U.S. ARMY ORDNANCE CENTER AND SCHOOL

PROPONENT EVALUATION REPORT
of the

Contact Maintenance Truck
mounted on the
Heavy HMMWV (HHV) M1097

- HHV-CMT -
Concept Evaluation Program
CEP #92-722

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FOR THE COMMANDER:

PATRICK W. BUTTON
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DEPARTMENT OF THE ARMY
US. ARMY ORDNANCE CENTER AND SCHOOL
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1. Please find enclosed a copy of the PER that has been reviewed and approved for release.

2. After publication corrections to the PER of the Contact Maintenance Truck are as follows:

a. Page 2, para 1.7. Should read, "The SECM O&O was approved by TRADOC on 3 January 1991. The Operational Requirements Document was approved by TRADOC 7 March 1993."

b. Page 2, para 1.8.1. Should read, "Early CMT Versions... and the M1037 Commercial Utility Carge Vehicle (CUCV)."

c. Page 3, para 1.9.3. Should read, "....sources: Iowa Mold and Tool Co., and Southwest Mobile Corporation."

3. The POC is MAJ Salesky, extension 3-4042.

Encl

MARK E. SALESKY
MAJ, AC
Chief, Maintenance Systems

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Concept Evaluation
of the
Heavy HMMWV Contact Maintenance Truck
CEP #92-722

EXECUTIVE SUMMARY

This Concept Evaluation Program (CEP) evaluated a 3rd generation contact maintenance truck (CMT) mounted on a Heavy HMMWV (HHV) as part of the materiel development concept formulation process. Three different HHV-CMT prototypes were fabricated and evaluated by light and heavy maintenance and engineer units from December 1991 through September 1992 at six locations, including the National Training Center. The U.S. Army Ordnance Center and School (USAOC&S) supervised trials and collected all field data.

On 3 January 1991, the Operational and Organizational Plan (O&O) for the Shop Equipment, Contact Maintenance (SECM) was approved by HQ TRADOC. Preliminary CEP planning was initiated in March 1990, however TRADOC funding ($257K) was not obtained until January 1991. The U.S. Army Engineer School was the co-proponent. The U.S. Army Armament, Munitions, and Chemical Command (AMCCOM), the materiel developer, participated in the CEP planning.

Overall, CEP was conducted to refine combat developer requirement documents and evaluate the feasibility of commercial equipment. The major components of the CMT evaluated were: profile of the contact maintenance mission, enclosure design and layout, selected commercial equipment, hand tool load, and power tool system.

The defining issue for the HHV-CMT CEP was weight. Earlier versions of the CMT were fielded with the total system exceeding the gross vehicle weight. In the field, soldiers added personal equipment, food, fuel, etc. Consequently, both the M887 and CUCV versions experienced frequent structural damage to the vehicle frame, suspension, and the enclosure. For the HHV-CMT, despite its increased payload, the combat and materiel developers committed to finding an optimal solution of equipment that stayed within the gross vehicle weight. As a result, the HHV-CMT prototypes were constant trade-offs between mission equipment and weight.

A summary of major issues and results follows:

1. What are the most frequent tasks performed during the contact mission, and on what supported systems?	Tasks in descending order of frequency: (a) power pack/train repairs (b) welding repairs (c) tire changes (d) broken bolt replacement

2. What systems are most frequently repaired?	Supported systems, in descending order of frequency: Heavy units: Trucks Support equipment Combat Veh/Weapons Systems Support vehicles Engineer vehicles Light units: Trucks M998 HMMWV general equipment Engineer units: all types construction equip
3. Does the repairer need access to tools from inside the enclosure or from outside the enclosure?	Outside.
4. What is the relative preference for the type of power tools?	Pneumatic. Electric tools are desirable as backup and alternates.
5. How often are two or more tasks done simultaneously that each require power?	No requirement documented, except for electrical light used with a power tool.
6. Is a common Engineer/Ordnance hand tool load, plus any supplements, adequate for the contact mission?	Yes.
7. Are there any other items of equipment identified as necessary above those in the requirements document?	No.
8. Will the elimination of 3/8" drive tools, leaving the 1/2" and 1/4" in place, significantly degrade the mission accomplishment.	Inconclusive.
9. Will the contact truck be required to remove track?	Occasionally.
10. Will the contact truck be required to repair tires?	Tire repair for tactical vehicles, no. Tire changing, frequently, on a variety of vehicles. However, tire repair for engineer equipment is necessary.
11. What distance from the supported equipment will the CMT routinely work?	20 feet, average (range=10' to 30')

12. What is the most likely welding task; thickness of metal; number of passes?	Inconclusive
13. Is a power metal spreader or jaws a necessary power tool?	Not evaluated.
14. How much curtained space is necessary for a blackout area?	Not evaluated.
15. How frequently is the system required to be airlifted by CH-47 internally and externally?	Not evaluated.

A summary of design issues follows.

1. Is the tool storage concept satisfactory to the repairer?	Access to tools storage from the outside was highly desirable. However, the height of the cabinet mounted on over the rear wheel well will be limited by the line of vision as the soldier looks into the uppermost drawer. Supplemental tool storage may be necessary from the rear of the enclosure.
2. Is there sufficient and well placed storage for tools, repair parts, crew equipment, and publications?	Yes.
3. What are the advantages/ disadvantages of the underhood versus APU welder power source?	The underhood welder was found to be equally reliable and effective, and more user friendly, than the APU powered welder.
4. Is the method of attachment the enclosure to the vehicle adequate?	Attachment of the enclosure to the vehicle by the manufacturer installed mounting points proved safe and adequate.
5. What is the best position to locate a work surface with vise.	Rear tail gate.
6. Blackout curtain.	Not evaluated.
7. Approximate relative payload weight of components:	Enclosure - 21% Parts, equip, supplies - 19% Soldiers & personal equip -18% Power Tool System - 13% Gas welding/cutting - 8% Other - 21%

A summary of conclusions follows.

1. The equipment required to support the contact mission can be subjected to risk analysis to determine the optimal equipment load.

2. In training exercises, wheeled vehicles require more automotive repairs than combat systems.

3. Primary access to tools and equipment should be from outside the enclosure.

4. Pneumatic power tools are preferred.

5. The power source for the contact truck can be sized to accommodate the maximum single power requirement, plus an electric light.

6. A common tool load for both Ordnance and Engineer is adequate.
7. While no other items of equipment were identified as necessary, a lightweight lift device would be a very useful additional item.

8. The issue of eliminating the 3/8 in drive is inconclusive.

9. Hand and power tool capabilities should be sized to enable track removal.

10. Tire repair is not a required capability.

11. Hoses and cords should be a minimum of 20 ft. Additional length over 30 ft. is not desirable because of the cube and weight penalties.

12. Although the welder was clearly a desirable and useful item, the most likely demands for welding capability remain undetermined.

13. The design and position of storage drawers and bins must be made with MANPRINT considerations for height, depth, and reach.

14. Operationally, the underhood welder is as acceptable as the APU powered welder.

15. Attachment of the enclosure will require no special provisions and therefore, remounting of the enclosure to another HHV is feasible.

16. A work surface located on the lowered tailgate is adequate.

17. The weight of the components will reasonably fall within the HHV maximum payload.

The field trials were concluded on 9 September 1992. This report concludes the CEP.

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SECTION I - GENERAL

1. General.

1.1. Authority. This Concept Evaluation Program (CEP) was conducted by the U.S. Army Ordnance Center and School (USAOC&S), the proponent, and the U.S. Army Engineer School, the co-proponent, under authority of Army Regulation 73-1, "Test & Evaluation Policy," 15 Oct 92) and TRADOC Reg. 71-3, "XXX," date. This CEP was approved and funded by TRADOC.

1.2. Purpose. The purpose of this CEP was to develop and refine combat developer requirements documents and evaluate the feasibility of selected commercial equipment.

1.3 Scope. The scope of this CEP included all considerations of the "contact maintenance" mission in light divisions and supporting corps assets, for both Ordnance and Engineer requirements.

1.4 Strategy. This CEP was accomplished by objective and subjective field evaluations. Evaluations were conducted during tactical exercises under unstructured field conditions. Some garrison activity data was also used.

1.5. Methodology. Each participating soldier was required to complete daily and post-trial Questionnaires. Trial Event Records (Appendix I) were also used to document unusual occurrences. Because of limited funding, no operational test agency was involved. Additionally, operational test agencies do not usually participate in TRADOC CEPs.

For each battalion-size trial, from one to three HHV-CMT prototypes were used, each with a different type Power Tool System (PTS). Each Iteration was on a voluntary, non-interference basis. Each evaluation lasted from 1 to 4 weeks; 12 Iterations were planned, 8 were completed.

For each participating unit, trials were conducted in three segments: a 1 day familiarization and training period; the "hands-on" trials; and, a 1 day follow-up evaluation. Field evaluations varied in length, from 7 to 30 days. Data was collected by USAOC&S non-commissioned officers on site, including weather conditions, HHV-CMT equipment failures and maintainability problems, and types and numbers of maintenance tasks completed.

Initially, this CEP was planned to primarily evaluate an commercial hydraulic power tool system, but it was expanded to also consider electric and pneumatic systems. Also, limited evaluations were to be made of the following commercial items: an "on-demand" air compressor, various type welders, and hand tools sets.

1.6. Objectives.

1.6.1 Define user requirements.

1.6.1.1. Determine optimum tool load.

1.6.1.2. Establish common tool load for Ordnance and Engineer.

1.6.1.3. Determine user preference for power tools.

1.6.1.4. Determine contact mission task profile.

1.6.1.5. Identify considerations for input to materiel developer.

1.6.2. Eliminate alternatives that become clear do not meet requirements.

1.6.3. Facilitate resolution of key design issues.

1.7. Documentation. The SECM O&O was approved by TRADOC on 3 Jan 91. The Operational Requirements Document was approved by TRADOC DDDD 1993.

1.8. Background.

1.8.1. Early CMT Versions. There are currently two prior generations of contact maintenance truck in the active Army inventory: the M887 (Dodge pickup) truck and the XXX Commercial Utility Cargo Vehicle (CUCV). The CUCV-CMT comes in three variants: Type I - EOD/Signal; Type II - Engineer; and Type III -Ordnance. The basic difference between Type II and III is that a welder is not included in #III, the Ordnance variant.

