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

NATIONAL SECURITY AND
INTERNATIONAL AFFAIRS DIVISION

AUGUST 13, 1985

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General Richard Thompson
Commander, U.S. Army Materiel Command
Department of the Army

Dear General Thompson:

Subject: GAO Concerns About Army Plans to Develop Intermediate Forward Test Equipment (GAO/NSIAD-85-137)

In February 1985, we began a review of Army automatic fault diagnostics equipment. While we have not completed our review, we have identified several concerns that we believe should be considered before awarding the full scale development contract for Intermediate Forward Test Equipment (IFTE).

Specifically, we believe that the Cost and Operational Effectiveness Analysis (COEA) performed to support the decision to award the development contract for IFTE has several shortcomings, including not considering all alternatives, using questionable assumptions, and excluding some applicable costs. Accordingly, we believe awarding the full scale development contract should be delayed until a reassessment of IFTE costs, benefits, and potential alternatives is completed.

IFTE is to be a general purpose automatic tester that will be used to support Army weapons in the forward maintenance area (organizational and direct support). IFTE will be mobile and will consist of a maintenance shop (Base Shop Test Facility) and a portable tester (Contact Test Set). IFTE will be used to screen, detect, and isolate faulty electronic parts. It will be the standard electronic tester at the direct support level of maintenance.

The IFTE concept definition phase is complete, and award of the full scale development contract is planned for September 1985. IFTE research and development cost is expected to be about $51 million. Current plans show IFTE production beginning in March 1988 and initial deployment in December 1989. Production and 20-year support costs are estimated to be about $685 million and $905 million, respectively. Overall, IFTE is expected to cost about $1.6 billion in fiscal year 1985 dollars.

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Efforts to justify and develop standard direct support test equipment began in July 1974. The need for this equipment, however, has been questioned by the Under Secretary of the Army and the Committees on Armed Services of the Senate and House of Representatives. Due to these questions, the Under Secretary of the Army requested an IFTE COEA to be used in the Army's IFTE development In-Process Review. Ostensibly, the COEA was to be the basis for determining whether the program should be continued with awarding of the development contract.

The COEA, completed in late 1984, showed that IFTE was cost effective. The COEA considered the following alternative maintenance concepts to support a "division slice"[1] and the Hawk air defense system: (1) using existing automated test equipment, (2) using no automated test equipment at direct and general support, and (3) developing IFTE and replacing the existing automated test equipment with IFTE. The following costs were compared between the three alternatives:

--stockage cost (the cost of line replaceable units required to be stocked at each level),

--transportation cost (the cost to transport electronic parts to and from depot maintenance),

--test equipment cost (hardware investment and maintenance costs for IFTE and existing test equipment), and

--software development and maintenance costs (software and the maintenance thereof for IFTE and existing test equipment).

For the systems evaluated in the COEA, IFTE is projected to save about $32 million in fiscal year 1985 dollars, when compared with using existing maintenance concepts and test equipment, and about $215 million when compared with using no test equipment at the intermediate levels of maintenance.

We found that IFTE may not be the most cost effective alternative for some weapon systems, since the Army did not consider modifying existing test equipment. Also, the projected IFTE savings will not materialize because much of it was based

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[1]As used in the COEA, a division slice is 11 weapons of a heavy division deployed to the European Theater. The weapons are the Sgt. York, the Multiple Launch Rocket System (MLRS), the Bradley, the Abrams, the Apache, the Blackhawk, the SINCGARS, the Maneuver Control System, the Trailblazer, the TACJAM, and the Teampack.

on questionable assumptions. For example, we question all $17.1 million of the stockage savings on the four systems we reviewed (Abrams, Apache, Hawk, and MLRS).

Additionally, the cost of IFTE will be more than projected because the COEA did not include costs for developing and converting to IFTE. For example, the development costs of IFTE are estimated at $51.1 million. Similarly, the COEA did not include costs for stocking additional printed circuit boards at the direct support levels. This could increase the cost of IFTE since repair parts would have to be stocked at more locations (stockage locations for Abrams could increase by 20 times).

