INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
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REPORT NO. 91-091 June 10, 1991

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION
ASSISTANT SECRETARY OF THE ARMY (FINANCIAL MANAGEMENT)
ASSISTANT SECRETARY OF THE NAVY (FINANCIAL MANAGEMENT)
ASSISTANT SECRETARY OF THE AIR FORCE (FINANCIAL MANAGEMENT AND COMPTROLLER)

SUBJECT: Survey Report on Antiarmor Munitions Requirements (Project No. 0RA-0070)

Introduction

This is our final report on the survey of Antiarmor Munitions Requirements. The overall objective of the survey was to determine whether the total DoD requirement for antiarmor munitions represents the most efficient and economical mix of resources to defeat the predicted array of hostile targets. We assessed target allocation among U.S. and Allied Forces. In addition, we assessed DoD's ability to produce munitions for weapon systems through the day of mobilization and after. We also evaluated internal controls as they related to the audit objectives. Excluding additional procurements expressly for Operation Desert Shield, DoD planned to spend about $520 million for antiarmor munitions in FY 1991, which represented about 9 percent of DoD's munitions budget.

During the time of our survey, the Conventional Systems Committee (Munitions) (CSC[Munitions]) was reviewing the Military Departments' requirements determination processes, and action was being taken to correct weaknesses and inconsistencies. In addition, the changing world military and political environment and Operation Desert Shield caused the Military Departments to reexamine their total munitions requirements, especially for antiarmor munitions. In view of those actions and events that would significantly affect antiarmor munitions requirements, the potential usefulness of continuing the audit was minimal; therefore, we terminated the project at the conclusion of the survey phase. The results of the survey are discussed below.

Survey Results

The survey showed that munitions requirements computed by the Military Departments serve only as a goal, because fiscal

constraints rarely enable procurement of total requirements. We identified a potential overlap in targets between the Army and the Air Force in the European theater, but it was not considered to be excessive. The survey also showed that DoD maintains a small industrial base for munitions because of budget constraints. In a large-scale war, existing munitions could not be quickly replaced.

Scope of Survey

For the purposes of this project, we defined antiarmor munitions as munitions intended primarily to destroy tanks. To determine the munitions in our universe, we coordinated a list of munitions (Enclosure 1) with the Military Departments. These munitions either were in the Military Departments' inventories or were scheduled for procurement by FY 1997. We excluded mines from the list, because their primary purpose is to serve as an obstacle rather than as a target-killing munition.

We reviewed the software models used by each Military Department to determine antiarmor munitions requirements. We also reviewed the RAND Corporation's 1987 analyses of the Military Departments' determination processes for munitions requirements and actions taken to correct identified weaknesses. In addition, we interviewed personnel in OSD, the Joint Staff, and the Military Departments on the processes for determining requirements and allocating targets. We also discussed with those officials the capabilities of the munitions industrial base. We reviewed applicable guidance issued by OSD and the Military Departments for preparing the budgets for FY's 1990 through 1997. Our Quantitative Methods Division assisted the auditors in evaluating the Military Departments' models for computing munitions requirements. During our survey, we did not validate input data or assumptions used in the models.

We did not examine the Marine Corps' process for determining ground-to-ground antiarmor munitions requirements, because the Marine Corps acknowledged that its existing process for computing those munitions requirements is outdated, poorly documented, and based on questionable methodologies. The Marine Corps is developing a new model for computing ground-to-ground munitions requirements. The new model, the Marine Corps Ammunition Requirements Management System, was scheduled to be operational by March 1991. The Navy computes air-to-ground munitions requirements for the Marine Corps, and we assessed those requirements as part of our review of the Navy's model.

This self-initiated economy and efficiency survey was made from May through November 1990. The survey was made in accordance with auditing standards issued by the Comptroller General of the United States as implemented by the Inspector General, DoD, and accordingly included such tests of internal controls as were considered necessary. The activities visited or contacted are listed in Enclosure 3.

Internal Controls

The Military Departments had not explicitly defined internal control objectives for their determination processes for antiarmor munitions requirements. Based on discussions with the functional managers, we defined the principal internal control objectives as the ability to compute reasonable antiarmor munitions war reserve requirements by type and quantity. We determined that the process used by each Military Department includes controls, primarily the use of validated quantitative models, to determine an appropriate mix of munitions. In addition, the Military Departments review the input data for reasonableness. Targets and threat data are coordinated with the Defense Intelligence Agency. The internal controls were deemed to be effective in that no material deficiencies were disclosed by the survey.

