Research Note 84-33

US ARMY FIREFINDER RADARS: A CASE STUDY OF MANPOWER, PERSONNEL AND TRAINING REQUIREMENTS DETERMINATION

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This report describes and analyzes the procedures used to determine manpower, personnel and training (MPT) requirements for the Firefinder Radars (AN/TPQ-36, AN/TPQ-37) and related accomplishment of actual MPT events/documents to those called for in the Life Cycle System Management Model (LCSMM). It addresses concerns being raised about the adequacy and timeliness of the Army's MPT requirements determination procedures.

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FOREWORD

The Army is currently implementing a broadly based force modernization program featuring the introduction of a large number of sophisticated new materiel systems and simultaneous redesign of its force structure (Division 86) in an all-volunteer environment. This ambitious effort places heavy demands on the Army's manpower and training resources. Projected declines in the qualitative and quantitative manpower pool from which the Army must recruit its future soldiers will compound that problem over the next several years.

A necessary early step in coping with the Manpower, Personnel, and Training (MPT) resource problem is the production of an accurate and timely accounting of the number of people and skills needed, system by system and in the aggregate, to operate and maintain new equipment once fielded. To this end, the Army has developed an elaborate materiel acquisition process and a number of regulations and instructions which address the MPT issues to be considered during system development and acquisition. Nevertheless, a number of negative judgements, summarized below and generally supported by previous study findings, have been made about the Army's ability to determine MPT requirements for new systems.

- Tools and techniques for predicting manpower requirements and guidance for their application are both inadequate and unevenly applied.
- The process whereby MPT requirements are documented and transmitted is overly complex, slow, and fails to include

direct early participation of Army personnel community representatives.

- Materiel developers often fail to understand the impact that MPT requirements have on the ultimate cost and operational utility of a new piece of hardware once fielded; consequently, insufficient funds and effort are devoted to MPT analysis and human factors engineering during early stages of system development.

Jointly sponsored by the Defense Systems Management College (DSMC) and the US Army Research Institute for the Behavioral and Social Sciences (ARI), this study effort by Information Spectrum, Inc. under contract MDA 903-81-C-0386 is one of several initiatives designed to respond to concerns being raised about the adequacy and timeliness of the Army's MPT requirements determination procedures. It supports ARI's intensive system manning technology research and development program and DSMC's increased educational emphasis on performance of more effective man-machine tradeoffs during early stages of the materiel acquisition process.

This report is one of five resulting from ISI's research effort. Each of the first four is a case study that describes and analyzes the procedures used to determine MPT requirements for a specific materiel system, and relates accomplishment of actual MPT events/documents to those called for in the Life Cycle System Management Model (LCSMM). A fifth report analyzes findings from the four case studies, draws systemic conclusions, and makes recommendations for improving the MPT requirements determination process.

EXECUTIVE SUMMARY

BACKGROUND

Growing concern with the soldier-machine interface problem, the future manpower pool available to the Army, and the Army's ability to make accurate and timely determinations of the quantitative and qualitative Manpower, Personnel, and Training (MPT) requirements for newly developed systems provided the impetus for the study of several emerging materiel systems. This report examines the FIREFINDER Program, one of four systems selected for study. A comparative analysis report examines the results of the four system case studies, identifies systemic problems with the Army's MPT requirements determination procedures, and recommends solutions to identified deficiencies.

APPROACH

The FIREFINDER Program review was divided into three major phases: literature review, data collection, and data analysis. Official Department of Defense (DOD) and Department of the Army (DA) publications concerning the MPT effort within the system acquisition process were reviewed; earlier and on-going studies were also researched. Specific FIREFINDER Program data was obtained from interviews with and draft and final MPT documentation prepared by Army materiel developers, combat developers, trainers, testers, manpower planners, personnel managers, and logisticians. Data was analyzed within the context of the MPT documents/events identified in the Life Cycle System Management

Model (LCSMM), as modified by the FIREFINDER Program acquisition strategy. Tools and techniques used to determine system MPT requirements were evaluated against those prescribed by the Army. The analysis paid particular attention to how much emphasis was placed on MPT issues in early requirement and contractual documents.

MAJOR FINDINGS

Human Factors Engineering (HFE) had little influence on the design of either radar because neither requests for proposals nor validation/engineering development phase contracts included definitive and/or enforceable HFE requirements. Some of the same HFE problems identified early in the acquisition process remain unresolved.

Manpower, Personnel, and Training (MPT) requirements/constraints were fairly well defined in the system requirements document for each radar, but were not adequately addressed in Requests for Proposals (RFPs), and early development contractual documents.

A significant number of MPT related deficiencies identified in the first operational tests of both radars can be traced to lack of emphasis on Reliability, Availability, and Maintainability (RAM), and a weak Logistic Support Analysis (LSA) effort. Some RAM goals still have not been met, and data thus far generated by LSA is inadequate for confident estimation of quan-

titative maintainance manpower requirements for either radar. Standard, analytically sound tools and techniques which could be used by manpower planners to either fine tune or compensate for weak LSA data are unavailable, thereby compounding the problem of determining maintenance manpower needs in an accurate and timely fashion.

Decisions concerning qualitative manpower requirements for the radars were slow in coming due in large measure to the lack of responsive horizontal communication and coordination among planners in different Army agencies, i.e., DARCOM, TRADOC, and MILPERCEN.

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SECTION I - INTRODUCTION

A. BACKGROUND

Materiel Systems Acquisition programs are the subject of continuing analyses, reviews, and evaluations. The scope and extent of these program appraisals are consistent with the high cost of materiel systems over a life cycle, their impact on operational capability and effectiveness, and their demand on current and future resources. Specific guidelines have been established for development and acquisition of major systems by the Departments of Defense (DOD) and the Army (DA). The process is detailed and involves many management levels.

Despite the detail and depth of documentation and directives governing the acquisition process, problems regarding establishment of manpower requirements and their true cost have been prevalent. Sufficient numbers of properly trained personnel are essential to operate, maintain, and support current and future materiel systems. The improvements in these systems offered by new technology, a corresponding requirement for more highly skilled personnel, the steady upward trend in operating and support costs, and the projected reduced availability of the recruitable population demand a close and early look at manpower requirements for materiel systems under development to measure both supportability and affordability.

A number of previous studies, some of which are cited below, have highlighted problems associated with the determination of

Manpower, Personnel, and Training (MPT) requirements for new systems.

1. In December 1978, the Logistics Management Institute concluded a study of manpower planning for new weapon systems for the Assistant Secretary of Defense, Manpower, Reserve Affairs, and Logistics (ASD, MRA&L), complemented by seven case studies. Two of these concerned Army systems, i.e., TACFIRE and Patriot.[1] Significant findings from that study included the following:

- o Most estimates of manpower requirements made during acquisition programs are too low.
- o Operating and support concepts are likely to vary throughout the acquisition process, causing fluctuations in the estimates of manpower requirements.
- o There is greater uncertainty associated with maintenance manning than with any other element of new weapon system manpower requirements.
- o Estimates of new system manpower requirements frequently reflect program goals rather than unbiased assessments of manpower needs.
- o Manpower goals or constraints established for new systems have addressed only the aggregate manning of the using unit, not total manpower or skill level requirements.
- o Controlling training requirements can be as important as constraining manning levels.
- o Operational test and evaluation conducted prior to DSARC III does not normally test the intermediate level of maintenance support.

2. In August 1980, Generals Walter T. Kerwin and George S. Blanchard prepared a discussion paper for the Army Chief of Staff

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[1]Betaque, Norman E., Jr., et al, Manpower Planning for New Weapon Systems, WN ML 801-1 Through WN ML 801-9. Logistics Management Institute. July - December 1978.

concerning the soldier-machine interface (SMI) problem.[2] In that report, Generals Kerwin and Blanchard stated,

> "The Army has made some progress in dealing with this problem. Many efforts are underway. However, these efforts, while representing steps in the right direction, are fragmented, based on reactions rather than vision, and, to a large extent, individually initiated. In our opinion, these efforts will fall short in coping with the extent of the problem in time to have an impact in the near term. Significant improvement will not occur quickly unless efforts are integrated, the personnel and doctrine people become more actively involved early in the materiel development process, and the Army addresses man/machine interface in its broadest sense and begins to think tactical system develop ment in lieu of individual materiel development, individual people development and individual support development."

Specific observations presented in the report included:

- The Life Cycle System Management Model (LCSMM) must be disciplined concerning the manpower, personnel, training and logistics aspects of the process. Qualitative and Quantitative Personnel Requirements Information (QQPRI) and Basis of Issue Plans (BOIP) were singled out as examples.
- Careful consideration of MPT impacts must precede any variation in strategy which skips a phase of development for the purpose of achieving an early initial Operational Capability (IOC).
- Better utilization of and improvements in the QQPRI process are needed.
- MPT requirements must be better defined during concept evaluation.
- System development programs must recognize training constraints and employ sophisticated techniques to reduce training requirements.
- Human Factors Analysis and Engineering must become a mandated part of system development early in the cycle.

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[2]Blanchard, George S. & Kerwin, Walter T., Man/Machine Interface - A Growing Crisis, Army Top Problem Areas, Discussion Paper Number 2, August 1980.

- o PMs and TSMs must increase their emphasis on the MPT features of the Integrated Logistics Support (ILS) process.
- o The personnel community must become an active, rather than reactive, part of the acquisition process.

3. Some of the problems with the BOIP/QQPRI process identified by Generals Kerwin and Blanchard, were also discussed in a 7 January 1980 report by the Army Force Modernization Coordination Office (AFMCO).[3] In its examination, the BOIP/QQPRI Task Force reviewed the status of 76 new systems and found that of these 76, the BOIP/QQPRIs were late in 29 of the systems by an average of 19.5 months. Note: the task force considered current status of the primary item only, it did not consider associated equipment; Test, Measurement, and Diagnostic Equipment (TMDE); or training devices. Nor did the task force consider BOIP/QQPRI quality.

Regarding the impact of the late BOIP/QQPRI, the task force stated:

> "When the BOIP/QQPRI are not submitted on time, there is a high probability that the fielded system will be inadequately supported. At a low intensity of modernization there is some opportunity to offset late BOIP/QQPRI by shifting personnel and materiel resources to take advantage of other system delays and the general phase-in of equipment. However, the increased in tensity of modernization during the next four to five years will not allow this opportunity. In short, twenty-nine of the Army Modernization Information Memorandum (AMIM) systems to be fielded in the next three years may not be adequately supported in the field."

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[3] HQDA, Office of the Chief of Staff, BOIP/QQPRI Task Force Report, 9 January 1980.

The report goes on to say:

> "There are many reasons for the number of late BOIP/QQPRI in the set of systems the task force examined. Part of the reason is a failure to adequately discipline the system. In many cases it is due to inadequate priorities being assigned to the extreme importance and value of the system with a consequent under resourcing of manpower at all levels. Above all, there exists no mechanism to centrally manage and police the preparation and submission of the BOIP/QQPRI."

4. A previous ISI study conducted for ARI,[4] identified and analyzed the MPT information required to be generated by the Army's LCSMM process. That study concluded that, if properly prepared in the sequence stipulated, MPT information should be adequate to meet LCSMM milestone goals. However, it also confirmed findings of other studies that the information generated in preparation for recent Army and Defense System Acquisition Review Council (ASARC/DSARC) reviews had been inadequate in some quality and timeliness of MPT planning and programming during the LCSMM process.

5. In January 1981, amid growing concern that its materiel systems are becoming too complex, HQDA directed U.S. Army Training and Doctrine Command (TRADOC) to lead an internal Army study to assess the impact of the SMI on total systems management and how the Army can better match men, skills, and machines.[5] The study was designed to either validate or recommend revision

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[4]Rhode, Alfred S., et al, Manpower, Personnel and Training Requirements for Materiel System Acquisition, ARI, February 1980.

[5]HQDA, Soldier-Machine Interface Requirements (Complexity) Study, January 1982.

to the existing materiel system acquisition procedures to insure that the Army pursues the best possible course to match men, skills, and machines during the next decade.

To accomplish the task, the study addressed in a very broad sense 30 different systems representative of most system types in various mission areas. Further, for each system, the study addressed all system-specific tasks associated with the immediate soldier-machine interface at operator; maintainer, and repairer (through GS) levels.

Since the objectives of that complexity study were similar to those of this effort, coordination was established with the complexity study team and information exchanged.

B. PURPOSE

This is one of four historical case studies dealing with Manpower, Personnel, and Training problems associated with the Army's acquisition of the following materiel systems.

- o AN/TYC-39 Message Switch & AN/TTC-39 Circuit Switch (TCC-39 Program)
- o Multiple Launch Rocket System (MLRS)
- o UH-60A Helicopter (BLACKHAWK)
- o AN/TPW-36 Mortar Locating Radar & AN/TPQ-37 Artillery Locating Radar (FIREFINDER)

Each case study examines the Army's ability to comply with its stated MPT requirements determination procedures during the development of specific systems, and assesses the timeliness and

quality of the MPT products. A fifth report, which accompanies these case studies, analyzes the four systems, identifying similarities and differences in the acquisition process and drawing comparisons where appropriate. It is stressed that the principal objective is to examine when and how well MPT requirements were developed and expressed, particularly during the early stages of system development.

C. APPROACH

1. System Selection

The systems selected for study represent a cross section of Army combat development mission areas, e.g., Fire Support (MLRS), Aviation (BLACKHAWK), Tactical Surveillance, Reconnaissance, and Target Acquisition (FIREFINDER), and Communications (AN/TTC-39 Program). Each of the systems selected has a high development priority and is well along in the acquisition process, thus permitting a more comprehensive examination of actual MPT events and documentation. Availability of US Army Materiel Development and Readiness Command (DARCOM) Project Managers (PM) and US Army Training and Doctrine Command (TRADOC) System Managers (TSM) to interact with study team members also influenced the choice of systems.

2. Scope

For each system case study, actual MPT events/documents and organizational elements responsible for their accomplishment are identified down to subordinate elements within DARCOM and the

subordinate proponent school level within TRADOC.

Occurrence of events are portrayed in time relative to the sequence called for in the Life Cycle Systems Management Model (LCSMM).[6] The May 1975 LCSMM was used as a baseline although some early acquisition stages in the systems examined began prior to that date. Tools and techniques used to generate MPT requirements are described and their value assessed. Qualitative and quantitative changes in MPT requirements are tracked, beginning with the initial establishment of system need and continuing through the latest completed event in the system's acquisition process. Reasons for such changes are also stated in those instances where data availability permitted such a determination to be made.

Where possible, the adequacy and timeliness of MPT information are assessed to determine whether ASARC; DSARC; Planning, Programming, and Budgeting System (PPBS); and fielding needs were met. If not, reasons for such deficiencies and their impact are stated.

The fifth report identifies and analyzes differences in when and how well MPT requirements were developed and expressed. The reasons for and impact, if any, of the identified differences are assessed to identify particularly effective/ineffective approaches to generation of MPT data; common problems and lessons learned are also highlighted. Recommendations for correction of identi-

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[6]HQDA, Pamphlet No. 11-25, Life Cycle System Management Model for Army Systems, May 1975.

fied deficiencies are made, taking into account significant efforts either recently completed or currently underway by the Department of Defense (DOD) and the Army to improve the MPT requirements determination process, e.g., Carlucci initiatives; changes in Army policies and procedures for processing QQPRI and BOIP (AR 70-2); and staffing a proposed new Military Standard for Weapon System and Equipment Support Analysis (MIL-STD-1388A).

The research effort was divided into three major phases: Literature Review; Data Collection; and Data Processing and Analysis.

3. Literature Review

The study effort began with a review of literature pertinent to the development and expression of MPT requirements for new materiel systems. It included an examination of policies and procedures promulgated by DOD; Headquarters, Department of the Army (HQDA); Headquarters, DARCOM; and Headquarters, TRADOC. Related study efforts and research reports such as those mentioned in paragraph A, supra, were also reviewed for background, ideas for data gathering and analysis methods, and to avoid unnecessary overlap and duplication of earlier efforts. Major policy and procedural document sources examined during this review are cited in Appendix A.

4. Data Collection

The evolution of MPT information for the FIREFINDER Program in response to materiel development policies and procedures,

including the LCSMM and the Integrated Logistics Support Management Model (ILSMM) processes, was tracked through each phase of the acquisition process. Data was gathered through examination of draft and final MPT documents and face-to-face interviews with Subject Matter Experts (SME) representing combat/materiel deve lopers, trainers, testers, manpower/personnel planners, and personnel managers. Data cutoff was 31 May 1982. Specific organizational elements contacted during the collection effort are identified in Appendix B. The major MPT source documents are listed in Appendix C.

5. Analysis

Information collected was cataloged and analyzed across acquisition milestones, measured against MPT data requirements in the LCSMM, and where appropriate, compared with like or similar systems; basic criteria for analysis were timeliness and adequacy of data relative to LCSMM and Army regulatory standards. The criteria were applied in examining the following major issues.

- Tools, techniques, and standards used to compute and express MPT requirements and tradeoffs.
- MPT requirements documentation and flow of information to decision makers.
- The acquisition process itself, in terms of MPT requirements determination.

II. SYSTEM SUMMARY

A. REQUIREMENT

1. Introduction

The FIREFINDER system consists of two radars, the AN/TPQ-36 mortar locating radar and the AN/TPQ-37 artillery locating radar. Five of these new radars (three AN/TPQ-36s and two AN/TPQ-37s) will replace the obsolete AN/MPQ-4A radars in the Target Acquisition Battery (TAB) of each Army Division on a one for one basis. In addition, the AN/TPQ-36 will be issued to the field artillery battalion of each separate brigade.

