

Research Problem Review 78-15

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# PROBLEMS IN ORGANIZATIONAL LEVEL MAINTENANCE ON THE M60A1 AND M48A5 TANKS

Tomme R. Actkinson

FORT HOOD FIELD UNIT

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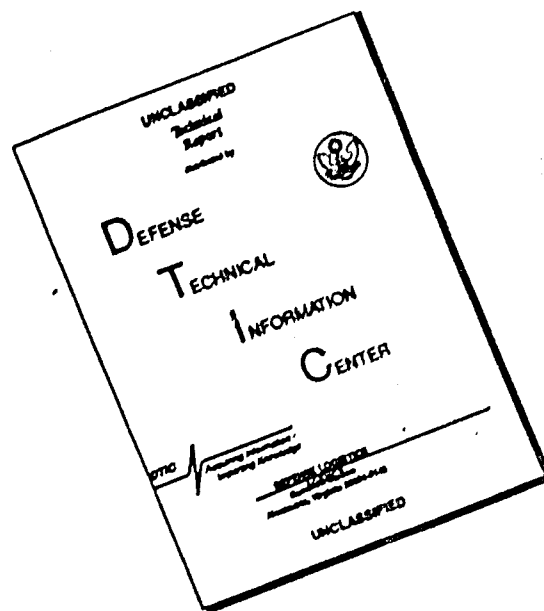
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(6) PROBLEMS IN ORGANIZATIONAL LEVEL MAINTENANCE  
ON THE M60A1 AND M48A5 TANKS

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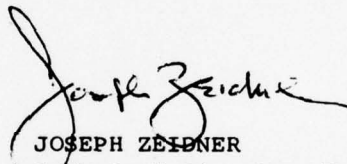
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## FOREWORD

The Fort Hood Field Unit of the Army Research Institute for the Behavioral and Social Sciences (ARI) provides technical advisory service to the Training and Doctrine Command (TRADOC) Combined Arms Test Activity (TCATA). Recently TCATA was tasked to conduct an evaluation of the reliability and maintainability of the M60A1 and M48A5 main battle tanks. In conjunction with this effort, ARI was asked to identify and examine human-factors-related organizational maintenance problems. This task was accomplished by conducting and analyzing interviews with organizational maintenance personnel who were experienced on the two tank subsystems.

The results of these interviews are presented in this review and are pertinent to all personnel concerned with M48A5 and M60A1 tank maintenance at the organizational level.

  
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## PROBLEMS IN ORGANIZATIONAL LEVEL MAINTENANCE ON THE M60A1 AND M48A5 TANKS

### BRIEF

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#### Requirement:

To identify organizational maintenance problem areas while maintaining the M48A5 and M60A1 tanks.

#### Procedure:

Twelve organizational level mechanics involved with the Baseline Armor Reliability Test (BART) were interviewed to identify possible problem areas in maintaining the M48A5 and the M60A1 tanks. Additionally, other organizational level mechanics were interviewed from the 1st Cavalry and the 2nd Armored Divisions to determine the generalizability of interview results to other M60A1 units. A similar sample of M48A5 mechanics was obtained through questionnaires mailed to a National Guard unit possessing M48A5 tanks. Data were gathered through use of a 9-item, open-ended questionnaire. With the exception of the questionnaires mailed to the National Guard, mechanics were interviewed individually and were encouraged to discuss and explain their comments.

#### Findings:

Items that mechanics believed to be the most difficult to maintain were the generator, brake system, final drives, and the add-on stabilization (AOS). Cannon plugs were difficult to remove, and mechanics from the National Guard experienced difficulty with sticky throttles caused by rust. It was found that

Procedural and administrative problems related to maintenance have resulted in significant unnecessary costs to the Army in terms of both manpower and materiel dollars. Crew preventive maintenance was often not done or was done improperly. Manuals for the M48A5 did not provide enough information. Tools were inadequate and were in short supply. Trained personnel were often assigned duties out of their Military Occupational Specialty (MOS) (i.e., driver). Personnel with secondary MOS in tank maintenance, but with little or no actual maintenance experience, were assigned to maintenance positions.

Further studies of the Army tank maintenance program should be conducted, not only at the organizational level but also at the crew and direct support levels.

## Utilization of Findings:

The results of this research have been incorporated into the TCATA BART report. In addition, this report serves as a useful guide for improved planning and execution of Army maintenance programs for tank systems.

# PROBLEMS OF ORGANIZATIONAL LEVEL MAINTENANCE ON THE M60A1 and M48A5 TANKS

## CONTENTS

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|                                                          | Page |
|----------------------------------------------------------|------|
| INTRODUCTION . . . . .                                   | 1    |
| METHOD . . . . .                                         | 2    |
| Subjects . . . . .                                       | 2    |
| Procedure . . . . .                                      | 2    |
| Analysis . . . . .                                       | 2    |
| RESULTS . . . . .                                        | 3    |
| Equipment Problems . . . . .                             | 3    |
| Safety Problems . . . . .                                | 5    |
| Procedural Problems . . . . .                            | 5    |
| DISCUSSION AND CONCLUSIONS . . . . .                     | 11   |
| APPENDIX A. GENERAL MAINTENANCE QUESTIONNAIRES . . . . . | 13   |
| APPENDIX B. PHASE II--INTERVIEWS . . . . .               | 15   |

## LIST OF TABLES

|                                                                                                                          |   |
|--------------------------------------------------------------------------------------------------------------------------|---|
| Table 1. Items indicated as being difficult to repair or in<br>need of frequent repair for M60A1 and M48A5 tanks . . . . | 4 |
| 2. Areas of crew maintenance that mechanics perceived<br>as not being done or improperly performed . . . . .             | 6 |

PROBLEMS IN ORGANIZATIONAL LEVEL MAINTENANCE  
ON THE M60A1 AND M48A5 TANKS

INTRODUCTION

Each tank battalion has an organizational maintenance component.<sup>1</sup> These maintenance personnel bear the responsibility for removing and replacing defective parts, making minor repairs, and performing preventive maintenance. The importance of this maintenance cannot be overemphasized because it is this level of maintenance (along with tank crew functions) that is responsible for keeping the tanks running. In the event of a breakdown, organizational maintenance is responsible for timely repair. Noting the importance of this link in the chain of repair, it is perhaps surprising that no previous study has looked specifically at organizational maintenance with a view to identifying maintenance-problem areas.

The Baseline Armor Reliability Test (BART),<sup>2</sup> conducted at the Training and Doctrine Command (TRADOC) Combined Arms Test Activity (TCATA) from March through November 1976, provided an opportunity to interview organizational level maintenance mechanics participating in the test. Individual comments are provided in the appendixes. What follows is a brief description of the BART test and maintenance mechanic interviews. Problem areas in organizational maintenance are reviewed, as well as proposals for future lines of inquiry.

The Baseline Armor Reliability Test primarily was designed to derive reliability and maintainability data for the M60A1 and M48A5 main battle tanks. The test was conducted in three phases. During each phase each tank was driven 750 miles (half on major roads and half on cross-country or secondary roads). In addition, each tank fired 150 main gun rounds during each phase. Between phases quarterly maintenance service (Q service) was performed in the battalion motor pool.

Quarterly service is similar to preventive maintenance on a new car. Just as a periodic oil change, grease job, etc., is recommended in a new car owner's manual, a quarterly service and inspection of the tank is performed. In the BART, Q service was performed after each of the three

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<sup>1</sup>Organizational level maintenance as it is used here includes both maintenance personnel assigned to specific companies and the battalion maintenance platoon.

<sup>2</sup>Tebo, R. J., Babosa, J. C., Emerick, W. G., Haisler, W. A., McGurk, J. R., Smith, J. R., Talley, J. W., Degelo, G. J., and Atkinson, T. R. TCATA Test FM379, Baseline Armor Reliability Test (BART), April 1977.

phases listed above. BART mechanics were interviewed during or just after Q service.

Three fleets of five tanks each were used: Overhauled M60A1's (i.e., identical to M60A1's currently in use except refitted with new or rebuilt parts), the M60A1 Reliability Improved Selected Equipment (RISE) tank, and the M48A5. After each phase, tank crew members answered a human factors questionnaire.

