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**AMMUNITION DISPLAY AND VISUALIZATION OF
INVENTORY AND CAPABILITY EVALUATION**

(ADVICE)

AUGUST 2002



**CENTER FOR ARMY ANALYSIS
6001 GOETHALS ROAD
FORT BELVOIR, VA 22060-5230**

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13. ABSTRACT <i>(Maximum 200 Words)</i> This project determined methods for displaying the capabilities of ammunition stocks without using combat models. As each ammunition type would require a different metric, CAA developed metrics for two ammunition types as illustrative examples. The metric for the Hellfire Longbow was a typical "division deep attack" and for the 25mm APFSDS-T M919 it was a typical combat "division day".				
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AMMUNITION DISPLAY AND VISUALIZATION OF INVENTORY AND CAPABILITY EVALUATION

SUMMARY

THE PROJECT PURPOSE was to develop a method that will help senior leaders better visualize the capabilities of ammunition stocks.

THE PROJECT SPONSOR was the Deputy Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASAALT) for Procurement.

THE PROJECT OBJECTIVES were to:

- (1) Develop a metric for displaying the capabilities of ammunition.
- (2) Determine the capabilities of the current stocks and the programmed procurement using the metrics developed.

THE SCOPE OF THE PROJECT was to develop metrics for only two ammunition types: the Hellfire Longbow (HF LB) and the 25mm Armor Piercing Fin Stabilized Discarding Sabot – Tracer (APFSDS-T) M919. The timeframes considered were the current year and the end of the programmed procurement.

THE MAIN ASSUMPTIONS were:

- (1) For the HF LB, that a typical “division deep attack” consists of two battalions with 24 aircraft each, each aircraft carrying a load of 9 HF LB, performing three turns (i.e., using three loads).
- (2) For the 25mm, that a typical “division day” consists of 260 IFVs/CFVs expending seven rounds per hour for 18 hours.

THE PRINCIPAL FINDINGS were:

- (1) That the metrics developed in this project do not depend on a combat simulation. However, they do provide insight into the combat capability of the ammunition stocks. Varying the parameters of the metrics can alter the perception on the severity of the shortfalls. Therefore, care must be taken to ensure that the unfunded requirements are not exaggerated.
- (2) That both of the ammunition types explored in this project had a large number of unfunded requirements. Using the metrics developed, the shortfalls were:

- For HF/LB, 8 of the 13 “deep attack” missions are unfunded.
- For 25mm, 114 of the 162 “division days” are unfunded.

THE PROJECT EFFORT was conducted by Ms. Linda Coblentz.

COMMENTS AND QUESTIONS may be sent to the Director, Center for Army Analysis,
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1 INTRODUCTION

1.1 Introduction

The Deputy Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASAALT) for Procurement requested this project.

1.2 Background

In recent years, the annual Army ammunition requirement has been \$2 billion. The actual funding has been \$1 billion. In order to satisfy the shortfall, the much of the total stockpile has been used. As a result, to reconstitute the stockpile and satisfy the yearly requirements, the funding requirement for fiscal year 2002 is \$16 billion. ASAALT is questioning the basis for the unfunded requirement (UFR) and desires analysis to help justify the UFR to the Army Chief of Staff.

1.3 Purpose

The purpose of this project is to develop a method that will help senior leaders better visualize the capabilities of the current ammunition stocks. In particular, it is to portray the data in a meaningful way that was not dependent on a combat model.

1.4 Scope

We used two different ammunition types that had a significant shortfall, the Hellfire Longbow (HF LB) and the 25mm Armor Piercing Fin Stabilized Discarding Sabot – Tracer (APFSDS-T) M919. The funding shortfalls for these two munitions are \$2.5 billion and \$.3 billion, respectively.

The current ammunition stockage levels of the two ammunition types were examined, as well as the programmed procurement.

1.5 Approach

The approach for this project was to develop a metric for each of the ammunition types. Because the types are used differently, a different metric was developed for each ammo type.

After the metrics were developed, we determined the capabilities of the current stocks, programmed buys, and the combat requirements.

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2 HELLFIRE LONGBOW METRICS AND CAPABILITIES

2.1 Hellfire Longbow (HF LB) Metric

For the Hellfire Longbow (HF LB), we used the number of typical “division deep attacks” that the amount of ammunition could accomplish as the metric. This metric would provide insight into to number of combat missions we could accomplish with the current and programmed stocks. In this case, we considered a typical division deep attack to consist of two battalions with 24 aircraft each. Each battalion would use three loads per attack and each load consists of nine HF LB per aircraft. Therefore, the number of division deep attacks that can be accomplished is calculated using the formula in Figure 1.

□ Use a typical “Division Deep Attack mission” as a metric. This operation would be conducted at night by a single division with corps assets.