1.8.2. Need. The need for HHV-CMT system was based on urgent requirements identified by the 725th Maintenance Battalion, 25 Infantry Division. The 725th reported a critical shortage of M887 contact trucks. They indicated an improved system was needed with mobility and operational characteristics equal to the M998 HMMWV vehicles. Maintenance units in the 3rd Infantry Division, 82d Airborne Division, and 101st Air Assault Division confirmed this urgent need and also identified: (a) a need for lift capability and a winch; and, (b) various tools and equipment deficiencies. USAOC&S confirmed these needs by a visit in 2d quarter 1990 to 782nd Maintenance Battalion, 82nd Airborne Division. In DDD, USAOC&S submitted a Operational and Organizational Plan to TRADOC HQ to document the need for a 3d-generation contact truck. It was approved 3 January 1991.

1.9. Materiel Descriptions

1.9.1. General. The HHV-CMT consists of a shop set mounted on a Heavy HMMWV Variant (HHV), the M1097. The HHV gross vehicle weight is 10,000 lbs. with a payload of 4400 lbs., or approximately 2000 lbs more than the standard HMMWV. This provides the capacity to carry sufficient equipment to forward repair sites, which retaining the excellent mobility of the HMMWV.

1.9.2. Generic HHV-CMT.

The SECM Operational Requirements Document listed the following features of the contact maintenance truck.

Feature	Addressed in CEP
* HHV-CMT Enclosure	YES
* Power Tool System (PTS)	YES
* Arc Welding (1/16 to 1 1/2" ferrous and aluminum)	YES
* Oxy-acetylene gas cutting (5" ferrous)	YES
* 110 VAC utility power	
* Compressed Air Module	YES
* Power tools	YES
* Hand tools	YES
* Work surface & Vise.	YES
* Blackout curtain	NO
* Storage for TMs, crew gear, repair parts,	NO
& camouflage system.	NO

All equipment and sub-system were to be individually dismountable to retain maximum mission capability despite any individual component failure.

1.9.3. HHV-CMT Enclosures. The HHV-CMT enclosure is intended as an equipment storage shelter, not an interior work area. Three prototypes were fabricated by commercial sources: Iowa Mold and Tool Co, and XXX. Two prototypes were fabricated of aluminum, and a third of aluminum frame and fiberglass sheathing. There was also some variety in design of the access doors and cabinet locations.

1.9.4. Tools. A subordinate objective of this CEP was find a common solution for both Engineer and Ordnance functions, in order to avoid fielding two separate systems that had only minor variations. The approach used was to identify that total desirable components for both functions, combine the duplicative items (which amounted to over 70% of total components) and then decrement components on a jointly-worked, item-by-item basis to meet the weight objectives for the total equipment load. A common equipment load for both Ordnance and Engineer was agreed upon, which will allow a single system to be fielded for both applications.

1.9.5. Power Tool Systems. The CUCV-CMT was developed by AMCCOM, the materiel developer. It uses a power take-off driven 110v. generator mounted in cargo area and 110v. electric tools and equipment. HMMWVs do not have a power take-off (PTO) to drive a generator and therefore require an auxiliary power system (APU). This CEP evaluated 2 commercial APU types, which provided both electric power and power tools. One type APU powered the hydraulic tools by means of a pump mounted on the HHV engine. The second type used a small diesel engine mounted on the cargo bed.

In an effort to use technology to enhance efficiency and convenience for the soldier, the HHV-CMT requirements document specified a power tool system will be included to enable drilling, grinding, and wrenching. A major sub-evaluation of this CEP assessed three type of PTS: air, hydraulic, and electric. USAOC&S considered pneumatic power (tools) in a previous CEP, but this study did not address a battlefield power system.

Although the CEP did not attempt to evaluate the absolute best system, nor the specific commercial system, it did assess two factors:

Is there anything about any of the three systems that should eliminate it from consideration, such as safety, obvious inadequacy or unreliability?

What type system did the users prefer?

The intent was to provide the materiel developer with a preference to help him make an overall selection based on cost, availability and user preference. It also established a standard for power tools for other future systems. Details of the three PTS evaluated are at Appendix XXX.

1.9.6. Electric welder. Similar to the PTS evaluation, a second sub-evaluation was of the utility of an "Underhood welder" which tool power directly from an alternator mounted on the HMMWV engine. This welder could be used without an auxiliary power source. Details of the welding systems are at Appendix J.

1.9.7. Safety. Fully assembled prototypes were evaluated by TECOM and granted conditional safety released for the conduct of the CEP. No personnel injuries and no major equipment damage occurred.

1.10. Project Status. This Proponent Evaluation Report (PER) completes HHV-CMT CEP.

1.11. Summary of Field Trials. All three prototypes were available for the CEP, but not all prototypes were used during every field evaluation. In particular, the electric-power CMT was delayed in fabrication and did not arrive until trial #8. This did not impact on the CEP objectives, however, because both the hydraulic and pneumatic Power Tool Systems also provided power for electric tools. Consequently, the soldiers used for the evaluation of the Power Tool System were still able to evaluate the relative preference of the type of power tool, not the specific system. This was consistent with the goals of the CEP.

Eight trials were conducted from Dec 91 thru Sep 92 at 6 locations, including the National Training Center, Fort Irwin, CA. Trial #5, 3-28 April 92, was conducted by Aviation Log School at Ft. Campbell using Prototype #2 (pneumatic power). The results of that trial have not been included in this CEP.

1.12. Summary of Other Evaluations and Tests. In 1989 two pneumatic tool sets and compressors were evaluated during USAOC&S CEP #89-634 (Ref. Appendix D-9).

1.13. Threat. Because of the nature of the HHV-CMT, no unusual or unique threat, vulnerability, or NBC survivability concerns were observed.

1.14 Field Unit Points of Contact and USAOC&S Project NCOICs.

1.14.1 Commanders of participating field units:

Fort Drum

10th DISCOM, Ft.Drum - COL M. Koch

710th Maint Bn, 10th Inf Div (Mtn) - LTC J. Kipers

41st Eng Bn, 10th Inf Div (Mtn) - LTC J. Hickey

Fort Campbell

801st FSB, 101 Inf Div (Air Asslt) - LTC C. Hobby.

326th Eng Bn - LTC J. Wetherell

Fort Bragg

230th MSB (ARNG) - LTC Hughes

82nd DISCOM - COL S. Garrett

Fort Benning

324th FSB, 24 Inf Div - LTC R. Dale.

1.14.2 Personnel Requirements.

Engineer School Project Manager - CW4 Dornhoeffer, Engineer School DCD
CEP Manager - Mr. Pete Gerard, Ordnance Center DCD
Contact Truck Project Non-Commissioned Officers -

SFC John Kammler, Ordnance Center DCD
SFC Larry Williams, 16th Ord Bn
SSG Jeffrey Winger, 16th Ord Bn
SSG Mark LuGrain, 16th Ord Bn

SECTION II - ISSUE ANALYSES

2. Analyses.

2.1. Summary of Trials.

TABLE I - SUMMARY OF CEP TRIALS					
Trial #	DATE	LOCATION	USER	PROTOTYPES	# SOLDIERS
1	DEC 91	Ft Chaffee	701 FSB	Pneumatic	6
			41 ENG BN		
2	JAN 92	Ft Campbell	801 FSB	Pneumatic	8
				Hydraulic	
3	FEB 92	Ft Campbell	801 FSB	Pneumatic	14
				Hydraulic	
4	MAR 92	Ft Campbell	326 CBT ENGR BN	Pneumatic	4
				Hydraulic	
5	APR 92	Ft Campbell	Avn Log	None	N/A
6	MAY 92	Ft Bragg	230 FSB	Pneumatic	7
				Hydraulic	
7	JUN 92	Ft Benning	324 FSB	Pneumatic	6
				Hydraulic	
8	AUG 92	Ft Erwin	801 FSB	Pneumatic	8
			324 FSB	Hydraulic	
				Electric	

Total number of participating soldiers = 53

2.2. Contact Mission Tasks

2.2.1. Issue: What are the most frequent tasks performed during the contact mission, and on what supported systems?

2.2.1.1. Results:

Contact Mission Tasks, listed in order of decreasing frequency				
ACTUAL EXPERIENCE				**PERCEIVED**
Uncategorized Repairs		31%		Repairs to M113
Engine Repair/Replacement		24%		Welding
Welding		16%		Repairs to M60
Tire Changing		12%		Tire Changes
Broken Bolt Removal		12%		Broken Bolt Replacement

2.2.1.2. Criteria: Tabulated data of observed and reported tasks provided data for the ACTUAL EXPERIENCE data. Soldiers were also asked after each trial to provide their perception of the tasks performed.

2.2.1.3. Analysis & Discussion: Although the contact mission tasks covered a range of various repairs, only two-thirds of could be clearly categorized. This reflects the nature of non-combat repairs occurring forward in the operating area. However, the two-thirds of categorized tasks fell into only four areas, with nearly 25% of the total tasks being engine repair/replacement. This allows us to identify associated tools and equipment with the categorized tasks, while accepting some risk with the uncategorized tasks to conserve weight and cube. Obviously, the contact truck cannot carry all possible tools and equipment, and this analysis provides a decision tool to assemble the optimal equipment load.

Note that the tasks the mechanics PERCEIVED match well with the tasks actually experienced. This tends to validate their collective judgement on tasks, which is often the only practical data that is available to the decision maker. Given this, we should acknowledge that the mechanic himself is probably the best single judge of what equipment is needed for his mission. Therefore, we should reserve a reasonable amount of weight and cube to allow him to tailor his equipment above the authorized equipment load.

2.2.1.4. Conclusion: The equipment required to support the contact mission can be subjected to risk analysis to determine the optimal equipment load.

2.2.1.5. Other Considerations: While this task analysis reflects the non-combat repairs typically done, it does not address combat-inflicted repairs. However, the use of BDAR expedient repair kits to supplement the authorized equipment load may be a temporary solution until combat experience provided information to further tailor the equipment load for each unit.

2.2.2. Frequency of repair.

2.2.2.1. Issue: What systems are most frequently repaired?

2.2.2.2. Criteria: Tabulated data of observed and reported tasks.

2.2.2.3. Results:

Supported systems, in descending order of frequency:

Heavy units:
- Trucks
- Support equipment
- Combat Veh/Weapons Systems
- Support vehicles
- Engineer vehicles

Light units:
- Trucks
- M998
- general equipment

Engineer units:
- all types construction equipment

2.2.2.4. Analysis & Discussion: In both light and heavy units, wheeled vehicles required more frequency of repairs. This seems consistent with what should be expected for non-combat failures. In field exercises, wheeled vehicles experience as much or greater usage than combat systems, and those combat systems experience no combat failures. This provides no basis for conclusion about the incidence of repairs required during hostilities. Nor does it address the fire control, electronic, optical, or other non-automotive failures that render a system Non-Mission Capable.