The two radars are designed to complement each other in the process of locating hostile indirect fire units. The AN/TPQ-36 will detect and locate mortars and short range artillery and rocket systems. The AN/TPQ-37 will detect and locate enemy short and long range artillery and rocket systems. Additionally, both radars will have the capability or registering and adjusting friendly fires. Sketches identifying the major components of the two radar sections are shown in Figure II-1.[7]

2. AN/TPQ-36 Mortar Locating Radar

In 1967, the Army established a high priority for initiation of the development of a 360-degree mortar locating radar for use in Vietnam. The resulting AN/TPQ-28, though not deployed because

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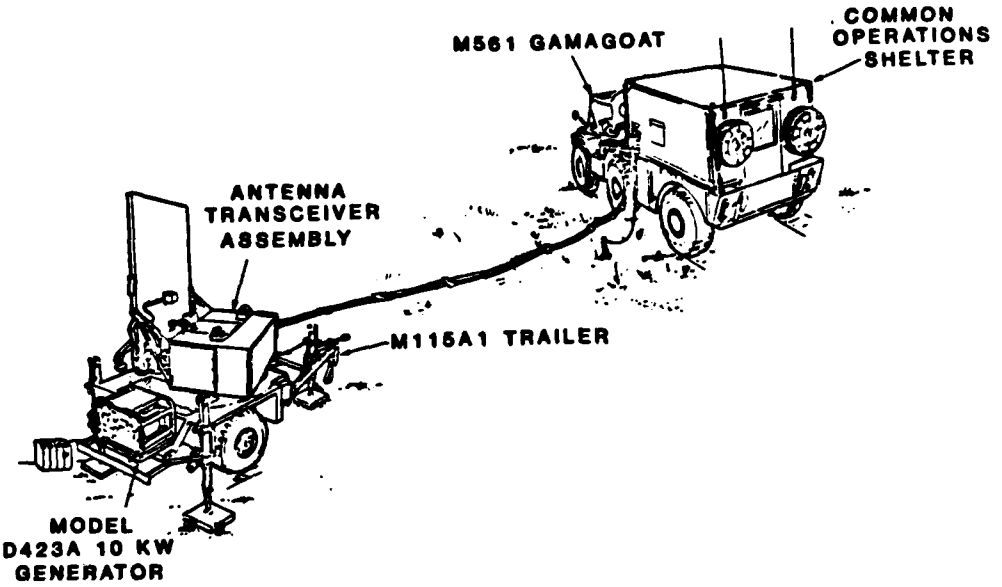
[7] Based on operational test results, some of the vehicles and trailers shown have been replaced.

AN/TPQ-36



AN/TPQ-37

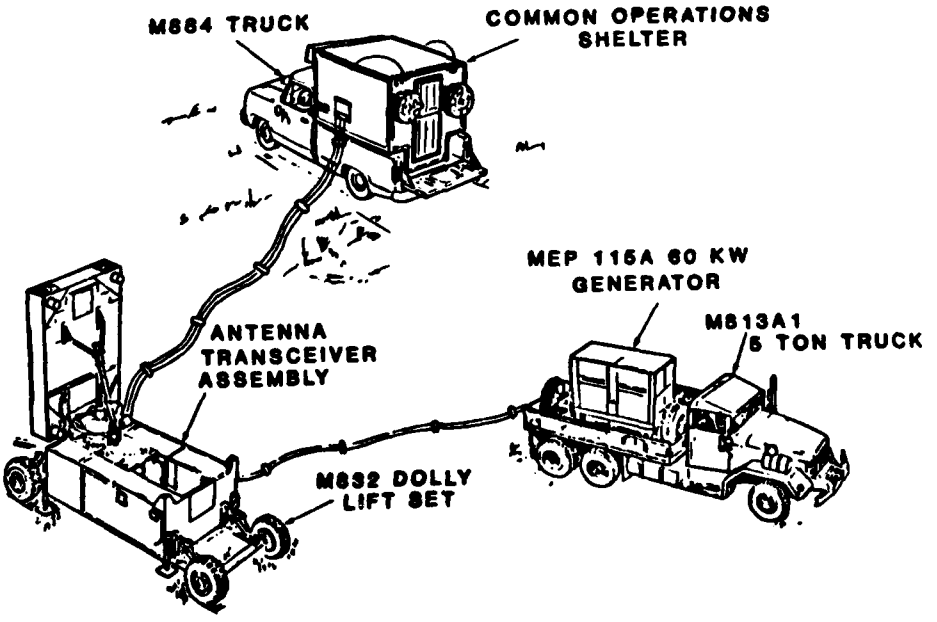


FIGURE II-1

of technical problems, demonstrated the feasibility of a fully automatic weapons locating radar. A HQDA approved Materiel Need, based on the AN/TPQ-28 characteristics, was published in November 1971.

The AN/TPQ-36, Mortar Locating Radar project was approved for development early in 1972. The program objective was to develop and field a radar system capable of meeting the Army's requirements for detecting and locating enemy weapons with sufficient speed and accuracy to permit rapid and effective engagement by friendly counterfire. The AN/MPQ-4A, which the AN/TPQ-36 will replace on a one-for-one basis, was placed in service in 1958. It uses vacuum tube technology, an analog computer, mechanical scanning, and unsophisticated extrapolation techniques; it also has significant operational shortcomings that include a small angle of coverage, manual target location entailing constant operator alertness, and degraded performance in inclement weather.

3. AN/TPQ-37, Artillery Locating Radar

After the AN/MPQ-10 was replaced as the Army's Mortar Locator in 1958, it was redesignated as an Artillery Locator. However, it was never effective as such, and was subsequently classified obsolete. The AN/MPQ-4 was used in a limited capacity against artillery in Vietnam, but proved to be no more effective than the AN/MPQ-10.

In 1966, development of an artillery locating radar resulted in the AN/MPQ-32. This was a mechanical scan radar which could not meet performance requirements that were then beyond the state-of-the-art. Study efforts were initiated to determine the feasibility of an artillery locating radar and to define realistic and attainable performance characteristics. From these studies, the design and performance characteristics were developed that became the basis for the AN/TPQ-37.

The need for an artillery locating radar system was recognized by the Army Scientific Advisory Panel (Committee for Artillery Locating Radar) which recommended that the Army proceed with an expedited development program. Such approval was given by HQDA in August 1971, and the Department of the Army Approved Materiel Need (MN) for Radar, Artillery Locating was promulgated by the U.S. Army Combat Developments Command in July 1972.

B. ACQUISITION STRATEGY

1. AN/TPQ-36

Because most of the Conceptual and Advanced Development efforts had already been accomplished during the AN/TPQ-28 effort, the AN/TPQ-36 project went directly into Engineering Development with the award of a contract to the Hughes Aircraft Company in October 1973. (The delay from MN approval to contract award was due to a period of litigation.). Testing of the Hughes systems, including a 1976 comparative test with the USMC Heavy Weapons Locating System (HWLS) was completed in 1977.

The ASARC III (AN/TPQ-36 did not require a DSARC because it was below the major program threshold) authorized Full Scale Production. A three-year contract for 154 systems for the Army and Marine Corps was awarded to Hughes in August 1978.

Two AN/TPQ-36 Engineering Development models have been in the field in Europe since October 1978 for testing. IOC was achieved in May 1982 and a FDTE for both the AN/TPQ-36 and AN/TPQ-37 was conducted in December 1981.

The AN/TPQ-36 acquisition process varied significantly from the standard LCSMM. This was largely due to the earlier efforts with the AN/TPQ-28 and confidence that the state-of-the-art was in hand and that development risk was low.

Figure II-2 depicts the AN/TPQ-36 Acquisition Milestones.

2. AN/TPQ-37

Because of the results of earlier study efforts, the AN/TPQ-37 project was initiated in June 1972 with a competitive Advanced Development Phase involving the Hughes Aircraft Company (HAC) and the Sperry Gyroscope Division of Speery Rand Corp. Competing radars were delivered to the government late in 1974 and, following DT/OT-I, HAC was selected to continue the project. The contract for an expedited Modification and Refurbishment Phase (originally planned to last 14 months but shortened by Congressional action) was awarded in May 1976. Only five months later, in October 1976, the Low Rate Initial Production (LRIP) decision

AN/TPQ-36 ACQUISITION MILESTONES

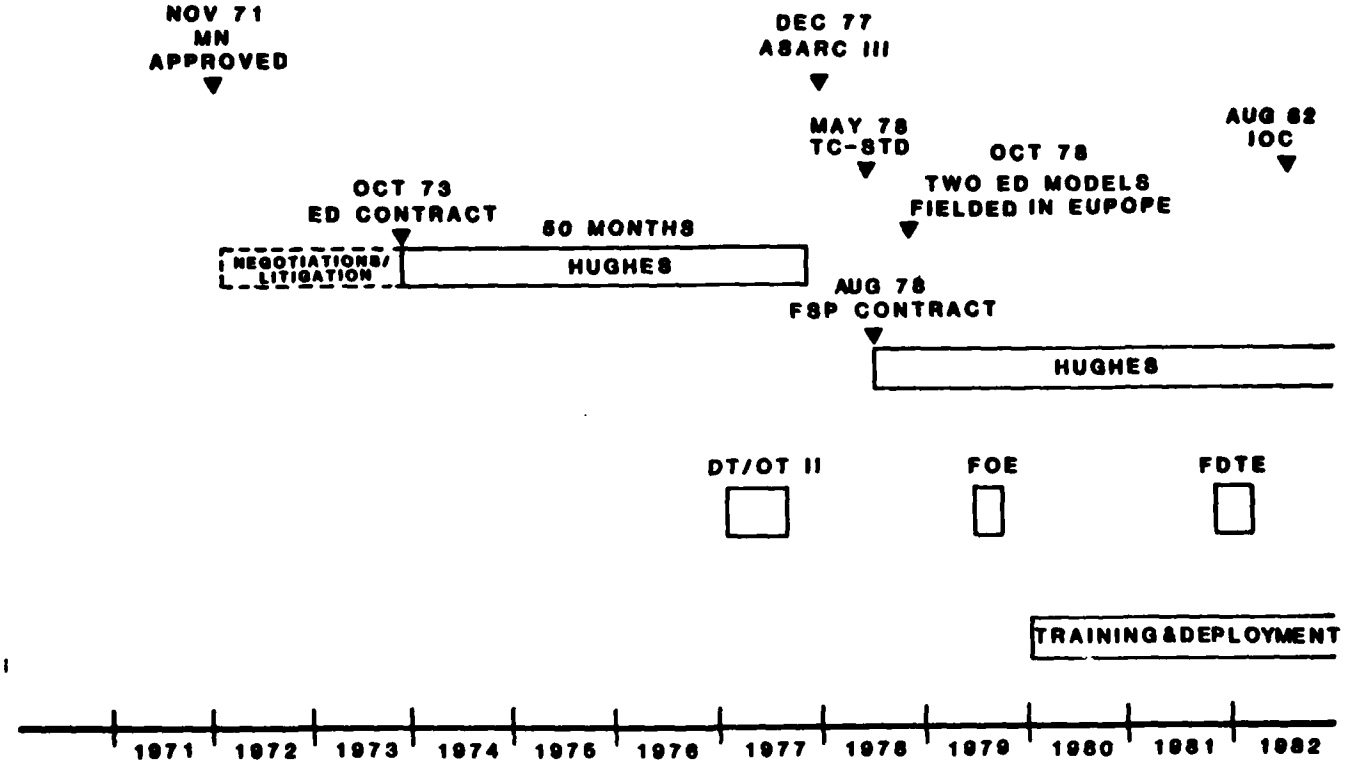


FIGURE II-2

was made by the ASARC II/III and contractual go-ahead was given in December. The project did not have a formal Engineering Development Phase. Full Scale Production and type classification-standard was authorized by the ASARC IIIa that met in February 1981.[8]

The radar has followed an unconventional accelerated development process and events have not occurred in their normal sequence. In spite of a low technical risk and acceleration of the schedule, the project will have taken 8 years and 6 months to reach IOC. Figure II-3 shows the AN/TPQ-37 acquisition milestones.

HQDARCOM granted the conditional release of two AN/TPQ-37s to the 1st Cavalry Division in December 1980 (IOC). The conditional determination was based on the fact that test and evaluation were incomplete, the ILS package was incomplete, there were performance restrictions, and the published manuals were not available. The December 1980 IOC for the AN/TPQ-37 actually represented retention of test assets (two radars) by the OT III activity and did not require staging, provisioning, new equipment training, or hand-off procedures. Early IOC was an intentional effort by the PM FIREFINDER to get radars in the hands of troops as soon as possible, shake-out problems, and make corrections in subsequent production models. The conditional release of eight AN/TPQ-37s

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[8] DSARC not required for AN/TPQ-37

AN/TPQ-37 ACQUISITION MILESTONES

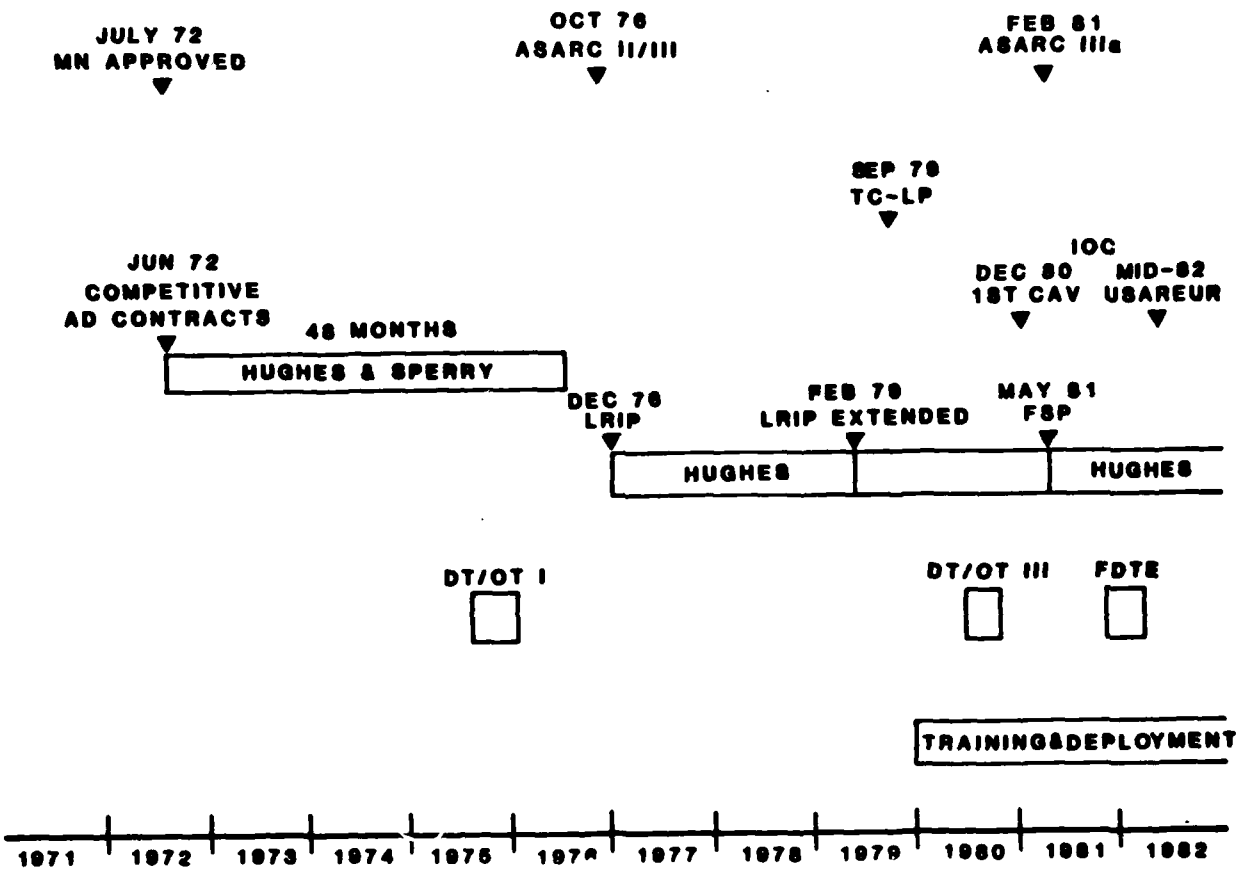

FIGURE II-3

was granted by DARCOM in December 1981 for issue to the using units in Europe. Full release (unconditional) of the AN/TPQ-37 is not expected until the first quarter of FY 84.

3. Figure II-4 compares the acquisition strategies for the two radars.

C. SYSTEM DESCRIPTION

1. Commonalities

Figure II-5 lists the equipments that are common to the AN/TPQ-36 and AN/TPQ-37 radars and the design features common to both. In addition, the FIREFINDER Radar Crewman, MOS 13R10; The FIREFINDER Radar Mechanic, MOS 13R10X5; and the FIREFINDER DS Mechanic, MOS 26B20K1 will be trained to operate and/or maintain both radars.

2. AN/TPQ-36

The AN/TPQ-36 is a highly mobile phased array radar which automatically locates hostile mortar and other high angle fire weapons and shortrange rockets. Its automation provides the capability of locating weapons firing simultaneously from multiple positions. The radar can be used to register and adjust friendly artillery fire. Using a combination of radar techniques and computer controlled signal processing, the Mortar Locating Radar detects, verifies, tracks projectiles in flight, and extrapolates the tracked data points to the location from which

FIREFINDER RADARS
ACQUISITION STRATEGY

AN/TPQ-36

- ACCELERATED PROGRAM
- OMITTED CONCEPT & ADV DEV PHASES
- COMMENCED WITH ENGR DEV PHASE
- SKIPPED LRIP
- FSP AUTHORIZED BY ASARC III
- HAD DT/OT II AND FOE
- TIME TO IOC: 106 MONTHS (AUG 82)

AN/TPQ-37

- ACCELERATED PROGRAM
- OMITTED CONCEPT PHASE
- COMMENCED WITH COMPETITIVE ADV PHASE
- SKIPPED ENGR DEV PHASE
- LRIP AUTHORIZED BY ASARC II/III
- FSP AUTHORIZED BY ASARC IIIa
- HAD DT/OT I AND DT/OT III
- TIME TO IOC: 102 MONTHS

FIGURE II-4

FIREFINDER RADARS CHARACTERISTICS

AN/TPQ-36

REPLACE THREE AN/MPQ-4A IN DIV TAB

CREW - 8

VEHICLES/TRAILERS - 2/2

EMPLACEMENT - 15 MIN

DISPLACEMENT - 5 MIN

AUTOMATICALLY LOCATES
- Mortars
- Other High Angle Fire Wpns
- Shortrange Rocket Lchrs
- Weapons Firing Simultaneously From Multiple Positions

CAN REGISTER & ADJUST FRIENDLY FIRE

CONTRACTOR - HUGHES AIRCRAFT CO

AN/TPQ-37

REPLACE TWO AN/MPQ-4A IN DIV TAB

CREW - 12

VEHICLES/TRAILERS - 3/2

EMPLACEMENT - 30 MIN

DISPLACEMENT - 15 MIN

AUTOMATICALLY LOCATES
- Artillery
- Rocket Lchrs
- Weapons Firing Simultaneously From Multiple Positions

CAN REGISTER & ADJUST FRIENDLY FIRES

CONTRACTOR - HUGHES AIRCRAFT CO

COMMONALITIES

OPERATIONS CONTROL GROUP
S-250 SHELTER
OP/ORG/DS/GS MOS
TRAINING & TRAINING DEVICES
MAINTENANCE CONCEPT
SUPPORT CONCEPT
MANY PCBs

FIGURE II-5

the projectile was fired. After correcting for altitude, the location is automatically formatted for transmission to the supported artillery fire direction center.

