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MAINTENANCE CATEGORIES - A SUBSTUDY OF THE MAINTENANCE
SUPPORT STRUCTURE FOR CONTINGENCY FORCES STUDY (ACN 21012).

Coordination Draft.

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY TRAINING AND DOCTRINE COMMAND
FORT MONROE, VIRGINIA 23651

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Letter on file

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ABSTRACT

↘ This study briefly recounts the origins of the current four categories or levels of maintenance effort (organizational, direct support, general support, and depot maintenance), and analyzes the background for current allocations of maintenance tasks. Teams of field-experienced maintenance personnel performed Level Of Repair Analyses on 50 Army maintenance-significant end items, and made necessary corrections in their Maintenance Allocation Charts. The cost/operational effectiveness of these corrected allocations was verified in comparison with the uncorrected allocations in a contractor-developed computer simulation which incorporated a combat scenario. The study concludes that some specific clarifications and minor policy changes in Army regulations and technical manuals are required. ↑

SUMMARY

1. BACKGROUND. When the US Army Combat Developments Command Maintenance Agency was disestablished in 1973, proponentcy for five maintenance studies was transferred to the US Army Ordnance Center and School. One of these studies evolved into "Maintenance Support Structure for Contingency Forces," a carrier program under which nine substudies were arrayed. This is one of those nine substudies.

2. PURPOSE. To examine the current categories of maintenance to determine if new commodity-oriented categories are necessary for operators and managers, at all levels in the field, to plan, organize, and execute their maintenance functions.

3. INTRODUCTION.

a. History. Since before World War II, maintenance categories (formerly called echelons) have existed as reference terms describing a structure of different levels at which responsibilities for maintenance tasks are allocated (assigned for performance).

b. Four categories are in current use: organizational, direct support, general support, and depot maintenance. Both maintenance complexity and the numbers of man-hours involved in repairs generally increase as one progresses from organizational, through direct support and general support, to depot maintenance. The purpose of this categorization is to relate maintenance to other military operations, to facilitate assignment of responsibility for

specific maintenance tasks for specific materiel to specific levels of command, and to permit an orderly and efficient distribution of maintenance assets.1,1-25/

c. The maintenance concept for a given commodity grouping of materiel specifies which, if not all, of the four maintenance categories will be utilized in the maintenance support of that commodity.1,2-3/ For example, the maintenance concept for small arms uses only three categories: organizational, direct support, and depot maintenance. Appendixes B through I of AR 750-1 describe the maintenance concepts and typical maintenance tasks for commodity groupings which encompass the majority of Army materiel. Thus it can be seen that the Army's current maintenance system already includes commodity-oriented maintenance concepts.

d. Maintenance allocations direct that specific maintenance tasks pertaining to a specific end item will be performed at specific maintenance categories. Consequently, a maintenance allocation takes precedence over a maintenance concept when they differ.

e. In the past few decades, the number and names of maintenance categories have changed, but these changes in categories have had little effect on Army maintenance in the field because maintenance allocations changed very little during the same period. The study team therefore focused its attention on the maintenance allocation process and on the product of that process, Maintenance Allocation Charts (MAC). An individual MAC applies

only to an individual model or family of similar end items of materiel, and usually is found as an appendix in the Organizational Maintenance Technical Manual for the end item.

f. Technical Manual 38-715-1, Provisioning Techniques, provides the most specific allocation policy, stating that the maintenance operations for each assembly will be assigned to the farthest forward category of maintenance capable of performing the task.^{2,93/}

g. Development of the MAC, or assuring the adequacy of a contractor-developed MAC, is the responsibility of the maintenance engineering activity 1,2-10/ which is an organizational element of the National Maintenance Point (NMP), a part of each Commodity Command within the US Army Materiel Development and Readiness Command (DARCOM).

h. Most MACs are developed originally by contractors, as a part of their responsibilities in connection with their development of a new end item for the Army. Although the new end item must have its own MAC, in most instances the new item is replacing a similar item. Given this situation, it has often seemed logical and desirable to the contractor that the new item should have its maintenance tasks allocated in a manner similar (in terms of maintenance categories) to the MAC of its predecessor. Unfortunately, where allocation errors have existed in the earlier MAC, this situation has often resulted in the perpetuation of those errors. The fact that this condition has developed is not

sufficient cause to condemn current maintenance allocations. It simply sets the stage for a more careful examination of this facet of the Army maintenance system.

4. DISCUSSION.

a. The study team discovered a surprisingly large number of persons who were unaware of the fact that MAC charts are the primary authorities governing maintenance responsibilities at all categories of maintenance. The team became convinced that the absence of any explicit reference, in AR 750-1, to this fundamental policy has led to misunderstandings and confusion on the part of many who are not intimately acquainted with the Army maintenance system.

b. The study team also found, in many maintenance engineering activities of DARCOM Commodity Commands, a lack of awareness of the specific maintenance allocation policy in TM 38-715-1. On the basis of this finding, the team reasoned that there was a strong probability that many end item contractors had been unaware of this policy while they were developing many of the MAC charts in current use. It therefore seemed probable that many existing MAC charts contain allocation errors, and that a significant proportion of existing maintenance tasks might not have been allocated to the farthest forward category capable of performing the task. The team recognized that, if this situation proved to be true, correction of the allocation errors would have a favorable impact on materiel operational availability rates.

c. Accordingly, the approach to the problem was to subject each MAC chart for a selected sample of end items to an objective Level of Repair Analysis (LORA) by Army personnel who had extensive hands-on experience in maintaining the items in a military environment. Field experience of this sort has seldom been consulted when maintenance allocation charts were being developed. Therefore, the study team concluded that the objective LORA approach, if well structured, would provide MAC chart corrections which could then be evaluated as to their effect on equipment operational availability rates.

5. ALTERNATIVES. The number of ways in which maintenance allocations might be corrected is essentially infinite. There are roughly 5,000 end items in the current inventory ^{3/}, most maintenance allocation charts contain many tasks, and there are usually four or more possible allocations for each task. For these reasons, the study team chose alternatives which are expressed in terms of general trends:

- (a) Retain the status quo.
- (b) Allocate a significant proportion of Army maintenance tasks to categories farther to the rear than at present.
- (c) Allocate a significant proportion of Army maintenance tasks to categories farther forward than at present.

6. METHODOLOGY.

a. Since it was not possible to analyze all of the approximately 5000 end items in the current inventory, the study

team addressed a selected sample of 50 end items. The maintenance allocations for these maintenance-significant items were analyzed by Level of Repair Analysis (LORA) teams, which were teams of experienced maintenance personnel of the proponent TRADOC schools. These personnel (usually non-commissioned and warrant officers) were without exception highly qualified and accustomed to thinking in terms of the field environment. Each LORA consisted fundamentally of an objective evaluation of the maintenance task allocations in a MAC. Each task allocation was challenged in terms of whether or not it was correctly allocated. The maintenance skills, tools and test equipment involved in the tasks were the major considerations. When an incorrect allocation was found, it was identified, together with the correct maintenance category to which it should be allocated. The methodology employed in the LORA is described in detail in Appendix E. With few exceptions, the final product of each LORA was a listing of maintenance allocation chart corrections for that end item. The lists are at Appendix H, and are summarized in Chapter 2. The summary statistics clearly reflected a trend toward allocation of a significant proportion of maintenance tasks to categories farther forward.

b. The Cost - Operational Effectiveness Analysis (COEA) and Scenario-Oriented Recurring Evaluation System (SCORES) for this study were integrated by a contractor into a single computer simulation model. A detailed discussion of the simulation model

and the COEA methodology is at Appendix I. Further details pertaining to SCORES evaluation are at Appendix G.

7. LEVEL OF REPAIR ANALYSES (LORA).

a. General. The corrections in maintenance allocations made by the LORA teams were too numerous to deal with individually. Consequently, to facilitate identification of any trends, the correction statistics were arrayed by commodity groupings - primarily the commodity groupings shown in the appendixes to AR 750-1. Arrayed in this way, the correction statistics not only revealed a trend, but also tended to highlight characteristic differences in the maintenance allocations developed by different DARCOM Commodity Commands. Item descriptions and allocation corrections or summary discussions for all of the end items in the sample are located at Appendix H.

b. Summary of LORA results.

(1) Following is a compilation, for the entire sample, of the total numbers of maintenance tasks which were moved forward:

TASKS MOVED FORWARD

DS to Org	585
GS to Org	25
GS to DS	227
Depot to Org	11
Depot to DS	111
Depot to GS	256

The total numbers of maintenance tasks moved rearward are shown below:

TASKS MOVED REARWARD

Org to DS	21
DS to GS	26
DS to Depot	2

Following are the totals of the allocations of those maintenance tasks which were found to be both unassigned in the current MACs, and important enough to justify allocation to a specific category.

NEW ALLOCATION

Org	115
DS	126
GS	50
Depot	5

A review of these results reveals a clearly evident trend which indicates that a significant proportion of maintenance tasks can and should be performed at categories farther forward than those to which they are currently allocated.

9. COEA-SCORES ANALYSIS.

a. Selection of acceptable alternatives. At the conclusion of the LORAs, Alternative 2 (see page xiv) became clearly recognizable as inconsistent not only with the trends established by the LORAs, but also with the philosophy of the new FM 100-5 4,12-7/.

Consequently, Alternative 2 was dropped from further consideration, and the COEA was structured to assess the relative worths of

Alternatives 1 and 3. Alternative 1 was taken as the baseline case, and Alternative 3 was compared with it. The COEA-SCORES analysis is described in Appendix I.

b. Results. The measure of effectiveness results of the COEA indicated that equipment operational availability (OA) rates increase as a result of implementing Alternative 3. The greatest enhancement in OA rates was observed on the self-propelled howitzer (+9%) and on the tank (+6%). Both of these items are characterized by relatively low mean time between failures, and, of course, by their importance to the tactical commander. Other model results indicated that no significant backlogs developed as a result of the increased workload at the organizational level.

9. FINDINGS.

a. During the course of the study, the study team discovered a surprising lack of understanding of the fundamental fact that MAC charts are the primary authorities governing maintenance responsibilities at all categories of maintenance. AR 750-1 fails to state this fundamental policy explicitly, and this omission appears to be a major contributor to the misunderstandings and confusion which are so frequently encountered, particularly among those who are not intimately acquainted with the maintenance system.

b. The results of the LORAs showed clearly that the maintenance task allocation policy contained in TM 38-715-1 frequently has not been followed during the preparation of MAC

charts. The efforts of the LORA teams showed that MAC chart corrections made by applying the TM 38-715-1 policy caused significant proportions of maintenance tasks to be moved farther forward. The COEA-SCORES analysis, in turn, showed that these corrections cost-effectively enhanced operational availability rates for materiel on the simulated battlefield.

c. Toward the completion of the LORAs, the study team investigated various ways of making it possible for the Army to take advantage of such LORA-based MAC chart corrections on a routine and continuing basis. The team discovered an existing mechanism called postprovisioning reviews, outlined in AR 700-18. The present policy governing these reviews will require modification to enable such reviews to take advantage of lessons learned from the study's LORAs, and to accomplish similar reductions in errors in, and improve the effectiveness of, future MAC charts.

10. CONCLUSIONS.

a. Confusion and misunderstanding would be reduced if the maintenance concepts in AR 750-1 were to state explicitly that MAC charts are the primary authorities governing maintenance responsibilities at all categories of maintenance.

b. Operational availability rates would be enhanced if the allocation policy in TM 38-715-1 were complied with during initial preparation of MAC charts, and if MAC charts corrected through compliance with this policy were to supersede current charts.

c. Future MAC charts would be improved if AR 700-18 were to make postprovisioning reviews mandatory (with LORA input from the TRADOC schools which train repairmen), and if DA Forms 2028 pertaining to the MAC charts were to be directed to those TRADOC schools.

11. RECOMMENDATIONS.

a. That the maintenance concepts in AR 750-1 be revised to state explicitly that MAC charts are the primary authorities governing maintenance responsibilities at all categories of maintenance.

b. That AR 750-1 be revised to cite the allocation policy in TM 38-715-1 as the primary reference for allocation of maintenance tasks, and that MAC charts corrected in compliance with this policy supersede current charts.

c. That AR 700-18 be revised to make postprovisioning reviews mandatory at 18 months and 36 months after deployment of a new end item, with LORA input from the TRADOC school which trains support maintenance personnel for the item in question, and that technical manuals containing MAC charts be revised so that DA Forms 2028 which pertain to their MAC charts will be directed to those TRADOC schools.

CHAPTER 1

INTRODUCTION

1-1. PROBLEM. To examine the current categories of maintenance to determine if new commodity-oriented categories are necessary for operators and managers, at all levels in the field, to plan, organize, and execute their maintenance functions.

1-2. BACKGROUND.

a. The STEADFAST reorganization of the Department of the Army in 1973 directed the disestablishment of the US Army Combat Developments Command Maintenance Agency. Consequently, a part of its mission was transferred to the US Army Ordnance Center and School, including the proponentcy for five maintenance studies. One of these was entitled "Maintenance Support Structure for Contingency Forces". Its study directive and associated correspondence are at Appendix A. A review of this study directive precipitated an intensive analysis of US Army retail maintenance. Its findings led to the conclusion that within the retail maintenance system there were several areas to be investigated, each of which deserved separate, individual study. Consequently, "Maintenance Support Structure for Contingency Forces" was established as a carrier program, and the specific areas of investigation which had been identified were arrayed as substudies of the carrier. This arrangement had the advantage of keeping the individual substudies manageable, while helping to foster continuity and compatibility between them. This

particular substudy, "Maintenance Categories", was derived from the original study directive and is one of nine substudies identified at the outset of the program.

b. A review of maintenance system history (See Appendix C) reveals that since before World War II, maintenance categories (formally called echelons) have existed as reference terms describing a structure of different levels to which responsibilities for maintenance tasks are allocated (assigned for performance). The purpose of this categorization is to relate maintenance to other military operations, to facilitate assignment of responsibility for specific maintenance tasks for specific materiel to specific levels of command, and to permit an orderly and efficient distribution of maintenance assets. 1,1-25/

c. Four categories are in current use: organizational, direct support, general support, and depot maintenance. 1,1-25/ A brief, simplified description of each category follows:

(1) Organizational Maintenance encompasses the maintenance responsibilities of the using unit commander. These responsibilities include preventive maintenance services and those repairs which maintenance allocation charts assign to the using unit.

(2) Direct Support Maintenance is usually performed by separate TOE maintenance units in direct support of using units. Repairs assigned to such units by Maintenance Allocation Charts (MAC) are performed on a repair-and-return-to-user basis.

(3) General Support Maintenance is performed by separate TOE maintenance units in support of lower category maintenance. Repairs assigned to such units by MAC charts are usually performed on a repair-and-return-to-supply-system basis. A general support maintenance unit may be required to provide temporary return-to-user support when a supported direct support maintenance unit is overloaded.

(4) Depot Maintenance encompasses the most extensive repairs assigned by MAC charts, and its output normally augments depot stocks of serviceable materiel. It also supports the farther forward categories, taking advantage of its more extensive shop facilities and equipment, and its personnel, who possess more specialized technical skills.

d. In the past few decades, the number and names of maintenance categories have changed, but allocations of maintenance tasks have remained essentially unchanged. The answer to the basic question, "Who repairs what?", can easily remain the same while maintenance categories are restructured and/or renamed. Recognition of this relationship caused the study team ultimately to focus its attention on the maintenance allocation process and on the product of that process, Maintenance Allocation Charts. However, confusion early in the study (including in the wording of the study's Problem statement) with regard to the relationship between maintenance categories and maintenance concepts makes it appropriate first to review the nature of maintenance concepts.

e. The maintenance concept for a given commodity grouping of materiel specifies which, if not all, of the four maintenance categories will be utilized in the maintenance support of that commodity. 1,2-3/ For example, the maintenance concept for small arms uses only three categories: organizational, direct support, and depot maintenance. Appendixes B through I of AR 750-1 describe the maintenance concepts and typical maintenance tasks for commodity groupings which encompass the majority of Army materiel. Elsewhere in the same regulation 1,2-3 & 2-10/, developers of new materiel are required to consider "tailoring" the basic (four category) maintenance concept to best conform to the maintenance requirements of each new item. Thus it can be seen that the Army's current maintenance system already includes commodity-oriented (and even some individual-end-item-oriented) maintenance concepts. The maintenance concepts described in Appendixes to AR 750-1 are useful in that they provide broad, generalized descriptions of typical maintenance tasks performed by personnel at the various category levels, but the primary determination of "who repairs what" is made in maintenance allocations, which direct that specific maintenance tasks pertaining to a specific end item will be performed at specific maintenance categories. Consequently, a maintenance allocation takes precedence over a maintenance concept when there is a difference between them.

f. Maintenance allocations are disseminated to the field, in technical manuals (TM), in the form of Maintenance Allocation

Charts (MAC). A MAC, which applies only to an individual model or family of similar end items of materiel, usually is found as an appendix in the Organizational Maintenance Technical Manual (-10, -12, or -20 TM) for the end item. It is intended to be a ready reference for all maintenance personnel, but particularly for organizational maintenance personnel because they usually make the earliest diagnosis as to which specific maintenance task must be accomplished in order to correct a failure.

g. The influence of a MAC, once it is developed, is far-ranging and difficult to assess completely. However, certain important effects are easily recognizable. Once a maintenance task is allocated to a specific category, the types of organizations/units authorized to perform that task are immediately identifiable. From these, one can also identify the MOSs of the personnel in those units, their tools and test equipment, and the repair parts which they must be able to obtain.

h. Figure 1 is a portion of the MAC for the Tank, Combat, FT, 105mm Gun, M60 and M60A1, found in TM 9-2350-215-20. As can be seen, it is quite specific. Once a failure has been diagnosed, the required maintenance action can easily be determined, and the maintenance element responsible for that maintenance action becomes readily apparent. This particular technical manual was prepared in 1965 and is in the format prescribed at that time.

i. Figure 2 is considerably more recent. It is a portion of the MAC for the Carrier, Personnel, FT, Armored, M113A1 and the

Maintenance Allocation Chart - Continued

GROUP NO.	COMPONENT AND RELATED OPERATIONS	CATEGORY						TOOLS REQ'D	REMARKS
		ORGANIZATIONAL			DS	GS	D		
		O/C	CO	BN					
1	2	3	4	5	6	7	8	9	10
2324	GROUP 2300 SIGHTING AND FIRE CONTROL (OPTICAL ITEMS) - Continued								
	Replace -----			X					
	Repair -----				X				
	Overhaul -----						X		
	PERISCOPE M32 (IR)								Gunner's
	Service -----	X							
	Adjust -----				X				
	Inspect -----	X							
	Replace -----			X					
	Repair -----				X				
	Overhaul -----						X		
	HEAD ASSEMBLY								
	Service -----	X							
	Inspect -----	X							
	Replace -----			X					
2326	POWER PACK AND IMAGE CONVERTER TUBE								
	Service -----				X				
	Inspect -----				X				
	Replace -----				X				
	PERISCOPE M34 (VISIBLE)								Com- mander's
	Service -----	X							
	Adjust -----				X				
	Inspect -----	X							
	Replace -----			X					
	Repair -----				X				
	Overhaul -----						X		
	HEAD ASSEMBLY								
	Service -----	X							
	Inspect -----	X							
	Replace -----			X					

Figure 1. Page from MAC for M60A1 Tank.

B-31

MAINTENANCE ALLOCATION CHART

(1) GROUP NO	(2) COMPONENT ASSEMBLY NOMENCLATURE	(3) MAINTENANCE FUNCTION											(4) TOOLS AND EQUIPMENT	(5) REMARKS
		Inspect	Test	Service	Adjust	Align	Calibrate	Install	Replace	Repair	Overhaul	Rebuild		
1301	GROUP 13 SUSPENSION ANCHOR, torsion bar BAR, torsion								O				85 through 88, Table B-1	Repair at "C" by replacing individual shoes (not sections).
	CYLINDER, suspension lock- out (M741 only).								O	F				
	TUBES, HOSES, AND FIT- TINGS, suspension lockout (M741 only).								O					
1303	ADJUSTER, track tension ARM, idler wheel			C					O	F				
	BEARINGS, SEAL, AND HUBS, idler wheel.				O				O				89 and 90, Table B-1	
	SPINDLE, idler wheel arm WHEEL, idler				C				O					
1304	CUSHION, drive sprocket carrier.								O					
	SPROCKET, drive								O				91, Table B-1	
1304	WHEEL, sprocket								O					
1305	TRACK, drive				C				O	O			87, 88, 92, and 93, Table B-1	
	TRACK SHOE								O	D	D	D		
1311	ARM, BEARINGS, HUBS, AND SEALS, road wheel.				O				O				83, 89, and 90, Table B-1	
	BUMPER AND BRACKET, road wheel arm.								O					
	ROAD WHEEL								O	D	D	D	94 and 95, Table B-1	
	GROUP 14 STEERING													
1403	BRAKE ASSEMBLY, pivot			O					O	F			96, Table B-1	
	CONTROLS AND LINKAGE, differential.				O				O					
	CONTROLS AND LINKAGE, pivot brake.				O				O					
	DISK, pivot brake								O					
	LINING, pivot brake								O					
	LINES, HOSES, AND FIT- tings, pivot brake.								O					
	MASTER CYLINDER, pivot brake.								O	F				

Figure 2. Page from MAC for M113A1 Armored Personnel Carrier.

family of vehicles utilizing the same chassis. The codes utilized in this are:

- C - Crew
- O - Organizational
- F - Direct Support
- H - General Support
- D - Depot

This MAC is also quite detailed, with a separate column for each possible maintenance function pertaining to a particular component, assembly, subassembly or piece-part which requires maintenance apart from the parent component. In a comparison of these two MACs, the second can be seen to have the potential of providing more information because of its format.

j. The third example of a MAC, Figure 3, pertains to the Central Office, Telephone, Manual AN/TTC-29, (in TM 11-5805-582-15 dated August 1971). This particular chart does not deal with components or subassemblies of the major item. The multiple category symbols in some of the columns, and some of the entries in the Remarks column suggest that there are in fact separable components or assemblies of the system, but these are not identified in the chart and therefore the usefulness of this particular chart is limited. Three other aspects which further limit its usefulness should also be noted. First, responsibility for replacement is not allocated at all. Second, the frequently-referenced tool "6" is described elsewhere only as

Figure 3. Page from MAC for AN/TTC-29 Manual Telephone Central Office.

"tools and test equipment associated with the components of this item". Third, the MAC for this item refers the reader to the MACs in four other TMs for allocations not made in this chart. The reader who can manage to locate these four second-level manuals will discover that two of them refer him once again - this time to a third level of manuals. The study team, familiar with the usually incomplete TM libraries in field units, did not pursue this exercise beyond the level indicated because it is improbable that maintenance personnel in the field would be able to progress even to that depth.

k. Current policies pertaining to allocation of maintenance tasks appear in more than one location. Technical Manual 38-715-1, Provisioning Techniques, provides the most specific policy, stating that the maintenance operations for each assembly will be assigned to the farthest forward category of maintenance capable of performing the task. 2.93/ AR 750-21, DA Equipment Maintenance Management Program, (which implements DOD Directive 4151.16, 30 August 1972) differs from this only slightly, stating that maintenance will be performed at the point that insures readiness without impairing the self-sufficiency and continuity of the using unit's mission. 5.3/

1. Development of the MAC, or assuring the adequacy of a contractor-developed MAC, is the responsibility of the maintenance engineering activity 1.2-10/ which is an organizational element of the National Maintenance Point (NMP), a part of each Commodity

Command within the US Army Materiel Development and Readiness Command (DARCOM). A MAC is prepared during the maintenance support planning phase of the development cycle which must be accomplished for each supportable end item and weapon system, including off-the-shelf and leased equipment.

m. Most MACs are developed originally by contractors, as a part of their responsibilities in connection with their development of a new end item for the Army. Although the new end item must have its own MAC, in most instances the new item is replacing a similar item. Given this situation, it has often seemed logical and desirable to the contractor that the new item should have its maintenance tasks allocated in a manner similar (in terms of maintenance categories) to the MAC of its predecessor. Unfortunately, where allocation errors have existed in the earlier MAC, this situation has often resulted in the perpetuation of those errors. The fact that this condition has developed is not sufficient cause to condemn current maintenance allocations. It simply sets the stage for a more careful examination of this facet of the Army maintenance system.

1-3. ASSUMPTIONS.

a. The current austere fiscal environment will continue and may become even more severe.

b. US Army contingency forces will be required to respond to any crisis world-wide and to sustain themselves for the duration of the crisis regardless of the environment. During such a crisis,

the availability of repair parts in the field, and the skills, shortages and MOS mismatches of maintenance personnel assigned to Army TOE units will be approximately the same as they were during FY66 in South Vietnam.

1-4. LIMITATIONS.

- a. This study considered active US Army forces only.
- b. CONUS TDA maintenance activities were excluded.
- c. Maintenance support provided other services and allies was excluded.
- d. The aircraft, rail and marine, missile, medical, cryptographic, Army Security Agency, and nuclear commodities of materiel were excluded.

CHAPTER 2

DISCUSSION/ANALYSIS

2-1. APPROACH TO THE PROBLEM.

a. The Background portion of the previous chapter described the considerations which led the study team to focus its attention on the maintenance allocation process and on Maintenance Allocation Charts (MAC). During the course of the study, team members briefed many visitors to the US Army Ordnance Center and School, and discussed various elements of the study with personnel at other logistics-oriented activities during dozens of TDY trips and countless telephone conversations. Two rather puzzling gaps in general knowledge emerged from these extensive contacts.

(1) First, the team discovered a surprisingly large number of persons who were unaware of the fact that MAC charts are the primary authorities governing maintenance responsibilities at all categories of maintenance. When asked to identify what maintenance tasks were to be accomplished by maintenance units at the various maintenance categories, many would refer to the maintenance concepts in the appendixes of AR 750-1, and to the examples of typical tasks listed there. On close examination, the team was surprised to find that the majority of these AR 750-1 maintenance concepts do not even mention this fundamental MAC authority, and the few references made are to types of maintenance tasks or functions. As the study progressed and additional examples of misunderstanding were encountered, the study team became

increasingly convinced that the absence of any explicit reference, in AR 750-1, to this fundamental policy has led to misunderstandings and confusion on the part of many who are not intimately acquainted with the Army maintenance system.

(2) Second, the study team found, in many maintenance engineering activities in the DARCOM Commodity Commands, a lack of awareness of the specific maintenance allocation policy in TM 38-715-1, which states that each maintenance task will be allocated to the farthest forward category of maintenance capable of performing the task. 2,93/ On the basis of this finding, the team reasoned that there was a strong probability that many end item contractors had been unaware of this policy while they were developing many of the MAC charts in current use. It therefore seemed probable that many existing MAC charts contain allocation errors, and that a significant proportion of existing maintenance tasks might not have been allocated to the farthest forward category capable of performing the task. The team recognized that, if this situation proved to be true, correction of the allocation errors would have a favorable impact on materiel operational availability rates.

b. The maintenance allocation decision which has the greatest impact on operational availability rates for materiel is the decision which results from the choice between allocating to the organizational maintenance category or allocating to the direct support maintenance category. The extensive differences in impact

between these two allocations can perhaps be seen most clearly by the using unit commander. When he is faced with an equipment failure, the pertinent maintenance allocation (as reflected in the MAC) may or may not authorize his own unit to make the needed repair. If it does, the arrangement is definitely to his advantage, since normally his unit can return the item to service in a relatively short period of time, and meanwhile he is in a position to influence the repair action through his establishment of priorities and responsibilities. If, on the other hand, the MAC does not authorize the needed repair to be performed at the organizational category, the commander must rely on another unit for assistance. This time he has no recourse but to relinquish control of the item and to pass that control on to his direct support maintenance unit (DSU). Usually this entails physically moving the failed item to a DSU work area, although often there are circumstances when (after at least a short delay) the DSU may send a maintenance support team to where the failed item is located. In any event, the time required for a DSU repair is generally greater, not only because of the increased complexity of the maintenance task to be performed, but also because this particular task must compete with others for the finite amount of support which the DSU is capable of providing. Furthermore, in this situation the using unit commander has lost his ability to directly influence any aspect of the repair action. The total time period that is involved in DS maintenance cannot be specified exactly, but an

expected range would be from a few hours to a few days. Waiting for the arrival of necessary repair parts can extend this time drastically.

c. Accordingly, the approach to the problem was to subject each MAC chart for a selected sample of end items to an objective Level of Repair Analysis (LORA) by Army personnel who had extensive hands-on experience in maintaining the items in a military environment. Field experience of this sort has seldom been consulted when maintenance allocation charts were being developed. Therefore, the study team concluded that the LORA approach, if well structured, would provide MAC chart corrections which could then be evaluated as to their effect on equipment operational availability rates.

2-2. ALTERNATIVES.

a. General. The number of ways in which maintenance allocations might be corrected is essentially infinite. There are roughly 5,000 end items in the current inventory ^{3/}, most maintenance allocation charts contain many tasks, and there are usually four or more possible allocations for each task. For these reasons, the study team chose alternatives which are expressed in terms of general trends. It was anticipated that, although the preferable trend would probably become apparent by the time the LORAs were completed, it would be necessary to await the results of the COEA-SCORES analysis before the desirability of that trend could be confirmed.

b. In view of the above, the following trend-type alternatives were selected:

- (1) Retain the status quo.
- (2) Allocate a significant proportion of Army maintenance tasks to categories farther to the rear than at present.
- (3) Allocate a significant proportion of Army maintenance tasks to categories farther forward than at present.

2-3. STUDY METHODOLOGY.

a. End Item Sample. Since there are about 5000 different end items in the current inventory,^{3/} it was immediately apparent that a review of all MACs was not feasible. The study team, therefore, searched for a manageable sample of about 50 end items which would be representative of the commodities within the scope of the study. The sample selected can be described as an adaptation of a list utilized by the US Army Maintenance Management Center (USAMMC) for intensive review and continuous monitoring.^{6,11/} USAMMC selected the end items on its list primarily for their maintenance significance and mission essentiality. The study team's adaptations of the USAMMC list consisted of deletion of a few duplicative items and the addition of such items as office machines, the protective mask, a laundry unit, a bakery plant, and several fire control instruments. Appendix D discusses the development of the sample in greater detail, and lists the end items which were analyzed during the course of the study.

b. Level of Repair Analysis (LORA).

(1) A Level of Repair Analysis (LORA) is fundamentally an objective evaluation of the task allocations in a Maintenance Allocation Chart (MAC). LORAs of the end items in the sample constituted a major part of the study effort. These analyses brought together the following elements:

- (a) Maintenance expertise and experience
- (b) Doctrinal references
- (c) Disciplined approach
- (d) Technical publications (maintenance and parts manuals)
- (e) Actual examples of end items

(2) The maintenance expertise utilized in the LORAs consisted of teams of maintenance instructors and supervisory personnel at the proponent TRADOC schools. These personnel were generally non-commissioned and warrant officers. The team members were without exception highly qualified, collectively experienced in all categories of maintenance, and accustomed to thinking in terms of the field environment. The analyses usually took place in instructional facilities where training-aid end items could be used for hands-on examinations. When a LORA team was assembled, it was equipped with applicable technical manuals. A member of the study team briefed the LORA team initially, explaining the nature of the study and applicable doctrinal references (including the allocation policy in TM 38-715-1), and cautioning the members of the LORA team that they

could consider only current unit capabilities, without changing existing unit skills, tools, or equipment.

(3) The analysis itself consisted of an objective evaluation of the maintenance task allocations as specified in the MAC. Each maintenance task was challenged in terms of whether or not it was correctly allocated in the MAC chart. The example of the end item, and appropriate tools and equipment were physically examined whenever a member of the LORA team so desired. When an incorrect allocation was found, it was identified, together with the correct maintenance category to which it should be allocated.

(4) With few exceptions, the final product of each LORA was a listing of maintenance allocation chart corrections for that end item. The lists are assembled at Appendix H. The LORA findings are summarized later in this chapter. The summary statistics reflected a trend which was an important consideration during the structuring of the COEA.

c. Cost-Operational Effectiveness Analysis (COEA) and Scenario Oriented Recurring Evaluation System (SCORES).

(1) The COEA and SCORES methodologies for this study were integrated by a contractor into a single computer simulation model 7/. The contractor found that he was not able to use an extensive simulation such as Models of the US Army Worldwide Logistic System (MAWLOGS), or even any of the relatively simple existing simulations. Consequently, the contractor developed a new simulation tailored to accomodate available inputs. Briefly,

the simulation consists of three parts: (a) A preprocessor which accepts policy, opens files, and generates "failures" based on unit engagement codes, (b) The main model where the actual simulation is played, and (c) The post-processor in which the results are tallied and output statistics are printed. Output statistics include operational availability rates by end item, by period. This output provides the primary measure of effectiveness.

(2) A more detailed discussion of the simulation model and the COEA methodology is at Appendix I. Further details pertaining to SCORES evaluation are at Appendix G.

2-4. LEVEL OF REPAIR ANALYSES (LORA).

a. General. The corrections in maintenance allocations made by the LORA teams were too numerous to deal with individually. Consequently, to facilitate identification of any trends, the correction statistics were arrayed by commodity groupings - primarily the commodity groupings shown in the appendixes to AR 750-1. Arrayed in this way, the correction statistics not only revealed a trend, but also tended to highlight characteristic differences in the maintenance allocations developed by different DARCOM Commodity Commands. Item descriptions and allocation corrections or summary discussions for all of the end items in the sample are located at Appendix H. Each of the following eight subparagraphs summarizes the LORA results for one of the commodity groupings.

b. Electronics equipment.

(1) Twenty-one items are included in this portion of the sample. The following figures summarize the results of these analyses, in terms of the numbers of electronics maintenance tasks which were found to be incorrectly allocated, and were corrected by reallocating them to other categories as indicated.

TASKS MOVED FORWARD

DS to Org	262
GS to Org	14
GS to DS	153
Depot to DS	102
Depot to GS	251
Depot to Org	10

TASKS MOVED REARWARD

Org to DS	12
DS to GS	17

Following is a summary of the numbers of tasks which were found to be unassigned in the sample MACs, and were therefore allocated to appropriate maintenance categories by the LORA teams.

NEW ALLOCATIONS

Org	6
DS	87
GS	48
Depot	2

(2) The electronics commodity proved to be particularly in need of this type of analysis. MACs in this commodity group presently identify many failures which the organizational repairman has the capability to isolate down to a subassembly or part. However, replacement of that subassembly or part is presently allocated to a maintenance category farther to the rear. Hands-on examination of these items by the LORA teams revealed that most of the replacement tasks also were within the organization's capabilities. Since maintenance tasks vary a great deal in complexity and in the time they require, it is important to recognize that the comparative size of these numbers is more significant than the numbers themselves. For example, the more complex and sophisticated nature of direct support repairs precludes their being compared with organizational repairs on anything like a one-for-one basis. Although piece-part repair may appear to be a departure from established electronics maintenance policy, it should be remembered that very little of today's electronic equipment is completely modularized. Therefore, a certain amount of piece-part replacement/repair is particularly advantageous if done at the organizational level, because maintenance there avoids the necessity for transporting major components, or even the entire set, to a maintenance activity some distance away. Electronics equipment is particularly susceptible to damage from improper handling during such trips. These analyses

were performed at Fort Huachuca, Fort Sill, and Aberdeen Proving Ground.

c. Automotive and Mobile Electric Power (MEP) Generating Equipment.

(1) In this portion of the sample, ten end items were analyzed for level of repair. Total numbers of maintenance tasks which were corrected by re-allocating them are shown below:

TASKS MOVED FORWARD

DS to Org	122
GS to DS	24

The maintenance tasks which were found to be unassigned were allocated as follows:

NEW ALLOCATIONS

Org	1
DS	10

(2) This commodity grouping was found to have fewer requirements for correcting allocations than the electronics equipment. This can be attributed to a number of factors. Principal among these in the view of the study team was the fact that this materiel is not modularized to any great extent, and therefore the repairman deals with a smaller number of relatively large assemblies such as engines, transmissions, and axles. Not only is the replacement of these assemblies time-consuming, but the diagnosis and repair of malfunctions of their internal components is impractical at the more forward categories of maintenance,

because of the excessive time and the repair parts loads that such repairs require. These analyses were performed at Aberdeen Proving Ground.

d. Combat Vehicles and Heavy Weapons.

(1) The study sample contains eight end items in this commodity group. Totals of allocations corrected in this part of the sample were as follows:

TASKS MOVED FORWARD

DS to Org	101
GS to DS	15
Depot to GS	4

During the course of this analysis, 14 maintenance tasks were moved rearward. An example is the Bearing Assembly, Traversing, on the M551. Its replacement requires removing the turret. While this bearing could conceivably be replaced at direct support, its failure would be expected to be accompanied by other failures requiring the higher category skills, tools, and facilities of GS maintenance. The LORA team, therefore, concluded that the farthest forward category which had the proper capability for this repair was general support maintenance.

(2) During the course of this analysis, a number of important tasks were found to be unassigned. The following list reflects the allocation of these additional tasks, by category:

NEW ALLOCATIONS

Org	68
DS	28
GS	1
Depot	3

These analyses were performed at Aberdeen Proving Ground.

e. Construction and Materials Handling Equipment.

(1) Five items of construction equipment and MHE were subjected to Level of Repair Analysis. The results were somewhat similar to those found in the Automotive and Mobile Electric Power Generating Equipment portion of the sample. Totals of maintenance tasks moved forward were:

TASKS MOVED FORWARD

DS to Org	48
GS to Org	5
GS to DS	5

During the course of this analysis, three maintenance tasks were moved rearward. Both replacement and repair of the engine assembly of the 20-ton crane were moved from direct support to general support. The third task was the replacement of the winch assembly on the Tractor, FT, D7E, which was moved from organizational to direct support. These decisions were based primarily on the equipment required for replacing these components. Maintenance tasks that were found to be unassigned during the course of the analysis were allocated as follows:

NEW ALLOCATIONS

Org	1
GS	1

(2) Most end items in this commodity grouping are essentially adaptations of standard commercial items. This fact frequently leads to maintenance difficulties because the equipment was not designed with an objective of making it compatible with Army maintenance concepts. The most obvious consequence is its lack of maintainability characteristics, which often causes maintenance tasks on such commercial items to require more time and effort than similar tasks on military-design items. As can be seen from the analysis results, however, the basic similarities between these items and standard Army automotive materiel are such that the trend of movement forward was repeated. These analyses were performed at Fort Belvoir and Aberdeen Proving Ground.

f. Small Arms.

(1) The study end item sample contains two small arms. They are the M16A1 Rifle and the M60 Machine Gun. Following is a summary of those maintenance tasks which were moved forward:

TASKS MOVED FORWARD

DS to Org	12
Depot to DS	9

Only a single task was moved rearward - the repair of the M16A1 stock assembly. This decision was based upon the fact that the stock is fiberglass and its repair is best accomplished in the

service section of a direct support unit. Following is the distribution of unassigned maintenance tasks which were detected during the analysis.

NEW ALLOCATIONS

Org	6
DS	1

(2) Small arms are particularly suitable for maintenance close to the place of failure. They are high density, mission-essential items which can be repaired with a minimum of special tools and Test, Measurement & Diagnostic Equipment (TMDE), and the tools required for their repair, as well as their repair parts, are relatively small and easily transported. These analyses were performed at Aberdeen Proving Ground.

g. Office Machines.

(1) Two office machines, a typewriter and an adding machine, are included in the end item sample. As is typical of items in this commodity, these items do not have Army technical manuals or maintenance allocation charts. Instead, users and maintenance personnel alike must rely on manufacturer's manuals. This situation necessitated an alteration in the approach to the analysis; the research team focused its attention on an evaluation of the maintenance concepts currently being taught in the service school.

(2) The results of this analysis included the recommendations that users of these machines continue to be responsible for

preventive maintenance, and that responsibility for repairing office machines be concentrated at the DS and GS levels. The majority of routine repairs would be performed by DS repairmen who would go forward to the using units and repair the equipment on-site. This approach is both feasible and desirable, since the necessary tools and high-mortality repair parts are small and easily transported by a single individual, and most office machines are quite susceptible to in-transit damage, like many items of electronic equipment.

This analysis was performed at Fort Lee.

h. Chemical-Biological Equipment.

(1) Two items of Chemical-Biological equipment are included in the end item sample. They are the M17A1 Mask and the APC-mounted flamethrower. The numbers of maintenance tasks which were moved forward are shown below:

TASKS MOVED FORWARD

DS to Org	40
GS to Org	6
GS to DS	30
Depot to Org	1
Depot to GS	1

No maintenance tasks were moved rearward on these items.

Allocations of those maintenance tasks found to be unassigned in the MACs for these items are shown below:

NEW ALLOCATIONS

Org	33

(2) The Chemical-Biological Equipment portion of the sample is unique among the groupings utilized in this study because it is comprised of greatly dissimilar items. There are no parts common to both the protective mask and the flame thrower. As a result, differing results were derived from their analyses. The flame thrower was treated much the same as other weapons. By contrast, the level of repair analysis on the protective mask included the recommendation that only the face piece group be repairable and that the carrier be a throwaway item. Furthermore, the recommended maintenance concept envisions only depot repair of the face piece above the organizational category. Under this concept, masks not repairable at the organization would be turned-in through supply channels on a one-for-one exchange basis. The unserviceable, repairable assets would then be shipped to a depot for repair and return to the supply system. Since the transactions would take place in supply channels, there would be no requirement for DS or GS maintenance on the protective mask. These analyses were performed at the Ordnance and Chemical Center and School at Aberdeen Proving Ground.

i. Summary of LORA results.

(1) Following is a compilation, for the entire sample, of the total numbers of maintenance tasks which were moved forward:

TASKS MOVED FORWARD

DS to Org	585
GS to Org	25
GS to DS	227
Depot to Org	11
Depot to DS	111
Depot to GS	256

The total numbers of maintenance tasks moved rearward are shown below:

TASKS MOVED REARWARD

Org to DS	21
DS to GS	26
DS to Depot	2

Following are the totals of the allocations of those maintenance tasks which were found to be both unassigned in the current MACs, and important enough to justify allocation to a specific category.

NEW ALLOCATIONS

Org	115
DS	126
GS	50
Depot	5

(2) The preceding discussion presented the results of the LORAs for the end items in the study sample. A review of these results reveals a clearly evident trend which indicates that a significant proportion of maintenance tasks can and should be

performed at categories farther forward than those to which they are currently allocated.

2-5. COEA-SCORES ANALYSIS.

a. Selection of acceptable alternatives. At the conclusion of the LORAs, Alternative 2 (see page 2-5) became clearly recognizable as inconsistent not only with the trends established by the LORAs, but also with the philosophy of the new FM 100-5 4,12-7/. Consequently, Alternative 2 was dropped from further consideration, and the COEA was structured to assess the relative worths of Alternatives 1 and 3. Alternative 1 was taken as the baseline case, and Alternative 3 was compared with it. The COEA-SCORES analysis is described in Appendix I. Highlights of that description are presented in the paragraphs below.

b. Model. The basic vehicle for the COEA was a contractor-developed computer simulation model, named Maintenance and Support Concepts, acronym MASC 7/. The contractor's product was further refined by members of the study team, who conducted an extensive supplementary analysis and made many additional model runs. An expanded version of the ME II Scenario was used as the operational setting from which force structures and scenario-dependent parameters were drawn. Operational availability (OA) rates for several mission-essential, maintenance-significant, high-density end items were used as the Measure of Effectiveness (MOE) for evaluation of the acceptable alternatives. This MOE complies fully with the requirement of FM 100-5 4,12-2/.

Model input specified the lowest level of repair for each of ten generic types of failures associated with each end item. For comparison of the two acceptable alternatives, MAC chart corrections resulting from the LORAs were translated into adjustments of these lowest levels of repair. The LORA corrections increased the number of organizational tasks by an average of only about twelve percent, but the nature of the model caused these corrections to affect lowest levels of repair to a considerably greater extent. This result had the effect of worst-casing the model's analysis of the increased workload at the organizational level.

c. Operational Effectiveness. The measure of effectiveness results of the COEA, as shown in Table 1, indicate that equipment operational availability rates increase as a result of implementing Alternative 3. This was the expected result, since the travel and administrative times involved in moving items from organizational to support levels are reduced.

