end of each hour.

Model \ Hour	1	2	3	4	5	6
I	1	50	9	34	close combat	
III	8	45	46	23	0	close combat

Table H-8

6. Measure # 6. The percent of target elements within specified zones being tracked at the end of each hour. Zones will be established as a function of distance from trace of forward Blue platoons.

TARGET ELEMENT DISTRIBUTION

Range (km) / Hour	0≤R≤3		3<R≤6		6<R≤9		9<R≤12		12<R≤15		R>15	
	I	III	I	III	I	III	I	III	I	III	I	III
0	0	0	0	0	0	0	0	0	0	0	92	92
1	0	0	1	1	27	27	29	29	0	0	35	35
2	0	0	1	1	85	85	3	3	0	0	3	3
3	0	0	38	38	49	49	2	2	0	0	3	3
4	25	0	13	62	49	24	2	3	0	0	3	3
5	43	35	3	27	41	24	2	3	0	0	3	3
6	cc	47	cc	23	cc	16	cc	3	cc	0	cc	3

cc - Close combat

Table H-9

PERCENT OF ELEMENTS TRACKED

Hour / Model	1						2						3						4						5					
	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F
I	0	0	4	0	0	0	0	0	59	0	0	0	0	24	0	0	0	0	43	0	0	0	0	0						
III	0	0	30	0	0	0	0	0	85	0	0	0	0	0	37	3	0	0	0	0	0	24	0	0	0	0	0	0	0	0

Table H-10

A: 0≤R≤3
B: 3<R≤6
C: 6<R≤9
D: 9<R≤12
E: 12<R≤15
F: R>15

7. Measure # 7. The mean and median distance between targets being tracked and a trace of forward Blue platoons at the end of each hour.

Model I: 7 data points; x = 5.5km, median = 5.3
Model III: 10 data points; x = 6.6km, median = 6.5

8. Measure # 8. The percent of detections as a function of the detection source.

Model \ Sensor	MRR	LRR	MREO	LREO	AR	AV	GV
I	22	-	0	-	08	35	35
III	11	24	0	0	05	41	19

Table H-11

9. Measure # 9. The mean and median of the difference between the reported and actual target locations for all targets tracked at the end of each hour.

Assessment model was not sufficiently precise to permit valid comparisons.

10. Measure # 10. Area under surveillance by STA devices and percent visible.

Model	Radars Used		Area Under Surveillance (km^2)	Percent Visible	Area Covered (km^2)
	MRR	LRR			
I	8	-	56.6	35	19.8
III	8	2	314.0	31	97.0

Table H-12

11. Measure # 11. Additional area covered by unattended ground sensors.

MODEL	# STRINGS	TOTAL # SENSORS
I	23	86
III	23	86

Table H-13

12. Measures 12-18 consider aspects of target engagements by supporting arms and are best dealt with in a combined fashion.

The tables below summarize the more detailed information of Table H-26.

NUMBER OF STRIKES

Model \ Arm	Arty	NGF	Air
I	11	7	6
III	10	11	4

Table H-14

MEAN ELAPSED TIME: DETECTION TO STRIKE (MIN)

Model \ Arm	Arty	Ngf	Air
I	24	32	4
III	22	24	21

Table H-15

STRIKES BY HOUR

Arm \ Hour	1	2	3	4	5	6
Arty I	0	1	4	4*	2	-
Arty III	0	2	2*	3*	0	3*
Ngf I	0	2	2	1	2	0
Ngf III	0	2	2	3	2	2
Air I	1	2	3	0	0	-
Air III	0	1	1	1	1	0

Table H-16

* includes one mortar strike.

13. Measure # 19. The number of Red casualties as a function of time.

The tables below give aggregations. See Table H-35 for breakout by supporting arm.

RED PERSONNEL CASUALTIES

Model \ Hour	1	2	3	4	5	6	Σ
I	25	79	90	67	50	-	311
III	0	110	146	57	48	54	415

Table H-17

RED MATERIEL LOSS

Model \ Hour	1	2	3	4	5	6	Σ
I	7/0/2	6/3/0	1/4/0	0/0/0	0/0/0	-	14/7/2
III	0/0/0	4/2/1	0/3/0	2/1/0	0/1/0	0/0/0	6/7/1

Table H-18

Entry: Wheeled Vehicle/Tank/Cannon-Mortar
Note: All losses caused by Air

14. Measure # 20. The number of Red casualties as a function of separation distance between Red and Blue.

CUMULATIVE RED CASUALTIES vs SEPARATION DIST

Model \ Dist (km)	5	3	2	1	0
I	104	194	224	261	311
III	110	256	313	361	514

Table H-19

CUMULATIVE RED MATERIEL LOSS

Model \ Dist (km)	5	3	2	1	0
I	13/3/2	14/7/2	14/7/2	14/7/2	14/7/2
III	4/2/1	4/5/1	6/6/1	6/7/1	6/7/1

Table H-20

Entry: Wheeled Vehicle/Tank/Cannon-Mortar

15. Measure # 21. The number of rounds respectively of mortar, artillery and NGF expanded per Red casualty.

RED PERSONNEL CASUALTIES

ARM	# CASUALTIES	# ROUNDS	ROUNDS/CAS
I Arty	88	645	7.3
III	105	1430	13.6
I Mort	28	140	5.0
III	103	540	5.2
I Ngf	102	1160	11.4
III	135	2400	17.8

Table H-21

16. Measure # 22. A comparison of the full strength firepower available to the Model I and III battalions.

MODEL	FIREPOWER SCORE	III/I
I	4.52	2.4
III	10.82	

Table H-22

17. Measures 23-26. These measures deal with aspects of close combat that are covered in the following table.

BATTLE	MODEL	FORCE REMAINING INFANTRY	FORCE APPLIED	FIREPOWER SCORE	FORCE RATIO B/R	PROBABILITY OF BLUE SUCCESS
1	I R	1150/83%*	722/63%**	8.53	.52	.35
	I B	1021/83%	1021/100%	4.41		
	III R	1035/75%	791/76%	13.32	.73	.40
	III B	784/72%	784/100%	9.68		

* Percent of start game strength
** Percent of remaining force

Table H-23

18. Measure 27 and 28. Ratio of Red to Blue casualties as a function of time and separation distance.

RATIO OF PERSONNEL CASUALTIES (R/B) vs TIME

Model \ Hour	1	2	3	4	5	6	Σ
I	0.3	1.4	1.1	2.3	1.1	-	1.1
III	0	2.0	1.8	0.9	1.4	0.8	1.1

Table H-24.

19. Rate of RED advance toward objective.

SEPARATION DISTANCE vs TIME

Model \ Hour	0	1	2	3	4	5	6
I	9.3	5.3	5.3	3.1	1.1	cc	-
III	9.3	5.3	5.3	3.1	2.2	0.7	cc

cc: close combat Table H-25

DETECTION RECORD

SENSOR \ HOUR		1	2	3	4	5	6	Σ
MRR	I	0/0/0	0/0/0	5/6/5	1/2/2	2/13/13	-	8/21/20
	III	0/0/0	0/0/0	3/14/13	1/23/23	0/0/0	0/0/0	4/37/36
LRR	I	-	-	-	-	-	-	-
	III	4/4/4	5/14/13	0/0/0	0/0/0	0/0/0	0/0/0	9/18/17
MREO	I	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	-	0/0/0
	III	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
LREO	I	-	-	-	-	-	-	-
	III	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
AR	I	2/51/51	1/29/29	0/0/0	0/0/0	0/0/0	-	3/80/80
	III	1/25/25	1/28/28	0/0/0	0/0/0	0/0/0	0/0/0	2/53/53
AV	I	1/24/24	5/133/79	5/38/30	1/34/34	1/8/8	-	13/237/175
	III	1/25/25	5/102/66	6/62/46	1/23/23	1/61/61	1/8/8	15/281/189
GV	I	4/24/24	2/50/50	1/6/6	1/9/9	5/70/44	-	13/159/133
	III	4/23/23	0/0/0	2/12/8	0/0/0	0/0/0	1/47/47	7/82/78
Σ*	I	7/99/53	8/212/79	11/50/65	3/45/34	8/91/45	-	37/497
	III	10/77/26	11/144/73	11/88/46	2/46/71	1/61/61	2/55/69	37/471
%**	I	58	86	71	37	49	-	-
	III	28	79	50	77	66	75	-

Table H-26

TABLE ENTRIES: # Detections/total #target elements/#different target elements.

* # of different target elements are derived from detection made during the hour and the carry-over target elements that were being tracked at the end of preceding hour.