- There are 24 aircraft per battalion
- There are 2 battalions per attack
- There are 3 turns (loads) per attack
- There are 9 HF LB per aircraft. Every missile loaded is used.

Number of Division Deep Attack missions that can be conducted =

$$\frac{\text{Total Number of HF LB}}{(\text{Turns} * \text{Bns} * \text{Acft} * \text{HF LB})} = \frac{\text{Total Number of HF LB}}{3 * 2 * 24 * 9}$$

Figure 1. Hellfire Longbow Metric (HF LB)

2.2 Hellfire Longbow Quantities

Figure 2 depicts the HF LB quantities that are available currently and will be available in the future due to programmed procurement in fiscal years 2005 and 2006. The Quantitative War Reserve Requirements for Munitions (QWARRM) requirement is the requirement determined in QWARRM 09, the requirements analysis performed by CAA. This includes the number of HF

LB required for all battalions in the Army. The last bar in the chart shows the number of HF LBs necessary to provide a load for every aircraft in the Army. The dark portions of the bars are the unfunded requirements.

It should be noted that the current stocks are unserviceable and can be used for combat only (with minor repairs).

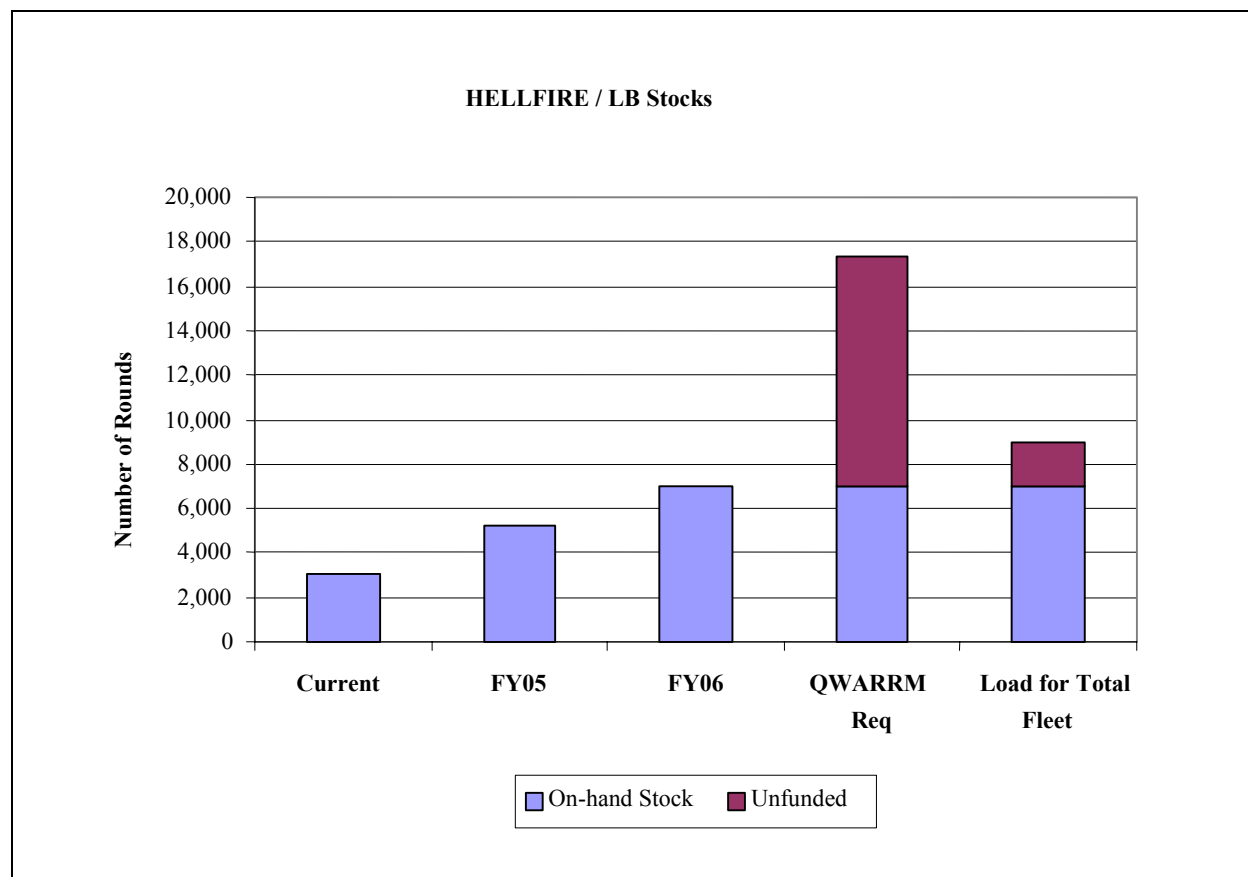


Figure 2. HF LB Quantities

2.3 HF LB Capabilities

Figure 3 depicts the number of “division deep attacks” that can be accomplished with the quantities in the previous chart. The entire QWARRM Requirement derived for QWARRM 09 would be sufficient for just over 13 “division deep attacks.” Of these, almost 8 are unfunded. Current stocks would be sufficient for just over 2 attacks. Projected on-hand stock of HF LB for 2006 would be sufficient for slightly more than 5 deep attacks.