## METHOD

### Subjects

Following Phase I, eight BART maintenance personnel (one motor sergeant, five track and wheel mechanics, and two turret mechanics) and two recovery-vehicle personnel were interviewed using an open-ended questionnaire format (see Appendix A). Following Phase II, 12 BART maintenance personnel (one fleet warrant officer, one motor sergeant, six track and wheel mechanics, and four turret mechanics) were again interviewed using a slightly modified questionnaire. Additionally, other organizational level personnel from the 1st Cavalry Division and maintenance personnel from the 2nd Armored Division were interviewed to insure that findings were not peculiar to the BART unit. Finally, copies of the interview forms were sent to maintenance personnel in a National Guard unit that had M48A5 tanks. These forms were answered as open-ended questionnaires. Although the procedure was somewhat different, the Guard questionnaires were helpful in extending the data base on the M48A5 tanks.

### Procedure

A 9-item, open-ended questionnaire was administered. Three questions concerned maintenance of tank subsystems (i.e., mechanical, electrical); four questions dealt with organizational or procedural matters (i.e., crew maintenance, tools and tool adequacy, and manuals); and two questions were related to safety incidents and a request for general comments. Except for the National Guard subsample, questions were administered orally to maintenance personnel. Personnel were interviewed individually and encouraged to elaborate on their answers. A summary of comments is provided below. (For more detail, see Appendix B.)

### Analysis

The materials do not lend themselves to either inferential or descriptive statistics because the data were gathered in an unstructured manner. Originally, the data were to serve only as a means of providing a better understanding of other aspects of the BART test. It was only after the data had started to come in that it was realized that the data

were providing a useful glimpse into problems in organizational maintenance. Also, because a relatively unstructured interview format was used, it was impossible to generalize about the group. For example, 20% of the group might have volunteered a comment that generator removal was a problem. The fact that 80% of the people did not cite generator removal as a problem did not necessarily mean that they don't think it is a problem. If asked specifically about generator removal, all personnel might have rated it high on their problem list.

## RESULTS

Interview results have been reduced to sections dealing with equipment problems, safety problems, and procedural problems. As shown in the tables that follow, certain comments have higher frequencies within each given unit. It is unclear whether this means that a problem occurs more frequently in that particular unit or has received special emphasis because it occurred more recently.

### Equipment Problems

Table 1 gives information on electrical and mechanical systems that are difficult to maintain (Questions 1 and 2). BART personnel indicated that the generator, add-on stabilization (AOS) system, cannon plugs, brakes, and final drives caused the most repair problems. Generators were seen as a problem because they (a) broke down frequently, (b) were heavy, and (c) were situated in an awkward location. One mechanic noted, "To replace the generator one man has to lie on his back and lift it into place." The AOS was new to personnel, and this unfamiliarity and lack of training were seen by mechanics to cause problems. Cannon plugs were often cited as difficult to repair because of inadequate hand space for removal. Brakes created a problem because they could be set so tightly that they would be hard to release. Final drives were cited because of their weight and the fact that they could not be seen during replacement; that is, while lifting the final drive, the mechanic has to guess the proper position and attempt to shove it into place. Replacing final drives was done on a trial-and-error basis. Because of the weight of the final drives, this trial-and-error positioning created problems. Several mechanics suggested that the addition of an external placement marker to the final drives would allow quicker replacement.

Maintenance personnel from other Active Army units had no experience with the AOS. They did, however, report that the generator, cannon plugs, and final drives caused maintenance problems. Also, the wiring harness was mentioned both by active personnel and the National Guard because of relative inaccessibility. Active personnel also said that the starter was heavy and difficult to remove because bolts were inaccessible (one mechanic indicated that the only way to remove the bolts was by using an improvised tool--a wrench that had been sawed in half and bent to fit).

Table 1

Items Indicated as Being Difficult to Repair or in Need of  
Frequent Repair for M60A1 and M48A5 Tanks

| Item                                | BART<br>mechanics | 1st CAV and 2AD<br>mechanics | National Guard<br>mechanics |
|-------------------------------------|-------------------|------------------------------|-----------------------------|
| Add-on stabilization                | 3                 | -                            | -                           |
| Generator                           | 5                 | 4                            | 4                           |
| Charging system                     | -                 | -                            | 6                           |
| Cannon plugs                        | 5                 | 3                            | -                           |
| Wiring harness                      | -                 | 3                            | 1                           |
| IR power drive and cable wiring     | -                 | 1                            | 2                           |
| Brakes                              | 2                 | 2                            | 5                           |
| Final drives                        | 2                 | 2                            | -                           |
| Starter (bolts)                     | -                 | 2                            | -                           |
| Hydraulic system for main gun       | -                 | 1                            | 1                           |
| Throttle linkages (sticky linkages) | -                 | -                            | 10                          |
| Range finder M48A5                  | 1                 | -                            | -                           |
| Slot pins                           | 1                 | -                            | -                           |
| Roadwheel bolts                     | 1                 | -                            | -                           |
| Instrument panel wiring             | -                 | 1                            | -                           |
| Fuel pump                           | -                 | 1                            | -                           |
| Turret motor                        | 1                 | -                            | -                           |

Guard personnel who worked on the M48A5 indicated similar areas of maintenance difficulty. The generator or charging system, brakes, and wiring were mentioned as areas of difficulty. In addition, 10 personnel cited sticky throttle linkages caused by rust.

In summary, certain mechanical and electrical subsystems cause recurring difficulty for maintenance personnel. In many cases, the solutions involve minor modifications. For example, it should be very easy to provide an external mark of some sort on the final drives to aid replacement. Further attention given to maintenance personnel comments can result in reduced maintenance time.

#### Safety Problems

Personnel were asked if any accidents or near accidents had occurred while maintaining the tank. For active duty personnel the typical response was "no" or "none." One of the turret mechanics did note that an improperly mounted fire extinguisher had blown up. Guard personnel noted that sticky throttles (see mechanical section) caused some problems. Other than the comment on sticky throttles, problems were of a recurring nature.

#### Procedural Problems

This section summarized how the organizational maintenance mechanic views the maintenance program. The section is based on five questions from the interview sheets that dealt with (a) crew maintenance; (b) tools, both appropriateness and availability; (c) manuals; (d) general comments; and (e) recommendations for improvement in the organizational maintenance program.

Crew Maintenance. There appear to be recurring problems in crew maintenance. Responses to the crew maintenance question are summarized in Table 2. As shown in the table, BART personnel felt that crew maintenance was neglected primarily in areas related to lubrication and suspension.

In the suspension system, loose center guides, end connectors, and roadwheel nuts were cited as problems. For example, one mechanic mentioned a tank that had lost 16 center guides in one day. Admittedly this is the worst case but does highlight the problem. At least one mechanic commented that some serious maintenance problems could be prevented if crews kept up the maintenance.

Proper lubrication was also frequently mentioned. Twenty mechanics in all groups commented on lubrication problems. Maintenance personnel noted overfilling of oil to be a problem as often as underfilling.

Table 2

Areas of Crew Maintenance That Mechanics Perceived  
as Not Being Done or Improperly Performed

| Item                                                                     | BART<br>mechanics | 1st CAV and 2AD<br>mechanics | National Guard<br>mechanics |
|--------------------------------------------------------------------------|-------------------|------------------------------|-----------------------------|
| Loose nuts and bolts (center guides,<br>end connectors, road wheel nuts) | 8                 | 1                            | 10                          |
| Lubrication (grease)                                                     | 5                 | -                            | -                           |
| Oil levels (over/underfill)                                              | 3                 | 4                            | 3                           |
| Gear box oil                                                             | 3                 | -                            | -                           |
| Bore evacuator                                                           | 2                 | -                            | -                           |
| Light bulbs                                                              | 1                 | -                            | 3                           |
| Breech firing pin (cleaning)                                             | 1                 | 1                            | -                           |
| Oil in traversing gear box                                               | 1                 | 1                            | -                           |
| Improper or late reporting                                               | 3                 | 2                            | -                           |
| Bleeding brakes                                                          | 1                 | -                            | -                           |
| Draining fuel filters                                                    | -                 | 3                            | -                           |
| Cleaning air filters                                                     | -                 | 1                            | -                           |
| Batteries                                                                | -                 | 1                            | 10                          |

A similar problem concerned failure to check battery levels. This was noted particularly by the guard personnel. It is unclear whether this is a problem peculiar to the guard unit queried or if battery levels on the M48A5 need more attention.

Timely reporting also appeared to be a concern. Several maintenance personnel indicated that crews often would not report a failure until it had become serious enough to result in a deadlined tank. Additionally, some failures might not be reported until quarterly service, thus resulting in further deterioration of the tank's condition.

