U.S. ARMY

Center for Army Analysis

NEA99 COSAGE BOARDS

APRIL 2001

CENTER FOR ARMY ANALYSIS
6001 GOETHALS ROAD
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13. ABSTRACT *(Maximum 200 Words)*

The Deputy Chief of Staff for Operations and Plans requested the Center for Army Analysis (CAA) to develop the 1999 Northeast Asia (NEA) Combat Sample Generator (COSAGE) boards to be used throughout the Department of Defense (DOD). The problem addressed was to develop combat samples to model the current year scenario in Northeast Asia. In order to complete the analysis, Combined Forces Command (CFC) 98 COSAGE boards were used as the base case from which NEA99 boards would be created. The analysis included use of updated force compositions, removal of improved conventional munitions from Threat artillery, updated US and allied direct fire rates of fire and single shot probability of kill (SSPK) files, development and utilization of a minimum SSPK function, and development and utilization of a new command and control algorithm in aviation units.

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NEA99 COSAGE BOARDS (COS-NEA99)

SUMMARY

THE PROJECT PURPOSE was to develop the Combat Sample Generator (COSAGE) boards to support theater level simulations throughout DOD for current year (1999) Northeast Asia (NEA) campaigns.

THE PROJECT SPONSOR is Director, Center for Army Analysis.

THE PROJECT OBJECTIVES were to:

(1) Update the 1998 Combined Forces command (CFC) boards to reflect 1998 force compositions.

(2) Develop a minimum single shot probability of kill (SSPK) function.

(3) Develop a new aviation command and control algorithm.

THE SCOPE OF THE PROJECT was to develop combat samples for use in theater simulations of NEA campaigns.

THE MAIN ASSUMPTION was that US, allied, and threat forces utilized were of sufficient size to develop statistically robust combat samples.

THE PRINCIPAL RECOMMENDATION is to utilize the developed COSAGE boards in theater level simulations for current year campaigns in NEA.

THE PROJECT EFFORT was conducted by Mr. Dave Reynolds and MAJ Robert Shearer, Force Strategy Division.

COMMENTS AND QUESTIONS may be sent to the Director, Center for Army Analysis, ATTN: CSCA-NE, 6001 Goethals Road, Suite 102, Fort Belvoir, VA 22060-5230.

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FIGURES

1 NEA99 COSAGE BOARDS

1.1 Introduction

Mr. Dave Reynolds, Operational Capability Assessments, Northeast Asia Division, served as the project leader for the 1999 Northeast Asia (NEA) Combat Sample Generator (COSAGE) boards. CPT Robert Shearer completed the boards while Mr. Reynolds attended the Operations Research Systems Analysis Military Applications Course (ORSA MAC) I.

1.2 Agenda

The agenda followed for this report is shown below.

- ❒ Introduction
- ❒ Problem Statement
- ❒ Essential Elements of Analysis
- ❒ Measures of Effectiveness
- ❒ Analysis
- ❒ Summary

1.3 Problem Statement

The Deputy Chief of Staff for Operations and Plans (DCSOPS) tasked the Center for Army Analysis (CAA) to develop the 1999 NEA COSAGE boards for use throughout the Department of Defense (DOD). The problem entailed development of combat samples to model the current year scenario in Northeast Asia.

1.4 Essential Elements of Analysis

Essential elements of analysis (EEA) consist of the questions that must be answered in order to complete a study. Mr. Reynolds and CPT Shearer utilized the standard Combat Sample Generator (COSAGE) essential elements of analysis as listed below to guide their efforts.

- Do the combat samples adequately represent the force structure?
- Do the postures adequately reflect doctrinal missions?
- Do the results adequately represent system-level performance?

1.5 Measures of Effectiveness for Essential Elements of Analysis

- Do the combat samples adequately reflect the force structure and equipment?
  - **Stylized force: proportional representation of theater forces in a "division" (equipment, weapons, munitions)**
- Do the postures adequately represent doctrinal missions?
  - **Force exchange ratio (FER)**
  - **Loss exchange ratio (LER)**
  - **System exchange ratio (SER)**
- Do the results adequately represent system-level performance?
  - **Interactions**
  - **Kills per shot (KPS)**
  - **Shots per system per day**

Figure 1. Measures of Effectiveness for Essential Elements of Analysis

Measures of effectiveness (MOE) are the metrics used to assess the essential elements of analysis. The standard COSAGE measures of effectiveness listed in Figure 1 were used in this analysis.

1.6 Analysis

This report covers in detail the analysis conducted during the development of the 1999 NEA COSAGE boards. Discussion of this analysis follows the outline listed below.

- ❒ Study Evolution
- ❒ Input Data Analysis
- ❒ Output Data Analysis
- ❒ Summary

1.7 Study Evolution

The study team utilized the Combined Forces Command (CFC) 98 COSAGE boards as the base case from which the NEA99 boards were created. Significant changes included incorporating updated force compositions, removal of improved conventional munitions (ICM) from the Threat artillery, updated US and any direct fire rates of fire, updated single shot probability of kill (SSPK) files from the Army Materiel Systems Analysis Agency (AMSAA), the development and utilization of a minimum single shot probability of kill function that prevented systems from engaging other systems when the probability of a hit fell below a given percentage, and the development and utilization of a new command and control (C2) algorithm in aviation units.

2 INPUT DATA ANALYSIS

2.1 Input Data Analysis

Input data analysis focused on relating COSAGE postures to the NEA theater concept of operations and significant major weapon systems of all forces. It included force postures and major weapon system highlights for US, allied, and threat forces as well as major weapon system quantities for all three forces.

2.2 COSAGE Force Postures

US Delay	**Threat x 4 Vs. US x 1**
US Hasty Defense	**Threat x 3 Vs. US x 1**
US Prepared Defense	**Threat x 3 Vs. US x 1**
Threat Prepared Defense	**Threat x 1 Vs. US x 2**
Threat Hasty Defense	**Threat x 1 Vs. US x 2**
Less Intense Static	**Threat x 1 Vs. US x 1**
Heavy Static	**Threat x 1 Vs. US x 1**

Figure 2. COSAGE Force Postures

COSAGE boards contain seven postures that fall into three categories: US attack, static, and US defend. The two defensive postures vary by the survivability of the defensive forces. The two static postures vary by the number of systems engaged in long-range preparatory fires. Analysis for NEA99 focused on US prepared defense, heavy static, and threat hasty defense.

2.3 US Major Weapon Systems Highlights

- Tanks
  - M1A1 and M1A2
- Antitank vehicles
  - M2A2 and M3A2 (25mm) (TOW IIB)
  - M966 (TOW IIB)
- Helicopters
  - AH-64 (Hellfire / Hellfire RF)
  - OH-58D (Hellfire)
- Artillery
  - MLRS, ATACMS
  - 105mm (T), 155mm (SP), 155mm (SP-Paladin)

Figure 3. US Major Weapon Systems Highlights

The US major weapon systems included in the COSAGE boards are listed in Figure 3.

2.4 Ally Major Weapon Systems Highlights

- Tanks
  - K1-105, M48A5, M48A3
- Antitank vehicles
  - KIFV-TOW IIA
- Helicopters
  - AH-1, MD 500
- Artillery
  - 105mm (T), 155mm (T), 155mm (SP)
  - 130mm MRLS, M270 MLRS

Figure 4. Ally Major Weapon Systems Highlights

The Ally major weapon systems included in the COSAGE boards are listed in Figure 4.

2.5 Threat Major Weapon Systems Highlights

- **Tanks**
  - **T55, T62, T62C**
- **Antitank Vehicles**
  - **M1973 (AT3), M1985 (85mm), M1992 (AT3), MT-12**
- **Helicopters**
  - **None**
- **Artillery**
  - **107, 122, 240 MRL, SCUD**
  - **122 (T) (SP), 130 (T) (SP), 152 (SP), 170 (SP) Howitzers**

Figure 5. Threat Major Weapon Systems Highlights

Figure 5 lists the Threat major weapon systems included in the COSAGE boards.

2.6 US Major Weapon Systems Quantities

US	system	NEA 99	CFC 98
Tanks			
	M1A1	218	258
	M1A2	110	70
AT			
	M2A2	211	228
	M3CFV	82	114
	M966 TOW IIB	177	102
Helicopters			
	AH-64	30, 6 (L)	48, 18 (L)
	OH-58D	30	18
Artillery			
	105mm (T)	42	30
	155mm (T)	120	60
	155mm (SP)	114	180
	8 in	0	12
	MLRS	54	27
	ATACMS	9	9

Figure 6. US Major Weapon Systems Quantities

Quantities of some US major weapon systems did change substantially from CFC98 to NEA 99. The (L) in the AH-64 quantities represents Longbows. These quantities represent a stylized division. A stylized division contains quantities of major weapon systems proportional to the amounts projected for the theater. These changes are shown in Figure 6.

2.7 Ally Major Weapon Systems Quantities

Ally	system	NEA 99	CFC 98
Tanks			
	K1 120	0	54
	K1 105	144	188
	KM48A5	54	0
	M48A3	176	104
AT			
	KIFV-TOW	80	44
Helicopters			
	AH-1S	12	18
	MD 500	12	24
	AH-64A	0	12
Artillery			
	105mm (T)	280	200
	155mm (T)	240	310
	155mm (SP)	160	192
	MRLS 130mm	24	72
	MLRS M270	6	12

Figure 7. Ally Major Weapon Systems Quantities

Quantities of some Ally major weapon systems also changed substantially from CFC98 to NEA 99. These changes are shown in Figure 7.

2.8 Threat Major Weapon Systems Quantities

Threat	system	NEA 99	CFC 98
Tanks			
	T55	144	91
	T62	96, 10 (C)	104, 39 (C)
AT			
	M1973	186	155
	M1985	36	48
	M1992	21	31
Helos			
	MD 500	6	0
	Hoplite	5	20
Artillery			
	107 MRL	114	88
	122 MRL	64	64
	240 MRL	20	32
	SCUD	9	9
	122mm (T)	144	54
	122mm (SP)	126	160
	130mm (T)	36	36
	130mm (SP)	39	48
	152mm (T)	72	0
	152mm (SP)	112	144
	170mm (SP)	35	35
	SCUDS	9	9

Figure 8. Threat Major Weapon Systems Quantities

Some Threat major weapon system quantities changed substantially from CFC98 to NEA 99 as well. Figure 8 highlights these changes.