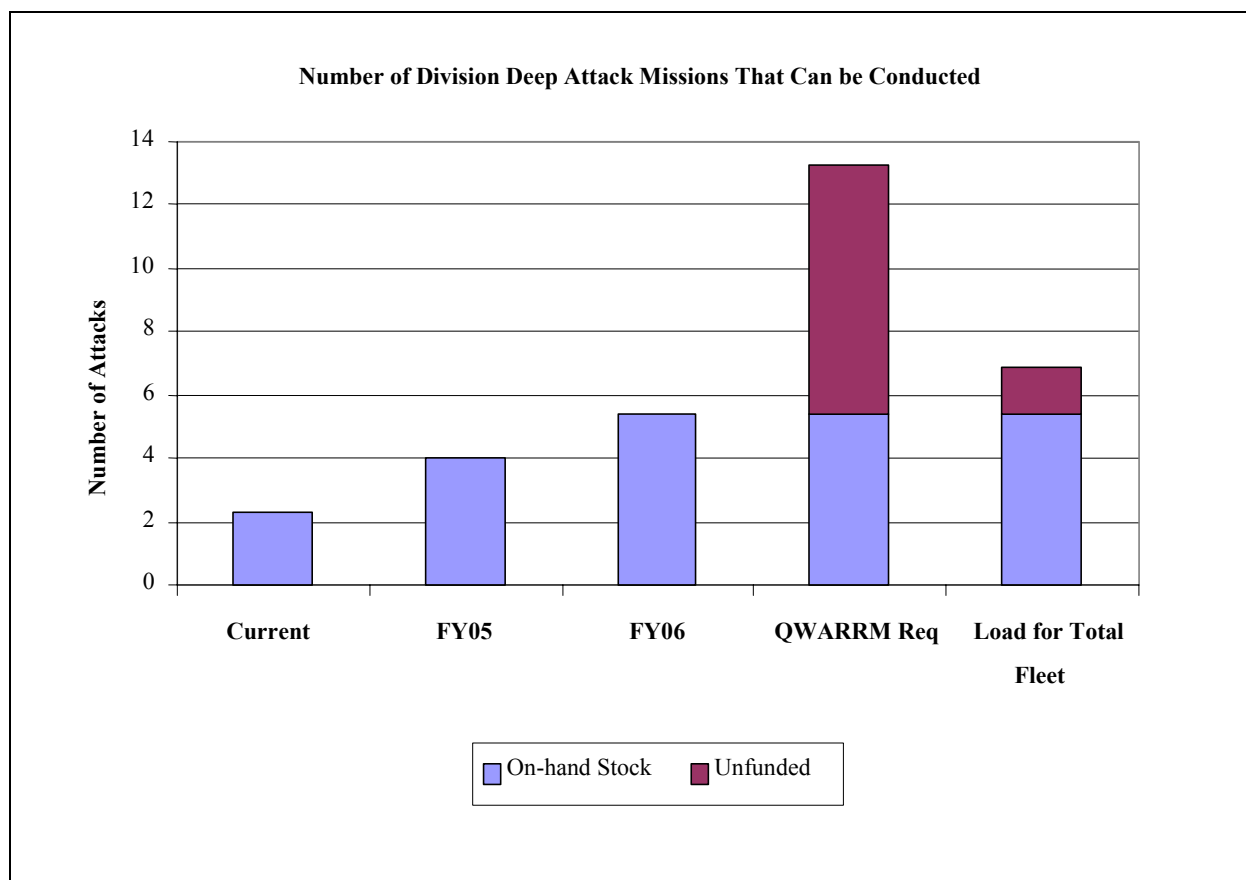


Figure 3. HF LB Capabilities

2.4 Sensitivity Analysis of HF/LB Metric

Because the metric developed uses a very specific definition of a “division deep attack,” a sensitivity analysis was performed. Using the same basic format for the metric, we varied the quantities for the number of HF LBs per helicopter and the number of turns per attack. Table 1 gives the changes that were made for each altered metric. The shaded areas highlight the changes that were made. Figure 4 provides the capabilities determined with the new metrics. The number of deep attack missions were determined for the programmed buy, the combat requirement, and for the amounts that we would have on hand if one quarter, half, and three quarters of the UFR were funded.