Many of the problems in preventive crew maintenance fell under what one motor sergeant called "head space problems." The crew would know what to do but would still do it wrong, such as failing to check end connectors or oil levels. The sergeant concluded that simple educational attempts (i.e., this is an end connector, and this is how to tell if it's loose) would not solve this type of problem.

The above comments concern conditions that could adversely affect physical maintenance assets, most notably the lack of preventive procedures resulting in an increase in the amount of repair needed. Morale could also be affected because of a perceived additional workload.

Another way morale was affected was in terms of the manner in which crews reported items needing repair. Often this reporting was not timely. For example, one mechanic noted that reportable failures often weren't reported until late in the workday. "Mechanics might sit around with little to do until near the end of the normal duty day; then, just before quitting time, get very busy." Implicit in this comment and others was the idea that most failures were reported at or near the end of the duty day.

In explaining this reporting problem, two explanations seem possible:

1. Tanks break down throughout the day, but reports are not rendered until the crew is almost ready to go off duty.
2. Mechanical failure is an accelerating function over the duty day.

A management study would be useful to determine times when mechanics are needed most. Personnel could then be programed flexibly to meet job requirements.

Tools. Tools and tool availability were seen as major problems by all the active units. Of the 22 maintenance personnel interviewed, 17 (81%) said that they did not have all of their tools, could not get them, or had to improvise to accomplish their jobs. It is interesting to note that all five persons who indicated that tools were satisfactory came from the BART unit. All maintenance personnel from the non-BART units indicated that they had tool problems. One possible explanation may be

that because of the importance of the BART test, maintenance personnel had better access to tools than did their regular Army counterparts. Even so, 58% of the BART mechanics indicated that tools were a problem.

Tool problems could be classed as problems relating to availability and problems relating to appropriateness of the tools. Availability was by far the major problem. Several mechanics indicated that they did not get an initial tool issue, or that it lacked several items. Replacement of lost, stolen, and broken tools was slow to nonexistent. Typical replacement times were 6 months and longer. Often, the man ordering the tool had left before the replacement arrived. Slow replacement causes a loss in maintenance time because of the necessity to seek out or borrow tools.

Several people (in different motor pools) suggested a system whereby a mechanic would initially be given a complete tool issue. If a tool were lost, the mechanic would be able to buy it immediately, either from a government vendor or from an authorized commercial source. Broken tools could be turned in for immediate replacement, in the way Sears, Roebuck and Co. does for many of its tools. Maintenance personnel felt that these suggestions would greatly reduce turn-around time and improve maintenance and morale.

"Special" tools--which are special-purpose tools belonging to the motor pool--were also seen as a problem. This problem was noted especially in the regular Army unit where 50% of the mechanics said that special tool availability was inadequate.

Tools were not always appropriate for the job. Tool modification or improvisation was common. Mechanics mentioned cutting, bending, and/or welding tools to get what they needed.

In conclusion, it appears that motor pools are short of tools, which leads to wasted manhours. This problem is aggravated by a supply system that takes 6 months or longer to replace lost, broken, or stolen tools.

Manuals. Manuals were generally felt to be adequate, although some problems were encountered. BART personnel did have some difficulty with the M48A5 manuals. (It should be noted that only draft manuals were available.) As two people put it: "There are problems in troubleshooting due to lack of clear guides and procedures." ". . . The manuals are not clear enough. They need to go step by step. The M48 manuals are worse than the M60A1." In general, mechanics appeared to rank M48A5 manuals as the worst, the regular M60A1 manuals in the middle, and manuals for the M60A1 RISE tanks as the best. Criticisms were usually general in nature; only the electrical system was specifically singled out as requiring more explanation.

Guard personnel also had their greatest difficulty with the electrical system. Guard personnel, however, had access only to draft crew repair manuals, and this may have been the cause of their difficulty.

Direct Support. Direct support (DS) refers to the level of maintenance immediately above organizational maintenance. In general, battalion motor pool mechanics (organizational maintenance) remove and replace rather than repair. They replace missing parts, provide lubrication checks, troubleshoot, and remove faulty equipment. Usually they are not responsible for fixing a broken item. Although theoretically this practice may provide certain advantages (i.e., less extensive training needed for maintenance personnel), difficulties can arise in practice that lead to poor morale and wasted manpower. A mechanic interviewed said, "A lot of time is lost preparing the vehicle for direct support maintenance. You have to thoroughly clean the vehicle and then strip it (of usable parts)." Implicit in the comment was the idea that the DS activity would take anything of value to their unit (i.e., don't leave seats in a jeep or they'll be taken). Because of this belief at the organizational level, much extra work goes into preparing vehicles for DS, with accompanying lost time and resources.

Perhaps a more serious objection to many of the DS maintenance activities is that the organizational mechanic feels prevented from doing a complete piece of work. Several mechanics displayed dissatisfaction over being allowed only to troubleshoot, remove, and replace. The following quotes from mechanics give a sampling of their opinions.

Maintenance personnel are demoralized by restrictions on what they are allowed to do on repair of components. People want to learn. The maintenance man knows he can do it (repair an item), has been trained to do it, but is not allowed to do it. You're belittling the mechanic when you say, "You're (the mechanic) not qualified to do a job, it must go to Direct Support." When in fact the mechanic can do it. The mechanic is not allowed to do a complete piece of work, he only takes off or puts on; from there it goes to direct support . . . . Many DS functions could be performed in the unit (organizational maintenance) if we were allowed to do them.

Doctrine should be changed. As it now stands, a lot of turn-around time is lost simply preparing the vehicle for DS.

. . . If you can't do it in the field, you can't turn it in until Direct Support looks at it. This costs time for the examination as well as getting the vehicle ready for Direct Support maintenance (i.e., have to strip the vehicle, wash, wax, etc.).

The above comments suggest the need to look at the philosophy behind direct support. It might be useful to determine what additional jobs could be more effectively done in the unit. One difficulty in reorganization, however, could arise because of manpower shortages and management practices.

Manning and Manpower Usage. Another area that organizational mechanics think needs to be changed concerned use of manpower. Problems included multiple assignment, shortages by MOS, and misassignment.

Three (of 22) mechanics indicated that multiple assignments (i.e., additional duties) interfered with their maintenance work. For example, one mechanic said he might be on guard duty all night and then be expected to work on the tanks all day. Another said, "Maintenance should receive priority. Right now you have the mechanic doing 15 other things (e.g., driver, sweeper) when you really need the guy to work on the tank." Another mechanic commented that the MOS meant nothing (e.g., a maintenance man was being used as a truck driver).

This problem is aggravated by a shortage of personnel and through the practice of assigning people not current in the maintenance field. An example of a personnel shortage was when three turret mechanics were authorized but only one was assigned. Personnel not current in the MOS included former tank commanders (TC's) and Redeye team commanders who are now wheel mechanics.

In addition to the above, several mechanics said problems existed because MOS was not tank specific (for example, a wheel and track mechanic may have worked only on armored personnel carriers or artillery).

In summary, organizational maintenance personnel feel that their units should be at full strength, that they should have fewer additional duties outside of their MOS, and that tank-experienced personnel should be assigned to their units.

Supply. Another organizational problem deals with replacement parts. Mechanics regarded getting replacement tank parts as a major problem. Several persons indicated that time would be saved if common items were stocked at organizational level or could be readily obtained. As one mechanic put it, "You lose time because common items such as bolts, filters, etc., are not available. If I had all the nuts, bolts, etc., I could do in 5 minutes jobs that now take all day."

Administrative Leadership. Finally, maintenance personnel pointed out a problem in maintenance because of differences in rank between the motor sergeant and tank commanders. The motor sergeant may tell a crew to do an item of preventive maintenance only to be overridden by the TC who outranks him.

In summary, the mechanics' major complaint is that they are not allowed to show their full capabilities. First, they often are not allowed to repair the tank (a direct support function); they merely troubleshoot, remove, and replace. Second, mechanics feel there is often misassignment, both for secondary duties and reassignments. Finally, maintenance crews feel that there is a real problem with getting parts and tools and that some administrative difficulties arise because of rank differences between the motor sergeant and tank commander.

## DISCUSSION AND CONCLUSIONS

The above interviews provide an initial look at maintenance at the battalion level. Interviews provided data on specific subsystem problems for both the M60A1 and the M48A5. Admittedly, many of these trouble-causing items may already be known from the BART test (e.g., frequent generator failure and suspension system failures). Even where problems are known to exist, however, the suggestions of the maintenance crew may be beneficial (e.g., put a zipper on the boot holding the generator because it is stiff, unwieldy, and difficult to remove in its present form).