Overall, we question whether the results of the COEA are a valid basis for continuing the IFTE development program.

After discussing our concerns with Army Materiel Command (AMC) personnel, they acknowledged the COEA shortcomings we had identified and agreed that the use of IFTE needed to be reassessed. While they agreed that the COEA had shortcomings, they believed that additional analysis under way in their current reassessment would show that IFTE's use at this level would be cost effective.

We believe that a comprehensive reassessment of IFTE costs, benefits, and alternatives should be completed before awarding the development contract. At a minimum, the reassessment should include an analysis of (1) the costs and advantages of improving built-in diagnostics and existing test equipment, (2) the operational advantages and disadvantages of relying on universal general purpose test equipment instead of dedicated weapon system test equipment, and (3) the cost of converting to IFTE and stocking additional printed circuit boards and related repair parts at direct support.

AMC staff maintained that even if IFTE was not justified for direct support maintenance, it would be needed to provide new technology for use at higher maintenance levels, e.g., echelons above corps. They told us that this was the underlying basis for approving the IFTE development contract. However, we found no approved requirement for IFTE at other levels of maintenance. Additionally, AMC personnel acknowledged that no formal analysis had been made to determine if using IFTE at echelons above corps justified continuing the program.

We did not assess the use of IFTE at higher maintenance levels and the need for new technology. Nevertheless, we believe the need for a system, and its cost effectiveness, should be demonstrated before it is developed. Even if there is

a need for new technology, we do not believe the planned contract which will be based on specifications for a field tester is the most efficient way to acquire this technology. If the Army later decides that a standard field tester is not justified, awarding the proposed IFTE contract would result in wasted expenditures and a less than optimum system for use at other maintenance levels. Therefore, we believe the award of the IFTE development contract should be delayed until the Army performs the necessary analyses to determine if this system is cost effective and how it will be used.

Our objective in assessing the COEA was to determine if it was a valid basis for continuing the IFTE program. Therefore, we limited our review to those alternatives which considered test equipment at the intermediate level of maintenance. When assessing the COEA, we used the following criteria:

--Potential alternatives should be considered.

--Assumptions should be reasonable.

--Input data should be accurate and complete as possible.

--Appropriate costs should be considered.

In applying these criteria, we relied heavily on interviews with and data provided by weapons and test equipment managers and users.

Our review concentrated on the MLRS, the Hawk air defense system, the Apache helicopter, and the Abrams tank, with particular attention being directed to the major costs and savings shown in the COEA for IFTE and existing test equipment. We did not review internal controls or validate the computer models used to project costs and savings. Otherwise, we performed our review in accordance with generally accepted government auditing standards.

The enclosure to this letter describes our concerns with the COEA which we believe should be considered before awarding the contract. We are reporting to you now, even though our work is not completed, because of the planned September contract award.

We are available to discuss these concerns in more detail with you or your staff and would like to be informed of any actions you plan on this program. We are sending copies of this report to the Secretaries of Defense and the Army.

Sincerely yours,

Henry W. Connor
Senior Associate Director

Enclosure

GAO CONCERNS WITH THE ARMY'S INTERMEDIATE FORWARD TEST EQUIPMENT COST AND OPERATIONAL EFFECTIVENESS ANALYSIS

ALTERNATIVES NOT CONSIDERED

The Army's Intermediate Forward Test Equipment (IFTE) Cost and Operational Effectiveness Analysis (COEA) should have considered what may be more cost effective alternatives to IFTE. These alternatives include modifying existing test equipment and improving built-in test capabilities. The COEA considered only the following three alternatives: (1) using existing automated test equipment (ATE), (2) using no ATE at direct support and general support, and (3) developing IFTE and replacing the existing ATE with IFTE.