** Entry = $\frac{\#\text{ different target elements detected}}{\text{total \# target elements (92)}}$

DETECTIONS VS RANGE TO CLOSEST BLUE UNIT

SENSOR \ RANGE		0<R≤1	1<R≤2	2<R≤3	3<R≤4	4<R≤5	5<R≤6	6<R≤7	7<R≤8	8<R≤10	Σ	%
MRR	I	0	2	1	0	0	5	0	0	0	8	22
	III	0	0	0	0	0	3	0	0	1	4	11
LRR	I	-	-	-	-	-	-	-	-	-	-	-
	III	0	0	0	0	0	0	8	1	0	9	24
MREO	I	0	0	0	0	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0	0	0	0	0
LREO	I	-	-	-	-	-	-	-	-	-	-	-
	III	0	0	0	0	0	0	0	0	0	0	0
AR	I	0	0	0	0	0	0	0	1	2	3	08
	III	0	0	0	0	0	0	0	1	1	2	05
AV	I	0	0	1	0	0	1	4	4	3	13	35
	III	0	0	0	2	0	2	3	5	3	15	41
GV	I	3	1	1	1	1	0	2	4	0	13	35
	III	1	0	0	0	1	1	1	3	0	7	19
Σ	I	3	3	3	1	1	6	6	9	5	37	-
	III	1	0	0	2	1	6	12	10	5	37	-
%	I	08	08	08	03	03	16	16	24	14	-	-
	III	03	0	0	05	03	16	32	27	14	-	-

Table H-27

DETECTIONS VS SENSOR RANGE

Sensor \ Range		0<R≤1	1<R≤2	2<R≤3	3<R≤4	4<R≤5	5<R≤6	6<R≤7	7<R≤8	Σ	%
MRR	I	1	3	4	-	-	-	-	-	8	38
	III	0	1	0	2	1	-	-	-	4	20
LRR	I	-	-	-	-	-	-	-	-	-	-
	III	0	0	0	0	0	0	4	5	9	45
MRED	I	0	0	-	-	-	-	-	-	0	0
	III	0	0	0	-	-	-	-	-	0	0
LREO	I	-	-	-	-	-	-	-	-	-	-
	III	0	0	0	0	0	0	0	0	0	0
GV	I	7	5	1	0	0	0	0	0	13	62
	III	3	2	2	0	0	0	0	0	7	35
Σ	I	8	8	5	0	0	0	0	0	21	-
	III	3	3	2	2	1	0	4	5	20	-
%	I	38	38	24	0	0	0	0	0	-	-
	III	15	15	10	10	05	0	20	25	-	-

Table H-28

CUMULATIVE DETECTIONS VS TIME

SENSOR \ TIME		T≤1	T≤2	T≤3	T≤4	T≤5	T≤6
MRR	I	0	0	5	6	8	8
	III	0	0	3	4	4	4
LRR	I	-	-	-	-	-	-
	III	4	9	9	9	9	9
MREO	I	0	0	0	0	0	0
	III	0	0	0	0	0	0
LREO	I	-	-	-	-	-	-
	III	0	0	0	0	0	0
AR	I	2	3	3	3	3	3
	III	1	2	2	2	2	2
AV	I	1	6	11	12	13	13
	III	1	6	12	13	14	15
GV	I	4	6	7	8	13	13
	III	4	4	6	6	6	7
Σ	I	7	15	26	29	37	37
	III	10	21	32	34	45	37

Table H-29

PERCENT DETECTIONS VS SENSOR

SENSOR \ HOUR		1	2	3	4	5	6	Σ
MRR	I	0	0	45	33	25	0	22
	III	0	0	27	50	0	0	11
LRR	I	-	-	-	-	-	-	-
	III	40	45	0	0	0	0	24
MREO	I	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
LREO	I	-	-	-	-	-	-	-
	III	0	0	0	0	0	0	0
AR	I	29	12	0	0	0	0	08
	III	10	10	0	0	0	0	05
AV	I	14	63	45	33	12	0	35
	III	10	45	55	50	100	50	41
GV	I	57	25	10	34	63	0	35
	III	40	0	18	0	0	50	19
Σ	I	19	21	30	08	22	0	-
	III	27	30	30	05	03	05	-

Table H-30

AIRCRAFT RECORD

ACFT \ HOUR		0	1	2	3	4	5	6	Σ
A6	I	1/1/0/0	1/0/1/28	1/1/0/28	1/0/1/0	0/1/0/0	0/0/0/0	-	4/3/-/56
	III	1/0/1/0	0/1/0/0	1/1/0/28	1/0/1/0	1/1/1/0	0/1/0/28	0/0/0/0	4/4/-/56
A4	I	0/0/0/0	0/0/0/0	2/0/0/20	4/0/0/40	0/0/0/0	0/0/0/0	-	6/0/-/60
	III	0/0/0/0	0/0/0/0	2/0/0/20	4/0/0/40	0/0/0/0	0/0/0/0	0/0/0/0	6/0/-/60
AV8	I	0/0/0/0	0/0/0/0	2/0/0/16	2/0/0/12	0/0/0/0	0/0/0/0	-	4/0/-/28
	III	0/0/0/0	0/0/0/0	2/0/0/32	0/0/0/0	2/0/0/16	0/0/0/0	0/0/0/0	4/0/-/48
F4	I	0/0/0/0	0/0/0/0	2/0/0/12	2/0/0/24	0/0/0/0	0/0/0/0	-	4/0/-/36
	III	0/0/0/0	0/0/0/0	0/0/0/0	4/0/0/48	0/0/0/0	0/0/0/0	0/0/0/0	4/0/-/48
AH1	I	4/0/4/0	2/0/4/0	0/1/4/0	0/0/0/0	1/0/1/0	0/0/1/0	-	7/1/-/0
	III	4/0/4/0	2/0/5/0	0/0/4/0	1/0/1/0	1/0/1/0	0/0/1/0	0/0/0/0	8/0/-/0
EA6	I	1/0/1/-	0/0/1/-	1/0/1/-	0/0/1/-	0/0/1/-	0/0/1/-	-	2/0/-/-
	III	1/0/1/-	0/0/1/-	1/0/2/-	0/0/1/-	0/0/1/-	1/0/1/-	0/0/1/-	3/0/-/-
UH1	I	0/0/0/-	2/0/2/-	0/1/1/-	0/0/0/-	1/0/1/-	0/0/1/-	-	3/1/-/-
	III	0/0/0/-	2/0/2/-	0/0/2/-	1/0/1/-	1/0/1/-	0/0/1/-	0/0/1/-	4/0/-/-
Σ	I	6/1/3/0	5/0/8/28	8/3/8/76	9/0/3/76	2/1/3/0	0/0/3/0	-	30/5/-/180
	III	6/0/6/0	4/1/8/0	6/1/6/80	11/0/4/88	5/1/4/16	1/1/3/28	0/0/2/0	33/4/-/212

Table H-31

TABLE ENTRY: ACFT LAUNCHED/ACFT LOSS/ON STATION END OF HOUR/WEAPONS DELIVERED

TARGET ENGAGEMENT RECORD

This record consists of three parts: Target Description, Model I; Target Description, Model III; Target Engagements, Models I and III.

TARGET DESCRIPTION (MODEL I)

Tgt #	Relationship	# Elements	Composition
5	Basic	24	Inf Bn with supporting arms
7	Basic	27	Inf Bn with supporting arms and 2 Tank Co
11	Basic	29	Inf Bn with supporting arms and 1 Tank Co
6	= 5	24	Inf Bn
10	⊃ 5	23	Inf Bn less D.S. Arty Btry
12	= 7	27	Inf Bn and 2 Tank Co
13	=11	29	Inf Bn and 1 Tank Co
19	⊃12	4	Tank Bn
20	⊃12	4	Tank Bn
23	⊃12	1	Mortar Btry
27	⊃12	9	2 Inf Co
28	=12	27	Inf Bn and 2 Tank Co

Table H-32

Table Explanations:

1. Target #: Excepting basic targets, only those targets that were hit are listed.

2. Relationship: This column gives the interrelationship of targets. Basic targets are mutually exclusive and exhaust all target elements that comprise the set of targets. (⊃ Means a subset of).