2.2.2.5. Conclusions: In training exercises, wheeled vehicles require more automotive repairs than combat systems.

2.2.3. Access.

2.2.3.1. Issue: Does the repairer need access to tools from inside the enclosure or from outside the enclosure?

2.2.3.2. Criteria: Subjective responses from questionnaires.

2.2.3.3. Results: Of a total of 17 respondents, 16 replied "outside."

2.2.3.4. Analysis & Discussion: This issue is conclusive. Although the three vehicles offered a combination of inside and outside access to tools and equipment, no tasks were observed being performed inside the enclosure. All tasks were done on the vehicle being repaired, or aside the contact truck. Therefore, accessibility to tools was clearly needed from outside, where repairs were performed. Weather and light conditions were not factors. It was noted by mechanics and data collectors that top-hinged outside access doors provided some welcomed cover from both rain and sun.

2.2.3.5. Conclusions: Primary access to tools and equipment should be from outside the enclosure.

2.2.4. Power Tools.

2.2.4.1. Issue: What is the relative preference for the type of power tools?

2.2.4.2. Criteria: Evaluated as a major sub-element of the CEP by separate analysis. Detailed evaluation is at Appendix G.

2.2.4.3. Results: Pneumatic power tools were selected by three independent expert panels as the best type of power tools.

2.2.4.4. Analysis & Discussion: This issue is conclusive. Detailed discussion is at Appendix G.

2.2.4.5. Conclusions: Pneumatic power tools are preferred.

2.2.5. Simultaneous Tasks.

2.2.5.1. Issue: How often are two or more tasks done simultaneously that each require power?

2.2.5.2. Criteria: Observed tasks.

2.2.5.3. Results: With the exception of a droplight, simultaneous tasks were not performed at all.

2.2.5.4. Analysis & Discussion: This issue is conclusive. No incidents were observed or reported that required power for two tasks at the same time. The implication is that the power source can be sized to provide sufficient power for only one operation at a time, such as welding or power tools. The only exception is the requirement for an electric light, preferably of 110vAC, to be used in conjunction with other tasks.

2.2.5.5. Conclusions: The power source for the contact truck can be sized to accommodate the maximum single power requirement, plus an electric light.

2.2.6. Common Tool Load.

2.2.6.1 Issue: Is a common Engineer/Ordnance hand tool load, plus any supplements, adequate for the contact mission?

2.2.6.2. Criteria: Tabulated data of observed and reported tasks.

2.2.6.3. Results: A common hand tool load was achieved, and is identified at Appendix H.

2.2.6.4. Analysis & Discussion: This issue is conclusive. A comprehensive review of the hand tool load was done in several iterations by personnel from the Engineer School, the Ordnance Center, and AMCCOM. This tool load was based on the CUCV Shop Equipment, Contact Maintenance, Ordnance and Engineer versions, assembled prior to the CEP trials, and validated with minor modifications by CEP participating mechanics. Although minor alterations may still be required, a common tool load within the weight constraints of the HHV-CMT is practical. Participating CEP units did not add and significant numbers of supplemental tools to the issued load.

2.2.6.5. Conclusions: A common tool load for both Ordnance and Engineer is adequate.

2.2.7. Additional Equipment.

2.2.7.1. Issue: Are there any other items of equipment identified as necessary above those in the requirements document?

2.2.7.2. Criteria: Tabulated data of observed and reported tasks.

2.2.7.3. Results: No additional items were identified as necessary. A lightweight lifting device was identified as a highly desirable item.

2.2.7.4. Analysis & Discussion: No additional items were reported by participating mechanics as necessary for the completion of their missions. However, a lightweight lifting device was identified as very desirable to move and reposition transmissions, engine components, and other heavy items. This had been already identified by the Ordnance Center as a materiel item to be pursued separately from the HHV-CMT.

2.2.7.5. Conclusions: While no other items of equipment were identified as necessary, a lightweight lift device would be a very useful additional item.

2.2.8. Hand Tool Drive Set Size.

2.2.8.1. Issue: Will the elimination of the 3/8" drive tools, leaving the 1/2" and 1/4" in place, significantly degrade mission accomplishments?

2.2.8.2. Criteria: Subjective response of participating mechanics.

2.2.8.3. Results: Based 18 possible responses on HHV-CMT #2 during Trial #8:

16 no responses
1 Yes
2 No

2.2.8.4. Analysis & Discussion: This issue addressed the elimination of possible duplicative sockets with the intent of saving weight. The consideration was that if the sockets sizes remain constant and only the drive heads of the ratchet wrench were different, and yet each size wrench comes with a complete set of sockets, can only the 1/4" and 1/2" drive wrenches adequately fulfill the needs of the mechanic? The lack of responses from the participating mechanics does not allow a conclusion. Also, since the potential weight savings is a relatively small percentage of the entire equipment package, it was decided not to pursue this issue during the remainder of the CEP.

2.2.8.5. Conclusion: Inconclusive.

2.2.9. Removing Track.

2.2.9.1. Issue: Will the contact truck be required to remove track?

2.2.9.2. Criteria: Observed and reported tasks.

2.2.9.3. Results: 3 instances of breaking track were reported.

2.2.9.4. Analysis & Discussion: This issue addressed the nature of the contact mission in support of heavy forces. Repairs to a combat vehicle's track is usually a crew task. Alternatively, if the damage is severe enough that the crew cannot make repair, it may require evacuation to the unit maintenance collection point. If, however, some repairs can be done with the contact truck, the sizing of the hand and power tools should be such to accommodate the diameter and torque requirements of fasteners. During those trials in support of heavy forced, there were instances of the contact truck being used to assist the repair of tracked vehicle. It was not clear, however, whether this used of the contact truck's power tools were required or merely a convenience. Nevertheless, it seems clear within acceptable limits of increased weight/cube/RAM penalties, a tool system sized to enable track removal is desirable.

2.2.9.5. Conclusion: Hand and power tool capabilities should be sized to enable track removal.

2.2.10. Repairing Tires.

2.2.10.1. Issue: Will the contact truck be required to repair tires?

2.2.10.2. Criteria: Observed and reported tasks.

2.2.10.3. Results: No instances of repair tire were reported. However 7 instances of replacing tires were reported.

2.2.10.4. Analysis & Discussion: This issue addressed the possible need to carry tire repair equipment and supplies. Since these items would add considerable weight and cube, verification during the CEP was important. Tire replacement is a crew/operator task. The instances of the contact team performing tire replacement were more a function of the power tools than of any unique capabilities of the contact team. Power tools simply made the task quicker and easier.

2.2.10.5. Conclusion: Tire repair is not a required capability for tactical vehicles. However, because of the low-density of specialty engineer equipment, tire repair for engineers is necessary.

2.2.11. Working Distance from Repair.

2.2.11.1. Issue: What distance from the supported equipment will the CMT routinely work?

2.2.11.2. Criteria: Observed and reported tasks.

2.2.11.3. Results: 20 feet.

2.2.11.4. Analysis & Discussion: This issue was intended to address the required length of hoses and electric cords. Based on 8 responses, the average distance was estimated at 20 feet, with a range of 10 - 30 feet. It is recommended that hoses and cords be commercially available standard lengths up to 50 ft, in order to facilitate ease of replacement.

2.2.11.5. Conclusion: Hoses and cords should be a minimum of 20 ft. Additional length over 30 ft. is not desirable because of the cube and weight penalties.

2.2.12. Welding.

2.2.12.1. Issue: What is the most likely welding task; thickness of metal; number of passes?

2.2.12.2. Criteria: Observed and reported tasks.

2.2.12.3. Results: Inconclusive.

2.2.12.4. Analysis & Discussion: The data collected was insufficient to identify patterns that answer this issue. The tasks and thicknesses of metal were of a variety that reflects the random nature of non-combat repairs. In all, 20 welding tasks were reported, but only 7 of these were to repair deadlining faults. Data was not collected on the number of passes.

2.2.12.5. Conclusion: Although the welder was clearly a desirable and useful item, the most likely demands for welding capability remains undetermined.

2.2.13. Non-evaluated issues.

2.2.13. Is a power metal spreader or jaws a necessary power tool? Because of limitation of funds, time, and/or personnel resources, this issue was not evaluated during the CEP. However, lack of evaluation did not have an impact on the completion of the requirements document for the HHV-CMT.

2.2.14. How much curtained space is necessary for a blackout area? Because of limitation of funds, time, and/or personnel resources, this issue was not evaluated during the CEP. However, this issue must still be resolved prior to acquisition of the HHV-CMT. It is projected that this issue will be resolved by joint assessment by the combat and materiel developer at a later time.

2.2.15. How frequently is the system required to be airlifted by CH-47 internally and externally? Because of limitation of funds, time, and/or personnel resources, this issue was not evaluated during the CEP. However, lack of evaluation did not have an impact on the completion of the requirements document for the HHV-CMT.

2.3. Design Issues.

2.3.1. Tool Storage.

2.3.1.1. Issue: Is the tool storage concept satisfactory to the repairer?

2.3.1.2. Criteria: Subjective responses of participating mechanics.

2.3.1.3. Results: Overall, the tools storage concept is satisfactory.

2.3.1.4. Analysis & Discussion: The overall response to this question was positive. However, some recurring comments indicate potential shortcomings in specific areas. Those comments in reflected the following:

- the height of tool drawers cannot exceed the soldier's line of vision, so that he can see into the drawer.

- a gang lock mechanism is more desirable than individual door/hatch locks. Also, locks must be hasp and padlock type, not cylinder locks.

2.3.1.5. Conclusion: The design and position of storage drawers and bins must be made with MANPRINT considerations for height, depth, and reach.

2.3.3. Underhood Welder.

2.3.3.1. Issue: What are the advantages / disadvantages of the underhood versus APU welder power source?

2.3.3.2. Criteria: Observed performance and subjective response of participating mechanics.

2.3.3.3. Results: Inconclusive.

2.3.3.4. Analysis & Discussion: The underhood welder proved no operational disadvantaged versus the APU welder power source. To the contrary, users were impressed with the user friendliness of the underhood welder. No degradation of welding capabilities were observed or reported. However, since the fundamental difference in these welders is the power source, not the welding equipment or techniques, the mechanics feedback does not address the RAM considerations that might prove the underhood welder more or less desirable.