3 OUTPUT DATA ANALYSIS

3.1 Output Data Analysis

- Threat attack, US/Ally prepared defense
  - Ally systems
    - ✓ K1 105mm cannon
    - ✓ KIFV TOW IIA
  - US systems
    - ✓ AH64A / AH64D Hellfire
  - nK systems
    - ✓ T55 100mm cannon
    - ✓ M1992 AT3 missile

- US/Ally attack, Threat hasty defense
  - US systems
    - ✓ M1A1 / M1A2 120mm cannon
    - ✓ M2A2 BFV TOW IIB
    - ✓ AH-64A / AH-64D Hellfire
  - nK systems
    - ✓ T55 100mm cannon
    - ✓ M1973 AT3 missile

Figure 9. Output Data Analysis

Output data analysis focused on the interactions between the major US, Ally, and Threat direct fire systems in the two postures shown in Figure 9. These postures serve as a representative sample of the seven postures for direct fire systems.

Output data analysis also focused on US indirect fire engagements, force and system performance ratios, and percentage of kills by systems.

3.2 Ally KPS: K1 (105mm)

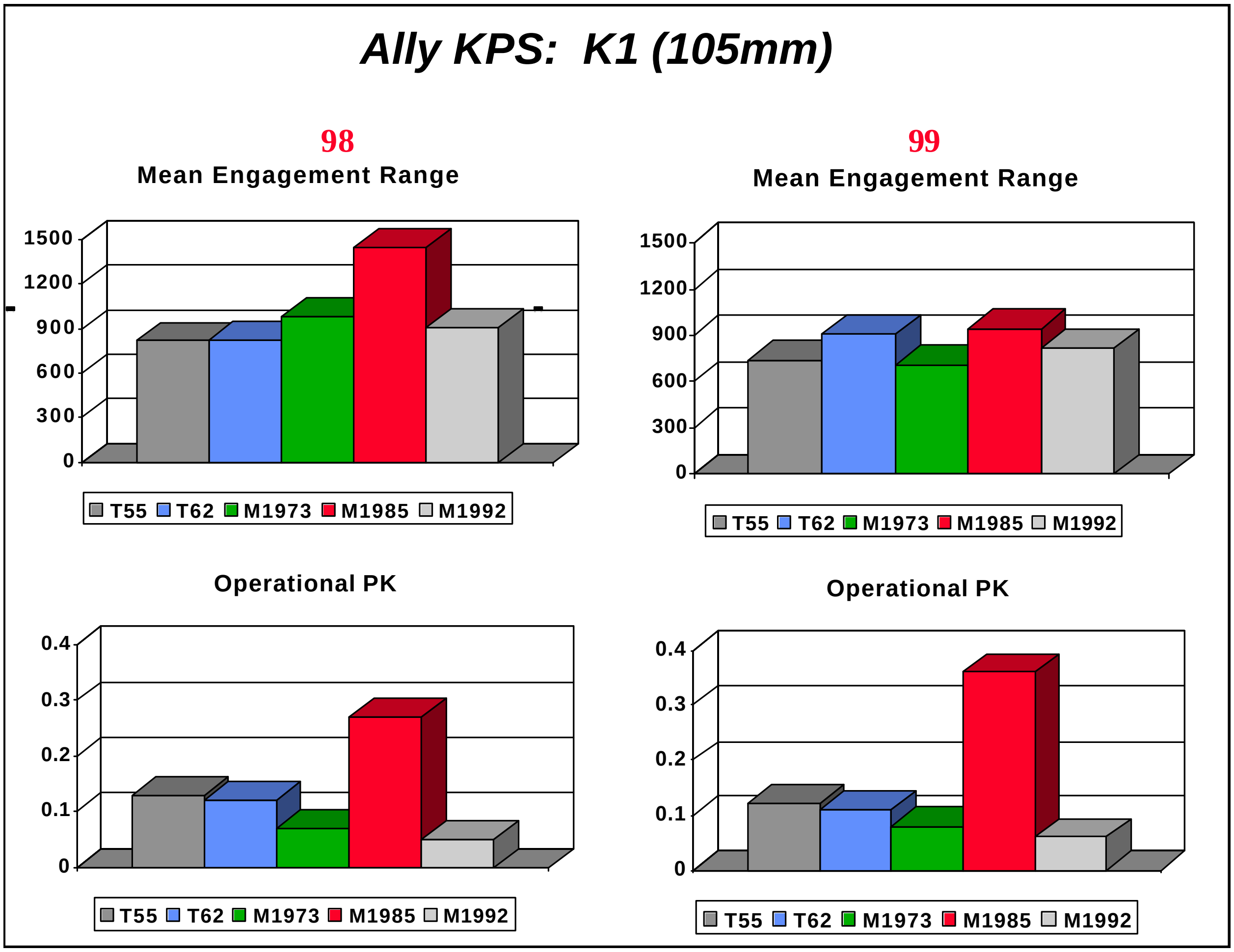

Figure 10. Ally KPS: K1 (105mm)

Analysis began with the Ally K1 tank (Figure 10). The system exists in both studies and engages the same targets in both. Mean engagement ranges decreased due to the minimum SSPK function; operational probability of kill (PK) values increased slightly due to the decreased engagement ranges.

3.3 Ally KPS: KIFV (TOW IIA)

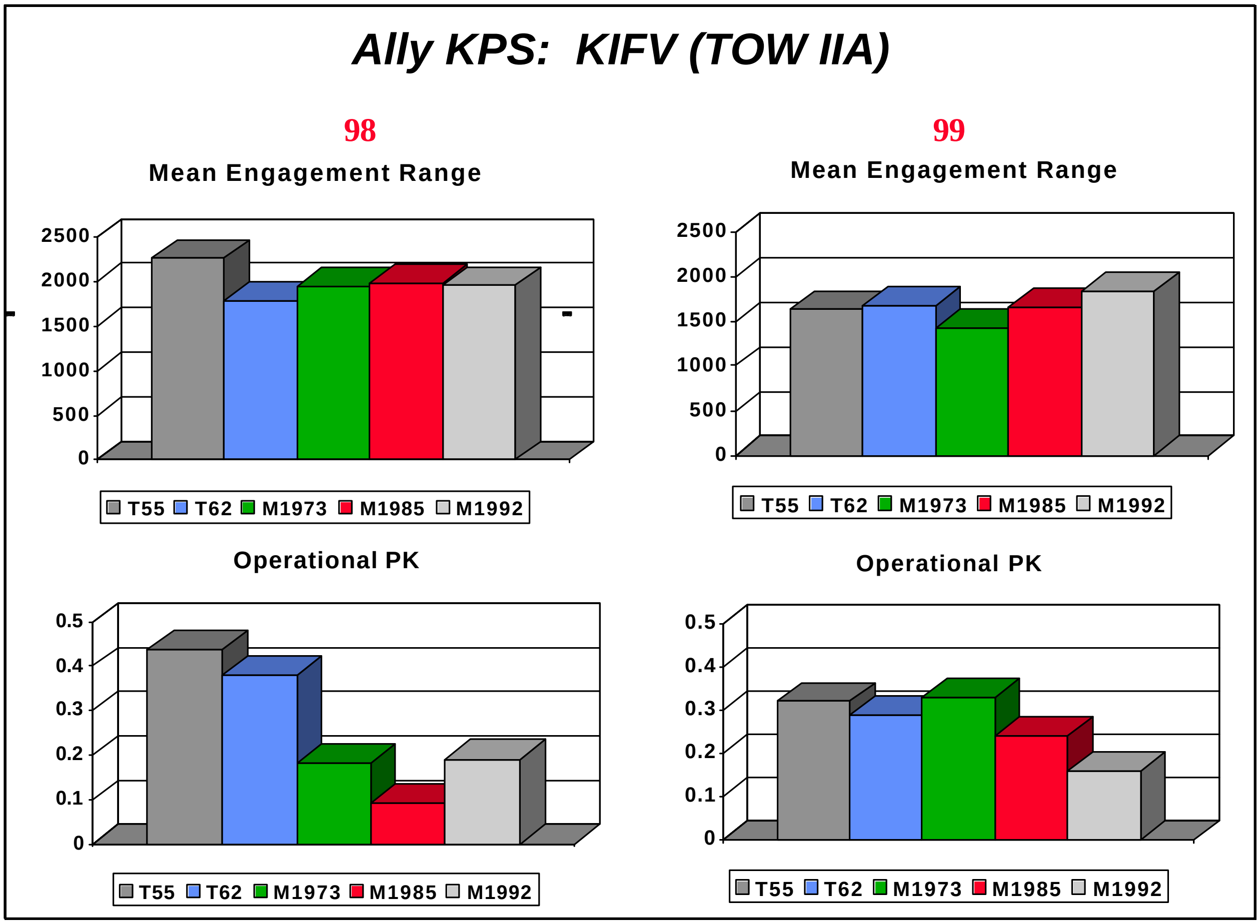

Figure 11. Ally KPS: KIFV (TOW IIA)

The next system considered was the Ally KIFV (TOW IIA), shown in Figure 11. This system exists in both studies and engages the same targets in both. Mean engagement ranges decreased slightly due to the minimum SSPK function. Operational PK values decreased, despite the decreased engagement ranges, due to updated SSPK values for the TOW IIA.

