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STATEMENT OF

WALTON H. SHELEY, Jr., DIRECTOR

MISSION ANALYSIS AND SYSTEMS ACQUISITION DIVISION

BEFORE THE

SUBCOMMITTEE ON INTERNATIONAL TRADE, FINANCE, AND SECURITY ECONOMICS

JOINT ECONOMIC COMMITTEE

ON

MATTERS RELATING TO THE M1 TANK

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Mr. Chairman, we are pleased to appear before your Committee to present the findings of our latest review of the Army's M-1 tank. As you know, we have been examining the tank's acquisition from its inception.

Previous M-1 Test Results

In January 1980 we reported on the M-1's performance in the mobility tests at Fort Knox which were completed in December 1979. Those were special tests ordered by the Secretary of Defense because earlier testing had shown the tank to be seriously deficient in reliability and durability.

At the conclusion of the 1979 Fort Knox tests, the Army's evaluation showed that the tanks performed well enough to raise the level of mean miles between system failures to 107 and the mean miles between combat mission failures to 299.

A system failure is one which impairs the functioning of the tank but not to the extent that it could not continue in its combat mission. A combat mission failure is one that makes it impossible or imprudent to continue the mission. The results achieved at Fort Knox in 1979 were higher than the Army's goals of 90 mean miles between system failures and 272 mean miles between combat mission failures.

The M-1's durability goal in the Fort Knox testing was .50 and the tanks achieved a level of .44, according to the Army's evaluation. The .50 goal is defined as a 50 percent probability that the tank's power train would operate 4,000

miles without a need to replace the engine, transmission, or final drive--the three major components making up the power train.

We concluded that the test scores were not an accurate barometer of the M-1's reliability. Principally, we felt the tests were not as stressful as operational tests and that the tanks had received the benefits of an inordinate amount of maintenance, not to be expected in a combat environment. We advised waiting until after the third and final round of operational and development testing before reaching a definite conclusion as to the M-1's reliability and durability.

In our January 1980 report, we also recommended that, unless the M-1's turbine engine showed improvement, the Army should start a backup diesel engine development program. The Congress appropriated funds for starting this development and a contract was awarded. However, there are no signs that the Army is interested in further pursuing a backup diesel engine after the current development contract is completed.

Current Test Results

Our latest review covered the M-1's final operational and development testing. For these tests higher reliability goals were established - 101 mean miles between system failures and 320 mean miles between combat mission failures. The durability goal of .50 remained the same. The maintainability goal was to expend no more than 1.25 manhours of maintenance for every hour of tank operation.

Operational testing ran from September 1980 to June 1981. Testing was done at Fort Knox, Kentucky with 4 tanks, and at Fort Hood, Texas with 41 tanks. Development testing, conducted principally at the Aberdeen Proving Ground Center, Maryland, began in September 1980 and is to be completed in January 1982. Some additional development testing was done at several other locations to assess performance in extreme climatic and environmental conditions. The final Army test evaluation reports will not be available for some time. However, we have examined interim reports and made some analyses of our own from the raw test data.

At two of three locations where we observed the tests - Fort Knox, and the Aberdeen Proving Ground Center - the tentative results, as scored by the Army, showed that, generally the M-1 was falling short of achieving most of its reliablilty, durability, and maintainability goals. Although the Army did not measure these parameters at Fort Hood, our own analysis of tests conducted there confirmed the results at the other locations.

The results, in comparison to the goals, are shown in the following tabulation.

Category	Goal	Achieved ---- Fort Knox Tests Completed	Achieved ---- Aberdeen Tests 60% Completed
System reliability (mean miles between failures)	101	130	75
Combat mission reliability (mean miles between failures)	320	304	251
Power train durability (probability of operating 4,000 miles without replacing a major component of the power train)	.50	.15	.34
Maintainability (manhours of maintenance to hours of operation)	1.25 to 1.0	2.86 to 1.0	1.71 to 1.0

Earlier, I referred to the current scores as "tentative". This is because the Army will make one further analysis before publishing the final results. This analysis will probably result in higher achievements than the present scores indicate. For example, in the 1979 test at Fort Knox the analysis resulted in the system reliability score being raised from 94 to 107, and combat mission reliability from 286 to 299. It is conceivable that when the current test scores are similarly analyzed the

final combat mission reliability score will approach or exceed the goal but it is virtually certain that the durability and maintainability goals will not be achieved.

Reliability

At Aberdeen, reliability of the M-1 tanks decreased progressively as they accumulated mileage. The following table shows that the reliability of the three tanks tested there fell further behind the reliability goals after each of five scoring conferences convened by the Army to evaluate the test scores.