Discussion of organizational maintenance provided a needed look at the maintenance program at the battalion level. A review of the literature through the TCATA Technical Information Center has shown no studies dealing specifically with organizational maintenance.

One related study, however, is the TRADOC Study on Improving the Tank Force: The Final Report of the Total Tank System Study Group, Volume I--Main Report,<sup>3</sup> which gives a good outline of the maintenance hierarchy in general, as well as a brief exposition of some of the problems. Especially interesting was a brief discussion of problems between the organizational and DS levels. The study group found that too many items were being incorrectly diagnosed at the organizational level as inoperable and were being sent to DS for repair.

This finding by the study group contrasted markedly with the attitudes expressed by the mechanics interviewed in the present study. In the present study, mechanics expressed a reluctance to send items to DS and a desire to be allowed to repair items locally. The fact that repairable items are being sent to DS despite the organizational mechanics' reluctance to do so could indicate that mechanics misunderstand the mission of organizational maintenance (i.e., they see it as simply remove and replace when in fact they should be repairing). Training deficiencies could also contribute to the problem (i.e., organizational mechanics are not properly diagnosing repair problems). In either case, the solution proposed by the Total Tank System Study Group of having a master mechanic would appear valuable.

On a more general level, a review of the total maintenance system should be undertaken. Our study was concerned with organizational maintenance (i.e., company/battalion). Although limited in scope, the study gave mechanics at the organizational level a chance to air attitudes on problems they saw. The Total Tank System Study Group appeared more concerned with maintenance at a higher level than the maintenance hierarchy,

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<sup>3</sup> Bahnsen, J. C., et al. Improving the Tank Force: The Final Report of the Total Tank System Study Group, Volume I--Main Report (FOUO), U.S. Army Training and Doctrine Command (ATTNG-TTS), Fort Monroe, Virginia, 1976.

notably direct support. An examination at every level of maintenance from crew up to direct support should be conducted to identify exactly what the mission tasks are and what the problems are in accomplishing these tasks. This examination appears needed both within each level and between levels. Unfortunately, studies of one maintenance level (such as the present one) that provide information about perceived problems at the organizational level may be too narrow in nature. For example, organizational-level mechanics perceive preventive crew maintenance, direct support, and resupply of tools and tank parts to be problem areas. In solving these problems at the organizational level, the total maintenance program may or may not help. A more general look at problems between levels needs to be undertaken with a view to achieving maximum satisfaction across levels as well as within one level of the maintenance hierarchy.

Within the organizational level, a first step to address realistic maintenance problems could be to increase the sample size. In the present study, the Active Army sample is small (22 mechanics from three battalions) and narrow (all units are at Fort Hood). A larger sample could determine if the common problems within these units are general or local in nature. An expanded questionnaire could be developed, based on the interview results, and distributed across a broader sample of organizational level motor pools. Possible areas of inquiry could include supply (parts and tools), a time/task analysis of the maintenance day with a view to restructuring the maintenance man's duty day (perhaps a flex-schedule), adequacy of technical manuals, problems in Q service, direct support, and so on. In addition to the organizational study, studies should be undertaken at crew and direct support levels to determine each level's particular problems and how they relate to one another. The present study has indicated organizational mechanics perceive choice problems in maintenance. If our maintenance program is to operate in an efficient and effective manner, these problems need more attention.

APPENDIX A

GENERAL MAINTENANCE QUESTIONNAIRE

NAME: \_\_\_\_\_

RANK: \_\_\_\_\_

PRIMARY MOS: \_\_\_\_\_

TANK: M48A5 NEW M60A1 OVERHAULED M60A1 (Circle one)

GENERAL MAINTENANCE

The following questions are intended to help identify problems encountered in maintaining the M48A5, new M60A1, or overhauled M60A1 tanks. Please answer the following questions as completely as possible. In addition please feel free to make any comments or suggestions in the space provided at the end.

1. In your opinion what is the most difficult electrical system to maintain on the tank. \_\_\_\_\_

\_\_\_\_\_

2. In general what is the most difficult mechanical system to maintain? What causes this difficulty? (Example, lack of parts or tools, inadequate work space, requires great deal of strength to remove, infrequent practice, etc). \_\_\_\_\_

\_\_\_\_\_

3. Did any accidents or near accident occur while maintaining the tank? If so, briefly describe the accident or near accident (be sure and describe the equipment involved). \_\_\_\_\_

\_\_\_\_\_

4. In general were all dials, knobs and indicators necessary for maintenance readily accessible? If not, which were inaccessible. \_\_\_\_\_

\_\_\_\_\_

5. What measures of preventive crew maintenance appear most often neglected?

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6. Do you have adequate tools to perform maintenance? If not, are they available by loan? \_\_\_\_\_

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7. Are manuals clear enough and provide enough information to conduct maintenance? \_\_\_\_\_

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8. What needs changing in the maintenance program if anything? \_\_\_\_\_

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9. Comments. \_\_\_\_\_

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## APPENDIX B

### PHASE II - INTERVIEWS

Appendix B reflects mechanics comments to the General Maintenance interviews. These interviews were conducted following Phase I and II of the BART test. Comments are reproduced as faithfully as an interview format will allow. In addition comments from California National Guard personnel with experience maintaining the M48A5 tank were solicited by use of the interview form as a mailed open ended questionnaire. These comments are reproduced as given with some minor editing changes for clarity.

## PHASE II - INTERVIEWS

Question #1. In your opinion what is the most difficult electrical system to maintain on the tank?

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Subject #1. The add on stabilization (AOS) system. It was the most difficult system to maintain because it was a new complicated system which people did not readily understand. Note the problems were not with the manuals or the system itself, but rather a lack of understanding of a new system. A major problem was not understanding how the system interfaced with the other tank subsystems.

Subject #2. The charging system was the most difficult to maintain due to inadequate manuals. The RISE manuals are the only ones which give specific ohms readings for troubleshooting.

Subject #3. The firing system is the most difficult to maintain due to various shorting problems.

Subject #4. The add on stabilization is difficult. It has many adjustments, which are hard to make due to it being a new and unfamiliar system.

Subject #5. The turret motor is hard to work on due to a lack of space.

Subject #6. The AOS is difficult because it is a new and complicated system, on which, the mechanic has had little practice.

Subject #7. The starting system provides problem. There are a lot of problems with the generator and blower motor going out. Sometimes the generator boot rips and causes the generator to stop operating. Also

the control box in the turret sometimes gets oil and dirt in it causing it to short out.

Subject #8. The charging system is the most difficult due to the frequency of repair. With the exception of the RISE the generator breaks down the most. (Note the RISE tank comes equipped with an alternator).

Subject #9. All M60A1's need top locking cannon plugs such as now exist for the RISE. Cannon plug removal on the RISE tank is very easy, whereas it's very difficult on the regular M60A1. Also, the alternator on the RISE is much better then the generator on the M60A1 as it works better and breaks down less.

Subject #10. The oil cooler lines and the fuel injector lines on the M48A5 are difficult to repair. Also the generator breaks down a lot and it's big and heavy. It takes two guys, one underneath holding it up and another pushing.

Subject #11. The generator is difficult to repair. You have to pull the pack (remove the engine) to take off the generator.

Subject #12. The generator often shorts out due to getting oil inside of it.

Subject #13. The instrument panel is hard to get out. The way it's mounted causes a real space problem. Also the generator blower motors don't last too long.

Subject #14. Cannon plugs are difficult to remove.

Subject #15. The battery relay is hard to replace due to unclear manuals and schematics.

Subject #16. All of the electrical system from the engine disconnect back is difficult to maintain because you have to pull the pack. The generator is the most difficult to get to because it's under the oil cooler stuff.

Subject #17. The fuel pumps are hard to get at due to their location. You have to pull the pack to get to them. Also the routing of the primary wiring causes problems. If some of the power lines in front could be rerouted it would be helpful.

Subject #18. The wiring and the wiring harness are difficult to get to. You have to remove the fuel cell to get at the wiring harness.

Subject #19. The accessory wiring harness in the hull is a good four or five hour job. You have to go in and around the hull to work on it. Cannon plugs are also a problem. A fast connect/disconnect is needed. Presently you can knock off your knuckles removing them.

Subject #20. The armament system is hard to maintain due to its complexity. There are so many wires going to so many places that it's hard even with schematics.