<u>Item</u>	<u>Alternative 1 Availability</u>	<u>Alternative 3 Availability</u>	<u>Percent Change</u>	<u>Relative Effectiveness</u>
1/4 Ton Truck	0.858	0.858	0%	1.00
2 1/2 Ton Truck	0.793	0.804	+1%	1.01
5 Ton Tractor	0.694	0.710	+2%	1.02
Forklift (6000 RT)	0.777	0.794	+2%	1.02
M113A1 Carrier	0.818	0.825	+1%	1.01
155MM SP Howitzer	0.486	0.530	+9%	1.09
M60A1 Tank	0.621	0.661	+6%	1.06

MOE: OPERATIONAL AVAILABILITY
Table 1

The greatest enhancement in OA rates was observed on the self-propelled howitzer and the tank. Both of these items are characterized by relatively low mean time between failures, and, of course, by their importance to the tactical commander. Other model results indicated that no significant backlogs developed as a result of the increased workload at the organizational level.

d. Cost Analysis. The methodology for the determination of costs for the acceptable alternatives was based upon the concept of incremental cost analysis. That is, only the changes in relevant costs 8,87/ between Alternative 1 and Alternative 3 were considered. The Cost Analysis concluded that no relevant changes in cost could be attributed to the implementation of Alternative 3. Therefore, the relative cost ratio was found to be 1.0. Details of the Cost Analysis are contained in Appendix 1.

e. Relative Worth. Since the relative cost ratio for Alternative 3 was found to be 1.0, the Relative Worth figures, as shown in Table 2, are identical to the Relative Effectiveness figures shown in Table 1.

Item	Relative Effectiveness	Relative Cost	Relative Worth
	MOE: Operational Availability (OA)		MOE: OA
1/4 Ton Truck	1.00	1.0	1.00
2 1/2 Ton Truck	1.01	1.0	1.01
5 Ton Tractor	1.02	1.0	1.02
Forklift (6000 RT)	1.02	1.0	1.02
M113A1 Carrier	1.01	1.0	1.01
155MM SP Howitzer	1.09	1.0	1.09
M60A1 Tank	1.06	1.0	1.06

Table 2. Relative Worth of Alternative 3.

2-6. IMPLICATIONS OF THE LORA.

a. If the maintenance allocation process is not executed properly, and its results carefully documented in the MAC, the subsequent task of maintenance manual development suffers. Such occurrences become evident when repair parts ("P"-suffix technical) manuals must be used in lieu of MAC charts. For several years, parts manuals have contained a Source-Maintenance-Recoverability (SMR) Code. A random sampling of parts manuals written during the past ten years reveals varying explanations for the maintenance code. However, they have always indicated the lowest category of maintenance at which repair or replacement of a particular part is authorized. The most recent parts manuals contain two maintenance

codes. One gives the lowest category where replacement of the part is authorized, and the other specifies the lowest category where repair of the part is authorized. These parts manuals are intended to be used by supply activities in conjunction with their responsibilities for editing requisitions, but obviously they can also be used as a source of maintenance allocation information. There is nothing improper about using parts manuals in this way, but they are less convenient and more time-consuming than properly prepared MACs. In some instances, however, these manuals are the only available source of maintenance allocation information, because no MACs exist for a number of end items in the field. This condition was reflected in the study sample. Of the 50 analyses conducted, only 38 could be based entirely upon end item maintenance allocation charts. For the remaining 12 analyses, the LORA teams were forced to rely upon repair parts manuals or manufacturers' literature.

b. The LORA results confirmed the fact that most existing MAC chart allocation errors correspond to a lack of conformance with the TM 38-715-1 policy of allocation to the farthest forward category of maintenance capable of performing the task. Since the team's discussions with representatives of various DARCOM Commodity Commands had revealed a widespread lack of awareness of the existence of that policy, the team searched for a reason for this lack of awareness. On the basis of these same discussions, the team concluded that a major reason is that TM 38-715-1 is not even

mentioned in the key Army regulation on Army materiel maintenance policies - AR 750-1. TM 38-715-1 is properly referred to in AR 700-18, Provisioning of US Army Equipment, 9,3-1/, but can easily be overlooked by those who search for maintenance policy in AR 750-1. The study team therefore reasoned that adding references to this TM in AR 750-1 (see Appendix J) would be a simple step which should prove to be highly beneficial.

c. As the Level of Repair Analyses were nearing completion it became apparent to the study team that what the LORA groups had done and were doing was not particularly difficult - at least not for personnel with their types of background and experience. During ensuing deliberations on the subject of the MAC chart system in general, members of the study team found themselves asking the question, "Why isn't this sort of corrective review an automatic step in the system?". The team's search for an answer to this question led it again to AR 700-18 9,2-10/. This regulation does in fact describe a postprovisioning review, the purpose of which is to re-examine all aspects of initial provisioning (which of course includes development of the MAC). The postprovisioning review is to be chaired by the DARCOM Commodity Command which developed the new end item, and is to be held one year after initial deployment of the new item. However, AR 700-18 leaves it optional with the developer as to whether such a review is needed, and the study team's investigation indicated that these reviews have very rarely been convened. In short, the basic mechanism for such reviews is

already in the regulation, but the reviews are optional, and the present condition of most MAC charts is a reflection of the fact that they usually have not been subjected to this type of formal review. The study team's conclusion was that for maintenance-significant end items, formal postprovisioning reviews should be a mandatory requirement at 18 months and again at 36 months after deployment of the new end item, and that the same type of personnel who performed the study's LORAs should be involved. The TRADOC school which trains support maintenance personnel for the end item in question should be the direct recipient of DA Forms 2028 pertaining to its MAC chart, and prior to the convening of a postprovisioning review, a LORA team composed of experienced maintenance personnel stationed at that school should challenge not only the allocations of maintenance tasks, but their mission essentiality as well, as has been done in the Standards Study 10/ and the WARPAC Project 11/. Since the LORA will be triggering changes in repair parts maintenance codes anyway, it is logical to make any necessary changes in essentiality codes at the same time. The TRADOC school review should be completed before the convening of the postprovisioning review, so that the TRADOC school representatives can formally present the needed corrections at the postprovisioning review. The annual maintenance man-hour totals, by maintenance category, for the corrected MAC chart would of course need to be recalculated by the applicable DARCOM Commodity

Command 12,2-1/ so that TOE Manpower Authorization Criteria (MACRIT) figures for the end item involved could also be corrected.

d. Summary

(1) During the course of the study, the study team discovered a surprising lack of understanding of the fundamental fact that MAC charts are the primary authorities governing maintenance responsibilities at all categories of maintenance. AR 750-1 fails to state this fundamental policy explicitly, and this omission appears to be a major contributor to the misunderstandings and confusion which are so frequently encountered, particularly among those who are not intimately acquainted with the maintenance system.

(2) The results of the LORAs showed clearly that the maintenance task allocation policy contained in TM 38-715-1 frequently has not been followed during the preparation of MAC charts. The efforts of the LORA teams showed that MAC chart corrections made by applying the TM 38-715-1 policy caused significant proportions of maintenance tasks to be moved farther forward. The COEA-SCORES analysis, in turn, showed that these corrections cost-effectively enhanced operational availability rates for materiel on the simulated battlefield.

(3) Toward the completion of the LORAs, the study team investigated various ways of making it possible for the Army to take advantage of such LORA-based MAC chart corrections on a routine and continuing basis. The team discovered an existing

mechanism called postprovisioning reviews, outlined in AR 700-18. The present policy governing these reviews will require modification to enable such reviews to take advantage of lessons learned from the study's LORAs, and to accomplish similar reductions in errors in, and improve the effectiveness of, future MAC charts.

CHAPTER 3

FINDINGS AND CONCLUSIONS

3-1. FINDINGS.

a. In AR 750-1, Army Materiel Maintenance Concepts and Policies, the maintenance concepts do not cite MAC charts as the primary authorities governing maintenance responsibilities at all categories of maintenance. This MAC chart authority is fundamental to the operation and control of the maintenance system. The absence of an explicit statement of this fundamental policy in AR 750-1 has led to misunderstandings on the part of, and is the source of unnecessary confusion to, many who are not intimately acquainted with the system.

b. The allocation policy in TM 38-715-1, Provisioning Techniques, frequently has not been followed during the initial preparation of MAC charts. MAC chart corrections resulting from compliance with this policy shift significant proportions of maintenance tasks farther forward, cost-effectively enhancing materiel operational availability rates.

c. AR 700-18, Provisioning of US Army Equipment, leaves postprovisioning reviews optional. Consequently, MAC charts remain uncorrected. Field-experienced maintenance personnel at TRADOC schools are well qualified to make necessary corrections.

3-2. CONCLUSIONS.

a. Confusion and misunderstanding would be reduced if the maintenance concepts in AR 750-1 were to state explicitly that MAC

charts are the primary authorities governing maintenance responsibilities at all categories of maintenance.

b. Operational availability rates would be enhanced if the allocation policy in TM 38-715-1 were complied with during initial preparation of MAC charts, and if MAC charts corrected through compliance with this policy were to supersede current charts.

c. Future MAC charts would be improved if AR 700-18 were to make postprovisioning reviews mandatory (with LORA and MEMO input from the TRADOC schools which train repairmen), and if DA Forms 2028 pertaining to the MAC charts were to be directed to those TRADOC schools.

CHAPTER 4

RECOMMENDATIONS

4-1. The following recommendations correspond to the conclusions in the previous chapter, and are presented in the same sequence as the conclusions to which they apply. All three recommendations are equally applicable during peacetime, transition to wartime, and wartime.

4-2. It is recommended that:

a. The maintenance concepts in AR 750-1 be revised to state explicitly that MAC charts are the primary authorities governing maintenance responsibilities at all categories of maintenance. (DA Forms 2028 attached at Appendix J).

b. AR 750-1 be revised to cite the allocation policy in TM 38-715-1 as the primary reference for allocation of maintenance tasks (DA Forms 2028 attached at Appendix J), and that MAC charts corrected in compliance with this policy supersede current charts.

c. AR 700-18 be revised to make postprovisioning reviews mandatory at 18 months and 36 months after deployment of a new end item, with LORA and MEMO input from the TRADOC school which trains support maintenance personnel for the item in question, and that technical manuals containing MAC charts be revised so that DA Forms 2028 which pertain to their MAC charts will be directed to those TRADOC schools. (DA Forms 2028 attached at Appendix J).

APPENDIX A

STUDY DIRECTIVE AND RELATED DOCUMENTS

A-1. REFERENCES.

- a. Letter, ATCL-CA, USALOGC, 10 September 1973, subject: US Army Logistics Center Study Directive: Maintenance Support Structure for Deployed Forces, ACN 21012.
- b. Letter, ATCL-CA, USALOGC, 20 September 1973, subject: US Army Logistics Center Study Directive: Maintenance Support Structure for Deployed Forces.
- c. Letter, ATSL-CTD-CS, USAOC&S, 24 October 1973, subject: Maintenance Support Structure for Deployed Forces, ACN 21012.
- d. Letter, ATSL-CTD-CS, USAOC&S, 27 November 1973, subject: Maintenance Support Structure for Deployed Forces, ACN 21012.
- e. Letter, ATSL-CTD-MS, USAOC&S, 5 December 1973, subject: Combat Development Study Plan: Maintenance Categories, a Substudy of the Maintenance Support for Contingency Forces Study, ACN 21012.
- f. Letter, ATCL-CA, USALOGC, 7 December 1973, subject: Maintenance Support Structure for Contingency Forces, ACN 21012.
- g. Letter, ATCL-CDD, USALOGC, 3 May 1974, subject: Combat Development Study Plan: Maintenance Categories.

A-2. STUDY DIRECTIVE. The study directive is found in reference a above.

A-3. STUDY PLAN. The study plan, reference g, was approved by LOGC on 3 May 1973 with some minor modifications. The approved study plan, with changes incorporated is shown at page A-22.



DEPARTMENT OF THE ARMY
UNITED STATES ARMY LOGISTICS CENTER
FORT LEE, VIRGINIA 23801

10 SEP 1973

ATCL-CA

SUBJECT: US Army Logistics Center Study Directive: Maintenance Support
Structure for Deployed Forces, ACN 21012

Commandant
US Army Ordnance School
ATTN: ATSL-CTD-CS
Aberdeen Proving Ground, Maryland 21005

1. References. See Annex 1, attached as Inclosure 1.
2. Purpose. To examine the current categories of maintenance, maintenance codes, and maintenance standards to determine if new commodity oriented categories, codes and standards are necessary to allow managers at all levels in the field to plan, organize and execute their maintenance functions.
3. Threat Considerations. A threat appendix, if applicable, will be prepared to support the study. Threat considerations will include the impact that enemy air, artillery, ground, and nuclear operations may have on the maintenance support structure throughout a theater of operations.
4. Study Sponsor. Concepts and Doctrine Directorate, USALOGC, Mr. Roland Linker, Autovon 687-2118, Fort Lee, Virginia.
5. Study Monitor. Concepts and Doctrine Directorate, USALOGC, Project Officer is LTC Wagner, Autovon 687-5751, Fort Lee, Virginia.
6. Terms of Reference.

a. Problem. Maintenance concepts and operations must be examined to determine what categories and standards of maintenance are required to give the maintenance manager a system to adjust personnel and material requirements as his mission and environment change. Climate, tactical situation, densities, type and age of equipment as well as economic factors have a bearing upon the quality and quantity of maintenance personnel required. Less effort may be required for STD B items because

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SUBJECT: US Army Logistics Center Study Directive: Maintenance Support
Structure for Deployed Forces, ACN 21012

of economic factors, therefore, it should be maintained at a level somewhat less than top condition. The tactical situation may dictate that only combat essential fault be corrected; this would require a different standard. These standards or levels should be identified. These levels should be identified either in general terms or by commodity, if applicable.

b. Objectives.

(1) Determine if the categories of maintenance are properly identified and missions appropriately assigned. In addition, identify the differentiating aspects according to materiel commodity groupings.

(2) Determine the feasibility of establishing various levels of maintenance standards for materiel based upon such considerations as economy, tactical situation and personnel availability. Define the levels by commodity as appropriate.

(3) Determine the impact of expanded direct exchange on the maintenance system and identify voids in mission categories.

c. Limits. The study will be limited to the maintenance structure of deployed forces and CONUS divisions with their GS level supporting elements. The study will not include CONUS post TDA maintenance elements.

d. Scope. The study will consider all commodities less medical and cryptographic equipment through all maintenance categories.

e. Time Frame. Current.

f. Assumptions. Assumptions considered necessary will be included with the study plan.

g. Essential Elements of Analysis (EEA). EEA will be developed in conjunction with the study plan, but will include:

(1) How will the expanded direct exchange program be supported in the field?

(2) Are procedures and units adequate for repair of recoverable items to be returned to supply stock?

(3) What units will perform in-storage maintenance of supplies?

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SUBJECT: US Army Logistics Center Study Directive: Maintenance Support Structure for Deployed Forces, ACN 21012

(4) Should GS units perform DS in support of DS units or should DS units be augmented with cellular units to increase capabilities?

(5) Are GS units too specialized or too broad in capabilities?

(6) How do maintenance standards change based upon combat situation, personnel availability, parts availability, funds availability, and the operating environment.

(7) Can maintenance standards be lowered to obtain high actual equipment availability.

(8) Does the age of equipment influence the standard at which it will be maintained.

h. Environment. The study will be developed for mid- and high-intensity conflict.

i. Constraints. None.

j. Methodology. The study will evaluate the present system using the current maintenance allocation charts (MAC) and possible/recommended changes to them as the basic media of analysis. Data obtained from EEA will be used as prime input to the analytical process.

k. Alternatives. Alternatives considered will range from the retention of current four categories of maintenance to developing a new structure of maintenance oriented toward commodities or commodity groupings.

l. Related Studies. The Army Aircraft Maintenance Structure (AAMS), Maintenance Organizational Structures for the Army in the Field, and Army Field Artillery Missile Maintenance System (AFAMMS).

7. Support and Resource Requirements.

a. HQ, US Army Logistics Center is designated proponent for this study.

b. Input and assistance from the US Army Ordnance, Transportation, Quartermaster, Signal, Missile and Munitions, Engineer Centers, and Schools will be requested as required. The USASTRATCOM and USAMC will also be requested to provide input and assistance as required.

ATCL-CA

20 SEP 1973

SUBJECT: US Army Logistics Center Study Directive: Maintenance Support Structure for Deployed Forces, ACN 21012

8. Administration.

a. Study Title. Maintenance Support Structures for Deployed Forces.

b. Study Schedule.

(1) D-- Date of receipt of approved study directive.

(2) D+30 - Submission of study plan.

(3) D+300 - Coordination draft distribution.

(4) D+330 - Coordination comments received.

(5) D+360 - Submission of final study.

c. Control Procedures. IPR's will be scheduled at least quarterly and as required by decision requirements and/or prior to submission of final report.

d. Study Format. Study format will be in accordance with USACDC Pamphlet 71-16.

e. Action Documents. As required or determined during development of the study.

f. Coordination and Other Communications. Coordination will be made with all USALOGC Directorates for appropriate support, for example, models, systems, etc. All communications will conform to USACDC Reg 71-1, Combat Development Procedures.

g. Distribution. Normal distribution of coordination draft(s) and final study will be made.

h. Security Classification Guidance. Normal classification procedures will be made.

9. Combat Developments Objective Guide. This study supports paragraph 1611a.

10. Management Data. This task will be programmed as USATRADOC ACN 21012. It has a LOGC priority of I-C-3. Management of this action is the

ATCL-CA

10 SEP 1973

SUBJECT: US Army Logistics Center Study Directive: Maintenance Support
Structure for Deployed Forces, ACN 21012

responsibility of the Concepts and Doctrine Directorate of the LOGC.
Request Research and Technology Work Unit Summary, DD Form 1498, see
Inclosure 2, be updated and returned to the LOGC, ATTN: ATCL-CA within
5 working days of receipt of study directive.

FOR THE COMMANDER:

2 Incl

as

Herbert T. Casey Jr.

HERBERT T. CASEY, JR.

Colonel, GS

Director, Concepts & Doctrine

ANNEX I

REFERENCES

1. AR 310-3, Military Publications, Coordination, and Approval of Department of the Army Publications, December 1968.
2. AR 310-25, Dictionary of United States Army Terms.
3. AR 71-6, Type Classification/Reclassification of Army Materiel.
4. AR 700-18, Provisioning of US Army Equipment.
5. AR 700-82, Joint Regulations Governing the Use and Application of Uniform Source, Maintenance, and Recoverability Codes.
6. AR 750-1, Army Materiel Maintenance Concepts and Policies, May 1972.
7. AR 750-4, The Army Materiel Plan - Part II Depot Materiel Maintenance and Support Activity.
8. DA Pam 750-38, TAMMS - Equipment Historical Records and Selected Maintenance Forms.
9. SB 740 Series, Storage Servicability Standards.
10. TB 750-94-10 through TB 750-99-69, Maintenance Expenditure Limits.
11. TM 38-750, The Army Maintenance Management System (TAMMS), November 1972.
12. TM 38-750-1, The Army Maintenance Management System (TAMMS) Field Command Procedures, November 1972.
13. FM 29-2, Organizational Maintenance Management, August 1971.
14. FM 29-23, Direct Support Maintenance Battalion (Nondivisional), September 1971.

ANNEX I

REFERENCES

15. FM 29-24, General Support Maintenance Battalion, December 1971.
16. FM 29-36, Aircraft Maintenance Support (Nondivisional), May 1972.
17. FM 29-30-1, Division Maintenance Battalion, September 1971.
18. FM 38-1, Logistics Management, March 1973.
19. DA Study, The Department of the Army Board of Inquiry on the Army Logistics System, January 1967.
20. DCSLOG Study, Army Aircraft Maintenance Structure (AAMS), USA Logistics Evaluation Agency.
21. USACDC Study, Maintenance of Aircraft Under Adverse Conditions, ACN 21612, November 1973.
22. USACDC Study, Echelons Above Divisions, December 1971.
23. USACDC Study, Rapid Integrated Logistics Support System, October, 1972.
24. USACDC Study, Maintenance Organizational Structures for the Army in the Field, ACN 16172, November 1971.
25. The Logistics Review, US Army Vietnam (1965-1969), HQ US Army, Vietnam.

RESEARCH AND TECHNOLOGY UNIT SUMMARY				1. AGENCY ACCESSION#		DATE OF SUMMARY		REPORT CONTROL NUMBER	
				21012		21 08 28		DD-DRA/EAH/53A	
2. DATE PREPARED	3. KIND OF SUMMARY	4. ACTIVITY	5. WORK SECURITY	6. REGRADING	7. S&L	8. STRM	9. SPECIFIC DATA CONTRACTOR ACCESS	10. LEVEL OF SUMMARY	11. WORK UNIT
		U	UNK				☐ YES ☐ NO		
12. NO./COLLUS.		PROGRAM ELEMENT		PROJECT NUMBER		TASK AREA NUMBER		WORK UNIT NUMBER	
A. PRIMARY									
B. CONTRIBUTING								2-8-18	
C. CONTRIBUTING								LOGMAP OBJ REF 2-9-11	
13. TITLE (Provide with Security Classification Code)				LOGC PRI I-C-3					
Maintenance Support Structure for Deployed Forces									
14. SCIENTIFIC AND TECHNOLOGICAL AREAS									
15. START DATE			16. ESTIMATED COMPLETION DATE			17. FUNDING AGENCY		18. PERFORMANCE METHOD	
73 10			74 10			DA			
19. CONTRACT/GRANT				20. RESOURCES ESTIMATE		21. PROFESSIONAL MAN YRS		22. FUNDS (in thousands)	
A. DATES/EFFECTIVE:				B. EXPIRATION:		C. PRECEDING			
D. NUMBER:						FISCAL YEAR			
E. TYPE:				F. AMOUNT:		CURRENT		74 1.0	
G. KIND OF AWARD:				H. CUM. AMT.		75 1.0			
23. RESPONSIBLE DOD ORGANIZATION				24. PERFORMING ORGANIZATION					
NAME: US Army Logistics Center				NAME: US Army Ordnance School					
ADDRESS: Fort Lee, Virginia 23801				ADDRESS: Aberdeen Proving Ground, Maryland 21005					
RESPONSIBLE INDIVIDUAL				PRINCIPAL INVESTIGATOR (Provide NAME if U.S. Academic Institution)					
NAME: LTC Wagner				NAME: MAJ Scharberg					
TELEPHONE: Autovon 687-5753				TELEPHONE: Autovon 870-5702/5727					
25. GENERAL USE				SOCIAL SECURITY ACCOUNT NUMBER:					
Study Category 4-S				ASSOCIATE INVESTIGATORS					
				NAME:					
				NAME:					
26. KEYWORDS (Provide EACH with Security Classification Code)									
27. TECHNICAL OBJECTIVE, 28. APPROACH, 29. PROGRESS (Provide individual paragraphs identified by number. Provide last of each with Security Classification Code.)									
23. The study will examine the present categories of maintenance and the missions assigned to each category. It will also determine if it is feasible and desirable to establish levels or standards of maintenance to coincide with the environment (i.e., tactical situation, climate, funding limitation, personnel quality and quantity. 24. Current organizations and studies will be evaluated to determine their capability to perform maintenance on all commodities of equipment under various situations and environments. Coordination with CACDA will be accomplished in order to define the tactical environment. The study results will be incorporated into wargaming exercises using approved scenarios, and should result in improved maintenance allocation charts as well as a more effective management tool. 25. Draft study directive has been submitted to the Logistics Center.									

DD FORM 1490

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1490A, 1 NOV 68 AND 1490-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE.



DEPARTMENT OF THE ARMY
UNITED STATES ARMY LOGISTICS CENTER
FORT LEE, VIRGINIA 23801

ATCL-CA

20 SEP 1973

SUBJECT: US Army Logistics Center Study Directive:
Maintenance Support Structure for Deployed Forces

Commandant

US Army Ordnance School

ATTN: ATSL-CTD-CS

Aberdeen Proving Ground, Maryland 21005

1. Reference: Letter, ATCL-CA, USALOGC, 7 Sep 73, subject as above.
2. Reference 1 is the study directive and LOGC tasking letter for the Maintenance Support Structure for Deployed Forces study.
3. Change paragraph 7a of reference 1 above to read, "USA Ordnance School is designated proponent for this study".
4. Change paragraph 7b of reference 1 above to read, "Input and assistance from the Transportation, Quartermaster, Signal, Missile and Munitions, Engineer Centers and Schools will be requested as required. The USASTRATCOM and USAMC will also be requested to provide input and assistance as required".

FOR THE COMMANDER:

Herbert T. Casey Jr.

HERBERT T. CASEY, JR.
Colonel, GS
Director, Concepts & Doctrine

MAJ Scharberg/lw/2870

ATSL-CTD-CS

27 November 1973

SUBJECT: Maintenance Support Structure for Deployed
Forces, ACN 21012

Commander
US Army Logistics Center
ATTN: ATCL-CA
Fort Lee, VA 23801

1. Reference is made to:

a. Letter, your headquarters, ATCL-CA, 10 Sep 73,
subject: US Army Logistics Center Study Directive:
Maintenance Support Structure for Deployed Forces, ACN 21012.

b. Letter, USAOC&S, ATSL-CTD-CS, 24 Oct 73, subject
as above.

2. Reference 1b advised of the USAOC&S intention to embark
upon an intensive problem definition phase prior to pre-
paring a study plan for the subject study. That effort
identified a number of potential study areas, all of which
can be related to the Maintenance Support Structure for
Deployed Forces Study. In addition, the studies already in
the program were reviewed.

3. The primary conclusion drawn from the problem definition
analysis was that these maintenance problems are too diverse
for adequate treatment in a single study effort. If attempted,
that study would be unmanageable and would not provide sub-
stantive results applicable to the current or near timeframe.
Therefore, the USAOC&S considers the Maintenance Support
Structure for Deployed Forces Study to be a carrier study with
several related substudies.

ATSL-CTD-CS

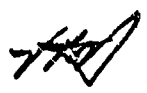
SUBJECT: Maintenance Support Structure for Deployed
Forces, ACN 21012

4. Currently, nine substudies have been identified as shown in Inclosure 1. They are listed in order of priority with projected start and completion dates. This list is not considered all-inclusive and is expected to change as the study effort progresses. The priorities were based upon subjective evaluations of relative importance and the perceived potential for doctrine improvement in the near timeframe.

5. The substudy shown as first priority in Inclosure 1 represents the main thrust of the carrier study program. It will draw heavily on the data generated in the TRADOC Standard Scenario Evaluation process. The study directive and plan will be developed as the scenario evaluation effort and time schedules are defined. In addition, a study plan is being written for the Maintenance Categories substudy. A directive is being drafted for the Technical Inspection/Quality Control substudy, and comments are being prepared on a draft study directive on the Adaptation of Commercial/Industrial Maintenance Practices substudy.

FOR THE COMMANDER:

1 Incl
as


VERLE B. HAMMOND
LTC, OrdC
Secretary

MAINTENANCE SUPPORT STRUCTURE
FOR DEPLOYED FORCES SUBSTUDIES

<u>PRIORITY</u>	<u>SUBSTUDY</u>	<u>START</u>	<u>FINISH</u>
1	Methodology for Rapidly and accurately Tailoring Maintenance Capability to a Given Force	374	275
2	Maintenance Categories	274 (Note 1)	275
3	Maintenance Standards	374	275
4	Technical Inspection/Quality Control	275	176
5	Operational Readiness Float Utilization and Management	474	375
6	Recovery, Collection, Classification and Disposal (Note 2)	275	176
7	Adaptation of Commercial and Industrial Maintenance Practices <i>(Note 3)</i>	374	275
8	Maintenance of Prepositioned Stocks	175	475
9	Deletion of Maintainable Items from the Maintenance System for Deployed Forces	275	176

NOTES: 1. Number is quarter and fiscal year, i.e., 274 is 2d quarter of FY74.

2. Substudy already begun by CDCMA. Currently in period of little activity for the proponent.

JCS 3. ~~Substudy very likely to be incorporated in one or more of the preceding substudies.~~

MAJ Scharberg/ps/5727

ATSL-CTD-MS

5 DEC 1973

SUBJECT: Combat Development Study Plan: Maintenance Categories, a
Substudy of the Maintenance Support Structure for Contingency
Forces Study, ACN 21012

Commander
U. S. Army Logistics Center
ATTN: ATCL-CA
Fort Lee, Virginia 23801

COMMANDANT'S READING FILE

1. Reference is made to:

a. Letter, ATCL-CA, LOGC, 10 Sep 73, subject: US Army Logistics
Center Study Directive: Maintenance Support Structure for Deployed
Forces, ACN 21012.

b. Letter, ATCL-CA, LOGC, 20 Sep 73, subject: US Army Logistics
Center Study Directive: Maintenance Support Structure for Deployed
Forces.

c. Letter, ATSL-CTD-CS, this HQ, 24 Oct 73, subject: Maintenance
Support Structure for Deployed Forces, ACN 21012.

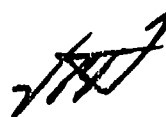
d. Letter, ATSL-CTD-CS, this HQ, 27 Nov 73, subject: Maintenance
Support Structure for Deployed Forces, ACN 21012.

2. The inclosed study plan is submitted for approval in accordance with
references 1a and 1c.

3. The Maintenance Categories Substudy is one of the initial efforts to
be associated with the Maintenance Support Structure for Contingency
Forces Carrier Study as outlined in reference 1d. The remaining study
draft directives/plans will be submitted as shown in the inclosure to
reference 1d.

FOR THE COMMANDER:

1 Incl
as


VERLE B. HAMMOND
LTC, OrdC
Secretary



DEPARTMENT OF THE ARMY
U. S. ARMY ORDNANCE CENTER AND SCHOOL
ABERDEEN PROVING GROUND, MARYLAND 21005

11 SEP 1974

ATSL-CTD-CS

SUBJECT: Combat Development Study Plan: Maintenance Categories, a Substudy of the Maintenance Support Structure for Contingency Forces Study, ACN 21012

SEE DISTRIBUTION

1. REFERENCES. See Inclosure 1.

2. PURPOSE. Examine the current categories of maintenance to determine if new commodity-oriented categories are necessary for operators and managers, at all levels in the field, to plan, organize, and execute their maintenance functions.

3. THREAT CONSIDERATIONS. A threat appendix is not considered applicable for the purpose of this study.

4. TERMS OF REFERENCE.

a. Problem.

(1) The categories of maintenance concept is one of the foundations of the US Army maintenance system. It forms the basis for the allocation of maintenance tasks and resources (supply personnel and personnel training, facilities and tools and test equipment) and as such exerts significant influence on maintenance unit organizations and structures and resources expenditures and distribution.

(2) Prior to the reorganization of the Department of the Army in 1962 there were, to some degree, unique maintenance systems by equipment commodity. After the functionalization of maintenance, most commodities were forced into a common system with common categories. This produced the one-stop maintenance support concept which continues to have a distinct advantage over previous concepts as far as the customer units are concerned.

(3) During the past several years, there appears to be an evolutionary process in action which is introducing unique, commodity-oriented maintenance systems. Army aircraft and missile maintenance are prime examples of this shift. When this trend is viewed in conjunction with the fact that certain commodities, such as medical, cryptographic, and ADPE materiel have always utilized unique systems, it becomes evident that the standard US Army system for maintenance is no longer completely standardized. The latter systems are operating, however, in a doctrinal environment which recognizes only limited exceptions.

(4) Since many facets relating to this subject cannot be completely quantified, statistical inference techniques are of little value. Instead, the study must be based upon the following research questions:

(a) Are the US Army equipment commodity groupings sufficiently unique to require unique or specially designed commodity-oriented systems of maintenance categories?

(b) If unique commodity-oriented categories are necessary, what should they consist of?

(c) If a commodity-oriented system of categories should be approved for implementation, what other changes would be necessary?

b. Impact of Problem.

(1) The ability of maintenance managers to effectively and efficiently utilize their resources is the crux of this problem. It is possible that the current system of maintenance categories is less than satisfactory and that this is a result of adhering to a standard system. This more or less arbitrary conformance may have resulted in task allocations which are neither practical nor efficient in the utilization of available tools, test equipment, and skills.

(2) If the situation described above is true, improvement can be achieved by recognizing that the basic differences between commodities do impact upon maintenance stratification. It follows also, that if the requirements differ, certain aspects of the maintenance system should also differ. In this study, the maintenance categories will be examined specifically to determine whether or not maintenance effectiveness and efficiency and resource distribution for all commodities can be improved.

(3) Any improvements achieved will impact significantly on the maintenance system through better utilization of resources.

c. Objectives. The objectives of this study are:

(1) Analyze current doctrine as well as concepts from studies and other literature which relate to the categories of maintenance.

(2) Define criteria for most effective and efficient maintenance task allocation and resource distribution.

(3) Analyze maintenance task allocation for selected equipment.

(4) Formulate commodity-oriented categories by arraying maintenance tasks in accordance with the criteria developed in (2) above.

(5) Evaluate the commodity-oriented system to determine whether or not there are sufficient advantages to warrant change.

(6) Identify other changes required if commodity-oriented categories of maintenance are adopted.

d. Limits.

(1) This study will consider all active US Army forces.

(2) CONUS installation maintenance activities (TDA) are excluded.

(3) Maintenance support provided other services and allies is excluded.

(4) All commodities less medical, crypto, ASA and nuclear will be considered.

e. Scope.

(1) This study will investigate the US Army maintenance system in terms of the categories of maintenance.

(2) Individual items of equipment will be analyzed in terms of maintenance task allocation and resource distribution.

(3) All of the end items in the Army inventory will not be considered. Those selected for analysis will be chosen in accordance with a valid sampling plan.

(4) This study will be developed for the current timeframe.

f. Assumptions. The following assumptions will be accepted as facts for the purpose of this study:

(1) The current austere fiscal environment will continue and may become even more severe.

(2) US Army contingency forces will be required to respond to any world-wide crisis and sustain themselves for the duration of the crisis regardless of the geophysical conditions present.

g. Essential Elements of Analysis (EEA).

(1) What is current doctrine on categories of maintenance by commodity?

(2) What changes in the maintenance system are proposed by current/on-going studies or research projects?

(3) What is current state of Maintenance Support Positive implementation in terms of maintenance categories and task allocation?

(4) What are programmed and anticipated actions in Maintenance Support Positive Implementation which may impact on this study?

(5) What are currently used criteria for maintenance task allocation by commodity (NMP)?

(6) Is the current Maintenance Allocation Chart (MAC) concept an efficient method to indicate what maintenance is authorized or required on an item of equipment?

(7) What are the criteria for commodity-oriented maintenance categories which will insure system effectiveness and efficiency?

(8) What special considerations, if any, are required in the categories of maintenance to insure complete realization of the EAD concept?

(9) What are the maintenance category implications created by the Closed Loop System?

(10) Does Direct Exchange Expanded require special consideration and accommodation in the maintenance categories system?

(11) What is the specific mission and functions of general support maintenance by commodity?

(12) Are general support maintenance units too broad in capabilities?

(13) Is backup to direct support a viable mission for general support maintenance units?

(14) How does combat environment affect the performance of organizational maintenance?

h. Environment. The study will be developed for mid and high intensity conflict.

i. Constraints. None.

j. Methodology. For planning purposes four phases have been identified as follows:

(1) Phase I. Literature Review and Preparation for Analysis Phase.

(a) Identify, assemble, and study related official publications, technical articles and other studies. This will place the problem and related factors in proper perspective and suggest other alternative approaches to the problem. It will also reveal research already accomplished.

(b) Define the equipment commodities both in terms of TRADOC school proponency and USAMC Commodity Command assignment.

(c) Acquire and analyze current USAMC policies and procedures for developing Maintenance Allocation Charts (MAC). These actions will constitute the study baseline in terms of the current system of categories.

(d) Acquire and analyze the proposed Maintenance Support Positive (MS+) criteria for allocating maintenance tasks and obtain copies of the test Maintenance Allocation Charts (MAC) that have been developed to date. The analysis of these criteria and test MAC will establish one variation to the baseline.

(e) Select the commodity-oriented end item samples in accordance with a predetermined sampling plan. The TRADOC schools will be requested to assist in this process in their respective areas of proponency. A great deal of care will be exercised in order to insure valid samples, yet keep the volume of MAC to be reviewed within a manageable quantity. One technique to be utilized will be to analyze only the minimum MAC per group of essentially like items. For example, SB 700-20, Army Adopted Items of Materiel, lists eight line item numbers (LIN) and 19 Federal Stock Numbers (FSN) for Truck, Cargo, 2 1/2 Ton. Several of these items are type classified as contingency items, and of the remainder, the distinguishing feature is usually the presence or absence of a winch or whether or not the vehicle has an extra long wheel base. In this case, it is expected that two or possibly three items will be sufficient for the 2 1/2 ton truck segment of the analysis. Similar situations occur throughout the other categories of equipment.

(f) Identify and refine measures of effectiveness upon which to base the study parameters for maintenance task allocation. These will be designed to answer the question, "What maintenance tasks should be done and how should it be done and how should resources be distributed by level?" The USAMC procedures will be revised/changed or a completely new set of measures of effectiveness will be developed as necessary.

(g) Refine the criterion of choice as stated in this study plan. This criterion must be sufficiently sensitive to clearly distinguish between the alternatives which will be developed in Phase II.

(2) Phase II. Maintenance Allocation Chart/Category Analysis.

(a) This step will consist of analyzing each MAC in the commodity samples. Criteria in the form of a decision table, developed during Phase I, will be used. In certain instances, the proponent school will be requested to assist with this step.

(b) By commodity, array the results in alternative systems of maintenance categories. One alternative will be the current system.

(c) Subject these alternatives to intensive review to determine the advantages and disadvantages of each.

(3) Phase III. MOS/TOE Analysis.

(a) Identify the nature and scope of required MOS changes. This step anticipates the situation wherein the current maintenance categories for an item or group of items are distinguished largely on the basis of skills or skill levels. Consideration must then be given to the benefits which might be derived from a change in the MOS(s).

(b) Identify the nature and scope of required TOE (organization) changes. This step anticipates that for any recommended change in the maintenance category system, there will be corresponding organizational changes.

(4) Phase IV. Evaluation and Recommendations.

(a) In light of the results from phases II & III, answer each REA.

(b) Apply criterion of choice and order alternatives in order of preference.

(c) Compare favored alternative with current system. Make evaluation concerning the potential benefits to be derived from change when balanced against the cost of making the change. This step will utilize the SCORES process evaluations to the maximum practicable extent. Certain of the alternatives will be inserted into the standard scenarios and analyzed for voids and weaknesses. This effort will be limited to the scenario evaluations which are performed during the course of this study effort.

(d) Prepare report.

k. Alternatives. The alternatives will range from the current system to a completely commodity-oriented system with varying categories for each commodity.

l. Measures of Effectiveness. The measures of effectiveness (MOE) have not been defined and will be developed during the initial phase of the study. The MOE will consist of a systematic procedure for assigning a value to a system by taking into account its relative rank in one or more relevant factors. These factors will consist of measureable elements such as numbers of personnel, tools and test equipment, and time to repair. Intangible factors such as motivation, supported/support unit rapport and the impact of combat conditions will also be included.

m. Related Studies:

- (1) Army Aircraft Maintenance Structure (AAMS) (in process).
- (2) Missile and Munitions Evaluation (MAME 71) Final Report, Dec 71.
- (3) Maintenance Organizational Structures for Support of the Army in the Field, ACN 16172, Nov 71.

n. Criterion of Choice. This criterion will be the end result of the ranking process based on the measures of effectiveness. Once the most preferable of the alternative systems or categories has been identified, it will be compared with the current system as specified by doctrine. A value judgment will be made concerning the potential work of the new system as opposed to the real and intangible costs associated with the introduction of a major change into the US Army maintenance system.

5. SUPPORT AND RESOURCE REQUIREMENTS.

a. Support Requirements.

- (1) Support will be required from within TRADOC as follows:
 - (a) US Army Logistics Center.
 1. Assist in coordination requirements with TRADOC service schools.
 2. Continue to update information on status of EAD implementation.
 - (b) TRADOC associated service schools and centers.
 1. Assist in selecting end item sample in accordance with parameters provided by USAOC&S.
 2. Assist as required in Maintenance Allocation Chart (MAC) analysis.
- (2) Support will be required from outside of TRADOC as follows:
 - (a) DA DCSLOG.
 1. Provide information on current status as well as projected actions relative to the Maintenance Support Positive concept implementation.
 2. Authorize direct coordination with USA Logistics Evaluation Agency.

(b) USAMC.

1. Authorize direct coordination with commodity commands, Materiel Management Center, the Major Items Data Agency, and the US Army Logistics Management Center.

2. Provide information on USAMC implementation of Maintenance Support Positive (MS+) concept.

(c) USAMC Commodity Commands.

1. Provide specific data on NMP procedures for allocating maintenance tasks.

2. Provide copies of latest changes to Maintenance Allocation Charts (MAC) for items in the study sample.

3. Provide information and available data on the anticipated MAC changes in accordance with MS+. Specifically, data relating to cost effectiveness methodology/criteria are required.

(d) US Army Major Item Data Agency. Provide density data required for individual decisions on an end item's eligibility for inclusion in the study sample.

(e) US Army Materiel Management Center.

Information and assistance as required.

b. Resource Requirements.

(1) USAOC&S manpower requirements are projected as follows:

(a) 2d Qtr, FY 74	6 man months
(b) 3d Qtr, FY 74	8 man months
(c) 4th Qtr, FY 74	8 man months
(d) 1st Qtr, FY 75	8 man months
(e) 2d Qtr, FY 75	6 man months

(2) Manpower requirements other than USAOC&S are projected to be a total of 12 man months.

c. Data Requirements. There are no known data requirements other than those described in paragraphs 4j and 5a above.

6. ADMINISTRATION.

a. Study Schedule. See Inclosure 2.

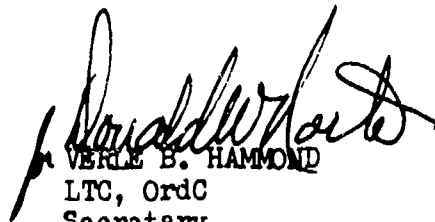
b. Study Outline. See Inclosure 3.

c. Study Project Officer. Major(P) Clifford L. Wollard, USAOC&S,
AUTOVON 870-5806/5824.

7. CORRELATION. This study has been assigned ACN 22189.

FOR THE COMMANDER:

3 Incl
as


VERLE B. HAMMOND
LTC, OrdC
Secretary

MAJ, Cull

DISTRIBUTION:

Cdr, USCINCPAC (1)
Cdr, USAMC (1)
Cdr, USAFORSCOM (1)
Cdr, TRADOC
 (ATCD-SM) (1)
 (ATCD-C) (2)
 (ATCD-F) (2)
 (ATCD-O) (1)
 (ATRM-M) (1)
 (ATLG-PPG) (1)
 (ATORI-IT) (1)
 (ATES-IT) (1)
 (ATPR-PR) (1)
 (ATFE) (1)
Cdr, USACACDA (5)
Cdr, LOGC (5)
Cdr, USAPACDA (3)

Cdr, USA CD Exper Comd (1)
Cdr, USACGSC (2)
Cdr, USAADS (1)
Cdr, USAARMS (1)
Cdr, USAAVNC/SCH (1)
Cdr, USAES (1)
Cdr, USAFAS (1)
Cdr, USAMMCS (1)
Cdr, USAIS (1)
Cdr, USAQMS (1)
Cdr, USASESS (1)
Cdr, USASCS (1)
Cdr, USATSCH (1)
Cdr, USA Intel Cen & Sch (1)

ANNEX 1

REFERENCES

1. AR 11-14, Logistics Readiness, 7 June 1968.
2. AR 220-1, Unit Readiness Reporting, 30 May 1973.
3. AR 310-3, Military Publications, Coordination and Approval of Department of the Army Publications, 20 December 1968.
4. AR 310-25, Dictionary of United States Army Terms, 1 June 1972.
5. AR 700-4, Supply and Maintenance Technical Assistance Program, 10 February 1971.
6. AR 750-1, Army Materiel Maintenance Concepts and Policies, 1 May 1972.
7. AR 750-37, Sample Data Collection-The Army Maintenance Management System, 24 March 1971.
8. AR 750-43, Test, Measurement, and Diagnostic Equipment, 3 March 1971.
9. AR 750-51, Maintenance Assistance and Instruction Team (MAIT) Program, 31 March 1972.
10. AR 750-52, Equipment Operationally Ready Standards, 20 September 1974.
11. DA PAM 11-25, Life Cycle Management Model for Army Systems, 11 October 1968.
12. DA PAM 350-23, Commander's Maintenance Management Course, 1 May 1972.
13. DA PAM 350-24, Maintenance Supervisor's Course, 1 May 1972.
14. DA PAM 701-1, 2 and 3, The Army Logistics System Master Plan (LOGMAP), July 1973.