3.4 Threat KPS: T55 (100mm)

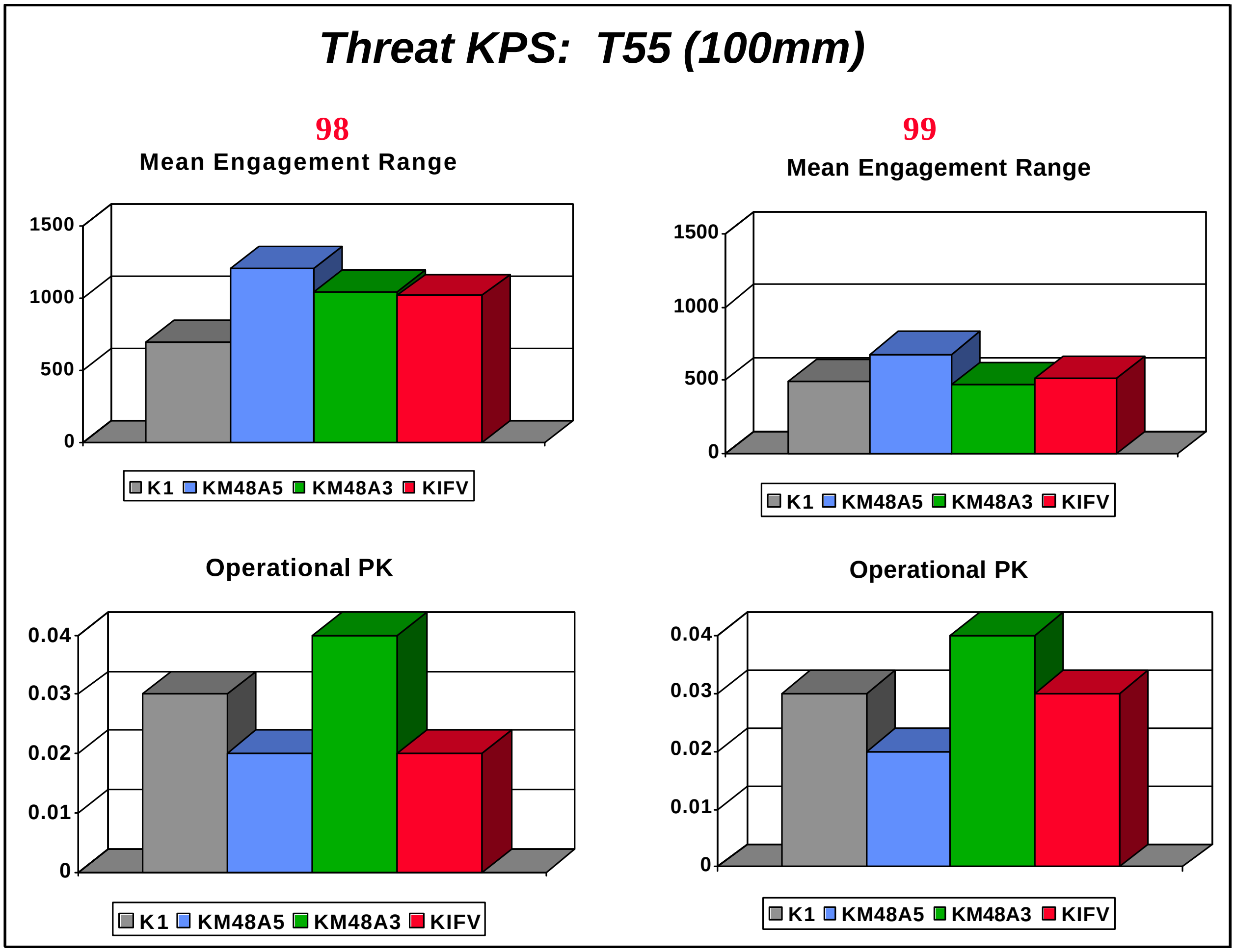

Figure 12. Threat KPS: T55 (100mm)

The Threat T55 tank was the next system to be analyzed (Figure 12). As with other systems, this system exists in both studies and engages the same targets in both. Mean engagement ranges decreased due to the minimum SSPK function, and operational PK values improved slightly due to the decreased engagement ranges.

3.5 Threat KPS: M1992 (AT3)

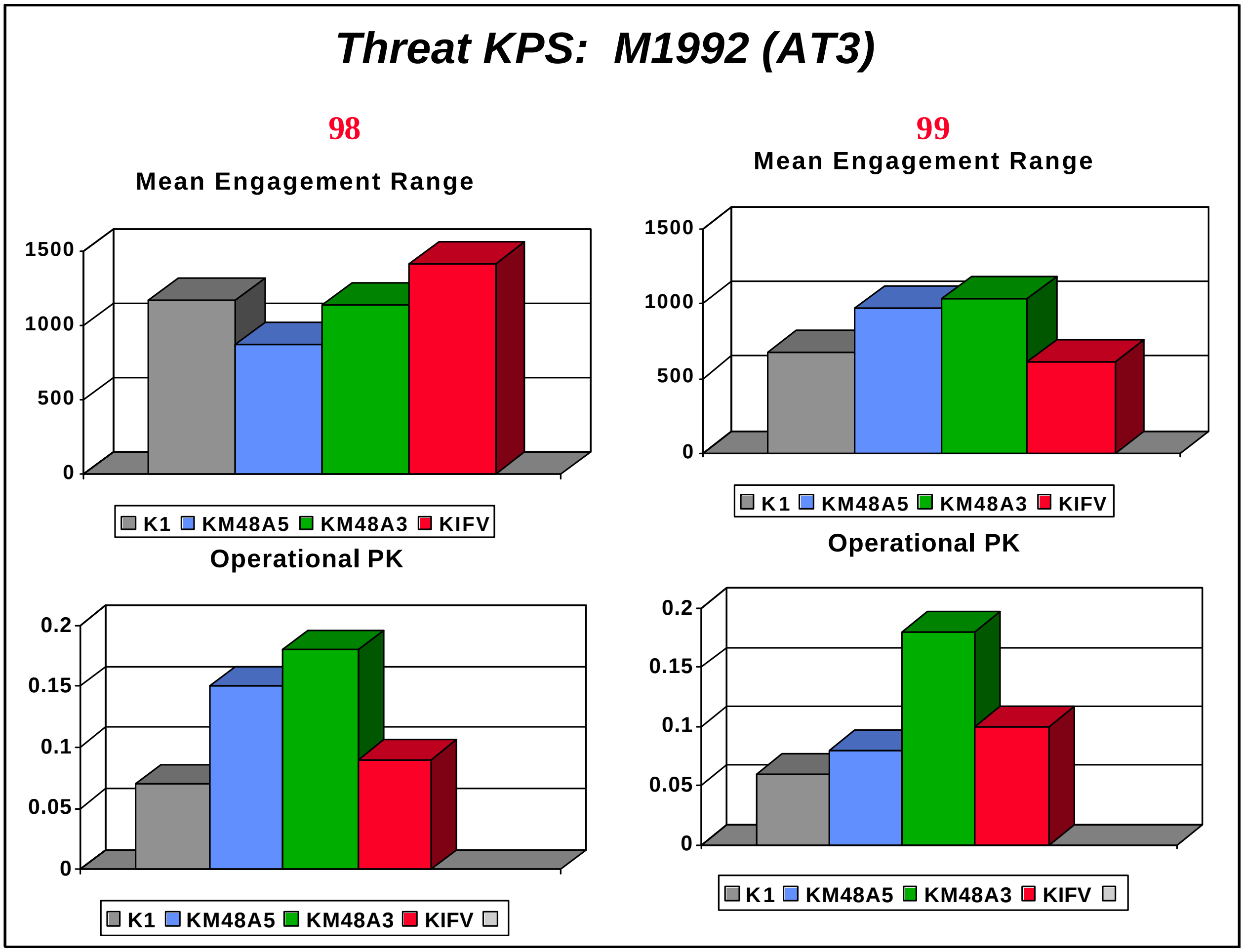

Figure 13. Threat KPS: M1992 (AT3)

Threat analysis continued with the M1992 (AT3), a system which also exists in both studies and engages the same targets in both. For this system, mean engagement ranges decreased due to the minimum (the minimum SSPK function). Operational PK values decreased, despite the decreased engagement ranges.