2.3.3.5. Conclusion: Operationally, the underhood welder is as acceptable as the APU powered welder.

2.3.4. Attachment.

2.3.4.1. Issue: Is the method of attachment the enclosure to the vehicle adequate?

2.3.4.2. Criteria: Observed performance.

2.3.4.3. Results: The proposed attachment is adequate.

2.3.4.4. Analysis & Discussion: This issue was intended to verify the feasibility of quick removal of the enclosure from the vehicle chassis. The requirements document called for the enclosure to be removable so that if the vehicle becomes non-mission capable, the equipment can be remounted on an alternate vehicle. For this to be feasible, the enclosure must not require special or permanent mounting requirements.

All three CEP vehicles were loaded to at least 95 percent of gross vehicle weight. Attachment on each was by bolts set into the manufacturer's pre-drilled mounting holes. All vehicles passed safety assessment by the Combat Systems Test Activity prior to being placed in the field. During trials, use of the vehicle over all terrain was unrestricted, with the exception of rail shipment. At the conclusion of the CEP, none of the vehicles or enclosures showed any sign of stress that would lead to detachment of the enclosure or unsafe attachment. While the CEP trials cannot substitute for pre-production testing, it is reasonable to conclude that the enclosure and equipment of the CMT, remaining within the weight and cube limitations of the vehicle, cause no extraordinary stresses on the vehicle and are within the design limitation of the vehicle payload.

2.3.4.5. Conclusion: Attachment of the enclosure will require no special provisions and therefore, remounting of the enclosure to another HHV is feasible.

2.3.5. Work Surface Location.

2.3.5.1. Issue: What is the best position to locate a work surface with vise?

2.3.5.2. Criteria: Subjective assessment of mechanics.

2.3.5.3. Results: Inconclusive.

2.3.5.4. Analysis & Discussion: No special work surface was provided on the CEP vehicles. A vise was place with removable mount on the left rear bumper of one of the vehicles. Therefore, no comparative data was collected on this issue. However, it was observed that mechanics regularly used the lowered tailgate as a shelf to place parts and tools, keeping them off of the ground. The tailgate was not, however, used as a work surface to perform component repairs. While side locations for a work surface may be feasible, this issue does not appear to impact on mission effectiveness.

2.3.5.5. Conclusion: A work surface located on the lowered tailgate is adequate.

2.3.6. Non-evaluated Issues.

2.3.6.1. Is there sufficient and well placed storage for tools, repair parts, crew equipment, and publications? Except for tool storage, insufficient data was collected to address total storage.

2.3.6.2. Is the blackout curtain concept satisfactory? Because of limitation of funds, time, and/or personnel resources, this issue was not evaluated during the CEP. However, this issue must still be resolved prior to acquisition of the HHV-CMT. It is projected that this issue will be resolved by joint assessment by the combat and materiel developer at a later time.

2.3.7. Weight.

2.3.7.1. Issue: What is the approximate relative payload weight of components?

2.3.7.2. Criteria: Approximate average weights derived during prototype fabrication.

2.3.7.3. Results:

Item	Weight (in lbs.)	Cumulative Weight	Candidate for weight reduction
Enclosure	750	750	No
Mechanics (2), plus gear	750	1,500	No
Power Tool System, incl APU	560	2,060	Yes
Gas welding/ cutting equip	300	2,360	No
Repair Parts	400	2,760	No
Hand tools	1000	3,760	Yes
Air Pump	100	3,860	Yes
Electric Welder	75	3,935	No
Vise	50	3,985	No
Blackout Curtain (not provided in CEP)	100	4,085	No
Camouflage System (not provided in CEP)	100	4,185	No

2.3.7.4. Analysis & Discussion: While these weights do not represent the final weights of the production equipment, they do demonstrate the entire equipment package called for in the requirements document can stay within the HHV maximum payload of 4400 lbs. This weight will accommodate all components, plus the crew and crew gear and 400+ lbs of repair parts and expendable.

2.3.7.5. Conclusion: The weight of the components will reasonably fall within the HHV maximum payload.

SECTION III. OVERALL EVALUATION AND CONCLUSIONS

3.1. A summary of major issues and results follows:

3.1.1. What are the most frequent tasks performed during the contact mission, and on what supported systems?	Tasks in descending order of frequency: (a) power pack/train repairs (b) welding repairs (c) tire changes (d) broken bolt replacement
3.1.2. What systems are most frequently repaired?	Supported systems, in descending order of frequency: Heavy units: Trucks Support equipment Combat Veh/Weapons Systems Support vehicles Engineer vehicles Light units: Trucks M998 HMMWV general equipment Engineer units: all types construction equip
3.1.3. Does the repairer need access to tools from inside the enclosure or from outside the enclosure?	Outside.
3.1.4. What is the relative preference for the type of power tools?	Pneumatic.
3.1.5. How often are two or more tasks done simultaneously that each require power?	No requirement documented, except for electric light used with a power tool.
3.1.6. Is a common Engineer/Ordnance hand tool load, plus any supplements, adequate for the contact mission?	Yes.
3.1.7. Are there any other items of equipment identified as necessary above those in the requirements document?	No.

3.1.8. Will the elimination of 3/8" drive tools, leaving the 1/2" and 1/4" in place, significantly degrade the mission accomplishment.	Inconclusive.
3.1.9. Will the contact truck be required to remove track?	Occasionally.
3.1.10. Will the contact truck be required to repair tires?	Tire repair for tactical vehicles, no. Tire changing, frequently, on a variety of vehicles. However, tire repair for engineer equipment is necessary.
3.1.11. What distance from the supported equipment will the CMT routinely work?	20 feet, average (range=10' to 30')
3.1.12. What is the most likely welding task; thickness of metal; number of passes?	Inconclusive
3.1.13. Is a power metal spreader or jaws a necessary power tool?	Not evaluated.
3.1.14. How much curtained space is necessary for a blackout area?	Not evaluated.
3.1.15. How frequently is the system required to be airlifted by CH-47 internally and externally?	Not evaluated.

3.2. A summary of design issues follows

3.2.1. Is the tool storage concept satisfactory to the repairer?	Access to tools storage from the outside was highly desirable. However, the height of the cabinet mounted on over the rear wheel well will be limited by the line of vision as the soldier looks into the uppermost drawer. Supplemental tool storage may be necessary from the rear of the enclosure.
3.2.2. Is there sufficient and well placed storage for tools, repair parts, crew equipment, and publications?	Yes.
3.2.3. What are the advantages/ disadvantages of the underhood versus APU welder power source?	The underhood welder was found to be equally reliable and effective, and more user friendly, than the APU powered welder.

3.2.4. Is the method of attachment the enclosure to the vehicle adequate?	Attachment of the enclosure to the vehicle by the manufacturer installed mounting points proved safe and adequate.
3.2.5. What is the best position to locate a work surface with vise.	Rear tail gate.
3.2.6. Blackout curtain.	Not evaluated.
3.2.7. Approximate relative payload weight of components:	Enclosure - 21% Parts, equip, supplies - 19% Soldiers & personal equip -18% Power Tool System - 13% Gas welding/cutting - 8% Other - 21%

3.3. A summary of conclusions follows.

3.3.1. The equipment required to support the contact mission can be subjected to risk analysis to determine the optimal equipment load.

3.3.2. In training exercises, wheeled vehicles require more automotive repairs than combat systems.

3.3.3. Primary access to tools and equipment should be from outside the enclosure.

3.3.4. Pneumatic power tools are preferred.

3.3.5. The power source for the contact truck can be sized to accommodate the maximum single power requirement, plus an electric light.

3.3.6. A common tool load for both Ordnance and Engineer is adequate.

3.3.7. While no other items of equipment were identified as necessary, a lightweight lift device would be a very useful additional item.

3.3.8. The issue of eliminating the 3/8 in drive is inconclusive.

3.3.9. Hand and power tool capabilities should be sized to enable track removal.

3.3.10. Tire repair is not a required capability.

3.3.11. Hoses and cords should be a minimum of 20 ft. Additional length over 30 ft. is not desirable because of the cube and weight penalties.

3.3.12. Although the welder was clearly a desirable and useful item, the most likely demands for welding capability remain undetermined.

3.3.13. The design and position of storage drawers and bins must be made with MANPRINT considerations for height, depth, and reach.

3.3.14. Operationally, the underhood welder is as acceptable as the APU powered welder.

3.3.15. Attachment of the enclosure will require no special provisions and therefore, remounting of the enclosure to another HHV is feasible.

3.3.16. A work surface located on the lowered tailgate is adequate.

3.3.17. The weight of the components will reasonably fall within the HHV maximum payload.

SECTION IV. APPENDICES

Appendix A. Heavy HMMWV Contact Truck Requirements Document (extract).

Appendix B. Vehicle Prototype & Equipment Detailed Data.

Appendix C. CEP Plan (PERT Graphic)

Appendix D. TECOM Safety Releases.

Appendix E. Sample Data Collection Forms.

Appendix F. Underhood Welder Information Paper.

Appendix G. Power Tool Selection Process and Results.

Appendix H. Generic Hand Tool List.

Appendix I. Photographs.

Appendix J. Report Distribution.

Appendix A -- Operational Requirements Document (ORD)(Extract)

OPERATIONAL REQUIREMENTS DOCUMENT

FOR

SHOP EQUIPMENT, CONTACT MAINTENANCE (SECM), HIGH MOBILITY MULTIPURPOSE WHEELED VEHICLE (HMMWV) HEAVY VARIANT (HHV) MOUNTABLE

1. General Description of Operational Capability.

a. The contact maintenance mission is a direct support maintenance mission that is part of the FIX Capability Package in the Combat Service Support Battlefield Functional Mission Area. The contact maintenance mission has been approved doctrine for many years and continues to be a critical part of maintenance requirements to support a Force Projection Army. The SECM Operational and Organizational Plan, CARDS Reference Number 1662P, was approved 3 Jan 91. The mission involves a team of DS mechanics with a tailored tool load plus repair parts that move to the site of the disabled combat equipment as far forward as the first terrain feature behind the FLOT. They make repairs or assist the crew/unit repairers to allow equipment to continue its mission either fully operational or in a degraded mode, or to "limp home" without a recovery vehicle. Repairs are done in all weather, climatic, and light conditions for all types of tracked, wheeled, engineer, armament, and generator equipment.

b. The SECM is a self-contained tool and equipment package that will mount on an HHV to form a contact maintenance truck (CMT).