TARGET DESCRIPTION (MODEL III)

Tgt #	Relationship	# Elements	Composition
3	Basic	24	Inf Bn with supporting arms
16	Basic	29	Inf Bn with supporting arms and 1 Tank Co
19	Basic	19	Inf Bn
20	Basic	8	2 Tank Co
11	⊃3	18	Inf Bn
26	= 20	8	2 Tank Co
24	= 19	19	Inf Bn
25	= 3	24	Inf Bn
32	⊃24	6	Inf Co and Mortar Btry
33	⊃16	23	Inf Bn with 1 Tank Co
35	=(16U19)	48	2 Inf Bn with 1 Tank Co

Table B-33

TARGET ENGAGEMENT RECORD

Model	Initial Strikes (tgt #)	Sensor	Elapsed Time (minutes)			Number of Repeat Strikes			Subsequent Strikes (tgt #)	Sensor	Elapsed Time (minutes)			Number Of Repeat Strikes		
			Arty	NGF	Air	Arty	NGF	Air			Arty	NGF	Air	Arty	NGF	Air
I	6	AV	-	-	15	-	-	-								
	12	RA	49	49	--	1	1	-	13	AR	22	22	0	1	-	-
	10	GV	-	30	-	-	-	-	23	MRR	14	-	-	2	1	-
	11	AV	-	-	06	-	-	1	19	AV	-	-	0	-	-	-
									20	AV	-	-	0	-	-	-
									27	GV	13	29	-	2	1	-
									28	AV	13*	-	-	1*	-	-
III	11	RA	44	44	-	-	-	-	24	AV	09	-	-	4*	2	-
	16	RA	-	-	02	-	-	-	25	AV	07*	11		1*	1	-
	19	LRR	24	24	-	-	-	-	32	MRR	-	11	-	-	-	-
	26	LRR	-	-	53	-	-	-	33	AV	28	28	24	-	3	-
									35	AV	-	-	05	-	-	-

Table H-34

Initial Strikes are the first time a target complex is hit.
Subsequent Strikes are strikes on subsets of the initial target elements.

* Includes 1 Mortar Strike

CASUALTY RECORD

SOURCE		HOUR	1	2	3	4	5	6	Σ
I	Arty*	R	0/0	9/100	34/230	35/195 28/140	10/120	-	88/645 28/140
		B	72/300	30/180	62/300	29/330	28/840	-	221/1950
	NGF	R	0/0	32/200	34/300	4/300	32/360	-	102/1160
		B	-	-	-	-	-	-	
	AIR	R	25/28	38/76	22/76	0/0	0/0	-	85/180
		B	0/0	28/6	18/4	0/0	0/0	-	46/10
	GC	R	-	-	-	-	8/-	-	8/-
		B	-	-	-	-	17/-	-	17/-
III	Arty*	R	0/0	54/720	22/300 79/360	14/210 17/90	0/0	15/200 7/90	105/1430 103/540
		B	71/300	34/180	51/330	65/600	35/540	56/780	312/2730
	NGF	R	0/0	32/400	33/400	12/300	38/800	20/500	135/2400
		B	-	-	-	-	-	-	-
	AIR	R	0/0	24/80	12/88	14/16	10/28	0/0	60/212
		B	0/0	21/4	31/6	0/0	0/0	0/0	52/10
	GC	R	-	-	-	-	-	12/-	12/-
		B	-	-	-	-	-	16/-	16/-
Σ	I	R	25/28	79/376	90/606	67/635	50/480	-	311/2125
		B	72/0	58/186	80/304	29/330	45/840	-	284/1660
	III	R	0/0	110/1200	146/1148	57/616	48/828	54/790	415/4582
		B	71/300	55/184	82/336	65/600	35/540	72/780	380/2740

Table H-35

Table Entry: # Casualties / # RDS

* Where double entries occur: top entry is arty; bottom is mortar

ANNEX I

CHARACTERISTICS OF SURVEILLANCE AND TARGET ACQUISITION EQUIPMENT AND ADVANCED WEAPONS EMPLOYED IN THE MARSAS WAR GAMES

Table of Contents

ANNEX I

Characteristics of Surveillance and Target Acquisition Equipment and Advanced Weapons Employed in the MARSAS War Games

1. Introduction.

a. This annex provides the characteristics of special USMC materiel involved in the MARSAS war games which are not in the hands of troops today. It is not concerned with threat materiel as only that known to be currently in the hands of Red troops was employed, except for war game MARSAS III where the Red force was given a surveillance and target acquisition capability identical with that described below for the USMC Model I infantry battalion.

b. Organization and employment doctrine for the surveillance and target acquisition (STA) equipment and advanced weapons was provided to War Game Branch by the MARSAS Study Group.

2. Battalion Model I. This is the current Marine infantry battalion modified by recommendations from CMC Project 30-70-02 which were approved by the Commandant of the Marine Corps on 6 September 1973. The materiel changes significant to the MARSAS series of war games are described below:

a. Surveillance and Target Acquisition Equipment.

(1) AN/PPS-15 Radar

Dimensions: 14" X 9" X 6"
Weight: 20 lbs. (radar, tripod, and internal battery)
Maximum range: vehicles - 3000 meters
Personnel - 1500 meters
Maximum field of scan: 90^{o}
Target radial velocities: 0.33 to 35 mph.
Location accuracy: azimuth $\pm$ 10 mrad, elevation $\pm$ 70 mrad.
Target interpretation: Operator dependent
Modes of operation: manual scan
automatic scan 45^{o} and 90^{o}
Degradation by environmental conditions: Sensitive to rain
Response time: Function of C^3 system
Countermeasures: Vulnerable to jamming and to direct attack by fire.
Power: Any external VDC source or BA-4386. Battery life - 12 hours continuous operation
Reliability: MTBF - 3000 hours
Displacement time: 1.5 minutes
Emplacement time: 2.5 minutes

(2) AN/TVS-4 Night Observation Device (NOD)

Dimensions: 29" long, 8.3" radius
Weight: NOD - 34 lbs.
Tripod - 10 lbs.
Maximum range: Starlight - 1200 meters
Moonlight - 2000 meters
Field of scan: 360^{o}
Field of view: 90 to 157 mils
Location accuracy: NA. Presents scene.
Target interpretation: 91% recognition capability
Degradation by environmental conditions: No significant advantage over direct viewing in rain, snow, fog, drizzle, haze, smoke, or dust.
Response time: function of C^3 system
Power: BA-110. Battery life - 12hours continuous operation.
Reliability: MTBF - 1000 hours
Displacement time: 2 minutes
Emplacement time: 5 minutes

b. Weapon

(1) Multishot Portable Flame Weapon (MPFW)

General Description: Four-tube, shoulder-fired M202 rocket launcher that fires XM-74 rockets from the 4-rd XM-74 clip.
Dimensions: Launcher W/clip - 34.75"
Launcher, closed - 27"
Clip W/rockets - 21.5"
Rocket: 21"
Weight: Launcher W/clip - 26.6 pounds
Launcher - 11.5 pounds
Clip W/rockets: 15.1 pounds
Rocket: 3 pounds
Rocket warhead: 1.3 pounds of triethylumin.
Maximum range: area targets - 750 meters
point targets - 200 meters
Minimum range: hard targets - 20 meters
Muzzle velocity: 375 fps
Bursting radius: 20 meters
Maximum rate of fire: 1 rd/sec per 4-rd clip
Hit probabilities against 1X2 meter target:

Range	1st rd	2d rd
50M	99%	99%
100M	40%	96%
200M	5%	39%

Reliability: .95 for 300 clips, after which launcher is discarded.

3. Battalion Model III. This is an evolutionary development of the current Marine infantry battalion. The materiel changes significant to the MARSAS War Games are described below.

a. Surveillance and Target Acquisition Equipment.

(1) Long Range Moving Target Indicator (MTI) Surveillance Radar

Dimensions and weights of three packages of basic unit:
12" X 24" X 2" - 10.2 lbs.
12" X 12" X 2" - 10.3 lbs.
12" X 12" X 2" - 10 lbs.
Dimensions and weight of accessory pack:
18" X 10" X 6" - 6.2 lbs
Antenna pedestal base rotates with respect to tripod level platform aligned to turn North by the electro-optic angle measurement device attached to pedestal base.
Clear weather effective range: vehicle - 10 Km
personnel - 5 Km
Minimum range: 10 meters
Selectable azimuth scan up to 360^{o}
Elevation scan: 100 mrad azimuth 20 mrad elevation increments within + 400 and -600 mrad from horizontal.
Automatic detection
Automatic tracking
Target radial velocities: 0.66 to 45 mph
Target location accuracy: azimuth $\pm$ 5 mrad
elevation $\pm$ 5 mrad
Target interpretation: Operator dependent
Degradation by environmental conditions: Sensitive to rain
Response time: Function of C^3 system
Countermeasures: Vulnerable to jamming and to direct attack by fire.
Power: 24-volt, 5 lb, zinc-air battery. Battery life-12 hours continuous operation.
Reliability: MTBF - 10,000 hours
Displacement time: 1.5 minutes
Emplacement time: 3.7 minutes

(2) Long Range Electro-Optic (E-O) Surveillance Device

Dimensions, Incl. Tripod: 34" X 10" X 10"
Weight, Incl. Tripod: 54.3 lbs.
Operational modes: Thermal, passive night vision (1/2 moon), and active night vision (black sky)