3.6 US KPS: M1A2 (120mm)

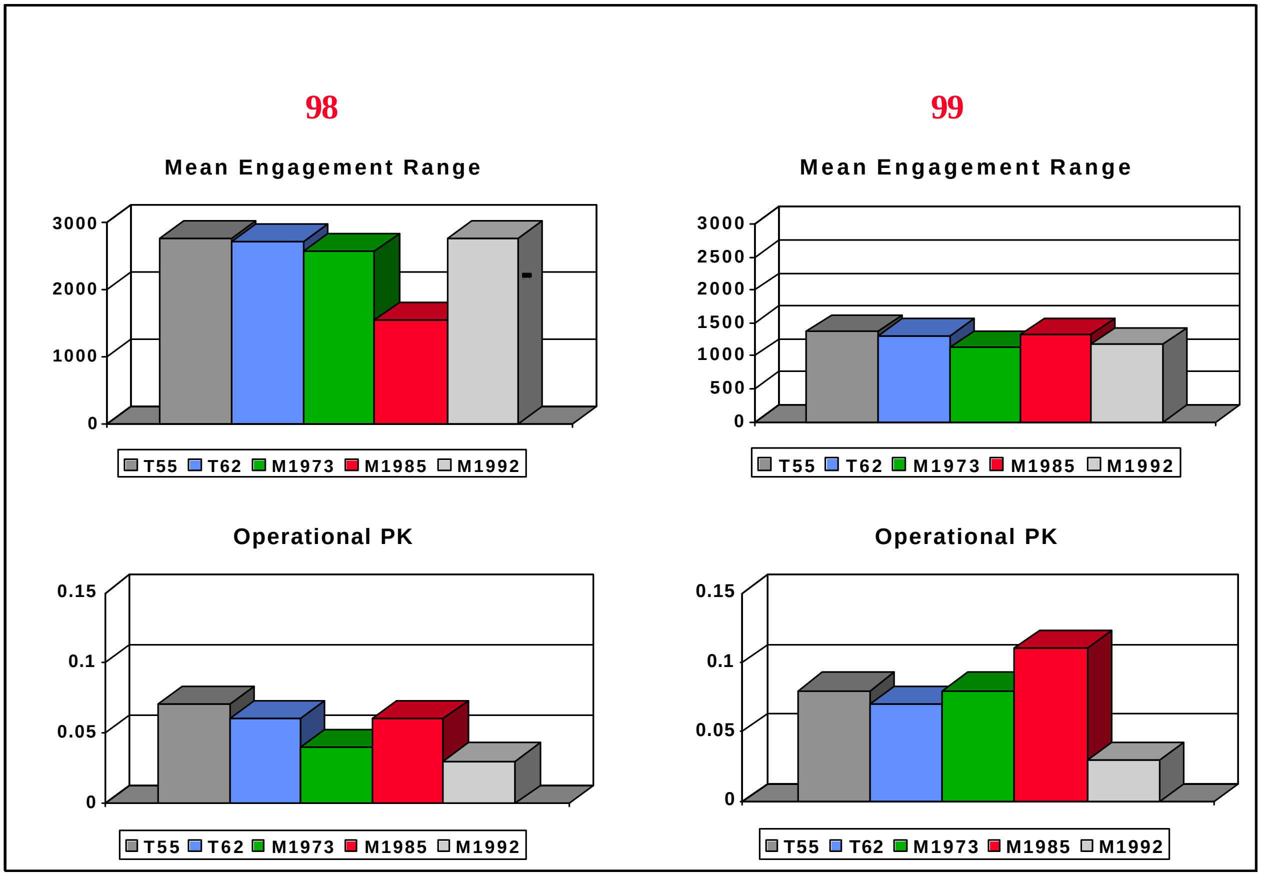

Figure 14. US KPS: M1A2 (120mm)

The analysis of US systems began with the US M1A2 tank, Figure 14. As with other systems, the system exists in both studies and engages the same targets in both. Mean engagement ranges decreased due to the minimum SSPK function. Operational PK values increased slightly due to the decreased engagement ranges.

3.7 US KPS: M2A2 (TOW IIB)

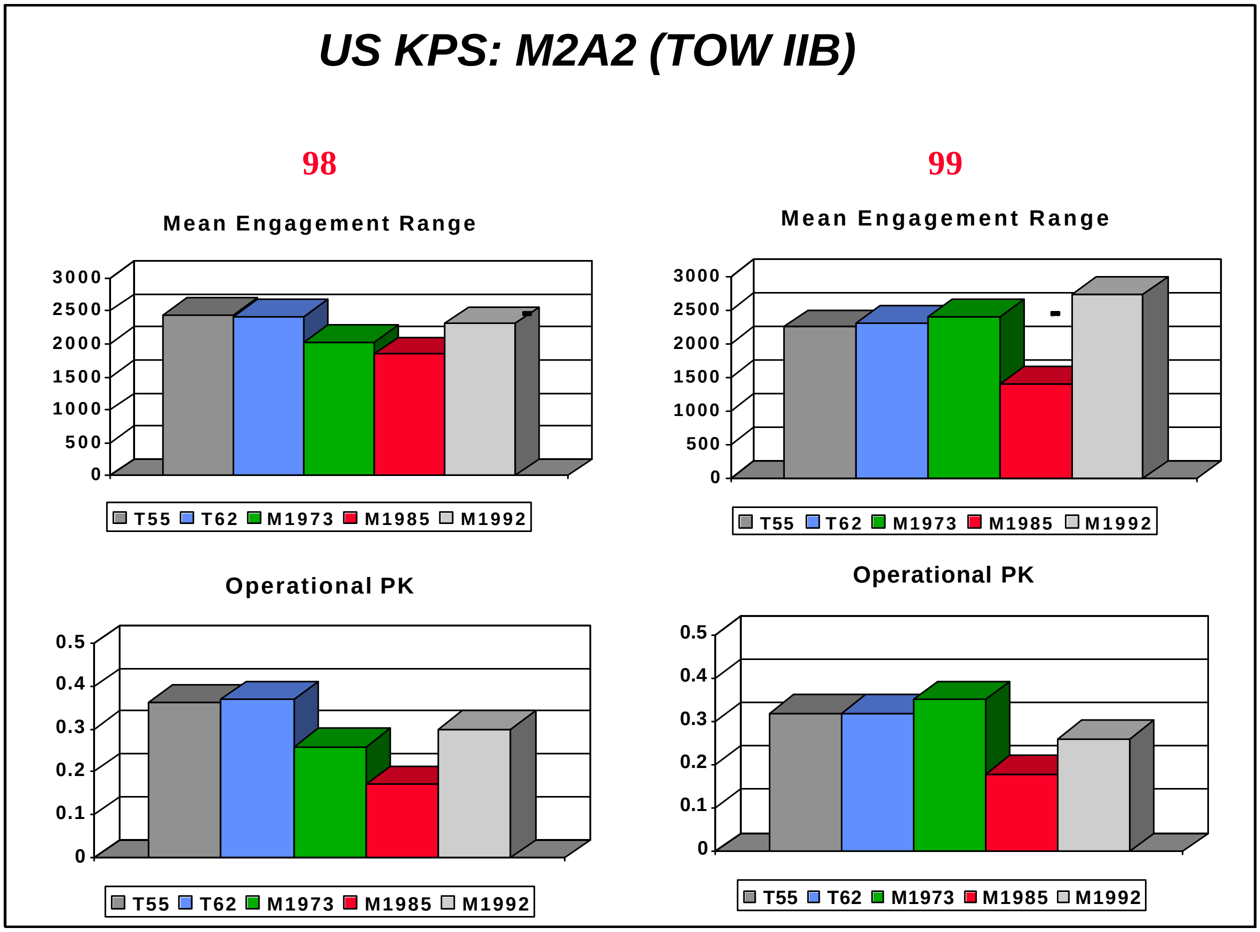

Figure 15. US KPS: M2A2 (TOW IIB)

Analysis continued with the US M2A2 (TOW IIB), as shown in Figure 15. As before, the system exists in both studies and engages the same targets in both. Mean engagement ranges decreased slightly for most systems due to the minimum SSPK function. Operational PK values decreased, for most systems despite the decreased engagement ranges, due to updated SSPK values for the TOW IIB.

3.8 US KPS: AH-64 (Hellfire)

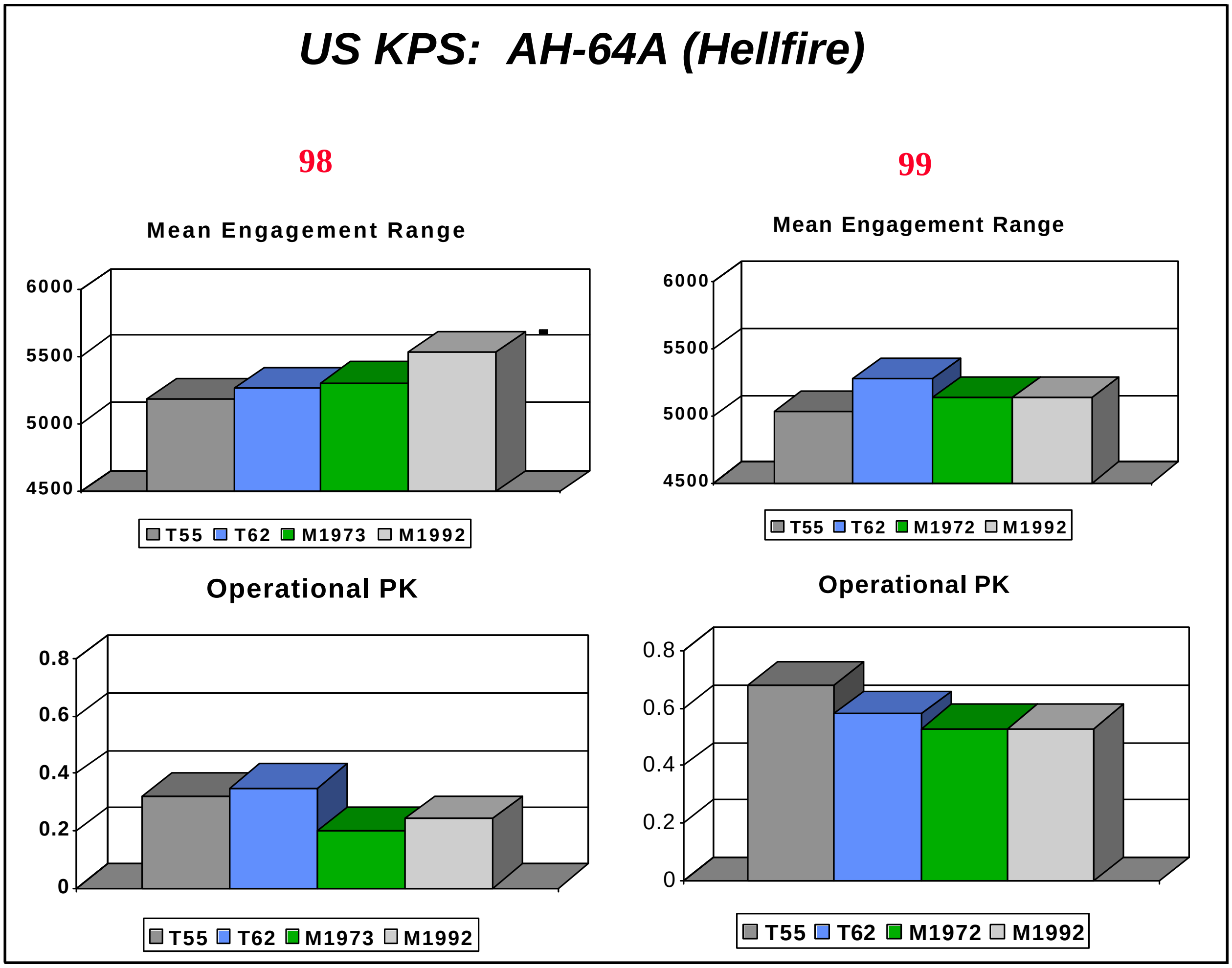

Figure 16. US KPS: AH-64 (Hellfire)