The Mortar Locating Radar AN/TPQ-36 consists of an Operational Control Group housed in an S-250 shelter and mounted on a 5/4 ton truck. An Antenna-Transceiver Group, and a Model D423A Generator Set (lightweight 10 kilowatt 400-hertz generator), are mounted on 1 1/2 ton trailer. The Antenna-Transceiver Group includes the antenna and associated electronics, the transmitter, and the receiver. The S-250 shelter provides space for the operation of the radar and includes the majority of the data processing hardware. The shelter and the antenna trailer subassemblies can be transported by medium lift helicopter.

3. AN/TPQ-37

The Artillery Locating Radar, AN/TPQ-37, will detect and locate enemy short and long range artillery and rocket weapons with sufficient timeliness and accuracy to permit immediate engagement by friendly counterfire. The radar locates weapon positions by automatically detecting and tracking a projectile to determine the point of origin. The weapon location is then displayed to the radar operator and can be automatically formatted and digitally transmitted to the supported artillery fire direction center, stored by the radar's computer, or deleted as the situation dictates. The radar is also capable of registering and adjusting friendly indirect fire when required. The

AN/TPQ-37 uses a combination of radar techniques and computer-controlled signal processing to perform the detection, verification, and tracking functions. The phased-array antenna allows the radar to switch beam positions electronically, thus providing a capability to search for new targets while simultaneously tracking targets already detected. It also enables the radar to detect and locate weapons firing simultaneously from multiple positions. The system is designed to provide sufficient track data to locate firing positions from the first detected round at ranges from 3 km to 50 km depending on the weapon type.

The Artillery Locating Radar AN/TPQ-37 consists of an Operations Control Group (identical to that of the AN/TPQ-36), an Antenna-Transceiver Group, a Generator-Power Distribution Group, and the Secondary Emitter. The Operations Control Group S-250 shelter (same as that used with the AN/TPQ-36) houses the data processing electronics and display and control equipment. The Power Distribution Group, (60 KW diesel generator) is mounted on a 5-ton truck which tows the Antenna-Transceiver Group trailer.

D. ORGANIZATIONAL AND OPERATIONAL CONCEPT

1. Introduction

The two radars will replace the AN/MPQ-4 on a one-for-one basis. Three AN/TPQ-36s replace three AN/MPQ-4s and two AN/TPQ-37s replace two AN/MPQ-4s in the Target Acquisition Battery of each Active and National Guard Division. In addition, one

AN/TPQ-36 will be distributed to each Direct Support Artillery Battalion supporting the Separate Brigades of the Active Army and the National Guard. In addition, the U.S. Marine Corps will employ the AN/TPQ-36 to satisfy its requirement for a Hostile Weapons Locating System.

2. AN/TPQ-36

a. Organization

The mobility and operational profile of the AN/TPQ-36 allows it to be deployed close to the Forward Line of Troops (FLT) with direct support artillery battalions. Its weapon locating capability will complement the longer range artillery locating capability of the AN/TPQ-37.

The AN/TPQ-36 radar section will be organized as follows:

Table II-1

AN/TPQ-36 RADAR SECTION-CURRENT

Title	Grade	MOS	Quantity
Radar Technician	WO	211A	1
Radar Section Chief	E6	13R30	1
Senior Radar Operator	E5	13R20	1
Radar Operator	E3/E4	13R10	4
Radar Mechanic	E4	13R10X5	1
			8*

* Same number of personnel as required for the AN/MPQ-4 Radar which it replaces.

b. Operations

AN/TPQ-36 radar sections are normally attached to each of the three direct support (DS) field artillery battalions of the Division Artillery. Attachment is done on a habitual association basis in order to promote ease of unit operations. The DS field artillery battalion may further attach the section to a subordinate firing battery or retain control of the section at headquarters level. In either case, the designated battalion is responsible for providing the attached radar section administrative and logistical support and survey and communications support as required.

In order to enhance survivability, it is envisioned that the radars will normally be in a non-radiating standby (ready) mode and must be cued to initiate radiation. The controlling headquarters will use reports from other battlefield sensors, surveillance devices, and observers, as well as maneuver unit requests, to direct the radars to radiate. After a specified radiation period (normally no more than 2 minutes), the radar will cease radiation and return to the non-radiating standby mode.

Radar sections will move to new locations in conjunction with and as part of displacements of the supported unit (or at least the movement of the battalion/battery to which attached). The radar sections may be forced or directed to move to alternative locations due to actual or suspected enemy acquisition, or

engagement by enemy fires. The mortar locating radar is light weight, highly mobile, and capable of moving several times in a 24 hour period.

Individual radar sections are incapable of providing more than the most basic self defense. Comprehensive security is obtained primarily through good camouflage and concealment practices and coordinating defense with nearby units. In a highly fluid environment characterized by large scale enemy small unit infiltration and/or guerrilla activities, the radar section should be deployed within the defense perimeter of the supported unit or be provided with augmentation security support.

3. AN/TPQ-37

a. Organization

Each AN/TPQ-37 radar section is functionally organized to provide independent weapons locating support to a designated field artillery headquarters. The Division Artillery may allocate radars to subordinate units by means of attachment of individual radar sections if deployment and positioning considerations warrant. Attached radar sections are provided administrative and logistical support by the unit to which they are attached.

The following personnel are required as AN/TPQ-37 radar crew members.

Table II-2

AN/TPQ-37 RADAR SECTION-CURRENT

Title	Grade	MOS	Quantity
Radar Technician	WO	211A	1
Radar Section Chief	E6	13R30	1
Senior Radar Operator	E5	13R20	1
FIREFINDER Radar Mechanic	E4	13R10X5	1
Radar Operator	E3/E4	13R10	7
Generator Operator/Repairer	E4	63B10	1
		TOTAL (per AN/TPQ-37)	12

b. Operations

Control of division counterfire efforts, to include target acquisition means, rests with the Division Artillery Commander. The two AN/TPQ-37s in each TAB will be positioned 10-12KM behind, the Forward Line of Troops (FLT) in support of a division. Each radiation period of the AN/TPQ-37 radar is cued in accordance with the overall counterfire plan.

Survivability of the radars is enhanced by normally placing them in a non-radiating standby (ready) mode from which they must be cued to initiate radiation. Also, radiation periods will be kept short, insofar as possible.

An AN/TPQ-37 in normal combat operations will displace approximately four times per day and average 8 miles per move. During a 24 hour operational day, each system will normally be in operation 14 hours per day, not including displacement/movement/emplacement time and scheduled down time.

Individual radar sections are incapable of providing more than the most basic self defense. More comprehensive security is obtained primarily through good camouflage and concealment practices and coordinating defense with nearby units or, in case of enemy infiltration, deployment within the defense perimeter of the supported unit.

E. MAINTENANCE AND SUPPORT CONCEPTS

1. Maintenance

The FIREFINDER maintenance plan utilizes the four standard levels of support: organizational, direct support, general support, and depot.

a. Organizational maintenance.

(1) Operator Maintenance Tasks. The operator monitors equipment and performs noncritical adjustments and preventive maintenance. He also performs selected repair functions such as replacement of defective fuses, lamps, and bolts.

(2) Organizational Maintenance Tasks: Ninety percent of all failures will be detected and corrected at this level. The organizational maintenance functions for the radar set include: preventive maintenance, making external adjustments on equipment and performing operational checks and adjustments, making continuity and operational checks on external interconnecting cable assemblies and performing minor cable and cable connector repair,

and analyzing the causes of equipment malfunction to the defective module (item, component, assembly, subassembly, printed/wired circuit board or card) using easy to interpret, built-in test equipment. The mechanic is limited to replacement modules, which are easy to remove/install, and authorized by the Maintenance Allocation Chart (MAC). Included are those items which do not require complex or critical adjustments or system alignment after replacement. Unserviceable modules are evacuated to DS for repair.

b. Direct Support (DS) Maintenance. The FIREFINDER direct support maintenance is provided by the Headquarters and Light Maintenance Company. The weapons support radar repairers (MOS 26B20 with K1 ASI) are members of the electronic maintenance section. They perform selected test, repair and/or replacement of components in an existing van mounted repair facility with a complete set of tools, test equipment and repair parts at their disposal. This facility is located in the division support area and it would normally be necessary to evacuate a radar to that location for major repair. As necessary, the repairer may join with the TACFIRE maintenance support team of the heavy maintenance company or be transported by the radar section or by TAB personnel to perform on-site maintenance. DS maintenance support for the AN/TPQ-36 generator is provided by the power generation equipment repairer (MOS 52D) assigned to the generator equipment maintenance section of the three forward support companies. The TAB must coordinate this support with each forward support company.

c. General Support (GS) Maintenance is limited to repair of printed circuit boards by the electronic repair facility using AN/USM-410 (EQUATE). The facility either repairs and returns boards to stock or evacuates unserviceable items to a designated repair facility in accordance with the MAC. There are 81 repairable printed circuit boards to FIREFINDER systems, 17 are peculiar to the AN/TPQ-37 and 8 are peculiar to the AN/TPQ-36.

d. Depot Maintenance provides the capability of complete overhaul and reconditioning of the major end items and assemblies which are beyond the capability of field maintenance units. There will be a gradual transition from contractor depot support to the Army depot system.

2. Support

There are no unusual support requirements for the FIREFINDER Radars.

III. DISCUSSION

A. INTRODUCTION

The discussion and findings presented in this section are based on an analysis of policy and procedure documentation, subject matter expert interviews, and specific system MPT data. The discussion has been organized chronologically to show progressive steps and changes in information as the FIREFINDER Program proceeded through the various phases of the acquisition process. Frequent use is made of figures, tables, and summaries to provide the reader with a more complete understanding of the interrelationship of events and the data flowing from them.

When analyzing the events that occurred in the acquisition of a particular system and comparing these events to the requirements of the LCSMM, the following advice from DA PAM 11-25 should be kept in mind.

> "...The LCSMM depicts the process by which Army materiel systems are initiated, validated, developed, deployed, and supported.... However, it is possible for many of the LCSMM events and, in some cases, entire phases, to be bypassed by the responsible command or agency....Only events deemed pertinent and necessary for the development of the particular system are accomplished...."

The FIREFINDER project is a good example of one that varied considerably from the LCSMM process.

A review of all early FIREFINDER acquisition documents and events was planned in order to determine the level of attention that was paid to MPT/HF related issues. However, two problems were encountered and the scope of the review had to be reduced.

First, the pre-award contractual documents for the ED Phase for the AN/TPQ-36 and the AD Phase for the AN/TPQ-37 had been destroyed. The Procurement Division, US Army Communications and Electronics Command (CECOM) verified that the pre-award documents are destroyed after 6 years. Attempts to locate these documents at the FIREFINDER Project Management Office and at the contractor's facility were unsuccessful. Included among the missing documents are the RFPs, the contractor's proposals, and the source selection evaluation board reports. Secondly, the contractor resisted attempts to schedule a visit to his facility on the basis of non-availability of the early documents or the personnel involved at the time of their preparation.

Although these documents were not available and personal contact with contractor personnel not made, interviews with project management, procurement, test and evaluation, and other personnel provided facts and opinions regarding the contents of the early documents.

B. CONCEPTUAL PHASE

1. General

Neither radar had a specific conceptual phase because each benefitted from the results of earlier Army efforts to develop similar radars. The FIREFINDER Radars, upon approval of Materiel Needs (MN), progressed directly into a later phase of development; the AN/TPQ-36 to Engineering Development and the AN/TPQ-37 to Advanced Development.

2. Materiel Needs

The characteristics, specifications, and concepts included in the MN for each FIREFINDER Radar were largely based on the results of the earlier development efforts and studies for the AN/TPQ-28 and AN/TPQ-32.

The MPT/HF topics covered by each MN are listed in Figure III-1. Detailed MPT/HF issues included within each topic are listed in Figures III-1a thru III-1e. The HFE and Health and Safety issues (Figure III-1c) were extensive and were identical for each system. Because the new radars were to replace existing systems, the operational and organizational concepts (Figure III-1a) received little emphasis other than efforts to limit the crew size and the number of items of equipment for each section, and to recognize the importance of rapid displacement capabilities to section survivability. With regard to the crew size, the MN stated that:

> "Final determination of the crew size is to be based on the results of operational tests. Crew size must support sustained operations over an extended period without performance degradation; meet specific emplace and displace times; allow for maintenance of associated equipment and vehicles; and allow for general maintenance, administrative, and logistical functions necessary for health, welfare, and safety."

The maintenance concept requirements (Figure III-1b) focused on continuing the status quo but added provisions for maximum on-site maintenance and the achievement of a high percentage of failure repair at the organizational level. Personnel and training issues (Figure III-1d) were oriented toward maintaining

FIREFINDER RADARS
MATERIEL NEED MPT/HF TOPICS

- ORGANIZATIONAL AND OPERATIONAL CONCEPTS
- MAINTENANCE CONCEPTS
- HUMAN FACTORS & SAFETY
- PERSONNEL AND TRAINING
- PRIORITIES

FIGURE III-1

FIREFINDER MATERIEL NEED
ORGANIZATIONAL AND OPERATIONAL CONCEPTS

AN/TPQ-36

- CREW SIZE - 8
  (LATER CHANGED TO 5-8)
- ONE/DS FA BN
  (LATER CHANGED TO DIV TAB
  AND DS FA BN OF SEP BDE)
- REACTION TIMES REQUIRED
- SHELTER FIT IN M561
- SPACE FOR TWO OPERATORS AND
  TWO SUPERVISORS
  (LATER CHANGED TO ONE AND ONE)
- POWER SOURCE - STANDARD

AN/TPQ-37

- CREW SIZE 8-12
- MAY BE ORGANIC TO DIV TAB
- REACTION TIMES REQUIRED
- TWO-THREE VEHICLES PER
  RADAR SECTION
- POWER SOURCE - STANDARD

FIGURE III-1a

FIREFINDER MATERIEL NEED
MAINTENANCE CONCEPT

AN/TPQ-36

- FOUR LEVELS OF MAINT
- GO-NO-GO TESTS
- PLUG-IN-PLUCK-OUT
- MINIMUM NUMBER INTERCONNECTING CABLES
- COMPATIBLE WITH DS/GS SYSTEM
- NO UNUSUAL REQUIREMENTS

AN/TPQ-37

- FOUR LEVELS OF MAINT-EXCEPT DS UNCERTAIN
- MAXIMUM USE OF BITE
- ORG REPAIR 90% OF FAILURES
- GS REPAIR END ITEMS, *MAJOR COMPONENT*, ASSEMBLIES
- MAXIMUM ON-SITE MAINT

FIGURE III-1b

FIREFINDER MATERIEL NEED
HUMAN FACTORS & SAFETY

AN/TPQ-36 / AN/TPQ-37

- HFE ANALYSIS REQUIRED
- NUMBER OF CONTROLS MINIMAL
- MARKING FOR EASE OF IDENTIFICATION
- CONTROLS MARKED, SHAPED, PLACED SO-AS-TO-BE READILY AVAILABLE
- OPERATION MUST NOT INDUCE UNDUE FATIQUE
- HFE INTEGRAL TO ALL SYSTEMS CHARACTERISTICS
- ELECTRICAL PROTECTION
- MICROWAVE RADIATION PRECAUTIONS
- OPERATORS NOT EXPOSED TO:
  - RADIATION
  - ANTENNA TRAVERSE
- NOISE LEVELS LIMITED (TB MED 251)

FIGURE III-1c

FIREFINDER MATERIEL NEED
PERSONNEL AND TRAINING

AN/TPQ-36

- CAPABLE OF OPERATION BY ONE MAN
- MINIMUM REQUIREMENT FOR HIGHLY SKILLED OP & MAINT
- OPERATORS FROM MOS 17B GP
- MAINTAINERS FROM MOS 26B GP (Later changed to Radar Op Gp)
- NO SCHOOL PROPONENCY CHANGES
- CONTRACTOR TRAIN INSTRUCTORS FOR OP & MAINT COURSES
- TRAINING DEVICE TO SIMULATE HOSTILE FIRING

AN/TPQ-37

- EMPLACEMENT BY NOT MORE THAN SIX PERSONNEL
- OPERATORS FROM MOS 17B GP
- MAINTAINERS FROM MOS 26B GP
- MOS 26B TRAINING TO BE EXPANDED TO INCLUDE LOGIC CURCUITRY
- TRAINING DEVICES NOT ADDRESSED

FIGURE III-1d

FIREFINDER MATERIEL NEED PRIORITIES

AN/TPQ-36

- 1ST ROUND ACCURACY
- RELIABILITY
- MAINTAINABILITY
- RANGE & SECTOR WIDTH
- PERFORMANCE IN RAIN
- WEIGHT
- PERFORMANCE IN ENVIRONMENTAL EXTREME
- ANTI-JAMMING

AN/TPQ-37

- 1ST ROUND ACCURACY
- SIMULTANEOUS FIRE
- RANGE & AZIMUTH COVERAGE
- RAM
- ADJ & REGIS OF FRIENDLY WEAPONS
- PERFORMANCE IN ENVIRONMENTAL EXTREMES
- AIR/SURFACE MOBILITY
- REACTION TIMES
- INTEROPERABILITY WITH TACFIRE
- ANTI-JAMMING

FIGURE III-1e

the current personnel selection and training procedures but prescribed operator and maintainer requirements that could lead to reduced training times, simplified operator and maintainer tasks, and lower entry requirements. The priority of radar characteristics, although different for each radar, were both heavily weighted toward performance and technical considerations, with RAM being the only MPT/HF related consideration having a stated priority. (Figure III-1e).