Background

The Department of Defense categorizes munitions requirements as threat-oriented or level-of-effort. Threat-oriented munitions are needed in quantities sufficient to destroy a finite number of targets. Aircraft and submarines are examples of targets that would be attacked by threat-oriented munitions. Requirements for level-of-effort munitions are based on the capability to fire or deliver munitions on replaceable targets such as vehicles and personnel. Different techniques are used to compute requirements for the two categories of munitions. Antiarmor munitions fall in the level-of-effort category. The Military Departments state requirements for level-of-effort munitions in the quantities needed for a given period of combat.

Prior Audits and Other Reviews

No prior audit reports have been issued that specifically address the process for determining antiarmor munitions requirements. However, in 1987 the RAND Corporation reviewed each Military Department's process for determining munitions requirements. RAND's results are highlighted in the Discussion section of this report.

Discussion

Requirements Determination Process. The Military Departments compute antiarmor munitions requirements in three steps. First, models calculate the quantities of munitions to be fired against intended enemy targets. Next, planning factors are used to compute quantities of munitions consumed in ways other than being fired at targets. Planning factors used in this second step vary among the Military Departments and include suspect targets, test firing of weapons, and shipments lost in combat. Finally, each Military Department has a board or committee to review computed requirements for reasonableness. The funding resources available to the Military Departments constrain the quantities of munitions actually procured.

Army. The Military Departments use diverse and complex models to compute antiarmor munitions requirements. The Army has the most complex models because of the complexity of a ground war. The Army's models must consider the interaction of conventional ground weapon systems, the air support provided by the Air Force and Navy along the battle lines, and the roles of Marine Corps ground and Navy surface forces. The Army's models also portray movement of the enemy and friendly forces during the simulated battle. The Army's models compile data from more than 50 sources, some of which are other models.

Navy and Air Force. The munitions requirements for the Navy and the Air Force are primarily constrained by the number of sorties available to attack ground targets. Thus, to determine munitions requirements, the Navy and the Air Force do not simulate the capabilities and interactions of all ground weapon systems.

RAND Corporation Review. Beginning in 1987, the RAND Corporation reviewed the processes used by the Military Departments to compute conventional munitions requirements. RAND published reports in 1989 that provided an overview of the processes and identified problems unique to each Military Department. For example, RAND reported that the Army's models did not include nonpreferred munitions (the Army keeps these munitions in inventory, but procures no additional quantities). Army officials stated that the models were subsequently changed to simulate the use of nonpreferred munitions should the preferred munitions be expended. RAND also reported that the Military Departments used different logistics planning factors. Subsequent to RAND's review, the CSC(Munitions) obtained commitments from the Military Departments that common planning

factors would be used, or an explanation would be provided to OSD. The Military Departments' processes for computing antiarmor munitions requirements are discussed further in Enclosure 2.

Allocation of Targets Among the Military Departments and Allies. The Air Force allocates ground targets among other U.S. and Allied Forces before operating its munitions requirements models. Considering the expected combined allied force structure and capabilities, the Air Force assumes that certain percentages of enemy tanks and other targets will be destroyed by its aircraft.

The Army and Navy do not allocate targets among other U.S. and Allied Forces before computing requirements. However, the Army's battlefield simulation model makes allowances for the capabilities and actions of other U.S. and Allied Forces when computing its munitions requirements. Navy officials stated that the potential contributions of other U.S. and Allied Forces were not included in its models, because the Navy and Marine Corps needed to be able to support the Marine Corps in combat ashore without relying on other forces.

The Army and the Air Force calculated different results for the effectiveness of close air support by the Air Force in the European theater of operations. As a result, the Army computed munitions requirements to kill targets that the Air Force also expected to kill. We do not consider the potential overlap in targets between the Air Force and the Army as excessive.

Industrial Base. Military Department officials stated that the munitions industrial base could not quickly satisfy all requirements for war reserves. Budget constraints force the DoD to stockpile war reserves sufficient for combat of short duration and to maintain a small industrial base for munitions. In a large-scale war, the existing munitions war reserves would be exhausted before the industrial base could expand to produce replacement munitions. Because of the changing world situation and expected acute budget reductions, DoD planned to reduce further the munitions industrial base capability.

We provided a draft of this report to the addressees on March 18, 1991. Because there were no recommendations, no management comments were required, and none were received. No monetary benefits are identified in the report.