The US Apache, Alpha model, was the next system considered (Figure 16). The system exists in both studies and engages the same targets in both. Mean engagement ranges changed little in response to the minimum SSPK function due to the flatness of the SSPK curve vs range for the Hellfire. Operational PK values increased due to the improved aviation algorithm incorporated into the COSAGE Model in January 2000

3.9 US KPS: AH-64D (Hellfire RF)

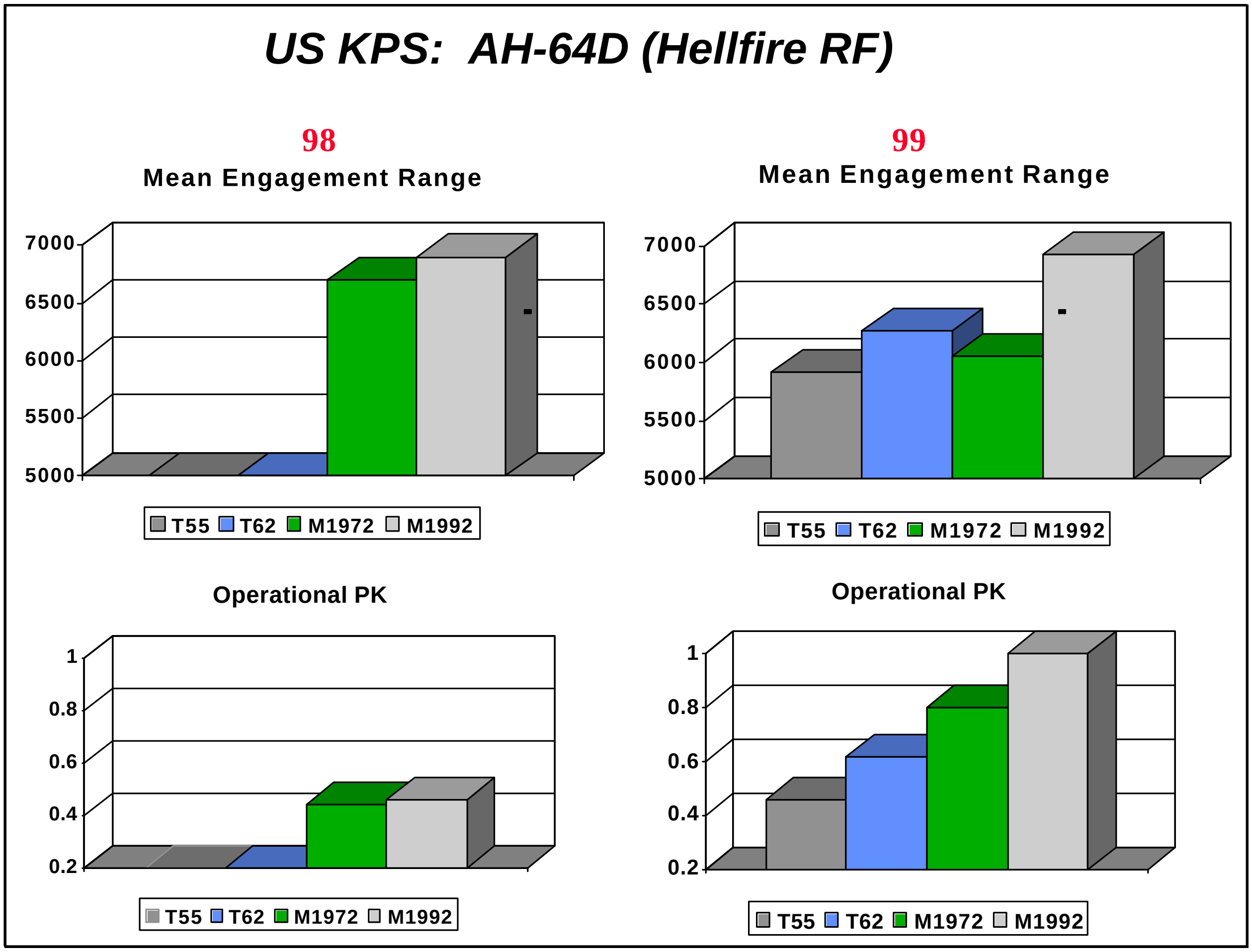

Figure 17. US KPS: AH-64D (Hellfire RF)

Next analyzed was the US Apache, Delta model, which also exists in both studies (Figure 17). Several Threat systems not targeted in CFC98 were added to the list of potential targets in NEA99. Mean engagement ranges changed little in response to the minimum SSPK function due to the flatness of the SSPK curve vs range for the Hellfire RF. Operational PK values increased due to the improved aviation algorithm incorporated into COSAGE in January 2000.

3.10 Threat KPS: T55 (100mm)

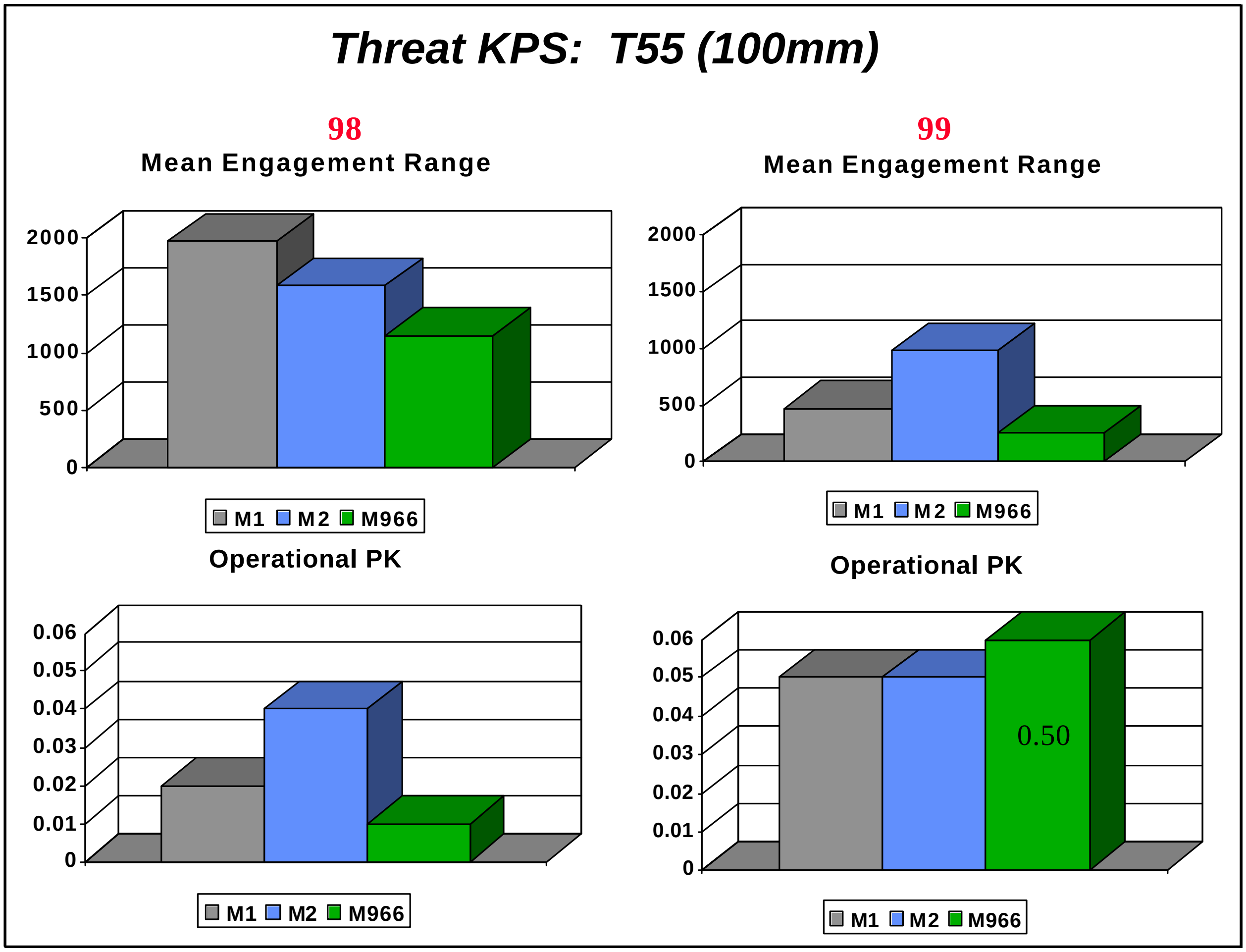

Figure 18. Threat KPS: T55 (100mm)

Analysis continued with the Threat T55 tank (Figure 18). This system exists in both studies and engages the same targets in both. Mean engagement ranges decreased due to the minimum SSPK function, and operational PK values improved due to the decreased engagement ranges. T55s had an extremely high operational PK (0.5) against the M966 due to a small number of T55 - M966 engagements.