C. ADVANCED DEVELOPMENT PHASE (AN/TPQ-37)

1. Introduction

Of the two FIREFINDER Radars, only the AN/TPQ-37 program had an advanced development (AD) phase. The AN/TPQ-37 AD Phase consisted of 48 months of competitive prototype development that commenced in June 1972.

2. MPT Events

a. Contractual Documents

The Request for Proposals, Source Selection Plan, and other early contractual documents were not available for review. However, based on the results of interviews and the examination of related documentation, including the MN priorities, it is certain that issues of technical performance and cost were paramount during the competitive AD Phase.

The AD Phase contract provided for the delivery of prototypes by each of the two competing contractors within 30 months after contract go-ahead. The contract was heavily oriented

toward two technical performance capabilities (target detection and location of hostile weapons), and the collection and analysis of RAM data from all testing. Funding, and therefore the level of contractor effort, for human factors engineering, logistical planning, technical manual preparation, and survivability was given a "backseat". In fact, during the competitive AD phase, the contractors experienced such high cost overruns that they eventually had to reduce further their levels of effort in cost areas other than technical performance and Design-to-Unit-Production Cost (DTUPC).

Figure III-2 lists the current specifications for the FIREFINDER radars. However, because the original Electronics Command Development Descriptions that were part of the contract could not be examined, it is not known if the specifications in the figure are the same as those in the original contract.

b. Requirements Documents

The AN/TPQ-37 requirement was stated in the MN dated July 1972. The MPT/HF issues contained in the MN were discussed in paragraph III. B. 2.

c. Logistic Support Analysis (LSA)

The LSA effort for the AN/TPQ-37 Radar during this phase was negligible for the reasons stated in paragraph III. C. 2a.

d. QQPRI/BOIP/MOS Decisions

FIREFINDER RADARS
DEVELOPMENT DESCRIPITIONS

- MODULAR APPROACH
- MAXIMUM USE BITE
- MINIMUM TOOLS & TEST EQUIPMENT AT ORG LEVEL
- 90% OF SYSTEM FAULTS CORRECTED AT ORG LEVEL
- DS CONTACT TEAM W/TOOLS & TEST EQUIPMENT
- MTTR

ORG	30 MIN	(1 HRS MAX)
DS	2 HRS	(3 1/2 HRS MAX)
GS	3 HRS	

- MTBF

MAV	100 HRS
DESIRED	400 HRS

- MISSION RELIABILITY - NOT DEFINED
- AVAILABILITY - NOT DEFINED

FIGURE III-2

(1) General. The QQPRI and BOIP are iterative documents that provide manpower and training planners the earliest and most current information concerning the numbers and qualifications of personnel required to operate, support, and maintain a materiel system under development. For the majority of acquisition programs, input to both documents comes from a variety of organizational sources within the materiel development (DARCOM) and combat development (TRADOC) communities. A substantial amount of basic data in both documents is derived from Logistic Support Analysis (LSA). The materiel developer, e.g., CECOM in the case of FIREFINDER, initiates both the BOIP and QQPRI processes by preparing BOIP Feeder Data (BOIPFD). A BOIPFD is prepared for each principal and associated item of equipment to include Test, Measurement, and Diagnostic Equipment (TMDE) required to support the new system. The materiel developer concurrently prepares a proposed QQPRI which lists skills, tasks, and knowledge required to operate and support the new item (and its support, components, and test equipment) and estimates of time required to maintain it. Both the BOIPFD and proposed QQPRI are forwarded by the materiel developer through DARCOM channels to TRADOC. The materiel developer's proposed QQPRI is refined by TRADOC by adding the training, support and doctrinal implications of the new system. Using data from both the QQPRI and BOIPFD along with the O&O concept and the requirements document, a TRADOC proponent school, e.g., US Army Field Artillery School in the case of FIREFINDER, develops the BOIP. The BOIP becomes a planning document for the receiving commands.

Following TRADOC's refinement of the QQPRI and development of the BOIP, both documents are staffed at Soldier Support Center-National Capital Region (SSC-NCR) and HQDA to determine if the system falls within manpower constraints, reflects the appropriate Military Occupational Specialty/Additional Skill Identifier (MOS/ASI), meets Standard of Grade Authorization (SGA), has a feasible grade structure, and can be supported by Army recruiting and training capabilities. As the system proceeds through the development process, QQPRI and BOIP must be updated to reflect the latest outputs from the LSA, and other processes which feed the BOIP and QQPRI.

(2) QQPRI. Although it is apparent that a preliminary QQPRI was submitted during this phase, a copy could not be located for examination.

(3) BOIPFD/BOIP. The first BOIPFD was submitted in August 1976 by the project office. HQTRADOC submitted the BOIP to HQDA which approved it in October 1976. The approved BOIP (No. 73-0122-I) established a basis of issue of two AN/TPQ-37 radars per division target acquisition battery, except for the Airmobile Division which had none. The BOIP described the section personnel changes as follows:

"There are some TOE changes required to operate the radar. The crew of an AN/TPQ-37 radar section is 12 members (one warrant office and 11 enlisted). Personnel changes require the addition of one warrant officer and 3 enlisted personnel for each radar and the deletion of the warrant officer in the battery."

Justifications for the additional section personnel, the Warrant Officer and the three Assistant Radar Operators, were as follows:

"A Warrant Officer (WO), MOS 211A, is designated as chief of the AN/TPQ-37 Radar. The AN/TPQ-37 is a vital, sophisiticated and expensive link in the field artillery's counterbattery plans. Employment of the radar will require that it often operate as a separate unit quite remote from its parent organization or any other unit. Therefore, it is imperative that the chief of this section have sufficient rank, maturity, and background to justify this important responsibility. The WO is qualified with the technical expertise essential to decision making concerned with electronic matters, i.e., equipment malfunctions, ECM/ECCM, decoy distribution, electronic camouflage, and related alignment considerations. The WO is also especially qualified in tactical matters concerned with the successful employment of the radars."

"Three assistant radar operators, MOS 17B20, grade E3 are required for each radar to perform the following duties under the supervision of the senior radar operator:

- o Assist in operation of radar and associated equipment in location of hostile artillery weapons.
- o Record and report weapon locations.
- o Assist in the use of radar and associated equipment to register and adjust friendly artillery fire.
- o Assist organizational mechanic in performance of maintenance on radar and associated equipment.
- o Assist in emplacement and march order of the radar and associated equipment.
- o Assist in camouflaging and improvement of radar position.
- o Participate in perimeter defense.
- o Assist in laying communication line from radar to wirehead."

The recommended organization of the AN/TPQ-37 Radar section is shown in the following table:

TABLE III-1

AN/TPQ-37 SECTION ORGANIZATION--OCTOBER 1976

MOS	POSITION	QUANTITY
W1 211A	Section Commander	1
17B40	Section Chief	1
17B20	Senior Radar Operator	1
17B10	Radar Operator	7
26B20	Radar Mechanic	1
52B10	Power Generator Operator and Mechanic	1
	TOTAL	12

(4) MOS Decisions. There were no MOS Decisions, tentative or final, announced during the AN/TPQ-37 AD Phase.

e. Training

Training was planned for the FIREFINDER System (AN/TPQ-36 and AN/TPQ-37 Radars). Therefore to avoid confusion the discussion of the training planning and execution is presented in Paragraph E.2.c. of this Section which includes both radars.

f. Human Factors Engineering (HFE)/Safety

There was little HFE/Safety emphasis during the AN/TPQ-37 competitive AD Phase. In fact, no contractual emphasis was placed on HFE and no HFE Contract Data Requirements were identified. The appropriate HE MIL-Hs and MIL-STDs were referenced, as well as the TB MED-270, Control of Hazards to Health from Microwave Radiation, which addressed a major safety concern with the radar. However, specific guidance concerning application of the standards was not provided. The U.S. Army Human Engineering Laboratory (HEL) was not consulted regarding the AD phase Request for Proposal (RFP) or contract provisions.

Because the competing contractors experienced significant cost overruns, all but those efforts relating to technical performance and cost were eliminated. Included among the discontinued efforts were the HFE and safety tasks. The contractor personnel were moved to other projects.

In spite of this, the HEL representative felt that the government obtained a reasonable effort from each contractor during the AD Phase. This reasonable effort was achieved partially because the contractors were each played off against the other, e.g., "If you don't do this, that's fine, but your competitor might."

g. Government Test, Evaluation, and Analysis

(1) Test and Evaluation. The AN/TPQ-37 had its AD Phase test and evaluation in 1975. The Development Test (DT) I was conducted by the U.S. Army Test and Evaluation Command (TECOM) in mid-1975 and the Operational Test (OT) I was conducted by the U.S. Army Operational Test and Evaluation Agency (OTEA) during the period 13 October thru 14 December 1975. The U.S. Army Materiel Systems Analysis Activity (AMSAA) prepared an independent evaluation of the DT I.

The results of the OTEA test and independent evaluation and the AMSAA evaluation of the AD models are summarized in Figures III-3 and III-4. AMSAA concluded that the system met the primary objectives of the advanced development phase but that the design changes planned for the next phase posed a potentially

FIREFINDER RADARS

AN/TPQ-37 OPERATIONAL TEST I 13 OCT-14 DEC 75

ISSUES	FINDINGS: EVALUATED	PARTIALLY EVALUATED	NOT EVALUATED	COMMENTS
*MISSION PERFORMANCE		✓		PERFORMED BASIC MISSION IN AN EFFECTIVE MANNER NO INCLEMENT WEATHER TEST
INTEROPERABILITY W/TACFIRE	✓			INTERFACE FUNCTION NOT RELIABLE
PERSONNEL SELECTION AND TRAINING		✓		17B CAN OPERATE MAINT TASKS NOT FULLY DEFINED IDENTIFIED AREAS REQUIRING ADDITIONAL TRAINING DOCUMENTATION INCOMPLETE
DOCTRINE, TACTICS, AND ORGANIZATION		✓		12 MAN CREW REQUIRED FOR SUSTAINED OPERATION CONCEPTS INCOMPLETE-UNABLE TO EVALUATE
*SYSTEM RELIABILITY		✓		NOT ACCEPTABLE GFE FAILURES IMPACTED ADVERSELY ON SYSTEM RELIABILITY CONTRACTOR PERFORMED MAINTENANCE
SYSTEM MAINTAINABILITY			✓	CONTRACTOR PERFORMED MAINTENANCE NO MAINT SUPPORT CONCEPT, MANUALS, OR MAC
SYSTEM AVAILABILITY			✓	CONTRACTOR PERFORMED MAINTENANCE
EMPLACEMENT/DISPLACEMENT TIMES		✓		TIMES EXCESSIVE-SOME HFE PROBLEMS-TRAINING INADEQUATE
TACTICAL MOBILITY			✓	ADVANCED DEVELOPMENT MODELS NOT SUBJECTED TO RIGOROUS TEST

CONCLUSION: TEST RESULTS SUPPORT ENTERING LRIP . EARLY PRODUCTION MODELS SHOULD BE TESTED IN SUBSEQUENT OT (OTEA IER-OT-026)

*CRITICAL

FIGURE III-3

FIREFINDER RADARS
AN/TPQ-37, DT-I, AMSAA IER

ISSUES	FINDINGS: EVALUATED	PARTIALLY EVALUATED	NOT EVALUATED	COMMENTS
*PERFORMANCE/ EFFECTIVENESS	✓			HAS SUFFICIENT GROWTH POTENTIAL TO MEET RQMT. DOLLY A PROBLEM, RADAR SECTION VEHICLES TBD
COMMAND & CONTROL			✓	NOT YET ADDRESSED IN DETAIL
PERSONNEL AND TRAINING	✓			AVERAGE TROOPS CAN OPERATE MAINTENANCE REQUIRES WELL QUALIFIED, HIGHLY TRAINED MECHANICS
EMPLACEMENT AND DISPLACEMENT TIMES	✓			REQUIREMENT MET
LOGISTICAL SUPPORT		✓		MOST LOGISTICAL ELEMENTS DEFERRED DUE TO PROGRAM ACCELERATION
RAM		✓		DATA INCOMPLETE- AVAILABILITY NOT DETERMINABLE ORG MAINT SHOULD BE WITHIN SPECS RELIABILITY EXPECTED TO EXCEED MAV
HF & SAFETY	✓			WELL DESIGNED FROM HF STANDPOINT SAFETY PRECAUTIONS APPEAR ADEQUATE

CONCLUSION: SYSTEM HAS MET PRIMARY OBJECTIVES OF ADV DEV PHASE HOWEVER, PLANNED DESIGN CHANGES POSE A POTENTIALLY SIGNIFICANT RISK BECAUSE OF PROGRAM ACCELERATION (AMSAA IER 3-77)

*CRITICAL

FIGURE III-4

significant risk because of program acceleration. These planned changes are shown in Figure III-5. OTEA stated that its test results supported entering LRIP but that early production models should be tested in subsequent operational tests because of the number of test issues that could not be properly evaluated in OT I. The October 1976 ASARC II/III authorized the start of LRIP and DT/OT III was scheduled for 1980.

(2) Analysis. A Human Factors Engineering Analysis was a stated requirement in the MN for the AN/TPQ-37. However, because the radar was not designated as an ASARC system until 1976, and the analysis had not been previously required, none was prepared. The program passed the ASARC II/III Milestone in October 1976 without the HFE analysis.

D. ENGINEERING DEVELOPMENT (AN/TPQ-36)

1. Introduction

Of the two FIREFINDER Radars, only the AN/TPQ-36 had a formal Engineering Development (ED) Phase. In fact, due to the results of the earlier AN/TPQ-28 efforts, the mortar locating radar program was approved to proceed directly into the ED Phase with Hughes Aircraft Company (HAC) as the prime contractor. Because of litigation following the announcement of the source selection process, the start of ED was delayed until October 1973. The phase continued for 50 months until terminated by the ASARC III full-scale production decision in December 1977.

2. MPT Events

a. Contractual Documents. Unclassified portions of the

FIREFINDER RADARS
AN/TPQ-37 DESIGN CHANGES PLANNED DURING 14 MONTH MOD/REFUR PHASE

- **UPGRADE ADV DEV MODEL**
  - INCREASE SURVIVABILITY
  - INSURE ADEQUATE HFE
  - INCREASE RAM PERFORMANCE
  - DEVELOP LOGISTIC SUPPORT MEASURES
  - DEVELOP TRAINING COURSE, MANUALS, TRAINING DEVICES
  - *INSURE THAT SAFETY INCORPORATED IN DESIGN AND OPERATING PROCEDURES*
- **SELECTED MODIFICATIONS**
  - DEVELOP COMMON OPERATIONS SHELTER
  - CHANGE TO 400 CYCLE GENERATOR
  - SELECT MOBILITY OPTION
  - ACCOMPLISH ANTENNA REDESIGN

"1976 CONGRESSIONAL ACTION RESULTING IN ELIMINATION OF MOD/REFUR PHASE INCREASED THE TECHNICAL RISK OF MEETING THE PLANNED IOC"

AMSAA IER

FIGURE III-5

contract for the AN/TPQ-36 ED Phase were reviewed at CECOM Headquarters. The contract required integration of the many Government Furnished Equipment (GFE) items with the developed radar to consummate the total AN/TPQ-36 Radar System. The major items of GFE included vehicles, trailers, a generator, the operations shelter (S-250), and many lesser items. The GFE later developed problems that caused delays in the program. Training of operators and organizational through general support maintainers was to be provided by the contractor at his facility as soon as all equipment was available. The six week course for 12 students was to devote not less than 40 percent of the time to practical exercises in operation, repair, alignment, and troubleshooting of the major end item and specialized test equipment.

Contractual data requirements included the following: (not a complete list). Also included were identification of the appropriate DIDs, MIL-STDs, TBs, and MIL-Hs.

- o HFE Plan
- o HFE Progress Reports
- o HFE Test Plan
- o Operator/Maintainer Taskload Analysis
- o Analysis of Critical Tasks
- o Safety Analysis and Hazard Evaluation Report
- o Training Aids and Devices Study
- o RAM Program Plans and Reports

o Maintenance Engineering Analysis (MEA)

o Test and Demonstrate Reports

The source selection details for the AN/TPQ-36 ED Phase were not available. However, based on the results of interviews and the study of related documentation including the MN Priorities (Figure III-2e), there is little question that technical performance and cost were the selection drivers.

b. Requirements Documents. The 1972 MN, as previously discussed in paragraph III. B.2, established the guidance governing the AN/TPQ-36 ED Phase.

c. Logistic Support Analysis. The LSA effort (then referrred to as MEA) did not become effective until the full scale production phase.

d. QQPRI/BOIP/MOS Decisions.

(1) QQPRI. The first QQPRI for the AN/TPQ-36 was submitted to the Army Materiel Command (AMC) by the Electronics Command (ECOM) on 27 June 1973, prior to the start of the ED Phase. This QQPRI presented a radar section consisting of an M561 Truck with a S-250 Electrical Equipment Shelter and a M116 3/4 ton trailer carrying the antenna and generator. Another M561 truck was to provide for transportation of the section personnel and equipment. For planning purposes, the radar section strength was estimated to consist of four personnel as shown in the following table.

TABLE III-2

AN/TPQ-36 SECTION ORGANIZATION--JUNE 1973

MOS	POSITION	QUANTITY
17B40	Section Leader	1
17B20	Senior Radar Operator	1
17B20	Radar Operator Plotter	1
17B10	Radar Operator, Truck Driver, Generator Operator	1
	TOTAL	4

The QQPRI acknowledged, however, that additional operators might be required for extended periods of operation and that intoduction of the radar system might require revision of or additions to the MOS structure.

Maintenance of the system was proposed as follows:

- Operator - MOS 17B, Radar Operator
- Organizational thru GS - MOS 26B, Weapons Support Radar Repairman
- Depot - MOS 26B (Military), WB 2604 or WB 2607 (Civilian)

Military personnel were proposed to man all maintenance positions from organizational through GS. Military or civilian personnel would man the depot maintenance positions. The grade structure would remain basically the same as the structure for the operation and maintenance of AN/MPQ-4 mortar locating equipment currently in the field.

Maintenance tasks, times, and concepts were also described in the QQPRI. Concepts included the use of DS Contact Teams,

provisions for the majority of unscheduled maintenance actions to be performed at the organizational level, and printed circuit card repair to be accomplished at the depot level.