Table 1. Change Matrix for HF LB Sensitivity Analysis

	Original Metric	Change 1	Change 2	Change 3
Helo / Bn	24	24	24	24
HF / LB per Helo	9	9	8	7
Bns / attack	2	2	2	2
Turns / attack	3	2	2	2

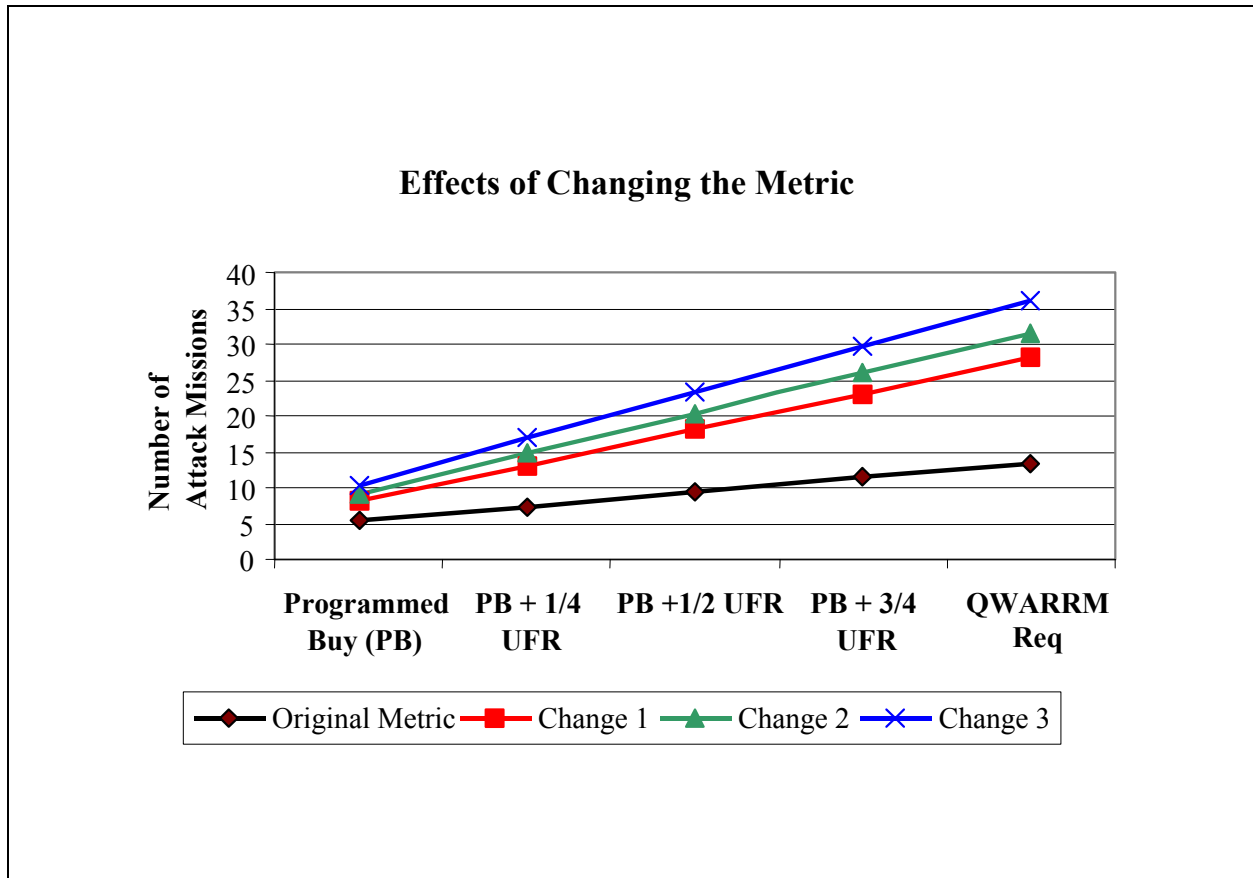


Figure 4. Sensitivity Analysis for HF LB Metric

As can be seen, changing the metric can cause a significant change in the perception of the effects of the shortfalls. For example, using the original metric, the number of missions that can be accomplished with the combat requirement is 250% higher than the number that can be accomplished with the programmed buy. When the number of HF LB per helicopter is changed to 7 and the number of turns per attack is changed to 2 (change 3), the difference is 350%. Although the actual unfunded requirement is approximately ten thousand rounds, the percentage difference between the on-hand amount and the combat requirements using the two metrics is significantly different, 250% versus 350%, so the metric used in change 3 gives the impression that the shortfall is more significant than the original metric. Therefore, it is important to determine the correct metric before using this metric to make comparisons.

2.5 Aircraft Loads of HF LB

In addition to the metric described above, we looked at the capability of the stocks to fully load the attack helicopter fleet. The requirement to fully load the projected attack helicopter fleet in 2009 will take 8920 missiles (16 per AH-64D and 8 per RAH-66). We found that:

(1) The QWARRM 09 requirement would provide almost 2 loads to each aircraft. Of these, almost 1.25 loads are unfunded.