15. FM 1-10, Army Aviation Organizational Aircraft Maintenance, 20 September 1965.
16. FM 9-59, Missile Support Unit Operations, 26 March 1970.
17. FM 10-417, Airdrop Equipment Repair and Supply Company, 20 April 1972.
18. FM 29-2, Organizational Maintenance Management, 26 August 1971.
19. FM 29-20, Maintenance Management in Theaters of Operations, 26 July 1968.
20. FM 29-23, Direct Support Maintenance Battalion (nondivisional), 7 September 1971.
21. FM 29-24, General Support Maintenance Battalion, 20 December 1971.
22. FM 29-25, Direct Exchange, Shop Supply, and Operational Readiness Float Procedures, 3 March 1972.
23. FM 29-27, Calibration Service in the Theater of Operations, 29 September 1971.
24. FM 29-30, Maintenance Battalion and Company Operations in Divisions and Separate Brigades, 26 July 1968.
25. FM 29-30-1, Division Maintenance Battalion, 2 September 1971.
26. FM 29-35, Maintenance Support in Separate Brigades, 6 January 1972.
27. FM 29-36, Aircraft Maintenance Support, 12 June 1972.
28. FM 38-1, Logistics Management, 21 March 1969.
29. FM 38-5, Logistics - Maintenance Management, 16 May 1969.
30. FM 54-1, The Logistical Command, 27 July 1962.
31. FM 54-2, The Division Support Command and Separate Brigade Support Battalion, 27 June 1969.

32. FM 54-7, The Theater Army Support Command, 3 March 1972.
33. FM 54-9, The Corps Support Command (Draft).
34. FM 100-10, Combat Service Support (Draft).
35. SB 700-20, Army Adopted and Other Items of Materiel Selected for Authorization, 20 December 1973.
36. TM 38-750, The Army Maintenance Management System (TAMMS), November 1972.
37. TM (Those containing the Maintenance Allocation Chart (MAC) for each end item to be analyzed).
38. USA Armor Center Team Study, Army Maintenance System Simplification, August 1972.
39. USACDC PAM 71-1, Force Developments--The Measurement of Effectiveness, January 1973.
40. USACDC Study, Rapid Integrated Logistics Support System (RILS) ACN 17902, October 1972.
41. USACDC Study, Echelons Above Divisions (EAD) ACN 16863, December 1971.
42. USACDC Study, Maintenance Organizational Structures for Support of the Army in the Field, ACN 16172, (Final Draft) November 1971.
43. USACDC Study, Maintenance - 75, ACN 6500 (Final Draft) September 1968.
44. USA Dept of the Army Study, The Department of the Army Board of Inquiry on the Logistics System, January 1967.
45. USA Missile and Munitions Center Team Study, Missile and Munitions Evaluation (MAME-71), November 1971.
46. USA Vietnam Report, The Logistics Review - US Army Vietnam, 1965 to 1969.

STUDY SCHEDULE

Receipt of approved Study Directive	Oct '73
Submission of Study Plan	Dec 73
Study Plan approved	May 74
Literature Review/Preparation for Analysis	Aug 74
Level of Repair Analysis (LORA)	Sep 74
MOS/TOE Analysis	Oct 74
Draft Study/Alternatives	Nov 74
External Coordination/Revision	Jan 75
COEA/SCORES	Mar 75
Coordination Draft	May 75
Final Study Submission	Jun 75

Inc 2

STUDY OUTLINE

SUBJECT: MAINTENANCE CATEGORIES, A SUBSTUDY OF THE MAINTENANCE SUPPORT STRUCTURE FOR CONTINGENCY FORCES.

- I. INTRODUCTION
- II. PROBLEM
- III. ASSUMPTIONS
- IV. DISCUSSION
 - A. BACKGROUND
 - B. PREVIOUS AND CURRENT RELATED STUDY EFFORTS
 - C. DEFINITION OF EQUIPMENT CATEGORIES
 - D. DEVELOPMENT OF ANALYSIS METHODOLOGY
 - 1. EVALUATION OF CURRENT AMC POLICIES AND PROCEDURES
 - 2. EVALUATION OF PROPOSED AMC PROCEDURES FOR MAINTENANCE ALLOCATION CHART (MAC) REVISION IN MAINTENANCE SUPPORT POSITIVE (MS+) IMPLEMENTATION
 - 3. REVIEW MS+ TEST MAC'S
 - 4. DEFINE MEASURES OF EFFECTIVENESS
 - 5. DEVELOP MAINTENANCE TASK ALLOCATION DECISION TABLE
 - E. SELECTION OF COMMODITY SAMPLES
 - 1. SAMPLING PLAN, RATIONALE AND METHODOLOGY
 - 2. SELECTION PROCESS
 - 3. COLLECTION OF APPLICABLE MAC FOR ITEMS IN THE SAMPLE
 - F. MAINTENANCE TASK ANALYSIS
 - 1. ANALYZE EACH MAC
 - 2. ALLOCATION OF MAINTENANCE TASKS IN ACCORDANCE WITH DECISION TABLE
 - 3. DEVELOPMENT OF ALTERNATIVE CATEGORY SYSTEMS BY COMMODITY

H. EVALUATION

1. ANSWER EEA
2. APPLICATION OF CRITERION OF CHOICE
3. CONCLUSIONS

I. RECOMMENDATIONS

7 DEC 1973

**Commander
US Army Ordnance Center and School
ATTN: ATSL-CTD-CS
Aberdeen Proving Ground, Maryland 21005**

1. Reference, letter, ATSL-CTD-CS, your headquarters, 27 November 1973, subject as above.
2. Concur with your approach to the Maintenance Support Structure for Contingency Forces study effort.
3. DD Forms 1498 and milestone charts for this carrier study and substudies should be forwarded to this Center, ATTN: ATCL-CA, for inclusion in the LOCC Program. Request this action be completed NLT 21 Dec 73.

FOR THE COMMANDER:

HERBERT T. CASEY, JR.
Colonel, GS
Director, Concepts & Doctrine



DEPARTMENT OF THE ARMY
UNITED STATES ARMY LOGISTICS CENTER
FORT LEE, VIRGINIA 23801

3 MAY 1974

ATCL-CDD

SUBJECT: Combat Development Study Plan: Maintenance Categories

Commandant
US Army Ordnance Center and School
ATTN: ATSL-CTD-CS
Aberdeen Proving Ground, Maryland 21005

1. Subject study plan (Incl 1) has been reviewed and comments are provided on the inclosed DA Forms 2028 (Incl 2).
2. Request you revise the study plan accordingly and proceed with the conduct of the study. DD Form 1498 should be revised to reflect adjusted manpower in para 5b, Incl 1 and be submitted to this Center (ATTN: ATCL-CA).
3. This study impacts on Manpower Authorization Criteria (MACRIT), The Army Authorization Document System (TADS), the MOS structure, skills and service school program of instruction. These factors should be considered throughout the course of the study.

FOR THE COMMANDER:

2 Incl
as

for: R. T. Casey, Jr.
HERBERT T. CASEY, JR.
Colonel, GS
Director, Concepts and Doctrine

RECOMMENDED CHANGES TO PUBLICATIONS For use of this form, see AR 310-1; the proponent agency is The Adjutant General's Office.						Use Part II (reverse side) for Repair Parts and Special Tools Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).		DATE 30 April 74	
TO: (Forward to proponent of publication) (Include ZIP Code), Commandant US Army Ordnance Center and School ATTN: ATSL-CTD-CS Aberdeen PG, MD 21005						FROM: (Activity and location) (Include ZIP Code) USALOGC Fort Lee, Virginia 23801			
PART I - ALL PUBLICATIONS EXCEPT RPSTL AND SC/SM									
PUBLICATION NUMBER ACN 21012						DATE 19 Mar 74		TITLE Combat Developments Study Plan: Maintenance Categories	
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)			
1	1	2	3			Add before "managers" <u>operators and</u> . Reason: Managers do not perform maintenance. The stratification of maintenance work is based on the operator and the distribution of maintenance resources.			
2	1	3	2-5			Delete all after "For the purpose of ..." Reason: The threat is not a viable factor in maintenance operations or management in this study. Just putting in words proves nothing.			
3	1	4a(1)	2-4			Change the sentence "It forms structure" to: It forms the basis for the allocation of maintenance tasks and resources (<u>supply personnel and personnel training, facilities and tools and test equipment</u>) and as such exerts significant influence on maintenance unit organizations, structures, and <u>resources expenditures and distribution</u> . Reason: While maintenance tasks distribution is important, resource distribution and personnel training are very significant and may be over-riding.			
4	1	4a(3)	8			Delete "Rather systems" Reason: This is a conclusion not necessarily substantiated. It is opinion not fact.			
5	2	4b(2)	3			Add "stratification" after <u>maintenance</u> and delete <u>requirements</u> .			
* Reference to line numbers within the paragraph or subparagraph									
TYPED NAME, GRADE, OR TITLE AND TELEPHONE NUMBER						SIGNATURE			
A-18									

RECOMMENDED CHANGES TO PUBLICATIONS For use of this form, see AR 310-1; the proponent agency is The Adjutant General's Office.						Use Part II (reverse side) for pair Parts and Special Training Data (RPSTL) and Supply Catalog/Supply Manuals (SC/SM).		DATE 30 April 74
TO: (Forward to proponent of publication) (Include ZIP Code) Commandant US Army Ordnance Center and School ATTN: ATSL-CTD-CS Aberdeen PG, MD 21005						FROM: (Activity and location) (Include ZIP Code) USALOGC Fort Lee, Virginia 23801		
PART I - ALL PUBLICATIONS EXCEPT RPSTL AND SC/SM								
PUBLICATION NUMBER ACN 21012						DATE 19 Mar 74		TITLE Combat Developments Study Plan: Maintenance Categories
ITEM NO.	PAGE NO.	PARAGRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)		
6	2	4b(2)	5-7			Reason: The total maintenance requirement does not change except by design. How the total maintenance requirement is distributed or stratified may be a function of a commodity. Change the last sentence to read: "In this study, the maintenance categories will be examined specifically to determine whether or not maintenance effectiveness, efficiency and resources distribution for all commodities can be improved."		
7	2	4c(2)	2			Reason: Resource distribution is a key factor in maintenance categorization. Add after "allocation" and resource distribution.		
8	3	4e(2)	2			Reason: A key factor must be considered. Add after "allocation" and resource distribution.		
9	3	4f(2) 4f(3)				Reason: Same as item 7. Delete.		
10	4	1st 4j	1			Reason: Both assumptions have no affect on the study. First 4j paragraph should be numbered 4g. Reason: Typographical error.		
* Reference to line numbers within the paragraph or subparagraph								
TYPE NAME, GRADE, OR TITLE AND TELEPHONE NUMBER						SIGNATURE		

A-19

DA FORM 2028

REPLACES DA FORM 2028, 1 APR 64, AND DA FORM 1616, 1 DEC 66, WHICH WILL BE USED

RECOMMENDED CHANGES TO PUBLICATIONS For use of this form, see AR 310-1; the proponent agency is The Adjutant General's Office.				Use Part I (reverse side) for Repair Parts and Special Tools Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM)				DATE 30 April 74	
TO: (Forward to proponent of publication) (Include ZIP Code) Commandant US Army Ordnance Center and School ATTN: ATSL-CTD-CS Aberdeen PG, MD 21005						FROM: (Activity and location) (Include ZIP Code) USALOGC Fort Lee, Virginia 23801			
PART I. ALL PUBLICATIONS EXCEPT RPSTL AND SC/SM									
PUBLICATION NUMBER ACN 21012						DATE 19 Mar 74		TITLE Combat Developments Study Plan: Maintenance Categories	
ITEM NO.	PAGE NO.	PARA GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)			
11	4	4g				Add following new paragraph 4g(6) and renumber subsequent paragraphs. "(6) Is the current maintenance allocation chart (MAC) concept an efficient method to indicate what maintenance is authorized or required on an item of equipment?" <u>Reason:</u> Current maintenance allocation charts indicate repair authorization to the equipment component level. The lowest maintenance level authorized to replace any piece-part on the component is shown as the level authorized to repair the component. As a result, if the DS level is authorized to replace even only one of 50 piece-parts in a component, DS level is shown in the MAC as being authorized to repair the component.			
12	5	4j(1) (f)	3,4			The question "who category?" should be "what maintenance tasks should be done and how should resources be distributed by level?" <u>Reason:</u> The allocation of tasks and resources to fulfill the total maintenance mission must be a completely unemotional action taking into account training capabilities, economics of tools and test equipment distribution, Class IX economical distribution, equipment design characteristics, economics of major item distribution, and essential materiel readiness or availability requirements.			
* Reference to line numbers within the paragraph or subparagraph									
TYPED NAME, GRADE, OR TITLE AND TELEPHONE NUMBER						SIGNATURE			
A-20									

RECOMMENDED CHANGES TO PUBLICATIONS For use of this form, see AR 316-1; the proponent agency is The Adjutant General's Office.						Use Part II (reverse side) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).		DATE 30 April 74
TO: (Forward to proponent of publication) (Include ZIP Code) Commandant US Army Ordnance Center and School ATTN: ATSL-CTD-CS Ft. Lee, VA 23801						FROM: (Activity and location) (Include ZIP Code) USALOGC Fort Lee, Virginia 23801		
PART I - ALL PUBLICATIONS EXCEPT NPSTL AND SC/SM								
PUBLICATION NUMBER ACN 21012						DATE 19 Mar 74		TITLE Combat Developments Study Plan: Maintenance Categories
ITEM NO.	PAGE NO.	PARA GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)		
13	6	4j (4) (c)				General Comment: The Living Model has been replaced by the SCORES Process. Explanation of the use of the SCORES Process needs to be more specific.		
14	A-1	Ref				10. Change date to "20 Sep 1974." 12. Rescinded. 16. Rescinded. 37. Change date to "20 Dec 1973."		
* Reference to line numbers within the paragraph or subparagraph.								
TYPED NAME, GRADE, OR TITLE AND TELEPHONE NUMBER						SIGNATURE		

SUBJECT: Combat Development Study Plan: Maintenance Categories, a
Substudy of the Maintenance Support Structure for Contingency
Forces Study, ACN 21012

1. REFERENCES. See Inclosure 1.

2. PURPOSES. Examine the current categories of maintenance to determine if new commodity-oriented categories are necessary for managers, at all levels in the field, to plan, organize, and execute their maintenance functions.

3. THREAT CONSIDERATIONS. A threat appendix is not considered applicable. For the purpose of this study, the enemy threat is sufficiently well known. In the event that a specific facet of the study requires evaluation in terms of the threat, a special review will be accomplished and included as an appendix.

4. TERMS OF REFERENCE:

a. PROBLEM:

(1) The categories of maintenance concept is one of the foundations of the US Army maintenance system. It forms the basis for the allocation of maintenance tasks and as such exerts significant influence on maintenance unit organizations and structure.

(2) Prior to the reorganization of the Dept of the Army in 1962 there were, to some degree, unique maintenance systems by equipment commodity. After the functionalization of maintenance, most commodities were forced into a common system with common categories. This produced the one-stop maintenance support concept which continues to have a distinct advantage over previous concepts as far as the customer units are concerned.

(3) During the past several years, there appears to be an evolutionary process in action which is introducing unique, commodity-oriented maintenance systems. Army aircraft and missile maintenance are prime examples of this shift. When this trend is viewed in conjunction with the fact that certain commodities, such as medical, cryptographic, and ADPE materiel have always utilized unique systems, it becomes evident that the standard US Army system for maintenance is no longer completely standardized. Rather, it is approaching the earlier commodity-oriented systems. The latter systems are operating, however, in a doctrinal environment which recognizes only limited exceptions.

(4) Since many facets relating to this subject cannot be completely quantified, statistical inference techniques are of little value. Instead, the study must be based upon the following research questions:

(a) Are the US Army equipment commodity groupings sufficiently unique to require unique or specially designed commodity-oriented systems of maintenance categories?

(b) If unique commodity oriented categories are necessary, what should they consist of?

(c) If a commodity-oriented system of categories should be approved for implementation, what other changes would be necessary?

b. Impact of Problem.

(1) The ability of maintenance managers to effectively and efficiently utilize their resources is the crux of this problem. It is possible that the current system of maintenance categories is less than satisfactory and that this is a result of adhering to a standard system. This more or less arbitrary conformance may have resulted in task allocations which are neither practical nor efficient in the utilization of available tools, test equipment, and skills.

(2) If the situation described above is true, improvement can be achieved by recognizing that the basic differences between commodities do impact upon maintenance requirements. It follows also, that if the requirements differ, certain aspects of the maintenance system should also differ. In this study, the maintenance categories will be examined specifically to determine whether or not maintenance effectiveness and efficiency for all commodities can be improved.

(3) Any improvements achieved will impact significantly on the maintenance system through better utilization of resources.

c. Objectives. The objectives of this study are:

(1) Analyze current doctrine as well as concepts from studies and other literature which relate to the categories of maintenance.

(2) Define criteria for most effective and efficient maintenance task allocation.

(3) Analyze maintenance task allocation for selected equipment.

(4) Formulate commodity-oriented categories by arraying maintenance tasks in accordance with the criteria developed in (2) above.

(5) Evaluate the commodity-oriented system to determine whether or not there are sufficient advantages to warrant change

(6) Identify other changes required if commodity-oriented categories of maintenance are adopted.

d. Limits.

(1) This study will consider all active US Army forces.

(2) CONUS installation maintenance activities (TDA) are excluded.

(3) Maintenance support provided other services and allies is excluded.

(4) All commodities less medical, crypto, ASA and nuclear will be considered.

e. Scope.

(1) This study will investigate the US Army maintenance system in terms of the categories of maintenance.

(2) Individual items of equipment will be analyzed in terms of maintenance task allocation.

(3) All of the end items in the Army inventory will not be considered. Those selected for analysis will be chosen in accordance with a valid sampling plan.

(4) This study will be developed for the current time frame.

f. Assumptions. The following assumptions will be accepted as facts for the purpose of this study:

(1) The current austere fiscal environment will continue and may become even more severe.

(2) The basic organizations and strengths of the type divisions will not be altered significantly during the period covered by this study.

(3) Contingency forces as addressed in this study consist of all active US Army forces.

(4) US Army contingency forces will be required to respond to any world-wide crisis and sustain themselves for the duration of the crisis regardless of the geophysical conditions present.

j. Essential Elements of Analysis (EEA).

- (1) What is current doctrine on categories of maintenance by commodity?
- (2) What changes in the maintenance system are proposed by current/ongoing studies or research projects?
- (3) What is current state of Maintenance Support Positive implementation in terms of maintenance categories and task allocation?
- (4) What are programmed and anticipated actions in Maintenance Support Positive implementation which may impact on this study?
- (5) What are currently used criteria for maintenance task allocation by commodity (NMP)?
- (6) What are the criteria for commodity-oriented maintenance categories which will insure system effectiveness and efficiency?
- (7) What special considerations, if any, are required in the categories of maintenance to insure complete realization of the EAD concept?
- (8) What are the maintenance category implications created by the Closed Loop System?
- (9) Does DX Expanded require special consideration and accommodation in the maintenance categories system?
- (10) What is the specific mission and functions of general support maintenance by commodity?
- (11) Are general support maintenance units too broad in capabilities?
- (12) Is backup to direct support a viable mission for general support maintenance units?
- (13) How does combat environment affect the performance of organizational maintenance?

h. Environment. The study will be developed for mid and high intensity conflict.

i. Constraints. None.

j. Methodology. For planning purposes four phases have been identified as follows:

(1) Phase I. Literature Review and Preparation for Analysis Phase.

(a) Identify, assemble, and study related official publications, technical articles and other studies. This will place the problem and related factors in proper perspective and suggest other alternative approaches to the problem. It will also reveal research already accomplished.

(b) Define the equipment commodities both in terms of TRADOC school proponency and USAMC Commodity Command assignment.

(c) Acquire and analyze current USAMC policies and procedures for developing Maintenance Allocation Charts (MAC). These actions will constitute the study baseline in terms of the current system of categories.

(d) Acquire and analyze the proposed Maintenance Support Positive (MS+) criteria for allocating maintenance tasks and obtain copies of the test Maintenance Allocation Charts (MAC) that have been developed to date. The analysis of these criteria and test MAC will establish one variation to the baseline.

(e) Select the commodity-oriented end item samples in accordance with a predetermined sampling plan. The TRADOC schools will be requested to assist in this process in their respective areas of proponency. A great deal of care will be exercised in order to insure valid samples, yet keep the volume of MAC to be reviewed within a manageable quantity. One technique to be utilized will be to analyze only the minimum MAC per group of essentially like items. For example, SB 700-20, Army Adopted Items of Materiel, lists eight line item numbers (LIN) and 19 Federal Stock Numbers (FSN) for Truck, Cargo, 2 1/2 Ton. Several of these items are type classified as contingency items, and of the remainder, the distinguishing feature is usually the presence or absence of a winch or whether or not the vehicle has an extra long wheel base. In this case, it is expected that two or possibly three items will be sufficient for the 2 1/2 ton truck segment of the analysis. Similar situations occur throughout the other categories of equipment.

(f) Identify and refine measures of effectiveness upon which to base the study parameters for maintenance task allocation. These will be designed to answer the question, "who should do which maintenance task and at which level (category)?" The USAMC procedures will be revised/changed or a completely new set of measures of effectiveness will be developed as necessary.

(g) Refine the criterion of choice as stated in this study plan. This criterion must be sufficiently sensitive to clearly distinguish between the alternatives which will be developed in Phase II.

(2) Phase II. Maintenance Allocation Chart/Category Analysis.

(a) This step will consist of analyzing each MAC in the commodity samples. Criteria in the form of a decision table, developed during Phase I, will be used. In certain instances, the proponent school will be requested to assist with this step.

(b) By commodity, array the results in alternative systems of maintenance categories. One alternative will be the current system.

(c) Subject these alternatives to intensive review to determine the advantages and disadvantages of each.

(3) Phase III. MOS/TOE Analysis.

(a) Identify the nature and scope of required MOS changes. This step anticipates the situation wherein the current maintenance categories for an item or group of items are distinguished largely on the basis of skills or skill levels. Consideration must then be given to the benefits which might be derived from a change in the MOS(s).

(b) Identify the nature and scope of required TOE (organization) changes. This step anticipates that for any recommended change in the maintenance category system, there will be corresponding organizational changes.

(4) Phase IV. Evaluation and Recommendations.

(a) In light of the results from phases II & III, answer each EEA.

(b) Apply criterion of choice and order alternatives in order of preference.

(c) Compare favored alternative with current system. Make evaluation concerning the potential benefits to be derived from change when balanced against the cost of making the change. This step will utilize the Living Model Scenario evaluations to the maximum practicable extent. Certain of the alternatives will be inserted into the standard scenarios and analyzed for voids and weaknesses. This effort will be limited to the scenario evaluations which are performed during the course of this study effort.

(d) Prepare report.

k. Alternatives. The alternatives will range from the current system to a completely commodity oriented-system with varying categories for each commodity.

1. Measures of Effectiveness. The measures of effectiveness (MOE) have not been defined and will be developed during the initial phase of the study. The MOE will consist of a systematic procedure for assigning a value to a system by taking into account its relative rank in one or more relevant factors. These factors will consist of measureable elements such as numbers of personnel, tools and test equipment, and time to repair. Intangible factors such as motivation, supported/support unit rapport and the impact of combat conditions will also be included.

m. Related Studies:

- (1) Army Aircraft Maintenance Structure (AAMS) (in process).
- (2) Missile and Munitions Evaluation (MAME 71) Final Report, Dec 71.
- (3) Maintenance Organizational Structures for Support of the Army in the Field, ACN 16172, Nov 71.

n. Criterion of Choice. This criterion will be the end result of the ranking process based on the measures of effectiveness. Once the most preferable of the alternative systems of categories has been identified, it will be compared with the current system as specified by doctrine. A value judgement will be made concerning the potential worth of the new system as opposed to the real and intangible costs associated with the introduction of a major change into the US Army maintenance system.

5. SUPPORT AND RESOURCE REQUIREMENTS.

a. Support Requirements.

- (1) Support will be required from within TRADOC as follows:

- (a) US Army Logistics Center.

1. Assist in coordination requirements with TRADOC service schools.
2. Continue to update information on status of EAD implementation.

- (b) Transportation, Quartermaster, SE Signal, Missile and Munitions, Engineer Schools and Centers.

1. Assist in selecting end item sample in accordance with parameters provided by USAOC&S.

2. Assist as required in Maintenance Allocation Chart (MAC) analysis.

- (2) Support will be required from outside of TRADOC as follows:

- (a) DA DCSLOG.

1. Provide information on current status as well as projected actions relative to the Maintenance Support Positive concept implementation.

2. Authorize direct coordination with USA Logistics Evaluation Agency.

(b) USAMC.

1. Authorize direct coordination with commodity commands, Materiel Management Center, the Major Items Data Agency, and the US Army Logistics Management Center.

2. Provide information on USAMC implementation of Maintenance Support Positive (MS+) concept.

(c) USAMC Commodity Commands.

1. Provide specific data on NMP procedures for allocating maintenance tasks.

2. Provide copies of latest changes to Maintenance Allocation Charts (MAC) for items in the study sample.

3. Provide information and available data on the anticipated MAC changes in accordance with MS+. Specifically, data relating to cost effectiveness methodology/criteria are required.

(d) US Army Major Item Data Agency. Provide density data required for individual decisions on an end item's eligibility for inclusion in the study sample.

(e) US Army Materiel Management Center.

Information and assistance as required.

b. Resource Requirements.

(1) USAOC&S manpower requirements are projected as follows:

(a) 2d Qtr, FY 74-	6 man months
(b) 3d Qtr, FY 74-	8 man months
(c) 4th Qtr, FY 74-	8 man months
(d) 1st Qtr, FY 75-	8 man months
(e) 2d Qtr, FY 75-	6 man months

(2) Manpower requirements other than USAOC&S are projected to be a total of 12 man months.

c. Data Requirements. There are no known data requirements other than those described in paragraphs 4.j. and 5.a. above.

6. ADMINISTRATION:

a. Study Schedule. See Inclosure 2.

b. Study Outline. See Inclosure 3.

c. Study Project Officer. MAJ Garry A. Scharberg, USAOC&S, AUTOVON 870-5727.

7. CORRELATION. This study has been assigned ACN 21012.

ANNEX 1

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2. AR 220-1, Unit Readiness Reporting, 30 May 1973.
3. AR 310-3, Military Publications, Coordination and Approval of Department of the Army Publications, 20 December 1968.
4. AR 310-25, Dictionary of United States Army Terms, 1 June 1972.
5. AR 700-4, Supply and Maintenance Technical Assistance Program, 10 February 1971.
6. AR 750-1, Army Materiel Maintenance Concepts and Policies, 1 May 1972.
7. AR 750-37, Sample Data Collection- The Army Maintenance Management System, 24 March 1971.
8. AR 750-43, Test, Measurement, and Diagnostic Equipment, 3 March 1971.
9. AR 750-51, Maintenance Assistance and Instruction Team (MAIT) Program, 31 March 1972.
10. AR 750-52, Equipment Operationally Ready Standards, 29 July 1971.
11. DA PAM 11-25, Life Cycle Management Model for Army Systems, 11 October 1968.
12. DA PAM 37-1, Strengthening the Army's System for Management of Operating Resources: A Command and Staff Guide for Resource Management, 8 May 1967.
13. DA PAM 350-23, Commander's Maintenance Management Course, 1 May 1972.
14. DA PAM 350-24, Maintenance Supervisor's Course, 1 May 1972.
15. DA PAM 701-1,2 and 3, The Army Logistics System Master Plan (LOGMAP), July 1973.

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16. DA PAM 750-10, Command Maintenance Management Inspection Handbook,
17. FM 1-10, Army Aviation Organizational Aircraft Maintenance, 20 September 1965.
18. FM 9-59, Missile Support Unit Operations, 26 March 1970.
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21. FM 29-20, Maintenance Management in Theaters of Operations, 26 July 1968.
22. FM 29-23, Direct Support Maintenance Battalion (nondivisional), 7 September 1971.
23. FM 29-24, General Support Maintenance Battalion, 20 December 1971.
24. FM 29-25, Direct Exchange, Shop Supply, and Operational Readiness Float Procedures, 3 March 1972.
25. FM 29-27, Calibration Service in the Theater of Operations, 29 September 1971.
26. FM 29-30, Maintenance Battalion and Company Operations in Divisions and Separate Brigades, 26 July 1968.
27. FM 29-30-1, Division Maintenance Battalion, 2 September 1971.
28. FM 29-35, Maintenance Support in Separate Brigades, 6 January 1972.
29. FM 29-36, Aircraft Maintenance Support, 12 June 1972.

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30. FM 38-1, Logistics Management, 21 March 1969.
31. FM 38-5, Logistics - Maintenance Management, 16 May 1969.
32. FM 54-1, The Logistical Command, 27 July 1962.
33. FM 54-2, The Division Support Command and Separate Brigade Support Battalion, 27 June 1969.
34. FM 54-7, The Theater Army Support Command, 3 March 1972.
35. FM 54-9, The Corps Support Command (Draft).
36. FM 100-10, Combat Service Support (Draft).
37. SB 700-20, Army Adopted and Other Items of Materiel Selected for Authorization, 21 November 1972.
38. TM 38-750, The Army Maintenance Management System (TAMMS), November 1972.
39. TM (Those containing the Maintenance Allocation Chart (MAC) for each end item to be analyzed).
40. USA Armor Center Team Study, Army Maintenance System Simplification, August 1972.
41. USACDC PAM 71-1, Force Developments- The Measurement of Effectiveness, January 1973.
42. USACDC Study, Rapid Integrated Logistics Support System (RILS) ACN 17902, October 1972.
43. USACDC Study, Echelons Above Divisions (EAD) ACN 16863, December 1971.

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44. USACDC Study, Maintenance Organizational Structures for Support of the Army in the Field, ACN 16172, (Final Draft) November 1971.
45. USACDC Study, Maintenance - 75, ACN 6500 (Final Draft) September 1968.
46. USA Dept of the Army Study, The Department of the Army Board of Inquiry on the Logistics System, January 1967.
47. USA Missile and Munitions Center Team Study, Missile and Munitions Evaluation (MAME-71), November 1971.
48. USA Vietnam Report, The Logistics Review - US Army Vietnam, 1965 to 1969.

STUDY SCHEDULE

Receipt of approved Study directive	D Day
Submission of study plan	D +75
Initial IPR (study plan approval)	D +100
2d IPR (midpoint review)	D +280
Coordination draft	D +380
Final IPR (LOGC decision briefing)	D +430
Final Draft Report	D +450

STUDY OUTLINE

SUBJECT: MAINTENANCE CATEGORIES, A SUBSTUDY OF THE MAINTENANCE SUPPORT STRUCTURE FOR CONTINGENCY FORCES.

- I. INTRODUCTION
- II. PROBLEM
- III. ASSUMPTIONS
- IV. DISCUSSION
 - A. BACKGROUND
 - B. PREVIOUS AND CURRENT RELATED STUDY EFFORTS
 - C. DEFINITION OF EQUIPMENT CATEGORIES
 - D. DEVELOPMENT OF ANALYSIS METHODOLOGY
 - 1. EVALUATION OF CURRENT AMC POLICIES AND PROCEDURES
 - 2. EVALUATION OF PROPOSED AMC PROCEDURES FOR MAINTENANCE ALLOCATION CHART (MAC) REVISION IN MAINTENANCE SUPPORT POSITIVE (MS+) IMPLEMENTATION
 - 3. REVIEW MS+ TEST MAC'S
 - 4. DEFINE MEASURES OF EFFECTIVENESS
 - 5. DEVELOP MAINTENANCE TASK ALLOCATION DECISION TABLE
 - E. SELECTION OF COMMODITY SAMPLES
 - 1. SAMPLING PLAN, RATIONALE AND METHODOLOGY
 - 2. SELECTION PROCESS
 - 3. COLLECTION OF APPLICABLE MAC FOR ITEMS IN THE SAMPLE
 - F. MAINTENANCE TASK ANALYSIS
 - 1. ANALYZE EACH MAC
 - 2. ALLOCATION OF MAINTENANCE TASKS IN ACCORDANCE WITH DECISION TABLE

3. DEVELOPMENT OF ALTERNATIVE CATEGORY SYSTEMS BY COMMODITY

H. EVALUATION

1. ANSWER EEA

2. APPLICATION OF CRITERION OF CHOICE

3. CONCLUSIONS

I. RECOMMENDATIONS

APPENDIX B

ESSENTIAL ELEMENTS OF ANALYSIS

B-1. What is current doctrine on categories of maintenance by commodity?

A. Current doctrine on commodity-oriented maintenance is discussed in subparagraphs 1-7b(3), 2-4b, and 2-13a(3)(a), in Chapter 5, and in Appendixes B through I of AR 750-1, Army Materiel Maintenance Concepts and Policies.

B-2. What changes in the maintenance system are proposed by current/ongoing studies or research projects?

A. The Commodity-Oriented General Support Study (ACN 23145, successively renamed Combat Oriented General Support, then Restructured General Support) proposes that commodity-oriented general support maintenance elements replace existing types of general support maintenance units. The Restructured Division Study (ACN 29825) proposes that organizational maintenance in the division be reorganized and that limited direct support maintenance capability be co-located with organizational maintenance capability in the maneuver elements of the division.

B-3. What is the current state of Maintenance Support Positive implementation in terms of maintenance categories and task allocation?

A. DA Circular 750-34, Maintenance of Supplies and Equipment, Maintenance Support Positive (MS+), Army Maintenance for the Seventies, has expired, and the USAMC study "Evaluation of the

Implementation of Maintenance Support Positive (MS+) " has been withdrawn from the Army Logistics System Master Plan (LOGMAP).

B-4. What are currently used criteria for maintenance task allocation by commodity (NMP)?

A. Efforts to obtain definitive criteria from the DARCOM national maintenance points proved to be unsuccessful in all cases.

B-5. Is the current Maintenance Allocation Chart (MAC) concept an efficient method to indicate what maintenance is authorized or required on an item of equipment?

A. When the guidance in TM 38-715-1 pertaining to the preparation of a MAC is followed conscientiously and completely during such preparation, the resulting MAC is an efficient and effective means of indicating what corrective maintenance is authorized on an item of equipment. The MAC is not intended to show all required maintenance; scheduled maintenance is listed separately in the Organizational Maintenance Technical Manual under the heading "Preventive Maintenance Checks and Services".

B-6. What are the criteria for commodity-oriented maintenance categories which will insure system effectiveness and efficiency?

A. The criteria for developing commodity-oriented maintenance concepts are outlined in subparagraphs 2-4b,c,d, and e of AR 750-1.

B-7. What special considerations, if any, are required in the categories of maintenance to insure complete realization of the EAD concept?

A. 1. Doctrine relative to EAD and Combat Service Support is still being defined. However, FM 54-9, Corps Support Command, April 1976, has been distributed widely, and this Field Manual provides some reasonably specific information relative to the EAD concept. The major impact of this concept is in Combat Service Support, where it eliminates the Field Army Support Command (FASCOM) and its subordinate Support Brigades, and replaces them with a Corps Support Command (COSCOM).

2. Review of the Maintenance Services Chapter of FM 54-9 reveals that all maintenance DS battalions within the COSCOM provide DS maintenance and repair parts supply to equipment users on a functionalized basis. Maintenance GS battalions also provide maintenance support on a functionalized basis (except for the transportation aircraft maintenance GS battalion). However, these GS battalions have no repair parts supply mission and they function, primarily, to perform GS maintenance on unserviceable components in support of the supply system.

3. Accordingly, pending the possible development of more specific and/or comprehensive doctrine, no special considerations are required in the categories of maintenance to insure realization of the EAD concept.

B-8. What are the maintenance category implications created by the Closed Loop System?

A. The Closed Loop System provides for intensive management of selected maintenance repair parts. This intensive management

results in improved availability of, and consequently more timely maintenance repairs which involve, these repair parts. These advantages exist regardless of the categories which are utilized or not utilized in the maintenance concepts pertaining to such repairs.

B-9. Does Direct Exchange Expanded require special consideration and accommodation in the maintenance categories system?

A. The standard Direct Exchange System now incorporates the provisions of the former Direct Exchange Expanded system. Thus, it is organized to involve all four maintenance categories. However, the categories at which a DX module may be exchanged are limited to the category at which the Maintenance Allocation Chart (MAC) authorized the repair of that module, and any lower support maintenance category. Consequently, the Direct Exchange System is accommodated by proper Maintenance Allocation Charts rather than by the maintenance categories system.

B-10. What is the specific mission and function of general support maintenance by commodity?

A. Appendixes B through I of AR 750-1 describe current maintenance concepts for commodity groupings which encompass the majority of Army materiel. The specific mission of general support maintenance, as stated in Table 1-2 of AR 750-1 is:

1. Support of lower category maintenance and installation/Army or local area supply operations by:

a. Repair of unserviceable modules in support of DX service to lower category maintenance activities.

b. Repair/modification of end items/modules for return to installation/command/local area supply stocks; operational readiness float stocks of designated direct support units and other activities; and repair and return to user programs.

c. Provision to, or upon the request of, supported DS maintenance units of technical assistance, on-site maintenance and contact team support.

2. Provision, on an exception basis, of area maintenance support, to include technical assistance, on-site maintenance and contact team support, when also assigned a DS maintenance mission where the density of supported units does not justify assignment of a DS maintenance unit.

B-11. Are general support maintenance units too broad in capabilities?

A. This question was addressed in a separate study (ACN 23145), originally entitled Commodity Oriented General Support, subsequently renamed Combat Oriented General Support, and now called Restructured General Support. That study concluded that advantages would accrue from limiting the scope of a GSU's maintenance activities to just one of a few relatively narrow commodity groupings, such as armament and combat vehicles, wheeled vehicles, communications/electronics, or ground support equipment.

B-12. Is backup to direct support a viable mission for general support maintenance units?

A. The General Support Maintenance mission statements contained in Table 1-2 of AR 750-1 indicate that "Provision to, or upon the request of, supported DS maintenance units of technical assistance, on-site maintenance and contact team support" is a normal mission for general support maintenance. The COGS Study (see answer to B-11 above) support concept perpetuates and expands this backup mission relationship.

APPENDIX C

MAINTENANCE SYSTEM HISTORY

C-1. EVOLUTION OF ARMY MAINTENANCE.

a. As long as there have been machines for the waging of war, it is certain that some type of maintenance has been accomplished. In the American military establishment, armorers and artificers were a part of the earliest organizations. However, the history of the maintenance function is difficult to trace because little has been written on the subject. This can be attributed at least partially to the fact that maintenance is not easily quantified, and therefore it does not lend itself to being recorded in the same manner as supply and procurement.

b. The first World War ushered-in the modern era of Army logistics. That conflict served as a catalyst in the mechanization of military materiel through its introduction and wide spread use of the internal combustion engine in tanks, aircraft, and wheeled vehicles. Other advances, such as the machine gun greatly increased the mechanization of US Army materiel and correspondingly increased requirements for its maintenance. The maintenance doctrine of that era evolved along technical service lines. Each of the five "supply arms and services" (Ordnance, Quartermaster, Engineer, Signal, and Chemical) developed some degree of responsibility for the maintenance of the materiel for which it was the proponent. The greatest share of the maintenance activity was assigned to the Ordnance Corps because of its mission in small arms and artillery.

c. During World War I, the Ordnance Corps relied primarily on a system of base and semi-fixed shops. These were designed to support the artillery pieces, gun carriages, trucks and tractors, machine guns, and small arms required by a force of two million men. In addition to these fixed facilities, there were mobile repair shops. These were organized in companies and were organic to the combat force being supported. Although provisions were made for battalion-like organizations, it was not until the advent of WWII that battalion and group headquarters were authorized.

d. During the period between the two World Wars, both the Quartermaster Corps (Motor Transport Service) and the Ordnance Corps developed maintenance doctrine. Each set up a maintenance system which included a structure of different levels at which maintenance tasks were allocated (assigned to be performed). The Quartermaster Corps system contained four levels, while the Ordnance Corps had three. These structures differed only in the fact that the Quartermaster system differentiated between the crew or operator and organizational maintenance personnel at using unit or organizational level. In 1942, the responsibility for motor transport maintenance was transferred to the Ordnance Corps which combined the two systems and established five levels known as echelons. Since the Ordnance Corps was responsible for the vast majority of the maintenance function from 1942 until the reorganization of the Army in 1962, its name became practically synonymous with the maintenance mission.

e. At the beginning of World War II, Ordnance maintenance support had limited mobility, as it had developed from the relatively static tactical situations of World War I. The fast-moving situations which developed during WWII, particularly in the European Theater of Operations, necessitated significant improvement in both the organization and mobility of maintenance units. The resulting changes greatly increased the flexibility of Army maintenance support, and formed the basis for the evolution of maintenance support to the field in the years that followed World War II.

f. The Korean War revealed that the maintenance doctrine which had evolved from World War II was basically sound. During the latter half of the 1950's, the Army maintenance system was still utilizing the five-echelon structure, but now the five echelons were identified as subdivisions of three broad categories of maintenance. The relationships were as follows:

<u>CATEGORIES</u>	<u>ECHELONS</u>	<u>RESPONSIBILITY OF</u>
Organizational	First	Operator or Crew
	Second	Organizational Maintenance
Field	Third	Direct Support
	Fourth	General Support
Depot	Fifth	Depot Maintenance

g. Along with this change in terminology went a policy change of much greater significance. Flexibility of the maintenance

system was increased by allowing a lower echelon to perform a maintenance task allocated to a higher echelon when authorized by that higher echelon. Conversely, a higher echelon could perform tasks allocated to lower echelons.

h. With these exceptions, Army maintenance changed relatively little through the Korean conflict and up until 1962. At that time, a major reorganization of the Army abolished the technical services, and promulgated the philosophy that maintenance is maintenance, even though there are obvious differences in the types or commodities of materiel to be maintained. Until then, each of the several technical services had had the responsibility for maintaining the equipment for which it alone was the proponent. The effects of this reorganization are still being felt throughout the Army. On the surface, at least, it provided an opportunity for functionalization and standardization of logistics activities. At the national level, most of the materiel responsibilities of the technical services, except the Medical Corps and the Corps of Engineers, were consolidated in the Army Materiel Command, recently renamed Army Materiel Development and Readiness Command (DARCOM). In the field, the same functionalization was accomplished through the introduction of "one-stop" maintenance. Prior to this time, each technical service had operated its own maintenance organizations. A using unit or customer was therefore forced to go to several different maintenance units in order to obtain support. After the 1962 reorganization, most direct support maintenance

requirements were satisfied by the same direct support unit. These units were essentially formed from existing Ordnance units, with additional skills , equipment, and repair parts added to enable the unit to repair other commodities of materiel also.

i. By 1965 the terminology applied to maintenance categories had changed again, this time to the designation still in current use:

<u>CATEGORIES</u>	<u>RESPONSIBILITY OF</u>
Organizational	Operator/Crew/Organizational maintenance
Direct Support	Direct Support
General Support	General Support
Depot	Depot Maintenance

C-2. TERMINOLOGY VS. REAL CHANGES.

a. A review of the changes in maintenance category terminology over the years reveals that the names have changed but the players have remained essentially unchanged. Far more significant than these changes in terminology have been those changes in policy which introduced "one-stop" maintenance and which significantly increased the flexibility of the maintenance system. The "maintenance-is-maintenance" philosophy promulgated at the time of the 1962 reorganization of the Army has gradually faded as the differences between the different commodities have been recognized more clearly. Current Army policy provides for different maintenance concepts for different commodities of conventional

materiel, while continuing the separate, specialized maintenance concepts for exceptional commodities such as medical and cryptographic materiel.

b. From the foregoing overview of maintenance system history, it can be seen that the names and numbers of maintenance categories have had relatively little effect on the system as it evolved. The answer to the basic question, "Who repairs what?" can easily remain unchanged while maintenance categories are shuffled and renamed. Meanwhile, the Maintenance Allocation Chart (MAC) continues to be the primary determinant of "Who repairs What?"

APPENDIX D

END ITEM SAMPLE

D-1. A quick review of Supply Bulletin 700-20 reveals that there are approximately 5,000 items in the current inventory. Level of repair analyses of all of the MAC charts for these items would have required a much greater level of effort than was available. In light of the resources available for the study, the study team recognized that the number of end items to be studied would have to be limited to a total of approximately 50 representative items from which maintenance data for the remaining equipments would be derived through an extrapolation process. Initially, the study team selected 50 representative items which were intended to provide a mix of maintenance-significant equipment, with a proper balance between combat, combat support, and combat service support types. At almost the same time, a visit to the US Army Maintenance Management Center (USAMMC) exposed the study team to a list of 57 items used there for evaluating the adequacy of DARCOM maintenance and supply support. The USAMMC selected those items for their maintenance significance and mission essentiality. After an extensive review, the study team concluded that, with a few adaptations, the USAMMC list would be preferable for use as the study sample. Accordingly, the USAMMC list was modified for this study by eliminating a few duplicative items and adding a few items in commodity groups not previously represented. For example, the USAMMC list contains both the 4.2 inch and the 81mm mortars. The

81mm mortar was retained for this study. In place of the deleted items, several items of fire control devices and instruments were added. These items are representative of the fire control devices and instruments which are mounted in various end items in the sample. However, since they are a materiel commodity in their own right, they are treated as separate end items to insure their visibility and consideration in the findings of the study. Also, office machines, the protective mask, a laundry unit, and a bakery plant were added to provide coverage of these commodity areas. D-2. The end item sample was thus established at 50 items and is listed below. Prices are as of 1 September 1976.