Direct Productive Annual Maintenance Manhour (DPAMMH) predictions were based on a mission scenario and RAM specifications as shown in Figure III-2, Supra. Manhours were estimated to be:

o Organizational - MOS 26B	185/radar
o DS - MOS 26B	291/radar
o GS - MOS 26B	284/radar
o Depot - MOS 26B/WB 2604/7	Not predicted

Training for DT/OT II test personnel and maintenance personnel was planned to be provided by the contractor at his facility. Later, after award of a production contract, the manufacturer would train key personnel on the AN/TPQ-36 and the special test equipment. New Equipment Training Teams (NETT) would train key personnel of receiving units until a TRADOC training base could be established.

The next QQPRI submission, a FQQPRI, was forwarded to the U.S. Army Maintenance Management Center (now MRSA) on 24 January 1977. It is possible that there were other QQPRI submitted between 1973 and 1977; however, a search of the files failed to uncover any evidence of earlier QQPRI. The 1977 QQPRI did not provide any clues because it did not reference earlier QQPRIs.

In the 1977 submission, ECOM expressed the opinion that the introduction of the AN/TPQ-36 into the Army inventory would have

a qualitative impact on the recommended MOSs required to operate and maintain the system because of the additional knowledge and skills required. Quantitatively, ECOM forecast that for the initial deployment period and for some time thereafter, so long as existing radars continued to be deployed and supported, additional personnel would be required. In addition, it was expected that the AN/USM-410 (EQUATE) system would require personnel assets; and a qualitative impact was also expected for an auxiliary item, the 10KW gas turbine generator, because of the aditional knowledge and skills required to operate and maintain it at the organizational level.

The AN/TPQ-36 radar section crew size required for missions and operational requirements for extended periods was estimated at 8 personnel. This was an increase from the 4 personnel predicted in the earlier QQPRI. The increase included provisions for organizational maintenance, the addition of a Section Commander (Warrant Officer), and two additional radar operators to provide for an extended section operational capability. Table III-3 shows the projected AN/TPQ-36 Radar Section organization and the change from the 1973 QQPRI.

TABLE III-3

AN/TPQ-36 RADAR SECTION ORGANIZATION--JAN 1977

MOS	POSITION	QUANTITY	CHANGE
211A	Radar Technician (Section Commander)	1	+1
17B40	Section Chief	1	
17B20	Senior Radar Operator	1	
17B20	Radar Operator	3	+2
26B20	Radar Mechanic	1	+1
52B20	Power Generator Operator and Mechanic	1	From 17B10 to 52B20

The suggested MOSs for AN/TPQ-36 operation and maintenance were 17B, 26B, and 52B. However, because of the additional knowledge and skill requirements, it was suggested that these MOSs would need to be revised or a Special Skill Identifier (SSI) established for the small group needed to satisfy the AN/TPQ-36 requirements. A training augmentation package would be sent to the field, controlled by the Army Trainer, and provide for the award of an SSI to those qualified.

Direct Productive Annual Maintenance Manhours (DPAMMH) for the Radar Set and the power group were predicted to be:

TABLE III-4

AN/TPQ-36 PREDICTED DPAMMH--JAN 1977

MOS	ORGANIZATIONAL	DS	GS
Radar Set			
26B20	371	---	---
26B30	---	136	13
Power Group			
52B20	54	---	---
52D20	---	108	117

These 1977 DPAMMH predictions were described as preliminary only. The radar set DPAMMHs were based on projected overall system Mean Time Between Failure (MTBF) of 400 hours and a mission operational running time of 21 hours daily (wartime). The generator DPAMMH predictions were provided by the Mobility Equipment R&D Command. They were extrapolations of actual performance time--"wrench-turning-time"--which represented confirmed historical data on similar type gas turbine generators.

(2) BOIPFD/BOIP. BOIPFD for the AN/TPQ-36 was submitted by the PM FIREFINDER in May 1975. The BOIP (No. 72-0303-I), prepared by TRADOC, was forwarded to HQDA on 11 December 1975 for approval. The BOIP presented the rationale for several of the radar section personnel changes that occurred between the 1973 and 1977 QQPRIs. The addition of a Warrant Officer, MOS 211A, to each radar section was based on the same justification already described in the AN/TPQ-37 AD Phase discussion.

The change from Radar Operator/Truck Driver/Generator Operator (MOS 17B10) to Power Generator Operator/Mechanic (MOS 52B20) was justified as follows:

"A Power Generator Operator/Mechanic MOS 52B20, Grade E4 is required for the generator organic to the section. The section will often operate as a separate unit quite remote from its parent organization. Therefore, it is imperative that a school trained operator/mechanic be assigned to each section. It would not be cost effective to train each radar operator to perform generator related duties. However, the 52B20 would be utilized in the radar section to assist in other duties, i.e., maintenance records, march order of radar and associated equipment, camouflage, perimeter defense, communication lines emplacement, driving, etc. Personnel trade-offs have been identified in appropriate TOE."

The personnel trade-offs consisted of reducing the number of radar operators by two in order to accommodate the addition of the Warrant Officer and Power Generator Operator/Mechanic without increasing the radar section strength above eight.

BOIPFD submitted in August 1976 provided the basis for another BOIP (No. 72-0303-II) submission by TRADOC to HQDA in October 1976. This BOIP identified additional items of associated and replaced equipment.

Comments on BOIP No. 72-030-II by the U.S. Army Ordnance Center and School included an analysis of the quantitative requirements for DS/GS maintenance of the AN/TPQ-36 by MOS 26B and 52D. The conclusion was that introduction of the AN/TPQ-36 and deletion of the AN/MPQ-4 would not result in additional MOS 26B personnel requirements. The same result was derived for the generator operator/mechanic MOS 52D.

The U.S. Army Field Artillery School submitted trainer information for MOS 26B30 and the rationale for new recommended MOSs 17X and 26X for operation and maintenance of the AN/TPQ-36

(as well as the AN/TPQ-37). The reasons presented for the recommendations were:

"Operation and maintenance procedures for the new and old systems are entirely different. The TPQ-36 and TPQ-37 are of state-of-the-art solid state design, using high speed digital control circuitry, chips, micro processors and hybrid logic circuits throughout the system. This creates a radical difference between old and new radar procedures, computerized vs semi-automatic. For instance, maintenance of the TPQ-36 and TPQ-37 requires the use of the following new equipment: VHF and UHF signal generators, digital and vector voltmeters, power-, SWR- and multimeters, dual trace oscilloscope, pulse generator, and spectrum analyzer. The old radars are electrical and mechanical systems equipped primarily with vacuum tubes. Initialization and operation of the TPQ-36 and TPQ-37 requires "talking to the computer" to enter data necessary to perform automated functions which have to be performed manually on the old systems. These functions include the use of TACFIRE data, the automatic calculation of terrain following, the automatic prioritization of information, and automatic grid location of friendly fire. Performance of these functions requires a solid foundation in digital logic and computer fundamentals, rather than a knowledge of electronics as in the 17B and 26B courses."

Based on its analysis of the course requirements, the Artillery School claimed that the new MOSs would be more practical and cost effective. The School also pointed out that a course of instruction covering five radar systems (Q-4, AN/TPS-25, AN/TPS-58, AN/TPQ-36, and AN/TPQ-37) is too much to expect of the individual student to learn and retain. In addition, a Letter of Agreement was approved by TRADOC for a new radar to replace the AN/TPS-25 and -58. Since the new radar would be similar to the operational and maintenance procedures of the AN/TPQ-36 and -37, it is a candidate radar to be operated and maintained by the MOSs proposed (17X and 26X).

HQTRADOC challenged the Artillery School claim that a new MOS would prove more practical and cost effective, and recom-

mended that a Cost and Training Effectiveness Analysis (CTEA) be submitted.

(3) *MOS Decisions.* No MOS decisions, tentative or final, for operation and maintenance of the AN/TPQ-36 were announced during the ED Phase which ended in December 1977.

e. Training

Training was planned for the FIREFINDER System (AN/TPQ-36 and AN/TPQ-37 Radars). Therefore, to avoid confusion, the discussion of the training planning and execution is presented in Paragraph E.2.c. of this Section which includes both radars.

f. HFE Deliverables. The AN/TPQ-36 Engineering Development Phase MPT/HF related plans, studies, and reports were delivered by the contractor as required by the contract. The HFE Plan, HFE Test Plan, and HFE Test Results were reviewed by the U.S. Army Human Engineering Laboratory and all found to be inadequate.

Specifically, the HFE Plan, dated 31 October 1974, was found to be unacceptable. It was described by HEL as vague, incomplete, not contractually binding, and it could not form a basis for determining compliance with HFE program requirements. HEL recommended that the plan be rejected.

The HFE Test Plan. dated 31 March 1975 was also found to be unacceptable. It was characterized as vague, not contractually binding, and grossly incomplete. HEL recommended that the plan be rejected and that a major rewrite be accomplished.

The Hughes Aircraft Co. Report of HFE Test, dated 16 March 1976 was found to be remiss in several respects and HEL recommended that the technical inaccuracies be corrected.

In spite of the HEL findings, the contractor was not required to revise his HFE Plan or his HFE Test Plan. In the words of the Hughes Aircraft Co. program manager, "the Army funded a small HFE effort by Hughes and that's what it got, not the big HFE that HEL wants." The FIREFINDER project funded a one-half of one man-year per year HEL effort to assist the FIREFINDER PM with both radars. This level of effort continued for three years and was gradually phased out, ending in 1979.

g. Government Test, Evaluation, and Analyses

(1) Test and Evaluation. The first government tests and evaluations for the AN/TPQ-36 radar having significant MPT/HF impacts were the Development Test II conducted by the U.S. Army Test and Evaluation Command (TECOM) during the period March 1976 to February 1977, the Operational Test II conducted by the U.S. Army Operational Test and Evaluation Agency (OTEA) during the period 7 March - 23 June 1977, and the U.S. Army Materiel Systems Analysis Activity (AMSAA) Independent Evaluation Report (IER) of DT II.

The results of the OTEA test and the AMSAA evaluation are summarized in Figures III-6 and III-7. AMSAA supported the transition to full scale production provided that a Follow-On Evaluation (FOE) was conducted, while OTEA expressed concern that there

FIREFINDER RADARS
AN/TPQ-36 OPERATIONAL TEST II 7 MAR-23 JUN 77

ISSUES	FINDINGS: EVALUATED	PARTIALLY EVALUATED	NOT EVALUATED	COMMENTS
*PERFORMANCE	✓			MET MISSION REQUIREMENTS
PERSONNEL SELECTION	✓			NO PROBLEMS
TRAINING		✓		NOT TRAINED BY PROPONENT SCHOOLS
HUMAN FACTORS	✓			SATISFACTORILY HUMAN ENGINEERED
DOCTRINE, TACTICS, AND ORGANIZATION		✓		MANUALS NEED IMPROVEMENT, FURTHER DOCTRINE & TACTICS TESTS RO'D
*COMMAND & CONTROL	✓			GENERALLY ADEQUATE EXCEPT SHELTER COMMUNICATIONS
*TACTICAL MOBILITY		✓		NEEDS FURTHER EXAMINATION
*RAM		✓		LIMITED DATA FROM ONE PROTOTYPE RADAR. ADDITIONAL OPERATOR & MAINTAINER TRAINING REQUIRED
*SUPPORTABILITY		✓		LIMITED DATA

*CRITICAL

CONCLUSION: OT OF PRODUCTION MODELS REQUIRED BEFORE FSP.
TEST TO INCLUDE DOCTRINE, TACTICS, PERFORMANCE TIMES
(OTEA IER-OT-206)

FIGURE III-6

FIREFINDER RADARS
AN/TPQ-36, DT-II, AMSAA IER

ISSUES / FINDINGS	EVALUATED	PARTIALLY EVALUATED	NOT EVALUATED	COMMENTS
PERFORMANCE	✓			Has demonstrated the ability to achieve its functional objectives
RAM		✓		Readily repairable at organizational level Reasonable to assume that the system will satisfy *RAM requirements*
SURVIVABILITY		✓		Is a weak area that needs increased effort
LOGISTIC SUPPORT		✓		No critical issues
HUMAN FACTORS AND SAFETY	✓			No significant or major problems
EMPLACEMENT/ *DISPLACEMENT TIMES*	✓			Times were met but only under ideal conditions
ANNUAL MAINTENANCE MANHOURS DETERMINATION	✓			QQPRI of Jan 77 uses unrealistic MTBF *and does not address* PCB repair times

CONCLUSION: AN/TPQ-36 HAS DEMONSTRATED THE ABILITY TO ACHIEVE ITS FUNCTIONAL OBJECTIVES AND SATISFY MOST OF ITS REQUIREMENTS. SUPPORT FSP WITH FOE.

(AMSAA IER 2-78)

FIGURE III-7

should be an operational test of production models before full scale production. In December 1976, the ASARC III authorized FSP with a requirement for the FOE to be conducted in 1979.

(2) Analyses. The basic FIREFINDER Cost and Operational Effectiveness Analysis (COEA) was completed in October 1975. The COEA included an analysis of several systems and mixes of systems including the AN/TPQ-36, AN/TPQ-37, U.S. Marine Corps Hostile Weapon Location System (HWLS), and the British Mortar Locating System (Cymbeline). The results of the analysis concluded that the top three preferred alternatives, based on cost and operational effectiveness, were:

- o Three AN/TPQ-37 Radars
- o Two AN/TPQ-37 and three AN/TPQ-36 Radars
- o Four AN/TPQ-36 Radars

The COEA recommended tht the AN/TPQ-37 radar be developed and fielded.

Cost and Training Effectiveness Analyses (CTEA) were also prepared for the FIREFINDER radars. The 1976 analyses concluded that training devices were more cost and training effective than the actual equipment for those purposes for which they are intended, i.e., most operator tasks and the majority of the organizational maintenance tasks.

Human Factors Engineering Analysis, required by the MN, was not performed for the AN/TPQ-36. Initially, because the

project was not an ASARC program, the analysis was not required. However, in 1976, the radar system became an ASARC program. In spite of this, the HFEA was not prepared for the ASARC II held in December 1976.

E. PRODUCTION PHASE (AN/TPQ-36, AN/TPQ-37)

1. Introduction

The AN/TPQ-36 progressed from ED to Full Scale Production (FSP) in August 1978. The AN/TPQ-37, upon completion of the competitive AD Phase, entered a period of Low Rate Initial Production (LRIP). The LRIP Phase lasted from December 1976 to February 1981 when the ASARC IIIa authorized FSP for the AN/TPQ-37.

2. MPT Events

a. Contractual Documents - The selection criteria for the AN/TPQ-37 LRIP Phase were reviewed at CECOM. Although specific weights were not given for the factors considered, it is apparent that greater emphasis was placed on MPT/HF issues at this phase of development than in the earlier phase. The three rated factors were 1) Performance, 2) Cost, and 3) Modification/ Refurbishment Phase Planning. The performance factor consisted of eighteen criteria which were listed in descending order of importance as follows:

1. Probability of 1st Round Acquisition and Location
2. Multiple Weapons and Volley Fire Location
3. Range and Azimuth Coverage
4. Reliability and Maintainability
5. Performance in EMC Environment
6. Ease of Operation and Safety*
7. Reaction Times*

8. Registration and Adjustment of Friendly Fires
9. Air Portability, Surface Transportability
10. Interface with TACFIRE
11. Display
12. Antenna Traverse
13. EMI/EMC
14. System Configuration
15. System Orientation
16. Prime Power and Distribution
17. Emplacement on Slopes*
18. All Other Specific Requirements Not Covered Above

* MPT/HF Related

Criteria for the AN/TPQ-36 Full Scale Production Phase - initiated in 1978 - were contained in the Engineering Development Contract which was discussed earlier. The contract, with over one-hundred amendments is still open for the AN/TPQ-36 FSP phase. The ASARC III, held in December 1977, had determined that the AN/TPQ-36 Radar was ready to progress from ED to production. The critical issues at the ASARC were RAM, supportability, and emphasis on commonality with the AN/TPQ-37. The latter issue had been initated by a ODDR&E memorandum in June 1976 directing that commonality be sought to the maximum extent possible.

b. Requirements Documents - No changes

c. Logistic Support Analysis - The LSA process began with the production phase, 1977 for the AN/TPQ-37 and late in 1978 for the AN/TPQ-36. As late as the July 1979 QQPRI for the AN/TPQ-36, the only LSA data available was from the AN/TPQ-37 effort which had started earlier (see discussion in following paragraph).

d. QQPRI/BOIP/MOS Decisions

(1) QQPRI (AN/TPQ-36). An Amended QQPRI was submitted by CECOM on 20 July 1979. This amendment of the previously amended QQPRI was necessitated by a change in the maintenance concept which deleted the requirement for GS level maintenance and delegated a portion of those tasks to the FIREFINDER Radar Set DS Repairer and the remainder to Depot. In addition, the availability of LSAR data made possible the revision of Annual Maintenance Manhours. Furthermore, the completed Ground Support Equipment Requirements Data (GSERD) permitted inclusion of test equipment along with manhour data and MOSs.

It determined that the changed maintenance concept would have no impact on DS personnel requirements but would remove the need for the MOS 26B requirement at the GS level.

Although LSAR data was available only for the AN/TPQ-37, data for the common shelter could be used for the AN/TPQ-36. The LSAR figures for the AN/TPQ-37 antenna trailer group, which is more complex, larger, and involves a greater number of elements were decreased by a factor of 20% and presented as AN/TPQ-36 data.

The QQPRI pointed out that:

"These figures of DPAMMH were derived from formula into which certain assumptions were incorporated. Among them was an assumed mission activity utilization of 1600 hours annually, which may be viewed as considerably less than a full utilization of the system under wartime conditions. This assumption works out to be 200 days of usage per year in a single shift (8 hr.) operation. Also assumed in the calculations were a MTBF of about 150 hours and task frequency figures that are predicted values

only, and concerning which no failure modes and effects analysis was performed. Hence, while these figures may be the best available for the type of electronics component considered, they are not demonstrated results based on full-scale reliability studies or field usage and therefore, their inclusion in the formula for DPAMMH has a decided effect on the confidence with which one approaches the resulting figures. It would appear that a summation of this analysis is that any decisions made today based on the tentative nature of the data available, in the manpower area, involving proposed additions or deletions in allowances of TO&E/TDA, are very likely to require re-evaluation and change in the future."