2. Threat. The SECM/HHV-CMT will not defeat a specific threat capability. Its purpose is to limit the attrition of mission essential equipment by enemy action, accidents, and maintenance breakdowns and to enhance sustainment of the force. The threat to the SECM depends on the battlefield location and the threat's ability to engage the supported unit.

3. Shortcomings of Existing Systems. Number 29 in the 1994-2008 Battlefield Development Plan addresses the need to provide improved cross-country mobile maintenance support to maneuver elements. The current CMTs, the gasoline-engine M887 Dodge Truck and the CUCV-CMT, are unable to traverse the terrain or maintain the speed to keep up with supported equipment while carrying tools and repair parts. The M887 fleet is overaged and due for retirement. Neither the M887 nor the CUCV-CMT are compatible with the desired "pure fleeting" of HMMWVs in the light divisions.

4. Capabilities Required.

a. System Performance. The SECM, in conjunction with its HHV:

(1) Must include weight allowance and storage space for a minimum of 400 pounds of expendable supplies and repair parts and 320 pounds of personal equipment for its two crew members (160 pounds per crew member). It is desirable the HHV-CMT also be capable of carrying a standard Army camouflage system.

(2) Must provide tools and equipment as specified in Supply Catalog (SC) 4940-95-B25/B26.

(3) Must provide efficient power tools to drill holes in metal and turn nuts with up

to no less than 150 foot-pounds of torque. Torque capability of 300 foot-pounds is desirable. It is desirable to have a power tool to cut sheet metal at least 1/16 inch thick and spread metal with at least two tons of force.

(4) Must provide electric lighting both inside and outside the enclosure.

(5) Must provide electrical power sufficient to operate onboard electrical equipment and power lights while powering tools or arc welding. It is desirable to be able to perform two tasks simultaneously while lights are also used.

(6) Must provide a capability to electric arc weld ferrous metals and aluminum ranging in thickness from 1/16 inch to 1 1/2 inches.

(7) Must provide capability to gas cut steel up to 5 inches thick and to gas weld and braze metal.

(8) Must provide compressed air on demand with sufficient pressure and volume, approximately 120 pounds per square inch and 5 cubic feet per minute, for cleaning air filters and other parts in addition to inflating repaired tires. It is desirable to have a suction air flow device also to "vacuum" dust and dirt from interior engine components.

(9) Must provide an external work surface of no less than 4 square feet with a replaceable surface of wood or some other resilient material. It is desirable that this workstation be at the right rear of the vehicle.

(10) Must provide a securely mounted rotating vise with minimum of 4 1/2 inch jaws. It is desirable the vise be mounted or easily attachable to the rear of the vehicle or to the resilient work surface. The working position of the vise must have a minimum of 12 inches clearance from the HHV or the enclosure.

(11) Must provide capability to operate power tools and conduct welding and cutting operations up to a minimum of 50 feet from the SECM.

(12) Must operate within parameters established for the XM1097 HHV. It must have mobility as good as the HHV loaded to GVWR. It will travel over primary and secondary roads and deploy cross-country to equipment repair sites.

(13) Will not degrade the HHV towing capability.

(14) Should provide removable blackout curtain or shroud to enable the repairers to work on equipment in blackout conditions. This could be as simple as a flat piece of material with minimum dimensions of 26 foot by 26 foot.

(15) Should permit the installation and use of a self-recovery winch on the HHV.

b. Logistics and Readiness.

(1) The SECM will not degrade the operational effectiveness of the HHV.

(2) SECM will be supported by existing Army maintenance and supply systems, standard tools, and current MOS qualified personnel. It will not require any special tools for maintenance or for installation on the HHV.

(3) Battle Damage Assessment and Repair (BDAR) techniques will be applicable to the SECM.

(4) SECM components, with the exception of built-in shelving or cabinets (if any are built-in), must be individually dismountable by the owning unit.

(5) Auxiliary Power Unit (APU), if required to power equipment, must operate on diesel fuel/JP8.

c. Critical System Characteristics.

(1) The SECM must mount on an M1097 HHV. The weight of the SECM and HHV when loaded with crew, equipment, and spare parts will not exceed the Gross Vehicle Weight Rating (GVWR) of the HHV. The SECM will not degrade the mobility of its HHV more than any other load of the same weight.

(2) The SECM must be transferable from one HHV to another using top lift. Drilled mounting points, if required, are the only permanent alterations to the HHV acceptable when mounting a SECM.

(3) The SECM must provide a semi-fixed means to connect the 24 volt electrical system of the SECM with the 24 volt system of the HHV.

(4) The SECM must provide a padlock secured, weather protected means to store and transport tools and equipment.

(5) The SECM must provide convenient external access to tools and maintenance equipment. It must provide convenient access to repair parts and the crew's personal equipment. It is desirable that the most frequently used tools and equipment be accessed from the right side of the SECM.

(6) The internal floor to ceiling height of the enclosure must be no less than 59 inches. It is desirable to have a roof that can be raised to a minimum of 74.4 inches above the floor and that is fully removable.

(7) The SECM must have a one-person "jumpseat."

(8) The SECM will permit the installation and use of appropriate SINCGARS or VRC 12 series radio, in secure, single network configuration, and position navigation (POSNAV) equipment in its associated HHV.

(9) The SECM must be NBC contamination survivable. It must be decontaminable to negligible risk levels and be hardened against NBC agents and the decontaminating process.

(10) The SECM must be survivable in a high-altitude electromagnetic pulse (HEMP) environment consistent with the survivability of the HHV. It must not degrade the HEMP hardening of the host HHV.

(11) The SECM will operate in climatic design types Hot, Basic, and Cold, as defined in AR 70-38. It must operate under all adverse weather conditions of these climatic design types.

(12) The SECM will operate in field conditions in both wartime and peacetime throughout the battlefield.

(13) The SECM, alone and in combination with the HHV, must be capable of unrestricted highway, rail and marine transport worldwide and must be capable of transport in C130 and larger aircraft. The SECM in combination with the HHV must be externally transportable by CH-47 helicopter. It is desirable that the SECM alone be externally air transportable. The SECM must use standard military lifting and tiedown provisions.

(14) The SECM must be able to rest upright and allow internal access and operation of the equipment when it is removed from the HHV. It is desirable that the SECM be self supported when removed from the HHV and not require additional blocking or bracing.

5. Integrated Logistics Support (ILS).

a. Maintenance Planning. The SECM will not require depot level maintenance. It is desirable to have all maintenance repair tasks done by the owning unit or by direct support. Components of the SECM will require preventive maintenance by the user. Torque wrenches and multimeters listed in the supply catalogs will require standard calibration.

b. Support Equipment. Using and supporting units will require no additional equipment to support the SECM.

c. Human Systems Integration.

(1) Fielding the SECM will have no effect on existing manpower or personnel structure.

(2) The primary operators and maintainers of the SECM will be in Career Management Field (CMF) 63. Operators and maintainers will hold Military Occupational Specialty (MOS) 44B, 52D, 62B, 63H, or 63W. Soldiers with MOS 63B and 63G may also maintain the SECM. Due to the skill level requirement to conduct contact maintenance operations, the senior crew member will most likely be a Staff Sergeant or a Sergeant, and the junior crew member will most likely be a Sergeant or a senior Specialist Four.

(3) It is a MANPRINT constraint that the SECM design accommodate operation and maintenance by the majority of the target audience wearing the full range of protective garments, including arctic; ballistic; and nuclear, biological, and chemical (NBC). It is a MANPRINT goal that the SECM design accommodate operation by the entire target audience.

(4) Operators with MOS 62B, 63H, or 63W will need additional welding instruction in order to make optimum use of the welding equipment on the SECM. It is most likely that this training will be conducted during the technical phase in the Basic Noncomissioned Officer Course (BNCOC). The SECM will require no other new training.

d. Computer Resources. None required at present. However, at a future date, when artificial intelligence expert diagnostic systems are available it is desirable to incorporate those portable computer assets into the SECM equipment load.

e. Other Logistics Considerations. The SECM will be fielded mounted mounted on its associated HHV. The Materiel Developer will provision spares for SECM components.

6. Infrastructure Support and Interoperability.

a. Command, Control, Communications, and Intelligence. Voice radio communications are desirable. The SECM will not interface with any command, control, and communications systems except by standard radio communications.

b. Transportation and Basing. The SECM will be deployed to the theater by air (C130 and larger), rail, ship, or self-deployment. It will be deployed in theater by air (C130 or CH47), rail, or self-deployment. The SECM will almost always be transported in combination with its HHV. However, should its HHV be damaged beyond repair, the SECM may be transported alone until a replacement HHV is obtained. The SECM will use standard military lifting and tiedown provisions. The SECM will not require any new facilities for basing.

c. Standardization, Interoperability, and Commonality. NATO interoperability will be considered by using NATO Standard cable connections where necessary and by including metric sized tools in the tool load. The US Marine Corps has similar requirements to those of this system. They do not have a system under development to meet their need. The SECM is a JOINT POTENTIAL system.

d. Mapping, Charting, and Geodesy Support. None Required.

e. Environmental Support. None Required.

7. Force Structure.

a. The SECM with HHV will replace, on a one for one basis, the Shop Equipment, Contact Maintenance, Truck Mounted, LIN T10138, and the Shop Equipment, Contact Maintenance, CUCV Mounted, LINs S30914 and S30982 (Engineer and Ordnance Variants) in combat divisions, separate brigades, armored cavalry regiments, and corps engineer units. Two SECM with HHV will be added to special operations support battalions. The SECM will be issued with the XM1097 HHV as an Associated Support Item of Equipment (ASIOE). The following Tables of Organization and Equipment (TOE) will require the SECM:

> 05025, 05035, 05045, 05107, 05113, 05127, 05143, 05145, 05147, 05155, 05157, 05165, 05215, 05255, 05445, 31705, 43007, 43008, 43009, 43058, 43067, 43068, 43079, 43146, 43147, 43187, 43197, 43509, and 43510.

b. Fielding will be by Force Package. Force Package I requirements are 356, Force Package II requirements are 467, and Force Package III requirements are 312. Current funding plans support only Force Package I. CUCV-CMTs will be displaced to lower priority units. M887 chassis will be retired when possible.