The courtesies extended to the audit staff are appreciated. If you have any questions on this report, please contact Mr. Michael Joseph at (703) 693-0138 (DSN 223-0138) or Mr. John

Mundell at (703) 693-0168 (DSN 223-0168). A list of audit team members is in Enclosure 4. Distribution of this report is listed in Enclosure 5.

Robert J. Lieberman
Assistant Inspector General
for Auditing

Enclosures

cc:
Secretary of the Army
Secretary of the Navy
Secretary of the Air Force
Director, Joint Staff

ANTIARMOR MUNITIONS DESIGNED TO DESTROY TANKS
(By Type of Munitions, by Service)

Tank and Artillery Rounds 1/			Army	Navy	Air Force	Marine Corps 2/
M829	APFSDS-T	(120MM) 3/	X			
M830	HEAT-MP-T	(120MM)	X			
M735	APFSDS-T	(105MM)	X			
M728	APDS-T	(105MM)	X			
XM900	APFSDS-T	(105MM)	X			
M833	APFSDS-T	(105MM)	X			
M774	APFSDS-T	(105MM)	X			
M712	Copperhead	(155MM)	X			
M456	HEAT-T	(105MM)	X			
Rockets and Missiles						
AT4			X			
Dragon			X			
Hellfire			X			X
AAWS-M			X			
Shillelagh			X			
LAW			X			
TOW			X			X
Maverick				X	X	X
Gun Rounds						
API (30 MM)					X	
Bombs						
Rockeye				X	X	X
Advanced Bomb Family				X		X
Smart Munitions						
Sensor Fuzed Weapon					X	

1/ See next page for legend.
2/ Air-to-ground munitions.
3/ Millimeter

ANTIARMOR MUNITIONS DESIGNED TO DESTROY TANKS
(By Type of Munitions, by Service) (Continued)

Legend of Antiarmor Munitions

AAWS-M	Advanced Antitank Weapon System-Medium
APDS-T	Armor Piercing Discarding Sabot-Tracer
APFSDS-T	Armor Piercing Fin Stabilized Discarding Sabot-Tracer
API	Armor Piercing Incendiary
AT4	Lightweight Multipurpose Weapon
HEAT-MP-T	High Explosive Antitank-Multipurpose-Tracer
LAW	Light Assault Weapon
TOW	Tube-Launched, Optical-Tracked, Wire-Guided Missile

DETERMINATION PROCESSES FOR COMPUTING ANTIARMOR MUNITIONS REQUIREMENTS

Army. The objective of the Army's requirements determination process is to determine the quantities and mix of munitions that would be required to conduct military operations against particular enemy forces under certain scenarios. The Deputy Chief of Staff for Operations and Plans (the Deputy Chief of Staff), Department of Army, requires the U.S. Army Concepts Analysis Agency (CAA) to develop the projected combat expenditures for a particular theater of operations using a particular scenario. To develop the projected combat expenditures, CAA uses a two-sided combat simulation[1/] to represent a particular campaign. Overall, three models are used to compute the antiarmor munitions requirements for the theater of operations: Combat Sample Generator (COSAGE), Combat Evaluation Model (CEM), and War Requirements Ammunition, Materiel, and Petroleum (WARRAMP).

- COSAGE is a stochastic model[2/] that portrays the actions of a representative sample of combat systems. COSAGE produces representative sample "killer/victim" scoreboards and weapon and munitions expenditures that are converted to coefficients for input to the CEM.

- The CEM calculates the equipment attrition and munitions expenditures occurring during the battle in a theater of operations. The CEM is a deterministic model[3/] that can simulate the conflict beginning at the brigade level and expanding to theater level. Other data entered into the CEM include force deployment schedules and theater resupplies. CEM also produces munitions-expenditure files that are used in WARRAMP.

- WARRAMP computes the total projected combat expenditures. WARRAMP includes a procedure that converts the data output of COSAGE and CEM into total munitions expenditures, in 10-day increments, for the duration of the combat scenario. Munitions expenditures for factors not directly determined by COSAGE and CEM are added to the total requirement. For example, factors not determined include suspect targets, test firing of weapons, and combat losses of munitions in destroyed vehicles and ships.

1/ A two-sided combat simulation portrays the actions of two or more opposing forces.
2/ A stochastic model portrays a decision-making process based on data input with values that can vary.
3/ A deterministic model portrays a decision-making process using data input whose values are assumed to be known.

The Deputy Chief of Staff approves the projected combat expenditures determined by the models. He then determines the munitions requirements by comparing the projections to a minimum acceptable number of munitions needed initially to fill the logistics system before combat begins. The larger of the two quantities is then identified as the Army's requirement.