<u>LINE NUMBER</u>	<u>NOMENCLATURE</u>	<u>DOLLAR VALUE</u>
R94977	Rifle 5.56mm M16A1	142.00 ea
L92386	Machine Gun 7.62mm M60	1,081.00 ea
M68000	Mortar 81mm M29A1	4,590.00 ea
M11895	Mask CBR: Protective Field M17A1	57.75 ea
J96594	Gun Air Defense Artillery SP: 20mm M163	276,377.00 ea
D12087	Carrier Personnel Full Tracked: Armored M113A1	76,594.00 ea
V13101	Tank Combat Full Tracked 105mm Gun M60A1	264,500.00 ea
K57667	Howitzer Heavy Self Propelled: 155mm M109A1	145,812.00 ea
R50544	Recovery Vehicle Full Tracked Medium M578	110,040.00 ea

<u>LINE NUMBER</u>	<u>NOMENCLATURE</u>	<u>DOLLAR VALUE</u>
R50681	Recovery Vehicle Full Tracked Medium M88	565,134.00 ea
X60833	Truck, Utility: 1/4 Ton 4 x 4 M151A1	3,196.00 ea
X40009	Truck, Cargo: 2 1/2 Ton 6 x 6 M35A2	17,813.00 ea
X59326	Truck, Tractor: 5 Ton 6 x 6 M818	37,633.00 ea
X59600	Truck, Tractor: 10 Ton 6 x 6 M123E2	60,210.00 ea
S70661	Semi Trailer Low Bed: HET 52 1/2 Ton M747	53,254.00 ea
X39940	Truck, Cargo 1 1/4 Ton 6 x 6 M561	12,312.00 ea
A93125	Armored Reconnaissance Airborne Assault Vehicle M551 Full Tracked 152mm	259,930.00 ea
Q16110	Radar Set AN/PPS-5 Less Power	46,201.00 ea
E72804	Compressor, Rty, Pwr Drvn 250 CFM GED 100 PSI	8,794.00 ea
J45836	Gen St Gas Eng 3KW 400 HZ 1-3PH AC 120/208/240V	1,631.00 ea
F39378	Crane Wheel MTD: 20 Ton With Boom Crane 30 Ft w/Blk Tkle 20 Ton 2385	113,494.00 ea
W76816	Tractor, Full Tracked Low Speed Med Draw Bar Pull D7E	32,916.00 ea
L76556	Loader Scoop Dsl 2 1/2 Cu yd Hinge Frm	21,213.00 ea
J74852	Grader, Road Mtrzd: DSL 6 x 4	22,521.00 ea

<u>LINE NUMBER</u>	<u>NOMENCLATURE</u>	<u>DOLLAR VALUE</u>
Q38299	Radio Set AN/PRC 77	943.00 ea
Q53001	Radio Set AN/VRC-46	1,491.00 ea
Q32756	Radio Set AN/GRC-106	14,875.00 ea
Q15414	Radar Set AN/MPQ-4A Less Power	272,743.00 ea
D79481	Central Office Telephone Manual Less Power AN/TTC-29	11,953.00 ea
D79866	Central Office Teletype- writer Less Power AN/MGC-17	10,994.00 ea
Q90120	Radio Teletype: AN/GRC-142	16,954.00 ea
G02204	Detecting Set Mine: AN/PRS-7	272.00 ea
Q16046	Radar AN/MPQ-49 FAAR	314,239.00 ea
H68200	Flame Thrower Mech Main Armament: APC MID	10,086.00 ea
*B18373	Bakery Oven Trailer MID: 2 Oven Deck	9,568.00 ea
*L48315	Laundry Unit Trailer MID: Single Trailer 60 lb Cap ELT9T	16,882.00 ea
X48914	Truck, Lift Fork: DSL Drvn 6000 lb Cap RT	34,520.00 ea
E76866	Computer Gun Direction M18	46,965.00 ea
*I60000	Telescope Elbow: M118C	1,753.00 ea
*I60114	Telescope Panoramic M117: For How MED SP Ft 155mm M109A1	6,648.00 ea
*I60075	Quadrant Fire Control: Elevation M15	1,033.00 ea

<u>LINE NUMBER</u>	<u>NOMENCLATURE</u>	<u>DOLLAR VALUE</u>
*I60071	Drive Ballistic: M10 for M60 Tank	1,099.00 ea
*I60108	Periscope Tank M32: For Tank Combat FT 105mm M60A1	3,618.00 ea
*I60107	Periscope Tank XM44E1: For ARAAV 152mm M551	21,582.00 ea
*B67218	Binocular: 7 x 50 Military Reticle M17A1	195.00 ea
A22496	Aiming Circle: M2 w/Equip- ment	1,267.00 ea
*Q03468	Quadrant Fire Control: Gunners M1A1	164.00 ea
*B67492	Binocular: Infra Red M18 w/Equipment	960.00 ea
*A16852	Adding and Subtracting Machine Listing Elec 10 Key	520.00 ea
*X78567	Typewriter Nonportable 13 inch Carriage	411.00 ea

* Items added to USAMMC sample.

APPENDIX E

STUDY METHODOLOGY

E-1. Introduction. The intent of this appendix is to set forth in a logical sequence the manner in which this study was approached. The study methodology has three principal subdivisions:

- a. Development of end item sample
- b. Level of Repair Analyses (LORA)
- c. Combined Cost-Operational Effectiveness Analysis (COEA) and Scenario Oriented Recurring Evaluation System (SCORES)

This appendix will concentrate on the Level Of Repair Analyses and on the simulation used for the COEA-SCORES analysis. Development and composition of the end item sample are discussed in Appendix D. Detailed discussions of SCORES and the COEA-SCORES analysis are found at Appendixes G and I respectively.

E-2. Level of Repair Analyses.

- a. A basic premise of this study was that the experts in maintenance task allocation are the individuals who are, or have recently been, personally involved in the performance of such maintenance in the field. They are familiar with the field environment and its need for consideration of conditions such as enemy action, terrain, weather, operational urgency, distances, unit capabilities, and available time. They have occasionally devised unique solutions to problems which are not addressed in current doctrine. For these reasons, an intensive effort was made

to reach personnel with recent field experience. This effort was most intensive at the US Army Ordnance and Chemical Center and School because of the large concentration of recently-experienced maintenance personnel readily available there, and the fact that the study team was based there. However, additional input was sought at every opportunity. Dozens of trips were made to various logistics-oriented headquarters and activities either specifically in connection with this study or the study program of which it is a part. Also, the study program was briefed to many visitors to the US Army Ordnance and Chemical Center and School. The objective at all times was to inform logisticians of the type of work being done and to solicit their critical appraisal of the study objectives and approach. The comments and suggestions received in this manner were carefully considered and incorporated into the study wherever feasible.

b. A Level of Repair Analysis (LORA) is fundamentally an objective evaluation of the task allocations in a Maintenance Allocation Chart (MAC). The analysis of each end item in the sample brought together the following elements:

- (1) Maintenance expertise and experience
- (2) Doctrinal references
- (3) Disciplined approach
- (4) Technical publications (maintenance and parts manuals)
- (5) Actual examples of end items

c. The maintenance expertise utilized in the LORAs consisted of maintenance instructors and supervisory personnel at the proponent TRADOC schools. These personnel were generally non-commissioned and warrant officers. The team members were without exception highly qualified, collectively experienced in all categories of maintenance, and accustomed to thinking in terms of the field environment. The analyses usually took place in instructional facilities where training-aid end items could be used for hands-on examinations. The number of personnel required in a team depended upon the size of the commodity sample as well as the size and complexity of the end items. When a LORA team was assembled, it was equipped with applicable technical manuals. A member of the study team briefed the LORA team initially, explaining the nature of the study and applicable doctrinal references (including the allocation policy in TM 38-715-1), and cautioning the members of the LORA team that they could consider only current unit capabilities, without changing existing unit skills, tools, or equipment. From that point on, a member of the study team was available for discussion, but the analysis itself was the product of the maintenance NCOs and warrant officers.

d. The analysis itself consisted of a systematic review of the maintenance task allocations as specified in the MAC. Each maintenance task was challenged in terms of whether or not it was correctly allocated in the MAC chart. The example of the end item and appropriate tools and equipment were physically examined

whenever a member of the LORA team so desired. When an incorrect allocation was found, it was identified, together with the correct maintenance category to which it should be allocated.

e. With few exceptions, the final product of each LORA was a listing of maintenance allocation chart corrections for that end item. The lists are assembled at Appendix H. Since the corrections were too numerous to deal with individually, the correction statistics were arrayed by commodity groupings - primarily the commodity groupings shown in the Appendixes to AR 750-1. Arrayed in this way, the correction statistics tended to highlight characteristic differences in the maintenance allocations developed by different DARCOM Commodity Commands, and they reflected a movement trend which was an important consideration during the structuring of the COEA.

E-3. Cost-Operational Effectiveness Analysis (COEA)

a. During the first phase of the study, an extensive survey was made of models available to the Army for use, with particular emphasis placed upon the analytical requirements of the Cost-Operational Effectiveness Analysis (COEA). The models which were examined and reluctantly discarded were generally of the type which are oriented on analysis of a single end item or single commodity, and were designed primarily for use in the development process. The optimization algorithms which many models incorporate require input data which can only be handled in terms of means or averages, such as the Mean Time Between Failure (MTBF) and Mean

Time to Repair (MITR). These types of values require extreme care and exhaustive sensitivity analysis to preclude biased results.

(NOTE: the reader may gain a wider appreciation for the relative merits of models by studying a report by the Applied Science Division of the USAMC Maintenance Support Center entitled, "Evaluation of Maintenance Support Optimization Models" ^{13/}). In view of the limited resources programmed for this study, a decision was made to obtain the services of a contractor for the necessary COEA effort (see Appendix F).

b. The apparent nonsuitability of the available logistics evaluation models did not exclude their possible application entirely. The statement of work for the contractual COEA effort stipulated that existing models should be adapted or modified if possible. The intent of this statement was to insure that all possibilities were explored, in recognition of the possibility that expert OR/SA technicians could detect possible applications not apparent to the study team. However, the contractor found that he was not able to use either an extensive simulation such as Models of the US Army Worldwide Logistic System (MAWLOGS), or any of the simpler existing simulations. The extensive quantitative data required for these simulations is either non-existent or not adaptable for such use, and thus from a practical standpoint is not available. This nonavailability necessitates aggregation of inputs and places severe limits on the amount of detail which can be obtained from such a simulation. Consequently, the contractor

developed a new simulation tailored to accomodate available inputs, and data was obtained on an "as required" basis. The desirability of this approach is described explicitly by Christianson, et al 14,42/ in their statement

"In order to understand and evaluate problems of the Army logistics system...it is absolutely essential that the operations analyst rely upon empirical data. In practice, the...system does not operate entirely according to regulation, nor does it conform totally with scientific theory. To determine how it is actually performing, and to effect appropriate changes based upon logic, computer simulations, or actual tests, one must observe and measure the degree to which reality fails to coincide with expectation."

c. The model employs an aggregative or macro approach rather than a detailed approach. However, through the use of appropriate techniques, the simulation is transparent, allowing the results obtained to be linked to their causes so that results derived from changes in policy or from deliberate manipulation of input variables can be distinguished from those due to chance. Briefly, the simulation consists of three parts: (1) A preprocessor which accepts policy, opens files, and generates "failures" based on unit engagement codes, (2) The main model where the actual simulation is played, and (3) The post-processor in which the results are tallied and output statistics are printed. The simulation deals with 12 end items which also represent the densities and maintenance workloads of about 150 other maintenance-significant end items. The scenario utilized (see Appendix G) employs a force model which contains 138 organizational maintenance activities, 23

direct support maintenance units, and three general support maintenance units. Each end item the model deals with is vulnerable to as many as ten types of failures, and each item is subject to being serviced in as many as 15 different types of shop facilities. In order to test and measure the impact of proposed changes, the model permits the alteration of variables such as the length of the scenario (in terms of periods and of hours in a period), maximum allowable queue lengths, lowest level (farthest forward maintenance category) of repair authorized, priorities, probability of encountering a repair parts stock-out condition, and the time required to obtain repair parts. The simulation can be run any number of times under the same conditions, except for those changed by the investigator. This capability permits changes in results to be related to the correct causal factors. Output statistics include numbers of failures by end item and failure type, numbers of completed repairs, average facility waiting times, average turn-around time, and operational availability rates by end item, by period. The latter output provides the primary measure of effectiveness.

d. A description of the Cost-Operational Effectiveness Analysis which employed this simulation is at Appendix I.

APPENDIX F

Contractual Agreement

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT 1. PROJECT NO. (If applicable) 2. PROJECT NO. (If applicable) 3. EFFECTIVE DATE 4. AMENDMENT NO. (If other than block 3) 5. AMENDMENT OF SOLICITATION NO. 6. MODIFICATION OF CONTRACT/ORDER NO.		7. DATE 8. CODE
9. CONTRACTOR NAME AND ADDRESS 10. CODE 11. FACILITY CODE 12. DATE 13. CODE		14. DATE 15. CODE
16. BDM Services 1920 Aline Avenue Vienna, Virginia 22180		17. DATE 18. CODE

THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

- ☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.
1. Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:
- (a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

6. ACCOUNTING AND APPROPRIATION DATA (If required)

ACRN: AW 2102040 57-1001 P615102-2572 S44036 NIPR: CDSM 21-75
 5-690000.22.11251 YE-A1 PRON: YE C0151 01 A1 A9

1. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

- (a) ☐ This Change Order is issued pursuant to _____
 The Changes set forth in block 12 are made to the above numbered contract/order.
- (b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.
- (c) ☒ This Supplemental Agreement is entered into pursuant to authority of 10 U.S.C. 2304(r)(1)
 It modifies the above numbered contract as set forth in block 12.

13. DISCUSSION OF AMENDMENT/MODIFICATION

a. By this action the Funded Amount of the contract is increased as follows:

	Funded Amount Before Modification	Amount Added by This Modification	Funded Amount Balance
Estimated Cost	1,418,934.00	\$92,924.00	1,511,858.00
Fixed Fee	104,463.00	6,969.00	111,432.00
Totals	1,523,397.00	\$99,893.00	1,623,290.00

b. The contractor shall commence performance of Task 5-75, entitled Maintenance Support Structure for Contingency Forces Study, in accordance with Statement of Work, pages 2 through 6, Annex A page 7, and Attachment 1, pages 8 and 9 hereof.

c. The effort required for performance of Task 5-75 shall comprise 21.6 Man Months.

Except as provided herein, all terms and conditions of the document referenced in block 8, as herebefore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/ORDER IS NOT REQUIRED TO SIGN THIS DOCUMENT 14. NAME OF CONTRACTOR/ORDER 15. NAME AND TITLE OF LOUER (Type or print) 16. DATE SIGNED		17. UNITED STATES OF AMERICA 18. NAME OF CONTRACTING OFFICE (Type or print) 19. DATE SIGNED JOHN J. AGOSTINO, JR.	

C O P Y

STATEMENT OF WORK
CONTRACT DAAG39-74-C-0018
TASK 5-75

1. Project Study Title (ACN): Cost-Effectiveness Methodology for Evaluation of Selected Maintenance Support Concepts (Under carrier study "Maintenance Support Structure for Contingency Forces," ACN 21012)

2. Scope of Contractor Effort:

a. General: The contractor shall provide analytical services to develop and selectively apply approaches for cost-effectiveness assessments of alternative maintenance support structures being evaluated under the cited carrier study. Cost-effectiveness methodology shall be explored in the context of nine substudies constituting the carrier program and covering the following areas: (a) maintenance categories, (b) maintenance standards, (c) technical inspection and quality control, (d) maintenance tailoring, (e) operational readiness float, (f) recovery, collection, classification and disposition, (g) adaptation of commercial and industrial maintenance practices, (h) maintenance of prepositioned equipment, and (i) deletion of maintainable items from the maintenance systems of contingency forces. The effort shall be directed toward (a) the structuring of such general approaches as may be feasible for joint or common evaluations of options arising in more than one substudy and (b) the conduct of detailed cost-effectiveness analyses for the substudies on technical inspection/quality control and maintenance categories, designated herein as the "priority" substudies.

b. Specific: The contractor shall perform the following specific subtasks in accomplishing the analytical effort outlined in paragraph 2a above.

(1) Subtask 1: The contractor shall delineate a time-phased work plan for the structuring of the cost-effectiveness methodology and the conduct of analyses in support of the priority substudies. The work plan shall be compatible to the maximum extent possible, with the carrier study program. Substudy directives, plans, references, schedules, and progress to date will be provided by the Government as an information base for the preparation of the work plan.

(2) Subtask 2: The contractor shall define measures of effectiveness for the carrier study program. Such measures shall, either directly or indirectly, reflect operational readiness. The contractor will consider operational availability of materiel as the primary criterion of readiness. Measures which correlate with availability will also be examined to facilitate comparative analyses for specific cases, particularly the priority substudies. These shall not be limited to materiel

aspects alone, but consider maintenance as a system and the requirement for responsive support to a combat force.

(3) Subtask 3: The contractor shall structure such generalized deterministic and/or simulation models as may be feasible to assess the effectiveness of alternative maintenance options in terms of the defined measures. Concurrently with the examination of potential effectiveness measures, the contractor shall select, adapt or develop technical approaches to quantify availability and other effectiveness indexes by logical groupings of variables which may pertain to different substudies. Parameters of candidate models should include but not be limited to reliability factors; e.g., mean time between failures, transportation time, delay in service at the maintenance unit, accessibility of repair parts, repair time, and availability of the item in the operational readiness float. Potential applications, to meet the objectives of the programmed substudies, shall be outlined in terms of input requirements, processing procedures and types of outputs to be generated. Detailed attention shall be given, in particular, to applications in support of the priority substudies.

(4) Subtask 4: The contractor shall delineate cost-estimation procedures compatible with accepted methods of economic analysis. For each substudy, the contractor shall identify component elements for which cost information will be required. Sources of cost data or estimates shall be surveyed to determine those most suitable for substudy purposes. The use of incremental costing, derivations of cost-estimating relationships, and the conduct of sensitivity analyses shall be considered in the development and applications of the costing methodology. In addition to the personnel and materiel costs directly associated with organizational level, direct support and general support maintenance activities, provision must be made for the inclusion of training resources implicit in the specific alternatives under study.

(5) Subtask 5: The contractor shall select, adapt or develop approaches for assessing viable maintenance options in terms of cost-effectiveness. Such composite cost-effectiveness indexes, as may be practical, shall be defined, and methodology explored for determining the relative merits of alternatives. Optimization techniques (e.g., mathematical programming) shall be examined for maximizing readiness within cost constraints or minimizing cost for given readiness states. Cost-effectiveness measures, and procedures for their use in comparative analyses, shall be delineated for applications in the priority substudies. For the other substudies under the carrier program, the procedures for combining the cost and effectiveness aspects shall be outlined in more general terms.

(6) Subtask 6: The contractor shall apply the overall cost-effectiveness methodology, (cost-effectiveness analysis) for evaluation of alternative maintenance structures entering into the two priority substudies. The rationales developed in response to Subtasks 2 through 5 shall be

systemically employed. Detailed documentation shall be provided as reference cases to facilitate future applications of the methodology. If the effectiveness models to be utilized permit the concurrent evaluation of variables primarily associated with other than the priority analyses, the documentation shall clearly indicate the interactions.

3. Assumptions: Assumptions shall be as specified in substudy directives and plans prepared pursuant to TRADOC Pamphlet 71-3.

4. Results (End Products) Required: The contractor shall provide:

a. A time-phased work plan pursuant to the requirements of Subtask 1 and subject to review and approval by the Government.

b. Measures of effectiveness and methodological approaches for their determination relative to assessments of maintenance options in terms of operational readiness.

c. Methodology for cost analyses reflecting the economic impact of maintenance alternatives at organizational, direct support and general support levels and including provision for training requirements.

d. Cost-effectiveness methodology, in generalized or outline form, for assessing the relative merits of maintenance options of interest in the carrier study program.

e. Comprehensive cost-effectiveness analysis in support of substudy on technical inspection and quality control.

f. Comprehensive cost-effectiveness analysis in support of substudy on maintenance categories.

5. Information to be Provided by the Government:

a. The Government shall provide the following information through the study sponsor's representative:

(1) Proposed/final substudy directives and plans.

(2) Carrier and substudy schedules

(3) Status reports on substudies with emphasis on variables, parameters, and maintenance options of interest for consideration under the contract.

(4) Approved sources of cost data.

(5) Relevant Government publications cited in directives and plans.

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b. Information shall be furnished within the following periods subsequent to contract initiation:

(1) Items 5a(1) and 5a(3)	15 days
(2) Items 5a(4) and 5a(5)	30 days

6. Period of Performance:

- a. Starting Date: Effective date of this modification
- b. Completion Date: Seven (7) months after effective date of this modification.
- c. Critical Milestone Events: The following events shall be completed within the specific times following effective date of this modification:

(1) Submission of work plan	30 days
(2) Submission of methodology approaches for effectiveness assessments	3 months
(3) Submission of cost-estimation approaches	3 months
(4) Submission of cost-effectiveness methodological approaches	3 1/2 months
(5) Draft cost-effectiveness analysis for technical inspection/quality control substudy	6 months
(6) Draft cost-effectiveness analysis ofr maintenance categories substudy	6 months

7. Reporting Requirements:

a. Contractor furnished reports shall be prepared in mutually agreed formats developed between the contractor and the study sponsor's representative. Required reports and submission times after effective date of this modification are as follows:

(1) Work plan pursuant to Subtask 1	30 days
(2) Memorandum on effectiveness methodology	3 months
(3) Memorandum on cost-estimation methodology	3 months
(4) Memorandum on methodological approaches to cost-effectiveness	3 1/2 months

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- (5) Draft cost-effectiveness analysis for technical inspection/quality control substudy 6 months
- (6) Draft cost-effectiveness analysis for maintenance categories substudy 6 months
- (7) Final report on effectiveness, cost and cost-effectiveness methodologies 7 months
- (8) Final reports on cost-effectiveness analyses for priority substudies 7 months

The work plan, memoranda, and draft reports shall be submitted in five copies each. Thirty (30) copies of the final reports shall be furnished.

ANNEX A TO STATEMENT OF WORK
CONTRACT DAAG 39-74-C-0018
TASK 5-75

1. Administrative Information:

a. Government Study Sponsor's Representative

MAJ Garry A. Scharberg
US Army Ordnance Center and School
ATTN: ATSL-CTD-CS
Aberdeen Proving Ground, Maryland 21005

b. Security Clearance Required: The Contract Security Specification, DD Form 254, is for a ~~SECRET~~ clearance and applies to this modification.

c. Government Furnished Support: Computer services and time with respect to facilities at Fort Leavenworth, KS, Aberdeen Proving Ground, MD, or Fort Lee VA, the site to be determined by the Government on the basis of available software and computer workloads at the candidate installations.

2. Computer Software Developed:

a. Existing computer programs within or available to TRADOC will be utilized to the maximum extent possible. Requests for modification will be submitted to the Contracting Officer's Representative (COR) for review and approval.

b. Only those programming languages may be employed for which compilers are available at designated TRADOC facilities.

3. Data/Report Requirements.

Shall be as set forth in the Contract Data Requirements List, DD Form 1423.

ATCH NR 1		EXHIBIT A		CONTRACT DATA REQUIREMENTS LIST		SYSTEM/ITEM Task 5-15	
TO do with 33/PR DA1639-75-R-9158		CATEGORY N/A		CONTRACTOR BDN Services Co.			
1. SEQUENCE NUMBER	2. TITLE OR DESCRIPTION OF DATA	3. CONTRACT REFERENCE	4. TECHNICAL OFFICE	5. FREQUENCY	6. DATE OF 1ST SUBMISSION	7. DATE OF SUBSEQUENT SUBMISSION	8. DISTRIBUTION AND ACQUISITION (MILITARY - Regular Contract/Prime Contract)
A0001	Technical Reports. 3. Time Phased Work Plan		ATL-CTD-CS	Once	Item 16	See	See - ATL-CTD-CS
DI-S-1800	Par 7a (1)		NO	NA	Item 16	N/A	See - ATL-CTD-CS
14. REMARKS	To be submitted in Contractor's format. In re Items 11 & 12: The memorandum shall be submitted 3 months after effective date of contract.						
A0002	Technical Reports. 3. Effectiveness Methodology		ATL-CTD-CS	Once	Item 16	See	See - ATL-CTD-CS
DI-S-1800	Par 7a (2)		NO	NA	Item 16	N/A	See - ATL-CTD-CS
14. REMARKS	To be submitted in Contractor's format. In re Items 11 & 12: The memorandum shall be submitted 3 months after effective date of contract.						
A0003	Technical Reports. 3. Cost Estimation Methodology		ATL-CTD-CS	Once	Item 16	See	See - ATL-CTD-CS
DI-S-1800	Par 7a (3)		NO	NA	Item 16	N/A	See - ATL-CTD-CS
14. REMARKS	To be submitted in Contractor's format. In re Items 11 & 12: The memorandum shall be submitted 3 months after effective date of contract.						
A0004	Technical Reports. 3. Methodology Approaches to cost affect.		ATL-CTD-CS	Once	Item 16	See	See - ATL-CTD-CS
DI-S-1800	Par 7a (4)		NO	NA	Item 16	N/A	See - ATL-CTD-CS
14. REMARKS	To be submitted in Contractor's format. In re Items 11 & 12: The memorandum shall be submitted 3-1/2 months after effective date of contract.						
PREPARED BY PETER J. MORAN, HDL, Wash., D.C.		DATE		APPROVED BY		DATE	
				C. J. Moran		19 DEC 74	
CD 1423		REPLACES EDITION OF 1 APR 64, WHICH IS OBSOLETE		PAGE 1 OF 2 PAGES			

Modification P00033

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ATCH NR 1 EXHIBIT A		CONTRACT DATA REQUIREMENTS LIST		SYSTEMATION Task 5-75	
TO CONTRACT/PR DAAG39-75-R-9158		CATEGORY N/A		CONTRACTOR BDM SERVICES Co.	
1. SEQUENCE NUMBER	2. TITLE OR DESCRIPTION OF DATA	3. CONTRACT REFERENCE	4. TECHNICAL OFFICE	5. FREQUENCY	6. DATE OF SUBMISSION
A0005	Effect. Reports 3. Draft of Final Report .Cost	ATL-CTD-CS	Once	Item 16	5 ca-ATL-
DI-S-1800	Par 7a (5)	NO	NA	Item 16	5 ca-ATL-
14. REMARKS To be submitted in contractor's format. In re Items 11 & 12: The draft report shall be submitted 6 months after effective date of contract.					
A0006	Tech. Reports 3. Draft of Final Report. Cost Effect. Analysis for Maint. Categories	ATL-CTD-CS	Once	Item 16	5 ca-ATL-CTD-CS
DI-S-1800	PAR 7a (6)	NO	NA	Item 16	5 ca-ATL-CTD-CS
14. REMARKS To be submitted in Contractor's format. In re Items 11 & 12: The draft report shall be submitted 6 months after effective date of contract.					
A0007	Tech. Reports 3. Final Report. Effectiveness. Cost and Effectiveness Methodologies	ATL-CTD-CS	Once	Item 16	30 ca-ATL-
DI-S-1800	Par 7a (7)	NO	NA	Item 16	30 ca-ATL-
14. REMARKS Submitted in Contractor's format as previously approved by ATL-CTD-CS In re Items 11 & 12: The final report shall be submitted 7 months after effective date of contract.					
A0008	Tech. Reports 3. Final Report. Cost Effectiveness Analysis for Priority Substudies	ATL-CTD-CS	Once	Item 16	30 ca-ATL-
DI-S-1800	Par 7a (8)	NO	NA	Item 16	30 ca-ATL-
14. REMARKS Submitted in Contractor's format as previously approved by ATL-CTD-CS In re Items 11 & 12: The final report shall be submitted 7 months after effective date of contract.					
PREPARED BY PETER J. MORAN, HDL, Wash., D.C.					
APPROVED BY <i>Mark W. Jones</i>					
DATE 14 DEC 74					
REPLACES EDITION OF 1 APR 66, WHICH IS OBSOLETE.					
PAGE 2 OF 2 PAGES					

APPENDIX G

SCORES

G-1. The Middle East II (ME II) heavy corps TRADOC standard scenario provided the basis for the framework within which this study effort was subjected to a Cost-Operational Effectiveness Analysis (COEA), which is discussed in detail in Appendix I.

G-2. ME II is a quick reaction, short duration (60 day), mid-intensity scenario conflict in which the friendly force is a US corps consisting of 3 1/3 US divisions (one mechanized infantry division, two armored divisions, and one separate infantry brigade) plus elements of the Corps Support Command (COSCOM).

G-3. The expanded (to 120 days) scenario developed for this evaluation provided the backdrop for an effective evaluation of the study's findings. Using the scenario's tactical situation along with the results of wargaming efforts conducted by the US Army Combined Arms Center at Fort Leavenworth, Kansas, and the SCORES Branch of the US Army Ordnance and Chemical Center and School, realistic battlefield input was incorporated into the evaluation of the study in terms of tactical and support unit maintenance workloads, and increases in maintenance efforts related to battle-damaged equipment expected to be experienced during intensive periods of combat within the scenario.

G-4. Equipment failures due to battle damage which could be expected to result from the combat situation on the battlefield were considered along with failures which could be expected to be

encountered through normal usage. The combination of these failures represented the workload which required repair by divisional and nondivisional maintenance elements within the force structure of the scenario. The impact of Maintenance Allocation Chart corrections made by Level of Repair Analysis teams was evaluated primarily in terms of equipment operational availability rates. See also Appendix I (Cost-Operational Effectiveness Analysis).

APPENDIX H

NOTE: SYMBOLS USED ON MAC CORRECTION SHEETS IN THIS APPENDIX ARE IDENTIFIED ON PAGE H-2.

H-1. ELECTRONICS EQUIPMENT

a. Radar Set, AN/MPQ-4A.

(1) Description. This radar is a mobile, intercept-type (nontracking) set designed primarily to locate hostile mortars and secondarily to adjust low-velocity artillery fire. Provision is made for local or remote operation of the radar. The radar operates in the 16,000 - megahertz frequency (K) band. Power is furnished by Generator Set, Gasoline Engine PU-107A/U, which is mounted on a trailer.

(2) Selected technical characteristics.

- (a) Range (max) 10,000 meters
- (b) Azimuth (coverage) 445 mils fixed sector scanning
- (c) Elevation (beam) 100 mils to + 200 mils
- (d) Emplacement time 15 to 30 min by 6 man crew
- (e) Computer - analog

(3) Unique Characteristics. The Radar Set, AN/MPQ-4A and its immediate predecessor, the AN/MPQ-4 have been in the Army inventory for over 20 years. Therefore, it reflects the technology of the 1950's with vacuum tubes and circuitry which is not miniaturized as in the newer electronic systems.

(4) Level of Repair Analysis (LORA)

(a) General. The analysis was performed at the US Army Field Artillery School at Fort Sill, Oklahoma. The LORA team included both warrant officer and NCO instructors.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the AN/MPQ-4A are shown on page H-3.

NOTE: Throughout this appendix, the letter symbols used on the MAC correction sheets are those normally used in MACs: C for Crew; O for Organizational; F for Direct Support; H for General Support; D for Depot Maintenance. Letters to the left of slant marks indicate the category designations presently found in MACs. Letters to the right of slant marks indicate the corrected category designations. A dash on the left of the slant mark indicates that task was found to be missing from the MAC.

EXAMPLES: F/O indicates an allocation corrected from Direct Support to Organizational Maintenance. -/H indicates a task (presently missing from the MAC) which should be added, allocated to General Support Maintenance.

Radar Set, AN/MPQ-4A (TM 11-5840-208-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
B	Indicator, Azimuth & Range		F/O		F/O	F/O		F/O	H/O	H/O	H/O	pg B-15
B	Rcvr-Transmitter Gp											pg B-17
B	Amplifier, Trigger Pulse		F/O		F/O			F/O	F/O			pg B-18
B	Control, Power Supply		F/O		F/O					H/O	H/O	pg B-19
C	Body, Chassis and Accessory Items		F/O	F/O					F/O	F/O		pg B-20
C	Motor and Gear Assy		F/O	F/O					F/O	F/O		pg B-20

b. Radar Set AN/MPQ-49 (FAAR)

(1) Description. The AN/MPQ-49 is a Forward Area Acquisition Radar consisting of a radar set, a generator, a vehicle with detachable trailer, and interconnecting cables. The radar set is housed on the vehicle. The purposes of the radar set are to detect low flying aircraft, to electronically identify them as friend or foe, and to display their position in relationship to the position of the radar set.

(2) Technical Characteristics. Refer to TM 9-1430-588-12 (CONFIDENTIAL).

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was conducted at the US Army Intelligence Center and School. Four instructors took part in the analysis. The set used for the hands-on examination was located in a classroom.

(b) Corrections to the Maintenance Allocation Chart (MAC) for this radar set are shown on page H-5.

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
0925	Circuit Board		F/O										
0930	Circuit Board		F/O										
1125	Wiring Harness		D/O						D/O				
1130	Wiring Harness		D/O						D/O				
1450	Circuit Card	F/O							F/O				
2000	Circuit Card		F/O										
2100	Circuit Card		F/O										
2200	Circuit Card		F/O										
3095	Circuit	D/D	D/D										
3120	Circuit	D/O	D/O						D/O				
3085	Circuit Card Assy	D/O	F/O		F/O				D/O				
5300	Gate, Electronic		F/O	F/O									
5700	Electronic Switch		F/O						F/O				

c. Radar Set, AN/PPS-5A

(1) Description. This radar is a portable battery powered set which can be used in battlefield surveillance to locate and identify moving ground targets. It presents targets as bright spots on a B-scope display, as waveforms on an A-scope display, as signals on an electrical headset, and as the deflection of a meter pointer.

(2) Selected Technical Characteristics.

(a) Range (max): moving personnel 6,000 meters
moving vehicles 10,000 meters

(b) Azimuth coverage: Choice of automatic sector scanning widths of 533, 1067, 1600, or 1955 mils.

(c) Sector scan speed: Choice of 41, 82, 164 or 328 mils per second.

(d) Elevation coverage: -600 to +400 mils.

(e) Assembly time: 10 min.

(3) Unique Characteristics. The AN/PPS-5A is unique among the radars analyzed only in the fact that it is very small.

(4) Level of Repair Analysis (LORA).

a. General. The analysis took place in an instructional facility where a set was available for examination The LORA

team was led by a Chief Warrant Officer.

b. Analysis. There did not appear to be sufficient reason for changing the Maintenance Allocation Chart (MAC) for this set.

Although this MAC is general, there is an excellent section in the manual (TM 11-5840-298-12) on organizational repairs.

d. Mine Detecting Set AN/PRS-7.

(1) Description. This set is a portable device capable of detecting buried nonmetallic and metallic objects such as buried antitank and antipersonnel mines. The set is powered by mercury batteries and is stored in a carrying case when not in use. The presence of a mine is indicated audibly through a head-set assembly.

(2) Selected Technical Characteristics.

- (a) Length (carrying case w/unit) - 24 inches
- (b) Width - 16 inches
- (c) Weight - 24 pounds
- (d) Audio Frequency - 1000 Hz
- (e) Temperature Range - 65 degrees F to +155
degrees F
- (f) Battery Voltage - 16.2 volts
- (g) Battery Life - 28 hours

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Engineer School at Fort Belvoir, Virginia, by members of the staff and faculty of the Mechanical and Technical Department, Office of the Deputy Commandant for Training and Education. The LORA team consisted of the chief, and additional instructors, of the Special Electronics Devices Repair Branch.

(b) Corrections to the Maintenance Allocation Chart (MAC) for this set are shown on page H-9.

MINE DETECTING SET AN/PDS-7 (TM 5-6665-293-13)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REPAIRS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
02	Control Box								F/O			
02	Handle and Cable Assy								F/O			
02	Handle, Short Assy								F/O			
02	Housing, Detector-Oscill								F/O			
06	Headset		F/O						F/O	F/O		

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e. Quadrant, Fire Control, Elevation, M15.

(1) Description. This M15 fire control quadrant is mounted on the right hand trunnion of the applicable end item, (see subpara.

(2)(h) below), and is used for making elevation adjustment corrections to the main gun of that end item. It is equipped with a mechanical mil counter to permit quick, accurate insertion of elevation correction factors peculiar to the individual cannon and cannon emplacement.

(2) Selected Technical Characteristics.

(a) Elevation	228 to $\pm$ 1,333 Mils
(b) Correction (elevation)	$\pm$ 55 Mils
(c) Cross level	34 degrees
(d) Length	12 inches
(e) Width	9 inches
(f) Height	9 inches
(g) Weight	23 1/4 pounds
(h) End item application	Gun, SP, M107, M108, M109, M110

and (3) Unique Characteristics. The delicate nature of this quadrant requires that maintenance on it be performed in a controlled, dust-free, environment.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The LORA team consisted of the senior instructors in the Fire Control Division.

(b) The Repair Parts List contained in TM 9-1290-322-35P was used as the basis for this analysis. Corrections in responsibilities for maintenance tasks are shown on page H-12 and H-13.

QUADRANT, FIRE CONTROL, ELEVATION, ML5 (TM 9-1290-322-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Insulator, Bushing								H/P				Pg 16 #3
	Cap, Protective								F/O				Pg 17 #2
	Washer, Flat								H/P				Pg 24 #6
	Counter, Rot, Fixed								H/P				Pg 24 #8
	Pin, Straight 3/32 DIA								H/P				Pg 25 #1
	Pin, Straight 1/16 DIA								H/P				Pg 25 #2
	Gear, Spur								H/P				Pg 25 #3
	Cap, Protective								F/O				Pg 28 #6
	Screw, Cap								H/P				Pg 34 #2
	Washer, Lock								H/P				Pg 34 #3
	Gear Sector								H/P				Pg 34 #4
	Screw, Machine								H/P				Pg 34 #5
	Key, Woodruff								H/P				Pg 34 #6

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QUADRANT, FIRE CONTROL, ELEVATION, M15 (TM 9-2190-322-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Cap, Purging, Valve								F/O				Pg 35 #3
	Valve, Core								F/O				Pg 35 #5
	Worm, Shaft, Assy								H/F				Pg 42 #1
	Ring								H/F				Pg 42 #2
	Worm, Shaft, Assy								H/F				Pg 42 #4
	Screw, Machine								F/O				Pg 44 #1
	Plate								F/O				Pg 44 #2
	Clip, Spring								F/O				Pg 44 #3
	Screw Cap								H/F				Pg 45 #5
	Light, extension								-/O				Pg 52 #3
	Connector, Plug								F/O				Pg 52 #4

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f. Quadrant, Gunners, M1A1.

(1) Description. This quadrant, with its M82 carrying case, is a portable, precision leveling instrument used for measuring the angles of elevation or depression of artillery weapons. It is also used for checking the adjustment of elevating mechanisms and for verifying the accuracy of sighting and fire control equipment.

(2) Selected Technical Characteristics.

(a) Elevation (Lower)	0-800 mils
(b) Elevation (Upper)	800-1600 mils
(c) Length	6 7/8 inches
(d) Width	1 1/16 inches
(e) Height	6 inches
(f) Weight	1.8 pounds
(g) End item application	All Weapons

(3) Unique Characteristics. The Gunners Quadrant is one of the least complicated fire control instruments. Nevertheless, the delicate nature of this quadrant requires that maintenance on it be performed in a controlled, dust-free environment.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the quadrant was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The LORA team consisted of senior instructors from the Fire Control Division.

(b) The Repair Parts List contained in TM 9-1290-200-14 was used as the basis for this analysis. Corrections in responsibilities for maintenance tasks are shown on pages H-16 to H-18.

QUADRANT, GUNNERS, M1A1 (TM 9-1290-200-14)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Rivet Solid								D/H				Pg C-8 #4
	Spring								D/F				Pg C-10 #1
	Arm								D/H				Pg C-10 #2
	Spring								D/F				Pg C-10 #3
	Cover								D/F				Pg C-10 #7
	Screw								D/F				Pg C-10 #8
	Setscrew								D/F				Pg C-10 #9
	Knob								D/F				Pg C-10 #10
	Mask								D/F				Pg C-10 #11
	Dial								D/F				Pg C-11 #1
	Setscrew								D/H				Pg C-11 #2
	Ring								D/F				Pg C-11 #3
	Ring								D/F				Pg C-11 #4

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QUADRANT, GUNNERS, M1A1 (TM 9-1290-200-14)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Ring Stop								D/F				Pg C-11 #5
	Pin Straight								D/F				Pg C-11 #6
	Nut								D/F				Pg C-11 #7
	Screw								D/F				Pg C-11 #8
	Washer Lock								D/F				Pg C-11 #9
	Screw								D/F				Pg C-13 #1
	Plate Left								-/F				Pg C-13 #2
	Plate Right								-/F				Pg C-13 #3
	Plunger								D/F				Pg C-13 #4
	Screw								D/H				Pg C-15 #1
	Shoe								D/H				Pg C-15 #2
	Pin Straight Headless								D/H				Pg C-15 #3

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GROUP NO.	FUNCTIONAL GROUP	Scale Elevation Scale	MAINTENANCE FUNCTION										REMARKS	
			INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
									D/H	D/H				Pg C-15 #4 Pg C-15 #5

g. Aiming Circle, M2

(1) Description. This aiming circle is used to measure the azimuth and elevation bearing angles of a ground or aerial target with respect to a preselected base line. The aiming circle has many of the characteristics of a surveyor's transit. Basically, it consists of a telescope mounted on a mechanism which permits unlimited azimuth and limited elevation movements.

(2) Selected Technical Characteristics.

(a) Magnification	4x
(b) Field of view	10 degrees
(c) Azimuth rotation	Unlimited
(d) Elevation (Max)	800 mils
(e) Depression (Max)	400 mils
(f) Length	39 inches
(g) Width	16.5 inches
(h) Height	9.75 inches
(i) Weight	65 pounds

(3) Unique Characteristics. The delicate nature of the optics within this device requires that maintenance on it be performed in a controlled, dust-free environment.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the aiming circle was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The LORA team consisted of senior instructors from the Fire Control Division.

(b) The Repair Parts List contained in TM 9-1290-262-35P was used as the basis for this analysis. Corrections in responsibilities for maintenance tasks are shown on pages H-21 through H-26.

AIMING CIRCLE M2 (TM 9-1290-262-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Bushing, Sleeve								D/F				Pg 5 #1
	Bushing, Sleeve								D/F				Pg 5 #2
	Cell, Eyelens								D/F				Pg 5 #3
	Cell, Objective								D/F				Pg 5 #4
	Cell, Optical								D/F				Pg 5 #5
	Dial Scale: az								D/F				Pg 5 #8
	Dial Scale: cl								D/F				Pg 5 #9
	Gasket								D/F				Pg 5 #14
	Lens, Optical								D/F				Pg 5 #17
	Lens, Optical								D/F				Pg 5 #18
	Lever Locking								D/F				Pg 5 #19
	Magnifier								D/H				Pg 5 #20
	Needle Compass								D/F				Pg 5 #21

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AIMING CIRCLE M2 (TM 9-1290-262-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Mut								D/H				Pg 5 #22
	Pin								D/F				Pg 5 #23
	Pin								D/F				Pg 6 #1
	Pivot								D/F				Pg 6 #2
	Plate								D/F				Pg 6 #3
	Plug								D/F				Pg 6 #4
	Plug								D/F				Pg 6 #5
	Plug								D/F				Pg 6 #6
	Plunger								D/F				Pg 6 #8
	Prism								D/H				Pg 6 #7
	Reflector								D/F				Pg 6 #8
	Reticle								D/F				Pg 6 #9
	Reticle								D/F				Pg 6 #10

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AIMING CIRCLE M2 (TM 9-1290-262-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Ring								D/F				Pg 6 #11
	Ring								D/F				Pg 6 #12
	Ring								D/F				Pg 6 #13
	Ring								D/F				Pg 6 #14
	Ring								D/F				Pg 6 #15
	Ring								D/F				Pg 6 #16
	Ring								D/F				Pg 6 #18
	Ring								D/F				Pg 6 #19
	Ring								D/F				Pg 6 #20
	Ring								D/F				Pg 6 #21
	Screw, Cap								D/F				Pg 7 #1
	Screw, Externally								D/F				Pg 7 #2
	Screw, Leveling								D/F				Pg 7 #3

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GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REPAIRS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Screw, Machine								D/F				Pg 7 #5
	Screw, Machine								D/F				Pg 7 #6
	Screw, Machine								D/H				Pg 7 #7
	Screw								D/H				Pg 7 #8
	Setcrew								D/F				Pg 7 #14
	Setcrew								D/H				Pg 7 #15
	Setcrew								D/H				Pg 7 #16
	Setcrew								D/H				Pg 7 #17
	Setcrew								D/H				Pg 7 #18
	Setcrew								D/F				Pg 7 #19
	Shaft								D/F				Pg 8 #1
	Shoe								D/F				Pg 8 #2

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AIMING CIRCLE W2 (TM 9-1290-262-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REL AIR	OVERHAUL		REBUILD
	Sleeve								D/F				Pg 8 #3
	Spring, Helical								D/H				Pg 8 #5
	Spring, Locking								D/H				Pg 8 #7
	Washer, Key								D/F				Pg 8 #10
	Washer, Nonmetallic								D/H				Pg 8 #11
	Window Observation								D/F				Pg 8 #12
	Window Observation								D/F				Pg 8 #13
	Worm: az								D/F				Pg 8 #14
	Worm: el								D/F				Pg 8 #15
	Worm: pk br3								D/F				Pg 8 #16
	Pin								D/F				Pg 9 #14
	Plunger								D/F				Pg 9 #15

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ALTIMETER CIRCLE #2 (TM 9-2190-262-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Spring								D/F				Pg 9 #16
	Slide								D/F				Pg 9 #17
	Clamp: leg lwr								D/H				Pg 9 #18
	Clamp: leg up								D/H				Pg 9 #19
	Screw, Wood								D/H				Pg 10 #4

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h. Drive, Ballistics, M10 Series.