The radar section organization remained unchanged from the previous QQPRI except it reflected an MOS Decision (to be discussed) to use a new MOS, 13R (Operator) and 13R W/ASI (X5) organizational maintainer, for FIREFINDER.

The Direct Productive Annual Maintenance Manhours predicted for the AN/TPQ-36 are shown in the following table.

TABLE III-5

AN/TPQ-36 PREDICTED DPAMMH - JUL 79

MOS	CREW	ORGANIZATIONAL	DS	GS
Common Shelter				
13R	77.1	1	--	--
13R (X5)	--	11.3	2	--
26B (K1)	--	--	1.2	--
Antenna Trailer				
13R	21.4	1	--	--
13R (X5)	14.5	38.5	--	--
26B (K1)	--	--	4.8	--
Power Generator				
13R	36	104	--	--
52D	--	--	80	51

AMMH were also listed for the test, associated, and ancillary equipments, e.g., radios, telephones, vehicles, signal generators, aiming circle, etc.

A third amended QQPRI was submitted by CECOM on 16 November 1979. Amendment was necessary in order to identify GS level repair MOSs, DPAMMH, and duties. Specifically, the AFQQPRI added the following to the data shown in Table III-5:

MOS	CREW	ORG	DS	GS
74XX	NA	NA	NA	6.31
TBD	NA	NA	NA	5.84

MOS 74XX, Tactical Data Equipment Operator, receives CCA's referred to the GS level repair activity from the FIREFINDER Radar DS Unit and performs troubleshooting and fault analysis/identification on the CCAs using the AN/USM-410 Test Set (EQUATE).

MOS To Be Determined (TBD), Electronic Circuit Card Assembly Repairer, performs the GS level repair of the FIREFINDER Radar Set CCAs that have already undergone troubleshooting and fault analysis.

The AMMH predicted for MOS 74XX and MOS TBD were based on studies concerned with LSAR and contractor-government investigation into the selected 106 distinctive categories of FIREFINDER CCAs that are designated for automatic programmed troubleshooting and test by the AN/USM-410 Test Set, and repair by the GS level Electronics CCA Repairer. Calculations, based on the rate of return of CCAs for repair over a specified period of time and for a specified operational mission (wartime) and the assumed main-

tenance time (excluding administrative and other) to repair a CCA, resulted in the predicted AMMHs for the AN/TPQ-36 of 6.31 and 5.84 hours for MOS 74XX and MOS TBD, respectively.

(2) QQPRI (AN/TPQ-37). A final QQPRI for the AN/TPQ-37 was submitted by ECOM in June 1977. In its forwarding letter, ECOM stated:

"It is the opinion of this headquarters that the introduction of the Artillery FIREFINDER Radar Set AN/TPQ-37 into the Army inventory will have a qualitative impact on the recommended MOSC's required to operate and maintain this equipment. The impact is such that due to the increased complexity, electronic sophistication and automated nature typified by the new radars including this system, as well as the AN/TPQ-36 Mortar FIREFINDER system, new operator and maintenance MOSC's are required. (NOTE: An Amended QQPRI for the Mortar FIREFINDER Radar Set AN/TPQ-36 is undergoing preparation at ECOM to justify a change in the recommendation of the developer from the position taken in FQQPRI for this equipment, dated 24 January 1977. The amended document will support the need for new MOSC rather than revised MOSC and thus present a unified and consistent position reference both radars.) The system operator and, to a much greater degree, the repairman, will require knowledge and skills associated with the new technological base incorporated in this radar that represents a distinct departure from the current family of radars which reflect for the most part the post-World War II technology. Tne personnel entering the Army and designated to man this equipment will require training that includes transistor and semiconductor theory and functions, logic and logical analysis, digital circuitry and processing, computer technology and programming, and computer-assisted diagnostics. Such training is not now a part of the TRADOC school MOSC qualifying course for MOSC 17B and 26B. Furthermore, based on the length of training required for operators and repairmen in connection with the system engineering development model and Army requirements of DT/OT testing (in which field-experienced personnel were utilized), the resultant school course from the add-on would be approximately one year in length. Such an extensive training period would be counter-productive to the needs for adequate number of personnel to operate and maintain the system upon deployment form 1980-1984. There is also a quantitative impact since existing unit TO&Es will require modification to accommodate the new FIREFINDER sections and the required crews. The quantitative assessment relative to numbers of repairmen needed for direct support and general support is based on the Maintenance Allocation Chart (MAC) for the current development-phase radar."

The number of operators required for the AN/TPQ-37 was predicted to be:

TABLE III-6

AN/TPQ-37 SECTION ORGANIZATIONAL - JUN 77

MOS	TITLE	QUANTITY
211A(WO)	Section Commander	1
17B40	Section Chief	1
17B20	Senior Radar Operator	1
17B20	Radar Operator	6
26B20	Radar Mechanic	1
52B20	Power Generator Operator/Mechanic	1
	TOTAL	11

Direct Annual Maintenance Manhours for the AN/TPQ-37 and support equipment are shown in the following table:

TABLE III-7

AN/TPQ-37 PREDICTED DPAMMH - JUN 77

MOS	EQUIPMENT	ORG	DS	GS
26B20	AN/TPQ-37 System	379.4	--	--
26B20	AN/TPQ-37 System	--	27.8	1.5
52B20	Generator Set	309	--	--
52D20	Generator Set	--	136	84
63B20	Lift Dolly	12	--	--
63H20	Lift Dolly	--	10.2	8.4

The response to this AQQPRI by the Artillery School was identical to its response to the AN/TPQ-36 FQQPRI (discussed earlier). Due to the similarities of the two systems, the merger of instruction into a single course was considered logical. It was also considered appropriate that the same recommendation for new operator/maintenance MOSs be submitted for the AN/TPQ-37 as was submitted for the AN/TPQ-36.

The next Amended QQPRI was submitted by the materiel developer in October 1979. It was necessitated by the change in the FIREFINDER maintenance concept as discussed earlier. It also reflected the MOS Decision announced by HQDA on 11 May 1979.

The number of operators required for the AN/TPQ-37 was presented as:

TABLE III-8

AN/TPQ-37 SECTION ORGANIZATION - OCT 79

MOS	TITLE	QUANTITY
211A(WO)	Section Commander	1
13R30	Section Chief	1
13R20	Senior Radar Operators	1
13R(X5)	Radar Organizational Mechanic	1
13R10	Radar Operator	7
63B	Generator Operator/Mechanic	1
	TOTAL	12

The Direct Productive Annual Maintenance Manhour data was obtained directly from the LSAR prepared by the contractor for the Operations Shelter and the Antenna Trailer Group. The QQPRI qualified the DPAMMH data, as was done for the July 1979 AN/TPQ-36 QQPRI and discussed earlier.

The AMMH presented for the AN/TPQ-37 were as follows:

TABLE III-9

AN/TPQ-37 PREDICTED DPAMMH - OCT 79

MOS	EQUIPMENT	CREW	ORG	DS	GS
13R	Common Shelter	77.1	1	--	--
13R(X5)	" "	--	11.3	2	--
26B(K1)	" "	--	--	3.6	--
13R	Antenna Trailer	26.2	1.3	--	--
13R(X5)	" "	18.3	48	--	--
26B(K1)	" "	--	--	6	--
63B	Power Generator	--	218	--	--
52D	" "	--	--	128	64

Comments received during staffing of the QQPRI included:

- o LOGC:
  - "MOS 63B does not operate radar sets"
  - "MOS 63B cross training as a radar operator should be reevaluated for accuracy"
  - "Generator Operator/Mechanic positions must be justified where separate generator equipment operator positions are required. Until such data is provided the LOGC, recommend that generator operator positions be filled by the system operators."

o USAFAC:

- "Separate training courses for the two radar sets are not required"
- "USAOC&S has no additional training requirements for MOS 63B, Power Generator and Wheel Vehicle Mechanic"
- "AMMH for MOS 63B Organizational Maintenance should be reevaluated. AQQPRI states 218 (305 after application of 1.4 indirect time authorization) AR 570.2 states 475."

Another amendment of the AN/TPQ-37 FQQPRI was submitted in January 1980. It expanded the list of supporting and ancillary equipment but made no DPAMMH, MOS, or crew size changes. It did not identify GS level repair MOSs, DPAMMH, or duties as was done in the third amended AN/TPQ-36 QQPRI discussed in paragraph (1) above. However, data furnished in the AN/TPQ-36 third amendment concerning the GS maintenance MOSs (74 xx and TBD) indicated that the same MOSs would also maintain AN/TPQ-37 Circuit Card Assemblies (CCA). Calculation of DPAMMH for GS repair of AN/TPQ-37 CCAs was possible from the data provided in the AN/TPQ-36 QQPRI amendment. The results are as follows and should be added to the data in Figure III-9.

MOS	CREW	ORG	DS	GS
74xx	NA	NA	NA	6.31
TBD	NA	NA	NA	5.84

(3) BOIPFD/BOIP (Both Radars).

Realizing that the AMMHs predicted by the QQPRI would not justify the posting of additional Weapons Support Radar Repairers

(MOS 26B) to the BOIP, the PM, TSM, and HQDA representatives discussed the situation in October 1980. TRADOC held that a requirement existed for one additional MOS 26B ASI K1 to be authorized in the headquarers and light maintenance company of a division direct suport maintenance battalion.

The MOS 26BK1 must provide direct support for five FIREFINDER radars positioned across a division battlefield (40-60 X 30 KM) and these personnel also must provide direct support for other systems, i.e., AN/TPS-58 or AN/TPS-25 radars, GMD-1 meteorological equipment, and M-90 or M36 chronographs. Time-distance factors involved, plus work load, support the need for an additional person. Therefore, TRADOC recommend that two MOS26BK1 be incorporated in BOIP 79-0159.

The TSM immediately initiated a decision paper to bypass the normal BOIP process in order to obtain DA approval prior to the ASARC IIIa in January 1981 (for the AN/TPQ-37). The BOIP for the AN/TPQ-37 and items to support the AN/TPQ-36 and AN/TPQ-37 Radar sets was approved by HQDA on 14 January 1981 with the required spaces for DS/GS maintenance.

(4) MOS Decisions (Both Radars). Since 1977, the materiel developer had expressed the opinion that the FIREFINDER Radars would require new skills and knowledge. In November 1977, MILPERCEN announced a tentative MOS decision for operator and maintenance personnel. The new MOSs were:

o 13R FIREFINDER Radar Crewman

o 13R W/ASI FIREFINDER Radar Mechanic

o 26B W/ASI FIREFINDER Radar DS/GS Maintenance

The rationale for these new MOSs was expressed as follows:

o "Section Chief and Radar Operators: Based upon data presented in QQPRI, new MOS 13R is being established to identify radar operational postions. Also, MOS13R will be desdigned to accommodate AN/TPQ-37, Artillery FIREFINDER Radar Set without further revision."

o "Organizational Maintenance Radar Mechanic: Proposed ASI for use with operator MOS (13R) is considered more feasible than separate MOS for organizational maintenance. BOIP indicates that only one radar will be issued in some units and maximum of three in others. Regardless, when the sets are operational, the organizational mechanic can be utilized in an operator capacity as opposed to idly standing by. This could save the requirements for a separate organizational mechanic position in those TOE having only one radar set. Further, the establishment of an ASI course will result in the attendee already being trained on the operation of the radar and it is envisioned that the proposed length of the AN/TPQ-36/37 organizational maintenance course will be reduced considerably from the projected 13 weeks 4 days, thereby resulting in further savings in training costs. Here, efficient use of manpower and savings of TOE spaces are also positive factors in arriving at this tentative proposal. ASI would be designated to accomodate both 36 and 37 radar sets."

o "Weapons Support Radar Repairman (DS/GS Maintenance on radar set): Review reveals that there would be only approximately 20 positions in DS/GS maintenance units responsible for maintenance of the AN/TPQ-36/37 Radar Sets. This is not enough to sustain a separate MOS identification. While it is realized that the new radar sets (-36 and -37) are solid-state, computer driven sets as opposed to the older sets they will eventually replace, there is not sufficient justification to establish a new MOS. The establishment of an ASI for use with MOS 26B will permit identification of the personnel qualified to maintain the radar sets. It is envisioned that once the older radar sets are phased out, the ASI could be dropped and incorporated directly into the MOS 26B."

The user community formally countered the proposal for MOS 26B W/ASI; it suggested establishing a new MOS 26J, FIREFINDER Radar Repairer for DS/GS Maintenance of radars.

Initially, only approximately 43 authorizations in this MOS would be required to maintain DS/GS maintenance support. However, the requirements for MOS 26J would increase as new equipment was forthcoming in future years.

MOS 26B, Weapons Support Radar Repairman, performs DS/GS maintenance on the AN/MPQ-4 radar as well as other items. In addition, a special waiver had previously been granted to authorize an assignment of the MOS 26B soldier to operating units for performance of organizational maintenance of the AN/MPQ-4 radar. The requirement for MOS 26B will be reduced by 176 personnel as the AN/TPQ-36 and AN/TPQ-37 replace the AN/MPQ-4. DS/GS maintenance of the new radars would be performed by the new MOS 26J and organizational maintenance would be performed by an operator further identified by an ASI.

One of MILPERCEN's initial objectives to a new MOS was its low density. However, the AMMH on which the density was computed was suspect because it was based on 400 mean hours between failures, whereas the actual figure would be something closer to 100 hours. The latter figure would increase the number of DS/GS maintenance positions, thereby increasing the density of the new MOS.

The initial MILPERCEN position favoring the use of an ASI with MOS 26B instead of a new MOS was based on an assumption that the ASI would be phased out when the AN/MPQ-4 radars were phased out leaving MOS 26B to maintain the new systems.

The counter position which questioned the MILPERCEN capability to manage personnel by ASI, also pointed out that the training for 26B (K1) would have to be significantly increased and that future 26B training would have to be modified as new solid state, computer driven systems are introduced.

In correspondence forwarding proposed FIREFINDER MOS designations to the HQDA staff for review in October 1978, MILPERCEN finally agreed with the field position that a new MOS 26J would be appropriate for DS/GS maintenance. Documentation concerning the HQDA staff review of the MILPERCEN proposals could not be found, but the MOS 26J proposal was apparently rejected.

MILPERCEN announced the MOS Decision in a Letter of Notification E-13-7, Revisions to CMF 13 - Field Artillery, published on 28 June 1979. The announcement established MOSs 13R, 13R W/ASI X5, and MOS 26B W/ASI K1 as the DS/GS maintainer.

In mid-1980, the ASARC membership expressed an interest in knowing why the same area score (SA 105) required by the Q-4 radar operators was being required by FIREFINDER radar operators when the Army was attempting to field equipment requiring less skill to operate. The TSM requested USAFAS to perform a Training Effectiveness Analysis. With the assistance of TRANSANA, the study was completed and a score of 105 was found to be a required prerequisite for FIREFINDER operator training.

e. Training.

(1) Training devices at Fort Sill for institutional training included the Operator Training Device which can be used for both radars, an AN/TPQ-36 Organizational Maintenance Trainer, and four each AN/TPQ-36s and AN/TPQ-37s.

(2) The initial training courses started:

- Operator MOS 13R10 — 31 Oct 1980
  A 6 week, 2 day course
  Requires a score of 105 or better in Area SC.
- Organizational Maintainer MOS 13RX5 — 15 Jan 1981
  A 14 week, 4 day course
  Requires completion of 13R10 Course
- DS Maintainer MOS 26BK1 — 22 Oct 1980
  A 22 week, 4 day course
  Requires qualified MOS 26B20 or completion of Weapons Support Radar Course

Recruiting for these MOSs started in April 1980 and personnel requisitions were initiated in July 1980.

(3) Doctrinal literature, FMs, SQTs, ARTEP, and ETMs were provided during the period March 1981 to August 1982 for MOSs, 13R and 26B. TMs were published in late 1981.

(4) The U.S. Army Field Artillery School utilized the Instruction Systems Development (ISD) model in the development of training literature for the FIREFINDER systems. Partial Skill Performance Aids (SPA) were developed. The front-end analysis,

task list, manuals, and exportable training package were prepared in accordance with the SPA directives. Because an extensive contractor front-end analysis was not conducted for FIREFINDER, it was developed by the Field Artillery School using reference material made available by the contractor.

(5) Exportable training packages were considered an essential element of the total system training package. With such a package, AN/MPQ-4A operators would not have to attend resident instruction at Fort Sill to qualify for MOS 13R, FIREFINDER Radar operators. However, training strategy provides that all oranizational and DS maintenance personnel will attend resident training.

(6) The 1978 Individual/Collective Training Plan for the FIREFINDER Radar System was revised and published 5 October 1979 by the USAFAS.

(7) A Recruiting and Training Plan (Draft) was published by the U.S. Army Administration Center in May 1978 in response to the TSM request for additional information on personnel requirements and availability of personnel for the FIREFINDER System. The plan, based on an April 1980 Initial Operational Capability (IOC) date for the AN/TPQ-37, was derived from conclusions resulting from logical deductive reasoning.

Later revisions of the plan acknowledged the delayed IOC dates and the new equipment delivery dates as they affected training plans.

(8) The Army Research Institute Detachments at Fort Sill and Fort Benning have supported the FIREFINDER program with training device requirement analyses, training development evaluations, and task validations for operator and selected maintenance personnel.

f. Human Factors Engineering/Safety. The PM funded an effort by HEL for three years which was then gradually phased down until it was terminated in 1979. The weak HFE effort that was characteristic of the AN/TPQ-37 AD Phase was supposed to be strengthened in the LRIP Phase; however, Hughes objected to "adding requirements in the LRIP Phase that weren't in the AD Phase." However, the HEL representative claims to have had a good rapport with the Hughes HFE personnel and also to having had a very supportive PM. Hughes responded very well to HFE suggestions even though the contract was "full of loopholes."

DOD Instruction 5000.2 requires that "new systems be designed to minimize both the numbers and the skill requirements needed for operation and support." AR 602-1, 1 June 1976 required an HFE analysis and also required a mandatory review by HEL of all Army systems under development. The regulation also required the DCSPER to "assure that equipment designs are compatible with the capabilities and limitations of the personnel who must operate and maintain them," and to "insure that systems engineering considers safety and health standards." Finally, in its 1980 RDA Management Model, HEL describes HFE involvement in nearly all R&D events from the MENS to Production and Deployment.

