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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

PROCUREMENT AND SYSTEMS
ACQUISITION DIVISION

B-157535

APR 3 1972



The Honorable
The Secretary of Defense

Attention: Assistant Secretary of Defense
(Comptroller)

Dear Mr. Secretary:

The General Accounting Office has completed a pilot review of the activities of Army test boards (GAO Code 67108). Our work was done at the Field Artillery Board, Fort Sill, Oklahoma.

We noted certain weaknesses in the testing objectives and criteria and in determinations of the extent and conditions of testing needed to evaluate the operational suitability of and need for new and modified equipment. We are bringing our findings and suggestions to your attention to assist the Department of Defense and the Army in current efforts to strengthen operational test and evaluation.

INTRODUCTION

The Artillery Board is one of 15 test centers under the jurisdiction of the Test and Evaluation Command (TECOM), Aberdeen, Maryland. As an element of the Army Materiel Command (AMC), TECOM is responsible for independent test and evaluation of equipment developed or modified by the AMC commodity commands. The Board plans, does, and reports on operational tests and evaluations of artillery equipment.

Important to the Board's test planning are such requirements documents as the Qualitative Materiel Requirement prepared by the Combat Developments Command (CDC), the Army command responsible for establishing user needs.

The Board's test reports are issued to a committee which includes representatives of the (1) AMC; (2) CDC; (3) Continental

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Army Command, the Army's training command; (4) Deputy Chief of Staff for Logistics; and (5) Chief of Research and Development. The committee considers the reports in deciding whether to recommend to the Army Chief of Staff that newly developed or modified equipment be procured for operational use.

During the review, we examined the records for 10 tests done by the Board in fiscal years 1970 and 1971. We noted conditions indicating a need for improvements in connection with seven tests.

The 10 tests represent about 15 percent of the Board's workload. These tests were selected at random and, therefore, our findings can not be projected over the Board's entire workload. We believe, however, that the findings merit your attention because of the types of weaknesses and their frequent occurrence.

MEASURING EQUIPMENT ACCURACY

In 4 of the 10 tests the Board did not use realistic criteria for demonstrating the accuracy of equipment used to locate enemy targets. This equipment included a counter-mortar radar, a doppler translocation radar, and two azimuth determining devices.

For example, the AN/MPQ-4A counter-mortar radar is used to compute the location of enemy mortars and direct return fire. CDC's criteria for testing the radar's accuracy called for measuring the dispersion of computed locations around a point representing the radar's average computation--referred to as the mean location. Specifically, CDC required that at least 50 percent of the computed locations be no more than 35 meters from the mean location. The mean location, however, could be different than the actual location of the enemy mortar.

The Board, recognizing that data obtained from testing under CDC's criteria would not be useful, reported the average distance of the radar's computed locations from the actual mortar location. Such information, in our opinion, is useful as an indicator of the radar's accuracy.

Since mortars are highly mobile, however, it seems that it would be more useful to also show the percentage of the computed locations that are within reach of the actual mortar location. This information would enable the Army to decide whether the counter-mortar radar is accurate enough to direct effective return fire.

HOW MUCH TESTING OF OPERATIONAL SUITABILITY

The determination of the extent and conditions of testing is important to assure that testing is sufficient to demonstrate the suitability of items without unnecessarily expending resources. In four tests, as described in the following sections, methods used to determine the scope of tests needed to demonstrate that equipment would perform reliably under expected operating conditions seemed questionable or nonexistent.

Self-propelled weapons

The Board tested the operational suitability of a modified 155mm howitzer and a modified 175mm gun. In the absence of formal performance requirements, the Board's criteria for reliability was that the items tested be as good or better than their predecessors.

For the modified 155mm howitzer, three test items were fired a total of 30,000 rounds and driven a total of 12,000 miles. For the modified 175mm gun, only one test item was fired 900 rounds and driven 4,000 miles.

Differences in extent of modifications, mission requirements, or other factors might, we recognize, have called for different test sample sizes. However, explanations of how such factors were considered in establishing the test plan could not be obtained from test records or Board personnel.

Direction determining device

The requirements document for the ARK-1 wild gyro aiming circle--an azimuth determining device--showed a minimum life of 1,000 hours and a mean time between failures of 500 hours. The test plan described how mean time between failures was to be estimated but not how the minimum life was to be estimated.

Two of these instruments were tested a combined total of 65.5 hours. One failure occurred and was easily corrected, but the life of neither instrument was exhausted.

The Board reported that the device would not meet either the required mean time between failures or the required minimum life. We question whether the Board did sufficient testing to establish that the device did not meet the minimum life criteria.

Radar equipment

The AN/MPQ-4A counter-mortar radar's primary mission is to locate enemy mortars. To compute the location, the radar detects enemy firings and measures the flight paths of the incoming shells. The Board's test objective was to demonstrate that the probability of detecting mortar shells in flight was at least 85 percent and that the average error in computing the location of the mortar was no more than 35 meters.