- (2) Current stock would fully load 33% of the fleet.
- (3) Projected on-hand stock for 2006 would provide a full load for about 75% of the fleet.

2.6 Summary of HF LB Metrics

We provided two methods of displaying the effects of the on-hand and required quantities of HF LBs. The first, using a typical “division deep attack”, focuses on the combat capabilities. The second, using aircraft loads, focuses on the ability to arm the attack helicopter fleet. With either metric, the Army has a significant shortfall of Hellfire Longbows.

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3 25MM APFSDS-T M919 METRICS AND CAPABILITIES

3.1 The 25mm APFSDS-T M919 Metric

For the 25mm, a typical “division day” was used as the metric as a way to determine how long a division could fight with the ammunition stocks. This was designed to reflect the expected daily expenditure of a single heavy division during combat. We only consider IFVs/CFVs, not the other Bradley variants. The metric assumes that there are 260 IFVs/CFVs in a division. Each Bradley engagement would expend 3-5 rounds each, averaging an expenditure of seven rounds per hour. There are 18 hours of combat in a day. The metric is described in the formula given in Figure 5.

- Use a typical “Division Day” as a metric. This would reflect the expected daily expenditure of a single heavy division
 - There are 260 IFVs/CFVs in a division (does NOT include other Bradley variants)
 - Engagements by Bradley Fighting Vehicles consist of 3-5 rounds each, resulting in an average of 7 rounds/hour expenditure rate
 - There are 18 hours of combat each day

$$\text{Number of Division Days} = \frac{\text{Total Number of 25mm}}{(\text{IFVs} * \text{Hours} * \text{Rounds per hour})} = \frac{\text{Total Number of 25mm}}{260 * 18 * 7}$$

Figure 5. 25mm APFSDS-T M919

3.2 25mm Quantities

Figure 6 provides the quantities of 25mm. There is no programmed procurement for this ammunition (i.e., there are no FY 05 and 06 stock increases as there were with the HF LB) and we assume that all rounds currently in stock are serviceable. The QWARRM requirement is the requirement determined in QWARRM 09. This includes the combat load. The combat load is

the number of 25mm required for all battalions in the Army with IFVs and its variants. This is analogous to the “total fleet” statistic for the HF LB. The last bar in the chart provides the amount of 25mm used in combat.