(1) Description. An M10 series ballistic drive is part of the fire control system of the applicable end item (see subpara. (2)(e) below). It provides a means for connecting the range finder, gunner's periscope, and ballistic computer into a single integrated sighting system. The drive also acts to depress the lines-of-sight of the range finder and periscope, in accordance with super-elevation data which is transmitted to the drive via the computer output shaft.

(2) Selected Technical Characteristics.

(a) Length	55 inches
(b) Width	45 inches
(c) Height	30 inches
(d) Weight	155/174 pounds
(e) End item application	M60, M60A1, M48A3

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the M10 series ballistic drive was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The

LORA team consisted of the senior instructors from the Fire Control Division.

(b) The Repair Parts List contained in TM 9-1220-220-35P was used as the basis for this analysis. Corrections in responsibilities for maintenance tasks are shown on page H-29.

DRIVE, BALLISTICS, M10 SERIES (TM 9-1220-220-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
	Boot, Telescope Shaft							D/F				Pg 5 #2
	Ring, Extern Threaded							-/D				Pg 6 #3
	Washer, Lock							D/F				Pg 7 #14
	Boot, Telescope Shaft							D/F				Pg 8 #1
	Screw, Machine							D/F				Pg 9 #5
	Washer, Lock							D/F				Pg 10 #11
	Boot Telescope, Shaft							D/F				Pg 10 #16
	Washer, Lock							D/F				Pg 13 #7
	Washer, Lock							D/F				Pg 13 #10

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i. Computer, Gun Direction, M18.

(1) Description. This computer is a solid state, general purpose, electronic digital computer designed to facilitate ballistic trajectory computation. As a general purpose device, the computer can perform any computational task for which a program has been written. The size of the memory (8,192 words) is the limiting factor.

(2) Selected Technical Characteristics.

(a) Capacity (Memory)	two caliber trajectory
(b) Operating speed	12,800 executions per second
(c) Word Length	36 bits
(d) Height	15 inches
(e) Width	29 inches
(f) Depth	34 inches
(g) Weight	200 pounds
(h) Power	3 phase, 4 wire, 400 Hz., 120/208V, 700W

(3) Unique Characteristics. The delicate components of this item require that support level maintenance be performed in a controlled environment repair facility.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the M18 computer was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The LORA team consisted of senior instructors from the Fire Control Division.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M18 are shown on pages H-32 and H-33.

COMPUTER, GUN DIRECTION M18 (TM9-1220-221-20/1)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
1.1	Dust Caps									F/O		Pg 43
2.1	Mechanical Reader									D/H		
2.5	Elapsed Time Meter	-/0	-/0							D/H		
3.1	Flip Flop Logic									D/H		
3.2	Generator, Pulse									D/H		
3.3	Logic Driver									D/H		
3.4	Network "A"									D/H		
3.5	Network "B"									D/H		
3.6	Network "C"									D/H		
3.7	Power Control "A"								O/F			
3.8	Power Control "B"								O/F			
3.9	Power Control "C"								O/F			
3.10	Power Supply Subassembly								C/F			
3.11	Read Amplifier									D/H		
3.12	Read Switch									D/H		
3.13	Rectifier Transistor Assy								O/F			

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COMPUTER, GUN DIRECTION M18 (TM9-1220-221-20/1)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
3.14	Transistor Assy								O/F			
3.15	Voltage Regulator Subassembly								O/F			
3.16	Voltage Regulator Subassembly								O/F			
3.17	Voltage Regulator Subassembly								O/F			
3.18	Voltage Regulator Subassembly								O/F			
3.19	Write Amplifier									D/H		
3.20	Write Switch									D/H		
3.21	Relays								O/F			
3.24	All other main frame components								H/F			
4.	Computer Table	H/F	H/F						F/O	O/F		
4.1	Dust Caps									F/O		
4.2	Power Terminal Strip									H/F		
4.3	Table Legs											
5.	Cables and Generator Adapter		F/O						H/O			

ATSL (OT) Form 38, 11 Aug 75 (Not to be reproduced subsequent to this date)

j. Telescope, Panoramic, M117.

(1) Description. This telescope is the basic instrument used in laying the self-propelled howitzers, M109 and M109A1, in azimuth and elevation for indirect fire. It is equipped with two four-digit counters for easy reference, plus a gunner's aid counter which allows for a correction deflection of from 0 to ± 50 mils.

All counters are self-illuminating for night operation.

(2) Selected Technical Characteristics.

(a) Elevation	± 300 mils
(b) Incremental reading	1/4 mil
(c) Azimuth	6,400 mils
(d) Field of view	10 degrees
(e) Magnification	4X
(f) Weight	14 pounds, 6 ounces
(g) Height	20 inches
(h) Width	8 1/4 inches
(i) Length	9 inches

(3) Unique Characteristics. The delicate nature of the optics within this telescope requires that maintenance on it be performed in a controlled, dust-free environment.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the M117 was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The team consisted of the senior instructors in the Fire Control Division.

(b) The Repair Parts List contained in TM 9-1240-274-35P was used as the basis for this analysis. Corrections in responsibilities for maintenance tasks are shown on pages H-36 through H-39.

TELESCOPE, PANORAMIC: M117 (TM9-1240-274-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
	Knob Assy							F/O	F/O			Pg 7 #2
	Knob							F/O	F/O			Pg 8 #9
	Screw, Cap, Socket Head							F/O	F/O			Pg 10 #29
	Packing, Preformed							F/O	F/O			Pg 10 #32
	Retainer							H/F	H/F			Pg 14 #1
	Prism, Dove Assy							H/F	H/F			Pg 14 #2
	Cap							F/O	F/O			Pg 14 #3
	Knob							F/O	F/O			Pg 17 #2
	Counter Assy						F/O					Pg 18 #8
	Ring, Retaining						F/O					Pg 19 #1
	Washer, Key						H/F					Pg 19 #2
	Packing, Preformed						H/F					Pg 19 #5
	Nut						F/O					Pg 21 #17
	Cap, Air Valve						F/O					Pg 21 #18
	Valve, Core						F/O					Pg 21 #19
	Valve, Stem, Purging						F/O					Pg 21 #20
	Plate						F/O					Pg 23 #2

TELESCOPE, PANORAMIC: MIL7 (TM9-1240-274-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Ball, Bearing								F/O				Pg 23 #3
	Cap Assy								F/O				Pg 23 #4
	Washer, Spring								F/O				Pg 23 #5
	Packing Preformed								F/O				Pg 23 #7
	Washer, Non-metallic								F/O				Pg 24 #8
	Contact, Electrical Assy								F/O				Pg 27 #2
	Knob								F/O				Pg 30 #21
	Knob								F/O				Pg 33 #2
	Gear, Split Assy								H/F				Pg 34 #9
	Ring Externally Threaded								H/F				Pg 37 #1
	Bearing, Ball								H/F				Pg 37 #8
	Bearing								H/F				Pg 40 #8
	Trunion								H/F				Pg 40 #9
	Trunion								H/F				Pg 40 #12
	Prism Optical Instr Bordered								H/F				Pg 40 #13
	Ring								H/F				Pg 40 #16

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TELESCOPE, PANORAMIC: M17 (TM9-1210-274-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Spring Tube								H/F				Pg 40 #17
	Prism, Optical Instr								H/F				Pg 41 #20
	Prism, Optical Instr Bonded								H/F				Pg 48 #11
	Cell Ascer								-/F				Pg 48 #14
	Diaphragm								-/F				Pg 71 #8
	Ring, Ext Threaded								H/F				Pg 72 #9
	Lens, Optical Instr								H/F				Pg 72 #10
	Spacer								H/F				Pg 72 #11
	Cell								-/F				Pg 72 #12
	Cap, Air Valve								-/F				Pg 72 #14
	Valve Core								F/O				Pg 72 #15
	Valve Stem Purging								F/O				Pg 72 #16
	Screw Special								F/O				Pg 72 #17
	Retainer, Optical Element								H/F				Pg 79 #1
	Lens								H/F				Pg 79 #4
									H/F				Pg 79 #5

TELESCOPE, PANORAMIC: M117 (TM9-1210-271-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Cell								H/P				Pg 79 #6
	Retainer, Optical Element								-/P				Pg 79 #7
	Reticle, Optical Instr								H/P				Pg 79 #8
	Set Screw								H/P				Pg 80 #10
	Tube Assy							-/P					Pg 80 #12
	Retainer, Optical Element								H/P				Pg 80 #13
	Lens								H/P				Pg 80 #14
	Retainer, Optical Element								H/P				Pg 80 #15
	Lens								H/P				Pg 80 #16
	Cell								-/P				Pg 80 #17
	Tube								-/P				Pg 80 #18
	Eccentric								H/P				Pg 80 #19
	Eccentric								H/P				Pg 80 #20
	Tube								H/P				Pg 80 #21

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k. Elbow, Telescope, M118, M118C.

(1) Description. This elbow telescope is used on the M108 and M109 self-propelled howitzers as the basic direct fire instrument used for positioning the weapon in deflection and elevation on targets visible from the weapon. It is mounted, by means of spherical seats and retaining king pins, on the appropriate telescope mount.

(2) Selected Technical Characteristics.

(a) Field of view	10 degrees
(b) Magnification	4X
(c) Axial cant correction	± 5 degrees
(d) Mirror, level	100 degrees
(e) Eyepiece operative range	± 20 degrees
(f) Weight	44 pounds
(g) Height	8 1/4 inches
(h) Width	18 1/2 inches
(i) Length	39 1/2 inches

(3) Unique Characteristics. The delicate nature of the optics within this telescope requires that maintenance on it be performed in a controlled, dust-free environment.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the elbow telescope was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The team consisted of the senior instructors in the Fire Control Division.

(b) The Repair Parts List contained in TM 9-1240-276-35P was used as the basis for this analysis. Corrections in responsibilities for maintenance tasks are shown on pages H-42 through H-47.

ELBOW, TELESCOPE, M18, M18C (TM9-1240-276-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Screw Cap								D/H				Pg 6 #1
	Clamp, Loop								F/O				Pg 6 #6
	Eyeshield, Optical								D/O				Pg 6 #7
	Screw, Cap								D/H				Pg 6 #8
	Packing, Preformed								D/H				Pg 6 #11
	Packing, Preformed								D/F				Pg 8 #12
	Pin, Straight								H/F				Pg 9 #17
	Screw, Cap, Socket Head								D/F				Pg 9 #23
	Limit, Plate								D/F				Pg 9 #25
	Setscrew, Hex								D/H				Pg 12 #1
	Ring, Externally Threaded								D/H				Pg 12 #4
	Lens, Optical								D/H				Pg 12 #5
	Lens, Optical								D/H				Pg 12 #7
	Cell, Optical								D/H				Pg 12 #8
	Retainer, Optical								D/H				Pg 12 #10
	Lens, Optical								D/H				Pg 12 #11

ELBOW, TELESCOPE, M18, M18C (TM9-1240-276-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Cell, Optical								D/H				Pg 12 #12
	Screw, Machine								D/H				Pg 13 #17
	Prism, Optical								D/H				Pg 13 #19
	Screw Cap, Socket								D/H				Pg 13 #23
	Setscrew								D/H				Pg 13 #24
	Retainer, Optical								D/H				Pg 13 #26
	Lens, Optical								D/H				Pg 13 #27
	Cell, Optical								D/H				Pg 13 #28
	Pin, Shoulder								-/H				Pg 16 #34
	Pin, Cotter								D/H				Pg 17 #32
	Washer, Flat								D/H				Pg 17 #33
	Spring, Helical								D/H				Pg 17 #35
	Packing, Preformed								D/H				Pg 17 #36
	Screw, Cap								D/H				Pg 17 #37
	Nut, Round								D/H				Pg 17 #38
	Washer, Nonmetallic								D/H				Pg 17 #39

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ELBOW, TELESCOPE, M118, M118C (TM9-1240-276-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
	Washer, Spring, Tension Ratchet							D/F				Pg 17 #4.1
	Screw, Cap							D/F				Pg 17 #4.3
	Washer, Spring							D/F				Pg 18 #4.4
	Ratchet, Fixed							D/F				Pg 18 #4.5
	Cup							D/H				Pg 18 #4.6
	Spacer							D/H				Pg 18 #4.8
	Seal, Plain							D/H				Pg 18 #4.9
	Setcrew, Hexagon Socket							D/H				Pg 18 #50
	Cell, Optical							D/H				Pg 20 #1
	Setcrew, Hexagon Socket							D/H				Pg 20 #2
	Setcrew, Hexagon Socket							D/H				Pg 20 #8
	Cell, Optical							D/H				Pg 20 #9
	Pin Straight							D/H				Pg 20 #10
	Pin Straight							D/H				Pg 20 #14
	Screw, Machine							D/H				Pg 20 #15
												Pg 21 #17

7-1-H

ELBOW, TELESCOPE, M18, M18C (TM9-1210-276-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Setscrew, Hexagon								D/H				Pg 21 #19
	Screw, Cap								D/H				Pg 21 #21
	Pin Straight								D/H				Pg 21 #24
	Setscrew								D/H				Pg 23 #1
	Ring, Externally Threaded								D/H				Pg 23 #3
	Lens, Optical Instr								D/H				Pg 23 #4
	Setscrew								D/H				Pg 23 #6
	Setscrew								D/H				Pg 23 #8
	Retainer, Optical Element								D/H				Pg 23 #10
	Lens, Optical								D/H				Pg 23 #11
	Clamp, Loop								D/H				Pg 26 #14
	Screw								D/H				Pg 26 #18
	Screw								D/H				Pg 26 #19
	Retainer								D/H				Pg 27 #33
	Lens, Optical								D/H				Pg 27 #34
	Light, Conductor								D/H				Pg 27 #36
	Worm Shaft Assembly								-/H				Pg 29 #3

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ELBOW, TELESCOPE, M18, M18C (TM9-1240-276-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Shim								D/H				Pg 29 #4
	Shim								D/H				Pg 29 #5
	Shim								D/H				Pg 29 #6
	Screw, Cap								D/H				Pg 29 #8
	Setcrew								D/H				Pg 29 #12
	Retainer								D/H				Pg 29 #14
	Lens, Optical Instrument								D/H				Pg 30 #16
	Cell, Optical Element								D/H				Pg 30 #17
	Screw, Cap								D/H				Pg 30 #20
	Packing, Preformed								D/H				Pg 30 #22
	Packing, Preformed								E/H				Pg 30 #23
	Pln, Straight								D/H				Pg 30 #24
	Light Conductor, Instr Illum								D/H				Pg 32 #7
	Light Conductor, Instr Illum								D/H				Pg 33 #14
	Screw, Cap								D/H				Pg 33 #15
	Seat, Ball Socket								D/H				Pg 33 #16

ELBOW, TELESCOPE, M118, M118C (TM9-1240-276-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Screw, Cap Socket Head Seat, Ball Socket Spring, Support Spring, Geneva Spring, Geneva Pin, Alignment Setscrew Setscrew Retainer, Optical Element Reticle Cell, Optical Element Pin, Straight Pin, Straight Headless Washer, Flat								D/H D/H D/H D/H D/H D/H D/H D/H D/H D/H D/H D/H H/R H/R H/R				Pg 33 #17 Pg 33 #18 Pg 33 #25 Pg 33 #26 Pg 33 #27 Pg 34 #30 Pg 34 #31 Pg 34 #32 Pg 36 #1 Pg 36 #2-5 Pg 36 #6 Pg 38 #5 Pg 40 #16 Pg 41 #8

ATSL (07) Form 38, 11 Aug 75(Not to be reproduced subsequent to this date)

1. Periscope, Tank, M44E1.

(1) Description. This periscope is the primary night or low visibility fire control instrument for sighting on a target and aiming the main weapon (152mm gun) on the AR/AAV M551 vehicle when the conventional round is fired. The periscope is considered passive, not requiring the aid of visible or infrared illumination. It is located in the turret opening on the right side of the main weapon, and consists of two separate and independently collimated units, a head assembly and a body assembly. The periscope contains three optical systems, nine power passive systems, reticle projection system and unity power system.

(2) Selected Technical Characteristics.

(a) Horizontal field of view

(unity system)	21 degrees 45 min

(b) Vertical field of view	8 degrees 2 min

(c) Field of view (passive system)	6 degrees

(d) Line of sight travel	18 to 22 degrees

(e) Weight	195 pounds

(f) Width	13 inches

(g) Height	21 1/8 inches

(h) Depth	20 1/2 inches

(3) Unique Characteristics. The delicate nature of the optics within this periscope requires that maintenance on it be performed in a controlled, dust-free environment.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the periscope was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The team consisted of senior instructors from the Fire Control Division.

(b) The Repair Parts List contained in TM 9-1240-309-35P was used as the basis for this analysis. Corrections in responsibilities for maintenance tasks are shown on pages H-50 through H-63.

PERISCOPE, TANK: XM4/E1 (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Decal								F/O				Pg 7 #2
	Decal								F/O				Pg 9 #2
	Cap, Valve								F/O				Pg 11 #3
	Valve Core								F/O				Pg 11 #4
	Valve Stem								F/O				Pg 11 #5
	Strap, Nylon								F/O				Pg 11 #6
	Valve, Poppet								F/O				Pg 11 #7
	Screw, Machine								H/F				Pg 15 #1
	Window, Optical Instrument								H/F				Pg 17 #3
	Screw Machine								H/O				Pg 19 #1
	Screw Machine								H/O				Pg 19 #2
	Screw, Machine								H/O				Pg 19 #3
	Screw, Cap Socket								H/O				Pg 19 #5
	Screw, Machine								H/O				Pg 20 #7
	Arm Assy, Riveted								D/H				Pg 23 #5
	Screw Cap								D/H				Pg 25 #4
	Eccentric								D/H				Pg 25 #5

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PERISCOPE, TANK: XM44K1 (TM9-124C-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Key								D/H				Pg 26 #9
	Arm Linkage								D/H				Pg 26 #10
	Bearing, Ball								D/H				Pg 26 #11
	Seal, Plain								D/H				Pg 26 #13
	Coupling								D/H				Pg 27 #17
	Plate								H/F				Pg 29 #3
	Window, Optical								H/F				Pg 29 #4
	Cap								D/H				Pg 29 #6
	Plate								D/H				Pg 30 #10
	Bearing, Ball								D/H				Pg 30 #11
	Ring, Retaining								D/H				Pg 30 #12
	Bearing, Ball								D/H				Pg 31 #17
	Packing								D/H				Pg 31 #19
	Shaft, Plumed								D/H				Pg 31 #20
	Packing								H/F				Pg 35 #3
	Reticle Projector Assy								H/F				Pg 35 #5
	Receptacle Assy								F/O				Pg 37 #1

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PERISCOPE, TANK: XM44E1 (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Washer								F/O				Pg 37 #5
	Retainer								H/F				Pg 38 #12
	Plate Diffusion								H/F				Pg 38 #13
	Wire								H/F				Pg 39 #1
	Ring, Retaining								H/F				Pg 39 #2
	Insulator								H/F				Pg 39 #3
	Spring								H/F				Pg 39 #4
	Contact								H/F				Pg 39 #5
	Cell Assy								D/H				Pg 41 #2
	Knob Assy Reticle								F/O				Pg 42 #2
	Retainer								H/F				Pg 49 #1
	Lens, Optical								H/F				Pg 49 #2
	Wire								H/F				Pg 50 #11
	Contact								H/F				Pg 50 #12
	Spring								H/F				Pg 51 #13
	Insulator								H/F				Pg 51 #14
	Ring, Retaining								H/F				Pg 51 #15

PERISCOPE, TANK: XM/EL (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Support, Reticle								H/F	D/F			Pg 55 #22
	Gasket								H/F				Pg 57 #4
	Cap Riveted								H/F				Pg 58 #10
	Contact								H/F				Pg 58 #11
	Cap Assy								D/F				Pg 59 #14
	Sleeve Assy								H/F				Pg 59 #16
	Bracket: Support								H/F				Pg 73 #6
	Bracket: Mounting								H/F				Pg 74 #11
	Clip								D/F				Pg 75 #16
	Cover								-/F				Pg 79 #3
	Cell Assy								D/H				Pg 81 #3
	Cell Assy								D/H				Pg 82 #2
	Adapter								-/H				Pg 82 #4
	Cell								-/H				Pg 85 #5
	Len, Optical								-/H				Pg 87 #3
	Cover								H/O				Pg 89 #3
	Bracket								H/F				Pg 89 #7

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PERISCOPE, TANK: XM4/E1 (TM9-12240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Packing								H/F				Pg 90 #8
	Pln								-/O				Pg 93 #1
	Packing "O" Ring								H/F				Pg 99 #3
	Cell Assy								H/F				Pg 100 #2
	Retainer								-/H				Pg 107 #1
	Lens, Optical								-/H				Pg 107 #2
	Spacer								-/H				Pg 107 #3
	Lens, Optical								-/H				Pg 107 #4
	Cell								-/H				Pg 107 #5
	Cap								F/O				Pg 109 #1
	Spring								F/O				Pg 109 #2
	Plunger								F/O				Pg 109 #3
	Lever								F/O				Pg 109 #5
	Housing								-/F				Pg 110 #9
	Pln								-/F				Pg 110 #10
	Gear-Spur								-/F				Pg 110 #11

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PERISCOPE, TANK: IM44EL (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Shaft								-/F				Pg 110 #12
	Packing								H/F				Pg 111 #1
	Adapter								-/F				Pg 111 #17
	Packing								D/F				Pg 111 #18
	Gear-Spur								-/H				Pg 113 #2
	Screw, Machine								D/H				Pg 115 #2
	Blank								-/H				Pg 117 #1
	Filter								-/H				Pg 117 #2
	Filter								-/H				Pg 117 #3
	Filter								-/H				Pg 117 #4
	Mount								-/H				Pg 117 #5
	Blank								-/H				Pg 119 #1
	Filter								-/H				Pg 119 #2
	Filter								-/H				Pg 119 #3
	Filter								-/H				Pg 119 #4
	Mount								-/H				Pg 119 #5

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PERISCOPE, TANK: XM4/4K1 (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Screw Cap								H/F				Pg 121 #6
	Foot								-/F				Pg 122 #7
	Housing								-/H				Pg 122 #8
	Cover								-/F				Pg 125 #2
	Window Optical Instrument								H/F				Pg 125 #3
	Gasket								-/F				Pg 127 #3
	Door Assy								H/F				Pg 127 #4
	Plate, Identification								-/O				Pg 129 #3
	Mirror Assy: Bonded								H/O				Pg 130 #9
	Cove & Related Parts								H/O				Pg 130 #11
	Decal								F/O				Pg 131 #2
	Setscrew								H/F				Pg 133 #1
	Cell Assy								H/F				Pg 133 #2
	Diaphragm								-/F				Pg 133 #3
	Lens, Optical								H/F				Pg 133 #4
	Spacer								H/F				Pg 133 #5

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PERISCOPE, TANK: ~~XXL/EL~~ (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Lens, Optical								H/F				Pg 133 #6
	Lens, Optical								H/F				Pg 134 #8
	Mirror								-/D				Pg 134 #9
	Cover								-/H				Pg 12 #11
	Ring								-/F				Pg 127 #1
	Lens, Optical								-/F				Pg 127 #2
	Cell								-/F				Pg 137 #3
	Eccentric								D/H				Pg 142 #9
	Lens, Optical								D/H				Pg 147 #4
	Spacer								-/H				Pg 147 #5
	Lens Optical								D/H				Pg 147 #6
	Prism Assy: Bonded								F/H				Pg 148 #9
	Cap, Valve								F/O				Pg 155 #1
	Valve Core								F/O				Pg 155 #2
	Valve Stem								F/O				Pg 155 #3
	Strap Nylon								F/O				Pg 155 #4
	Plate Filter								-/O				Pg 156 #7

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PERISCOPE, TANK: XM441 (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Bushing								F/H				Pg 159 #1
	Insulator								F/H				Pg 159 #2
	Plate, Cres								H/F				Pg 159 #5
	Pin								-/F				Pg 163 #1
	Pin								-/F				Pg 163 #3
	Shield								-/F				Pg 163 #5
	Rod								-/F				Pg 164 #8
	Pin, Special								-/F				Pg 164 #9
	Arm								-/F				Pg 164 #11
	Spacer								-/F				Pg 164 #13
	Screw, Special Shoulder								-/F				Pg 164 #15
	Link, Crescent								-/F				Pg 165 #16
	Link Assy								-/F				Pg 165 #17
	Pin								-/F				Pg 167 #1
	Pin								-/F				Pg 167 #2
	Pin								-/F				Pg 167 #3
	Pin								-/F				Pg 167 #4

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PERISCOPE, TANK: MM4A1 (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Link								-/F				Pg 167 #5
	Cover								-/F				Pg 169 #2
	Gasket								F/H				Pg 169 #3
	Terminal Lug								F/H				Pg 170 #12
	Wire								-/H				Pg 170 #13
	Insulator								F/H				Pg 171 #15
	Socket								-/H				Pg 171 #20
	Plate								-/H				Pg 171 #21
	Standoff								-/H				Pg 171 #8
	Standoff								-/H				Pg 171 #9
	Plate								H/F				Pg 193
	Support								H/F				Pg 194 #10
	Seal								H/F				Pg 194 #11
	Screw, Machine								H/F				Pg 197 #1
	Spring								H/F				Pg 197 #3
	Pawl								H/F				Pg 197 #4

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PERISCOPE, TANK: XM/LEI (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Ring Retaining								H/F				Pg 197 #5
	Bearing Bolt								H/F				Pg 197 #6
	Screw, Cap								F/O				Pg 201 #1
	Screw, Machine								F/O				Pg 201 #4
	Seal								F/O				Pg 201 #5
	Ring Retaining								D/F				Pg 203 #1
	Pin								-/F				Pg 203 #2
	Link								-/F				Pg 203 #3
	Pin								-/F				Pg 203 #4
	Link								-/F				Pg 203 #5
	Pin								-/F				Pg 204 #6
	Latch								-/F				Pg 204 #7
	Spring								-/F				Pg 204 #8
	Handle								-/F				Pg 204 #10
	Shaft								-/F				Pg 204 #11
	Screw Cap								-/F				Pg 204 #12
	Bracket								-/F				Pg 205 #14

PERISCOPE, TANK: NM/LEI (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Mount Assy								-/F				Pg 205 #15
	Bracket Assy								-/F				Pg 211 #4
	Pin								-/F				Pg 211 #5
	Spring Helical								-/F				Pg 211 #6
	Plunger								-/F				Pg 212 #7
	Bracket								-/F				Pg 212 #8
	Pin								-/F				Pg 212 #9
	Setscrew								-/F				Pg 212 #10
	Pin								-/F				Pg 212 #11
	Plunger								-/F				Pg 215 #1
	Setscrew								-/F				Pg 215 #2
	Seat								-/F				Pg 215 #3
	Stop								-/F				Pg 215 #4
	Ring, Retaining								H/F				Pg 215 #5
	Washer, Special								-/F				Pg 215 #6
	Plunger								-/F				Pg 216 #7
	Spring								-/F				Pg 216 #8

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PERISCOPE, TANK: XM44E1 (TM9-1240-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Lever								-/F				Pg 216 #9
	Terminal								-/F				Pg 229 #1
	Tubing								-/F				Pg 229 #2
	Connector Plug								-/F				Pg 229 #7
	Connector Plug								-/F				Pg 229 #9
	Tubing								-/F				Pg 229 #11
	Washer, Terminal Retaining								-/F				Pg 229 #12
	Pin, Contract								-/F				Pg 230 #13
	Shell Single Female								-/F				Pg 230 #14
	Cable								-/F				Pg 230 #16
	Tubing								-/F				Pg 230 #17
	Terminal Assy								-/F				Pg 230 #18
	Sleeve								-/F				Pg 230 #19
	Shell Single Male								-/F				Pg 230 #20
	Pin, Straight								F/O				Pg 257 #2
	Spring Helical								F/O				Pg 257 #4
	Nozzle Assy								F/O				Pg 277 #3

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PERISCOPE, TANK: JMW/JEL (TM9-1210-309-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
	Washer, Flat							F/O				Pg 277 #2
	Well-Nut Special							F/O				Pg 277 #3
	Strap, Retaining							F/O				Pg 277 #4
	Tubing							F/O				Pg 278 #11
	Tee							F/O				Pg 278 #12
	Pump, Retainer							F/O				Pg 278 #15
	Washer, Strainer							F/O				Pg 278 #16
	Cover							F/O				Pg 278 #17
	Tubing							F/O				Pg 279 #18
	Reservoir							F/O				Pg 279 #4

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m. Periscope, tank: M32.

(1) Description. This periscope is an optical instrument used by the M60 and M60A1 tank gunner for laying the weapon in on a target without exposing himself. It is a monocular-type optical instrument having the ability for daylight, infrared, and unity power sighting.

(2) Selected Technical Characteristics.

(a) Unity power magnification	1x
(b) Daylight magnification	8x
(c) Infrared magnification	8x
(d) Field of view (infrared/ daylight)	8 degrees
(e) Weight	52 pounds
(f) Height	20 1/2 inches
(g) Width	13 3/8 inches
(h) Depth	12 inches

(3) Unique Characteristics. The delicate nature of the optics within this periscope requires that maintenance on it be performed in a controlled, dust-free environment.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the periscope was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The team consisted of senior instructors from the Fire Control Division.

(b) The Repair Parts List contained in TM 9-1240-313-35P was used as the basis for this analysis. Corrections in responsibilities for maintenance tasks are shown on pages H-66 through H-71.

PERISCOPE, TANK: M32 (TM 9-1240-313-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Reticle Mirror Mount								D/H	D/H			Pg 13 #4
	Lens, Optical Instrument								D/H	D/H			Pg 14 #8
	Packing, Preformed								D/H	D/H			Pg 18 #6
	Housing Assembly								D/H	D/H			Pg 19 #21
	Cell, Optical								D/H	D/H			Pg 22 #6
	Index								D/H	D/H			Pg 25 #2
	Index								D/H	D/H			Pg 25 #3
	Setcrew								D/H	D/H			Pg 25 #6
	Disk, Solid, Plain								D/H	D/H			Pg 25 #7
	Setcrew								D/H	D/H			Pg 26 #13
	Cell Assy Optical								D/H	D/H			Pg 26 #14
	Cell Assy								D/H	D/H			Pg 26 #15
	Packing Preformed								D/H	D/H			Pg 27 #19
	Packing Preformed								D/H	D/H			Pg 29 #1
	Retainer								-/H	-/H			Pg 29 #2
	Lens Eye								-/H	-/H			Pg 29 #2
	Spacer								-/H	-/H			Pg 29 #3

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PERISCOPE, TANK: M32 (TM 9-1240-313-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
	Lens Center									-/H		Pg 29 #4
	Spacer									-/H		Pg 29 #5
	Lens, Field									-/H		Pg 29 #6
	Spacer									-/H		Pg 29 #7
	Lens Aspheric									-/H		Pg 30 #8
	Cell									-/H		Pg 30 #9
	Retainer									-/H		Pg 33 #1
	Lens Eye									-/H		Pg 33 #2
	Spacer									-/H		Pg 33 #3
	Lens Center									-/H		Pg 33 #4
	Spacer									-/H		Pg 33 #5
	Lens Field									-/H		Pg 33 #6
	Cell									-/H		Pg 33 #7
	Sleeve Assy									H/F		Pg 39 #2
	Contact									H/F		Pg 39 #3
	Prism, Optical									D/H		Pg 56 #1

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PERISCOPE, TANK: M32 (TM 9-1240-313-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
	Dial, Control								H/F			Pg 59 #3
	Dial, Control								H/F			Pg 59 #7
	Screw, Machine								D/H			Pg 60 #3
	Screw, Machine								D/H			Pg 60 #5
	Pin Straight								-/F			Pg 71 #1
	Setscrew								-/F			Pg 71 #2
	Contact								-/F			Pg 71 #3
	Plate								-/F			Pg 71 #4
	Cover								-/F			Pg 71 #5
	Ring, Externally								D/H			Pg 73 #1
	Reticle, Optical								D/H			Pg 73 #2
	Cover								D/H			Pg 73 #5
	Spring Helical								D/H			Pg 73 #7
	Plate								D/H			Pg 74 #11
	Cell								D/H			Pg 74 #15
	Screw, Machine								D/H			Pg 77 #1
	Contact (Staked)								D/H			Pg 78 #10

PERISCOPE, TANK: M32 (TM 9-1240-313-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
	Screw, Machine							D/H	-/F	-/F		Pg 81 #1
	Shaft Eccentric							D/H		D/H		Pg 81 #3
	Spring Conical							-/F				Pg 83 #2
	Receptacle, Electrical											Pg 83 #3
	Cell Assy							-/F	D/H	D/H		Pg 87 #7
	Ring, Retaining							-/H	-/H	-/H		Pg 88 #8
	Lens, Optical							-/H	-/H	-/H		Pg 88 #9
	Cell, Optical							-/H	D/H	D/H		Pg 88 #10
	Packing, Performed							D/H	D/H	D/H		Pg 88 #11
	Packing, Performed							D/H	D/H	D/H		Pg 88 #12
	Packing, Performed							D/H	-/F	H/F		Pg 88 #13
	Knob, Assy							-/F	H/F	D/H		Pg 92 #7
	Rod Light Conductor							D/H	D/H	D/H		Pg 93 #15
	Ring							D/H	D/H	D/H		Pg 109 #2
	Reticle, Optical							D/H	D/H	D/H		Pg 109 #3
	Prism, Optical							D/F				Pg 113 #4

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PERISCOPE, TANK: M32 (TM 9-1240-313-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Nut Plain Round								D/H				Pg 115 #3
	Prism (Cemented)								D/H				Pg 116 #8
	Clamp								D/H				Pg 118 #1
	Packing								D/H				Pg 125 #2
	Packing								D/H				Pg 125 #3
	Packing								D/H				Pg 125 #4
	Cell, Assy								D/H				Pg 126 #7
	Ring Retaining								D/H				Pg 126 #8
	Gasket								D/H				Pg 128 #27
	Eccentric Ring								D/H				Pg 128 #29
	Cell Assy								D/H				Pg 128 #30
	Window, Optical Instrument								D/H				Pg 148 #3
	Eccentric								D/H				Pg 151 #5
	Cap								D/H				Pg 152 #8
	Coupling Arm Assy								D/H				Pg 152 #10
	Eccentric								D/H				Pg 153 #3

PERISCOPE, TANK: M32 (TM 9-1240-313-35P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Arm (Riveted) Support Assy Weight Mirror Window, Optical Instrument Cover, Window Bridge Setscrew Ring Window Window, Optical Packing Setscrew Wedge Assy								D/H D/H D/H D/H D/H D/H D/H D/H D/H D/H D/H D/H D/H D/H				Pg 153 #19 Pg 153 #20 Pg 161 #4 Pg 161 #5 Pg 167 #5 Pg 167 #7 Pg 168 #11 Pg 169 #19 Pg 171 #2 Pg 171 #3 Pg 171 #4 Pg 171 #5 Pg 171 #5 Pg 172 #6

n. Binoculars, M3, M7, M13, M13A1, M15A1, M16, and M17A1.

(1) Description. These binoculars each consist of two prismatic telescopes pivoted about a common hinge so as to permit adjustment of the distance between the eyepieces. The hinge is equipped with a scale which indicates this distance in millimeters. Binoculars are usually designated by the power of magnification and the diameter of the objective lens. A 6x30 binocular magnifies six times and has objective lenses which are 30 millimeters in diameter.

(2) Selected Technical Characteristics. Specific characteristics such as size, weight, objective lense size and magnification will depend on the specific model of binoculars.

(3) Unique Characteristics. The delicate nature of the optics within these binoculars requires that maintenance on them be performed in a controlled, dust-free environment.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the binoculars was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The team consisted of senior instructors in the Fire Control Division.

(b) The Repair Parts List contained in TM 9-1240-372-34P was used as the basis for this analysis. Corrections in responsibilities for maintenance tasks are shown on pages H-73 through H-75.

BINOCULAR (TM 9-1240-372-34P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
	Objective Assembly							H/P				Pg 10 #2
	Eyepiece, Assembly							H/P				Pg 10 #4
	Screw, Machine							H/P				Pg 10 #5
	Cover, Right							H/P				Pg 10 #6
	Screw, Machine							H/P				Pg 10 #7
	Shelf, Assy							H/P				Pg 10 #8
	Eyepiece, Assy							H/P				Pg 10 #9
	Cover, Left							H/P				Pg 10 #10
	Reticle, Assy							H/P				Pg 10 #11
	Shelf, Assy							H/P				Pg 10 #12
	Screw, Machine							H/P				Pg 12 #1
	Screw							H/P				Pg 12 #2
	Scale							H/P				Pg 12 #3
	Setscrew							H/P				Pg 12 #4
	Screw							H/P				Pg 12 #5
	Stdm, Solid							H/P				Pg 12 #6

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BINOULAR (TM 9-1240-372-34P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Screw								H/P				Pg 12 #7
	Shim, Solid								H/P				Pg 12 #8
	Pin, Straight								D/P				Pg 12 #9
	Axle								D/H				Pg 12 #10
	Ring								H/P				Pg 14 #1
	Washer, Key								H/P				Pg 14 #2
	Gasket								H/P				Pg 14 #3
	Cell, Optical								H/P				Pg 14 #4
	Cell, Optical								H/P				Pg 14 #5
	Gasket								H/P				Pg 14 #6
	Lens, Optical								H/P				Pg 14 #7
	Ring, External								H/P				Pg 14 #8
	Cell, Optical								H/P				Pg 14 #9
	Adapter, Eyepiece								H/P				Pg 16 #1
	Screw, Headless								H/P				Pg 16 #2
	Ring, Clamping								H/P				Pg 16 #3

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BINOCULAR (TM 9-1240-372-34P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Scale, Diopter								H/F				Pg 16 #4
	Ring, Stop								H/F				Pg 16 #5
	Cell, Assembly								H/F				Pg 16 #6
	Ring, Retaining								H/F				Pg 16 #7
	Ring, Retaining								H/F				Pg 16 #8
	Lens, Optical								H/F				Pg 16 #9
	Lens, Optical								H/F				Pg 16 #10
	Separator								H/F				Pg 16 #11
	Screw, External								D/F				Pg 18 #1
	Clip								D/F				Pg 18 #2
	Clip								D/F				Pg 18 #3
	Pad, Cushioning								D/F				Pg 18 #4
	Shield, Prism								D/F				Pg 18 #5
	Prism, Optical								D/F				Pg 18 #6
	Shelf, Assembly								D/F				Pg 18 #7
	Shelf, Assembly								D/F				Pg 18 #8

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o. Binocular, M18.

(1) Description. The tank commander employs this binocular for making infrared observations. The binocular resembles conventional hand-held binoculars, but it contains an image converter tube in each of its two infrared optical channels, a reticle projection system, and an electric power unit.

(2) Selected Technical Characteristics.

(a) Magnification	3.5x
(b) Field of view	12.5 degrees
(c) Equivalent focal length of objective	3.78 inches
(d) Interpupillary adjustment limits	64mm and 75mm
(e) Weight	4.75 pounds
(f) Length	10.625 inches
(g) Width	5.75 inches
(h) Height	4.375 inches

(3) Unique Characteristics. The delicate nature of the optics within this binocular requires that maintenance on it be performed in a controlled, dust-free environment.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the binocular was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Weapons Training Department. The team consisted of senior instructors from the Fire Control Division.

(b) The Repair Parts List contained in TM 9-6650-215-34P was used as the basis for this analysis. Corrections in responsibilities for maintenance tasks are shown on pages H-78 through H-81.

BINOCULAR M18 (TM 9-1240-372-34P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Plate, Binocular								D/H				Pg 8 #9
	Ring, Optical								D/H				Pg 8 #10
	Screw, Machine								D/H				Pg 8 #12
	Contact								D/H				Pg 10 #17
	Spring, Helical								D/H				Pg 10 #18
	Ring, Retaining								D/H				Pg 10 #20
	Ring								D/H				Pg 11 #1
	Lens, Optical								D/H				Pg 11 #4
	Packing								D/H				Pg 11 #6
	Mirror Assy								D/H				Pg 11 #7
	Nut								D/H				Pg 11 #9
	Ring Retaining								D/H				Pg 11 #11
	Ring Contact								D/H				Pg 11 #12
	Spring, Helical Compression								D/H				Pg 11 #13
	Ring								D/H				Pg 11 #14
	Lens, Optical								D/H				Pg 12 #15

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BINOCULAR M18 (TM 9-1240-372-34P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Lens, Optical								D/H				Pg 12 #17
	Screw, Machine								D/H				Pg 14 #1
	Setscrew								D/H				Pg 14 #2
	Ring								D/H				Pg 14 #3
	Setscrew								D/H				Pg 14 #4
	Disk								D/H				Pg 14 #5
	Mount Eyepiece Cell								D/H				Pg 14 #8
	Pin								D/H				Pg 14 #9
	Packing								D/H				Pg 14 #10
	Nut								D/H				Pg 14 #11
	Adapter								D/H				Pg 14 #12
	Pin								D/H				Pg 14 #13
	Packing, Preformed								D/H				Pg 16 #14
	Packing, Preformed								D/H				Pg 16 #15
	Cell Eyepiece Assy								D/H				Pg 16 #16
	Ring								D/H				Pg 16 #17

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BINOCULAR NO.8 (TM 9-1240-372-34P)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
	Lens, Optical							D/H				Pg 16 #18
	Lens, Optical							D/H				Pg 16 #19
	Lens, Aspheric							D/H				Pg 16 #20
	Packing, Preformed							D/H				Pg 16 #23
	Cell Eyepiece							D/H				Pg 16 #24
	Setscrew							D/H				Pg 17 #1
	Disk							D/H				Pg 17 #2
	Ring							D/H				Pg 17 #3
	Setscrew							D/H				Pg 17 #13
	Spacer							D/H				Pg 17 #14
	Pin							D/H				Pg 17 #17
	Ring							D/H				Pg 17 #21
	Contact							D/H				Pg 17 #22
	Contact							D/H				Pg 17 #24
	Insulation							D/H				Pg 18 #25
	Connector							D/H				Pg 18 #28
	Gasket							D/H				Pg 18 #5

BINOCULAR M8 (TM 9-1240-372-34P)

GROUP NO.	FUNCTIONAL GROUP		MAINTENANCE FUNCTION	REMARKS
	Plate Plate, Identification		INSPECT	Pg 18 #7 Pg 18 #8
			TEST	
			SERVICE	
			ADJUST	
			ALIGN	
			CALIBRATE	
			INSTALL	
D/H D/H			REPLACE	
			REPAIR	
			OVERHAUL	
			REBUILD	

p. Radio Set AN/PRC-77.

(1) Description. Radio Set AN/PRC-77 is a completely transistorized, short-range, manpack portable, frequency modulated (fm) receiver-transmitter used to provide two-way voice communication. It is replacing the AN/PRC-25.

(2) Selected Technical Characteristics.