Clear weather, effective ranges:
Thermal: vehicle - 8.4 km
personnel - 4.2 km
Passive: vehicle - 15 km
personnel - 5 km
Active: vehicle - 4.5 km
personnel - 1.5 km
Field of view: 2^{0}
Location accuracy: Obtains range from laser and azimuth and elevation from co-mounted E-O angle measurement device.
Detects stationary and moving targets
Target interpretation: accurate
Degradation by environmental conditions: No significant advantage over direct viewing in rain, snow, fog, drizzle, haze, smoke, or dust.
Response time: Function of C^3 system.
Power: 100-hour life battery
Reliability: MTBF - 10,000 hours
Displacement time: 1.3 minutes
Emplacement time: 2.7 minutes

(3) Long Range Multipurpose Laser Device

Dimensions, incl. tripod: 13" X 9" X 9"
Weight: Overall - 55 lbs.
Basic unit, incl. tripod - 35 lbs.
Scan drive and remote unit - 20 lbs.
Clear weather effective range: Range finding - 10 km
target designation (illumination) 10 km
Target interpretation: Depends on human eye, co-mounted 10X telescope, or E-O device.
Degradation by environmental conditions: E-O device used for night target acquisition has no significant advantage over direct viewing in rain, snow, fog, drizzle, haze, smoke, or dust.
Response time: Function of C^3 system
Power: Battery, rechargeable every 2 hours.
Reliability: MTBF - 10,000 hours.
Displacement time: 1.3 minutes
Emplacement time: 2.7 minutes

(4) Electro-Optic Angle Measurement Device

Dimensions: 5" X 6" X 7"
Weight including battery: 5 lbs.
Function: Provides accurate target elevation and heading information, with elevation

coordinates relative to the horizatonal and azimuth relative to true North relates elevation to that inherent in the PLRS system.

Effective range: NA
Target Location accuracy: Elevation - 2 mils
Azimuth - 2 mils
Target interpretation capability: none
Degradation by environmental conditions: none directly, but limited to that of the MTI radar, E-O device, and/or laser with which it is employed.
Response time: NA
Countermeasures: No significant signature
Power: Battery, rechargeable every 12 hours
Reliability: MTBF - 10,000 hours
Displacement/emplacement times: Co-mounted with radar, E-O device, or laser, as desired. Add 10 seconds to times for pertinent equipment.

(5) Moving Target Indicator (MTI) Surveillance Radar.

General description: Medium range, handheld or tripod-mounted, X-band radar consisting of a receiver/transmitter, processor/display, connecting cable, headset, tripod, and 10 power telescope.
Dimensions: 12" X 13" X 3"
Weight: Three components - 21.3 lbs.
basic unit - 11.2 lbs
remote package - 10.1 lbs
Clear weather effective range: vehicle - 5 km
personnel - 2 km
Azimuth coverage 360° and contour scan in elevation both automatic.
Target location accuracy: Range - 10 meters
Azimuth - $\pm$ 5 mrad
Elevation - $\pm$ 5 mrad
Target radial velocities: 0.66 to 45 mph.
Target detection and location: Presented aurally and visually to operator. Displays permit night operation without disclosing position.
Target interpretation: Operator dependent.
Adjustable scan in two beam widths (12°).
Degradation by environmental conditions: Sensitive to rain
Response times: Function of C^3 system
Countermeasures: Vulnerable to jamming and to direct attack by fire.

Power: Battery, with 12 hour life.
Reliability: MTBF - 10,000 hours
Displacement time: 1.5 minutes
Emplacement time: 3.7 minutes

(6) Electro-Optic (E-O) Surveillance Device

Dimensions: 9" X 8" X 3.5"
Weight: 12 lbs
Hand-held or tripod mounted
Operational modes: Thermal, passive night vision (1/2 moon) and active night vision (black sky)
Clear weather effective ranges:
Thermal: vehicle - 1.5 km
Personnel - 400M
Passive: vehicle - 3 km
personnel - 1 km
Active: vehicle - 2.25 km
personnel - 750 m
Field of view: 1.5^{o}
Location accuracy: Obtains range from laser and azimuth and elevation from co-mounted E-O angle measurement device.
Target Interpretation: Accurate for all stationary and moving targets within range of operating mode.
Provides sighting for laser at night and in bad weather.
Degradation by environmental conditions: No significant advantage our direct viewing in rain, snow, fog, drizzle, smoke or dust.
Response time: Function of C^3 system
Power: Battery with 100-hour continuous operation life
Reliability: MTBF - 10,000 hours
Displacement time: 1.3 minutes
Emplacement time: 2.7 minutes

(7) Multipurpose Laser Device

Dimensions: 9" X 6" X 4"
Weight: Overall - 17 lbs.
Basic unit - 6 lbs.
Accessories - 11 lbs.
Hand-held or tripod-mounted
Clear weather effective range: Range finding - 3 km
Target designation - 3 km
Target location accuracy: 0.1% of range for laser, modified by PLRS accuracy (15m CEP)
Target interpretation: Depends on human eye, co-mounted low power telescope for day or E-O device for night.
Degradation by environmental conditions: E-O device for night target acquisition has no significant advantage over direct viewing in rain, snow, fog, drizzle, haze, smoke or dust.

Response time: Function of C^3 systems
Power: Battery rechargeable every 15 minutes
Reliability: MTBF - 10,000 hours
Displacement time: 1.3 minutes
Emplacement time: 2.7 minutes

(8) Rifle Night Vision Sight

Dimensions: 3.5" X 4.5" X 13"
Weight, incl. battery: 3.5 lbs
Rifle-mounted, three-power
Effective range vs. man target: Highlight level - 2.5km
Lowlight level - 500m
Angular field of view: 7.5°
Target location accuracy: azimuth - 1 mrad
elevation - 1 mrd
range - operator estimate
Target interpretation: accurate
Recognition criteria: 4 line pairs across target (shape)
Degradation by environmental conditions: No significant advantage over direct viewing in rain, snow, fog, drizzle, haze, smoke, or dust.
Response time: Function of C^3 system
Power: battery rechargeable every 100 hours
Reliability: MTBF - 10,000 hours
Displacement and emplacement times: N/A (Snaps on)

(9) Pocketscope (night vision device)

Dimensions: 7" X 2.3" X 5.9"
Weight: 1.5 lbs
Effective range: 350 meters
Field of view: 14°
Resolution: 1.9 lp/mrad
Focus range: 4' to infinity
Target location accuracy: No intrinsic elevation, azimuth, or range capability
Target interpretation: 91% recognition
Degradation by environmental conditions: Operates under ambient night sky conditions (starlight through moonlight) No significant advantage over direct viewing in rain, snow, fog, drizzle, haze, smoke, or dust
Response time: N/A
Power: dry cell battery
Displacement/emplacement time: N/A (instant operation)

(10) Position Location and Reporting System (PLRS)

General description: PLRS is an automated location system with two basic functional roles to facilitate execution of

command and control. First, it shall generate, transmit, receive, and process signals from which accurate three dimensional position information will be derived, rapidly updated, and displayed within designated command and control centers. Secondly, PLRS will provide individual air and ground users with the ability to demand and receive via their own PLRS equipments, a variety of position, navigation, and related information.

Components: (1) master unit (MU) and sub-master unit (SMU): contains systems control electronics and ADP equipment mounted on 2 1/2 T. truck. SMU is back-up for MU.
(2) user unit: operable from batteries or vehicle power, in manpack, vehicle mount, or aircraft mount.
Weight: User unit including battery: 10 lbs.
Position accuracy: 15 meter CEP
Users accommodated: 2000, at 66 users per second
Ranging and comm network: 200 mi diameters
Security: Cryptographically secure and protected from jamming, spoofing, and exploitation.

b. Weapons

(1) Dragon

General description: Man-portable, tube-launched, optically-tracked, wire-guided antimechanized/assault missile system fired from a recoilless, disposable launcher.
Dimensions: Overall - 3.73'
Missile - 2.44'
Weight: Complete: 27.5 lbs
Missile: 14.4 lbs
Warhead: 5.4 lbs
Ammunition: 5" HEAT
Direct fire range: 1 km
Armor penetration: 20", 0° obliquity

(2) Multishot Portable Flame Weapon (WPFW)

See paragraph 2b (1) above

(3) Improved 81mm Mortar

General Description: This is an improved mortar to replace the Army's 107mm. Most data are the same for the M29.
Maximum range: 6.2km

(4) Squad Automatic Weapons System (SAWS)

Length: Overall - 41.5"
Barrel - 24.0"
Weight: w/200rd magazine, bipod, and accessories: 19.8 lbs
without: 11.5 lbs
Calibre: 6mm
Maximum range for helmet penetration: 1 km
Operation: dual gas system
Feed: sprochet (disintegrating metal link)
Locking: Rotary (3 lug)
Rate of fire: 480 SPM
Number of modular groups: 8

ANNEX J

SPECIAL ASSESSMENT RULES

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ANNEX J

SPECIAL ASSESSMENT RULES

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I. GENERAL

The Rule Manual of the Landing Force War Game provided the assessment procedures for the conduct of the MARSAS War Games. However, inasmuch as MARSAS Model III surveillance and target acquisition equipment is conceptual, it was necessary to obtain certain assessment data from the MARSAS study group. Furthermore, it was necessary to develop supplementary methodology for the assessment of Red electronic counter measures (ECM) in as much as the Red force was given an ECM capability in War Game MARSAS IV.