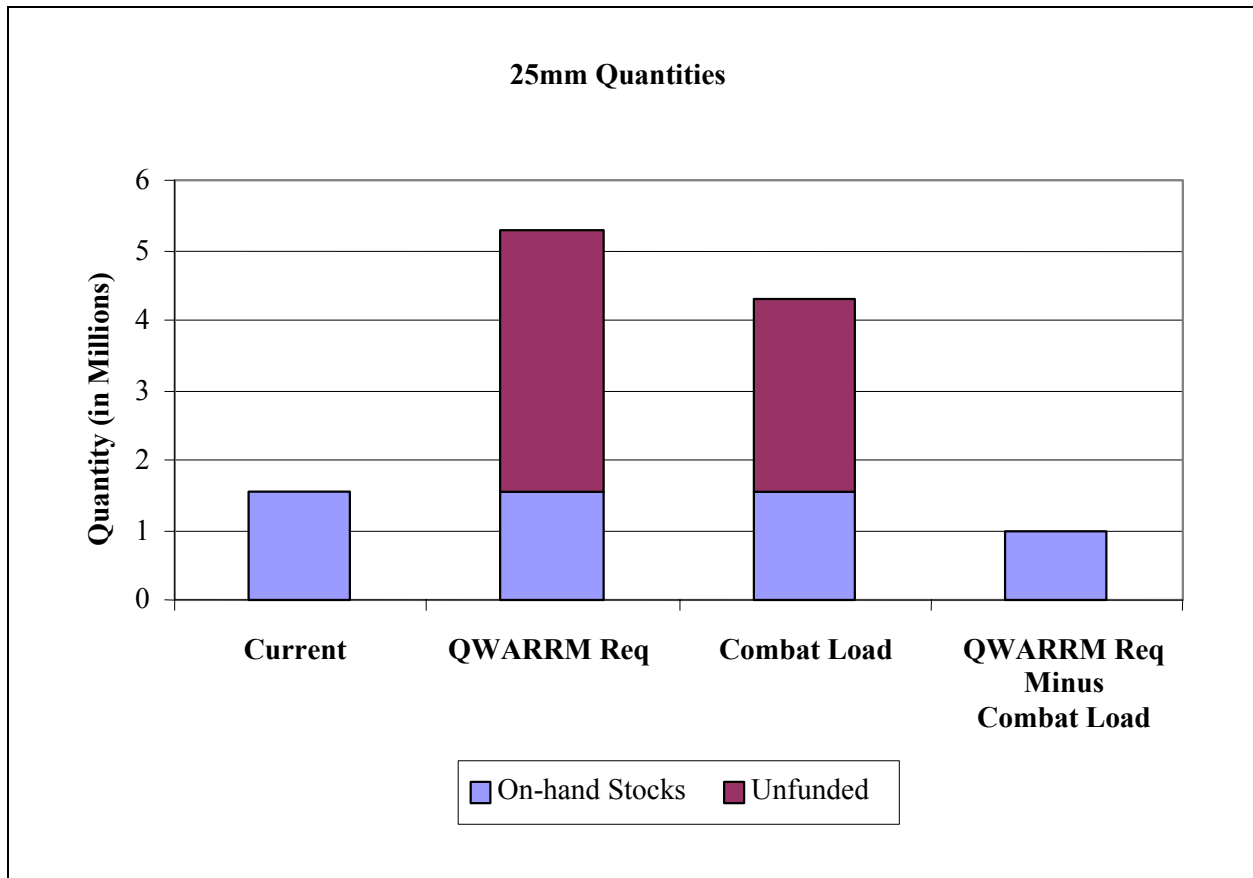


Figure 6. 25mm Quantities

3.3 25mm Capabilities

Figure 7 depicts the number of “division days” that are possible with the quantities provided in Figure 6. The darkly shaded portion is not funded.

If every round of the QWARRM Requirement derived for QWARRM 09 was fired, it would be sufficient for almost 162 division days” (114 days unfunded), or almost 27 days for each of the six heavy divisions (19 days unfunded).

Current stocks would be sufficient for almost 48 division days of combat, or almost 8 days for six divisions.