Subject #21. The wiring harness to the blower motors decays and shorts out a lot.

Subject #22. The wiring behind the instrument control panel is difficult to work on due to too many wires in a small space. Also the

generator blower motors are difficult to maintain because water tends to get in them. The alternator on the RISE tank is sealed much better.

(National Guard)

Subject #1. The I.R. power cable and cupola.

Subject #2. I.R. power cable, he has difficulty in getting access to use.

Subject #3. Replacing regulator and parts.

Subject #4. Light bulbs burn out and wiring is hard to get to.

Subject #5. The lamps do not last too long, both the head light and tail lamps.

Subject #6. Lights burning out.

Subject #7. Most of the wiring is hard to get to.

Subject #8. Light bulbs have a very short life span, and all wiring is very inaccessible.

Subject #9. Charging system.

Subject #10. Charging system.

Subject #11. Charging system.

Subject #12. Charging system. (There are) no schematics for the electrical system.

Subject #13. Charging system. Mostly the regulator. Blower motor, because wires are hard to get to.

Subject #14. Charging system.

Subject #15. The first shot fire extinguisher microswitch goes bad.

Subject #16. The first shot fire extinguisher microswitch goes bad and causes the fuel shutoff system to stay activated constantly.

Subject #17. Battery & generating system.

Subject #18. Generator system.

Subject #19. Turret or overcharging.

Subject #20. Turret or charging.

Subject #21. Charging system. In some cases can't get the proper voltage in the charging system.

Subject #22. Charging system.

Subject #23. T.C. override switch.

Subject #24. Generator (charging).

Subject #25. Generator system - main engine.

Question #2. In general what is the most difficult mechanical system to maintain? What causes this difficulty? (Example, lack of parts or tools, inadequate work space, requires a great deal of strength to remove, infrequent practice, etc.)

---

Subject #1. The most difficult mechanical job is replacing sheared bolts on the roadwheel arm support. You have to raise the tank, block it up, and remove both sides. It's very time consuming.

Subject #2. The hardest thing to maintain (other than heavy items) is the generator exhaust boot. It's so stiff that it's hard to get to the bolts to remove the generator. Also the boot doesn't mount easily. A zipper is needed in the boot to facilitate its removal.

Subject #3. N/A

Subject #4. The gear box is difficult to maintain when it goes out of adjustment.

Subject #5. N/A

Subject #6. On the M48A5 the rangefinder is hard to remove due to a lack of space.

Subject #7. Brakes are difficult because you almost have to pull the pack to adjust them. The biggest problem however, is the final drives. Presently, we often screw up the seals installing them. What's needed is some way of marking them so we can get them back in easily. It's the biggest problem we have.

Subject #8. The master cylinder for the brakes is too far up in the front corner for all tanks.

Subject #9. The final drives are very heavy and are hard to reinstall. What's needed is some form of external marking for relining them. Currently you have to feel for correct alignment and this is difficult due to the weight.

Subject #10. Cannon plugs are hard to get to.

Subject #11. Cannon plugs.

Subject #12. Torsion bars.

Subject #13. The starter is difficult to maintain, as it has a couple of bolts which are hard to get at, and it weighs a lot.

Subject #14. Brakes are difficult to maintain. Only one person can work on it at a time. He has to put 1000 lbs. of pressure on them and reach way over to bleed them. It's hard to hold the pressure while bleeding the brakes. There's a special bleeder tool out, but special tools are hard to come by. In addition to the brakes, it's hard to get to the rear starter bolts. In order to remove the bolts, you have to cut a wrench in half and bend the wrench.

Subject #15. The access panel for the fuel shut off is hard to get through. Also cannon plugs are hard to get to.

Subject #16. Final drives are difficult to work on because there is inadequate space to hook them up and they are heavy.

Subject #17. The final drives are difficult to maintain.

Subject #18. The parking brakes need to be modified to have a simple adjustment mechanism. Also there should be a hole behind the road wheel housing where you can stick a bar in and get a good push on the torsion bar.

Subject #19. The generator boot could use some kind of zipper to aid in its removal and replacement. Presently the boot takes a lot of time and is often cut when it is put on.

Subject #20. The elevation mechanism on the main gun is hard to reach and is heavy.

Subject #21. Generators are hard to work on in their present position. As often as they (the generators) go out they need to be in an easier position. Also you often have to wire the parking brake open or closed to get it to work properly.

Subject #22. Cannon plugs on the RISE tank are on top and are no problem. On the regular M60A1 and M48A5 tanks, cannon plugs are a problem.

(National Guard)

Subject #1 The hydraulic system under the main gun is hard to get to. Additionally you need special tools to work on it.

Subject #2. Throttle linkage system, throttle sticking; brake linkage system, sticking linkages, etc.

Subject #3. Adjustments on brakes.

Subject #4. Throttle sticks, linkages hard to get to.

Subject #5. Our tanks only have a few hours of operation but the most difficult problem I have found is a sticky throttle. Additionally, we have no 20 manuals.

Subject #6. Brakes locking up.

Subject #7. Throttle and brake system--the throttle sticks due to rust. The crew applies too much brake pressure and cannot release it.

Subject #8. Throttle system and the brake system. The throttle sticks due to rust and is not easy to lube. Crews apply too much brake pressure and then can't release them.

Subject #9. Sticky accelerators.

Subject #10. Sticky accelerators.

Subject #11. Sticky accelerators.

Subject #12. Sticky accelerators. You have to remove the engine to clean rust from the connecting shaft under the left front of the engine.

Subject #13. There's not enough room for removing the wiring harness from the bulkhead. Removing and replacing the hullplate because of its weight. Throttle linkages. Free pin put from front to back.

Subject #14. Track and suspension system--shock pins coming out, end connectors loosening, dead track pods, road wheels losing rubber more than usual.

Subject #15. Road wheels either separate or chunk badly. Turbochargers go bad due to the crews shutting down the engines too fast.

Subject #16. N/A.

Subject #17. Suspension and motor blowers and throttle linkages sticking. Brakes locking up.

Subject #18. The throttle linkage is hard to get to and rusts up too fast.

Subject #19. Brakes lock up. Also when fuel pumps are left on for a period of time fuel goes into the oil.

Subject #20. Brake system, brakes lock up. Tachometer cables. Also when the fuel pump is left on for a period of time you get fuel in the oil.

Subject #21. The brakes are pretty difficult to maintain. They sometimes lock up and it is pretty difficult to get them undone.

Subject #22. Track and suspension, shocks and road wheels, also turbo chargers.

Subject #23. N/A.

Subject #24. Road arms rust, dirt and moisture.

Subject #25. Throttle linkage, located in front of main engine at junction boxes.

Question #3. Did any accidents or near accidents occur while maintaining the tank? If so, briefly describe the accident or near accident (be sure and describe the equipment involved).

---

Subject #1. No.

Subject #2. No.

Subject #3. There was an instance where an improperly mounted fire extinguisher exploded.

Subject #4. No.

Subject #5. No.

Subject #6. While pulling gun over foot rest it was dropped on a mechanics finger.

Subject #7. No.

Subject #8. No.

Subject #9. No.

Subject #10. No.

Subject #11. No.

Subject #12. No.

Subject #13. No.

Subject #14. No.

Subject #15. No.

Subject #16. No.

Subject #17. No.

Subject #18. No.

Subject #19. No.

Subject #20. No. Sometimes get minor cuts on the hands when removing tight bolts but nothing specific.

Subject #21. No.

Subject #22. Only hand cuts, from sharp edges.

(National Guard)

Subject #1. No.

Subject #2. Driver preparing to drive tank sometimes, will encounter the throttle sticking in w.o. (wide open) position after tank is engaged in gear.

Subject #3. Excess fuel on the vehicle which was not wiped off causes slippery surfaces.

Subject #4. M48A5, while rotating turret with grill door open, turret pushed grill door over and hit a mechanic on the ankle.

Subject #5. None.

Subject #6. No.

Subject #7. No.

Subject #8. Many near misses because of sticky throttles.

Subject #9. M48A5--sticky accelerator.

Subject #10. --

Subject #11. M48A5--sticky accelerator.

Subject #12. M48A5--sticky accelerator.

Subject #13. Broken track, because of the way it swings out. When you replace the track it can slip or jump off.

Subject #14. Should have a steering lock device. While shifting levers in neutral position, people will start engine then grab hold of steering wheel to help themselves into the chair.