3.11 Threat KPS: M1973 (AT3)

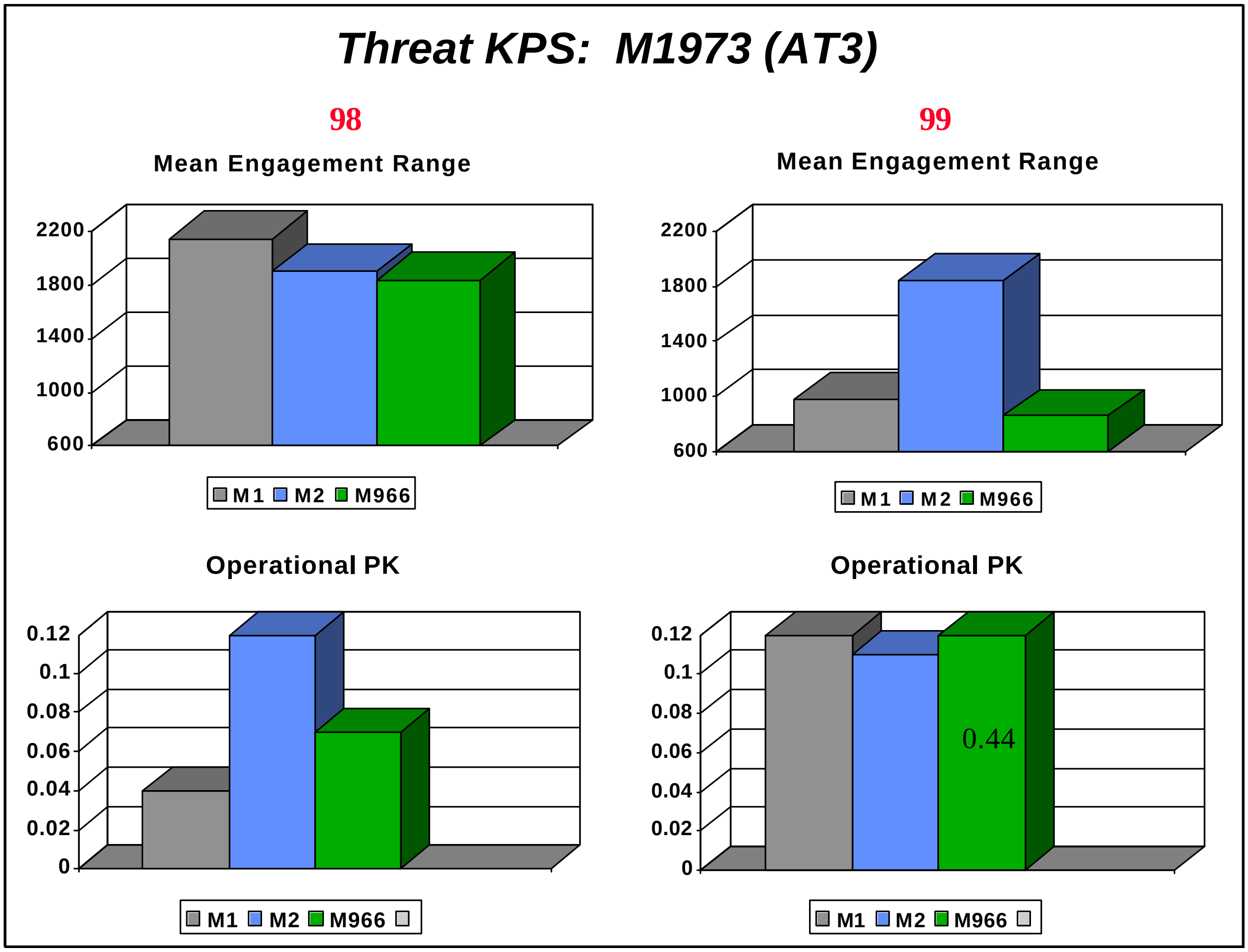

Figure 19. Threat KPS: M1973 (AT3)

The Threat M1973 (AT3) was the next system considered (Figure 19). The system also exists in both studies and engages the same targets in both. Mean engagement ranges remained constant due to the flatness of the AT3 SSPK curve. Operational PK values changed little due to the constancy in engagement ranges. M1973s had an extremely high operational PK (0.44) against the M966 due to a small number of M1973 - M966 engagements.

3.12 US Direct Fire (engagement/system/day)

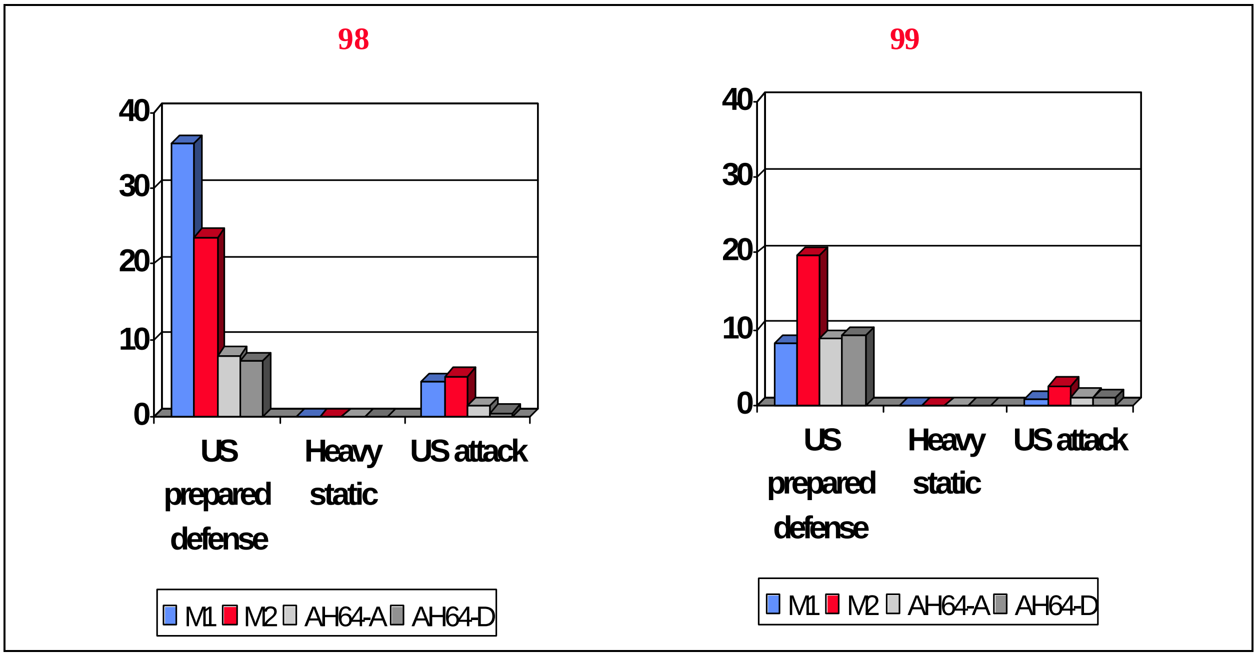

Figure 20. US Direct Fire (engagement/system/day)

The minimum SSPK function decreased the number of indirect shots by limiting the systems to engaging targets only when a reasonable chance of hitting the target existed. This had a greater impact on tank engagements than missile engagements due to the flatness of the missile SSPK curves, as shown in Figure 20. An engagement is defined as a single round fired.

3.13 US Indirect Fire (rounds/tube/day)

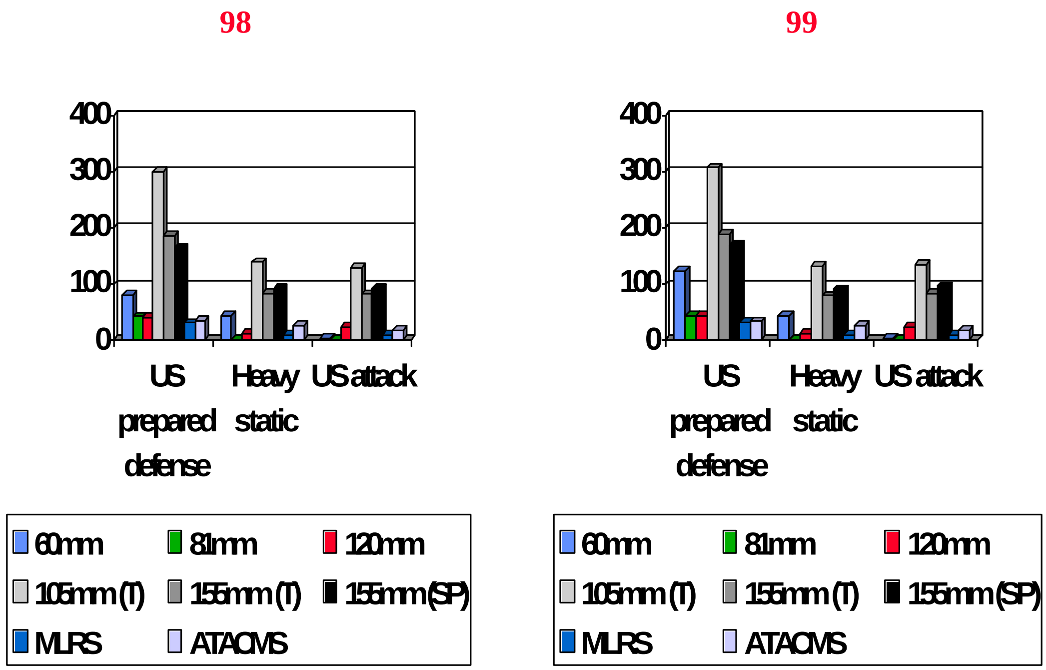

Figure 21. US Indirect Fire (rounds/tube/day)

As shown in Figure 21, indirect fire engagements remained constant from CFC98 to NEA99.