(a) Frequency range	30.00 to 52.95 MHz
(b) Number of channels	920
(c) Channel spacing	50KHz
(d) Power requirements	12.5 - 15 volts dc, 700 ma (transmit), 6 ma (receive)
(e) Transmitter output power	1.5 - 4.0 watts
(f) Range	5 miles
(g) Antenna	whip or semi-rigid steel tape
(h) Battery life	30 hours (9:1 receive- transmit ratio)

(3) Unique Characteristics. The AN/PRC-77 can be equipped to provide secure voice capability.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by members of the staff of the Command and Staff Training Department, USAOC&S. The LORA team was led by a Chief Warrant Officer.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the AN/PRC-77 are shown on page H-84.

RADIO SET, AN/PRC-77 (TM 11-5820-667-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Radio Set, AN/PRC-77 Handset H-189/GR Bag, Cotton Harness ST-138/PRC25 Receiver-Transmitter IPA Motherboard A49 Synthesizer Motherboard Audio and Control Chassis Chassis Assembly		F/O			F/O				F/O F/O F/O F/O F/O F/O F/O			PGC-2 #1 PGC-2 #2 PGC-2 #5 PGC-2 #6 PGC-3 #1 PGC-3 #2 PGC-3 #3 PGC-3 #4 PGC-3 #6

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q. Radio Set, AN/VRC-46.

(1) Description. Radio Set AN/VRC-46 is a short-range, vehicle-mounted, frequency modulated (fm) receiver-transmitter used to provide two-way voice communication. The antenna contains a matching unit which automatically selects the proper impedance associated with the transmitter frequency. The set makes extensive use of plug-in modules, and also contains printed circuit boards which may be flipped up for easy access.

(2) Selected Technical Characteristics.

(a) Frequency range	30.00 to 75.95 MHz
(b) Number of channels	920
(c) Channel spacing	50 KHz
(d) Power requirements	22 to 30 volts dc 3a @ low power, 10 a @ high power
(e) Transmitter output power	0.5 - 35 watts
(f) Range	approx. 5 miles on low power approx. 25 miles on high power
(g) Antenna	whip
(h) Power drain	0.75 amp at 25 volts dc

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by members of the staff of the Command and Staff Training Department, USAOC&S. The LORA team consisted of highly qualified Signal Corps commissioned and warrant officers.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the AN/VRC-46 are shown on page H-87.

RADIO SET AN/VRC-46

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION											REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	
1	Radio Set AN/VRC-46												
1A	Receiver-Transmitter RT524				H/O								
1B	Mount MT-1029					D/H							
1C	Antenna AS-1729												

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r. Radio Set, AN/GRC-106.

(1) Description. The AN/GRC-106 is a high frequency (hf), single-side-band (SSB), radio receiving-transmitting set. It is used for receiving and transmitting upper-sideband (USB) voice, USB compatible amplitude-modulated (compatible am), and continuous wave (cw) signals in a simplex operation. The AN/GRC-106 is primarily intended for use as a mobile radio link in a communications network; however, it may be used in a fixed mobile station. It is usually vehicular mounted.

(2) Selected Technical Characteristics.

(a) Frequency range	2.0 - 29.999 MHz
(b) Selectively tuned operating frequencies	28,000
(c) Primary voltage	27 volts dc $\pm$ 3
(d) Bandwidth	3.2 KHz
(e) Power output	400 watts
(f) Antenna	whip or doublet
(g) Effective range	50 miles nominal (groundwave) 1500 miles (skywave)

(3) Unique Characteristics: None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by members of the staff of the Deputy Commandant for Training and Development, Organization and Evaluation Division. The LORA team was led by a Chief Warrant Officer.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the AN/GRC-106 are shown on pages H-90 and H-91.

RADIO SET AN/GRC-106 (TM11-5820-520-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION											REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	
1A1	Radio Set AN/GRC-106		F/O		F/O	F/O				F/O			PCB-3 #1 PCB-4 #1
1A1A5	RT-662/GRC and RT-834/GRC Chassis Assembly	F/O	F/O	F/O	F/O	F/O		F/O		F/O			
1A2	Internal PPC Assembly	F/O	F/O	F/O	F/O					F/O			
1A3	100 KC Syn Assembly	F/O		F/O						F/O			
1A4	Freq Std Assembly	F/O		F/O						F/O			
1A5	10 and 1 KC Assembly	F/O		F/O						F/O			
1A6	Transmit IF and Audio Ass	F/O		F/O						F/O			
1A7	Freq Divider Assembly	F/O		F/O						F/O			
1A8	Receiver IF Assembly	F/O		F/O						F/O			
1A9	Translator Assembly	F/O		F/O						F/O			
1A10	MC Syn Assembly	F/O		F/O						F/O			
1A11	Receiver Audio Assembly	F/O		F/O						F/O			
1A12	DC to DC Converter Assembly	F/O		F/O						F/O			
	RF Amplifier Assembly	F/O		F/O						F/O			
	AM-3349/GRC-106		F/O		F/O	F/O		F/O					

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RADIO SET AN/CRC-106 (TM11-5820-520-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
2A1	Chassis Assembly	F/O		F/O	F/O					F/O			
2A2	Turret Assembly	F/O			F/O					F/O			
2A3	Antenna Coupler Assembly	F/O				F/O				F/O			
2A4	Discriminator Assembly	F/O								F/O			
2A5	Front Panel Assembly	F/O	F/O							F/O			
2A5A1	Filter Assembly	F/O								F/O			
2A5A2	DC to DC Converter	F/O								F/O			
2A5A3	Plate Assembly	F/O								F/O			
2A5A5	Terminal Board Assembly	F/O								F/O			
2A5A6	Start Circuit Assembly	F/O								F/O			
2A5A7	Protection Circuit	F/O								F/O			
2A6	Case Assembly									F/O			
2A6A1	Inverter Assembly	F/O								F/O			
2A7	Relay Assembly	F/O	F/O							F/O			
2A8	Driver Assembly	F/O	F/O		F/O					F/O			
2A9	Antenna Group		F/O										

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s. Radio Teletypewriter AN/GRC-142.

(1) Description. The AN/GRC-142 is a shelter-contained radio teletypewriter system that provides one-way reversible communication (transmit and receive, but not simultaneously). This set includes provisions for local (mobile or fixed) or remote operation, and is vehicular or air transportable. It is wired to accept an additional teletypewriter, receiver-transmitter, inverter, antenna, and auxiliary loudspeaker. This provides simultaneous 2-way remote or local teletypewriter communication. Remote field telephone facilities are also provided, allowing the local operator in the shelter to communicate with a remote operator over land lines. Facilities are included to accomodate security equipment. The AN/GRC-142 may be netted with other series of teletypewriters.

(2) Selected Technical Characteristics.

(a) Frequency range	2.0-29.999 MHz
(b) Types of signals	85 Hz narrow frequency
transmitted/received	shift keyed (nsk), or
	850 Hz frequency shift
	keyed (fsk)

- (c) Compatibility Amplitude modulated,
single side band, voice,
and continuous wave.
Voice and teletypewriter
simultaneously (voice
plus nsk). Nsk
diversity.
- (d) Mobile carrier M-37B1 3/4-ton truck,
or M-715 1 1/4-ton truck,
both with 100 amp kit
- (e) Transmitted power output 400 watts, peak envelope
(max) power
- (f) Effective transmit range 50 miles nominal (ground
wave); 100-1500 miles
(skywave)
- (g) Antenna systems Whip or doublet
- (h) Weight 1694 pounds
- (i) Max DC power 28.5 volts dc at 87
consumption amperes
- (3) Unique Characteristics: None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at The US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by members of the staff of the Command and Staff Training Department, USAOC&S. The LORA team consisted of commissioned and warrant officer instructors.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the AN/GRC-142 are shown on pages H-95 through H-100.

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	AN/GRC-142 Low Level Sig Device TT-523 Cable Assemblies Remote Control Box Control Panel Dummy Box		F/O					F/O	F/O	F/H			PCB-3 #1 PCB-3 #10 PCB-4 #2 PCB-4 #3 PCB-4 #4 PCB-5 #1

H-95

CONTROL GROUP AN/GRA-6 (TM 11-5038)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION											REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	
	Control Group AN/GRC-6 Bag CM-189/GR: 14 Local Control C-434/GR: 23 Remote Control C-433/GR: 22		F/O							F/O F/O F/O			PG 3 #1 PG 3 #2 PG 3 #5 PG 4 #2

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MODEL, RADIO TELETYPEWRITER MD-522/GRC (1.2.1-5805-387-15-1) (COMPONENT OF AN/GRC-14.2)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Modem Radio Teletypewriter Panel Assembly Front Chassis Assembly Receiver Audio Scope Module Transistor Module Receiver Module Loop Battery Module		F/O F/O F/O F/O F/O F/O F/O F/O		F/O F/O F/O					F/O F/O F/O			PGC-2 #1 PGC-3 #1 PGC-4 #1 PGC-5 #1 PGC-5 #2 PGC-6 #1 PGC-7 #1 PGC-8 #1

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TELETYPEWRITER SETS (TM 11-5815-238-12) (COMPONENT OF AN/CRC-142)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Reperforator TT-76A/GGC Motor Universal	F/H	F/H	F/H	F/H				F/H				PG A3-3 #2 PG A3-3 #3

TELETYPEWRITER SETS (TM 11-5815-200-12) (COMPONENT OF AN/GRC-142)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
	Power Supply PP-978/FG Teletypewriter TT-98/FG Motor Alternating Current								F/H	F/H F/H			PGA 3-3 #2 PGA 3-3 #3 PGA 3-3 #4

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TELEPHONE SET TA-312/PT (TM11-5805-201-12) (COMPONENT OF AN/ERC-112)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
1	Telephone Set TA-312/PT	F/O	F/O	F/O	F/O					F/O			

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t. Teletypewriter Central Office AN/MGC-17.

(1) Description. The AN/MGC-17 is a self-contained, shelter-housed, voice-frequency (vf) telegraph switching center with a power source. It is used as a telegraph central office in a division area of an area type communications system. It contains facilities for three teletypewriter circuits (nonsecure, half or full duplex) or two secure, half duplex teletypewriter circuits, when required, by the addition of communication security equipment.

(2) Selected Technical Characteristics.

(a) Teletypewriter circuits

(nonsecure) 3

(b) Teletypewriter switchboard

circuits 12

(c) Intershelter communication

facilities 1

(d) Security circuits 2

(e) Power requirements 115v, 60Hz single phase, 3.1KW

(f) Weight, including trlr-mtd

power unit 3700 lbs.

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by members of the staff of the Command and Staff Training Department. The LORA team consisted of highly qualified Signal Corps commissioned and warrant officers.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the AN/MGC-17 are shown on page H-103.

TELETYPEWRITER CENTRAL OFFICE AN/MGC-17

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
1B	Cable Assemblies, 26 pr Converter, TG-TL TA-182 Reel Unit RL-31 SB-ZZ/PT Telephone Set TA-312/PT Teletypewriter TT-4/TG Device, Low Level Signaling TT-523/GGC Converter, Telegraph-Telephone Signal CV-425/U									F/O	D/P		
1F						H/F				F/O	D/P		
1H													
1I											H/P		
1J			F/O	F/O		F/O						D/H	
1L													
1O												H/P	
							H/F					H/P	
1P													

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u. Central Office, Telephone, Manual AN/TTC-29

(1) Description. The AN/TTC-29 is a self-contained, shelter-housed assemblage used to provide nonsecure manual central office telephone switchboard facilities for corps and larger command communication systems.

(2) Selected Technical Characteristics.

(a) Two-wire signal lines 60

(b) Intercommunications line 1

(c) Field telephone line 1

(d) Working limits of types

of signalling:

Magneto 22 - 25 miles of field wire

Common battery 4 1/2 - 5 miles of field wire

Common battery (truck) 9 - 10 miles of field wire

Common battery (civilian
truck) 4 1/2 - 5 miles of field wire

(e) Power requirements

AC 115 v, 60Hz single phase, 2KW

DC BA-200/U and BA-30 batteries

(f) Weight 1806 lbs.

(g) Volume 272 cubic feet

(3) Unique Characteristics: None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by members of the staff of the Command and Staff Training Department. The LORA team consisted of highly qualified Signal Corps commissioned and warrant officers.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the AN/TTC-29 are shown on page H-106.

CENTRAL OFFICE, TELEPHONE, MANUAL AN/TTC-29

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION											REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	
1B	Intercommunications Station LS-147C/FL Telephone Set TA 312/PT												
1F		F/O	F/O		F/O					F/O	D/P		

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H-2. AUTOMOTIVE, POWER GENERATION, AND SUPPORT EQUIPMENT.

a. Truck Utility 1/4 Ton 4 x 4 M151A1.

(1) Description. This truck is a general purpose all-weather personnel or cargo carrier designed for use over all roads and cross-country terrain.

(2) Selected Technical Characteristics.

(a) Engine: 4 cylinder, in line, overhead valve producing 71 HP @ 4000 RPM.

(b) Transmission: Manual, 4 forward speeds, 1 reverse speed.

(c) Transfer: Single speed low range.

(d) Weight 2350 pounds (3600 pounds GVW)

(e) Length 132 inches

(f) Width 64 inches

(g) Fuel tank capacity 17 gallons

(h) Range 300 miles

(3) Unique Characteristics. The Truck Utility 1/4 ton 4x4 is unique among Army tactical wheeled vehicles due to its unitized construction body and independent suspension. All four wheels are individually suspended on coil springs while other wheeled vehicles use a leaf spring suspension system.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed in the Mobility Training Department (MTD), US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by warrant officer and NCO instructors.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M151A1 are shown on page H-109.

Truck Utility 1/4-Ton M51A1 (TM 9-2320-218-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0100	Engine								F/O			
0300	Clutch Assy								F/O			
0501	Radiator, Engine								F/O			
0504	Pump Water		F/O							F/O		
0700	Transmission Assy				-/F				F/O			
0801	Transfer Assy				-/F				F/O			
1002	Carrier Differential Front and Rear				-/F							
1201	Band Assy Parking Brake									-/F		
1202	Brakeshoe and Lining									-/F		
1204	Cylinder Master									-/F		
	Cylinder Wheel									-/F		
1401	Steering Gear Assy				F/O				F/O	-/F		

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b. Truck Cargo, 2 1/2 Ton 6x6 M35A2.

(1) Description. This truck is a general purpose all-weather cargo carrier designed for use over all roads and cross country terrain. The truck is equipped with one driving front axle, two driving rear axles, and a 12 foot flat bed steel body. This truck is used primarily to haul troops and/or general cargo.

(2) Selected Technical Characteristics.

(a) Engine: Six cylinder, multifuel LD 465-1, 140 HP @ 2600

RPM

(b) Transmission: Manual, five forward speeds, one reverse speed

(c) Transfer: Two speed, hi and low range

(d) Weight 13,530 with winch

(e) Length 262 inches

(f) Width 88 inches

(g) Fuel tank capacity 50 gallons

(h) Range 500 miles

(3) Unique Characteristics. The Truck Cargo, 2 1/2 ton 6x6 is a cross-country, ten driving wheel vehicle with a 5000 lb cross-country payload. The diesel engine will operate on gasoline or a blend of diesel fuel and gasoline.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Ordnance Center and School at Aberdeen Proving Ground, Maryland, by members of the school staff.

(b) Analysis. Corrections to the Maintenance Allocation Chart (MAC) for the M35A2 are shown on pages H-112 through H-114.

Truck Cargo, 2 1/2-Ton, 6x6 M35A2 (TM9-2320-209-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0101	Head Cylinder Multifuel Arm, Rocker Rod, Push Shaft Rocker-Arm Screw, Adjusting Pan, Oil Valve Heat Control Bearing Release Clutch Fork Clutch Release Bearing Shaft Fork Clutch Lines and Connections Manifold Heater Igniter Spark Unit Igniter Transmission Shaft Input								F/O			
0105									F/O			
									F/O			
									F/O			
									F/O			
0106									F/O			
									F/O			
0202									F/O			
									F/O			
									F/O			
									F/O			
0310									F/O			
									F/O			
									F/O			
0700									F/O			
0702									H/F			

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Truck Cargo, 2 1/2-Ton, 6x6 M35A2 (TW9-2320-209-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0702	Shaft Output Countershaft Shaft Idler Transfer								H/F H/F H/F			
0800	Shaft, Input Shaft, Intermediate								F/O H/F H/F			
0801	Shaft Output Front Axle Shaft Output Rear Axle								H/F -/F			
0802	Clutch and Controls Pork Shifter Shaft								F/O H/F H/F			
1006	Shafts Shifter Axle, Front								F/O F/O			
10004	Shaft Axle of U Joint								F/O			
1100	Axle, Rear Linkage and Lever Gear, Steering								F/O H/F			

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Truck Cargo, 2 1/2-Ton, 6x6 M35A2 (TM9-2320-209-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION											REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	
1810 2004	Seat, Troop Power Take Off								F/O	F/O H/P			

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c. Truck Tractor, 5-ton 6x6 M818.

(1) Description. This truck has a tractor fifth wheel mounted on a short wheelbase chassis. The truck is equipped with a driving front axle and two rear driving axles, a 5 forward-speed transmission, and a two-speed transfer case.

(2) Selected Technical Characteristics.

(a) Weight	19,260 pounds
(b) Length (w/winch)	280 inches
(c) Width	97 inches
(d) Height	89 inches
(e) Fuel tank capacity	110 gallons

(3) Unique Characteristics. The Truck Tractor 5-ton 6x6 M818 uses a Cummins NHC 250 diesel engine instead of the LD-465-1 multi-fuel engine used on the earlier 5-ton models. A different exhaust system is also used on the M818.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the Mobility Training Department (MTD), US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by personnel from MTD and the school staff.

(b) Corrections to the MAC for the M818 are shown on pages H-116 and H-117.

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
0100	Mounting Engine Pad Engine Mounting								F/O	F/O			
0200	Bearing Pilot								F/O	F/O			
	Disk Clutch								F/O	F/O			
	Plate Pressure								F/O	F/O			
	Bearing Release Clutch								F/O	F/O			
0202	Lever								F/O	F/O			
0504	Water Pump								F/O	F/O			
0613	Harness Wiring								F/O	F/O			
0700	Transmission								F/O	F/O			
0801	Transfer								F/O	F/O			
1000	Axle Front								F/O	F/O			
1100	Axle Rear								F/O	F/O			
1201	Drum, Handbrake								F/O	F/O			
1209	Compressor, Air								F/O	F/O			
1407	Gear, Steering								F/O	F/O			
1506	Fifth Wheel								F/H				

TRUCK TRACTOR, 5-TON 6x6 MB18 (TM9-2320-260-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
1801	Door								F/O				
	Hood								F/O				
1802	Fender								F/O				
	Board Running								F/O				
1806	Seat								F/O				
1808	Boxes, Brackets and strips								F/O				

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d. Truck, Tractor, 10 Ton, 6x6, M123A1C.

(1) Description. This truck has a tractor fifth wheel mounted on a short wheelbase chassis. The truck is equipped with a driving front axle and two rear driving axles. The M123A1C is designed to haul heavy combat equipment over-the-road, with limited off-road capability. It is also capable of loading heavy combat vehicles onto Semi-trailer HET M747 or Semi-trailer M15 by means of tractor-mounted winches.

(2) Selected Technical Characteristics

(a) Engine	8 cylinder V-type, 4-cycle, liquid cooled diesel.
(b) Transmission	Manual, 5 speeds forward, 1 reverse
(c) Weight	30,230 pounds
(d) Length	280 inches
(e) Width	114 inches
(f) Height	113 inches
(g) Fuel tank capacity	166 gallons
(h) Range	300 miles

(3) Unique Characteristics. The M123A1C exceeds the dimension limitations permitted under AR 700-105. Advance planning is required in the selection of routes because of bridge capacities and underpass and road clearances involved.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the Mobility Training Department (MTD), US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by members of MTD and the school staff.

(b) Corrections to the MAC for the M123A1C are shown on pages H-120 and H-121.

TRUCK TRACTOR 10-TON, 6x6, M123A1C (TM9-2320-206-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0103	Housing Flywheel Pump Fuel (Diesel) Governor Engine (Gasoline) Pulley, Hub Generator Turn Signals Horn	H/F							H/F			
0302									F/O			
0308					F/O							
0505									F/O			
0601					F/O					F/O		
0608				F/O								
0611					F/O					F/O		
1004	Bearing Seals								F/O			
	Knuckle Steering								F/O			
	End, Drive Front Axle								F/O			
	Shaft, Axle								F/O			
1100	Shaft Axle								F/O			
1201	Cam Actuating								F/O			

TRUCK TRACTOR 10-TON, 6x6, M123A1C (TM9-2320-206-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
1202	Camshaft Shoe Brake								F/O				
1209	Compressor, Air								F/O				
1311	Bearing Hub Front Axle								F/O				
	Hub, Front Wheel								F/O				
	Seals Oil Hub Front								F/O				
1401	Drive Angle Steering								F/O				
	Steering Drive Propeller								F/O				
1412	Cylinder Power								F/O				
1414	Valve Control Steering								F/O				

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e. Truck, Cargo 1 1/4 Ton 6x6 M561.

(1) Description. The Truck, Cargo M561 is used for hauling general cargo or troops, or as an ambulance over rough terrain or improved roadways and highways. The M561 has an aluminum cab and body with watertight crew, engine and cargo compartments.

(2) Selected Technical Characteristics

(a) Engine GM 3-53 3 cylinder Diesel - 103 H.P. @ 2800 RPM

(b) Transmission: Manual Synchromesh 4 speed

(c) Length 227 inches

(d) Width 84 inches

(e) Height 91 inches

(f) Weight 10,200 pounds

(g) Fuel tank capacity 40 gallons

(h) Range 300 miles

(3) Unique Characteristics. The M561 has unusual rough terrain capability because the vehicle consists of two modules, the tractor and the carrier. The tractor-to-carrier coupling is a double universal joint separated by a yoke. The coupling assembly connects the center differential to the carrier propeller shaft and

transmits drive force to the propeller shaft and rear differential, while allowing the carrier to pitch in respect to the tractor. The M561 has a swimming capability when the removable bottom drain plugs are in place.

(4) Level of Repair Analysis (LORA)

(a) General. The analysis was performed at the Mobility Training Department (MTD), US Army Ordnance Center and School, Aberdeen Proving Grounds, Maryland, by warrant officer and NCO instructors.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M561 are shown on pages H-124 and H-125.

TRUCK CARGO: 1 1/4-Ton 6x6 M561 (TM9-2320-242-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
0102	Seal, Crankshaft Oil Pulley, Drive								F/O F/O				
0103	Flywheel Assembly Flywheel Housing								F/O F/O				
0105	Shaft Rocker Arm Rod, Push								F/O F/O				
0106	Cooler Assy Engine Oil Pan Engine Oil								F/O F/O				
0200	Clutch Assy	F/O							F/O				
0202	Bearing Clutch Release Fork, Release Bearing	F/O F/O							F/O F/O				
0301	Injector Fuel Lines and Fittings Lever, Rack Control	F/O							F/O F/O F/O				
0308	Governor, Engine Speed Control & linkage		F/O		F/O F/O F/O				F/O				

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TRUCK CARGO: 1 1/4-Ton 6x6 M561 (TM9-2320-242-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
0311	Engine Coldstart System Seals		F/O						F/O				
0804	Lubrication Pump Lines & Fittings								F/O				
1002	Seals								F/O				
1102	Vent Lines Fittings Differential Assy Center & Rear Seals								F/O	H/F			
1407	Vent Lines and Fittings Steering Gear Box				F/O				F/O				
1601	Springs, Coil Tractor & Carrier					F/O							
2205	Pump, Bilge									H/F			

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C

f. Semitrailer, Low Bed, HET, 52 1/2 Ton XM747.

(1) Description. The Semitrailer, Low bed, Heavy Equipment Transporter, 52 1/2 ton, XM747 is an eight-wheel vehicle designed for use as a heavy equipment transporter. The semitrailer has limited off-road capability, to bypass road obstructions and to reach vehicle collecting points and areas for concealment. The trailer consists of a frame assembly, with a gooseneck at the front and flat bed at the rear, loading and unloading ramps, walking beam suspension, air suspension system, air brake system, a 24 volt electrical system and a series of rollers used to guide winch cables during loading and unloading operations. The XM747 is towed by a 22 1/2 Ton M746 or a 10 Ton M123A1C tractor. Its primary mission is to evacuate disabled tanks or other combat vehicles over primary or alternate MSR's to vehicle collecting points or maintenance establishments. In addition, this transporter provides a means of transporting such vehicles from railheads, ports, depots, or supporting units to user or maintenance areas, and of transporting non-disabled combat vehicles over extended distances when movement under their own power is not desired or feasible.

(2) Selected Technical Characteristics.

(a) Length	513 inches
(b) Width	137 inches
(c) Height	119 inches
(d) Weight	30,776 pounds
(e) Maximum permissible payload	120,000 pounds
(f) Bed height	44 inches
(g) Bed length	317 inches
(h) Bed Width	120 inches

(3) Unique Characteristics. This semitrailer is the only four-axle trailer in the Army inventory. The two front axles utilize an unsprung walking beam suspension system. The two rear axles use an air-suspension trailing-arm arrangement. When the trailer is unloaded or only lightly loaded, the two rear axles can be raised approximately three inches by a pneumatic lift system. This provides better maneuverability when turning corners and reduces tire wear when driving without a payload.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed in the Mobility Training Department (MTD), US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by warrant officer and NCO instructors.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the XM747 are shown on page H-129.

SEMI-TRAILER, LOW BED, HET, XM747 (TM9-2330-294-14)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
1301	Air Valves (except regulators) Pressure Regulator Valves		H/F										
1311	Drum, Brake		H/F							H/F			
1501	Brackets (welded)								H/F				
1507	Landing Gear									H/F			

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g. Generator Set, Gas Engine, 3KW

(1) Description. This generator set is a self-contained, frame mounted, portable unit powered by a 4-cylinder Military Standard engine. The generator is a self-excited 400-Hertz, alternating current generator with an output of 120/240 volts, single phase; 120 volts, 3-phase; or 120/208 volts, 3-phase, 4 wire; and is rated at 3 kilowatts (KW). The generator set is considered to be a simply maintained item which requires no special tools or test equipment at the organizational level.

(2) Selected Technical Characteristics.

(a) Frequency	- 400 Hertz (Hz)
(b) Power output	- 3 kilowatts (KW)
(c) Speed	- 3428 rpm
(d) Fuel Tank Capacity	- 3.75 gallons
(e) Length	- 35 inches
(f) Width	- 24 inches
(g) Height	- 25 inches
(h) Weight	- 275 pounds

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Engineer School at Fort Belvoir, Virginia, by members of the staff and faculty of the Mechanical and Technical Department, Office of the Deputy Commandant for Training and Education.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the 3KW generator set are shown on page H-132.

GENERATOR SET, GAS ENGINE, 3KW (TM5-2805-203-14)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION											REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	
01	Frame Assembly Shock Mounts								F/O				
02	Control Box Assembly Voltage Regulator		F/O		F/-				F/O				
03	Generator Assembly		-/0										

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h. Compressor, Rotary, Air, Trailer Mounted, GED, 250 CFM, 100
PSI

(1) Description. This compressor unit is a trailer mounted, diesel engine driven, sliding-vane-type rotary air compressor. It furnishes 250 cubic feet of free air per minute at a discharge pressure of 100 pounds per square inch. The engine is a four cylinder four cycle, liquid-cooled, diesel which drives the compressor assembly through a flexible coupling.

(2) Selected Technical Characteristics.

(a) Manufacturer - Davey Compressor Company

(b) Type - Sliding-vane, air, rotary

(c) Air delivered - 250 CFM

(d) Air pressure - 100 PSI

(e) Fuel Tank - 45 gallons

(f) Fuel consumption - 5.6 gallons per hour

(g) Weight - 6,584 pounds

(h) Length - 211 inches

(i) Width - 96 inches

(j) Height - 82 inches

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA)

(a) General. The analysis was performed at the US Army Engineer School at Fort Belvoir, Virginia, by members of the staff and faculty of the Mechanical and Technical Department, Office of the Deputy Commandant for Training and Education.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the 250 CFM compressor are shown on page H-135.

COMPRESSOR, ROTARY, AIR, 250CFM (TM5-4310-250-15)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
5004	Rotors, Seals								H/F				
5004	Vanes, Rotor								H/F				
5007	Compressor Drive; Adapter, Housing Assembly								H/F				
5009	Spline, Coupling								H/F				
	Unloader Assembly								F/O				

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(i) Bakery Plant, Trailer Mounted, M-1945.

(1) Description. This bakery plant consists of three trailer-mounted bakery ovens, one trailer-mounted dough mixing and makeup outfit, three dough-proofing cabinets, one electric flour sifting machine, and two generator sets.

(2) Selected Technical Characteristics.

(a) Oven

<u>1</u> Capacity (pans)	36 pans-per oven
<u>2</u> Capacity (loaves)	6 per pan
<u>3</u> Length	16 feet 1 inch
<u>4</u> Width	7 feet 4 inches
<u>5</u> Weight	6,500 pounds

(b) Mixing and Makeup Outfit

<u>1</u> Capacity (dough)	492 pounds
<u>2</u> Water tank	30 gal
<u>3</u> Height	9 feet 3 inches
<u>4</u> Length	20 feet 1 inch
<u>5</u> Weight	11,000 pounds

(c) Proofing Cabinets

<u>1</u> Capacity	36 pans-per
<u>2</u> Height	5 feet 10 inches
<u>3</u> Length	5 feet 10 inches
<u>4</u> Weight	386 pounds

(d) Flour Sifter

<u>1</u> Capacity	60 pounds per min
<u>2</u> Height	66 inches
<u>3</u> Width	42 inches
<u>4</u> Weight	210 pounds

(3) Unique characteristic. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the bakery plant was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Chemical and Ground Support Training Department. The LORA team consisted of senior NCO instructors in the Materiel and Maintenance Division.

(b) TM 10-7360-201-20 was used by the team for its analysis. The LORA revealed no requirement for corrections to present maintenance tasks.

j. Laundry Unit, Trailer Mounted

(1) Description. The Eidal Laundry Unit, Model ELT9T is a complete laundry unit capable of operating for 20 hours per day continuous operation. It is powered by a 10KW engine-generator set. The water heater can be operated using either gasoline or fuel oil.

(2) Selected Technical Characteristics.

(a) Power Supply	10KW
(b) Height	96 inches
(c) Width	96 inches
(d) Length	200 inches
(e) Weight	9,300 pounds

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the laundry unit was performed at the US Army Ordnance Center and School by members of the staff and faculty of the Chemical and Ground Support Training Department. The team consisted of senior NCO instructors in the Materiel and Maintenance Division.

(b) TM-10-3510-208-12 was used by the team for its analysis. Corrections to the Maintenance Allocation Chart (MAC) are shown on page H-139.

Laundry Unit Trailer Mtd (TM 10-3510-208-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
2202	Hoses, Suction									F/O			
4201	Transformer		O/F										
5001	Body, Assy								F/O				
	Head and Sleeve Assy								F/O	F/O			
5005	Valve Assy								F/O	F/O			
	Seats Springs								F/O	F/O			
5303	Valve Assy								F/O				
6015	Motor Electrical									-/F			

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H-3. COMBAT VEHICLES AND HEAVY WEAPONS

a. Mortar, 81mm: M29 and M29A1.

(1) Description. This mortar is a smooth-bore, muzzle-loading, high angle-of-fire weapon consisting of a cannon, bipod assembly and baseplate. The cannon barrel has a base plug and a fixed firing pin for drop firing. It is employed as a ground weapon or mounted on combat vehicles.

(2) Selected Technical Characteristics

- (a) Weight - 107 lb.
- (b) Elevation - 40° to 80° (approx)
- (c) Traverse - (R or L) 4° (approx)
- (d) Range (max 45° elev) - 3,885 yards
- (e) Rate of Fire (normal) - 18 rd/min

(3) Unique Characteristics. The 81mm Mortar- the only mortar in the study sample-is unique by virtue of its simplicity. Aside from the mount, there are virtually no moving parts. This characteristic reduces the maintenance requirements significantly from that of other weapons of comparable size.

(4) Level of Repair Analysis (LORA)

(a) General. The analysis was conducted at the US Army Ordnance Center and School by members of the faculty assigned to the Conventional Weapons Division of the Weapons Training Department.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M29 and M29A1 are shown on page H-142 and H-143.

Mortar, 81mm, M29 and M29A1 (TM 9-1015-200-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
2	Ring, Barrel								F/O	F/O		
4	Bipod								-/O	F/O		
5	Traversing Mechanism								-/O	F		
6	Elevating Mechanism								-/O	F		
8	Baseplate (two piece steel)								-/O	F		

b. Carrier, Personnel, Full tracked, Armored, M113A1

(1) Description. The M113A1 full tracked Armored Personnel Carrier is used to transport troops or cargo in support of tactical operations. It is designed to operate in rough cross-country terrain and is capable of high speed operation on improved roads. The carrier is air-transportable and air-droppable. The carrier accommodates a driver, troop commander, and 11 passengers.

(2) Selected Technical Characteristics.

(a) Engine: Detroit Diesel 6 cylinder, V-type, 2 cycle, liquid cooled, 215 hp.

(b) Transmission: Automatic, torque converter with lock-up clutch. Three forward speeds, 1 reverse speed.

(c) Weight	22,615 pounds
(d) Length	192 inches
(e) Width	106 inches
(f) Height	98 inches
(g) Fuel tank capacity	80 gallons
(h) Range	200 miles
(i) Max speed	40 miles per hour
(j) Fording depth	Vehicle can float

(3) Unique Characteristics. The M113A1 carrier is unique because of its low silhouette, light weight and ability to swim small lakes, rivers and streams.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by members of the staff of the Mobility Training Department (MTD).

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M113A1 are shown on pages H-145 and H-146.

Carrier, Personnel Full-Track, Armored, M13A1 (TM 9-2300-224-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0100	Engine							F/O				
0101	Head Cylinder							F/O				
0102												
0105	Seal Rear Crankshaft							H/F				
	Gear, Crankshaft							H/F				
	Arm Rocker							F/O				
	Lifter Valve Hyd							F/O				
	Rod Push							F/O				
0106	Shaft Rocker Arm							F/O				
	Spring Valve							F/O				
	Pan Oil Engine							F/O	F/O			
	Stud Manifold							H/F				
0108												

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Carrier, Personnel Full-Track, Armored, M13A1 (TM 9-2300-224-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
0607	Harness Instrument Panel Panel Assy Instrument Panel Assy Master Switch Panel Assy Warning Lights Distribution Box								F/O				
									F/O				
									F/O				
									F/O				
									F/O				
									F/O				
									F/O				
0710	Harness Right Headlight								F/O				
	Transmission Oil Pan								H/F				
1604	Bearing Shock Absorber								F/O				
1801	Mount Periscope								D/H				

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c. Gun, Air Defense Artillery, Self-Propelled 20mm, M163.

(1) Description. The M163 anti-aircraft system is a lightweight, air transportable, amphibious vehicle capable of high speed travel on improved highways. It is essentially an M113A1 chassis mounting an electrically driven 20mm six-barrel automatic cannon. It is manned by a four-man crew and is effective against subsonic low flying aircraft, and ground targets. The six-barrel gun is provided with two barrel clamps to provide the best pattern against air or ground targets. The gun fires the 1100-round basic load of 20mm ammunition at rates of 3000 rounds per minute continuously or 6000 rounds per minute with interrupted bursts. Major components are the M168 Cannon, M61 Sight, AN/VPS Radar Set, M157 Mount, and M741 Chassis.

(2) Selected Technical Characteristics.

(a) Weight	24,370 pounds
(b) Length	191.5 inches
(c) Width	106 inches
(d) Height	106 inches
(e) Fuel tank capacity	95 gallons
(f) Range	300 miles
(g) Max speed	40 miles per hour

(3) Unique Characteristics: The six-barrel "Gatling" type automatic cannon.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by members of the staff of the Weapons Training Department (WTD).

(b) The LORA for the M741 chassis is identical to that for the M113A1, and consequently was not repeated for this vehicle. Corrections to the Maintenance Allocation Chart (MAC) for the weapon and ammunition feed portions of the system are shown on page H-149.

GUN, AIR DEFENSE ARTILLERY, SELF-PROPELLED 20mm M163 (TM 9-2350-300-20P; 34P)

GROUP No.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS		
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD	
Cannon	Clamp Assembly, Mid-Barrel Clamp Assembly, Muzzle Contact Assembly, Firing Conveyor Unit Assembly Drum Assembly									F/O			pg 8-5, 34 Manual	
										F/O			pg 8-6, 34 Manual	
										F/O			pg 8-10, 34 Manual	
											H/P	D/H	pg 8-67, 34 Manual	
A2												H/P	D/H	pg 8-67, 34 Manual
A7												H/P	D/H	pg 8-68, 34 Manual

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d. Tank, Combat, Full Tracked, 105mm Gun, M60A1

(1) Description. The M60A1 tank is a steel-hulled, full tracked combat vehicle designed to engage and defeat enemy combat vehicles. This tank is designed to provide maximum ballistic protection for the crew and is heavily armed. The tank crew consists of a commander, gunner, loader and driver.

(2) Selected Technical Characteristics.

(a) Engine	Continental model AVDA-1790-2A, 12 cylinder 90 degree V-type 4- cycle air cooled diesel engine
(b) Transmission	Automatic, torque converter with high-low range, 2 speeds forward, 1 reverse.
(c) Weight	108,000 pounds
(d) Length	286 inches
(e) Width	143 inches
(f) Height	130 inches
(g) Fuel	375 gallons (diesel fuel)
(h) Range	320 miles

- (i) Maximum speed 30 miles per hour
- (j) Armament 105mm high velocity gun, 50
cal MG, 7.62mm MG
- (k) Turning radius Pivot to infinity
- (3) Unique characteristics. Vehicle can ford to a depth of
four feet (15.5 feet with snorkel kit).
- (4) Level of Repair Analysis (LORA).
 - (a) General. The analysis was performed at Aberdeen Proving
Ground by the Weapons and Mobility Training Departments of the US
Army Ordnance Center and School, Aberdeen Proving Ground, Maryland.
 - (b) Corrections to the Maintenance Allocation Chart (MAC) for
the M60A1 are shown on pages H-152 through H-154.

Tank, Combat, Full-Track, 105mm, Gun, M60A1 (TM 9-2350-215-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION									REPAIRS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	
0302	Lines, Fuel HP Nozzle, Fuel Injector							F/C	F/C	H/F	
0710	Shaft, Input							F/O	F/O	F/O	
1303	Link Track Tension										
1901	Seat							-/O	-/O		
1903	Platform Turret Access Door							-/O	-/O		
1904	Door Loaders Hatch							-/O	-/O		
	Drive Hand Traversing Gear									H/F	
	Pump Hand Elevating									-/O	
1905	No Back									-/O	
	Pump Oil Traversing Gear									F/O	
	Lock Turret Traversing										

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Tank, Combat, Full-Track, 105mm, Gun, M60A1 (TM 9-2350-215-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
1905	Actuator Super-elevation Filter Oil Peservoir Reservoir Oil Hydraulic Sys Motor Electric Hydraulic Sys Power Pack & Image Converter Tube Power Pack & Image Converter Tube		-/F						-/F	-/F			
2324	Power Pack & Image Converter Tube								O/F				
2328	Power Pack & Image Converter Tube								F/O				
2349	Sight Infinity				F/O								
2518	Drive Ballistic M10A5								F/O				
2537	Mount Periscope M118								F/O				
2538	Mount Periscope M119								F/O				
2702	Elevating Mechanism								F/O				

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Tank, Combat, Full-Track, 105mm, Gun, M60A1 (TM 9-2350-215-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
2702	Blasting Machine								F/O				
2703	Azimuth Gear Box Assy			F/O						F/O			
2705	Electrical Sys									F/O			
	Feed Tray Group									F/O			
	Guide Rod Assy												
	Back Plate Assy				F/O								
0100	Receiver Assy									O/F			
	Power Plant								F/O				
	Engine, Trans Cooler								F/O	F/O			
0305	Turbocharger								F/O				

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e. Howitzer, Medium, Self-Propelled: 155mm, M109A1

(1) Description. The M109A1 is an armored, full-tracked, self-propelled, turret-mounted artillery weapon capable of being transported in large cargo aircraft. It is designed to provide direct artillery support to ground forces. Except for its longer cannon tube which provides increased range, the M109A1 is essentially identical to the M109.

(2) Selected technical characteristics.

(a) Engine: Detroit Diesel, turbo-charged, 8 cylinder, V-type, 2-cycle, liquid cooled, 405 HP @ 2450 RPM.

(b) Transmission: Allison torque converter type which also provides steering and brakes.

(c) Length	261 inches
(d) Width	124 inches
(e) Height	120 inches
(f) Fuel	135 gallons (diesel fuel)
(g) Range	220 miles
(h) Speed	35 miles per hour
(i) Armament	155mm Howitzer M126 or M126E1
(j) Weight	52,461 pounds

(3) Unique Characteristics. The M109A1 is unique in that it has the same chassis as the Howitzer, Light, Self-Propelled: 105mm, M108. The interchangeability of chassis parts tends to enhance the operational availability rates for both end items.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the Mobility Training and the Weapons Training Departments of the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by a team of NCO instructors.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M109A1 are shown on pages H-157 through H-161.

HOMITZER, MEDIUM, SELF-PROPELLED: 155mm, M109A1 (TM9-2350-217-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION									REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	
0100	Engine								F/O		
0106	Oil Filter									F/-	
	Core, Oil Cooler								F/O		
0108	Exhaust Manifold								F/O		
0304	Cleaner, Air (Dry)								-/O	F/-	
0305	Shaft Blower Drive								F/O		
	Turbocharger								F/O		
	Turbocharger Regulator								F/O		
0306	Tank, Fuel								F/O	F/O	
0310	Heater, Airbox Engine									H/F	
0501	Radiator									F/O	
0508	Radiator Shroud									F/O	

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HOWITZER, MEDIUM, SELF-PROPELLED: 155mm, M109A1 (TM9-2350-217-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0505	Fan Drive Assembly Housing Fan Drive								F/O			
0603	Coil Field								F/O			
0607	Harness, Wiring Instrument Panel								H/P			
0608	Master Relay								F/O			
0613	Harness, Wiring Hull (Main)								-/O	F/O		
	Harness, Wiring Cab (Misc)								F/O			
0614	Arm, Slip Ring									O/P		
	Cab Power Relay Box									O/P		
0711	Controls & Linkage, Shifting									F/O		
1301	Arm, Roadwheel									F/-		
1801	Lock, Gun Travelling								-/O	O/-		

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HOWITZER, MEDIUM, SELF-PROPELLED: 155mm, M109A1 (TM9-2350-217-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
1901	Lock, Cab Traverse Racks, Ammunition	-/0		-/0					-/0	-/0	F/0	
1905	Elevating Cylinder Assembly		-/F					F/0	F/0			
	Elevation Control Assembly	-/0						F/0	H/F			
	Accumulator, Manual Elevation									F/0		
	Valve, Power Solenoid	-/0						-/0	-/0			
	Valve, Elevation Selector	-/0						-/0	-/0			
1905	Valve, By-Pass	-/0						-/0	-/0			
	Valve, Safety Relief	-/0						-/0	-/F			
	Accumulator, Main	-/0		-/0				-/0	-/0			
	Gunnery Control							F/0				
	Hydraulic Motor	-/0						-/0	-/F			

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HOWITZER, MEDIUM, SELF-PROPELLED: 155mm, M109A1 (TM9-2350-217-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
1905	Traversing Mechanism Gearbox			-/0					-/0	-/F			
2005	Handwheel Assembly (M109A1)	-/0							-/0	-/F			
	Spade								-/0	0/F			
2202	Fuel Pump (Pers Heater)								-/0	-/0			
3401	Breechlock								F/0				
	Breechblock Carrier Assembly								-/0	F/0			
	Breechblock Operating Handle								F/0				
3401	Breech Ring							-/D	F/D	F/D			
	Breech Ring Body			-/0				-/F	-/F				
	Cannon Assembly	-/F											
	Evacuator Chamber	-/0		-/0					-/0				
	Firing Block Assembly								F/0				
	Muzzle Brake			-/0					-/0				

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HOWITZER, MEDIUM, SELF-PROPELLED: 155mm, M109A1 (TM9-2350-217-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
3401	Mount, M127 Replenisher (accumulator) Variable Recoil Group Rammer Tray Rammer Assembly Telescope Panoramic M117 Fuse Setter M26 Equilibrator Hand Pump			-/O	-/O		-/H	-/P	F/O		-/D	-/D	
3403											D/H		
4309									F/O				

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f. Recovery Vehicle, Full Tracked: Light, Armored, M578.