Subject #15. No.

Subject #16. No.

Subject #17. Breaking track and replacing same, because of the gross weight and instability.

Subject #18. Not enough non-skid on decks.

Subject #19. None.

Subject #20. None.

Subject #21. --

Subject #22. The sudden turn of the tank, people standing near the tank could be struck by sudden turns.

Subject #23. No.

Subject #24. No.

Subject #25. No.

Question #4. In general were all dials, knobs, and indicators necessary for maintenance readily accessible? If not, which were inaccessible.

---

Subject #1. No problem.

Subject #2. Yes.

Subject #3. Yes.

Subject #4. Yes.

Subject #5. Yes.

Subject #6. The elevation and depression gauges are hard to reach on the sight.

Subject #7. Yes.

Subject #8. Yes.

Subject #9. Yes.

Subject #10. We had to change some gauges. The tachometer gauge breaks down, and the tach pin adapter breaks or gets lost.

Subject #11. N/A.

Subject #12. Yes.

Subject #13. Yes.

Subject #14. Yes.

Subject #15. Yes.

Subject #16. The No. 3 fire extinguisher is sometimes hard to get to to check. On the P.C.s a safety system is needed. If the oil bypass line is not completely connected it can blow the main filter at \$37.60 each. A safety relief valve is needed so that if there is a blow up it won't ruin the filter.

Subject #17. The oil pressure warning light could be moved forward. Presently it's right over the generator, and it tends to get broken every time the pack is pulled.

Subject #18. N/A.

Subject #19. N/A.

Subject #20. No problems.

Subject #21. A plug in maintenance panel is needed for running checks on the tanks. Many of the present indicators are "idiot lights," and these often break down.

Subject #22. When adjusting the transmission you need two men; one to adjust the brakes and one to read the dial. The dial should be moved so that one person can adjust the transmission.

(National Guard)

Subject #1. Yes.

Subject #2. All indicators are easily accessible.

Subject #3. The dial for the air valve compressor plunger for (water jacket) turret, is in the wrong place.

Subject #4. Yes.

Subject #5. Yes.

Subject #6. Yes.

Subject #7. Yes.

Subject #8. Yes.

Subject #9. Yes.

Subject #10. Yes.

Subject #11. Yes.

Subject #12. Yes.

Subject #13. The como knobs fall off all of the time (mostly on the intercom system).

Subject #14. Yes.

Subject #15. Yes.

Subject #16. Yes.

Subject #17. Yes.

Subject #18. Yes.

Subject #19. The tach cable is in a hard area to reach.

Subject #20. Yes.

Subject #21. Yes.

Subject #22. Yes.

Subject #23. Yes.

Subject #24. Yes.

Subject #25. Yes.

Question #5. What measures of preventive crew maintenance appear most often neglected?

---

Subject #1. Track tension.

Subject #2. The suspension system. You get loose center guides, end connectors and road wheel nuts. Also timely reporting (before a complete system breakdown) is needed. For example, when the charging system is reading low, it would be easier to troubleshoot as soon as it goes low rather than after it completely breaks down.

Subject #3. The crew doesn't follow the lubrication order. There's too much grease at points. Also the crew doesn't clean the bore evacuators with oil as required. Loose connectors are also a problem. We're losing back plates and pins. It would help if the pins were slotted so as to stay in better.

Subject #4. The measures of preventive crew maintenance which are most often neglected are changing the oil in the gear box and cleaning the turret.

Subject #5. The crew was supposed to change the oil in the gear box but didn't.

Subject #6. Crews often neglect crew service on the bore evacuator and checking and maintaining oil levels in the evacuator. Also crews fail to check to make sure that the ammo handles are closed and they get ripped off. Additionally, crews don't replace nuts and bolts or lose them. Timely reporting is a problem. Also crews don't keep the

breeches and firing pins clean. Crews forget to clean the bore evacuator or do a sloppy job. Finally, crews don't follow the lube order and forget to check the oil levels in the transversing gear box. The typical excuse for not doing crew maintenance is "I can't, I haven't got the men."

Subject #7. Crews don't stay after lubrication like they should. Also they don't check or tighten nuts and bolts on a daily basis. A lot of maintenance problems would be solved with better preventive crew maintenance.

Subject #8. Crews check oil levels fairly well, however there is a problem with loose wedge bolts and end connectors. These often are so loose that they fall off and crews may not even know that they're missing.

Subject #9. Crews don't get to all their lube points. Maintenance personnel have to double check (especially the hard to get at lube points) even if the points were specifically pointed out to them. Crews don't check center guides like they should. One tank came in for service missing 16 centerguides ("that's because they're loose"). Also crews don't report faults as they should. They wait until someone with rank inspects the tank and discovers something broken, then say, "Oh that's been broken for two months."

Subject #10. The crews do a pretty good job but they have some problems working with the mechanics.

Subject #11. Crews don't check the oil on the final drives, which causes the final drives to go out. Crews don't check the brakes as they should. This leads to bleeding brakes. Lubrication is neglected.

Subject #12. Crews forget to grease the roadwheel arms and the chassis. Also crews overfill oil levels.

Subject #13. Crews don't check the wheel bearings and seals on the suspension system. Don't check the fire extinguishers. Sometimes the starter relay is left where the tank could start up and move.

Subject #14. The most often neglected areas of preventive crew maintenance are draining the fuel filters and cleaning the air filters.

Subject #15. Crews don't check their gauges often enough. For example, they could be driving with the temperature gauge way up and yet keep driving until the tank breaks down.

Subject #16. Proper cleaning and replacement of filters is a problem. Crews will often put old oil filters back in if a new one is not immediately available. Also fuel filters are not drained everyday as they should be. This results in clogged injectors.

Subject #17. Crews don't clean the batteries as they should or if they clean it they leave the drain plugs open until Q service. Sometimes dirty water is put into the battery. Crews also neglect to see if the shock absorbers are working properly.

Subject #18. Crews don't drain the primary and secondary fuel filters as they should.

Subject #19. Crews neglect lubrication points to the extent that the machinery will freeze up. Oil is both over and underfilled.

Subject #20. If the crew feels that something which needs doing is not at their echelon they ignore it until a breakdown occurs. Crews let the replenisher get low on oil for the recoil mechanism. Crews wait until accumulator gets so low on fuel that the engine starts to whine. Then they say they have a problem. In addition the breech box on the main gun isn't cleaned often enough and/or isn't cleaned adequately (if there's the least amount of dirt it won't fire and the tank is deadlined).

Subject #21. Crews don't report items which aren't working. Also, they'll do things like trying to fix something when they don't know how. (He also mentioned crews sticking water hoses down the tanks turret to clean it).

Subject #22. Crews don't pull maintenance everyday like they should. They need to report automotive problems on a more timely basis. Road wheel nuts, shocks and cleaners are often neglected areas of preventive crew maintenance.

(National Guard)

Subject #1. The electrical firing system.

Subject #2. There is a lack of maintenance from the crews on batteries, the suspension and lights.

Subject #3. Before, during, and after P.M. (preventive maintenance) operations; a) batteries, b) end connectors, and c) electrical connectors.

Subject #4. Batteries overlooked and the track out of adjustment.

Subject #5. Cleaning of the inside of the tank.

Subject #6. Battery.

Subject #7. Checking batteries.

Subject #8. Track tension, end connector and overall cleanliness (inside and out) and lack of a good descriptive 2404.

Subject #9. Track adjustment.

Subject #10. Checking oil levels, they're never read the same twice.

Subject #11. Track adjustment.

Subject #12. Track adjustment.

Subject #13. Cleaning the tubes and the inside of the tank; servicing the batteries.

Subject #14. Checking the batteries for water levels and loose connections.

Subject #15. Crew shutting down engine too fast causes turbo charger to go bad. Also battery cables are checked incorrectly; road wheels are not always checked for torque, dented fenders due to drivers exceed (ing the safe) speed for such heavy vehicles, are other problem areas.

Subject #16. Batteries.

Subject #17. N/A.

Subject #18. Crews have a problem in remembering to turn fuel pumps off. Also have problems with fuel in oil. Crews also have problems with brakes locking up. All maintenance crews have little or no knowledge of the vehicle, or don't use the knowledge.

Subject #19. None.

Subject #20. None.

Subject #21. Track being loose and end connectors are not being tightened as often as they should be.

Subject #22. Track and suspension, all oil checks and visual checks.

Subject #23. N/A.

Subject #24. Main engine and transmission oil levels and warning light bulb replacement.