II. PERFORMANCE OF MODEL III OPTICAL SENSORS

Table J-1 contains environmental scaling factors providing by the MARSAS Study Group and employed by War Games Branch in assessing Model III optical sensors.

III. PERFORMANCE OF MODEL III MTI RADAR

Table J-2 contains environmental scaling factors provided by the MARSAS Study Group and employed by the War Games Branch in assessing Model III MTI Radar.

PERFORMANCE OF MARSAS OPTICAL SENSORS

		Scene Illuminance lm/m^2	Human Eye	Infrared Viewing 10.5mm	Night Vision	Ranging (10.5mm)	Designation Receive (10.5mm)
Clear Air	Direct Sunlight	$1-1.3x10^5$	1.0	1.0	1.0	1.0	1.0
	Full Daylight	$1-2\ x10^4$	1.0	1.0	1.0	1.0	1.0
	Overcast Sky	10^3	0.83	1.0	1.0	1.0	1.0
	Very Dark Day	10^2	0.63	0.95*1	1.0	1.0	1.0
	Twilight	10	0.31	0.1 *1	1.0	1.0	1.0
	Deep Twilight	1	0.19	0.1 *1	1.0	1.0	1.0
	Full Moon	10^{-1}	0.06	0.95*1	0.73	1.0	1.0
	Quarter Moon	10^{-2}	0.04	0.95*1	0.45	1.0	1.0
	Starlight	10^{-3}	0.002	0.95*1	0.15	1.0	1.0
	Overcast Starlight	10^{-4}	-	0.95*1	0.05	1.0	1.0
Precipitation	Drizzle (1/4mm/hr)		0.5	0.16	0.5	0.16	0.16
	Snow (1mm/hr)		0.13	0.09	0.13	0.09	0.09
	1mm/hr Rain		0.4	0.13	0.4	0.13	0.13
	4mm/hr Rain		0.2	0.07	0.2	0.07	0.07
	16mm/hr Rain		0.04	0.01	0.04	0.01	0.01
	Fog (1-3mm radius)		0.02-0.11	0.12	0.02-0.11	0.12	0.12
	Haze (0-3mm radius)		0.003-0.02	0.12	0.003-0.02	0.12	0.12

Note: *1 Applies to metal targets only. Men type targets will be 1.0 for all conditions of day or night.

Table J-1

PERFORMANCE OF MARSAS

MTI RADAR

		MTI Radar
Precipitation	Drizzle (.25mm/hr)	0.96
	Snow	
	1mm/hr Rain	0.4
	4mm/hr Rain	0.12
	16mm/hr Rain	0.04
Fog		1.0
Haze		1.0
Day Night		1.0

IV. ELECTRONIC WARFARE ASSESSMENTS

1. General. This document sets forth the nature, extent and assessment rules for the Electronic Warfare (EW) that will be injected into the last game of the MARSAS series of battalion war games. As such, it constitutes a special addendum to Chapter 18 (Electronic Warfare) of the Landing Force War Game.

2. General Force Capabilities

a. Red Forces will be given the capability to conduct both Electronic Support Measures (ESM) and Electronic Counter Measures (ECM) commensurate with a reasonable amount of assets that would be provided based upon the composition of the force and the scenario. Red will not be given sophisticated SIGINT capability since the time span of the game is sufficiently short to rule out such support.

b. Blue forces will not accrue additional ESM/ECM/ECCM capability over and above the capability to jam air defense radars that existed in the previous games. Such action is in line with the assets that would be provided a force of this composition under the circumstances of the scenario.

c. EW against Electro/Optic (E/O) devices and the Position Locating Reporting System (PLRS) will not be played for following reasons:

(1) E/O Devices. The game will be conducted during daylight hours and, therefore, reduced visibility devices will experience little, if any, use. Under such conditions it is improbable that Red would attempt to employ any countermeasures. The laser will only be used for range finding and in this mode is virtually immune to E/W countermeasures. E/O countermeasure were not considered.

(2) PLRS. There is insufficient empirical data available at this time to allow development of quantitative assessment rules for PLRS and the LFWG rules are not designed for this level of resolution. It is noted that a PLRS EW field test will be conducted after the prototype units are delivered in late CY74.

3. Red EW Assets. One signal company will be assigned to the Regiment that is confronting the total Blue force. A detachment of this company will support the two Red battalions that are involved in the game. In addition, the Direction Finding (DF) Net supporting the Red Regiment covers the Blue force. Specific Red assets are:

Jammers

VHF/UHF	Power	1 KW	100W	<10W
	Number	2	3	4

Communications Intercept: 10 positions
VHF/UHF
Direction Finding: 1 net*
VHF/UHF
Radar DF/Jam: 3 DF/Jammers

*No specific numbers of equipments were played. The detection/location probabilities were established based upon the assumption that there were two (2) DF stations which could cover any point in the AO.

4. Red Employment Doctrine

a. Radio Communications. Red doctrine is to locate (DF) radio transmitters with objective of destroying/neutralizing by fire the capability associated with these transmitters. Priority is given to locating command posts. Jamming will not be employed until the final stages of Red attack/defense unless prior to that time Red is unsuccessful in locating radios associated with a Blue capability that is inflicting damage on Red. When jamming is employed in attack/defense priority is given to command and fire request/control nets.

b. Ground Radars. Since line of sight must exist between the Red DF/Jammer and the Blue Radar, Red will position their DF/Jammers based upon terrain analysis and disposition of Red forces. Red will attempt to maximize the distance of their DF/Jammers from the FEBA to avoid detection and countermeasures by Blue. The policy for Red retaliatory action against Blue Radars is the same as above policy for radios — that is: destroy/neutralize by fire if located, jam as last resort.

c. Communications Intercept. Red has 10 positions available for intercept and possesses, therefore, the capability to monitor all Blue nets on a nearly simultaneous basis. The probability that any Blue transmission is monitored is near certain and, therefore, it is assumed that all clear transmissions by Blue are monitored and understood. However, ciphered transmissions will not be understood.

d. Miscellaneous

(1) Red forces have demonstrated that they can maintain radio silence when necessary. Radio silence will be maintained while Red is deploying to attack.

(2) Chaff is an impractical countermeasure against ground MTI radar and will not be used.

(3) Red jammers will be semi-advanced noise jammers. They will have a listen-through capability and will be keyed by the transmitter-receiver to be jammed.

5. Red Player Requirements. To allow assessment of EW interactions Red Player Team must make the following inputs at appropriate junctures in the game.

a. Specify location of each radio jammer and the blue receivers targeted.

b. Specify location of Radar DF/Jammers.

c. Specify priority for DFing by type Blue communication net.

d. Provide SOP for retaliatory action against Blue radios/radars that are located or, alternatively, respond to Control information on a case-by-case basis.

6. Blue Player Requirements

a. Provide SOP or intermittent orders concerning actions radar operators will take to avoid detection, such as time-on-air.

b. Specify separation distance between antenna and center of mass of the unit/facility using the radio for each radio.

c. Specify in advance of a game interval any unusual communications disciplinary measures that are to be practiced during the interval.

7. Control Assessments

a. Assessing Red DF Performance (Radios). At the end of each game interval assess each Blue radio to determine if located by Red. For this purpose play one radio at each platoon, recon team, artillery battery and battalion headquarters. Procedures are:

(1) Count the number of transmissions [Di; i=1°°°n (n=total number of platoons played)] made during the interval as a result of target detections. Note: Platoon radios make 2 transmissions per detection if radio communications only are used; 1 transmission if wire is laid in company area.

(2) Count the number of transmissions [Fi; i=1°°°n] made during the interval as a result of fire mission requests.

(3) Count the number of transmissions from FSCC to FDC [FSR] as a result of fire support orders.

(4) Compute time-on-air [Ti] for each platoon radio:

$$Ti\ (i=1^{\circ\circ\circ}n) = (Di)\ 2\ min + (Fi)\ 4\ min + * (Di+Fi)\ 1\ min$$

* This factor accounts for other tactical traffic on company and battalion nets.

(5) Compute time-on-air for recon team radios [Tr; r=1•••k].