		---- SCORING CONFERENCE ----				
	Goal	First	Second	Third	Fourth	Fifth
Accumulated Mileage		3,275	4,588	5,977	8,917	10,984
System Reliability	101	93.6	81.9	76.6	76.0	75.0
Combat Mission Reliability	320	448	428	344	277	251

On the other hand, the Fort Knox results do not show a consistent pattern, as indicated below:

	---- SCORING CONFERENCE ----				
	First	Second	Third	Fourth	Fifth
Accumulated Mileage	1,622	4,244	6,131	9,386	14,026
System Reliability	81	125	109	107	130
Combat Mission Reliability	193	319	296	277	304

We have not completed our analysis of these statistics

and, at this point, are unable to account either for the progressive decline in reliability at Aberdeen, or the sudden improvement during the last 4,600 miles of testing at Fort Knox.

The system and mission reliability statistics developed by the Army were designed to assess the product delivered by the contractor in accordance with certain criteria adopted by the Army. These are not, however, fully indicative of the reliability to be anticipated on the battlefield. The Army's statistics do not consider breakdowns or mishaps which it attributes to crew error during operation, maintenance errors, mishaps resulting from accidents, temporary quality control problems, and breakdowns that could be repaired within 30 minutes.

These mishaps are relevant, however, in assessing the M-1's potential for sustained performance. Therefore, we tabulated the average number of miles the tanks traveled before they had to stop for unscheduled maintenance. The miles traveled were:

	No. of Tanks	Total Miles Traveled	Average Miles Per Tank	Miles Between Stoppages for Unscheduled Maintenance
Aberdeen	3	10,984	3,661	30
Fort Knox	4	14,026	3,506	32
Fort Hood	6	1,702	284	89

The Fort Hood statistics are on six of the total of 41 tanks being tested there that we selected at random to make our

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own analysis, since the Army did not measure reliability at that location. The higher achievement at Fort Hood is undoubtedly due to the very small mileage accumulated there.

Availability

Another assessment of the M-1 tank can be made by comparing it's availability during the tests with the Army's requirement of 92 per cent inherent availability, as stated in its M-1 justification documents. Inherent availability is defined as the relationship of operating time to operating time plus time spent on unscheduled maintenance.

Two other availability measurements are "achieved" and "operational". Achieved availability considers the additional factor of scheduled maintenance and operational availability further considers standby time and down time awaiting logistics support.

The emerging results at the operational test sites show:

	Fort Knox	Fort Hood
Inherent availability	54.2%	86.1%
Achieved availability	48.7	83.2
Operational availability	45.9	48.2

The Aberdeen tests did not measure availability.

The much better showing at Fort Hood in the first two categories, we believe, is again due to the low mileage accumulated by the 41 tanks tested there, compared to the mileage accumulated by the 4 tanks tested at Fort Knox. Consequently, their required maintenance would have been much less, and their

availability much higher. The low operational availability at Fort Hood was due to problems with logistically supporting the tank, principally obtaining replacement parts, and excessive time repairing the tanks due to defective test sets and maintenance manuals.

Durability

Power train durability has declined from the level it achieved in the Fort Knox tests in the previous year. Following is a comparison of power train failures by components experienced in the earlier Fort Knox tests with those experienced in the current tests.

	1979 Tests	Current Tests
Mileage Accumulated	16,070	17,143
Power train failures		
Engine	3	5
Transmission	3	2
Final Drive	0	1
Durability Achieved	.22	.15

This comparison shows the results achieved before the Army's final analysis discussed earlier. In 1979, the analysis doubled the durability score from .22 to .44. It is doubtful that a similar analysis of current durability scores will be sufficient to raise the result to the .50 goal even with the higher .34 score attained at Aberdeen, where testing is 60% complete. To reach the .50 goal will require accumulating more mileage without a durability failure than is planned in the tests remaining.

Maintainability

The most recent series of tests was the first in which the Army attempted to measure the M-1 tank's maintainability. The results show the tank to be below the Army's objective of attaining a level not to exceed 1.25 manhours of maintenance for each hour of operation. The ratios achieved were:

	Fort Knox	Aberdeen
Mileage	14,026	10,984
Maintenance Ratio	2.86 to 1.0	1.71 to 1.0

At Fort Hood we developed a ratio of .31 to 1.0 for unscheduled maintenance for the six tanks we chose at random. This low ratio is, again, due to the low accumulated mileage.

The inadequate test sets and maintenance manuals were also problems at all test locations and have plagued the M-1's maintenance since the tanks were first delivered. The test sets frequently diagnose problems incorrectly. The manuals are frequently incomplete or incorrect. At the Aberdeen Proving Ground the test sets were judged only 65 per cent accurate. Fort Hood personnel judged their accuracy to be much lower. Maintenance personnel at all test sites often relied on their own technical knowledge and instincts in preference to relying on the test sets. It is to be expected that improvements in the manuals and test sets, and improving the delivery of spare parts, along with more experience in maintaining the M-1, will eventually reduce the disppointing maintenance burden to more acceptable levels.