Subject #25. Change of warning lamps, checking of battery water levels and loose clamps.

Question #6. Do you have adequate tools to perform maintenance? If not, are they available by loan?

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Subject #1. No. I don't have adequate tools. Improvised tools are used at both organizational and direct support levels (e.g., wrenches cut off and welded together to approximate the needed tool).

Subject #2. My initial tool issue was short. Tools are no problem if you have the money, but you're bankrupt if you have to buy many. Tools take four or five months to replace. Also some tools such as the 9/16" sockets are almost impossible to get. The biggest problem though is dollars to buy new tools. It would be helpful if the army could get a guaranteed tool replacement like Sears has with its Craftsman tools. (Sears replaces free of charge any Craftsman tool which is broken).

Subject #3. Yes, I have adequate tools, but I wish I had more. I wish I had a test system for the RISE tank to cover the AOS. Also I wish I had a test kit which would combine a multimeter with a pressure reading kit.

Subject #4. Yes, I have adequate tools. If not I can get them.

Subject #5. I'm missing a 3/8" ratchet, some Allen wrenches and a 3/4" wrench. However they are available by loan.

Subject #6. I can't get small soldering irons. The battalion is supposed to have multimeters. We don't have them, and they're really needed.

Subject #7. We're short a lot of tools in the battalion. We're short test equipment. Also voltmeters and multimeters are broken or turned in, and the companies won't lend them.

Subject #8. Yes.

Subject #9. There is a tool accountability problem. It takes six to eight months or longer to get replacements. Excess tools are remade to what is needed (heated, bent and otherwise improvised). Some tools just don't fit. For example you have to modify the injector line tools so that they can be used on the injector lines.

Subject #10. At first (start of the test) I didn't have any tools at all. Even later, I didn't get a complete issue. I'm still missing some of my tools.

Subject #11. I don't have a tool box. I get my tools from the tool room or borrow them.

Subject #12. Yes, and special tools are available on loan.

Subject #13. No, I don't have adequate tools. I need bigger sockets and automotive wrenches. Although tools are available on loan it's a real problem. You lose a lot of time running all over the motor pool looking for them (tools to borrow).

Subject #14. Special tools are hard to come by. There's a new bleeder tool out for bleeding the brakes but we don't have it. Tools are improvised. To remove the rear starter bolts you have to cut a wrench in half and bend it. We are very short on special tools. Estimate we

only have \$100.00 worth of special tools whereas we should have approximately \$15,000.00 worth. Also it takes a long time to get special tools after ordering them. Tools can be borrowed if they're not an everyday use tool.

Subject #15. No. Tools are worn out or broken (don't have 3/8" drive set or universal) but it takes too long to replace them. I've got tools for common problems but special tools are hard to get (e.g., pressure gauge).

Subject #16. No. We're lacking the big special tools. We only have the regular mechanics tool set. For example, since we don't have the special tools we can't even adjust the servo bands. We only have 1/2" but need a 3/4" drive. For the low reverse servo band you need a special socket. The manual shows this socket but I've never seen one in the motor pool. Tools are hard to get. They can be borrowed by the motor sergeant but this takes a lot of time.

Subject #17. No. We don't have adequate tools. The general mechanics tool list is inadequate. For example the turret mechanic needs an ohm meter. What you should do is give the mechanic his tool box. The tool box would go with him from unit to unit. Then give him a monthly tool allowance every payday. Once a month a tool truck would come by and the mechanic would be required to replace anything not in his tool box.

Subject #18. No, tools are inadequate. Special tools are not readily available and there's too much of a time lag to replace them. If tools

are broken it takes drastically too long (6 mos to 18 mos) to replace them. For example there is no injector nozzle wrench available in the battalion. Some tools currently in use are cheap and break too easily. We need a Sears type trade in system. Most mechanics wouldn't mind paying for tools if they would get the tool back immediately. Currently it makes more sense to steal the tool than to try and replace it.

Subject #19. Tools are O.K. except you lose a lot and it takes too long to replace them. If a tool is broken you might as well go steal a replacement as it takes too long to get a replacement. We're short some common tools (e.g., no hammer). There's a lot of "make do" for missing tools. The idea of a "Sears Type" replacement order system sounds like a dream.

Subject #20. I only have one-half of my tools right now. Sometimes it gets as low as 25 percent (e.g., don't have a 3/8" drive set).

Subject #21. Tools aren't adequate. We don't even get breaker bars. All things are being cut down.

Subject #22. No. Especially specialty tools. You have to use an automotive wrench and modify by cutting or rounding. More tools were available in Germany. However, you can usually borrow tools when you're in a jam.

(National Guard)

Subject #1. Yes.

Subject #2. Yes. Tool room equipment also .

Subject #3. Most of the time.

Subject #4. Yes, so far.

Subject #5. The final drives pose a small amount of difficulty. A special tool should be made.

Subject #6. Yes.

Subject #7. Yes.

Subject #8. I have adequate tools.

Subject #9. No, I don't have adequate tools. Yes, they are available by loan.

Subject #10. Yes, we have tools.

Subject #11. No, I don't have adequate tools. Yes, they are available by loan.

Subject #12. Yes.

Subject #13. Bore brushes need to be larger and made of brass wire.

Subject #14. No.

Subject #15. No. The tools are not always available or even stocked.

Subject #16. Yes.

Subject #17. Yes.

Subject #18. Yes.

Subject #19. Yes.

Subject #20. Yes.

Subject #21. Yes.

Subject #22. Yes.

Subject #23. Yes.

Subject #24. Yes.

Subject #25. Yes.

Question #7. Are manuals clear enough, and do they provide enough information to conduct maintenance?

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Subject #1. There is a lack of correlation between manuals of the same family. One manual says a task is organizational maintenance, while another indicates that it is direct support (e.g., replacement of the No-BAK assembly is indicated as both organizational and direct support maintenance). Sometimes part lists are not compatible (i.e., a part may be listed as DS and organizational level).

Additionally, there is a need to change doctrine. There is a lot of turn around time lost getting vehicles ready for DS.

Subject #2. Manuals are clear enough (in most instances) if we can get them. We ordered 20P manuals on the M60A1 but haven't received them. We get manuals on equipment we don't have rather than what we need. The RISE manual is the only one that gives ohm readings for troubleshooting the charging system. This would be desirable in the other manuals.

Subject #3. The M48A5 manual doesn't cover Q service.

Subject #4. Yes.

Subject #5. Yes.

Subject #6. We don't have turret manuals on the M48A5.

Subject #7. The manuals are not clear enough. They need to go step by step. The M48 manuals are worse than the M60A1 manuals.

Subject #8. The manuals are easy to follow.

Subject #9. The M48 manuals would be difficult for a turret mechanic to follow as things are set up differently. The M48 manual is still a draft manual.

Subject #10. The manuals are clear except more explanation is needed on the electrical system.

Subject #11. Yes.

Subject #12. Yes. Although the servo band adjustment of 50 lbs torque, caused one set of brakes to lock up.

Subject #13. The manuals are O.K. However, the older mechanics don't like to use them.

Subject #14. Yes, the manuals are clear enough for anybody.

Subject #15. No, the manuals aren't clear. The electrical ones are especially hard to follow. For example, when replacing the battery relay the information in the manual and the schematics are hard to read.

Subject #16. The manuals are O.K., but a lot of updating needs to be done.

Subject #17. The M48A5 manuals don't have enough wiring information.

Subject #18. Yes, manuals are clear enough to provide enough information, except a lot of the 20P series will say: "Final drive seal on M60A1 look to Item 13. You turn to Item 13 and its been eliminated."

Subject #19. We don't use the manuals as we don't have time. We do use the 20P's (parts manuals). In this motor pool you do it yourself or ask the motor sergeant. You could walk into the motor pool everyday for 365 days and never see a manual in use. The manuals stay on the shelf to stay clean for inspections.

Subject #20. On the traversing gear box the book says to drop both gears but you're only supposed to drop one. While in school at Graf. we were told to only drop one.

Subject #21. The troubleshooting guides don't always lead to the problem. For example, if the blower motor is bad, you replace it. However, the problem may just be a wire going into it. The troubleshooting guides don't go into enough detail.

Subject #22. The M60A1 manuals are O.K. I really like the manuals for the RISE tanks.

(National Guard)

Subject #1. The manuals don't provide enough information on armaments.

Subject #2. Ten and twenty manuals--yes.