$Tr = (Dr)\ 2 \text{ min}$

(6) Compute time-on-air for Bn HQ, /FSCC radio:

$$T_B = \left(\sum_{i=1}^{n} Di + \sum_{r=1}^{k} Dr + FSR\right) 2 \text{ min}$$

$$+^{*}\left(\sum_{i=1}^{n} Di + \sum_{r=1}^{k} Dr + FSR\right) 1 \text{ min}$$

*Accounts for other traffic

(7) Compute time-on-air for artillery battery radio:

$$T_A = \left(\sum_{i=1}^{n} Fi\right) 4 \text{ min} + (FSR)\ 2 \text{ min}$$

(8) Compute probability [P_L; L=1•••t (t=total # radios)] that each radio is located

$P_L = P_{(1)}^{2}$ $P_{(1)}$ = probability of DF by single reciever

Table 1

Ti (min)	$P_{(1)}$
2	.05
5	.2
10	.4
20	.6
30	.8

(9) Assess if each radio is located using computed P_L: Draw a random number. If number is less than P_L x 100, radio is located. Refer to Table 18-32, Chapter 18 for location accuracy.

(10) Provide assessment results to Red team and request action to be taken during next interval.

(11) Based upon Red team response assess damage in next interval. In assessing damage account for separation distance between antenna and center of mass of unit/facility using radio.

b. Assessment of Red DF Performance (Radars). At the end of each game interval assess each Blue radar to determine if located by Red. Procedures are:

(1) Determine where LOS exist between Blue radars and Red DF/ Jammers.

(2) Where LOS exist determine if Radar if DF'ed:

$$R = \frac{\text{Distance between Radar and DF/Jammer}}{\text{Effective Range of Radar (personnel Targets)}}$$

p = probability of detection per sweep

Table 2

R	p
2.0	.05
1.7	.10
1.5	.20
1.2	.30
1.0	.40
0.8	.50
<.8	.50

a Compute R and enter Table 2 to determine p.

b Compute number of sweeps. Refer to Blue employment SOP and Radar sweep rates.

c Determine if Radar is DF'ed by drawing random numbers (RN). Stop the draw when the RN≤100p or when the number of draws is equal to the number of sweeps, whichever occurs first. The radar is DF'ed if a RN≤100p is drawn.

(3) The radar is located if DF'ed by at least two DF/Jammers. Refer to Table 18-32, Chapter 18 for location accuracy.

(4) Provide assessment results to Red team and request action to be taken during next interval.

(5) Based upon Red team response assess damage in next interval.

c. Assessing Red Jamming Performance (Radios). When Red employs jamming, effectiveness will be assessed on a real time (game) basis for each attempted transmission to report a detection, request a fire mission or order a fire mission. The result of the assessment will be the time delay to complete the transmission. Procedures are:

Table 3

Type Transmission	Transmitter	Targeted Receiver
Detection Reports	Platoon Recon Tm	Bn Hq's
Fire Mission Request	Platoon	Arty FDC
Fire Mission Orders	Bn Hq's	Arty FDC

Note: Red team must specify at game intervals location of jammers and nets targeted for each jammer.

(1) Measure the distances between the jammer and targeted receiver $[D_{jr}]$ and between the transmitter and targeted receiver $[D_{tr}]$.

(2) Compute K.

$$K = \frac{Wj}{Wt}\left(\frac{Dtr}{Djr}\right)$$

Wj = Jammer Power
Wt = Xmtr Power
See Tables 15-17
Chapter 15

(3) Determine probability of successful transmission using Table 4.

Table 4

K	P	K	P
<.1	.99	5	.40
.2	.90	10	.20
.5	.80	20	.10
1	.70	30	.06
2	.60	40	.02
3	.50	50	0

(4) Draw a random number. If number is greater than 100p, the link is jammed.

(5) If link is jammed inform Blue on a real time (game) basis. Allowable action by Blue is to dispatch a courier or position a relay radio. If courier option is used assess the communication delay time (Chapter 15). If relay is used assess whether that link is jammed.

d. Assessment of Red Jamming Performance (Radars). If a Red DF/Jamme is able to DF a Blue radar it is also able to jam the same radar if Red chooses to do so.

ANNEX K (AUTOMATED RECORDS OF GAME PLAY)

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1. General. Game records include team operation orders, fragmentary orders, fire missions, and daily flight schedules as well as control work sheets for assessment of tactical and logistical activities. These data are source documents for the machine records generated by control for each interval of game play. Decks of cards are retained (or placed on magnetic tape) so that the game can be reconstructed or replayed at any time.

2. MARSAS I-IV. Twelve IBM 407 electronic accounting machine (EAM) records were kept during game play - Unit History Record (Red and Blue), Report Record (Red and Blue), Equipment Lost Record (Red and Blue), Supporting Arms Record (Red and Blue), Air Record (Red and Blue), and target List (Red and Blue). All twelve records were the source of the statistical data presented in this report. It is necessary to understand the abbreviated EAM codes for full utilization of these records, but these codes are too detailed for incorporation in the descriptions which follow.

a. Unit History Record (Figure K-1). This record shows for each unit, at game resolution, its activity during each interval of game play. The information presented consists of the following:

(1) End-interval time and day. This is issued initially as start-game information.
(2) Unit designation, type and size.
(3) Total unit strength at begin-game and end-interval (current).
(4) Number of casualties sustained during interval.
(5) Unit location (coordinate) at end-interval.
(6) End-interval activity and time and day it began.
(7) Type of support and unit supported, if applicable.
(8) Number of tanks, radio jeeps cargo trucks, recoilless rifles, amphibian tractors, etc on hand at end-interval, if applicable.
(9) Unique number assigned each unit, used for identification.
(10) These columns are reserved for machine coding and sorting.

b. Report Record (Figure K-2). This record provides each team with intelligence information and, hence, is commonly known as the detection record. However, it is not only a chronological report of the interactions of the two opposing sides, as seen by one side, during each game interval, but a report of certain unit actions not involving enemy intelligence. The information presented consists of the following:

(1) End-interval time and day.
(2) Unit reporting.
(3) Unique number assigned each report.
(4) The message from the reporting unit in abbreviated prose.
(5) These columns are reserved for machine coding and are not germane to the enemy or friendly intelligence presented.

BLUE UNIT HISTORY

1	2	3	4	5	6	7					8											9	10
TIME HOUR	D Y	O/B	TY SZ	BGN GM STR	CUR STR	HC CS	LOCAT	CUR ACT	D HQ	TYP RV	WHO SPT	SPT	TK	J RE DE OP	CT GR OK	I O 6 RR	L V L	B R D A	B T R	D R A G	81 MR	T U B E	60 MR	M U L E		C OM GDO MED
0200	1	HS1/2	IN HQ	226	226		103706	UPD						16											LN NO	M13
0200	1	HQA1/2	IN HQ	016	016		093709	DPD						01										03		M13
0200	1	1A1/2	IN PL	053	052	01	078712	DPD								1				03				04		M13
0200	1	2A1/2	IN PL	046	044	02	082711	DPD												02				01		M13
0200	1	3A1/2	IN PL	072	072		096707	DPD												01	3			03		M13
0200	1	HQB1/2	IN HQ	016	016		096706	DPD						01												M13
0200	1	1B1/2	IN PL	046	046	02	091708	DPD																01		M13
0200	1	2B1/2	IN PL	074	073	01	096707	DPD								1					3			03		M13
0200	1	3B1/2	IN PL	050	048	02	100709	DPD												03				04		M13
0200	1	HQC1/2	IN HC	016	016		104709	DPD						01												M13
0200	1	1C1/2	IN PL	048	047	02	103712	DPD																02		M13
0200	1	2C1/2	IN PL	062		01	104711	DB													2			02		M13

K-2

Figure K-1

REPORT RECORD

1	2	3	4	5
TIME HR	DAY	O/B	LN NO	NARRATIVE DESCRIPTION	G DN	CM M	DD
				2200 - 2300 D-DAY			
2205	D	2MAW	C01	MSN NO 1 DETECT 10 VEHICLES, WHEELS AND TRACKS, MOVING SE ON	1	M	13
				ROAD, LEAD LOCATED AT 089819. I WILL DROP HALF OF MY ORD.	1	M	13
2207	D	2MAW	C02	MSN NO 1 REPORT, NOPPING 14 OF ON TGT AT 088819. NO BDA.	1	M	13
				WILL CONTINUE TO FLY MY ROUTE.	1	M	13
2224	D	2MAW	C03	MSN 1 DETECTS 11 VEHICLES, WHEELS AND TRACKS, MOVING SE ON	1	M	13
				ROAD, LEAD LOCATED AT 090813. WILL DROP REMAINDER OF MY ORD.	1	M	13
				REQUEST RELIEF. ALSO DETECTED 4 VEHICLES MOVING SE ON ROAD.	1	M	13
				LEAD LOCATED AT 092831.	1	M	13
2226	D	2MAW	C04	DROPPED REMAINDER OF MY ORD ON TGT LOCATED AT 0881[illegible]. ONE	1	M	13
				SECONDARY EXPLOSION FROM TARGET AREA. I WILL CONTINUE MY	1	M	13
				ROUTE UNTIL MY RELIEF ARRIVES.	1	M	13
2241	D	2MAW	C05	MSN 1 DETECTS 11 WHEELS AND TRACKS, MOVING SE. LEAD LOCATED	1	M	13
				AT 013809 AND 4 VEHICLES MOVING SE. LEAD LOCATED AT 062819.	1	M	13
2246	D	2MAW	C06	MSN 1 DETECTS 4 VEHICLES, WHEELS AND TRACKS, MOVING SE. LEAD	1	M	13
				LOCATED AT 081[illegible].	1	M	13