Navy. The Navy seeks to obtain the most cost-effective combination of munitions per aircraft flight for the Marine Corps' close air support mission. The Deputy Chief of Naval Operations (Naval Warfare) has oversight responsibility for determining antiarmor munitions requirements. Antiarmor munitions requirements are generated by a series of three one-sided[4/], theater-level, deterministic models: PHASER, Navy/Marine Ordnance Requirements (NAVMOR), and Miscellaneous Requirements Generator (MRG).

- PHASER computes the number of sorties for all Navy and Marine Corps aircraft that expend ordnance. Data that are input to PHASER include aircraft inventories, weather, maintenance factors, attrition rates, and types of sorties. The results of PHASER are used as input data for the NAVMOR and MRG models.

- NAVMOR determines munitions requirements for fixed-wing aircraft on the basis of cost-effectiveness. For each type of sortie, NAVMOR assigns the most cost-effective munitions from inventories on hand or scheduled for procurement.

- MRG determines munitions requirements for helicopters. Data input for the MRG model include the number of sorties from the PHASER model, the types of sorties, and the number of munitions per sortie. After the calculations by NAVMOR and MRG are completed, the Navy applies a factor to the total requirements to determine the quantity of munitions needed to replace shipments of munitions that are lost at sea.

The Navy's Non-Nuclear Ordnance Planning (NNOP) Board and the NNOP Board Review Group approve the input to the models and the output from the NAVMOR and MRG. The boards consist of representatives of the principal users of antiarmor munitions. After the requirements are agreed on by both boards, the munitions requirements are used to help decide which munitions to buy.

4/ One-sided models portray the actions of one force.

Air Force. The objective of the Air Force munitions requirements process is the determination of the most efficient, cost-effective weapon combination per aircraft type and sortie. The Deputy Chief of Staff, Plans and Operations; Headquarters, U.S. Air Force, manages the determination process known as Non-Nuclear Consumables Annual Analysis. Air Force requirements are generated by a series of four deterministic, one-sided models: SABER, SELECTOR, HEAVY ATTACK, and HEAVY GOAL. Data output from the SABER, SELECTOR, and HEAVY ATTACK models becomes data input for the SELECTOR, HEAVY ATTACK, and HEAVY GOAL models, respectively.

- SABER computes the expected number of destroyed targets per pass for each combination of aircraft, target, weather, and munition. Data input to SABER include aircraft, target, and munition effectiveness.

- SELECTOR determines the preferred weapon for each combination of aircraft, target, and weather; and ranks them by their expected cost to kill the target. Data input for SELECTOR includes aircraft and weapon attrition and costs of the aircraft.

- HEAVY ATTACK converts the munitions consumed by each aircraft type into expenditures-per-sortie factors. Data input for HEAVY ATTACK includes numbers of sorties and targets. HEAVY ATTACK is run several times with adjustments to its various parameters. Air Force major commands review the factors used in HEAVY ATTACK and its data output for reasonableness.

- HEAVY GOAL computes the total munitions requirements. Data inputs for HEAVY GOAL include sorties, munitions inventories, and munitions cost and weight. HEAVY GOAL summarizes the quantity, weight, and cost for each munition by each theater of operation. Quantities are increased, through the use of a multiplier, to compensate for expected losses of munitions over sea and land.

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Comptroller of the Department of Defense, Washington, DC
Director, Net Assessment, Office of the Under Secretary of Defense For Policy, Washington, DC

Joint Staff

Director, Joint Staff, Washington, DC

Department of the Army

Assistant Secretary of the Army (Research, Development and Acquisition), Washington, DC
Office of the Deputy Chief of Staff for Intelligence, Washington, DC
Office of the Deputy Chief of Staff for Logistics, Washington, DC
Office of the Deputy Chief of Staff for Operations and Plans, Washington, DC
Army Materiel Command, Alexandria, VA
Army Concepts Analysis Agency, Bethesda, MD

Department of the Navy

Office of the Assistant Chief of Naval Operations, Air Warfare, Washington, DC
Office of the Deputy Chief of Naval Operations (Logistics), Washington, DC
Office of the Deputy Chief of Naval Operations (Naval Warfare), Washington, DC
Office of the Deputy Chief of Naval Operations (Navy Program Planning), Washington, DC
Marine Corps Research Development and Acquisition Command, Arlington, VA
Marine Corps Combat Development Center, Quantico, VA

Department of the Air Force

Office of the Assistant Secretary of the Air Force (Acquisition), Washington, DC

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