(1) Description. The M578 is a low-silhouette, all-welded steel recovery vehicle mounting an independently operated cab and boom. All the recovery and suspension equipment is hydraulically controlled and operated. Each of the M578's ten pairs of road wheels is equipped with an independent torsion-bar suspension system. The crane consists of a box-section boom mounted on an armored cab containing the boom elevating cylinders and winch devices. The M578 is used for maintenance support of tactical and combat vehicles. It is air-transportable and is designed to service, repair and tow vehicles weighing up to 30 tons. As an artillery support vehicle, it is used to change artillery tubes and handle rocket equipment.

(2) Selected Technical Characteristics

(a) Engine:	Detroit Diesel, 8 cylinder, V-type, turbo charged, two cycle liquid cooled, 425 hp
(b) Transmission:	Automatic torque converter with automatic lock up clutch. Four forward speeds, 1 reverse; 2 speed final drive. Provides steering and braking.

- (c) Length 250 inches
- (d) Width 124 inches
- (e) Height 130 inches
- (f) Weight 59,000 pounds
- (g) Fuel 320 gallons (diesel fuel)
- (h) Range 450 miles
- (i) Maximum speed 37 miles per hour
- (j) Fording depth 42 inches

(3) Unique Characteristics. The M578 is unique among track-laying recovery vehicles in that its crane is mounted on a turret ring and traverses 360 degrees. The M578 uses the same chassis as the Howitzer, Heavy Self-propelled 8-inch, M110, and Gun, Field artillery, 175mm, M107.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the Mobility Training Department (MTD), Aberdeen Proving Ground, Maryland, by warrant officer and NCO track vehicle instructors.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M578 are shown on page H-164.

RECOVERED VEHICLE, FULL-TRACKED, LIGHT ARMORED, M578 (TM 9-2350-238-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0100	Engine								F/O			
0101	Head Cylinder								F/O			
0301	Injector Fuel								F/O	H/F		
0302	Pump Assy Engine Fuel								F/O			
0306	HP Fuel Lines								F/O			
0309	Filter Assy Fuel HP								F/O			
	Element Fuel Filter HP								F/O			
0311	Pump Assy Air Box Heater Fuel								F/O	H/F		
0503	Tubes, Water Bypass and Crossover								F/O			
0710	Transmission Assy								F/O			
0801	Transfer Assy Power								F/O			
1901	Bearing Turret								H/F			
2005	Controls, Spade								F/O			

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g. Recovery Vehicle, Full Tracked, Medium, M88

(1) Description. The M88 is a full tracked armored recovery vehicle. The hoist winch uses an "A" frame boom which may be operated in two positions. In the low position, objects and equipment may be lifted to a height of 19 feet. In the high position, this height is increased to 22 feet. The M88 is equipped with an 11-foot-wide spade, which is normally used to stabilize the vehicle, but which can also be used for limited bulldozing. The M88 mounts a .50 cal machine gun for defense.

(2) Selected Technical Characteristics.

(a) Engine:	12 cylinder V-type, turbo charged, 4 cycle, air cooled fuel injected (gasoline) 1020 hp.
(b) Transmission	Automatic, torque converter with automatic lockup clutch. Three forward speeds, 1 reverse. Provides steering and braking.
(c) Weight	112,000 pounds
(d) Length	326 inches
(e) Width	135 inches

- (f) Height 123 inches
- (g) Fuel tank capacity 252 gallons
- (h) Range 222 miles
- (i) Draw bar pull (Max) 81,000 pounds
- (j) Fording depth 64 inches

(3) Unique Characteristics. The M88 recovery vehicle is unique because it is the last gasoline-powered full tracked armored vehicle in the Active Army.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the Mobility Training Department (MTD) of the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by warrant officer and NCO track vehicle instructors.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M88 are shown on page H-167.

RECOVER VEHICLE FULL-TRACKED MEDIUM, M88 (TM 9-2350-242-20)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
2962	Regulator, Generator								F/O	H/F			

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h. Armored Reconnaissance/Airborne Assault Vehicle,
Full-tracked, 152MM M551

(1) Description. The M551 is a light weight, full-tracked, diesel powered armored reconnaissance/airborne assault vehicle. It is capable of amphibious operation and can be transported or air-dropped by cargo aircraft. Armament consists of a 152MM gun/launcher capable of firing either conventional ammunition or guided missiles. The gun/launcher is mounted in a 360° rotating turret.

(2) Selected Technical Characteristics.

(a) Engine:	Detroit Diesel, 6 cylinder, V-type, turbocharged, 2 cycle liquid cooled, 300 hp at 2800 rpm.
(b) Transmission:	Automatic, torque converter with lockup clutch. 4 forward speeds, 1 reverse; 2-speed final drive. Provides steering and braking.
(c) Length	248 inches
(d) Width	110 inches
(e) Height	116 inches

- (f) Range 373 miles
- (g) Fuel Tank Capacity 158 gallons
- (h) Maximum speed 43 miles per hour

(3) Unique Characteristics. The M551 is unique in that it can fire either a conventional round or a guided missile, and is lighter in weight than most other heavily armed tracked vehicles.

(4) Level of Repair Analysis. (LORA)

(a) General. The analysis was performed at the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by warrant officer and NCO instructors from the Weapons Training Department (WTD), and the Mobility Training Department (MTD).

(b) Corrections to the Maintenance Allocation Chart (MAC) of the M551 are shown on pages H-170 through H-172.

ARMORED RECONNAISSANCE/AIRBORNE ASSAULT VEHICLE: FULL-TRACKED 152mm M551 (TM 9-2350-230-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0100	Engine								F/O			
0101	Head Cylinder								F/O			
0102	Pulley, Crankshaft Seal Oil Crankshaft								F/O			
0106	Regulator, Pressure, Engine Oil								F/O			
0109	Quilt Air Blower Drive								F/O			
0306	Drive, Gear, Air Blower Lines, Hoses and Fittings Fuel System								F/O			
0603	Generator		-/0									
0608	Starter		-/0									
0612	Relay, Master		-/0									
0613	Cable Battery		-/0									
0614	Harness Gen-Reg to Gen Harness Hull and Power Plant Ring Electrical Contact		-/0									

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ARMORED RECONNAISSANCE/AIRBORNE ASSAULT VEHICLE: FULL-TRACKED 152mm M551 (TM 9-2350-230-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0614	Slip Ring		-/O									
0616	Blower Turret Ventilating Seal, Output Shaft		-/O						F/O			
0712	Power Supply, Turret Control									F/O		
0618	Box Loader's Control		-/F									
	Box Cupola Control		-/F									
	Box Cupola Trav Mech Control		-/F									
	Switches and Cams Limit		-/O									
	Conventional Weapons System		-/F						-/F			
	Box Reticle Dimmer		-/F									
	Control Selector Gun and Turret		-/F						-/F			
0619	Box Circuit Cutout		-/F									
0620	Motor Generator Assy		-/F	-/F								
	Harness		-/F									
	Bearing Assy Traversing								F/H	F/H		
1901	Lock Turret Traverse								-/O			

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ARMORED RECONNAISSANCE/AIRBORNE ASSAULT VEHICLE: FULL-TRACKED 152mm M51 (TM 9-2350-230-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
1901	Mechanism Seat								-/0	F/H			
1903	Motor Servo Cupola Traverse									F/H			
1904	Motor Servo Traverse and Elev									F/H			
3401	Ammunition Detent			-/0									
	Scavenger System Closed Breech				-/0				-/0				
	Ammunition Detent									F/H			
	Motor Electric Drive		-/F						F/O				
	Wiring Harness								-/0				
	Mount Co-Axial 7.62mm MG									-/0			
	Reservoir Recoil Mech												
	Relief, Valve Assy						-/F						
4000	Electric Motor Compressor		-/F							F/H			
6715	Test Set Elec Drive Cont		-/F										
	Harness Test Set												

H-4. CONSTRUCTION AND MATERIEL HANDLING EQUIPMENT

a. Crane, Wheeled Mounted, 20-ton, RT

(1) Description. This 20-ton, rough terrain crane is diesel engine driven, has a 20-ton lift capacity, and is equipped with a 30-foot boom, a utility blade, and a 20-ton block and tackle. It is wheel mounted and is designed for operation on rough terrain. The crane is air transportable by segmentation of components.

(2) Selected Technical Characteristics.

(a) Manufacturer	American Hoist and Derrick Company
(b) Engine	8 cylinder, inline, liquid cooled diesel, 265 hp
(c) Transmission	Automatic
(d) Length with boom	521-1/2 inches
(e) Height	154 inches
(f) Width	128 inches
(g) Weight	61,500 pounds
(h) Fuel tank capacity	110 gallons

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Engineer School at Fort Belvoir, Virginia, by members of the staff and faculty of the Mechanical and Technical Department, Office of the Deputy Commandant for Training and Education. The team consisted of six senior instructors in the Mechanical Division.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the 20-ton crane are shown on page H-175.

CRANE, WHEELED MOUNTED, 20-TON, RT (TM 5-3810-232-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
03	Pan, Oil								F/O	F/O		
05	Injector, Fuel								F/O	-/H		
05	Engine Starting Aids								F/O			
07	Fan Assembly, Drive Shaft								H/O	H/O		
10	Propellar Shaft, U-joints								F/O			
13	Air Brake Valves								F/O			
15	Steering U-joints								F/O	F/O		
19	Hydraulic Cylinder, dozer								F/O	H/F		
20	Unloader Governor								F/O			
21	Utility Blade (Dozer Assembly)								F/O			
23	Engine Assembly Crane								F/H	F/H		
23	Engine Cooler, Oil								F/O	F/O		
27	Water Pump								F/O			

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b. Loader, Scoop, 645M

(1) Description. This item is a four-wheel-drive, rubber-tired, articulated, multi-purpose bucket front end loader with a 2-1/2 cubic yard bucket capacity. The bucket has two cylinders, one mounted on each side, which operate the bucket clam. The bucket can be used as a front end bucket loader, a clam-type bucket, a bulldozer, and a scraper.

(2) Selected Technical Characteristics.

(a) Manufacturer	Allis Chalmers
(b) Engine	6 cylinder, inline, liquid cooled diesel, 157 hp
(c) Transmission	Automatic, torque converter, 2 speeds forward, 1 reverse
(d) Length	279 inches
(e) Width	101 inches
(f) Height	102 inches
(g) Weight	25,200 pounds
(h) Fuel tank capacity	110 gallons

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA)

(a) General. The analysis was performed at the US Army Engineer School at Fort Belvoir, Virginia, by members of the staff and faculty of the Mechanical and Technical Department, Office of the Deputy Commandant for Training and Education. The team consisted of senior instructors in the Mechanical Division.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the scoop loader are shown on page H-178.

LOAFER, SCOOP, 645M (TM 5-3805-239-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0108	Manifolds								F/O			
0302	Pump, Fuel								F/O			
0501	Radiator									H/F		
0504	Pump								F/O			
0900	Shafts, Propellar									H/O		
1209	Governor								F/O			

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c. Grader, Road, 440HA

(1) Description. The 440HA is a self-propelled motor grader with a hydraulically-positioned moldboard. The grader requires only one operator.

(2) Selected Technical Characteristics.

(a) Manufacturer	Westinghouse Air Brake Company
(b) Engine	4 cylinder, inline, 2 cycle, liquid cooled diesel
(c) Transmission	Mechanical, 6 speeds forward, 3 speed reverse
(d) Length	309 inches
(e) Width	92 inches
(f) Height	92 inches
(g) Weight	26,500 pounds
(h) Fuel tank capacity	52 gallons

(3) Unique Characteristics. None

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Engineer School at Fort Belvoir, Virginia, by members of the

staff and faculty of the Mechanical and Technical Department,
Office of the Deputy Commandant for Training and Education. The
team consisted of senior instructors in the Mechanical Division.

(b) Corrections to the Maintenance Allocation Chart (MAC) for
the 440HA are shown on page H-181.

d. Tractor, Full-tracked, D7E

(1) Description. The D7E is a full-tracked, low speed, medium drawbar pull bulldozer. It is powered by a four cylinder, four-cycle, turbocharged diesel engine, and is equipped with a 24-volt starter.

(2) Selected Technical Characteristics.

(a) Engine	4 cylinder in-line, 4 cycle, turbocharged, diesel, liquid cooled, 200 hp.
(b) Transmission	Automatic, torque converter
(c) Height	96 inches
(d) Length	176 inches
(e) Width	133-1/2 inches
(f) Weight	31,870 pounds
(g) Fording depth	30 inches

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Engineer School at Fort Belvoir, Virginia, by personnel from the Mechanical and Technical Department, Office of Deputy Commandant for Training and Education. The team consisted of senior instructors from the Mechanical Division.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the D7E are shown on page H-184.

TRACTOR, FULL-TRACKED, D7E (TM 5-2410-214)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
0305	Turbo Charger								F/O			
0721	Hose Fittings								-/O	O/-		
0721	Pump Hydraulic		H/F									
0721	Strainer								F/O			
2000	Winch Assembly								C/F			

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e. Truck, Forklift, Diesel Engine, Rough Terrain, 6000 lb.

(1) Description. The truck Forklift, RT, is capable of operating over all types of terrain. The truck is equipped with two-wheel and four-wheel drive, enabling it to negotiate mud, snow, sand, and steep grades. The body and forks of the truck may be tilted right or left in relation to the front axle. The truck has hydraulic brakes, power steering, and a torque converter transmission.

(2) Selected Technical Characteristics.

(a) Engine:	Detroit Diesel 4 cylinder 453-N 136 HP @ 2800 RPM
(b) Transmission	Automatic, Torque Converter
(c) Length	228 inches
(d) Width	102 inches
(e) Height	124 inches
(f) Maximum weight load	6000 pounds

(3) Unique Characteristics. This forklift is unique because it is equipped with front and rear axle steering which enables it to move sidewise at 20 degree angles, and also gives it a shorter turning radius.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Ordnance Center and School, Aberdeen Proving Ground, Maryland, by warrant officer and NCO instructors of the Mobility Training Department (MTD).

(b) Corrections to the Maintenance Allocation Chart (MAC) for the RT Forklift are shown on pages H-187 and H-188.

TRUCK FORTILITY RT 6000 IB (TM 10-3930-242-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
0101	Cylinder Head Assy								F/O				
0103	Flywheel Assy								F/O				
0105	Rocker Arm Assy				F/O				F/O				
0106	Cooler, Oil								F/O				
0301	Injector Assy Fuel								F/O				
0305	Blower Assy								F/O				
0306	Fuel Tank Assy								F/O				
0308	Engine Governor		F/O		F/O								
0705	Transmission Linkage				F/O								
0900	Propeller Shaft									F/O			
1000	Axle Assy Front								F/O	H/F			
1002	Differential Assy								H/O				
1003	Planetary Drive								F/O				
1101	Rear Axle Assy								F/O	H/F			
1102	Differential Assy								H/O				
1103	Planetary Drive								F/O				

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TRUCK FORKLIFT RT 6000 LB (TM 10-3930-242-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
1201	Brake, Parking								F/O				
1202	Brakes, Service								F/O				
1204	Pump Hydraulic Brakes Valve, Brake Accumulator								F/O				
1410	Pump Hydraulic Valves, Flow			F/O					F/O				
2402	Cylinder, Lift								F/O				
2405	Cylinder, Slave Slide, Boom								F/O				

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H-5. SMALL ARMS

a. Rifle, 5.56mm, M16A1

(1) Description. The M16A1 is a light-weight, air-cooled, gas operated, magazine-fed, shoulder or hip weapon designed for semi-automatic or full-automatic fire which utilizes a 20-round box type magazine or a 30 round curved-box magazine.

(2) Selected Technical Characteristics.

- (a) Weight (20 round magazine) 7.6 pounds
- (b) Length (with flash suppressor) 39 inches
- (c) Ammunition type Ball and Tracer
- (d) Range (Maximum) 2,653 meters
- (e) Rate of Fire
 - Semiautomatic 45-65 Rd/Min
 - Automatic 150-200 Rd/Min
 - Sustained 12-15 Rd/Min

(3) Unique Characteristics. Replacement of the M16A1 barrel is authorized at the direct support level. On earlier weapons, this was a depot maintenance task.

(4) Level of Repair Analysis (LORA).

(a) General. This analysis was performed at the US Army Ordnance Center and School by personnel of the Conventional Weapons Division, Weapons Training Department.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M16A1 are shown on page H-191.

b. Machine Gun, 7.62mm, M60

(1) Description. The M60 is an air-cooled, link-belt-fed, gas-operated automatic weapon. It features fixed headspace which permits rapid changing of barrels.

(2) Selected Technical Characteristics.

(a) Weight

Machine gun	23 pounds
Mount	15 pounds

(b) Length 43.5 inches

(c) Range 3,200 meters

(d) Rate of Fire

Cyclic	500 Rd/Min
Sustained	100 Rd/Min
Rapid	200 Rd/Min

(e) Muzzle Velocity 3,800 FPS

(3) Unique Characteristics. None.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the M60 machine gun was performed at the US Army Ordnance Center and School by members of the Conventional Weapons Division, Weapons Training Department.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M60 are shown on pages H-193 and H-194.

MACHINE GUN, 7.62mm, M60 (TM9-1005-224-24)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
1b	Machine Gun											
	Bipod Assembly	F/O		F/O				F/O	F/O	F/O	D/F	
2	Trigger Mechanism Grip Gp								-/O	D/F		
3	Gun Shoulder Stock								F/O	F/O	D/F	
4	Forearm Assembly								F/O	F/O	D/F	
5	Cover Assy and Cartridge Assy Gp (old manufacture)								-/O	D/F		
6	Cover Assy and Tray and Hanger Assy Gp (new manufacturer)								-/O	D/F		
7	Buffer Assy and Operating Rod								-/O	D/F		
8	Breech Bolt Assy								-/O	D/F		
1	Traversing and Elevating Mechanism Gp								-/O	D/F		

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MACHINE GUN, 7.62mm, M60 (TM9-1005-224-24)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
2	Pintle Assy and Tripod Gp								-/0		D/P		

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H-6. OFFICE MACHINE EQUIPMENT

a. Typewriter, Electric, IBM (Model D)

(1) Description. This typewriter is a non-portable, electric, 15 inch carriage, upper and lower case characters machine. The Model D has the American Standard Keyboard consisting of 42-44 keys, elite or pica type.

(2) Selected Technical Characteristics.

(a) Power	110 volt/60 Hz
(b) Motor Speed	1625 RPM
(c) Motor Rated	1/35 horsepower
(d) Carriage	15 inches

(3) Unique Characteristics. There is neither a Maintenance Allocation Chart nor a Department of the Army Technical Manual for this typewriter. Maintenance training for typewriter repairmen is conducted using USAQMS student workbooks which are developed from existing equipment manufacturers' repair manuals.

(4) Level of Repair Analysis (LORA).

(1) General. The analysis was performed at the US Army Quartermaster School at Fort Lee, Virginia, by members of the staff and faculty of the Office Machine Branch, Office of the Deputy Commandant for Training and Education. The team consisted of the Chief of the Office Machine Branch and two senior instructors.

(b) The LORA was limited due to the absence of both MAC and TM's. The analysis team recommended that repair of this item be accomplished at the DS level. The maintenance concept should place responsibility for Preventive Maintenance on the User, with necessary repairs being accomplished by a DS repairman, on-site to the maximum extent feasible.

b. Adding Machine, 10-Key, Listing, Victor

(1) Description. This item is a light weight, electric, listing, 10-key, adding and subtracting machine. The motor may be operated without damage from a 25 Hertz alternating current supply or any other frequency that does not exceed 60 Hertz. Motors are available as original equipment or for replacement that are designed to operate from 220-240 volt, 60 Hertz alternating, or direct current.

(2) Selected Technical Characteristics.

(a) Voltage	110-120 or 220-240
(b) Power Supply	DC or AC (25-60 Hz)

(3) Unique Characteristics. This particular adding and subtracting machine is one of four (Burroughs, Olivetti, Remington, Victor) used at USAQMS for instruction of MOS 4LJ students. There is neither a Department of the Army Technical Manual nor Maintenance Allocation Chart for this machine. Maintenance training for the adding machine is conducted using USAQMS student workbooks which are developed from existing equipment manufacturers' repair manuals.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis was performed at the US Army Quartermaster School at Fort Lee, Virginia, by members of the staff and faculty of the Office Machine Branch, Office of the Deputy Commandant for Training and Education. The team consisted of the Chief of the Office Machine Branch and two senior instructors.

(b) The LORA was limited due to the absence of both MAC and TM's. The analysis team recommended that the repair of this item be accomplished at the DS level. The maintenance concept should place responsibility for Preventive Maintenance on the User, with necessary repairs being accomplished by a DS repairman, on-site to the maximum extent feasible. This concept is presently used by most civilian office machine repair firms. The required high-mortality repair parts and tools are relatively small and can be carried by the repairman.

H-7. CHEMICAL-BIOLOGICAL EQUIPMENT

a. Mask, Chemical-Biological, Field, M17A1

(1) Description. This mask is issued in three sizes with five major components: facepiece, carrier, eyelens outserts, canteen cap and water-proofing bag. The mask is used to protect the face, eyes, and respiratory tract of the wearer from field concentrations of chemical and biological agents. The mask does not protect the user against ammonia or carbon-monoxide fumes, nor is it effective in confined spaces where the oxygen content of the atmosphere is too low to maintain functional capability (below 18 percent).

(2) Selected Technical Characteristics.

(a) Self-contained systems	2 (drinking, resuscitation)
(b) Basis of issue	1 per individual except those authorized tank or aircraft masks
(c) Filter	2 ea (M13 series)
(d) Filter shelf life	M13A1 - NA (for riot control & training only) M13A2 - 5 years
(e) Model use	M13 - for training only M13A1 - riot control agents & training M13A2 - approved for toxic agents

(3) Unique characteristics. The simplicity of the maintenance function for this item makes it a unique piece of equipment.

(4) Level of Repair Analysis (LORA).

(a) General. The analysis of the protective mask was performed at the US Army Ordnance and Chemical Center and School by members of the staff and faculty of the Chemical and Ground Support Training Department. The team consisted of senior chemical equipment instructors (MOS 54D) in the Materiel and Maintenance Division.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the M17A1 Mask are shown on page H-200.

MASK CBR: PROTECTIVE FIELD, M7A1 (TMJ-4240-258-14)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REPAIRS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
100	Facepiece Group Head Harness Clip and Buckle Temple Pin Nosecup Valve, Disk Filter Element Short Flap Button Long Flap Button Inlet Valve Cap Inlet Valve Disk Outlet Valve Disk Voicemitter-Outlet Valve Cover Carrier Group Carrier Assy C15A1	-/C		-/C					-/O			
		-/C		-/C					-/O			
		-/C		-/C					-/O			
		-/C		-/C					-/C			
		-/C		-/C					-/C			
		-/C		-/C					-/O			
		-/C		-/C					-/C			
		-/C		-/C					-/C			
		-/C		-/C					-/O			
		-/C		-/C					-/C			
		-/C		-/C					-/O			
		-/C		-/C					-/C			
		-/C		-/C					-/O			
200	Carrier Group Carrier Assy C15A1	-/C		-/C					-/O			
										F/-		

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b. Flamethrower, Mechanized, Main Armament, APC Mounted.

(1) Description. The mechanized flamethrower is a full-tracked, lightly armored vehicle consisting of an M10-8 kit-type flame thrower permanently mounted in a cupola on a modified M113 APC chassis. The cupola contains the flame gun and shroud, periscope and vision blocks, and the machine gun. It is manually elevated and traversed. The cupola is linked to four air and fuel tanks carried inside the cargo compartment of the vehicle. These tanks are mounted on skids on a metal frame pallet, can be disconnected from one another and from the pallet, and thus removed from the vehicle, greatly increasing the speed with which the vehicle can be reserviced. The normal crew for the vehicle is a gunner and a vehicle driver.

(2) Selected Technical Characteristics.

(a) Gun firing time	32 seconds
(b) Elevation/Depression	+ 55 degrees to - 11 degrees
(c) Azimuth traverse	360 degrees
(d) Air tank capacity	3,000 psi
(e) Fuel tank capacity	200 gal

(3) Unique Characteristics. None.

1

(4) General. The analysis of the flamethrower was performed at the US Army Ordnance and Chemical Center and School by members of the staff and faculty of the Chemical and Ground Support Training Department. The team consisted of senior chemical equipment instructors in the Materiel and Maintenance Division.

(b) Corrections to the Maintenance Allocation Chart (MAC) for the Flamethrower are shown on pages H-203 through H-205.

FLAME THROWER, MECH, MAIN ARMAMENT, M10-8 (TMG-1040-209-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
100	Chute, Ejection Cover Assy Handle Assy Flame Gun Assy Insert Nozzle Cable, Electrical Bolt, Assy Link Assy, Sight Strainers, Sediment Strainer, Sediment Regulator, Fluid Press Regulator, Fluid Press								F/O F/O			
			H/P	F/O					F/O F/O			
									F/O F/O			
									F/O F/O			
									F/O F/O			
200	Strainers, Sediment Strainer, Sediment Regulator, Fluid Press Regulator, Fluid Press	F/O		F/O H/P					F/O F/O			
400	Regulator, Fluid Press Regulator, Fluid Press											

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FLAME THROWER, MECH, MAIN ARMAMENT, M10-8 (TMG-1040-209-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REMARKS	
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL		REBUILD
200	Timer, top Accumulator, Hyd Rotary Joint Assy Cable Assy, Electrical Contact Assy, Electrical Ring, Assy Tank Assy, Fuel & Air Tube, Flexible Hose Assy, Med Press Hose Assy, High Press Hose Assy, Med Press Cable Assy, Power Cable Assy, Electrical Cable Assy, Branched Hose Assy, Rubber Strainer, Sediment		H/P F/O H/O H/O H/P H/P F/O	F/O					H/P F/O F/O F/O H/P H/P F/O	H/P			Pg 53 #1 Pg 53 #3 Pg 53 #4 Pg 53 #5 Pg 53 #6
300		F/O		F/O					F/O F/O F/O F/O F/O F/O F/O F/O	H/P			

FLAME THROWER, MECH, MAIN ARMAMENT, M10-8 (TM3-10.40-209-12)

GROUP NO.	FUNCTIONAL GROUP	MAINTENANCE FUNCTION										REPAIRS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	
300	Vent Assy Tanks, Air Coupling, Clamp, Pipe Hose Assy, Rubber Press Control & CO ₂ Cab Assy	F/O		F/O					F/O	H/P	D/H	
400	Cabinet Assy, CO ₂ Pressure, Control Unit Strainer, Sediment Valve, Manual Strainer, Sediment Head, 1" Safety Valves, Ball Filter, Fluid, Pressure Valves, Check Exciter, Ignition Gasoline Tank Assy Box, Fire Control	F/O	H/O	F/O					H/P	F/O	H/P	
200			H/P	F/O					F/O	F/O	F/O	

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APPENDIX I

COST AND OPERATIONAL EFFECTIVENESS ANALYSIS (COEA)

I-1. INTRODUCTION.

a. The acceptable alternatives in this study were subjected to an independent cost and operational effectiveness analysis to evaluate their relative worth. The basic vehicle for the effectiveness evaluation was a computer based simulation model, Maintenance and Support Concepts (MASC), developed under contract by BD⁹ Services Company (BDMSC). The SCORES ME II scenario was selected as the operational setting from which force structures and scenario dependent parameters were drawn.

b. This appendix describes, in general terms, the alternatives evaluated, the methodologies developed and used, the results obtained, and the conclusions derived. A detailed description of the contractor's methodology can be found in the BDMSC report, Maintenance Support Concepts Effectiveness, Cost, and Cost-Effectiveness Methodologies, With Cost and Operational Effectiveness Analysis for Priority Substudies.^{7/}

I-2. ALTERNATIVES CONSIDERED.

a. This study identified three trend-type alternatives with respect to allocation of maintenance tasks:

- (1) Retain the status quo.
- (2) Allocate a significant proportion of Army maintenance tasks to categories farther to the rear than at present.

(3) Allocate a significant proportion of Army maintenance tasks to categories farther forward than at present.

b. The study team anticipated that, although the preferable trend would probably become apparent by the time the Level of Repair Analyses (LORAs) were completed, it would be necessary to await the results of the COEA before the desirability of that trend could be confirmed. This proved to be the case, as Alternative 2 became recognizable as inconsistent with the trend established by the LORAs. Thus, the COEA methodology was structured to assess the changes in cost and effectiveness resulting from a comparison of Alternatives 1 and 3. Alternative 1 was taken as the baseline case, and Alternative 3 was compared with it.

c. The specific alternatives evaluated were:

(1) Baseline: Current published maintenance allocations.

(2) Alternative: Allocation of a significant proportion of maintenance tasks to categories farther forward than at present.

I-3. OPERATIONAL EFFECTIVENESS METHODOLOGY.

a. Measure of Effectiveness (MOE): The operational availability (OA) of 12 representative mission-essential, maintenance-significant, high density end items was used as the primary measure of effectiveness for evaluation of the recommended alternative in the contractor's methodology. Since the objective of maintenance operations is to maximize OA of Army materiel, OA rates were regarded as the most appropriate MOE. The positive correlation between OA rates and battlefield effectiveness is

widely recognized, but its quantification is best left to the equipment user. The results reported in this appendix are based on supplementary analysis conducted to assess fully the effectiveness of the Maintenance Allocation Chart (MAC) corrections resulting from the LORAs. In this additional analysis, the operational availability of seven selected major end items was considered to be the measure of effectiveness.

b. Scenario: An expanded SCORES ME II scenario was used as the operational setting from which scenario-dependent parameters were drawn. Where specific data was not available, such as during ungamed time periods between critical incidents, both professional military judgment and mathematical techniques were used to predict required information. Specific instances of this are described below:

(1) Modeled Force: A US corps consisting of 3 1/3 US divisions (one mechanized infantry division, two armored divisions, and one separate infantry brigade, plus elements of the Corps Support Command) was used as the modeled system. Maintenance elements at organizational, direct support, and general support levels were considered.

(2) Operational Availability: For the purposes of this evaluation, operationally available equipment was defined as equipment that was operative and in the hands of the using soldier or crew. Unavailability was measured from the time of damage or failure which required maintenance, to the time when the repaired

end item was returned to the using soldier or crew. Time delays associated with movement of end items (both operative and inoperative) between supporting and supported units were considered in determining operational availability.

c. Maintenance Workload: The maintenance workload, used to load and ultimately to test the acceptable study alternatives, is generated in the MASC model preprocessor as a stream of materiel malfunctions or failures. The generation of these failures is based on the passage of time, equipment usage, and equipment failure rates which are automatically increased during periods when equipment is subject to combat damage in addition to normal failures.

- (1) The preprocessor establishes, for each generated failure,
 - (a) the end item and type of failure,
 - (b) the unit to which the end item belongs, and
 - (c) the type of repair facility required for correction of the failure.

- (2) Appropriate wait for transportation, wait for diagnosis, wait for parts, repair, and final inspection times are documented for each generated failure, which proceeds through the maintenance system until one of three events occurs:

- (a) the failed item is returned to service,
 - (b) the failed item is removed from the system (salvage or evacuation for depot maintenance), or
 - (c) the scenario ends.

d. System Model: A detailed system model description is contained in the BDMSC report. Since the scenario was limited to a length of 120 days (a period so short that results of depot maintenance of scenario-generated failures could scarcely be felt on the battlefield) the model focuses on organizational, direct support, and general support maintenance capabilities. The model permits only end items whose failures must be repaired above the general support level to leave the modeled system. The number of such failures is so small (and restricted to a single end item, binoculars) that no items are brought into the system as replacements for evacuated end items.

e. Model Parameters Manipulated:

(1) Changes in operational availability, as a result of the allocation corrections made by the LORA teams, were accomplished by manipulating the lowest level of repair permitted. Model input specified the level of repair for each failure type associated with each end item, and thus, the input could reflect the corrections in the MAC chart associated with each end item. Examples of actual input are provided later in this appendix.

(2) Model parameters are fully identified in the BDMSC report. It should be noted that a number of the parameter values, particularly those for the various time delays and for parts availability, were based on judgmental estimates. This method was necessary because of the absence of valid data on organizational and support maintenance unit performance. The estimates, developed

by a panel of maintenance personnel, were based on the limited documented data and on the panel's extensive operational experience in maintenance in the field.

I-4. OPERATIONAL EFFECTIVENESS EVALUATION.

a. The BDMSC report describes the MASC model and the results of the BDMSC operational effectiveness evaluation of the study's acceptable alternatives. The effectiveness results documented in the BDMSC report were considered inadequate to accurately assess the effectiveness of the compared alternatives. This inadequacy resulted from three basic deficiencies: (a) Failure to recycle incorrect repairs which are passed on final inspection, or which received no final inspection at all; (b) Improper tracking of current OA levels in the main model because of counting returns from support maintenance at the end of the simulated period and not at the time of actual return to service; and (c) failure to identify and evaluate valid secondary measures of effectiveness, such as item turnaround times at the various maintenance levels. Additionally, program logic errors were discovered in the preprocessor which caused improper selection of repair times given a correct diagnosis, and improper determination of repair parts availability.

b. To refine the BDMSC analysis and correct the deficiencies and errors noted above, it was necessary for members of the study team to conduct extensive supplementary analysis and to make additional model runs. The basic approach for the supplementary

analysis was to make maximum use of the results documented by BDMSC and thus limit the expenditure of computer time and manpower. The first step was to reduce the number of end items considered from twelve to seven. The seven selected were those which compete for maintenance resources in the armament and automotive areas. The items excluded were those where special, dedicated maintenance facilities are provided and there is relatively little competition for resources. Table I-1 lists the representative items considered in the supplementary analysis. Second, the portion of the scenario examined was reduced from 120 days to 40 days. This was appropriate since the BDMSC results indicated that operational availability rates stabilize at about ten to fifteen days into the scenario and thus are predictable into the latter part of the scenario.

c. Tables I-2 and I-3 indicate the lowest level of repair permitted for the baseline and the Alternative 3 cases respectively. This level is presented by end item/failure type combination, e.g., failure type 3 for the APC indicates fuel system, but failure type 3 for the SP Howitzer indicates cooling system. Initial computer runs indicated little or no difference in operational availability rates between the baseline and Alternative 3. Mean out-of-service times for maintenance actions dropped significantly (as expected) as a result of shifting authority for performing certain maintenance actions farther forward. Because the observation of substantial decreases in out-of-service time

END ITEM TYPE

Truck, Utility 1/4 ton, M151A1

Truck, Cargo, 2 1/2 ton, M35A2

Truck, Tractor, 5 ton, M818

Truck, Lift Fork, 6000 lb., RT
DSL, MLT-6CH

Carrier, FT, Personnel, M113A1

Howitzer, SP 155mm, M109A1

Tank, Combat, FT, M60A1

REPRESENTATIVE END ITEMS

TABLE I-1

ITEM	FAILURE TYPES*									
	1	2	3	4	5	6	7	8	9	10
1/4 Ton Truck	2	1	1	1	1	1	2	1	1	2
2 1/2 Ton Truck	2	2	2	1	1	1	1	1	1	2
5 Ton Truck	2	2	2	1	1	1	1	2	1	2
Forklift (6000 RT)	2	2	2	1	1	2	2	2	1	2
M113A1 Carrier	2	2	2	1	1	1	1	2	2	2
155MM SP Howitzer	2	2	1	2	1	1	1	2	2	2
M60A1 Tank	2	2	2	2	1	1	2	2	2	1

Table I-2. Lowest Level of Repair (Alternative 1)

ITEM	FAILURE TYPES*									
	1	2	3	4	5	6	7	8	9	10
1/4 Ton Truck	2	1	1	1	1	1	2	1	1	1
2 1/2 Ton Truck	2	1	1	1	1	1	1	1	1	1
5 Ton Truck	2	1	1	1	1	1	1	1	1	1
Forklift (6000 RT)	2	1	1	1	1	1	1	1	1	1
M113A1 Carrier	2	1	1	1	1	1	1	1	1	1
155MM SP Howitzer	1	1	1	1	1	1	1	1	1	2
M60A1 Tank	1	1	1	1	1	1	1	1	2	1

Table I-3. Lowest Level of Repair (Alternative 3)

Repair Code 1 = Organizational. Repair Code 2 = Direct Support.

*Failure types correspond to referenced BDMSC report.

contradicted the observation of no significant change in operational availability, a detailed examination of the MASC model program was undertaken. From this examination it was determined that out-of-service times were being correctly identified and computed, but that the current operational availability level was being tracked inaccurately in the main model. This inaccuracy resulted from the model's failure to consider equipment returned from higher level maintenance to be available until the end of an eight-day period in the simulation. The effect was a distorted mean time between failure rate and inaccurate operational availability observations, particularly where a large proportion of maintenance actions were performed above organizational level. Since Alternative 3 proposes the shifting of a substantial number of actions to a lower maintenance level, it was necessary to correct the operational availability observations to allow comparison. Details of the correction factor used and its proof are found in paragraph I-5 below.

I-5. METHODOLOGY CORRECTIONS.

a. The MASC simulation system is written in three parts, a preprocessor, a main model and a postprocessor. The preprocessor generates failures, i.e., the time an item fails using failure rates based on all TOE assigned equipment in the force. The main model determines the return-to-service time for each failure by tracking it through the appropriate levels of repair, adding delay such as transportation times, times for diagnosis, and waiting time

for facilities, among others. The postprocessor collects operational availability (OA) statistics by determining the daily unavailability for each item, as well as other statistics such as turnaround time, parts wait, wait for facilities, etc. Since failures in the preprocessor are based on all TOE assigned equipment, the total number of failures so generated includes failures generated in equipment which is already inoperative. For this reason, the main model considers only a portion of the failures generated by the preprocessor; this portion matches the current level of OA.

b. The main model processes failures for each organizational unit, in turn, within a specific computation period (in this case eight days). Processing of organizationally-repaired failures is completed first, but the tracking of failures to be repaired at DS or GS must be delayed until all supported units are considered. Therefore, in contrast to those at organizational level, DS/GS repaired items cannot update the main model availability counter until the end of each computation period. This affects the resultant failure rate, an equivalent effect being that any DS/GS repaired item that is to return to service in a specific computation period will not be available to fail again until the beginning of the next period. Since the return to service time is considered correctly in the postprocessor, the computer output values of OA are overstated.

c. A correction factor has been developed to be applied to the computer output OA as follows. Consider a fleet of items in which i th piece of equipment has a_i organizationally repaired and b_i DS/GS repaired failures. The total in-service time for the i th item (T_i) may be expressed by

$$T_i = \sum_{j=1}^{a_i} t_{ij} + \sum_{j=1}^{b_i} t_{ij} + \sum_{j=1}^{b_i} V$$

where V is a random variable representing the aforementioned delay of an item's next failure opportunity.

d. If it is assumed that all organizationally repaired failures are from a common failure distribution and all DS/GS repaired failures are also from a common, but different, failure distribution, then the expected in-service time for the i th item is

$$E(T_i) = a_i F_{oi} + b_i F_{di} + b_i P/2$$

where the variable V is assumed to come from a uniform distribution with limits of 0 and the length of the computation period P . Here F_{oi} is the mean time between failure for organizational repairs; F_{di} is the mean time between failures for DS/GS repairs. The

expected total out-of-service time, $E(S_i)$ can be similarly developed and is found to be

$$E(S_i) = a_i S_{oi} + b_i S_{di}$$

where S_{oi} and S_{di} are the mean out of service times for organizational and DS/GS repairs respectively. If it is further assumed that the failure distributions and out-of-service distribution are also common for all items, then the expected fleet in-service time, $E(T)$, is

$$E(T) = F_o \sum_i a_i + F_d \sum_i b_i + P/2 \sum_i b_i$$

and the expected total out-of-service time, $E(S)$, is

$$E(S) = S_o \sum_i a_i + S_d \sum_i b_i$$

Recall that a_i and b_i were the number of organizational and DS/GS failures for each item. Therefore, the sums are simply the total number of such processed failures in the fleet.

e. Finally, operational availability is computed in MASC by dividing total in-service item-hours by total item hours.

An approximation to the expected OA is given by

$$OAP = \frac{n_o F_o + n_d F_d + n_d P/2}{n_o F_o + n_d F_d + n_d P/2 + n_o S_o + n_d S_d}$$

This is an approximation since, in general, the expected value of a reciprocal is not precisely equal to the reciprocal of the expected value, i.e.

$$E\left(\frac{1}{z}\right) \neq \frac{1}{E(z)}$$

f. The availability approximation equation may be divided through the total number of failures and rearranged to provide the equation

$$OAP = \frac{f_o F_o + f_d (F_d + P/2)}{f_o (F_o + S_o) + f_d (F_d + P/2 + S_d)}$$

where f_o and f_d are now the fraction of organization and DS repaired failures respectively. The correct OA would be the same

equation with P equal to 0. Note that, while F_0 , F_d , f_0 , and f_d can be predetermined on the basis of initial data, S_0 and S_d can not as they are mean out-of-service times and contain all transportation, diagnosis, wait for facilities, wait for parts, and repair times. As such, they are available only from the postprocessor computer output. It is tempting to calculate a revised operational availability directly from the last equation with P set equal to 0. However, several assumptions were made that require stability of the simulation for their validity. Therefore, the computer output results can best be corrected by a ratio of OA_0/OA_P since in several instances stability has not been reached.

g. Further simplification to provide a computational formula can be made by noting that the terms $f_0F_0 + f_dF_d$ and $f_0S_0 + f_dS_d$ are weighted averages yielding the mean time between failures and mean out-of-service time for all type failures. The resultant formula is

$$OA_P = \frac{F + f_d P/2}{F + S + f_d P/2}$$

h. Tables I-4 and I-5 contain the correction for the baseline and Alternative 3 cases respectively. The following notation is used in the tables:

F = Mean clock time between failures

f_d = Fraction of maintenance actions performed at support
maintenance levels

S = Mean observed out-of-service time for completed actions

OA = Computed operational availability

OA_p = Corrected computer operational availability

OA_o = Operational availability observed in simulation

(D+11 thru D+40)

OA_c = Correct operational availability

ITEM	F	f_d	S	OA	OA_p	OA_0	OA_c
5	528	0.11	75.8	0.874	0.877	0.861	0.858
6	480	0.36	95.5	0.834	0.844	0.803	0.793
7	291	0.39	99.4	0.745	0.767	0.715	0.694
8	749	0.81	148.3	0.835	0.848	0.789	0.777
9	641	0.44	109.7	0.854	0.862	0.826	0.818
10	129	0.70	128.4	0.501	0.604	0.586	0.486
11	184	0.52	101.5	0.644	0.697	0.672	0.621

Operational Availability Correction
(Alternative 1)

Table I-4

ITEM	F	f_d	S	OA	OA_p	OA_0	OA_c
5	528	0.08	75.8	0.874	0.876	0.860	0.858
6	480	0.06	90.0	0.842	0.844	0.806	0.804
7	291	0.06	90.6	0.763	0.766	0.713	0.710
8	749	0.02	125.8	0.856	0.857	0.795	0.794
9	641	0.03	101.8	0.863	0.864	0.826	0.825
10	129	0.20	103.8	0.554	0.588	0.563	0.530
11	184	0.06	85.0	0.684	0.691	0.668	0.661

Operational Availability Correction
(Alternative 3)

Table I-5

I-6. EFFECTIVENESS RESULTS

a. Table I-6 tabulates effectiveness results comparing the baseline, or current allocation of maintenance tasks, with Alternative 3. The operational availability figure shown for each item is the mean availability for D+11 through D+40 of the scenario. This statistic avoids the erratic, transitory observations recorded during the initial simulation period and it closely approximates the stabilized availability level observed during the longer simulation runs documented by BDMSC. Table I-7 provides a comparison of mean out-of-service times under the two alternatives.

b. The results indicate an increase in operational availability and a decrease in mean out-of-service time as a result of implementing Alternative 3. This was the expected result since the travel and administrative times involved in moving items from organizational to support levels are eliminated. Other model results indicated no significant queue buildups as a result of increased workload at the organizational level. It should be noted that the greatest enhancement in maintenance system performance was observed on the M109A1 155MM SP Howitzer and the M60A1 tank. These items are characterized by relatively low mean time between failures and high combat essentiality.

c. Tables I-6 and I-7 present the relative effectiveness of Alternative 3 using two measures of effectiveness (MOE): operational availability and mean out-of-service time. Relative

effectiveness using the former is the ratio of Alternative 3's effectiveness to the baseline effectiveness. For the latter measure, it is the inverse of that ratio because a decrease in time is an increase in effectiveness.

d. Relative effectiveness is presented by end item for both MOE. While an overall index would be ideal, validated weighting factors for a mix of combat and support end items do not yet exist. It is hoped that the Correlating Combat Effectiveness of Logistic Support (CELOGS) methodology will provide measures to compare the criticality of primary end items.

I-7. CONCLUSIONS.

Implementation of Alternative 3 will provide significant increases in operational availability rates and attendant decreases in mean out-of-service times. The most significant improvements in maintenance system performance can be found in complex weapons systems with relatively low mean time between failures.