The FIREFINDER Radars, however, did not have HFE Analyses. One hurry-up partial HFE review for the AN/TPQ-37 ASARC IIIa was performed by HEL but a copy was not made available for this study. According to an HEL Subject Matter Expert (SME), the review did not identify any significant HFE deficiencies and there were no HFE reasons for not going into full-scale production.

The Army Research Institute Field Unit at Fort Hood, TX, performed a Human Factors Evaluation at the request of OTEA in support of the AN/TPQ-37 OT III and the ASARC IIIa. The primary means of data collection consisted of questionnaires and interviews administered to test players and evaluators. Although, overall, the system was rated as satisfactory, the following problems were noted:

- Inadequate training on operator preventative maintenance checks and services on the Dolly Set
- Difficulty in sighting through the boresight telescope at night
- Safety hazards associated with camouflaging the radar
- Difficulities in interoperating with TACFIRE
- Inadequate temperature control, ventilation, seats, and space in the S-250 shelter
- Insufficient maintenance tasks planned for performance at the organizational level
- Inaccuracies in system technical manuals

At the invitation of the PM-FIREFINDER, the Army Environmental Hygiene Agency assisted with radar radiation measurements

and with the preparation of the safety portions of the system manuals.

Also, in the mid-70s, approximately 20 experienced radar technicians and NCOs went to the contractor's plant to assist in the design of equipment locations in the shelter.

g. Government Test, Evaluation, and Analyses

(1) General. Test and Evaluation conducted during this phase included a DT/OT III for the AN/TPQ-37 and a Force Development Test and Experimentation (FDTE) with both radars.

(2) The AN/TPQ-37 DT/OT-III was conducted in preparation for the ASARC IIIa that was held on 18 February 1981 for the purpose of determining if the radar was ready for type classification as standard and to proceed into full scale production; DT was conducted by TECOM. Figure III-8 presents comments from the TECOM Final DT Test Report of March 1981.

A combined OTEA and AMSAA Independent Evaluation Briefing concerning DT/OT II results was presented to the ASARC IIIa. It included the following observations.

- The AN/TPQ-37 has demonstated the required levels of reliability and availability and can be maintained by the proposed logistic system - although the % of corrections at the oranizational level was low.
- Survivability/vulnerability require further assessment.
- C^3 not fully resolved.
- TACFIRE interface should be refined and investigated further in FDTE.

FIREFINDER RADARS
AN/TPQ-37, DT III, TECOM

COMMENTS FROM FINAL REPORT, MARCH 1981

- HAS SYSTEM AND NIGHT ORIENTATION PROBLEMS

- HAS MANY HFE PROBLEMS
  - Unsafe to operate
  - Dangerous to maintain
  - HF considerations not adequately addressed

- MAINTENANCE CONCEPT ONLY PARTIALLY EVALUATED
  - Non-availability of EQUATE is high risk area

- NOT RELIABLE-MTBF TOO LOW

- MAINTAINABILITY GOAL NOT MET

- ENVIRONMENTAL TESTS NOT COMPLETED

- 7 DT I (1975) DEFICIENCIES STILL UNCORRECTED

CONCLUSION

HIGH RISK IN TRANSITING TO FSP. PROBLEMS WITH SAFETY, HF, RAM, PERFORMANCE CAN PROBABLY BE SOLVED

RECOMMENDATION

DEFER FSP DECISION UNTIL ENVIRONMENTAL REQUIREMENTS CAN BE MET

FIGURE III-8

In contrast to its ASARC briefing, the AMSAA Independent Evaluation Report (IER), January 1981, reported the concerns, conclusions and recommendations as shown in Figure III-9. The OTEA test Report as shown in Figure III-10 was consistent with the ASARC briefing but included other MPT related issues as shown. Human Factors Engineering and Safety issues were not discussed during the program review. The decision of the ASARC was to approve type classification standard and full scale production.

(3) The FDTE was conducted at Fort Hood, Texas using the 1st Cavalry Division Artillery Target Acquisition Battery during late 1981.

(4) It is DARCOM policy that Program Managers of those systems that receive ASARC Tasker letters (including FIREFINDER) should in turn task the U.S. Army Human Engineering Laboratory to provide assistance in organizing, interpreting, and presenting the Human Factors Engineering Analysis (HFEA). As a portion of the HFEA, the HEL will provide the health hazard assessment and/or biomedical considerations which have been developed by the U.S. Army Medical Research and Development Command. The intent of the HFEA is to provide the DCSPER with an appraisal of the PM's incorporation of human factors engineering in the research, development, and acquisition of Army systems. If there is a consensus among Pre-ASARC attendees that HFE is progressing properly, no formal HFEA briefing is required at the ASARC. The

FIREFINDER RADARS
AN/TPQ-37, DT III, AMSAA IER, JAN 1981

AMSAA CONCERNS

- SAFETY HAZARDS
- DOLLY SET UNSATISFACTORY
- RELIABILITY GOAL NOT MET
- INCOMPLETE ENVIRONMENTAL TESTS
- MOBILITY NOT FULLY TESTED

CONCLUSIONS

- HF PROBLEMS DO NOT PRECLUDE FIELDING
- ADDITIONAL TESTING REQUIRED BEFORE FSP DECISION

RECOMMENDATIONS

- COMPLETE MOBILITY AND ENVIRONMENTAL TESTS BEFORE FSP

FIGURE III-9

FIREFINDER RADARS
AN/TPQ-37, OT III, OTEA, SEP-NOV 1980

ISSUES	FINDINGS: EVALUATED	PARTIALLY EVALUATED	NOT EVALUATED	COMMENTS
VALIDATE CREW SIZE	✓			ADEQUATE
TACFIRE COMPATIBILITY	✓			INTERFACE QUESTION REMAINS
C^3	✓			NOT FULLY RESOLVED
TACTICAL MOBILITY	✓			NEED SOP TRAINING
SURVIVABILITY/ VULNERABILITY		✓		NEED FURTHER ASSESSMENT
RAM		✓		MAINTENANCE SUPPORT BY CONTRACTORS NO MAINTENANCE TEST PACKAGE
PERSONNEL SELECTION AND TRAINING	✓			NO PROBLEMS
DOCTRINE, TACTICS AND ORGANIZATION	✓			ADEQUATE

FIGURE III-10

ODCSPER representative at the ASARC then comments from the table on the adequacy of HFE. In the case of ASARC IIIa for the AN/TPQ-37, a hurry-up HFEA in the form of a trip report was presented by HEL and accepted by the preliminary review attendees. There was not recorded discussion of HFE at the ASARC.

(5) A Manpower Analysis Paper (MAP) was prepared in February 1981. The paper identified a 50 percent increase in crew size (8 versus 12) between the AM/MPQ-4 and the new AN/TPQ-37. Based on a planned assignment of two AN/TPQ-37s to each active division (16), the paper calculated a total active Army manpower increase directly attributable to FIREFINDER of 128 personnel (32 crews x 4 per crew = 128).[9] No trade-off options were identified in the analysis, and there was an indication that the 128 spaces had already been accommodated in the programmed Army force structure.

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[9] The AN/TPQ-37 is not planned for assignment to the air assault division; therefore, the total personnel increase should be 120 versus 128.

IV. DETERMINATION OF MPT REQUIREMENTS - ANALYSIS

A. INTRODUCTION

As discussed in Sections II and III, the FIREFINDER Program has not followed the acquisition pattern outlined in the Army's LCSMM. The skipped Conceptual and Demonstration/Validation Phases during development of the AN/TPQ-36 and movement from Demonstration/validation directly to Production and Deployment in the case of the AN/TPQ-37 are examples of how the program departed from the suggested LCSMM process. Such deviations from "standard" are neither unusual nor necessarily damaging to a system development program, as long as the acquisition community takes steps to ensure that critical events are not skipped and to compensate for those steps that are bypassed.

The key to making the process work, particularly when the LCSMM is significantly modified, is communication. Clear, continuous, and multiple lines of formal and informal communication should be established early in the acquisition process between counterparts representing the materiel developer, combat developer, tester, and contractor(s). While simple enough in theory, this seems to rarely happen in actual practice. Often times, equivalent counterparts either do not exist or, at best, are hard to find in all segments of the heterogeneous acquisition community for a given system. Organizational and geographical separation combined with inequalities among counterparts in such

areas as experience, training, grade level, organizational depth, program priority, and assignment stability also weaken communication effectiveness and consistency.

The FIREFINDER Program has not been immune to this problem. Underlying most of the issues addressed in this analysis is evidence of either good or poor communication, depending on how the issue was handled.

B. HUMAN FACTORS ENGINEERING

How well soldier and machine interface in any new system is largely a function of how well and how early human factors engineering is integrated into the total system design. This is not to imply that full or even prime responsibility for effective Soldier-Machine Interface (SMI) falls on the shoulders of the Human Factors Engineer working for the system contractor. On the contrary, the ultimate responsibility for ensuring good system SMI rests with the Army itself and begins with aggressive involvement in the initial process of defining a new system. Definition should go beyond hardware description to include Human Factors Engineering and Manpower, Personnel, and Training (HFE/MPT) requirements and constraints to be considered in the basic design.

The second and more difficult step is articulation of constraints and/or requirements to contractors in precise language that can be both understood and applied during the design pro-

cess; simple reference to military standards and specifications is not enough. It can be argued that detailed specifications dampen design initiative and imagination and lead to development of systems which are inferior to those designed with relatively few constraints. The counter argument is that life cycle cost considerations, in terms of both dollars and people, require that contractors be given some specific criteria concerning operation and maintenance of proposed systems. Otherwise, a contractor might design a highly capable and even cheap to produce system, but one which can be neither operated nor maintained by projected available manpower (quantitative or qualitative).

Language in RFPs and contracts related to MPT/HFE requirements/constraints, in addition to being definitive and precise, ought to be forceful and enforceable. In RFPs, for example, HFE/MPT issues should be specifically and significantly weighted in the source selection criteria.

In the case of both FIREFINDER radars, the statements of materiel need (MN) addressed a number of MPT requirements/constraints such as crew size; ease of operation and organizational maintenance; and specific RAM criteria (pgs 32 & 33 and Figure III-1a-e, supra). Had these factors been as definitively addressed in RFPs and contractural documents, and stressed during the source selection process, Human Factors Engineering could have significantly influenced design of both radars. Unfortunately, that did not happen, and HFE took a backseat in terms of

both government effort and contract dollars during critical development phases. Primary emphasis. in contractual documents was on technical performance and Design-to-Unit Production Costs.

Comments concerning HFE in the DT III Report by TECOM illustrate the effect of a weak HFE effort in design of the AN/TPQ-37. The system was found to be unsafe to operate, dangerous to maintain, and plagued by other HFE problems. Since AMSAA, in its DT III IER, concluded that the HFE problems do not preclude fielding, it may be sometime after fielding the AN/TPQ-37 before the impact of a weak HFE effort on the quality of the soldier-machine interface can be fully assessed.

C. QUALITATIVE MANPOWER REQUIREMENTS

There is no reliable standard set of tools/techniques for determining qualitative manpower requirements for new Army sytems; however, a number of research initiatives are underway to develop such a methodology. Currently, Subject Matter Experts (SME) in the Army's materiel (DARCOM) and combat (TRADOC) development communities independently estimate qualitative requirements using a variety of criteria such as professional judgement; operational and maintenance experience with like or similar systems; the existing MOS structure; and when available, task and skill analyses generated either by LSA or other similar processes. The qualitative estimation process is initiated by the materiel developer and documented in a QQPRI.

The 1972 Materiel Need (MN) statements for both FIREFINDER radars envisioned using the same MOSs as were operating and maintaining the predecessor radar, AN/MPQ-4. The 1973 AN/TPQ-36 QQPRI affirmed that qualitative concept by listing MOS 17B as the radar/generator operator and MOS 26B as the organizational through GS level maintainer.

Data examined during this study indicates that it was not until 1977 that voices in the acquisition community began to call attention to the fact that new technology being designed into both radars would require significantly different -- but not necessarily greater -- skills to operate and maintain them. This is attributable to a number of factors, some of which are cited below.

- Early qualitative estimates were primarily based on experience with like and similar systems rather than a task and skill analysis generated by the LSA process, which theoretically would have been a more accurate predictor.
- The LSA process as we know it today was just beginning to be implemented during the early FIREFINDER acquisition stages. That, combined with low funding of LSA during the same period, precluded the use of any reliable qualitative tools besides professional judgement and prior experience with similar systems.
- The first FIREFINDER operational test (AN/TPQ-37) in 1975 did not evaluate soldier-machine interface in sufficient detail to discover any mismatch between existing skills and those needed to operate and maintain the new equipment.
- Army manpower planners in the combat development (TRADOC) and personnel (MILPERCEN/DCSPER) communities did not directly participate in the qualitative manpower determination process during the early FIREFINDER acquisition phases. Early qualitative predictions in the MNs and materiel developer input to preliminary QQPRIs went essentially unnoticed, unanalyzed, and consequently, unchallenged by the manpower planners.

During the almost two years between the tentative MOS decision in November 1977 and the final in June 1979, no significant qualitative manpower changes occurred. The major qualitative issue addressed during that period, and the one apparently responsible for it taking 2 years to move from a tentative to final decision concerned whether the FIREFINDER maintainer should be MOS 26B with an ASI or a new MOS. Had more direct communication taken place, i.e., face-to-face meetings of the responsible parties (TRADOC, DARCOM, and MILPERCEN) rather than relying on written correspondence through channels (see discussion at III.E.2.d.(4) supra), the issue might have been resolved more quickly and with a better understanding of all the facets of the problem.

D. QUANTITATIVE MANPOWER REQUIREMENTS

1. General

The tools and techniques for determining quantitative manpower requirements are no more standard or analytically sound than those in use for estimating qualitative needs. Quantitative estimation techniques currently in use include professional judgement, particularly for operator positions; operational and maintenance experience with like or similar systems; O&O concepts, including usage and displacement rates; and for maintenance requirements, DPAMMH, either estimated or generated by the LSA process, in combination with factors provided in AR 570-2, Manpower Authorization Criteria (MACRIT).

The quantitative process, like the qualitative, is initiated by the materiel developer (usually a subordinate Materiel Development and/or Readiness Command (MDC/MRC) within DARCOM, e.g., CECOM in the case of FIREFINDER) through preparation of a QQPRI. Quantitative inputs to the QQPRI by the MDC/MRC inlcude an estimate of direct operators needed to make up a single shift crew, and DPAMMH by MOS and level of maintenance for each system component. Except for the direct crew size, the materiel developer makes no independent estimate of quantitative manpower requirements. The combat developer (usually a proponent school with TRADOC, e.g., U.S. Army Field Artillery School in the case of FIREFINDER) makes the quantitative estimate using data from the QQPRI, and employing some combination of the nonstandard tools listed above. The quantitative estimate is then documented in a BOIP which lists changes in manpower by MOS and grade required in each Army organization slated to receive the system.

2. Crew Size

The AN/TPQ-36 crew size of eight, initially predicted in the MN, is the same as for the AN/MPQ-4 radar being replaced, and has remained unchanged throughout the acquisition process. While it was originally thought that the AN/TPQ-37 crew size might also be eight, the OT I in 1975 determined that a 12-man crew was needed for sustained operations.

3. Maintenance Requirements

Predictions of DPAMMH for each radar, a key input to the formula used to calculate maintenance spaces, have flucuated significantly over time. Early predictions were based on experience with like or similar systems. Later estimates have been based on incomplete and admittedly weak LSA. A summary and comparison of various DPAMMH for each radar reported in successive QQPRIs is shown in Table IV-1 below.

TABLE IV-1

DPAMMH BY LEVEL OF MAINTENANCE
REPORTED IN SUCCESSIVE QQPRIs

Maintenance Level	AN/TPQ-36			AN/TPQ-37	
	1973	1977	1979	1977	1979
Crew/Organizational	185	425	305	700	401
Direct Support	291	244	88	174	140
General Support	284	130	63	94	76
Depot	-	-	-	-	-

In the case of FIREFINDER, the generation of inconsistent maintenance data has thus far had no real effect on quantitative maintenance manpower requirements. None of the various DPAMMH reported in successive QQPRIs will, when inserted into the MACRIT formulas provided in AR 570-2, produce a requirement of more than one maintainer per system at any given maintenance level.

E. TRAINING REQUIREMENTS

An estimate of training requirements (course length & content) for a new system can be only as good as the prediction of qualitative manpower required to operate and maintain it. The two are inexorably linked, thereby suggesting that the combat developer (TRADOC proponent school) should be the key participant in the process of performing both appraisals.

Within the acquisition community, a proponent school for any given CMF is theoretically in the best position to know all the dynamics affecting MOSs in that CMF, e.g., other new systems planning to use the same MOS, training shortfalls reported by field units, CMF restructering studies, and difficulties in meeting training projections (input or output).

In the case of the FIREFINDER radars, the U.S. Army Field Artillery Center & School (USAFAC&S) is the proponent school. The USAFAC&S has been actively involved in the MPT requirements determination process since 1977, and was instrumental in the decision to combine training for both radars.

FIREFINDER operator (MOS 13R10) training (6 weeks, 2 days) is two weeks shorter than AN/MPQ-4 radar operator (MOS 17B10) training (8 weeks, 2 days). This is primarily attributable to the electronic automation of many operational tasks in the FIREFINDER systems.

The FIREFINDER organizational maintainer (MOS 13RX5) course (14 weeks, 4 days), when combined with the prerequisite operator

course, is two days longer than the AN/MPQ-4 organizational maintainer (MOS 27B20) course. Specific organizational maintenance tasks are fewer on the FIREFINDER radar than those required on the AN/MPQ-4 due to BITE, solid state design, and module replacement capability. However, about the same amount of training is necessary to ensure that FIREFINDER system students are well grounded in the advanced technology featured in the new system, e.g., digital logic, computer fundamentals, and electronic troubleshooting with sophisticated test instruments.

The decision not to create a new DS maintenance MOS for FIREFINDER meant that the basic MOS 26B30 DS/GS maintenance course (9 weeks, 2 days) had to be extended for those students designated for assignment as FIREFINDER DS maintainers (MOS 26B30K1). That extension amounts to 13 weeks, 2 days, or in other words, a total training time of 22 weeks, 4 days. It was earlier estimated that training of a separate DS maintenance MOS for FIREFINDER would require 14 weeks, 2 days.