While the COEA did not consider modifying existing equipment, a U.S. Army Missile Command analysis of Hawk test equipment alternatives disclosed that modifying existing equipment, the GETS 1000, would accomplish what is needed for the Hawk and would cost less than using IFTE. According to this analysis, to modify and support existing Hawk test equipment for 10 years would cost $101.8 million, whereas IFTE would cost $108.5 million for the same period. Thus, according to this analysis, modifying existing Hawk equipment would cost $6.7 million less than IFTE and save $7.5 million.

Army Materiel Command representatives told us that the IFTE Program Manager revised this analysis to reflect a change in the concept of supporting Hawk. According to the revised analysis, IFTE would cost less than improving the GETS 1000 and would save $3 million over 10 years.

We did not assess the reasonableness of assumptions and cost estimates used in these analyses. However, neither analysis included IFTE development costs, and in each analysis the estimated costs and savings were relatively close. Considering the closeness of these estimates, we believe the Army should have considered improving existing test equipment as an alternative to IFTE.

The COEA also did not consider modifying and using the Simplified Test Equipment - Expandable (STE-X) as an alternative to developing the direct support Contact Test Set (CTS), a major component of IFTE.

The STE-X is being developed for organizational maintenance (Army's lowest level of maintenance) and is expected to be the Army standard electronic tester at this level. It will be used by organizational mechanics to confirm readouts from built-in diagnostic equipment and troubleshoot (identify and locate)

failures to the line replaceable unit (LRU) level of repair. The CTS will also be used to troubleshoot failures to the LRU level. The CTS, however, is expected to be more sophisticated and have more capability.

Some Army officials assert that the STE-X would have to be upgraded to perform the diagnostics required to be done by the CTS. In our opinion, even if upgrades are needed, they should not be significant because the testers will be designed to do essentially the same tasks at the same locations, e.g., troubleshoot weapon system failures to faulty LRUs at the organizational level. Nevertheless, upgrading the STE-X may cost less than developing another tester and would reduce the number of testers the Army has to support.

Similarly, the COEA did not consider improving built-in test equipment. However, when assessing alternatives to limit the removal of good LRUs, the Multiple Launch Rocket System (MLRS) project office decided to improve built-in test capabilities instead of adding external test equipment. While in this case the MLRS project office did not consider using IFTE, it did consider using an external "bite-box." MLRS representatives told us that the improvements in the built-in diagnostics cost less than what the bite-box would have cost.

The Apache and Abrams project offices had not independently assessed either IFTE or other alternatives. Generally, they were satisfied with existing test equipment. Abrams representatives told us, however, that the Abrams direct support tester was being modified to accommodate changes being made during the M1A1 Block II Program and that more built-in test would be added. We did not assess how these changes would affect the COEA results but believe the COEA should have considered improving built-in test as an alternative to IFTE.

Consideration of improving existing test equipment is very important because new systems will be designed with more built-in diagnostics, eliminating the need for some external test equipment, particularly at the intermediate maintenance levels.

The new helicopters, for example, are expected to use the latest advances in microelectronics, such as Very Large Scale Integration and Very High Speed Integrated Circuitry (VHSIC). VHSIC technology allows processors to be smaller and weigh less, and they will be more reliable than current technology. Also, the use of VHSIC allows functionally partitioned architectures which permit fault isolation to a chip level, which is internal to the LRU; simplify diagnostics and maintenance; and allow the use of two-level, or "throw-away," support concepts. Under this concept, electronic components will be removed from the aircraft and returned to echelons above corps or depot for repair. This bypasses Aviation Intermediate Maintenance where IFTE is

expected to be deployed. Using this maintenance concept, IFTE would not be needed to support the new helicopters.

PROJECTED SAVINGS ARE BASED ON QUESTIONABLE ASSUMPTIONS

When comparing the three alternatives--(1) using existing ATE, (2) using no ATE at direct support and general support, and (3) replacing existing ATE with IFTE--the COEA considered LRU stockage, intertheater transportation, test equipment, and test program sets (TPSs) development and support. For the alternative of using no ATE at direct support and general support, the COEA also considered costs for additional transportation vehicles and depot labor. The following table shows the Army's costs and projected IFTE savings for using existing ATE versus replacing it with IFTE.