I-8. COST ANALYSIS.

a. Introduction:

(1) The BDMSC-provided cost analysis was not utilized in this assessment because it failed to account properly for the force unit cost of the total force in which the operational effectiveness changes were realized. Consequently, the cost assessment documented below was substituted for the BDMSC product.

(2) The methodology for the determination of costs for the acceptable alternatives was based upon the concept of

<u>Item</u>	<u>Baseline Availability</u>	<u>Alternative 3 Availability</u>	<u>Percent Change</u>	<u>Relative Effectiveness</u>
1/4 Ton Truck	0.858	0.858	0%	1.00
2 1/2 Ton Truck	0.793	0.804	+1%	1.01
5 Ton Tractor	0.694	0.710	+2%	1.02
Forklift (6000 RT)	0.777	0.794	+2%	1.02
M113A1 Carrier	0.818	0.825	+1%	1.01
155MM SP Howitzer	0.486	0.530	+9%	1.09
M60A1 Tank	0.621	0.661	+6%	1.06

MOE: OPERATIONAL AVAILABILITY
(D+11 thru D+40 - Corrected)

Table I-6

<u>Item</u>	<u>Baseline</u>	<u>Alternative 3</u>	<u>Percent Change</u>	<u>Relative Effectiveness</u>
1/4 Ton Truck	75.8	75.8%	0%	1.00
2 1/2 Ton Truck	95.5	90.0	-6%	1.06
5 Ton Tractor	99.4	90.6	-9%	1.10
Forklift (6000 RT)	148.3	125.8	-15%	1.18
M113A1 Carrier	109.7	101.8	-7%	1.08
155MM SP Howitzer	128.4	103.8	-19%	1.24
M60A1 Tank	101.5	85.0	-16%	1.19

MOE: OUT-OF-SERVICE
(Hours)

Table I-7

incremental cost analysis. That is, only the changes in relevant costs between Alternative 1 and Alternative 3 were considered. Relevant COEA costs are defined as "the dollar costs required to achieve and maintain a capability in a military environment for a time prior to the commitment of that force in a combat situation."8,87/

b. Determination of Costs.

(1) For purposes of clarification, it is restated that the current system is defined as Alternative 1 or the baseline case, and the system resulting from the LORA corrections is defined as Alternative 3.

(2) The following categories of costs were considered in determining the changes in costs between Alternatives 1 and 3:

(a) Materiel. Alternative 3 proposes no change to equipment authorizations.

(b) Personnel and Training. Alternative 3 proposes no change in personnel authorization policies or in training programs.

(c) Operations. There are two recognizable but unquantified operating cost changes associated with Alternative 3:

1. Transportation. Alternative 3 reduces transportation costs by virtue of the fact that more items requiring maintenance are repaired at the organizational level, and therefore they do not have to be transported to support maintenance locations.

2. Repair parts. Alternative 3 provides higher equipment operational availability rates, and therefore greater numbers of

failures occur. The cost of the additional repair parts required to repair these additional failures has not been quantified. Some increase is foreseen in the cost of repair parts stockage associated with the allocation of more tasks to the organizational maintenance level. However, these costs also have not been quantified, and they probably cannot be quantified accurately until the conclusion of tests of the Restructured Division. In any event, the existence of all these operating cost changes is recognized, but because of the difficulty in quantification and their offsetting relationship, their net incremental cost in this analysis was considered to be zero.

(d) Support. There are no discernable incremental costs associated with Alternative 3.

(e) Implementation. There are some costs associated with current and future implementation, e.g., changes to technical manuals and other publications. However, MAC chart and associated revisions can be incorporated (at relatively slight cost) to on-going revisions of manuals, which occur rather frequently. For example, the organizational maintenance manual for the M60A1 Tank has been revised nine times in the 12 years since it was first published, or an average of a change every 16 months. The interval between the last two changes was only 13 months. In any event, there is no rational basis for apportioning relevant implementation costs, and consequently they have been omitted from this analysis.

(f) Summary. Alternative 3 contains no recommendations to obtain additional personnel, develop new materiel, or alter training, and these are the significant cost items in any doctrinal change. No changes in relevant costs can be attributed to the implementation of Alternative 3 as compared to Alternative 1, the base case. Therefore, the relative cost ratio is found to be 1.0.

I-9. COST AND OPERATIONAL EFFECTIVENESS INTEGRATION.

a. Table I-8 summarizes Alternative 3 as compared to Alternative 1 in terms of relative cost and relative effectiveness.

b. The relative worth of Alternative 3 is provided based upon the two measures of operational effectiveness considered.

Item	Relative Effectiveness		Relative Effectiveness		Relative Worth	
	MOE: Operational Availability (OA)	MOE: Mean Out-of-Service Time (OST)	Relative Cost	MOE: OA	MOE: Mean OST	
1/4 Ton Truck	1.00	1.00	1.0	1.00	1.00	
2 1/2 Ton Truck	1.01	1.06	1.0	1.01	1.06	
5 Ton Tractor	1.02	1.10	1.0	1.02	1.10	
Forklift (6000 RT)	1.02	1.18	1.0	1.02	1.18	
M113A1 Carrier	1.01	1.08	1.0	1.01	1.08	
155MM SP Carrier	1.09	1.24	1.0	1.09	1.24	
M60A1 Tank	1.06	1.19	1.0	1.06	1.19	

Table I-8. Relative Worth of Alternative 3.

APPENDIX J

IMPLEMENTORS

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).		DATE 27 Apr 77	
For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.									
TO: (Forward to proponent of publication or form) (Include ZIP Code) Deputy Chief of Staff for Logistics ATTN: Director of Maintenance Department of the Army Washington, DC 20310						FROM: (Activity and location) (Include ZIP Code) Commander US Army Ordnance & Chemical Center & School ATTN: ATSL-CD-CSM Aberdeen Proving Ground, MD 21005			
PART I. ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS									
PUBLICATION FORM NUMBER AP 750-1						DATE May 72		TITLE Army Materiel Maintenance Concepts and Policies	
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)			
1	2-14	2-19a				CHANGE: Subparagraph a to read: "To assure attainment of established readiness goals and to minimize operating and investment costs for equipment maintenance support, the allocation of maintenance tasks within the maintenance structure will: (1) Be determined by level of repair analysis in accordance with Chapter 14, TM 38-715-1. (2) Specifically include consideration of discard-at-failure for modules (components/assemblies) and parts as an alternative to repair. REASON: Analysis of many existing maintenance allocation charts indicates that they have not been prepared in conformance with the allocation policy contained in Chapter 14 of TM 38-715-1, which is to allocate tasks "to the lowest category of maintenance capable of performing the task." Rewording the subparagraph in the manner recommended will make unmistakable the fact that conformance with the allocation policy in TM 38-715-1 is a requirement. The citation of TM 38-715-1 is needed both for clarity and for emphasis.			
2	2-14 & 2-15	2-21a				CHANGE: Subpara a(1) and a(3) to read: " (1) Performed in accordance with AR 700-18; Chapter 9, AR 700-120; TM 38-703-3; and TM 38-715-1." " (3) Based on maintenance allocation charts (MAC), prepared IAW TM 38-703 series, TM 38-715-1, and considerations of economy of logistic support resources." REASON: See the reason for item 1 above. The addition of references to TM 38-715-1 in these			
*Reference to line numbers within the paragraph or subparagraph.									
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PUBLICATION/FORM NUMBER AR 750-1						DATE May 72	TITLE Army Materiel Maintenance Concepts and Policies
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)	
3	A-4					subparagraphs also is needed both for clarity and for emphasis. Rewording the subparagraphs in the manner recommended will make unmistakable the fact that conformance with the policies in TM 38-715-1 is a requirement. ADD: "A-38. Maintenance categories. A designation within a system of maintenance of materiel which is based on the extent of capabilities, facilities, and skills required for the operation. Categories of maintenance are organizational maintenance, direct support maintenance, general support maintenance and depot maintenance." NOTE: Succeeding definitions will all need to be renumbered. REASON: Maintenance categories are referred to repeatedly in AR 750-1, but are not defined in it. This situation encourages each reader to assume that his own private definition is correct. To preclude possible misinterpretations of such an important basic term, it should be formally defined in this AR. (Definition is from AR 310-25.)	
4	A-5	A-44				CHANGE: The comma after "inventory" to a period, and the word "echelons" (in the last sentence) to "categories." REASON: The comma is a typographical error. The term "echelons" was replaced by "categories" several years ago.	
5	B-1 B-2	all				CHANGE: Body of Appendix to read: (2)	
*Reference to line numbers within the paragraph or subparagraph.							
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PUBLICATION FORM NUMBER AR 750-1						DATE May 72		TITLE Army Materiel Maintenance Concepts and Policies			
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)					
						"B-1. Organizational Maintenance. Performs those organizational maintenance functions authorized by maintenance allocation charts, using technical manuals, authorized test, measurement, and diagnostic equipment, repair parts, tools, and equipment. When so authorized: performs preventive maintenance services including visual and tactile inspections, testing, cleaning, tightening/adjusting and other minor adjustments; makes external adjustments on equipment and performs minor cable and cable connector repair; analyzes the causes of equipment malfunction to the defective module (item, component, assembly, subassembly, printed/wired circuit board or card) using technical manuals, authorized easy to interpret, built-in test equipment or other authorized noncomplex diagnostic/fault isolation equipment, and replaces unserviceable modules. Evacuates to direct support maintenance those unserviceable modules and component end items requiring maintenance not authorized to be performed at the organizational category. B-2. Direct Support Maintenance. Performs those direct support maintenance functions authorized by maintenance allocation charts, using technical manuals, authorized test, measurement, and diagnostic equipment, repair parts, tools, and equipment. When so authorized: troubleshoots, inspects, tests, adjusts, calibrates, repairs, replaces, and aligns unserviceable modules for return to user or for the direct exchange program. Provides quick reaction maintenance support to organizational maintenance through maximum use of authorized direct exchange and/or operational readiness float items. Provides forward (3)					
*Reference to line numbers within the paragraph or subparagraph.											
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PUBLICATION/FORM NUMBER AR 750-1						DATE May 72		TITLE Army Materiel Maintenance Concepts and Policies
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)		
						maintenance support and technical assistance through use of mobile maintenance support teams. Has the capability to perform all maintenance functions authorized to be performed at the organizational category. Evacuates to appropriate higher categories of maintenance those modules and component end items requiring maintenance not authorized to be performed at the direct support category. B-3. General Support Maintenance. Performs general support maintenance functions authorized by maintenance allocation charts, using technical manuals, authorized test, measurement, and diagnostic equipment, repair parts, tools, and equipment. When so authorized: troubleshoots, inspects, tests, adjusts, calibrates, repairs, replaces, and aligns modules in support of direct exchange service to designated forward categories of maintenance, operational readiness float activities, and/or for return of items to the supply system. Operates collecting points in appropriate areas. Provides area maintenance support and technical assistance through use of mobile maintenance support teams on a periodic or as-required basis. Has the capability to perform all maintenance functions authorized to be performed at the organizational and direct support categories of maintenance. Evacuates to depot maintenance those component end items and end items requiring maintenance not authorized to be performed at the general support category." REASON: The former wording of this appendix barely mentioned one of the most basic of all maintenance policies pertaining to any commodity (4)		
*Reference to line numbers within the paragraph or subparagraph.								
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PUBLICATION/FORM NUMBER AR 750-1					DATE May 72	TITLE Army Materiel Maintenance Concepts and Policies	
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)	
6	D-1					of materiel: maintenance personnel at each maintenance category perform those maintenance functions authorized by maintenance allocation charts (MAC). MAC, and not statements in an appendix such as this, determine what maintenance tasks are authorized and required to be performed at a given category of maintenance. Elsewhere in AR 750-1, it is frequently and correctly recognized that a maintenance support concept sometimes needs to be specifically tailored for a given piece of equipment. The concept descriptions in this appendix, therefore, should be limited to statements which avoid reference to specific examples. Adequate specific examples are already provided in Table 1-2. <u>CHANGE:</u> Last line of parenthetical note in heading of Appendix D to read: "...guidance contained in Appendix G.)" <u>REASON:</u> The combining of former appendixes E and G (see item #7 below) causes former Appendix H to be redesignated Appendix G.	
7	E-1 E-2 G-1 G-2					<u>CHANGE:</u> Combine former Appendix G with Appendix E and reword Appendix E as follows: "APPENDIX E - MAINTENANCE CONCEPT FOR AUTOMOTIVE, CONSTRUCTION/MATERIEL HANDLING, AND MOBILE ELECTRIC POWER GENERATING EQUIPMENT (Includes all types of tactical wheeled vehicles, trailers, and wheeled vehicle prime movers.) E-1. Organizational Maintenance. Performs those organizational maintenance functions authorized by maintenance allocation charts, using technical manuals, authorized test, measurement and diag- (5)	
*Reference to line numbers within the paragraph or subparagraph.							
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ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)			
						nostic equipment, repair parts, tools, and equipment. When so authorized: performs preventive maintenance services including visual and tactile inspections, lubrication, cleaning, tightening, adjusting, testing, and preserving; troubleshoots, analyzes, fault isolates, and performs diagnostic analysis of mechanical, electrical, hydraulic and pneumatic system malfunctions, using technical manuals, installed instrumentation, authorized easy-to-interpret, built-in test equipment, or other authorized noncomplex diagnostic/fault isolation equipment, and replaces unserviceable modules. Evacuates to direct support maintenance those end items requiring maintenance not authorized to be performed at the organizational category. E-2. Direct Support Maintenance. Performs those direct support maintenance functions authorized by maintenance allocation charts, using technical manuals, authorized test, measurement and diagnostic equipment, repair parts, tools, and equipment. When so authorized: troubleshoots, inspects, tests, adjusts, calibrates, repairs, replaces, and aligns unserviceable modules for return to user or for the direct exchange program; accomplishes performance evaluation of pollution emissions and adjusts, replaces, or repairs as necessary to sustain performance within emission standards; operates a direct exchange program in support of organizational maintenance activities supported. Provides quick reaction maintenance support to organizational maintenance through maximum use of authorized direct exchange and/or forward maintenance support and technical assistance through use of mobile maintenance support (6)			
*Reference to line numbers within the paragraph or subparagraph.									
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ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)			
						teams. Has the capability to perform all maintenance functions authorized to be performed at the organizational category. Evacuates to appropriate higher categories of maintenance those end items requiring maintenance not authorized to be performed at the direct support category. E-3. General Support Maintenance. Performs general support maintenance functions authorized by maintenance allocation charts using technical manuals, authorized test, measurement and diagnostic equipment, repair parts, tools, and equipment. When so authorized: troubleshoots, inspects, tests, adjusts, calibrates, repairs, replaces, and aligns modules in support of direct exchange service to designated forward categories of maintenance, operational readiness float activities, and/or for return of items to the supply system. Provides area maintenance support and technical assistance through use of mobile maintenance support teams on a periodic or as-required basis. Collects and classifies evacuated or abandoned Class VII materiel less aircraft, COMSEC, missiles, rail, and marine. Operates a cannibalization activity to augment the direct exchange program and the supply system, and operates a terminal in the closed loop support system. Has the capability to perform all maintenance functions authorized to be performed at the organizational and direct support categories of maintenance. Evacuates to depot maintenance those end items requiring maintenance not authorized to be performed at the general support category." (7)			
*Reference to line numbers within the paragraph or subparagraph.									
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PUBLICATION/FORM NUMBER AR 750-1						DATE May 72	TITLE Army Materiel Maintenance Concepts and Policies
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON <i>(Exact wording of recommended change must be given)</i>	
8	F-1 to F-3					REASON: Former Appendixes E and G have been combined because their maintenance concepts are so similar, and both formerly separate commodity groupings of equipment share the characteristic of having installed instrumentation which can often be used during troubleshooting. The former wordings of Appendixes E and G barely mentioned one of the most basic of all maintenance policies pertaining to any commodity of materiel: maintenance personnel at each maintenance category perform those maintenance functions authorized by maintenance allocation charts (MAC). MAC, and not statements in appendixes such as these, determine what maintenance tasks are authorized and required to be performed at a given category of maintenance. Elsewhere in AR 750-1, it is frequently and correctly recognized that a maintenance support concept sometimes needs to be specifically tailored for a given piece of equipment. The concept descriptions in this appendix, therefore, should be limited to statements which avoid reference to specific examples. Adequate specific examples are already provided in Table 1-2. NOTE: Appendixes H through L will need to be redesignated as Appendixes G through K, respectively. CHANGE: Body of Appendix F to read: "F-1. Organizational Maintenance. Taking advantage of the capabilities of assigned crew personnel, performs those organizational maintenance functions authorized by maintenance allocation charts, using technical manuals, authorized test, measurement and diagnostic equipment, repair (8)	
*Reference to line numbers within the paragraph or subparagraph.							
TYPED NAME, GRADE OR TITLE				TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION		SIGNATURE	

DA FORM 2028
1 FEB 74

REPLACES DA FORM 2028, 1 DEC 66, WHICH WILL BE USED.

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).		DATE 27 Apr 77
TO: (Forward to proponent of publication or form) (Include ZIP Code)						FROM: (Activity and location) (Include ZIP Code)		
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS								
PUBLICATION FORM NUMBER AR 750-1						DATE May 72		TITLE Army Materiel Maintenance Concepts and Policies
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)		
						parts, tools, and equipment. When so authorized: performs preventive maintenance services including visual and tactile inspections, lubrication, cleaning, tightening, adjusting, testing, and preserving; troubleshoots, analyzes, fault isolates, and performs diagnostic analysis of mechanical, electrical, and hydraulic system malfunctions, using technical manuals, authorized easy-to-interpret, built-in test equipment or other authorized noncomplex diagnostic/fault isolation equipment, and replaces unserviceable modules. If maintenance which is not authorized at the organizational category is required, notifies the direct support maintenance unit, which will determine whether the end item must be physically evacuated to the DS facility for the required maintenance. F-2. Direct Support Maintenance. Performs those direct support maintenance functions authorized by maintenance allocation charts, using technical manuals, authorized test, measurement and diagnostic equipment, repair parts, tools, and equipment. When so authorized: troubleshoots, inspects, tests, adjusts, calibrates, repairs, replaces, and aligns unserviceable modules for return to user or for the direct exchange program; accomplishes performance evaluation of pollution emissions and adjusts, replaces, or repairs as necessary to sustain performance within emission standards; operates a direct exchange program in support of organizational maintenance activities supported. Provides quick reaction maintenance support to organizational maintenance through maximum use of authorized direct exchange and/or operational readiness float items. Provides (9)		
*Reference to line numbers within the paragraph or subparagraph.								
TYPED NAME, GRADE OR TITLE					TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION		SIGNATURE	

DA FORM 2028
1 FEB 74

REPLACES DA FORM 2028, 1 DEC 66, WHICH WILL BE USED.

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).		DATE 27 Apr 77
For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.								
TO: (Forward to proponent of publication or form) (Include ZIP Code)						FROM: (Activity and location) (Include ZIP Code)		
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS								
PUBLICATION/FORM NUMBER AR 750-1						DATE May 72		TITLE Army Materiel Maintenance Concepts and Policies
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO *	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)		
						forward maintenance support and technical assistance through use of mobile maintenance support teams. Has the capability to perform all maintenance functions authorized to be performed at the organizational category. Evacuates to appropriate higher categories of maintenance those end items requiring maintenance not authorized to be performed at the direct support category. F-3. General Support Maintenance. Performs general support maintenance functions authorized by maintenance allocation charts, using technical manuals, authorized test, measurement and diagnostic equipment, repair parts, tools, and equipment. When so authorized: troubleshoots, inspects, tests, adjusts, calibrates, repairs, replaces, and aligns modules in support of direct exchange service to designated forward categories of maintenance, operational readiness float activities, and/or for return of items to the supply system. Provides area maintenance support and technical assistance through use of mobile maintenance support teams on a periodic or as-required basis. Collects and classifies evacuated or abandoned Class VII materiel less aircraft, COMSEC, missiles, rail, and marine. Operates a cannibalization activity to augment the direct exchange program and the supply system, and operates a terminal in the closed loop support system. Has the capability to perform all maintenance functions authorized to be performed at the organizational and direct support categories of maintenance. Evacuates to depot maintenance those end items requiring maintenance not authorized to be performed at the general support category." (10)		
*Reference to line numbers within the paragraph or subparagraph.								
TYPED NAME, GRADE OR TITLE				TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION		SIGNATURE		

DA FORM 2028
1 FEB 74

REPLACES DA FORM 2028, 1 DEC 68, WHICH WILL BE USED.

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).		DATE 27 Apr 77			
For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.											
TO: (Forward to proponent of publication or form) (Include ZIP Code)						FROM: (Activity and location) (Include ZIP Code)					
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS											
PUBLICATION FORM NUMBER AP. 750-1						DATE May 72		TITLE Army Materiel Maintenance Concepts and Policies			
ITEM NO.	PAGE NO.	PARA- GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)					
9	H-1					REASON: The former wording of this appendix failed to even mention one of the most basic of all maintenance policies pertaining to any commodity of materiel: maintenance personnel at each maintenance category perform those maintenance functions authorized by maintenance allocation charts (MAC). MAC, and not statements in an appendix such as this, determine what maintenance tasks are authorized and required to be performed at a given category of maintenance. Elsewhere in AR 750-1, it is frequently and correctly recognized that a maintenance support concept sometimes needs to be specifically tailored for a given piece of equipment. The concept descriptions in this appendix, therefore, should be limited to statements which avoid references to specific examples. Adequate specific examples are already provided in Table 1-2. CHANGE: Body of Appendix G (formerly Appendix H) to read: "APPENDIX G - MAINTENANCE CONCEPT FOR SMALL ARMS (Includes all types of individual and crew-served weapons through .60 caliber as well as all types of grenade launchers.) (Not includes are mortars and missiles. Fire control, scopes, sights, etc., will follow concept in Appendix B.) G-1. Organizational Maintenance. Performs those organizational maintenance functions authorized by maintenance allocation charts using technical manuals, authorized test, measurement, and diagnostic equipment, repair parts, tools, and equipment. When so authorized: performs preventive maintenance services including visual and tactile (11)					
*Reference to line numbers within the paragraph or subparagraph.											
TYPED NAME, GRADE OR TITLE						TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION		SIGNATURE			

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	DATE 27 Apr 77
For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.							
TO: (Forward to proponent of publication or form) (Include ZIP Code)						FROM: (Activity and location) (Include ZIP Code)	
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS							
PUBLICATION/FORM NUMBER AR 750-1						DATE May 72	TITLE Army Materiel Maintenance Concepts and Policies
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON <i>(Exact wording of recommended change must be given)</i>	
						inspections, lubrication, cleaning, tightening, adjusting, testing, and preserving; troubleshoots, analyzes, performs diagnoses, isolates faults to the defective module or assembly, using technical manuals and authorized test, measurement, and diagnostic equipment and replaces defective modules and assemblies. Evacuates to direct support maintenance those end items requiring maintenance not authorized to be performed at the organizational category. G-2. Direct Support Maintenance. Performs those direct support maintenance functions authorized by maintenance allocation charts using technical manuals, authorized test, measurement, and diagnostic equipment, repair parts, tools, and equipment. When so authorized: troubleshoots, inspects, tests, adjusts, calibrates, repairs, replaces, and aligns unserviceable end items or modules for return to user or for the direct exchange program, respectively. Provides quick reaction maintenance support to organizational maintenance through maximum use of authorized operational readiness float items. Provides forward maintenance support and technical assistance through use of mobile maintenance support teams. Has the capability to perform all maintenance functions authorized to be performed at the organizational category. Evacuates to depot maintenance those end items requiring maintenance (including restoration of nonreflective phosphatized or black oxide finishes) not authorized to be performed at the direct support category." REASON: The former wording of this appendix failed to even mention one of the most basic of (12)	
*Reference to line numbers within the paragraph or subparagraph.							
TYPED NAME, GRADE OR TITLE						TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

DA FORM 2028
1 FEB 74

REPLACES DA FORM 2028, 1 DEC 68, WHICH WILL BE USED.

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).		DATE 27 Apr 77			
For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.											
TO: (Forward to proponent of publication or form) (Include ZIP Code)						FROM: (Activity and location) (Include ZIP Code)					
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS											
PUBLICATION FORM NUMBER AR 750-1						DATE May 72		TITLE Army Materiel Maintenance Concepts and Policies			
ITEM NO	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)					
10	I-1 I-2					all maintenance policies pertaining to any commodity of materiel: maintenance personnel at each maintenance category perform those maintenance functions authorized by maintenance allocation charts (MAC). MAC, and not statements in an appendix such as this, determine what maintenance tasks are authorized and required to be performed at a given category of maintenance. <u>CHANGE:</u> Body of Appendix H (formerly Appendix I) to read: "APPENDIX H - MAINTENANCE CONCEPT FOR ENVIRONMENTAL/TEMPERATURE CONTROL EQUIPMENT (Includes air-conditioning, dehumidification, heating and refrigeration equipment) H-1. Organizational Maintenance. Performs those organizational maintenance functions authorized by maintenance allocation charts using technical manuals, authorized test, measurement and diagnostic equipment, repair parts, tools, and equipment. When so authorized: performs preventive maintenance services including visual and tactile inspections, lubrication, cleaning, tightening, adjusting, testing, and preserving; troubleshoots, analyzes, fault isolates, and performs diagnostic analysis of mechanical, electrical, forced air circulation, combustion, and refrigerant system malfunctions, using technical manuals, installed instrumentation and other visual indicators, authorized easy-to-interpret built-in test equipment, or other authorized noncomplex diagnostic/fault isolation equipment, and replaces unserviceable modules. Evacuates to direct support maintenance those modules and end items requiring (13)					
*Reference to line numbers within the paragraph or subparagraph.											
TYPED NAME, GRADE OR TITLE						TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION			SIGNATURE		

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	DATE 27 Apr 77
TO: (Forward to proponent of publication or form) (Include ZIP Code)						FROM: (Activity and location) (Include ZIP Code)	
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS							
PUBLICATION/FORM NUMBER AR 750-1						DATE May 72	TITLE Army Materiel Maintenance Concepts and Policies
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)	
						maintenance not authorized to be performed at the organizational category. H-2. Direct Support Maintenance. Performs those direct support maintenance functions authorized by maintenance allocation charts, using technical manuals, authorized test, measurement and diagnostic equipment, repair parts, tools, and equipment. When so authorized: troubleshoots, inspects, tests, adjusts, calibrates, repairs, replaces, recharges, and aligns unserviceable modules for return to user or for the direct exchange program; operates a direct exchange program in support of organizational maintenance activities supported. Provides quick reaction maintenance support to organizational maintenance through maximum use of authorized direct exchange and/or operational readiness float items. Provides forward maintenance support and technical assistance through use of mobile maintenance support teams. Has the capability to perform all maintenance functions authorized to be performed at the organizational category. Evacuates to appropriate higher categories of maintenance those end items requiring maintenance not authorized to be performed at the direct support category. H-3. General Support Maintenance. Performs general support maintenance functions authorized by maintenance allocation charts, using technical manuals, authorized test, measurement and diagnostic equipment, repair parts, tools, and equipment. When so authorized: troubleshoots, inspects, tests, adjusts, calibrates, repairs, replaces, recharges, and aligns unserviceable modules in support of direct exchange service to (14)	
*Reference to line numbers within the paragraph or subparagraph.							
TYPED NAME, GRADE OR TITLE				TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION		SIGNATURE	

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SB).	DATE 27 Apr 77
For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.							
TO: (Forward to proponent of publication or form) (Include ZIP Code)						FROM: (Activity and location) (Include ZIP Code)	
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SB) AND BLANK FORMS							
PUBLICATION FORM NUMBER AR 750-1						DATE May 72	TITLE Army Materiel Maintenance Concepts and Policies
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)	
11	J-2	J-2d				designated forward categories of maintenance, operational readiness float activities, and/or for return of items to the supply system. Operates collecting points in appropriate areas. Provides area maintenance support and technical assistance through use of mobile maintenance support teams on a periodic or as-required basis. Has the capability to perform all maintenance functions authorized to be performed at the organizational and direct support categories of maintenance. Evacuates to depot maintenance those end items requiring maintenance not authorized to be performed at the general support category." REASON: The former wording of this appendix failed to even mention one of the most basic of all maintenance policies pertaining to any commodity of materiel: maintenance personnel at each maintenance category perform those maintenance functions authorized by maintenance allocation charts (MAC). MAC, and not statements in an appendix such as this, determine what maintenance tasks are authorized and required to be performed at a given category of maintenance. CHANGE: The fourth sentence in this para to read: "Each maintenance task, however, IAW the allocation policy prescribed in Chapter 14, TM 38-715-1, will be allocated to the lowest category of maintenance capable of performing the task, considering authorized skills, tools, and equipment including TMDE." REASON: Same as for Item #1. (15)	
*Reference to line numbers within the paragraph or subparagraph.							
TYPED NAME, GRADE OR TITLE						TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

DA FORM 2028
1 FEB 74

REPLACES DA FORM 2028, 1 DEC 69, WHICH WILL BE USED.

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	DATE 27 Apr 77
For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.							
TO: (Forward to proponent of publication or form) (Include ZIP Code) Deputy Chief of Staff for Logistics ATTN: Director of Maintenance Department of the Army Washington, DC 20310						FROM: (Activity and location) (Include ZIP Code) Commander US Army Ordnance & Chemical Center & School ATTN: ATSL-CD-CSM Aberdeen Proving Ground, MD 21005	
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS							
PUBLICATION FORM NUMBER AR 700-18					DATE Sep 73		TITLE Provisioning of US Army Equipment
ITEM NO	PAGE NO.	PARA- GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)	
1	2-5	2-10				<u>CHANGE:</u> Paragraph to read: "2-10. Postprovisioning review. a. Reviews of the suitability and effectiveness of provisioning determinations, especially the allocation of maintenance tasks in the maintenance allocation chart (MAC) and the selection and coding of repair parts, will be conducted on those programs which have resulted in deployment of maintenance-significant items. Reviews will be conducted at 18 months and again at 36 months after initial deployment. Care must be taken to insure that reviews are properly planned. Prior to the convening of a review, the TRADOC school responsible for training support maintenance personnel for the deployed item will conduct a level of repair analysis of the MAC and a review of the range and essentiality and SMR codings of repair parts. Personnel field-experienced in maintenance of the deployed item will be utilized to the maximum extent practicable during such analyses. b. Revisions to the MAC and any other provisioning decisions determined by postprovisioning review to be necessary will be made as expeditiously as practicable." <u>REASON:</u> The Level of Repair Analyses conducted during this study confirmed a need for after-deployment review of most MAC charts. Military personnel field-experienced in the maintenance of a deployed item are best qualified to evaluate the suitability of initial maintenance task allocations and associated ranges and codings of repair parts. Postprovisioning reviews need to	
*Reference to line numbers within the paragraph or subparagraph.							
TYPED NAME, GRADE OR TITLE					TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION		SIGNATURE

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).		DATE 27 Apr 77	
TO: (Forward to proponent of publication or form) (Include ZIP Code)						FROM: (Activity and location) (Include ZIP Code)			
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS									
PUBLICATION FORM NUMBER AR 700-18						DATE Sep 73		TITLE Provisioning of US Army Equipment	
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)			
						be mandatory in order to insure that they take place; such reviews have been optional for several years, but have seldom been convened. The corrections made by such reviews will be better founded in field experience if the first review is not held until 18 months after deployment of the end item. Some lessons learned from field experience, however, will not become apparent until after the first review. To make necessary corrections based on these lessons learned, a second review is needed 36 months after initial deployment.			
						(?)			
*Reference to line numbers within the paragraph or subparagraph.									
TYPED NAME, GRADE OR TITLE						TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION		SIGNATURE	

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).		DATE 27 Apr 77	
For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.									
TO: (Forward to proponent of publication or form) (Include ZIP Code) Deputy Chief of Staff for Logistics ATTN: Director of Maintenance Department of the Army Washington, DC 20310						FROM: (Activity and location) (Include ZIP Code) Commander US Army Ordnance & Chemical Center & School ATTN: ATSL-CD-CSM Aberdeen Proving Ground, MD 21005			
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS									
PUBLICATION/FORM NUMBER AR 310-3						DATE Dec 68		TITLE Preparation, Coordination, and Approval of Department of the Army Publications	
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)			
1	9-5	9-17i(3)				<u>CHANGE:</u> Subparagraph to read as follows: "You can improve this manual by recommending improvements using DA Form 2028 (Recommended Changes to Publications and Blank Forms) or DA Form 2028-2 (Test) located in the back of the manual. Recommended changes pertaining to the Maintenance Allocation Chart (MAC) should be mailed directly to (insert address of the TRADOC school which trains support maintenance personnel for the end item). Recommended changes pertaining to the remainder of this technical manual should be mailed directly to (insert address of the DARCOM commodity command which was responsible for development of the end item). A reply will be furnished direct to you." <u>REASON:</u> Military personnel field-experienced in the maintenance of a deployed item are best qualified to evaluate the suitability of task allocations in Maintenance Allocation Charts (MAC). The largest concentrations of such personnel readily available to perform Level of Repair Analyses (LORA) are normally found at the TRADOC school where support maintenance resident training is conducted. Routing DA Forms 2028 pertaining to Maintenance Allocation Charts to these TRADOC schools will enable these personnel to take earliest advantage of the expressed recommendations of other field-experienced personnel, and thus maximize the effectiveness of their MAC LORA prior to postprovisioning reviews (see Item #1 on preceding DA Form 2028 pertaining to AR 700-18).			
*Reference to line numbers within the paragraph or subparagraph.									
TYPED NAME, GRADE OR TITLE						TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION		SIGNATURE	

DA FORM 2028
1 FEB 74

REPLACES DA FORM 2028, 1 DEC 68, WHICH WILL BE USED.

APPENDIX K

CITED REFERENCES

1. AR 750-1 Army Materiel Maintenance Concepts and Policies
2. TM 38-715-1 Provisioning Techniques.
3. SB 700-20 Army Adopted/Other Items Selected for Authorization/List of Reportable Items.
4. FM 100-5 Operations
5. AR 750-21 DA Equipment Maintenance Management Program.
6. _____. Review and Analysis. Lexington, Kentucky: Maintenance Management Center, 3D Quarter FY 1975.
7. BDM Services Company, Combined Arms Research and Analysis Facility, Maintenance Support Concepts Effectiveness, Cost and Cost-Effectiveness Methodologies, with Cost and Operational Effectiveness Analysis for Priority Studies, Final Report, Vols 1 and 2, 6 Jun 76.
8. US Army Training and Doctrine Command. TRADOC Pamphlet 11-8: Cost and Operational Effectiveness Handbook (Draft), 15 November 1974.
9. AR 700-18 Provisioning of US Army Equipment
10. UL Army Ordnance Center and School. Maintenance Standards Study, ACN 22190. Aberdeen Proving Ground, MD. 1975
11. US Army Logistics Center. Wartime Repair Part Consumption Planning Guide Project, ACN 23300. Letter. Fort Lee, 4 June 1975.
12. AR 570-2 Organization and Equipment authorization Tables-Personnel
13. Stratton, Willard F. et al., Evaluation of Maintenance Support Optimization Models, Report. Chambersburg, Pennsylvania: USAMC Maintenance Support Center, April 1973.
14. Christianson, Conway J., et al. Development of a Methodology for Improving Repair Parts Support to Army Units. Report on GRC Study 53401. McLean, Virginia: General Research Corporation; November 1974.

ADDITIONAL REFERENCES

Army Regulations

11-14	Logistics Readiness
71-6	Type Classification/Reclassification of Army Materiel
220-1	Unit Readiness Reporting
310-3	Military Publications, Coordination and Approval of the Army Publications
310-25	Dictionary of United States Army Terms
611-101	Manual of Commissioned Officer Military Occupation Specialties
611-112	Manual of Warrant Officer Military Occupational Specialties
611-201	Enlisted Career Management Fields and Military Occupational Specialties
700-4	Supply and Maintenance Technical Assistance Program
700-18	Provisioning of US Army Equipment
700-82	Joint Regulations Governing the Use and Application of Uniform Source, Maintenance, and Recoverability Codes
750-4	The Army Materiel Plan - Part II Depot Materiel Maintenance and Support Activity
750-37	Sample Data Collection - The Army Maintenance Management System
750-43	Test, Measurement, and Diagnostic Equipment
750-51	Maintenance Assistance and Instruction Team (MAIT) Program
750-52	Equipment Operationally Ready Standards

Army Circulars

700-24 Supply and Maintenance Procedures for Direct Exchange

Army Pamphlets

5-2 Improvement Tools for Soldier Managers

11-25 Life Cycle Management Model for Army Systems

350-23 Commanders Maintenance Management Course

350-24 Maintenance Supervisor's Course

701-1,2,&3 The Army Logistics System Master Plan (LOGMAP)

750-13 Operating Guide for TDA Support Maintenance Activities

750-19 Quality Management for Direct Support/General Support Maintenance Operations

750-38 TAMMS - Equipment Historical Records and Selected Maintenance Forms

Tables of Organization & Equipment

29-15H Maintenance Battalion, Infantry Division

29-16H Headquarters and Light Maintenance Company, Maintenance Battalion, Infantry Division

29-17H Forward Support Company, Maintenance Battalion, Infantry Division

29-18H Heavy Maintenance Company, Maintenance Battalion, Infantry Division

29-25H Maintenance Battalion, Infantry Division (Mechanized)

29-26H Headquarters and Light Maintenance Company, Maintenance Battalion, Infantry Division (Mechanized)

29-27H Forward Support Company, Maintenance Battalion, Infantry Division (Mechanized)

29-28H	Heavy Maintenance Company, Maintenance Battalion, Infantry Division, (Mechanized)
29-35H	Maintenance Battalion, Armored Division
29-36H	Headquarters and Light Maintenance Company, Maintenance Battalion, Armored Division
29-37H	Forward Support Company, Maintenance Battalion, Armored Division
29-38H	Heavy Maintenance Company, Maintenance Battalion, Armored Division
29-55H	Maintenance Battalion, Airborne Division
29-56H	Headquarters and Headquarters Detachment, Maintenance Battalion, Airborne Division
29-57H	Main Support Company, Maintenance Battalion, Airborne Division
29-58H	Forward Support Company, Maintenance Battalion, Airborne Division
29-79H	Maintenance Company, Support Battalion, Separate Armored or Infantry (Mechanized) Brigade
29-85H	Maintenance Battalion, Airmobile Division
29-86H	Headquarters and Main Support Company, Maintenance Battalion, Airmobile Division
29-87H	Forward Support Company, Maintenance Battalion, Airmobile Division
29-99H	Maintenance Company, Support Battalion, Separate Infantry Brigade
29-105H	Support Battalion, Separate Airborne Brigade
29-109H	Maintenance Company, Support Battalion, Separate Airborne Brigade
29-118H	General Supply Company, General Support
29-134H	Maintenance Company, Light Equipment, General Support

29-137H	Maintenance Company, Heavy Equipment, General Support
29-139H	Service Company (Classification and Collection)
29-207H	Maintenance Company, Forward, Direct Support
29-208H	Maintenance Company, Rear, Direct Support
29-427G	Maintenance Company (Direct Support) (Communications Zone)
29-610G	Mechanical Direct Support/General Support Maintenance Teams
29-620G	Collection, Classification and Property Disposal
29-630H	Communications-Electronics Direct Support/General Support Maintenance Teams
29-660G	Canvas and Webbing Maintenance Teams

Field Manuals

9-59	Missile Support Unit Operations
29-2	Organizational Maintenance Management
29-20	Maintenance Management in Theaters of Operations
29-23	Direct Support Maintenance Battalion (Nondivisional)
29-24	General Support Maintenance Battalion
29-25	Direct Exchange, Shop Supply, and Operations
29-27	Calibration Service in the Theater of Operations
29-30	Maintenance Battalion & Company Operations in Division and Separate Brigades
29-30-1	Division Maintenance Battalion
29-35	Maintenance Support in Separate Brigade

29-36	Aircraft Maintenance Support (Nondivisional)
38-1	Logistics Management
38-750	Logistics - Maintenance Management
54-1	The Logistical Command
54-2	The Division Support Command and Separate Brigade Support Battalion
54-7	The Theater Army Support Command
54-9	Corps Support Command
100-10	Combat Service Support
101-10-1	Staff Officers' Field Manual
101-10-2	Staff Officers' Field Manual

Technical Manuals

3-1040-XXX-20	9-1240-XXX-35
3-4240-XXX-14	9-1290-XXX-12P
3-4240-XXX-20P	9-1290-XXX-35
5-2410-XXX-12	9-1430-XXX-12
5-2805-XXX-14	9-1440-XXX-12
5-3805-XXX-12	9-2300-XXX-20
5-3805-XXX-14	9-2320-XXX-20
5-3805-XXX-20	9-2330-XXX-14
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APPENDIX L

GLOSSARY

TERMS

Assembly—A group of two or more physically connected or related parts which is capable of disassembly (carburetor, powerpack, IF circuit, amplifier).

Commodity groups—A grouping or range of items which possess similar characteristics, have similar applications, or are susceptible to similar logistic management methods.

Component—An assembly or any combination of parts, subassemblies and assemblies mounted together in manufacture, assembly, maintenance or rebuild.

End item—A final combination of end products, component parts and/or materials which is ready for its intended use, e.g., ship, tank, mobile machine shop, aircraft.

Maintenance allocation—The assignment of a specific maintenance task for accomplishment at the lowest category of maintenance where the capability to perform that task exists in terms of availability of time, tools, test and support equipment, skills, and employment of the end item.

Maintenance Allocation Chart (MAC)—A chart listing maintenance operations applicable to an end item with an indication of the lowest level or echelon of maintenance to which each operation is allocated. This chart will normally cover the end item and any accessories issued with it.

Maintenance capability—Consists of those resources (namely, facilities, tools, test equipment, drawings, technical publications, trained maintenance personnel, engineering support, and an insured availability of spare parts) required to modify, retain materiel in, or restore materiel to, serviceable condition.

Maintenance Category—A designation within a system of maintenance of materiel which is based on the extent of capabilities, facilities and skills required for the operation. Categories of maintenance are organizational maintenance, direct support maintenance, general support maintenance, and depot maintenance.

Maintenance Concept—A maintenance support structure that specifies which, if not all, of the four maintenance categories will be utilized in the maintenance support of a particular end item or commodity grouping of materiel.

Maintenance Operations—That activity of materiel maintenance which accomplishes the physical performance of those actions and tasks involved in the servicing, repairing, testing, overhaul, modification, calibration, modernization, conversion, inspection, etc., of materiel in the operational inventory. Maintenance operations are normally carried out at several categories, i.e., organizational maintenance, direct support maintenance, general support maintenance, and depot maintenance.

Maintenance-significant item/materiel--An end item, assemblage, component, or system proposed or intended for issue to the Army in the field, the maintenance support concept for which envisions the performance of corrective maintenance services on a recurring basis.

Maintenance task--Any action or actions required to preclude the occurrence of a malfunction or to restore an equipment to satisfactory operating condition.

Materiel--Consists of all tangible items (including ships, tanks, self-propelled weapons, aircraft, etc., and related spares, repair parts, and support Equipment) necessary to equip, operate, maintain, and support military activities without distinction as to its application for administrative or combat purposes.

Materiel maintenance--The function of sustaining materiel in an operational status; restoring it to a serviceable condition; or updating and upgrading its functional utility through modification.

Mean-Time Between Failures (MTBF)--For a particular interval, the total measured functioning time of a population of materiel, divided by the total number of failures within the population during the measured period.

Mean-Time to Repair (MTTR)--The statistical mean of the distribution of times to repair. The summation of active repair

times during a given period of time, divided by the total number of malfunctions during the same time interval.

Mission-essential materiel--That materiel authorized and assigned to approved combat and combat support forces which would be immediately employed to: destroy the enemy or his capacity to continue war; provide battlefield protection of personnel; communicate under war conditions; detect, locate, or maintain surveillance over the enemy and permit continuous combat transportation and support of men and materiel.

Module--An assembly or component (e.g., electrical/mechanical or functional entity; i.e., tire) which is designed to be handled as a single unit to facilitate maintenance and/or supply actions.

Operational availability rate--The percentage, of a population of end items, which is operable and in the hands of using operators/crews.

Repair--To restore an item to serviceable condition through correction of a specific failure or unserviceable condition.

Source, Maintenance, Recoverability Codes--

Codes assigned to each repair and other support item by maintenance engineering personnel:

Source--The source or means by which the repair part or other support item will be obtained by material maintenance activities.

Maintenance—The lowest category of maintenance authorized to use the item or remove, replace, and check out a repair part; and/or the lowest category with the capability for complete repair of the item.

Recoverability—Guidance for the disposition of unserviceable or excess repair parts and other support items.

APPENDIX M

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