8. Schedule Considerations.

a. IOC and FOC. The SECM is not employed in numbers; each is capable of performing the contact maintenance mission. Therefore, Initial Operational Capability (IOC) is not depended on a specific number of SECMs being fielded. However, to eliminate the deficiencies of the older type CMTs, IOC can be defined as that point when the first combat division has received its total authorized SECMs and their associated HHVs. The division will then be capable of providing the timely contact maintenance it requires. Full Operational Capability can be defined as that point when all combat divisions, separate brigades, armored cavalry regiments, and corps engineer units, both active and reserve, have received total authorized SECMs and their associated HHVs. A heavy division requires 27 SECMs. A light division requires 10 SECMs. A heavy separate brigade and an armored cavalry regiment each require 6 SECMs.

b. Fielding Schedule. The SECM should be fielded in parallel with the availability of the HHV. If this occurs any later than FY 93, the CMT will be the only exception to "pure fleeting" of

HMMWVs in the active duty light divisions. This would increase logistical burden and degrade support capability. The Army's Long Range Research, Development and Acquisition Plan (LRRDAP) provides FY 96-97 funding for the SECM.

Appendix B -- Vehicle Prototype & Equipment Detailed Data.

1. Vehicle Payloads:

	payload (lbs)
HMMWV (M998)	2500
CUCV	3600
M880	4200
Heavy HMMWV	4400

- HMMWV family -

	M998	M1037	HHV M1097
Curb	5200	5424	5601
Payload	2500	3236	4400
GVW	7700	8660	10,001

2. HHV-CMT Prototype Components descriptions & physical characteristics:

HHV-CMT Prototype #1(Hydraulic APS)	#2(Electric APS)	#3(Pneumatic APS)
a. Enclosure.		
Supplier		
SouthWest Mobile Corp.	Iowa Mold & Tool	Iowa Mold && Tool
Material		
frame & sheet steel.	fiberglass.	fiberglass.
Access		
from Outside	from Outside	from Inside
Number of doors		
5 doors.	5 doors.	3 doors.
Canopy		
No.	Yes.	Yes.
Double Floor		
No.	Yes.	Yes.
Gear Storage		
Yes.	No.	No.
Weight (approx. lbs/empty)		
750	750	750
b. Auxiliary Power		
Underhood(vehicle) powered hydraulic	Electric APU	Pneumatic integrated system
c. Compressor		
Integrated	CompAir Kellogg electric-driven 10 PUTS rotary sliding-vane	Integrated

d. Welder

Miller DC Inverter XMT 200 CC/CV.

Lestex/Resco Mfg.Co. SST-130 high freq.; (rectified)(alternator); Miller S-32P8 Wire Feeder, Gun, accessories.

Miller DC Inverter XMT 300 CC/CV

e. Generator

Integrated   8.5 kw Pow'r Gard Integrated

3. Auxiliary Power Systems Descriptions

a. Hydraulic APS. Prototype #1 was outfitted with the Stanley "HITS-III" APS designed to support operation of a full-size welder and other hydraulic tool operation simultaneously. This APS consisted of following components:

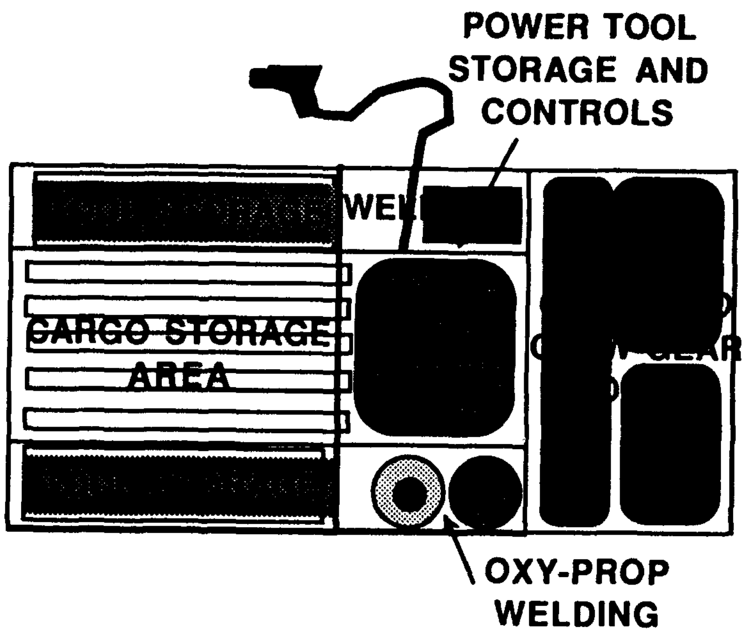
- Pump, with electric clutch; mounted "underhood"; fixed displacement, variable volume, belt driven; delivers 21 gpm at 2150 psi.
- Governor (for M998 engine); Reservoir (15 gal.); Filter and Flow Splitter.
- Hoses (supply/return); Control Manifold; Oil Cooler; and, Reel/Hose Set.

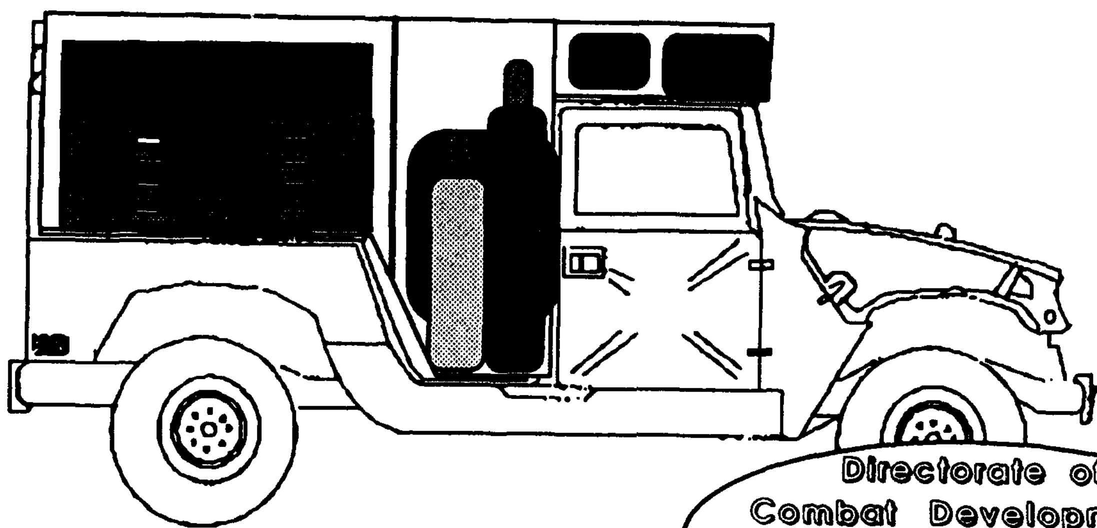
Stanley also provided: (a) Generator, 8.5 kw, 1 ph. 120/240 v. driven by 2-stage hyd. motor; (b) Welding Module (Miller, XMT 200 CC/CV), a 230v., 49 amp, 6.35 kw DC unit; (c) Compressed Air Module (2400 hydraulic-driven comp., 24 cfm, "on-demand"); and,(d) power hand-tools (IW08 and IW12 1/2" and 3/4" Impact Wrenches; DL08 1/2" Drill; and, GR29 & HG60 (6" and 9") Grinders. A CO23 14" dia. Cutoff Saw was also provided but not evaluated.

b. Electric APS. Prototype #2 outfitted by OC&S included a diesel-driven 8.5 kw electric APU procured by AMCCOM from T & J Mfg., Inc., Oshkosh, WI. This APU consisted primarily of a Pow'r Gard model DG8E 1 phase, 120/240 v. 3600 rpm generator; and, a diesel Deutz/Ruggerini 16 hp 3600 rpm 2-cylinder engine (Ser #. 0337-107873). This engine had a 24 v. starter but no battery; it was slave started from HHHWV. An air compressor and an "under-hood" welder were also procured by AMCCOM. The air compressor was a CompAir/Kellogg model 10 PUTS (Ser# HS201693) 2-hp rotary sliding-vane unit. The welder was a Resco SST-130 rectified high-frequency DC unit with a Miller S-32P8 wire feed gun and accessories. AMCCOM also provided the following power hand-tools: A 24v. Aircraft Dynamics Robotool 1/2" Impact Wrench; a 24v. Robotool Model 1001 Straight 1/2" Variable Speed, Reversing Drill; a 110v. Sioux 1/2" Impact Wrench; and, a 110v. Milwaukee Model 6140 4" Cutter/Grinder. By replacing the existing M998 60 amp (or 100 ampoption) alternator with the 200 amp unit (currently used on the M997 Ambulance), an electric APS is a possibility. Optional 100 amp is standard on the M1037 Shelter Carrier. M1069 HHV ambulance and Standardized Integrated Command Post System (SICPS) variants will use a 200 amp unit; a 300 amp unit may be an option. The 60 and 100 amp alternators weigh about 30 lb.; a 200 amp, 50 lbs; and, a 300 amp is approximatelyn 75 lbs.

c. Pneumatic APS. Prototype #3 included the modified Ingersol-Rand Air Powered Tool System (IRAPTS) "650 RD" pneumatic APS. One "650 RD" was modified by Ingersol-Rand / Iowa Molt Tool (IMT) by adding a 6.5 kw alternator, as required by USAOC&S CEP needs. Approximately 60 IRAPTS 650 RD systems (without alternator) were purchased by the U.S. Marine Corp in 1992. The modified "650 IRAPTS" is 46"(l) x 26"(w) x 24"(h) and was driven by a 16 hp, 3700 rpm Ruggerini 151 diesel engine. A battery was not included because the 24 v. electric starter was slaved off vehicle NATO receptacle. The 6-cylinder 1500 rpm 50 cfm/90 psi IMT air-cooled aluminum compressor and 6.5 kw Onan 3600 rpm alternator (model "YCB-3S") were driven by groved power belts. Either but not both of these two components operate at a given time (no simultaneous operation). IR also provided the following power hand-tools: IR #2705 1/2" Impact Wrench; IR #2920 1" Impact Wrench; IR #7AQ4 1/2" drill motor; and a # TXA 135 Grinder. IR also provided a fuel transfer pump and an M1 filter "T-Bar" cleaning wand.