The approach of using an ASI (K1) for MOS 26B30 rather than creating a new MOS will increase initial FIREFINDER system training costs. However, the low density of FIREFINDER DS maintainers seems to justify use of an ASI.

VI. CONCLUSIONS

A. Manpower, Personnel, and Training (MPT) requirements/ constraints, although fairly well defined in the system requirements document (MN) for each radar, were neither adequately addressed in RFPs and early development contractual documents nor significantly stressed in the source selection process. Consequently, early development efforts focused on technical performance and cost. Little attention was paid to achieving RAM goals, implementing a viable LSA program, or integrating HFE into early system design efforts. A significant number of deficiencies identified in the first operational tests of both radars can be traced to a lack of emphasis on RAM and a weak LSA effort; some RAM goals still have not been met.

B. Weak contractual requirements and guidance concerning HFE, low funding of the early HFE, and minimal involvement of HEL in monitoring and assessing the contractor's HFE effort, contributed to HFE related problems, some of which remain unresolved.

C. Determination of FIREFINDER qualitative manpower requirements was slow and complicated because of a weak LSA effort, inadequate early operational testing, and a lack of timely communication and coordination between planners in various Army agencies (DARCOM, TRADOC, and MILPERCEN).

D. True quantitative maintenance manpower requirements for FIREFINDER radars remain unknown due to inconsistent and

questionable data thus far generated by the LSA process; problems concerning the availability and employment of EQUATE at the GS maintenance level; and a lack of standard and analytically sound tools and techniques which could be used to either fine tune LSA data or compensate for its weakness in the calculation of quantitative requirements.

APPENDIX B

FIREFINDER Program Data Collection Sources

Headquarters, Department of the Army (HQDA), Washington, D.C.

- o DA System Coordinator (DASC), Office of the Deputy Chief of Staff, Research, Development, and Acquisition (ODCSRDA).
- o Force Integration System Officer (FISO), Office of the Deputy Chief of Staff, Operations (ODCSOPS).
- o Requirements Directorate, ODCSOPS
- o Army Force Modernization Coordination Office (AFMCO), ODCSOPS
- o Manpower Programs and Budget Directorate, Office of the Deputy Chief of Staff, Personnel (ODCSPER)

US Army Materiel Development and Readiness Comand (DARCOM)

- o Headquarters, DARCOM, Alexandria, VA
  - Office of Project Management
  - Equipment Authorization Review Activity (EARA)
- o Electronics Research and Development Command, Adelphi, MD
  - Product Assurance Division (Telephonic)
- o Communications and Electronics Materiel Readiness Command, Fort Monmouth, N.J.
  - Project Management Office, FIREFINDER/REMBASS
  - Maintenance Engineering Directorate
  - Procurement Directorate
- o Test and Evaluation Command, Aberdeen Proving Ground, MD
  - Material Test Directorate Human Factors, Group (Telephonic)
  - Technical Directorate (Telephonic)
- o Materiel Readiness Support Activity (MRSA), Lexington Blue Grass Army Depot, KY
  - Maintenance Division

APPENDIX A

MAJOR MPT RELATED REFERENCES

POLICIES & PROCEDURES

Department of Defense

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MIL-H-46855B, Human Engineering Requirements for Military Systems, Equipment, and Facilities

Department of the Army

AR 1-1	Planning Programming and Budgeting Within the Department of the Army
AR 10-4	US Army Operational Test and Evaluation Agency
AR 10-5	Department of the Army
AR 10-11	US Army Materiel Command
AR 10-25	US Army Logistics Evaluation Agency
AR 10-41	US Army Training and Doctrine Command
AR 11-4	System Program Reviews
AR 11-8	Principles and Policies of the Army Logistic System
AR 15-14	Systems Acquisition Review Council Procedures
AR 70-1	Army Research, Development and Acquisition
AR 70-2	Materiel Status Recording

AR 70-10	Test and Evaluation During Development and Acquisition of Materiel
AR 70-16	Department of the Army System Coordinator (DASC) System
AR 70-27	Outline Development Plan/Development Plan, Army Program Memorandum/Defense Program Memorandum/ Decision Coordinating Paper
AR 70-61	Type Classification of Army Materiel
AR 71-1	Army Combat Developments
AR 71-2	Basis of Issue Plans
AR 71-3	User Testing
AR 71-9	Materiel Objectives and Requirements
AR 71-10	Department of the Army Force Integration Staff Officer (FISO) System
AR 310-31	Management System for Tables of Organization and Equipment (The TOE System)
AR 310-34	Equipment Authorization Policies and Criteria, and Common Tables of Allowances
AR 310-49	The Army Authorization Documents System (TAADS)
AR 350-1	Army Training
AR 350-10	Management of Army Individual Training Requirement and Resources
AR 350-35	New Equipment Training and Introduction
AR 570-2	Organization and Equipment Authorization Tables - Personnel
AR 602-1	Human Factors Engineering Program
AR 611-1	Military Occupational Classification Structure Development and Implementation
AR 611-201	Enlisted Career management Field and MOSs
AR 70-18	Provisioning of U.S. Army Equipment
AR 700-127	Integrated Logistic Support
AR 702-3	Army Materiel Reliability, Availability and Maintainability (RAM)

AR 750-1 Army Materiel Maintenance Concepts and Policies

AR 750-43 Test, Measurement, and Diagnostic Equipment

AR 1000-1 Basic Policies for Systems Acquisition

DA PAM 11-2 Research and Development Cost Guide for Army Materiel Systems

DA PAM 11-3 Investment Cost Guide for Army Materiel Systems

DA PAM 11-4 Operating and Support Cost Guide for Army Materiel Systems

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- o Human Engineering Laboratory (HEL), Aberdeen, MD (Telephonic only)

  - HEL Detachment, Fort Sill, OK

- o Materiel Systems Analysis Activity (AMSAA), Aberdeen, MD

  - Combat Support Division

  - Reliability, Availability, and Maintainability Division

US Army Training and Doctrine Command (TRADOC)

- o Headquarters, TRADOC, Ft Monroe, VA

  - Deputy Chief of Staff, Combat Developments

- o US Army Field Artillery Center and School, Ft. Sill, OK

  - TRADOC System Manager (TSM), FIREFINDER

  - Combat Developments Directorate

  - Training Developments Directorate

  - Field Artillery Board

- o US Army Ordance Center and School, Aberdeen Proving Ground, MD

  - Combat Developments Directorate

- o Soldier Support Center - National Capital Region (SSC-NCR), Alexandria, VA

  - Military Occupational Development Directorate

  - Personnel Resources Analysis Directorate

- o Logistics Center, Ft Lee, VA

- o Training Support Center, Ft Eustis, VA

US Army Operational Test and Evaluation Agency (OTEA), Falls Church, VA

US Army Research Institute for the Behavioral Sciences, Alexandria, VA

- o ARI Field Unit, Fort Hood, TX

- o ARI Field Unit, Fort Sill, OK

APPENDIX C

FIRFINDER PROGRAM DOCUMENTS REVIEWED

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ODCSOPS

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US Army Materiel Development and Readiness Command

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FIREFINDER Project Office

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Materiel Fielding Plan, AN/TPQ-36 and AN/TPQ-37, 28 March 1980

Decision Coordinating Paper, Milestone IIIa, AN/TPQ-37, 8 December 1980.

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US Army Test and Evaluation Command

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US Army Human Engineering Laboratory

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HQ, TRADOC

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APPENDIX D

GLOSSARY OF ACRONYMS

AAO--Authorized Acquisition Objective
AAPMH--Available Annual Productive Man-Hours
AD--Advanced Development
ADP--Automatic Data Processing
ADTA--Aircraft Development Test Activity
AEFA--Aviation Engineering Flight Activity
AFH--Annual Flight Hours
AFMCO--Army Force Modernization Coordination Office
ALMC--Army Logistics Management Center
AMIM--Army Modernization Information Memorandum
AMMH--Annual Maintenance Manhours
AMSAA--Army Material Systems Analysis Activity
AP--Acquisition Plan
APA--Aviation Procurement-Army
APM--Army Program Memorandum
AR--Army Regulation
ARI--Army Research Institute for the Behavioral and Social Sciences
ARTEP--Army Training Evaluation Program
ASARC$_3$--Army System Acquisition Review Council
ASD,C^{3}I--Assistant Secretary of Defense, Command, Contro, Communications, and Intelligence
ASD, MRAL--Assistant Secretary of Defense, Manpower, Reserve Affairs, and Logistics
ASI--Additional Skill Identifier
ASIOE--Associated Support Items of Equipment
ASP--Ammunition Supply Plant
ASVAB--Armed Services Vocational Appitude Battery
ATE--Automatic Test Equipment
ATSC--Army Training Support Center
AURS--Automated Unit Reference Sheet
AUTODIN--Automatic Digital Network
AVIM--Aviation Intermediate Maintenance
AVUM--Aviation Unit Maintenance
BCE--Baseline Cost Estimate
BCS--Battery Computer System
BITE--Built-In Test Equipment
BLACKHAWK--UH-60 Utility Helicopter
BN--Battalion
BOI--Basis of Issue
BOIP--Basis of Issue Plan
BTA--Best Technical Approach
BTRY--Battery
C$_3$--Command, Control & Communications
C^{3}I--Command, Control, & Communications, and Intelligence
CAC--US Army Combined Arms Center
CAIG--Cost Analysis Improvement Group
CARDS--Catalog of Approved Requirements Documents
CD-Combat Developer
C-E--Communications-Electronics
CECOM--US Army Communications and Electronics Command
CEFR--Communications-Electronics Functional Review
CFE--Contractor Furnished Equipment
CFP--Concept Formulation Package
CFV--Cavalry Vehicle System
CM--Configuration Management
CMF--Career Management Fueld
CMMH--Corrective Maintenance Manhours
COA--Comptroller of the Army
COEA--Cost and Operational Effectiveness Analysis
COMSEC--Communications Security
CONUS--Continental United States
CPFF--Cost Plus Fixed Fee
CPIF--Cost Plus Incentive Fee
CPG--Central Processor Group
CPX--Command Post Exercise
CSA--Chief of Staff, US Army

CTA--Common Table of Allowances
CTEA--Cost and Training Effectiveness Analysis
CTP--Coordinated Test Program
DA--Department of the Army
CSAC--Combat Support Aviation Company
DAPAM--US Army Materiel Development and Readiness Command
DASC--Department of the Army System Coordinator
DCA--Defense Communication Agency
DCP--Decision Coordinating Paper
DCSLOG--Deputy Chief of Staff for Logistics
DCSOPS--Deputy Chief of Staff for Operations and Plans
DCSPER--Deputy Chief of Staff for Personnel
DCSRDA--Deputy Chief of Staff for Research, Development, and Acquisition
DDRE--Director of Defense Research and Engineering
DEPSECDEF--Deputy Secretary of Defense
DIO--Director of Industrial Operations
DOD--Department of Defense
DODD--Department of Defense Directive
DODI--Department of Defense Instruction
DP--Development Plan
DPAMMH--Direct Productive Annual Maintenance Manhours
DPM--Defense Program Memorandum
DS--Direct Support
DSARC--Defense System Acquisition Review Council
DSMC--Defense Systems Management College
DT--Developmental Testing
DT (I, II, III)--Development Test (I, II, III)
DTC--Design to Cost
DTUPC--Design to Unit Production Cost
EARA--Equipment Authorization Review Activity
ECP--Engineering Change Proposal
EQUATE--Electronic Quality Assurance Test Equipment
FACS--Field Artillery Center & School
FAMAS--Field Arfillery Meteorological Acquisition System
FDTE--Force Development Testing and Experimentation
FIREFINDER--AN/TPQ-36 Mortar Locating Radar & AN/TPQ-37 Artillery Locating Radar
FISO--Force Integration System Officer
FM--Field Manual
FMMRS--Force Modernization Milestone Reporting System
FOE--Follow-On Evaluation
FORSCOM--US Army Forces Command
FQQPRI--Final QQPRI
FSED--Full Scale Engineering Development
FVS--Fighting Vehicle System
FY--Fiscal Year
FYTP--Five Year Test Program
GCT--Government Competitive Test
GEMM--Generalized Electronics Maintenance Model
GFE--Government Furnished Equipment
GS--General Support
GSRS--General Support Rocket System
HEL--US Army Human Engineering Laboratory
HEMAT--Heavy Expanded Mobility Ammunition Trailer
HEMTT--Heavy Expanded Mobility Tactical Truck
HET--Heavy Expanded Truck
HF--Human Factors
HFE--Human Factors Engineering
HHS--Headquarters and Headquarters & Service Battery
HQDA--Headquarters, Department of the Army
ICTP--Individual and Collective Training Plan
IEP--Independent Evaluation Plan

IER--Independent Evaluation Report
IFV--Infantry Fighting Vehicle
ILS--Integrated Logistic Support
ILSM--Integrated Logistic Support Manager
ILSMM--Integrated Logistic Support Management Model
ILSMT--Integrated Logistic Support Management Team
IOC--Initial Operational Capability
IPR--In Process Review
IPS--Integrated Program Summary
IPTF--Indirect Productive Time Factor
ISI--Information Spectrum, Inc.
ISMMH--Inspection & Servicing Maintenance Manhours
ITV--Improved TOW Vehicle
JCS--Joint Chiefs of Staff
JTA--Joint Table of Allowances
JWG--Joint Working Group
LCSMM--Life Cucle System Management Model
LEA--US Army Logistics Evaluation Agency
LIN--Line Item Number
LLM--Launcher Loader Module
LOA--Letter of Agreement
LOGCEN--US Army Logistics Center
LOGSACS--Logistic Structure & Composition Sys.
LON--Letter of Notification
LP/C--Launch Pod/Container
LR--Letter Requirement
LRIP--Low Rate Initial Production
LSA--Logistic Support Analysis
LSAR--Logistic Support Analysis Record
LSP--Logistic Support Plan
MAA--Mission Area Analysis
MACOM--Major Army Command
MACRIT--Manpower Authorization Criteria
MADP--Material Acquisition Decision Process
MAP--Manpower Analysis Paper
NCC--Mission Configuration Change
MD--Material Developers
MDC-Material Development Command
MEA--Maintenance Engineering Analysis
MENS--Mission Element Need Statement
MFK--Mission Flexibility Kit
MFP--Material Fielding Plan
MICOM--US Army Missile Command
MILPERCEN--US Army Military Personnel Center
MIRAT--MILPERCENT Initial Recruiting & Training Plan
MIST--Man Integrated System Technology
MLRS--Multiple Launch Rocket System
MOE--Measure of Effectiveness
MOS--Military Occupation Specialty
MPT--Manpower, Personnel, and Training
MRC--Materiel Readiness Command
MRF--Milestone Reference File
MRSA--US Army Material Readiness Support Activity
MTBF--Mean-Time Between Failures
MTBM--Mean Time Between Maintenance
MTBR--Mean Time Between Removal
MTOE--Modification Table of Organization Equipment
MN--Material Need
MTTR--Mean-Time-To-Repair
NET--New Equipment Training
NETP--New Equipment Training Plan
NETT--New Equipment Training Team
NSA--National Security Agency
OCO--Operational Capability Objective
ODP--Outline Development Plan
OLM--Organizational Maintenance
OOC--Operational & Organizational Concept
OPA--Other Procurement-Army
OSA--Orrice, Secretary of the Army
ODS--Office, Secretary of Defense
OT--Operational Testing
OT--(I, II, III)--Operational Test (I, II, III)
OTE--Operational Test and Evaluation

OTEA--US Army Operational Test and Evaluation Agency
OTP--Outline Test Plan
PCB--Printed Circuit Board
PERSACS--Personnel Structure and Composition System
PGSE--Peculiar Ground Support Equipment
PIP--Product Improvement Proposal
PLDMD--Platoon Leader's Digital Message Device
PM--Project Manager
PMP--Project Management Plan
POC--Point of Contact
POM--Program Objective Memorandum
PPBS--Planning, Programming, and Budgeting System
PQQPRI--Provisional QQPRI
PTTDAR--Personnel, Training, and Training Device Analysis Report
QQPRI--Qualitative and Quantitative Personnel Requirements Information
RAM--Reliability, Availability, Maintainability
RDTE--Research, Development, Test and Evaluation
REOC--Replenishment of Expendables and Operational Checks
RFP--Request for Proposal
ROC--Required Operational Capability
SA--Secretary of Army
SACS--Structure and Composition System
SECDEF--Secretary of Defense
SIMOR--Space Imbalance MOS.
SISMS--Standard Integrated Support Management System
SME--Subject Matter Expert
SMI--Soldier-Machine Interface
SMIR--Soldier-Machine Interface Requirements
SOW--Statement of Work
SPAS--Skill Performance Aids
SPLL--Self-Propelled Launcher Loader
SQT--Skill Qualification Test
SRC--Stadard Requirements Code
SSC-NCR--Soldier Support Center - National Capital Region
SSEB--Source Selection Evaluation Board
SSG--Special Study Group
SSI--Specialty Skill Identifier
STF--Special Task Force
STOG--Science and Technology Objectives Guide
TAADS--The Army Authorization Documents
TACFIRE--Field Artillery Tactical Fire Direction System
TAMMS--The Army Maintenance Management System
TC--Type Classification
TDR--Training Device Requirement
TDA--Table of Distribution and Allowances
T&E--Test and Evaluation
TECOM--US Army Test and Evaluation Command
TEMP--Test and Evaluation Master Plan
TIWG--Test Integrated Working Group
TM--Technical Manual
TMOS--Tentative Military Occupation Specialty
TOA--Trade-Off Analysis
TOD--Trade-Off Determination
TOE--Table of Organization and Equipment
TRADE--Training Devices
TRADOC--US Army Training and Doctrine Command
TRASSO--TRADOC System Staff Officer
TRITAC--Tri-Service Tactical Communication System
TSARCOM--US Army Troop Support and Aviation Material Readiness Command
TSM--TRADOC System Manager
USAAC--US Army Aviation Center
USAFAC--US Army Field Artillery Center
USAMMCS--US Army Missile & Munitions Center and School
USAREUR--US Army Europe
USASC--US Army Signal Center
USATSC--US Army Training Support Center
UTTAS--Utility Tactical Aircraft System
VCSA--Vice Chief of Staff Army