The lower the angle of enemy fire, the more difficult it is for the radar to detect the incoming shells and compute mortar locations accurately. The Board's test plan indicated that the radar had to be capable of accurately locating enemy mortars whose angle of fire was as low as (1) 56 degrees as the minimum requirement and (2) 48 degrees as the desired capability. According to the test report, however, the Board tested the radar with mortars whose angle of fire ranged from 57 degrees to 63 degrees.

Thus, the detection and accuracy capabilities were demonstrated under conditions less difficult than conditions for which operationally effective equipment was required and desired. In its test report, however, the Board concluded that the radar met all test objectives.

Because the Board tested the radar using mortar set at less difficult firing angles than called for, we question whether the test conditions were appropriate to establish that the radar met detection and accuracy criteria.

EVALUATING PRODUCT IMPROVEMENT

Army Regulation 700-35 provides that each proposed product improvement should be evaluated to determine whether the improvement is warranted in view of the cost and time involved to achieve the expected benefits. We question whether the Board adequately evaluated if a proposed cover for the panoramic telescope on a modified howitzer and on an existing howitzer would sufficiently improve the effectiveness of these weapons to warrant the cost involved.

The major difference between the modified self-propelled howitzer M109E1 and the existing howitzer M109 is that the M109E1's tube is about 8 feet longer than the M109's tube. The longer tube was intended to increase the howitzer's range of effective fire.

During operational testing of the M109E1, the Board also tested a telescope cover. The cover was being considered for the M109E1 and the M109 because of telescope failures during operational use of the M109.

The requirements documents and test records did not provide specifics on the types or frequency of failures incurred with the M109 which this cover was intended to reduce. Background data stated the following:

"Numerous deficiencies have been experienced in the field with the panoramic telescope on the M109 howitzer. It is believed that most of the failures have been caused by shock and burst produced by the high efficiency muzzle brake installed on the M109."

The test objectives were to determine whether the cover would reduce telescope failures on the M109 as well as on the M109E1. But, according to the test records, the cover was tested on the M109E1 only.

Three M109E1 howitzers were tested as follows:

| | <u>Rounds</u> <u>Fired</u> | <u>Miles</u> <u>Driven</u> | <u>Failures</u> |
|---------------|-------------------------------|-------------------------------|-----------------|
| With cover | 1,072 | 342 | 0 |
| With cover | 2,869 | 505 | 0 |
| Without cover | 2,079 | 478 | 1 |

In the one failure on the M109E1 which did not have a cover, the telescope's reticle--a focusing device--was out of alignment. However, after it was corrected, the telescope did not fail during 80 percent, or about 1,600, of the test firings.

In its report on the M109E1 test results, the Board concluded that the cover would reduce telescope failures on the M109E1 and apparently would reduce failures occurring with the M109. The Board recommended that the cover be procured and installed on all M109 and M109E1 howitzers.

In the test report section on the telescope cover, the Board stated that overpressure from the muzzle brake was reduced when the covers were used. However, in evaluating the modified howitzer, the Board attributed blast and overpressure reduction to the M109E1's longer tube.

One failure occurring early in testing the uncovered telescope seems inadequate to support a conclusion that the cover is a significant improvement meriting procurement for use on all M109's and M109E1's. The Board's recommendation is especially questionable because (1) no M109 was tested and (2) the suspected cause of failures occurring on M109's may have been remedied by another improvement, i.e., the longer tube for the M109E1.

In November 1971, AMC told us that it has prepared a purchase order in the amount of \$780,000 for 1,400 covers to be installed on the M109E1's and the M109's, but that funds are not available for the procurement.

CONCLUSIONS AND RECOMMENDATION

The weaknesses discussed in this report raise questions on the Artillery Board's evaluations of the operational suitability and worth of new or modified equipment. We recommend that the Army, in cooperation with the Deputy Director of Defense Research and Engineering for Test and Evaluation, select a representative number of ongoing nonmajor equipment acquisitions and assess the requirements documents and plans for operational testing. The purpose is to identify the improvements which might assure (1) realistic criteria for establishing confidence that equipment will satisfy accuracy and other mission requirements, (2) objective determinations of the type and extent of testing needed to show that the equipment meets the criteria for operational suitability, and (3) critical evaluations of whether the equipment's performance and utility are sufficiently improved to warrant the procurement.

Since this report contains a recommendation for your consideration, copies are being sent to the Appropriations and Government Operations Committees of both Houses of the Congress under the provisions of Section 236 of the Legislative Reorganization Act of 1970. Copies of this report are also being sent to the Armed Services Committees, the Director of Defense Research and Engineering, and the Secretary of the Army.

If you desire, we will be glad to discuss these matters in greater detail with you or your staff.

Sincerely yours,



Director

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