HHV-CMT GENERIC LAYOUT





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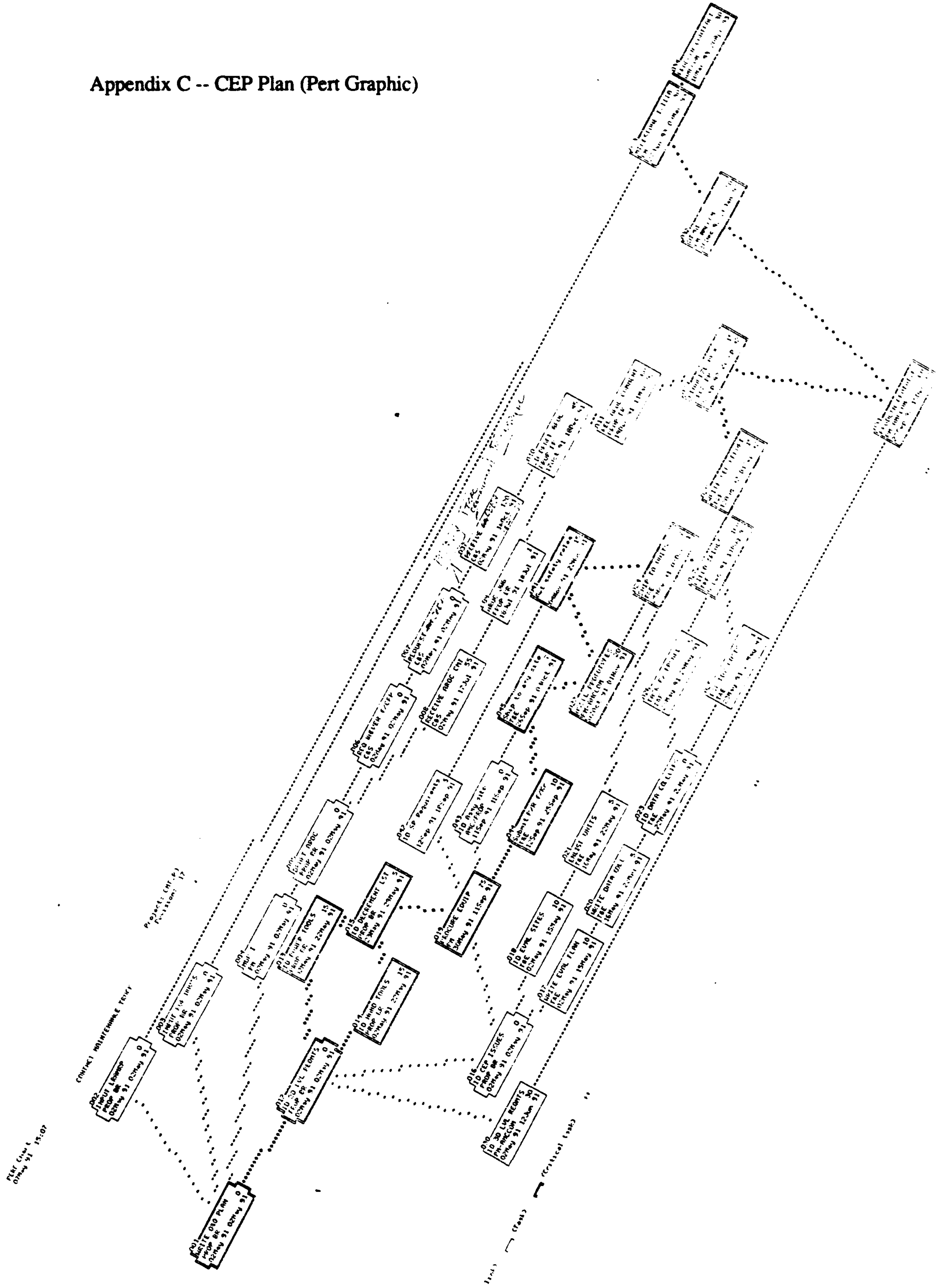
Center & School

Appendix C -- CEP Plan (Pert Graphic)



Appendix D -- TECOM Safety Releases

Documents follow.

(SOP MP 70-6)

<table>
<tr><td>Test Record No:
AE-T-59-92</td><td>Test Record</td><td>Date of record:
7 JUL 1992</td></tr>
<tr><td>Date(s) of Test:
21 October 1991 through
5 June 1992</td><td>Combat Systems Test Activity
Aberdeen Proving Ground, MD
21005-5059</td><td>Authority: TECOM Test
Directive, AMSTE-TA-T,
10 April 1991</td></tr>
<tr><td colspan="2" rowspan="3">Type of Test: USATECOM Project No: 8-ES-645-000-007
Safety Testing of the Contact Maintenance Vehicle</td><td>Requesting Agency:
TECOM - AMSTE-TA-T</td></tr>
<tr><td>Contract No:
Not available</td></tr>
<tr><td>Work Order No:
330-26201-70</td></tr>
<tr><td colspan="3">Object of Test
The objective of the test was to provide safety testing to support a safety release for the High Mobility Multipurpose Wheeled Vehicle Contact Maintenance Vehicle (HMMWV CMV).</td></tr>
<tr><td colspan="3">Test Item
Three contact Maintenance Vehicles developed by the U.S. Army Ordnance Center and School.</td></tr>
<tr><td colspan="3">Test Facilities
Bldg 436 - Field Engineering Shop: Munson Automotive Test Area;
Perryman Automotive Test Area.</td></tr>
</table>

Test Record No: AE-T-59-92 (continued) Use additional sheets if required.

REMARKS

The Contact Maintenance Vehicle (CMV) is a 'ligh Mobility Multi-purpose Wheeled Vehicle (HMMWV) with a special enclosure that contains a variety of hand and power tools and a power unit. There are three different CMV prototypes, each of which have a different power unit. Prototype number one has a hydraulic power unit. Prototype number two has an electric power unit and prototype number three has a pneumatic (compressed air) power unit.

The requirements of this test were to evaluate three Contact Maintenance Vehicles for safety. The testing done on the CMVs included weights, C.G., side and longitudinal slopes and a 100 mile road test. The results of the CMVs performance testing is contained in enclosure 1. The test results were compared to other known HMMWV/Shelter combinations to validate the CMVs vehicular stability. The 100 mile road test was to verify the CMVs enclosure integrity. A CMV is shown in figure 1 (enclosure 2). A safety evaluation was also conducted on the CMV's special enclosure and its contents. This evaluation was comprised of a review of the operators manuals and other written material, a visual inspection and the operation of all of the power tools. Safety Release Recommendations were issued for all three of the CMVs. The results of the testing done was positive. The weights and CG of the CMVs were within known parameters of other HMMWV/Shelter combinations. The CMVs were stable and displayed no undersireble handling characteristics on the side and longitudinal slopes. There were no incidents during the road test. There were no safety hazards found on the CMVs that would have prevented them from further testing.

This is the final report on this task.

3 Encls
as

OBSERVERS

Brian E. Frymiare - CSTA, Test Director
Mike Forman - CSTA, Field Engineering Branch Engineer

Signature:

BRIAN E. FRYMIARE, Test Director

LARRY W. OVERBAY, Dir, A&SED, CSTA

Distribution:
See enclosure 3

This test record signifies that the requested testing has been completed. It does not constitute approval or disapproval of the test item by Aberdeen Proving Ground.

REPORT NO. 92-IM(F)-23.
COMBINED REPORT FOR
SAFETY TESTING OF CONTACT MAINTENANCE VEHICLE
TECOM Project No. 8-ES-645-000-007

1. WEIGHT AND CENTER-OF-GRAVITY.

a. Objective. The objective was to determine the weight distribution and center-of-gravity (CG) of the vehicle; these results were compared with previously tested HMMWVs to determine if the vehicle was outside the envelope of known HMMWV/shelter combinations.

b. Test Procedure. The following TOPs were used as guidance during testing:

1) 2-2-800, Center-of-Gravity, 3 December 1981.

2) 2-2-801, Weight Distribution and Ground Pressure, 7 August 1981.

The weight exerted on the ground by the four individual wheels was measured on calibrated scales. Total vehicle weight was then determined by the summation of the four individual weights.

The vehicle CG location was determined by the reaction method for the longitudinal and vertical planes. For this method, the vehicle was lifted at one end and pivoted at the other. A loadcell was used to determine the weight of the lifted end of the vehicle. A vertical line was projected at the calculated CG location. The lifted and pivoted ends were reversed and a second vertical line was projected. The intersection of the two lines defined the vertical CG of the vehicle. The weighing method was used to determine the transverse CG of the vehicle. The weight exerted on the ground by the wheels and the wheel spacings were used to find the lateral CG of the vehicle.

c. Test Results. Weight distribution characteristics of the vehicle are presented in Table 1.

TABLE 1. WEIGHT DISTRIBUTION

	CMV No. 1		CMV No. 2		CMV No. 3	
WHEEL	kg	lb	kg	lb	kg	lb
LF	870	1918	792	1745	777	1714
RF	848	1870	778	1715	830	1830
LR	1285	2832	1077	2375	1120	2469
RR	1435	3163	1133	2497	1195	2635
TOT	4438	9783	3780	8332	3922	8648

The CG locations are presented in Table 2.

TABLE 2. VEHICLE CENTER-OF-GRAVITY

Direction Location	Distance CMV No. 1 mm	in	CMV No. 2 mm	in	CMV No. 3 mm	in
Longitudinal						
Forward of rear axle centerline	1285	50.6	1375	54.1	1362	53.6
Vertical						
Above rear axle centerline	553	21.8	553	21.8	547	21.5
Above ground level	965	38.0	957	37.7	959	37.8
Lateral						
Right of vehicle longitudinal centerline	26	1.0	10	0.4	30	1.2

For comparison, the CG location of a M1037 HMMWV and a XM1097 HHV with a S250 shelter with a vehicle weight of 4065 kg (8961 lbs) and 4513 kg (9943 lbs) is presented in Table 3.

TABLE 3. COMPARISON VEHICLE CENTER-OF-GRAVITY

Direction Location	Distance M1037 mm	in	XM1097 mm	in
Longitudinal				
Forward of rear axle centerline	1266	49.8	1170	46
Vertical				
Above ground level	1055	41.5	1150	45
Lateral				
Right of vehicle longitudinal centerline	30	1.2	50	2

d. Assessment. As shown in Tables 2 and 3, the CG location of each CMV was lower and forward of the previously tested M1037 HMMWV and XM1097 HHV. There should not be any problem with weight transfer to the front axle during braking since the CG is lower on the CMV. Therefore, the CMV would tend to be a more stable vehicle configuration. The CMV's performance should be as good or better than that of the previously tested HMMWV. Its test results are presented in Table 4.