3.14 LER Comparison

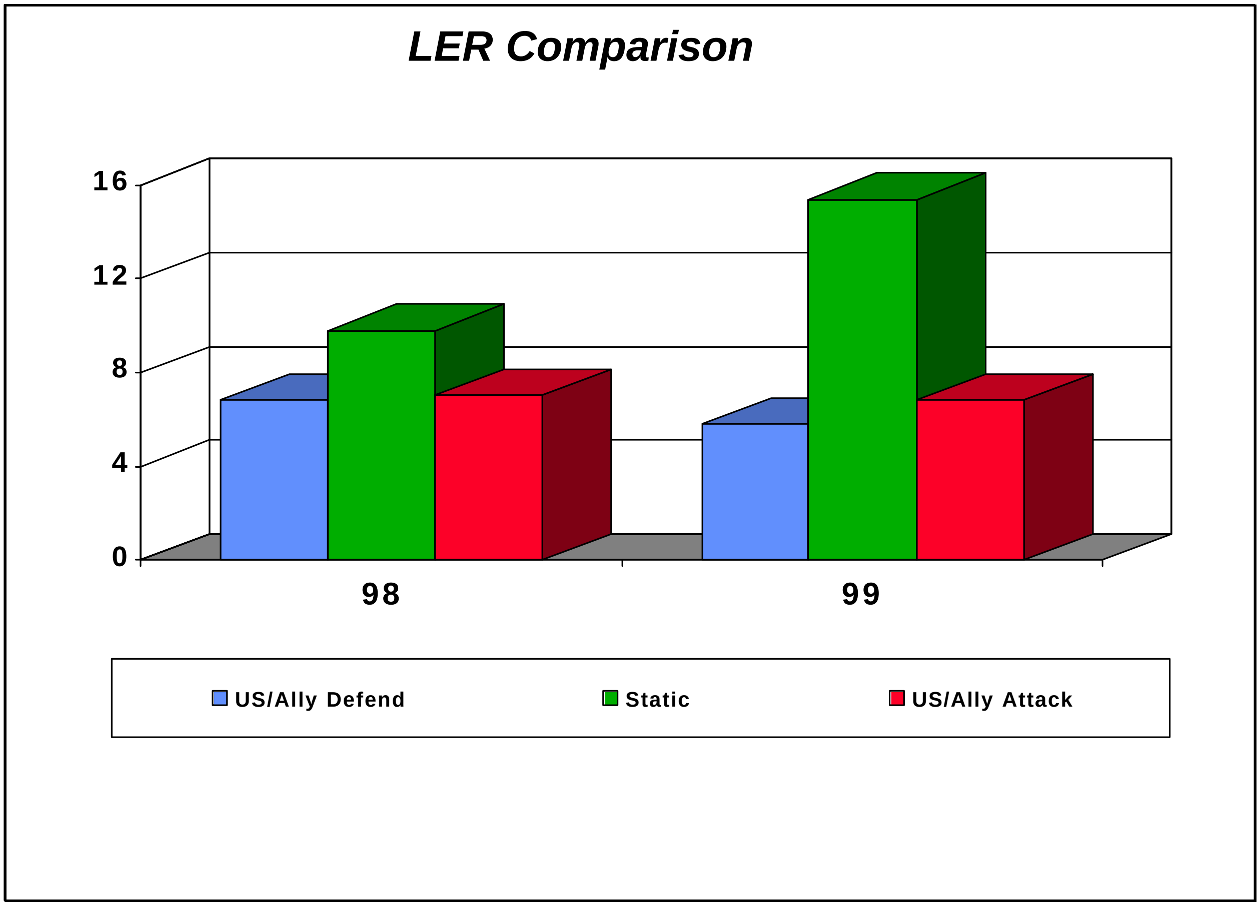

Figure 22. LER Comparison

Figure 22 shows that LER patterns remained constant across both studies. The improved US aviation algorithm accounted for the improved LER values in NEA99.

3.15 FER Comparison

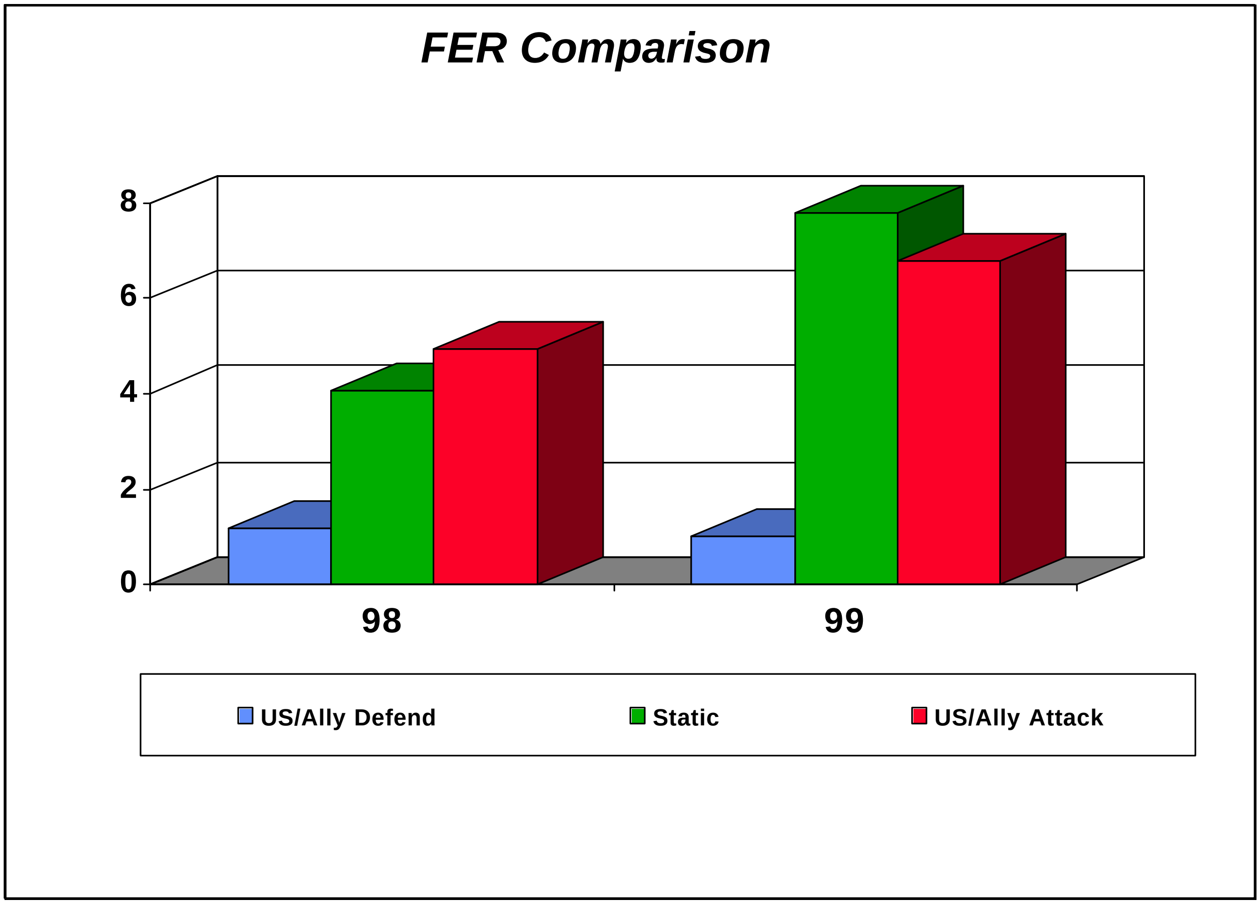

Figure 23. FER Comparison

FER values increased for 98-99, as shown in Figure 23. The improved US aviation algorithm accounted for much of the improved FER values in NEA99.

3.16 SER Comparison

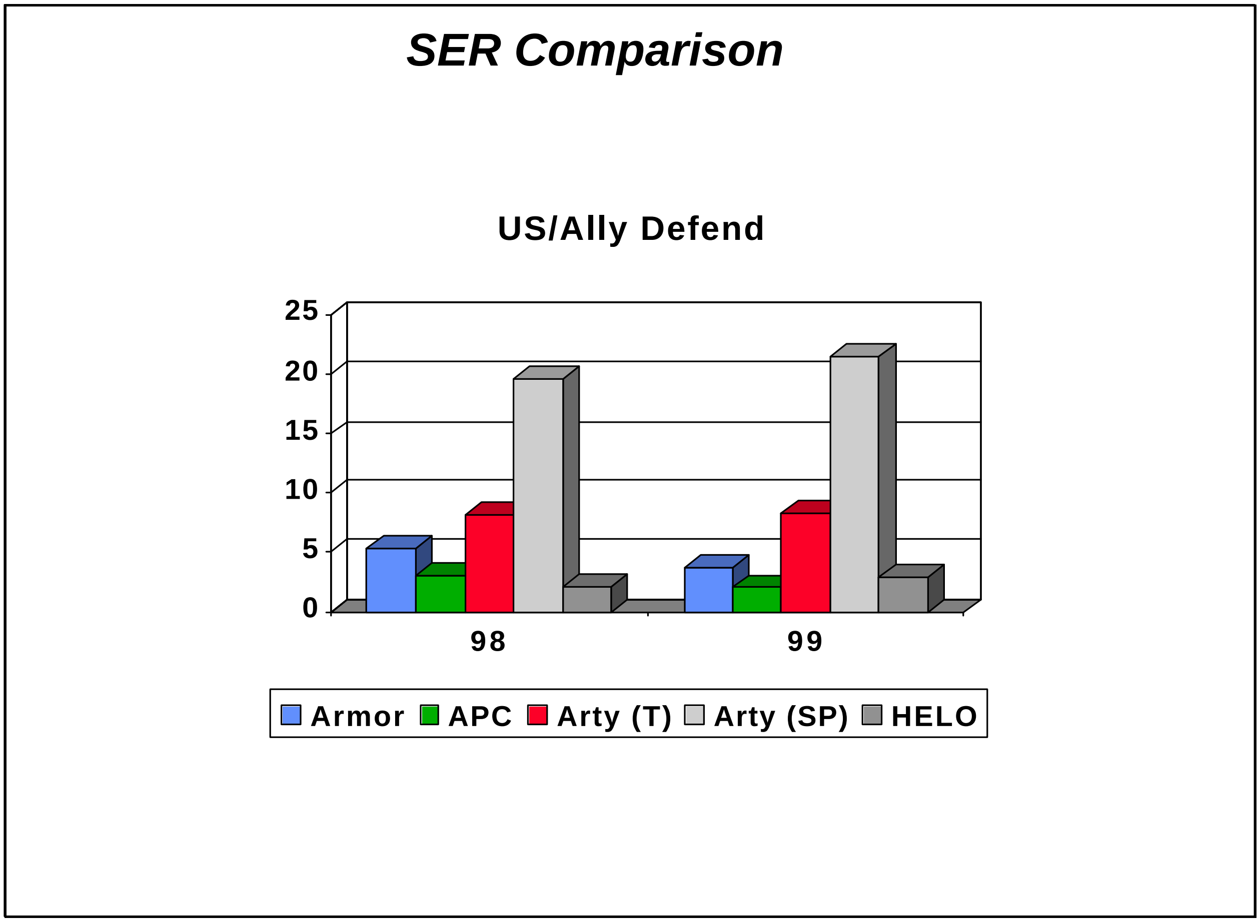

Figure 24. SER Comparison

SER patterns during the US/Ally Defend posture remained constant across both studies, as Figure 24 shows.