Costs and Projected Savings[a]
Existing Test Equipment and IFTE

Cost Element	Costs: Existing Test Equipment	Costs: IFTE	IFTE Savings
	(millions)		
LRU stockage	$175.0	$150.1	$24.9
Transportation	11.6	8.2	3.4
Test equipment	14.1	6.9	7.2
TPS development and support[b]	8.6	12.4	(3.8)
Total	$209.3	$177.6	$31.7

[a]"Division slice" and Hawk.

[b]Costs are based on COEA briefing charts. The final COEA report presented estimated Army-wide costs for these systems. The COEA analyst acknowledged that this was inconsistent with the other costs. He agreed that the amounts shown in the briefing charts were representative of and consistent with the other COEA costs.

As shown above, most of the projected IFTE savings is in LRU stockage costs. The stockage savings, however, are based on questionable assumptions. Assumptions made in the COEA were as follows:

--The 12 weapons studied would convert to and use IFTE at the direct support maintenance level.

--The weapons and components studied are representative of an Army division.

--Most electronic LRU maintenance will be done at the direct support level using IFTE.

For the four systems we reviewed, the COEA projected that IFTE would save $17.1 million in LRU stockage cost. The following shows by system the amount and primary reason(s) we question all these savings.

System	Amount	Reason(s)
	(millions)	
MLRS	$ 3.2	Use of IFTE conflicts with maintenance concept, and LRUs will be bought before IFTE is available.
Hawk	4.9	LRUs used in the COEA will not or cannot be repaired at direct support.
Abrams	3.6	Users are satisfied with existing direct support equipment, and increases in its capabilities are being considered. LRUs will be bought before IFTE is available.
Apache	5.4	Project manager officials are satisfied with current test equipment, and LRUs will be bought before IFTE is available.
Total	$17.1	

A discussion of the COEA assumptions and the reasons why we question the projected LRU savings follows.

IFTE users will be fewer than projected

The COEA assumed that all weapons studied would use IFTE at the direct support maintenance level. In our opinion, this will not occur because some existing weapons have direct support test equipment that users are satisfied with and other weapons do not need direct support test equipment. Additionally, some of those weapons that need test equipment will have developed, procured, and fielded the test equipment and related support before IFTE is available.

Of the four systems included in our review, the Hawk appears to be the most likely IFTE user. Only the Hawk project office had a Memorandum of Agreement with the IFTE developer, providing specific test requirements. Further, available documentation, i.e., trip reports, correspondence, etc., indicates that Hawk project officials have worked closely with the developer in planning the program and evaluating alternative approaches. The projected Hawk savings will not materialize, however, because only 11 of the 54 LRUs used in the COEA can be repaired at the direct support level.

The other project offices (Abrams, MLRS, and Apache) have no formal plans to convert to IFTE, and their participation in the program appears to have been minimal.

Abrams project office representatives and users told us that they were satisfied with the existing electronic direct support tester and that they saw no need to use IFTE. Presumably, IFTE could be used to test new LRUs resulting from Abrams improvements. However, Abrams representatives told us that the existing direct support tester was being modified to test these LRUs.

Abrams officials also acknowledged that they had no formal plans for converting to IFTE and that their involvement in the program had been limited. They told us that even if Abrams converted to IFTE, the projected savings would not be realized because essentially all the electronic LRUs would have been procured before IFTE was available.

Similarly, Apache and MLRS representatives told us that they were generally satisfied with existing test equipment. They also acknowledged that their participation in the program had been limited and that they had no plans to convert to IFTE. They told us that even if they converted to IFTE, the projected LRU savings would not be realized because the LRUs would be bought before IFTE was available. MLRS representatives explained that some minimal savings might occur in the outyears since procurements for replacements could be reduced. This assumes that IFTE can be used and that it meets all the performance requirements.

Additionally, MLRS representatives have told us that the MLRS Required Operational Capability document prohibits the use of IFTE at direct support. They have also told us that using IFTE conflicts with the MLRS fix-forward concept and "clutters" the battlefield.