Subject #3. We need TM "20" and "20P" manuals on the M48A5.

Subject #4. Yes.

Subject #5. No. We do not have any manuals which are useful.

Subject #6. Yes.

Subject #7. Fair.

Subject #8. There is no 20 manual to answer maintenance questions.

Subject #9. Electrical schematic.

Subject #10. Yes.

Subject #11. Electrical schematic.

Subject #12. Electrical schematic. (From 9, 11 and 12, it is unclear whether what is desired is more schematics, clearer schematics, or what.)

Subject #13. We are short of TM's. We only have the draft copy of 10 (ten), no 20's (twenty) at all.

Subject #14. Yes.

Subject #15. The crew or operators manual is clear enough, but as of yet, we don't have an organizational manual.

Subject #16. The 10 manuals are fine. We haven't yet received 20 manuals.

Subject #17. Manuals can always be improved upon, (e.g. more detailed photographs).

Subject #18. Yes.

Subject #19. No, we have no 20 manuals for the A5.

Subject #20. Yes.

Subject #21. N/A.

Subject #22. Yes.

Subject #23. Yes.

Subject #24. Yes.

Answers to question 8 and question 9 were combined.

Question #8. What needs changing in the maintenance program if anything?

Question #9. Comments.

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Subject #1. Maintenance personnel are demoralized by restrictions on what they are allowed to do on repair of components. People want to learn.

The maintenance man knows he can do it (repair something) has been trained to do it, but is not allowed to do it. You're belittling the mechanic when you say he's not qualified to do a job, it must go to direct support (when in fact the mechanic could do it). The mechanic is not allowed to do a complete piece of work, he only takes off or puts on, from there it must go to direct support. For example; transmission output seals are D.S., brake activator seals D.S. function. Many D.S. functions could be performed in the unit in 15 minutes if they were allowed to do them. Doctrine should be changed, as it stands now there's a lot of around time lost simply preparing the vehicle for D.S.

Subject #2. The Army should do away with direct support. More jobs could be done at the organizational level. People at the D.S. level don't know how to troubleshoot (e.g., got one engine back with the injector lines crossed). If you can't do it in the field, can't turn it in until D.S. looks at it. This costs time for the examination as well as in getting the vehicle ready for D.S. maintenance (i.e. have to strip the vehicle so that items won't be stolen, wash, etc.). Also more of certain types of parts need to be kept on hand. For example,

if you need a roadwheel arm there may be none on the post. The tank may be down as long as 45-90 days while waiting the part. I feel that on this post there should be at least two (replacement) parts for each item on the tank.

Subject #3. A quick disconnect fire extinguisher is needed.

Presently, if you accidentally set off the extinguisher you have to clean the engine. Also, I would prefer to do more rather than send it to direct support. This would save a lot of time, and hassle. I have the knowledge. Also parts are not coming in. It would be nice to have a van in each unit stocked with major parts.

Subject #4. Leave it (the maintenance program) as it is.

Subject #5. The stabilization system is hard to work on, the test set doesn't tell you where the problem is.

Subject #6. There is a problem in multiple assignments. A person may be working guard duty, BART and so on. There is a shortage of manpower. Additionally, need to have LT's (tank commanders) work on getting crew maintenance done. The hatches need to be improved, especially the loaders. Currently, it's welded solid to the hull. If a link breaks it flops loose. The hatch mount is welded solid, with slots. The center piece of metal usually breaks off. A different hinge system is needed.

Subject #7. N/A.

Subject #8. There is a need for additional training. Some guys were sent to wheel school, then here. They also needed to go to track school.

Subject #9. We need the unit up to full strength. For example, a guy pulls guard duty and then is off the next day leaving us shorthanded.

Another problem is that people are assigned to jobs out of the maintenance area. When they are assigned to maintenance at a later date they're not really qualified. For example, a track and wheel mechanic spends a number of years as a tank commander or perhaps as a "Red Eye" commander then he's reassigned to maintenance as a wheel mechanic. Additionally, I think the Army should do the same as the Marine Corps. I don't think that direct support is needed. The Army should abolish direct support and train mechanics to do the total job. This would: (a) save money, (b) cause more people to be assigned to the units where they are needed, (c) let the organizational mechanics work internally (within the tank), (d) help train the mechanics for civilian life.

Subject #10. A day and night shift is needed.

Subject #11. There are too many bosses. Everyone has a different way of doing things.

Subject #12. Everything is pretty smooth.

Subject #13. Some way around scheduling problems is needed nothing happens until 3 or 4 in the afternoon, then a lot of maintenance suddenly crops up.

Quick supply and tools would also be helpful. You lose time because common items such as bolts, filters etc. are not available. If I had

all the nuts bolts etc. I needed, I could do in five minutes jobs that now take all day. It was better at school than here.

Subject #14. Maintenance should receive priority, right now you have the mechanic doing 15 other things, (e.g. driver, sweeper, etc.) and you need the guy to work on the tank.

Subject #15. There is too much changing around before the maintenance job is finished. Also there's a problem in leadership. For example the major may want his jeep right now when he only needs it in two weeks.

Subject #16. The biggest problem now is trying to get new parts for the tanks. Also more flexibility is needed in Q service. For example if oil has just been changed prior to Q service and the tank has zero or only a few miles, there's no point in changing the oil. (Currently you have no alternative but must change the oil.)

Subject #17. I can fix a lot of stuff, but I'm not authorized to do so. A lot of people, when they joined the service, thought they'd be allowed to repair the whole system. Instead they're only allowed to trouble-shoot. Also the parts system is too slow. I'd also like to recommend an Air Force type jumpsuit or coveralls, as fatigues give inadequate protection.

Subject #18. The 63C has been made into a universal MOS and this causes problems. For example the Army takes a 63C who has been an APC mechanics and then expects him to work on tanks. This causes problems. We need artillery, infantry and tank MOS tracks.

Subject #19. We need to cover the work. Right now you have to work out in the weather even in the motor pool. We need a garage. It would be convenient to have work shoes, I've probably smashed 15 toes.

Subject #20. We need more help. We're authorized three turret mechanics and I'm the only one.

Subject #21. We need different MOS's for each section, e.g. mechanical, electrical suspension.

Subject #22. Poor management (of personnel) needs to be changed. In my company the MOS means nothing (e.g. put a maintenance man to work driving a truck. Another example of management problems in the motor pool centers around who has the authority to control maintenance. The motor sergeant should run the motor pool, but it doesn't always work that way. For example the sergeant tells the tank commander or crew to do something and the tank commander says (to the crew) to forget it. Since the tank commander outranks the motor sergeant it doesn't get done.

(National Guard)

Subject #1. No comment!!

Subject #2. An SOP for checking, engine oil, so everyone will have the same system. Track components, suspension are showing signs of wear, shock pins backing out or rotating while in position, end connectors worn out in less than 200 miles.

Subject #3. N/A.

Subject #4. During Q service, while pack is out, throttle box should be cleaned and lubed.

Subject #5. We need clarification of the proper oil level on the engine. There seems to be some difference of opinion. We need to know the acceptable levels.

Subject #6. No changes.

Subject #7. None.

Subject #8. More time is needed for maintenance training with the units.

Subject #9. Not at this time.

Subject #10. N/A.

Subject #11. Not at this time.

Subject #12. None at this time.

Subject #13. Lubrication of the vehicles. Like in the desert, after a weekend of tank movement road wheels and torsion bars should be lubed.

Subject #14. Give up to date classes on new vehicles and machinery used daily.

Subject #15. Crew and organizational crews should cooperate together and instruction in maintenance should be given so everyone's on the same page. The front fenders act as funnels and throw dirt and small rocks into the drivers face. The throttle linkages binds up in the junction box below engine.

Subject #16. The front fenders act as funnels for dirt rocks and debris that fly up and hit the driver.

Subject #17. Full time people should not have to attend drills. The A5's are better then A1's. Mainly because of the different engines. Diesels will always be better than gas.

Subject #18. A better supply system is needed.

Subject #19. N/A.

Subject #20. O.K.

Subject #21. The brakes on the M48A5 need to be stronger.

Subject #22. More crew maintenance is needed.

Subject #23. The cupola crash pad is a problem area. Also T.C. linkage are a problem.

Subject #24. Using units need to be better educated in what is their maintenance level from crew, company battalion and direct support.

Also incorporate a safety valve in the brake lock system to prevent extreme pressure from being applied when parking.

Subject #25. More classes on the equipment being used are needed.