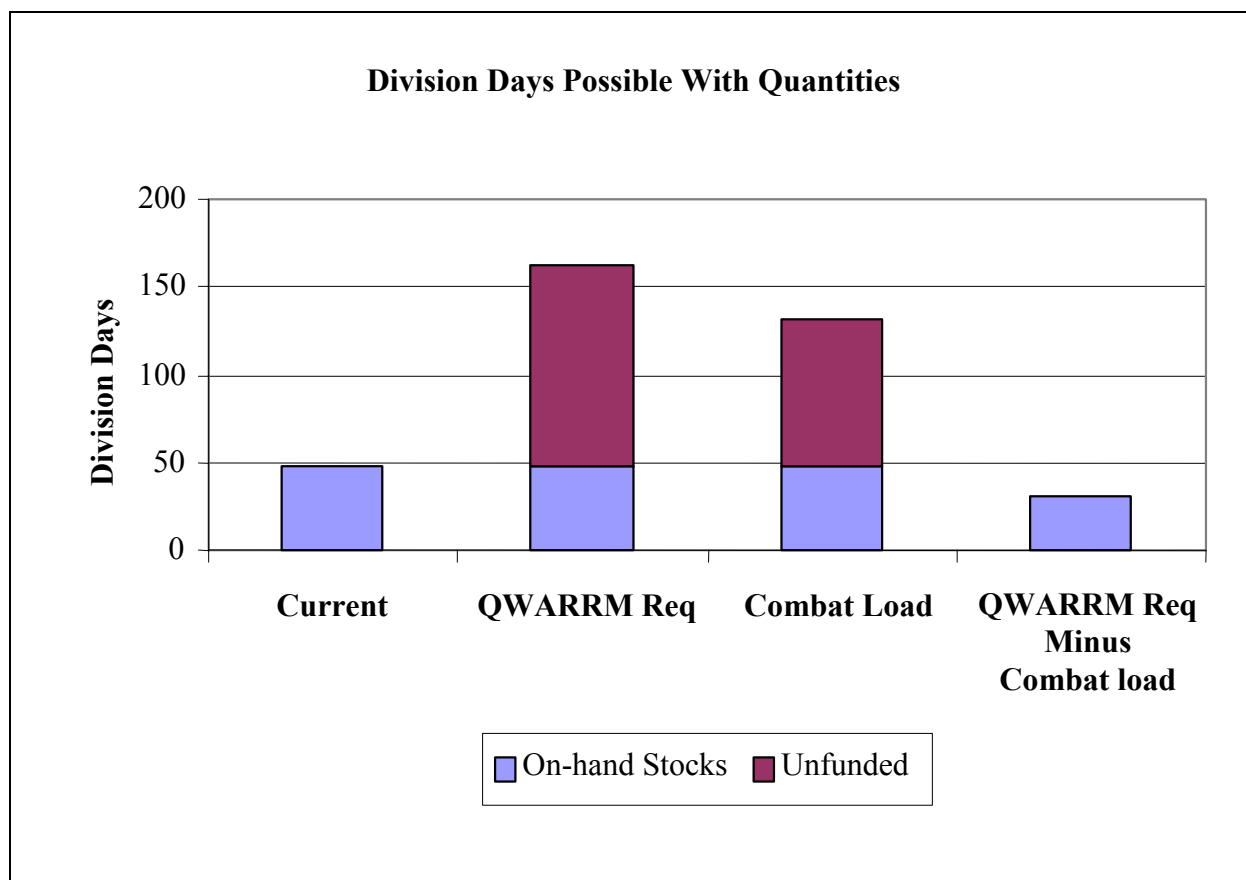


Figure 7. 25mm Capabilities

3.4 25mm Combat Loads

A majority of the QWARRM requirement for 25mm is for combat load of vehicles. Once hostilities have ended, the desired endstate is one combat load per vehicle. A combat load for Bradley Fighting Vehicle (BFV) is about 750 rounds (varies from 690 to 1125). The QWARRM 09 requirement would be enough for over 7060 combat loads, with about 4960 loads unfunded. For Total Army Analysis 2009, the number of BFVs and variants is over 4800. The remainder of the requirement (QWARRM requirement minus combat load) would be sufficient for just over 30 “division days,” or about 5 days for each of the six heavy divisions.

Current stock would be enough for about 2100 combat loads, which is not enough for the entire Bradley fleet.

3.5 Sensitivity Analysis of 25mm Metric

As with the HF LB metric, we performed a sensitivity analysis on the metric that was developed. The seconds of engagement and the hours of battle per day were varied. The matrix in Table 2 provides a description of the changes made for each case presented in the chart in Figure 8. The number of division days were determined for the onhand quantities, the combat requirement, and for the amounts that we would have on hand if one quarter, half, and three quarters of the UFR were to be funded.

Table 2. Change Matrix for the 25mm Sensitivity Analysis

	Original Metric	Change 1	Change 2	Change 3
Rds / min	200	200	200	200
Seconds of Engagement	2.1	3.0	5.0	6.0
Hours of Battle/Day	18	18	16	20
IFVs/Division	260	260	260	260