K-3

Figure K-2

c. Equipment Lost Record (Figure K-3). This record combines Red and Blue casualties and equipment losses and serves as a source for updating appropiate entries in the Unit History record. The information presented consists of the following:

(1) Time and day of each incident resulting in casualties or major material loss.
(2) Unit description, type, and size.
(3) Number of tanks, radio jeeps, cargo trucks, amphibian tractors etc lost during game interval.
(4) Coordinate location where casualties occurred.
(5) Personnel casualties and cause (artillery, mortar, naval gunfire, ground combat, tanks, anti-tank, aircraft or mines).
(6) Assessment work sheet number, such as an artillery fire mission number.
(7) Enemy unit inflicting the loss.
(8) These columns are reserved for machine coding and are not germane to data presented.

d. Supporting Arms Record (Figure K-4). This record is a recapitulation of the artillery and naval gunfire missions assessed during the game, the air arm being kept as a separate record (see subpara e, below). This record shows:

(1) Time and day firing began.
(2) Unit firing the mission.
(3) Type weapon and type round.
(4) Number of rounds and type fusing.
(5) Mission number (assigned by team ordering fire).
(6) Target number a unique number assigned each detected target (see target list record subpara f, below).
(7) Target location.
(8) Target detection range and target engagement range: first two digits in each of the fields represent kilometers; last digit in each field represents nearest hundred meters.
(9) Forward observer designation, if applicable.
(10) Unit requesting the supporting fire.
(11) Time and day target was detected.
(12) Time and day target was engaged.
(13) Target activity and terrain cover afforded the target.
(14) Number of tubes used to fire mission.
(15) Unit being supported by the artillery or naval gunfire.
(16) These columns are reserved for machine coding and are not germane to data presented.

e. Air Record (Figure K-5). This record is a recapitulation of aircraft missions flown during the game. The information presented consists of the following:

(1) Take off time and day.
(2) Type aircraft and side number.
(3) Type ordnance loaded and mode of delivery.
(4) Origin of aircraft (seabased/landbased).
(5) Number of sorties.
(6) Time of landing after mission.
(7) Number of aircraft shot down during mission and type air defense weapon responsible.
(8) Combat damage sustained from air defense weapons systems to aircraft not shot down.
(9) Mission number (from air schedule).
(10) Total aircraft shot down.
(11) Target location (where ordnance actually was dropped).
(12) Target activity and cover (foxholes, woods, open).
(13) Target number (from target list).
(14) Number of passes and number of bombs dropped on target.
(15) Type mission (close air support, deep air support, armed reconnaissance).
(16) Designation of unit supported.
(17) Forward air controller, if applicable.
(18) Time and day of strike.
(19) These columns are reserved for machine coding and are not germane to the data presented.

f. Target List Record (Figure K-6). This record is a listing of all targets detected during game play by each team's target acquisition devices. The information presented consists of the following:

(1) Time and day target was detected.
(2) Unit/sensor making detection.
(3) Type sensor (air visual, ground visual, ground radar, electro-optic device, etc.), and whether the target was an initial or subsequent detection.
(4) Line of sight range in meters.
(5) Detection range in meters.
(6) Target location.
(7) Line number of detected unit (from the unit history record).
(8) A field used to record a C for control usage only or a B for Blue team usage.
(9) A field used to record whether a target is being tracked at the end of the interval (Y=yes, N=no).
(10) Location error (CEP) of target expressed in meters.
(11) Abbreviated target description.
(12) Number assigned each target.
(13) These columns are reserved for machine coding and are not germane to data represented.

EQUIPMENT LIST

TIME HOUR (1)	DY (1)	O/S (2)	TY (2)	TK (2)	J DF AF DP (3)	CI AR RK (3)	RR (3)	VT (3)	[illegible] (3)	[illegible] (3)	[illegible] (3)	[illegible] (3)	[illegible] (3)	[illegible] (3)	VULE (3)	LOCAT (4)	CAS ART (5)	CAS MTR (5)	CAS NGF (5)	CAS GC (5)	CAS TKS (5)	CAS A/T (5)	CAS A/C (5)	CAS MN (5)	EVNT NO (6)	INFLCT O/S (7)	T C (8)	GN CC (8)
0201	1	A1/2	IN													083707	5									A1/16	B	MI
02?1	1	A1/2	IN													083707	4									1A/17	B	MI
[illegible]	[illegible]	A1/	IN													102707	5									1SARTY	B	MI
0201	[illegible]	C1/2	IN													100706	7									G3/16	B	MI
02?1	1	1A2TK	TK	02												[illegible]733					CCB				T003	B/7	B	MI
0205	1	1A2TK	TK	01												[illegible]					CC4				T004	A/22	B	MI
0205	1	1A2TK	TK	01												[illegible]						4			T004	1A/18	B	MI
0205	1	1A2TK	TK	01												[illegible]707						4			T005	2A/18	B	MI
0221	1	[illegible]/2	IN													102707	4									2A/17	B	MI
0231	1	G1/2	IN													107692	1									G3/16	B	MI
0241	1	C1/2	IN													100704	5									3A/17	B	MI
0300	1	A1/2	IN													083707				10					01	4MIB	B	MI
0100	1	[illegible]1/2	IN													102713				06					02	5MIB	B	MI

Figure K-3

SUPPORTING ARMS

1 FIRE TIME	2 FIRING O/B	3 TYP WPN	3 TYP RDS	4 NO RDS	4 TY FZ	5 MSN NO.	6 TGT NO	7 TGT LOC	8 TGT DIST RNG	8 RNG TO FDA	9 FO O/B	10 ORIGIN O/B	11 TIME DET'D	12 TIME ENG	13 TGT ACT	13 [illegible]	14 NO TU	15 WHO SUPPT	[illegible]
2301 D	CLG	536	HCC	030	MX	001	002	045778	N/A	27	A1/2	MSN001	2229 D	2301 D	MI/	U	02	122MA U	[illegible]
0005 1	55PLT	155	HE	024	MX	002	013	054761	050	0[illegible]	01/2	CRRC 3	2353 D	0005 1	AI/	U	02	01/ 2	[illegible]
0005 1	CLG	538	HC	[illegible]	MX	[illegible]	010	054761	[illegible]	04	01/	[illegible]	2336 D	0005 1	MIV	U	02	01/ 2	[illegible]
0005 1	A1/10	105	HE	030	MX	001	010	054761	05	[illegible]	[illegible]	CRRC 3	2333 D	0005 1	MI[illegible]	U	02	01/ 2	[illegible]
[illegible] 1	CLG	538	HCC	540	MX	[illegible]	005	054747	[illegible]	[illegible]	[illegible]	1/	0051 1	0110 1	MI[illegible]	U	03	1/ [illegible]	[illegible]
0110 1	CLG	647	HCC	120	[illegible]	[illegible]	[illegible]	054747	040	03	01/2	1/2	0051 1	0110 1	MIV	U	02	1/ 2	[illegible]
011[illegible] 1	00	[illegible]	HCC	[illegible]	MX	[illegible]7	005	054747	040	00	[illegible]	1/2	0051 1	0110 1	MI[illegible]	U	01	1/ 2	[illegible]
[illegible]110 1	[illegible]PLT	1[illegible]	[illegible]	[illegible]	[illegible]	004	[illegible]	[illegible]4747	040	[illegible]	[illegible]	1/[illegible]	[illegible]51 1	[illegible]10 1	[illegible]	[illegible]	02	[illegible] 2	[illegible]
[illegible] 1	A1/[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]724	000	[illegible]	A1/[illegible]	1/[illegible]	0059 1	0103 1	[illegible]	U	00	[illegible] 001	[illegible]
011[illegible] 1	A1/10	105	HE	[illegible]	MX	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	A [illegible]	1/[illegible]	0059 1	0110 1	[illegible]	U	05	1/ 2	[illegible]
01[illegible] 1	A1/[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]11	[illegible]	[illegible]	[illegible]	[illegible]	A[illegible]	1/2	[illegible] 1	[illegible]29 1	[illegible]	U	02	1/ 2	[illegible]
[illegible] 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	01/[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0[illegible]	1/ [illegible]	[illegible]