The MLRS maintenance concept is rapid repair of the end item through replacement of components. Built-in test identifies the faulty electronic LRU, which is removed and shipped to general support for diagnosis and repair. A good LRU

is used to replace the faulty one immediately after it is removed. This gets the system back in an operational condition quickly, and the shipment and repair of the faulty LRU at general support help reduce the battlefield clutter.

While MLRS officials had not assessed the feasibility and cost effectiveness of using IFTE, they told us that such an assessment would have to be made before converting to IFTE. They told us that they did not oppose the IFTE program, but that they doubted whether it would be practical or cost effective for the MLRS, especially considering that the MLRS would have procured the LRUs and other support items before IFTE was available.

Components may not be representative

While the COEA included systems from each of the maintenance areas--missile, heavy equipment, aviation, etc.--it did not include all LRUs for the systems studied. In some cases, only high cost LRUs were considered, and in other cases, the COEA included items not provided by the project offices.

The Hawk, for example, has 210 electronic LRUs. Yet, only 54 high cost LRUs that are expected to fail frequently were included in the study. The Apache project office submitted 53 LRUs. The COEA considered only 19 of these but added 11 more items which hadn't been submitted by the project office. We noted that 98 percent of the Apache savings is based on these 11 LRUs. Similarly, the Abrams representatives submitted 12 LRUs, but the analysis considered 33 items, including some items that cannot be tested with IFTE, such as a mechanical "gearbox" and electro-optical components. Stockage savings cited for two of the electro-optical LRUs amounted to $900,000 of the $3.6 million total for Abrams.

Project office and study representatives did not know or understand why the COEA had sometimes included items not submitted by the project offices and in other cases had not included all items submitted. Generally, the project offices did not know what LRUs had been used in the study. They assumed that the information they provided had been used and did not know the source of the other information. The analyst who developed LRU stockage costs told us he did not know the reason for the range of LRUs provided by the project offices and those used in the study.

Not all LRU repair will be done at direct support, and repair times may be unrealistic

Generally, the COEA assumed that most electronic LRUs would be repaired at the direct support level. We found that

many of the LRUs included in the analysis would not be repaired this level.

For example, Hawk officials told us that of the 54 Hawk LRUs used in the study, only 11 would be repaired at the direct support level. And these LRUs are already being repaired at the direct support level.

MLRS officials told us that with sufficient facilities, including a "base shop" with a reasonably clean environment, all nine LRUs could be repaired at direct support. However, they acknowledged that with existing facilities and from a cost and operational standpoint, none of the LRUs could or would be repaired at direct support. Additionally, the system contractor's optimum repair level analysis showed that LRU repair would cost more at direct support than at general support, primarily because spares and test equipment would be required at more locations.

Thus, given ideal conditions without considering cost effectiveness, only 20 of 63 LRUs considered for the Hawk and MLRS missile systems can be repaired at direct support, 11 of which are already repaired at this level.

The Apache LRU savings are attributed primarily to 11 of 30 LRUs considered in the COEA. Apache representatives told us that while 10 of these 11 items could be repaired at the Aviation Intermediate Maintenance level, 7 were already being repaired at this level. This means that only three more LRUs could be repaired at this level with IFTE.

Also, when projecting LRU stockage requirements and costs, the COEA analysts used standard repair cycle times of 23, 45, 75, and 150 days for organizational, direct support, general support, and depot maintenance, respectively. However, actual repair times will vary by LRU, and in some cases, the variances could be significant because some LRUs are more sophisticated than others. For example, according to a Hawk sample data collection report, repair times at direct support for 94 different parts ranged from 28 minutes to more than 60 days.

U.S. Army Materiel and Missile Command representatives acknowledged that actual repair cycle times varied by LRU. They also recognized how inappropriate repair times could affect the COEA results. Materiel Command representatives told us that this was one area that would be reviewed in the IFTE reassessment.