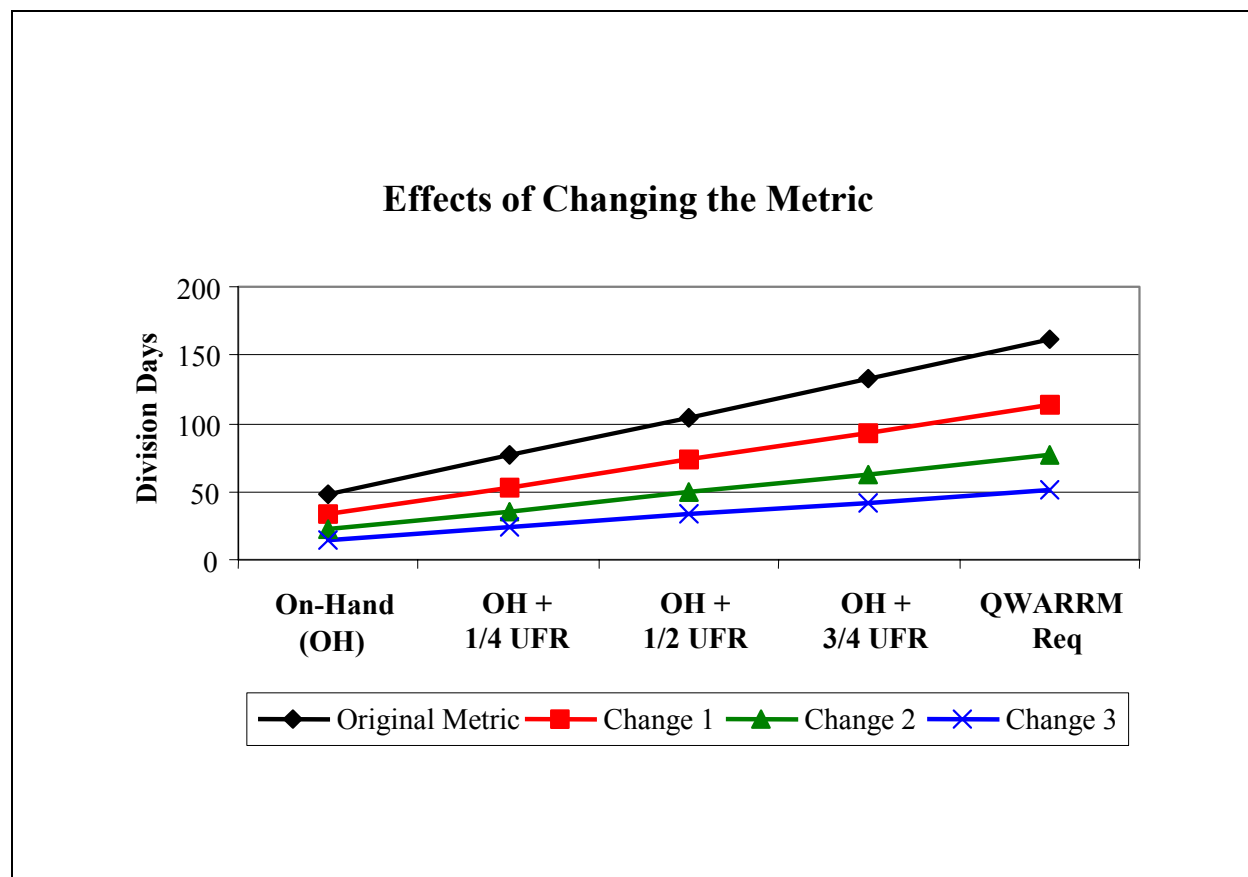


Figure 8. Sensitivity Analysis for 25mm

As can be seen, changing the metric can cause a significant change in the perception of the effects of the shortfalls. For example, using the original metric, the unfunded requirement (the difference between on-hand ammunition and the QWARRM requirement) equates to over 110 division days. But when the seconds of engagement are changed to 6 and the hours of battle are changed to 20 (change 3), the unfunded requirement is around 35 days. Although the actual unfunded requirement is almost four million rounds, the difference in division days between the on-hand amount and the QWARRM requirement using the two metrics is significantly different, 110 versus 35, so the metric used in change 3 gives the impression that the shortfall is less significant than the original metric. Therefore, it is important to determine the correct metric before using this metric to make comparisons.

3.6 Summary of 25mm Metrics

We provided two methods of displaying the effects of the on-hand and required quantities of HF LBs. The first, using a typical “division day,” focuses on the combat capabilities. The second, using combat loads, focuses on the ability to provide combat loads for all combat vehicles. With either metric, the Army has a significant shortfall of 25mm APFSDS-T M919.

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4 OBSERVATIONS

4.1 Observations

The metrics developed in this project do not depend on a combat simulation. However, they do provide insight into the combat capability of the ammunition stocks. As demonstrated in the sensitivity analysis, varying the parameters of the metrics can alter the perception on the severity of the shortfalls. Therefore, it is important to determine the correct metric before using metrics to make comparisons.

Both of the ammunition types explored in this project had a large number of unfunded requirements. Using the metrics developed, the shortfalls were:

- For HF/LB, 8 of the 13 “deep attack” missions are unfunded.
- For 25mm, 114 of the 162 “division days” are unfunded.

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APPENDIX A PROJECT CONTRIBUTORS

1. PROJECT TEAM

a. Project Director:

Ms. Linda Coblenz, Resource Analysis Division

b. Team Members:

LTC Dean Mengel

c. Other Contributors:

LTC Allen East
LTC William Tarantino

2. PRODUCT REVIEWERS

Dr. Ralph Johnson, Quality Assurance

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APPENDIX B REQUEST FOR ANALYTICAL SUPPORT

P A R T 1	Performing Division:	RA	Account Number:	2002147	
	Tasking:	Verbal	Mode (Contract-Yes/No):	In-house	
	Acronym:	ADVICE			
	Title:	Ammunition Display and Visualization of Inventory and Capabilities Evaluation			
	Start Date:	06-Mar-02	Estimated Completion Date:	30-Apr-02	
	Requestor/Sponsor (i.e., DCSOPS):	ASA(ALT)	Sponsor Division:	ZP	
	Resource Estimates:	a. Estimated PSM:	1.5	b. Estimated Funds:	\$0.00
	c. Models to be Used:	none			
	Description/Abstract:	To develop a method of portraying the Army ammunition stocks (current and POM quantities) in a manner that portrays current requirements and capabilities.			
	Study Director/POC Signature:	<i>Original Signed</i>	Phone#:	703-806-5364	
	Study Director/POC: Ms. Linda Coblenz				
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.					
Background:					
P	In recent years, the Army ammunition requirement has been \$2 billion, with actual funding at \$1B. This has eroded the stockpile of ammunition, which has been used to satisfy the shortfall. This incurred a requirement of \$16B. The Secretariat is looking for a method to effectively convey the seriousness of the situation, without relying on specific combat modeling results.				
A					
R					
T	Scope: This will be an illustrative project focusing on one or two ammunition types, to be determined by the proportion of the ammunition unfunded requests (UFR).				
2					
Issues: What quantities of the selected ammunition are stockpiled? At what rate are they disposed of due to age? What is the programmed buy? What is the requirement? How can we depict the capabilities of the stockpile without using specific combat modeling?					
Milestones: 15 April - complete analysis; 30 April - complete documentation					
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) :					

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