3.17 SER Comparison, Static Posture

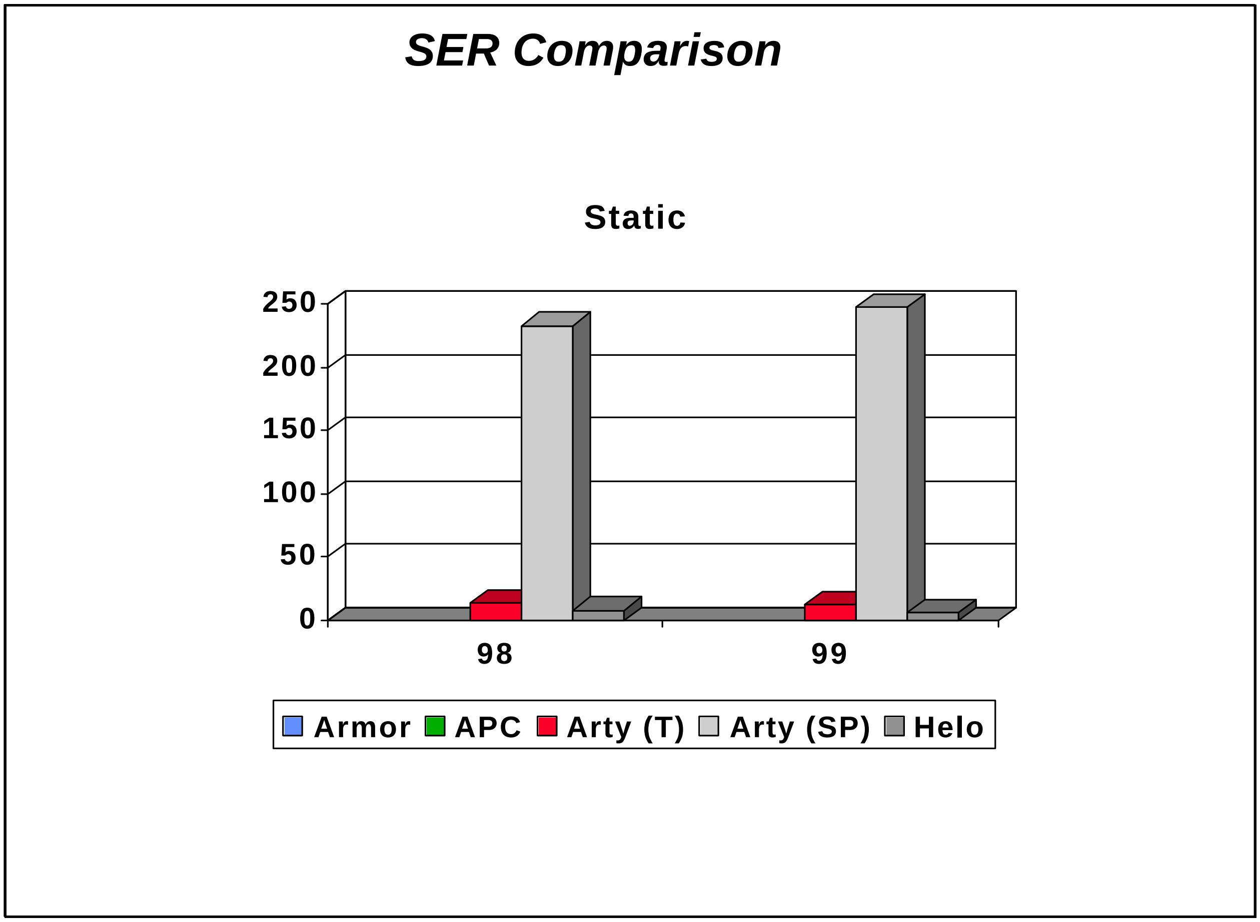

Figure 25. SER Comparison, Static Posture

SER patterns during the Static posture remained constant across both studies (Figure 25).

3.18 SER Comparison, US/Ally Attack

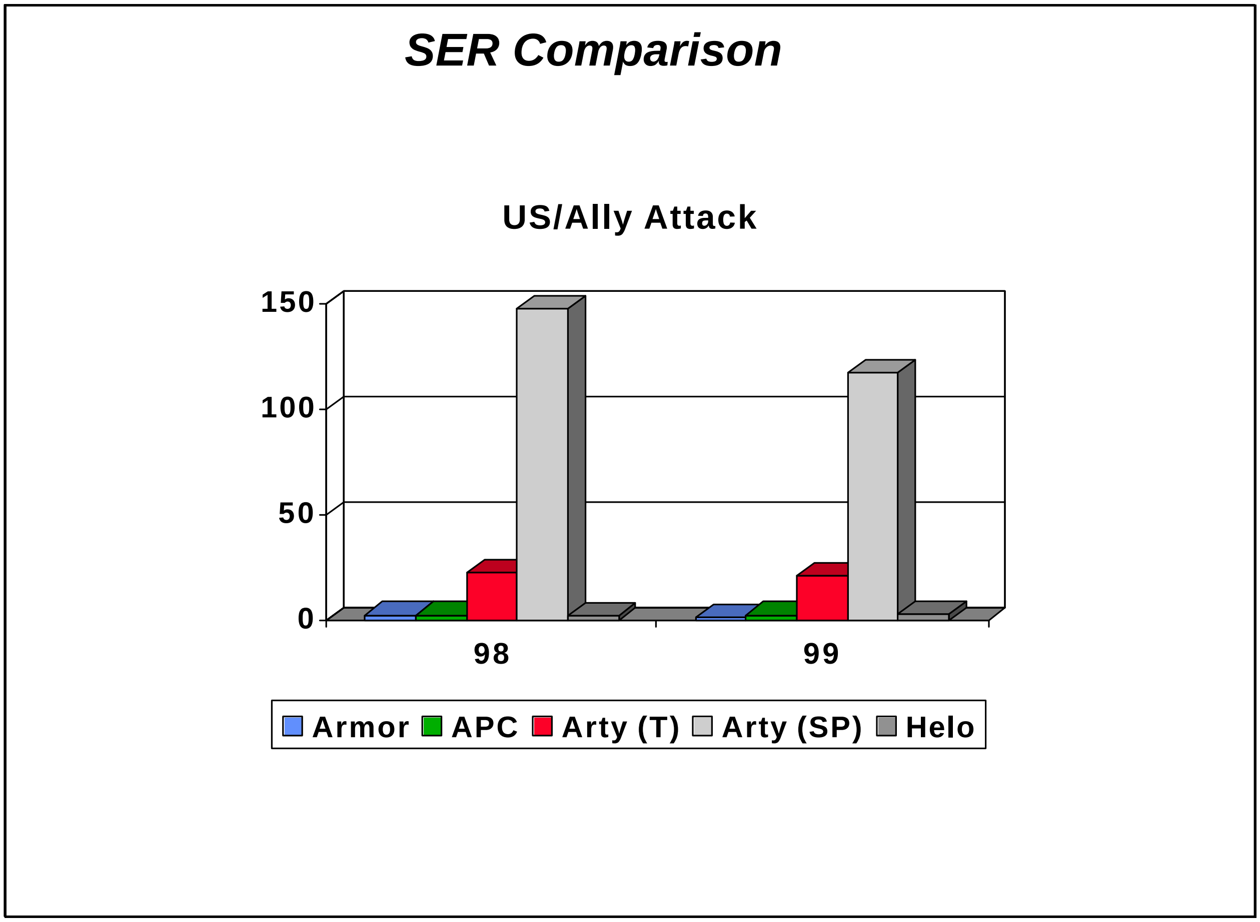

Figure 26. SER Comparison, US/Ally Attack

As shown in Figure 26, SER patterns during the US/Ally Attack posture remained constant across both studies.

3.19 Summary

The NEA 99 COSAGE boards

- Adequately represent the force structure in NEA for 1999.

- Adequately reflect the doctrinal needed for theater simulations in Northeast Asia.

- Adequately represent system level performance of the major weapon systems for the forces in Northeast Asia.

Mr. E. B. Vandiver, Director, CAA, approved the release of the NEA99 boards for use in the Concepts Evaluation Model (CEM) on 5 April 2000.

APPENDIX A PROJECT CONTRIBUTORS

1. PROJECT TEAM

a. Project Director

Mr. Dave Reynolds, Operational Capability Assessments-Northeast Asia

b. Team Members

MAJ Robert Shearer

2. PRODUCT REVIEW

Dr. Ralph E. Johnson, Quality Assurance

APPENDIX B REQUEST FOR ANALYTICAL SUPPORT

PART 1

Performing Division: NE *Account Number:* **99093**

Tasking: Informal *Mode (Contract-Yes/No):* No

Acronym: **COS-NEA99**

Title: Northeast Asia Current Year COSAGE Boards

Start Date: 12-Jul-99 *Estimated Completion Date:* 15-Oct-99

Requestor/Sponsor (i.e., DCSOPS): CAA *Sponsor Division:* NE

Resource Estimates: *a. Estimated PSM:* 3 *b. Estimated Funds:* $0.00

c. Models to be **COSAGE, CEM**

Description/Abstract:

Develop current year COSAGE boards for OCA-NEA

Study Director/POC Signature: ***Original Signed*** *Phone#:* 703-806-5519

Study Director/POC: **Mr. David Reynolds**

If this Request is for an External Project expected to consume 6 PSM or more, Part 2 Information is Not Required. See Chap 3 of the Project Directors' Guide for preparation of a Formal Project Directive.

PART 2

Background:

Current Year COSAGE boards for OCA-NEA need to be updated.

Scope:

Issues:

Milestones:

TBD

Signatures *Division Chief Signature:* ***Original Signed and Dated*** *Date:*

Division Chief Concurrence:

Sponsor Signature: ***Original Signed and Dated*** *Date:*

Sponsor Concurrence (COL/DA Div Chief/GO/SES) OCA NEA