Comparison to M-60 Tank

A question that is often and legitimately asked is whether the M-1's reliability, availability, and maintainability problems are unusually high, or whether they are comparable to problems experienced with the currently deployed M-60 tank. In 1976, a reliability test of tanks, including five new M-60 A1s coming off the production line, was conducted at Fort Hood by the TRADOC Combined Arms Test Activity, the same organization that tested the M-1 at that location this year. The M-60 A1 tank was an improved version containing a newly developed engine and improved track and gun stabilization. Testing was conducted under expected operational conditions and failure criteria were the same as developed for the M-1 tank. The five tanks accumulated a total of 11,292 miles and showed that the M-60 was superior to the M-1 in all test results except for system reliability. Durability, where the M-1 is the weakest, was not scored in these tests. A comparison of the test results follows:

	M-1			M-60 A1
	Fort Hood	Aberdeen	Fort Knox	
Miles Accumulated	25,925	10,984	14,026	11,292
System Reliability (mean miles between failures)		75	130	101
Combat Mission Reliability (mean miles between failures)		251	304	395
Maintainability (manhours of operation)		1.74 to 1.0	2.86 to 1.0	0.41 to 1.0
Inherent Availability (per cent)	86.2	not measured	54.2	92.4
Achieved Availability (per cent)	83.3	"	48.7	87.9
Operational Availability (per cent)	48.4	"	45.9	81.8

M-1's Cost

The cost of the M-1 has increased significantly since its development began. The latest average procurement cost for the 7,058 tanks in the program, as reported by the Army in March, was about $2.5 million per tank.

The program has undergone several changes since it was started. Inflation rates used to estimate costs for the duration of the program have been changed several times. The original quantities have increased from 3,312 to 7,058 and the planned monthly production rates have gone from the original 30 a month to a build-up of 90 a month with a surge capacity

of 150 tanks a month. Another planned change since the program's inception would incorporate the 120mm gun to replace the 105mm gun about 1984. The cost of modifying the tank for this change is included in the current estimate.

A particularly large increase in the program estimate - almost $5.9 billion - was reported in December 1980 over the previous quarter's estimate. The largest portion of the increase, about $4 billion, was due to a change from the data base used early in the program for estimating costs to a new data base consisting of the contractor proposals for the 1979, 1980 and 1981 procurements.

For the future we foresee further significant changes in the M-1 cost estimates. For example, the costs reported in March already reflect lower projected escalation rates than were used in the December estimate. Escalation rate projections may continue to fluctuate.

The rate of production will also be a factor in future cost estimates. The recent infusion of funds into the fiscal year 1982 budget may have enabled the Army to avoid stretching out the procurement of many weapon systems like the M-1 tank, with resulting higher unit costs. But if future funding constraints materialize similar to the one that occurred this year it could again force changes in the production schedule and, in turn, increases in program costs.

Changes in the production schedule will also influence the

number of tanks to be outfitted with the more expensive 120mm gun currently planned to be incorporated in 1984.

M-1 Production

M-1 production has not kept pace with planned deliveries. The tank is being produced at a Government-owned plant in Lima, Ohio, operated by Chrysler Corporation. A second plant, in Warren, Michigan, is being readied for production to start this November. Engines are being produced by AVCO Corporation at Stratford, Connecticut, and the transmissions are produced at Detroit Diesel Allison, a division of General Motors.

Through last month Chrysler was to have delivered 220 tanks but had delivered only 125. AVCO was to have delivered 407 engines but had delivered only 180, including 13 to be used as spares. Allison, after a slow start due to a delay in receiving Government-furnished equipment and tooling, had about caught up with its contract delivery schedule of 397 transmissions.

AVCO told us that it's difficulties stemmed from problems in transitioning from development to production. A spraying operation to permit engines to withstand high temperatures had to be contracted out when AVCO's own equipment was down. Other operations which were to have been automated had to be performed manually pending delivery of certain manufacturing machinery.

Chrysler's contract called for it to begin producing in

excess of 30 a month beginning last March. Chrysler contends that it did not produce to the schedule because it was waiting for more engines to be delivered. However, Chrysler's production in June 1981, a month in which AVCO produced 29 engines, was only 18 tanks.

In summary, while the M-1 tank is impressive in meeting its three major combat requirements--firepower, mobility, and armor protection--these advantages are offset to a considerable degree by shortcomings in most of the so-called RAM-D factors, and by the M-1's rising cost. Engine failures have been more frequent and the maintenance burden is substantially above the Army's desired levels. What concerns us most is that the efforts to improve the durability of the power train do not appear to have made much progress in the past year.

The Department of Defense is to decide in September whether to permit the Army to increase its rate of M-1 procurement above the present limitation of 30 a month. This decision is to be based on the prognosis for the M-1's achieving its RAM-D objectives by the conclusion of the current testing.

We would again urge that the Department of Defense also consider continuing with the development and testing of a back-up diesel engine in view of the failure to improve the turbine to a more acceptable level of durability than a year ago.