Figure K-4

AIR RECORD

1	2	3	4	5	6	7							8	9	10	11	12		13	14		15	16	17	18	19	
TAKE OFF TIME	D A Y	TYP A/C	AC NO	TY OU	MODE N	ORG N	NO OF SO	LAND TIME	U Y	N O 57 MM	O 14 .5	/ SA 7	HOW SM	CP	SMT 23 MM	SM AR	CB DA	MSN NO	TL SH DB	TGT LOCAT	TGT ACT	CUV E N	TGT NO	NOP A S	NO EXP	M S N	# MO SUPPT	OBSER	STK TIME	D A Y	T C	GN UG
2145	D	A6	1	2	R	S	1											1		971620	MIV	0	0	1	2	14	L					2207	0	B	M1
2145	D	A6	1	2	R													1		997815	MIV	0	0	2		14	L					2227	0	B	M1
2145	D	A6	1	2	R	S							1					1	1	234780							L					2301	0	B	M1
2145	D	EA6	1		R	S	1	0045	1									5			*						C							0	M1
2303	D	A6	2	2	R	S	1	0030	1									2		079759	MIV	0	0	6	2	14	L					2320	0	B	M1
2303	D	A6	2	2	R	S		0030	1									2		018761	MIV	0	0	9		14	L					2325	0	B	M1
2303	D	F4	2	G	V	S	1	0048	1									9		079759	MIV	0	010	2		4	1					2322	0	B	M1
2303	D	F4	3	G	V	S	1	0048	1									9		079759	MIV	0	010	2		4	1					2322	0	B	M1
2303	D	A4	2	2	V	S	1	2339	0									9		079759	MIV	0	010	1		10	S					2324	0	B	M1
2303	D	A4	3	2	V	S	1	2341	0									9		079759	MIV	0	010	1		10	S					2326	0	B	M1
2303	D	F4	3	G	V	S		0048	1									9		08 74	STA	0	016			4	1	1/20N				0033	1	B	M1
2358	D	F4*	1	2	V	S	1	0052	1									10		083750	FIR		16	1		6	S					0037	1	B	M1
2358	D	F4	4	2	V	S	1	0052	1									10		083750	FIR		16	1		6	S					0037	1	B	M1
2358	D	A4	4	2	V	S	1	0054	1									10		098774	DPD		17	1		10	S					0039	1	B	M1
0040	1	A4	1	2	V	S	1	0137	1									11		093738	MIV	0	037	1		10	S	1/20N				0122	1	B	M1
0040	1	A4	6	2	V	S	1	0141	1									11		093738	MIV	0	037	1		10	S	1/20N				0122	1	B	M1
0040	1	AV8	1	G	V	S	1	0135	1									11		093738	MIV	0	037	1		6	1	1/20N				0120	1	B	M1
0040	1	AV8	2	G	V	S	1	0137	1									11		093738	MIV	0	037	1		6	1	1/20N				0120	1	B	M1
0045	1	A6	4	2	R	S		0150	1									4		064730	MIV	0	033	1		14	L	1/20N				0127	1	B	M1
0150	1	AV8	3	2	V	S	1	0225	1									12		078617	MIV	0	048	1		8	S	A1/2				0208	1	B	M1
0150	1	AV8	4	G	V	S	1	0227	1									12		078617	MIV	0	048	1		6	1	A1/2				0208	1	B	M1

Figure K-5

TARGET LIST

1		2	3		4	5	6	7	8	9	10	11	12	13	14
TIME OF DET YOUR	D Y	UNIT DET	TY SN	I / S	LINE OF SIGHT RANGE	DET RANG	TGT RANGE TO FEBA	TGT LOC	LN NO	C / D	Y / N	LOC LNK	TARGET DESCRIPTION		T EN L OC
2224	D	MSN001	RA	S	N/A	N/A	12900	000813		D	N		31 TRACK AND WHEEL VEH MOV E	002	M 13
2224	D	MSN001	RA	S	N/A	N/A	12900	000813	45	C	N		31 TRACK AND WHEEL VEH MOV E	002	M 13
2224	D	MSN001	RA	S	N/A	N/A	12900	000813	25	C	N		31 TRACK AND WHEEL VEH MOV E	002	M 13
2224	D	MSN001	RA	S	N/A	N/A	12900	000813	20	C	N		31 TRACK AND WHEEL VEH MOV E	002	M 13
2226	D	FRC02	GV	S	00300	00300	13700	010827		D	N	220	2 SPAN 6 TUB ANTY 3 BM VEH	004	M 13
2226	D	FRC02	GV	S	00300	00300	13700	010827	69	C	N	220	2 SPAN 6 TUB ANTY 3 BM VEH	004	M 13
2226	D	FRC02	GV	S	00300	00300	13700	010827	43	C	N	220	2 SPAN 6 TUB ANTY 3 BM VEH	004	M 13
2350	D	C/5A	GS	S	00300	00100	7300	034772		D			MANY BM AND TRK VEHICLES MOV S	016	M 13
2350	D	C/5A	GS	S	00300	00100	7300	034772	23	C	N		MANY BM AND TRK VEHICLES MOV S	016	M 13
2350	D	C/5A	GS	S	00300	00100	7300	034772	07	C	N		MANY BM AND TRK VEHICLES MOV S	016	M 13
2350	D	C/5A	GS	S	00300	00100	7300	034772	06	C	N		MANY BM AND TRK VEHICLES MOV S	016	M 13
2350	D	C/5A	GS	S	00300	00100	7300	034772	09	C	N		MANY BM AND TRK VEHICLES MOV S	016	M 13
2351	D	LRR02	GR	S	05200	05200	5200	063763		D			2 VEHICLES MOV SE	018	M 13
2351	D	LRR02	GR	S	05200	05200	5200	063763	43	C	Y		2 VEHICLES MOV SE	018	M 13
2352	D	EOSLR2	GV	S	05200	05200	5200	063763		D			1 PT-76 AND 1 BRDM MOV SE	019	M 13
2352	D	EOSLR2	GV	S	05200	05200	5200	063763	43	C	Y		1 PT-76 AND 1 BRDM MOV SE	019	M 13
2351	D	LRR03	GR	S	06800	06800	5200	063763		D			2 VEHICLES MOV SE	020	M 13
2351	D	LRR03	GR	S	06800	06800	5200	063763	43	C	Y		2 VEHICLES MOV SE	020	M 13
2352	D	EOSLR3	GV	S	06800	06800	5200	063763		D			1 PT-76 AND 1 BRDM MOV SE	021	M 13
2352	D	EOSLR3	GV	S	06800	06800	5200	063763	43	C	Y		1 PT-76 AND 1 BRDM MOV SE	021	M 13

Figure K-6

ANNEX L

LIST OF ABBREVIATIONS

AAMG	Antiaircraft Machine Gun
AMTRAC	Amphibious Tractor
AR	Airborne MTI Radar
ASAP	As Soon As Possible
ATGM	Antitank Guided Missile
AV	Air Visual
BICC	Battlefield Information Control Center
BRDM	Amphibious Armored Reconnaissance Vehicle (Red)
BTR	Armored Personnel Carrier (Red)
CLG	Guided Missile Light Cruiser
COP (L)	Combat Outpost (Line)
DD	Destroyer
ECM	Electronic Counter Measures
E-O	Electro-Optic
EW	Electronic Warfare
GV	Ground Visual
H & I	Harrassing and Interdiction
IOWS	Infantry Organization and Weapons Systems
km	kilometer
LFWG	Landing Force War Game
LOD	Line of Departure
LREO	Long Range Electro-Optic Device
LRR	Long Range MTI Radar
LVT	Landing Vehicle Track
m	meter
mm	millimeter
MAB	Marine Amphibious Brigade
MAF	Marine Amphibious Force
MAR	Marine Regiment
MARSAS	Marine Search and Attack System
MAU	Marine Amphibious Unit
MCDEC	Marine Corps Development and Education Combat
MIB	Mechanized (or Motorized) Infantry Battalion
MID	Mechanized (or Motorized) Infantry Division
MIR	Mechanized (or Motorized) Infantry Regiment
MPFW	Multishot Portable Flame Weapon
MREO	Mid Range Electro-Optic Device
MRR	Mid Range MTI Radar
MTI	Moving Target Indicator
NGF	Naval Gunfire

PD	Point Detonation
PGRG	Potomac General Research Group
PLRS	Position Location and Reporting System
RCA	Radio Corporation of America
Rcn	Reconnaissance
Rein	Reinforced
RG	Recoillessgun
RR	Recoilless Rifle
SAM	Surface-to-Air (Missile)
SAW	Squad Automatic Weapon
STA	Surveillance and Target Acquisition
T/O (E)	Table of Organization (Equipment)
UGS	Unattended Ground Sensor
VT	Variable Time
WGB	War Games Branch