COSTS NOT CONSIDERED

The COEA did not consider IFTE development costs; printed circuit board (PCB) and repair parts stockage costs; and

conversion costs, such as costs for retraining equipment users and maintenance personnel, revising system technical manuals and maintenance charts, and translating and validating test equipment software.

IFTE development costs are estimated by the project office at about $51 million.

The cost to stock parts which would enable LRU repair at the direct support maintenance level is hard to quantify. Project office representatives told us that they had not analyzed how IFTE would affect parts stockage and that the information to determine the overall costs for the additional parts was not readily available. But considering the cost of some PCBs and the additional stockage points, the cost to stock repair parts at the direct support level could significantly increase the cost of IFTE.

MLRS representatives, for example, told us that PCB and related parts stockage costs could increase four or five times over the current estimates because of the increase in the number of stockage locations. They explained that while some decreases in stockage might occur at the higher maintenance levels because some work would be done at lower maintenance levels, the overall stockage of PCBs and repair parts would increase substantially. Even with IFTE at direct support, parts will still have to be stocked at general support and depot to handle work load "overflows."

Hawk, Abrams, and Apache representatives also believe overall parts stockage would increase if LRUs were repaired at direct support, primarily because of the need to stock parts at more locations. According to Abrams representatives, increases in PCB and parts stockage could be significant. They told us that the number of Abrams stockage points would increase by 20 times, assuming parts were stocked at all direct support units.

We could not determine how much the additional stockage will cost. But to determine the potential significance of this cost, we identified the PCBs used to repair a few of the LRUs and compared the cost of the LRU with the aggregate cost of the PCBs. The comparisons follow.

System/LRU	LRU Cost	PCBs Number	PCBs Aggregate Cost
Abrams/thermal imaging power control unit	$56,359	7	$40,022
Apache/TADS electronic unit	83,081	11	69,494
Hawk/receiver assembly	18,573	1	2,234
MLRS/electronics unit	134,166	14	92,020
Total	$292,179	33	$203,770

Since we could not determine how many PCBs are needed at the various maintenance levels, we could not project and compare the PCB stockage costs with LRU stockage costs. But, as shown above, the aggregate PCB cost for these four items is about 70 percent of the aggregate LRU cost. This indicates that the additional PCB stockage may significantly increase the cost for IFTE, particularly in those cases where PCBs will have to be stocked at several more locations.

Project offices had not quantified conversion costs, such as costs for training and documentation, and these costs were not included in the COEA. Project office representatives told us, however, that these costs would be significant.

The cost to develop or translate existing test program sets for IFTE could also be significant. A TPS consists of the software, interconnect/interface devices, cables, etc., used with automatic test equipment to fault diagnose electronic LRUs and PCBs.

The COEA assumed that IFTE would be able to use existing software with no modification, with the only additional TPS cost to convert to IFTE being the cost to obtain new interface components. The COEA included no cost for software translation. This is based on the assumption that IFTE will be capable of using all existing software. We question this assumption considering the many different types of test equipment and related software that IFTE is supposed to replace.

Project office representatives acknowledged that the cost to convert existing TPSs could be significant and that it should have been considered in the COEA. For example, the Hawk has 341 different TPSs that are used on 2 different testers. Missile Command representatives estimated that each TPS would cost at least $50,000 to be converted to IFTE. On the basis of this estimate, the Hawk's TPS conversion cost could be more than $17 million.

Although not as substantial, additional costs will be incurred to convert other systems. For example, the Abrams direct support tester does not use the ATLAS language that will be used by IFTE. Converting to ATLAS was estimated by Abrams representatives to cost about $5,000 for each TPS.

The COEA analysts acknowledged that they had not validated the TPS data used in the analysis and that the Army's lack of experience in this area made costing the TPSs and postdeployment software support very difficult. Accordingly, they recognized that no firm conclusion could be reached among the alternatives regarding TPS development and support costs.

We agree with project office representatives who believe that the overall cost to modify or develop TPSs to use IFTE will be significant and that these costs should be included in the reassessment currently being made.