TABLE 4. COMPARISON M1037 HMMWV STEERING PERFORMANCE

NATO LANE CHANGE RESULTS

Maximum Speed, km/hr	62.8

SKID PAD RESULTS

	Left Steer	Right Steer
Road Speed, km/hr	39.4	39.4
Lateral Accel, g's	0.44	0.40

2. GRADEABILITY AND SIDE SLOPE OPERATION.

a. Objective. The objective was to assess the safety of operation of each version of the CMV.

b. Test Procedure. The TOP 2-2-610, Gradeability and Side Slope Operation, 18 July 1980 was used as guidance during testing.

The vehicle was operated in both directions on the 60 percent longitudinal and 40 percent side slopes. While parked on each slope in both directions, the engine was shut-down for a duration of two minutes and then restarted to assure starting capability.

c. Test Results. The vehicle satisfactorily negotiated the 60 percent longitudinal and 40 percent side slopes in both directions. The engine shutdown/restart sequence was satisfactorily performed.

The CMV vehicle inclination relative to the slope while on the 60 percent longitudinal grade is shown in Table 5. This measurement is related to the weight transfer to the lower axle of the vehicle on the slope.

TABLE 5. VEHICLE INCLINATION ON 60 PERCENT LONGITUDINAL GRADE

Direction of Vehicle	Vehicle Inclination, deg		
	CMV No. 1	CMV No. 2	CMV No. 3
Uphill	0.7	1.3	0.7
Downhill	3.3	2.9	2.1

The vehicle inclination relative to the slope while on the 40 percent side slope is shown in Table 6. This measurement is related to the weight transfer to the lower side of the vehicle on the slope.

TABLE 6. VEHICLE INCLINATION ON 40 PERCENT SIDE SLOPE

Direction of Vehicle	Vehicle Inclination, deg		
	CMV No. 1	CMV No. 2	CMV No. 3
Left Side Up	5.1	5.4	6.7
Right Side Up	6.0	6.0	6.4

d. Assessment. The performance of each version of the CMV on longitudinal and side slopes was considered satisfactory and comparable to previously tested HMMWVs.

(SOP MP 70-6)

Test Record No: AE-T-68-92	Test Record	Date of record: 17 DEC 1992
Date(s) of Test: 22 September 1992 through 16 October 1992	Combat Systems Test Activity Aberdeen Proving Ground, MD 21005-5059	Authority: TECOM Test Directive, AMSTE-TA-T, 10 April 1991
Type of Test: USATECOM Project No: 8-ES-645-000-007 Safety Testing of the Contact Maintenance Vehicle		Requesting Agency: TECOM - AMSTE-TA-T
		Contract No: Not available
		Work Order No: 330-26301-70

Object of Test

The objective of the test was to provide noise level tests and vehicle weights of the High Mobility Multipurpose Wheeled Vehicle (HMMWV) Contact Maintenance Vehicle (CMV).

Test Item

Three contact Maintenance Vehicles developed by the U.S. Army Ordnance Center and School.

Test Facilities

Munson Automotive Test Area.

REMARKS

The Contact Maintenance Vehicle (CMV) is a High Mobility Multi-purpose Wheeled Vehicle (HMMWV), with a special enclosure that contains a variety of hand and power tools and a power unit. There are three different CMV prototypes, each of which have a different power unit. Prototype number one has a hydraulic power unit. Prototype number two has an electric power unit and prototype number three has a pneumatic (compressed air) power unit. A CMV is shown in figure 1 (enclosure 1).

The objectives of the test were to evaluate the three different CMV prototypes for noise levels and vehicle weights. Two noise level tests were conducted: an 85 dB(A) contour test and an enclosure's power unit operator station noise level test. The results of the CMV's noise level testing are contained in enclosure 2, the Human Factors report on CMV testing. The CMV's weights are contained in Table 1, below.

TABLE 1. WEIGHT DISTRIBUTION

	CMV No. 1		CMV No. 2		CMV No. 3	
WHEEL	kg	lb	kg	lb	kg	lb
LF	817	1802	762	1680	915	2017
RF	819	1805	764	1685	720	1587
LR	1275	2810	1105	2435	1094	2412
RR	1316	2900	1144	2520	1356	2990
TOT	4227	9317	3775	8320	4085	9006

The HMMWV's engine on prototype number 3 was inoperable. This prevented the enclosure's power unit operator station noise level test from being conducted on the vehicle.

In a summary of results from the noise level testing, all three of the CMVs exceeded 85 dB(a). This requires the use of single hearing protection during operation of the power units.

The CMVs compare unfavorably to the currently fielded Contact Maintenance Shop (CMS) mounted on a Cargo Utility Commercial Vehicle (CUCV). The CUCV data was reported in report number USACSTA-6989, dated July 1990, TECOM Project Number 8-ES-645-000-006. The CUCV CMS was quieter than all three of the HMMWV CMVs. This is probably due to the CMS's power unit being driven off of the CUCV's power take off (PTO), as opposed to the CMV's separate power units.

This is the final report on this task.

3 Encls
as

OBSERVERS

Greg Rymarz - CSTA, Test Director
Susan Schindler - CSTA, Human Factors Technician

Signature:

BRIAN E. FRYMIARE, Test Director

LARRY W. OVERBAY, Dir, A&SED, CSTA

Distribution:
See enclosure 3

This test record signifies that the requested testing has been completed. It does not constitute approval or disapproval of the test item by Aberdeen Proving Ground.

Appendix E -- Sample Data Collection Forms

Documents follow.

CEP Trial ID#: ______.
(Army post: ______.)

Mission Questionnaire (MQ)
for Contact Teams (CTs)
(2 page form; on yellow paper)
(Refer to 5-page Guidelines (yellow paper) in OC&S' Data Collection Plan)

Sect. I. - MISSION TASK INFORMATION

Name (CT Leader) /SS#: ______________________/______.
2nd CT crew Name/SS#: ______________________/______.
CMT # : ___ (#1(H),#2(E), or #3(A)) Odometer : ______ Date/Time: ______ / ______.
How Task Received: ______________ Your Location at Time of Tasking: ______________.
Task/Service Requested: ______________________. Unit Supervisor Name: ______________
Tasked By: ______________ Special Instructions/Comments: ______________________.

Sect. II. ACTIONS TAKEN

Work Done: (19) (What) Tools / Equipment / Parts / POLs (#s.Qts.) (20) (How, With, Usage ?) Remarks (21)

Step #A ____
Step #B ____
Step #C ____

(Use back side of this MQ if more space needed)

Sect. III. - DISABLED EQUIPMENT SITE

Ground Conditions: ______________. Weather Cond. ______________. Temp. (__ F)
Arrival Time: ______. Odometer: ______. Disabled Location: ______________.
APU Hour Meter: Start ____; Stop ____.
Tactical Conditions: ______________________. Min.access dist. (ft.): ____.
Your Assessment of Failure (same/different than Task): ______________________.

Sect. IV. TASK COMPLETION

Time Departed Disabled Equip. ______ . Task Completed: Y/N. If No, explain: ______________.
Were Tools/Equip. Adequate? Y/N. If No, explain: ______________________.
All equipment functioning? Y/N. If No, explain : ______________________
Was a TER (Trial Event Record) Written? Y/N. (#s: ___, ___) (Use back side of this MQ if more space needed)

Sect. V. SPECIFIC QUESTIONS (must be answered)

1. Access to Tools: From Inside CMT (#2) or Outside (#1,#3). Which do you prefer? ______________.
2. When operating CMT's aux. power unit, did you have more than 1 task ? (Y/N) Which? ______________________.
3. Usefulness of 3/8" drive (only on #2): Did you use it ? (Y/N). Comments: ______________.
4. From CMT to Disabled Vehicle (Access Distance): How close were you able to come? ______ (ft.).
5. Did you use the tailgate-mounted Vice? (Y/N). Comments: ______________________.
6. Was the tail-gate "work surface" used ? (Y/N) . Commemts: ______________________.

MQ Form
for HHV-CMT CEP, #92-722
ATSL-CD-T / Aug92.

CEP Trial ID#: ______.
(Army post: ______.)

Mission Questionnaire (MQ)
for Contact Teams (CTs)

Sect. VI. COMMENTS, OBSERVATIONS & RECOMMENDATIONS.

CT Members: ____
____
____.

Unit Supervisor: ____
____
____.

Sect. I. - MISSION TASK INFORMATION - (Continued from Page 1, if needed)

Sect. II. ACTIONS TAKEN (Continued from Page 1)

Work Done: (19) (What)	Tools / Equipment / Parts / POLs (#s.Qts.) (20) (How, With, Usage ?)	Remarks (21)
Step #D ______	______ ______ ______ ______ ______	______
Step #E ______	______ ______ ______ ______ ______	______
Step #F ______	______ ______ ______ ______ ______	______

Master Log (ML)

for CMT CEP NCOIC Daily Use

(1 p. form; on white paper)

(ML Page # ___.)

(Army base: ____.)

Date	NCO Initials	Location / Unit	which CMT#s (1H,2E,3A)	Daily Comments / Notes

ML Form
for HHV-CMT CEP, #92-722
ATSL-CD-T / Feb 92.

CEP Trial ID#: ______.

(Army post: ________.)

Post-Trial Questionnaire (PTQ)

for Contact Teams (CTs)
(6 pages, 41 question form; on blue paper)

Sect. I. - MILITARY BACKGROUND INFORMATION

1. Name and Rank: ____________________ ________________.
2. Unit / Organization: ______________________________.
3. Have you completed a CMT Personal Data Form (PDF)? Y/N. If no, stop here and do so.

••••••••••

Sect. II. - KNOWLEDGE and INTEREST in HHV-CMT

4. Knowledge of HHV-CMT Program: Limited ___. Familiar __. Extensive ___.
5. Exposure to Prototypes (select one): (a) Used Prototype ___Y/N. Which #, #s ? ____.
   (b) via inspection ___; (c) via briefing ___; (d) photos &/or documents ___.
6. If used CMT, have you completed all Mission Questionnaire's? Y/N. If no, stop here and
7. Concept of Operation: (summerize how you perceive the HHV-CMT to be employed in support of your unit/org.) ______________________________
   ____
   ______________________________.
8. Do you agree with the overall HHV-CMT concept?: YES____ NO____
9. Explain answer to #8 above:______________________________
   ______________________________.
10. Degree of Support: (summerize your impression of whether or not the HHV-CMT will fulfill a deficiency.) ______________________________
   ____
   ______________________________.

•••••••••••••

Sect. III. - GENERAL COMMENTS

11. Prototype #1 (Hydraulic): ______________________________
   ____
   ____
   ____
12. Prototype #2 (Electric): ______________________________
   ____
   ____
   ____
13. Prototype #3 (Pneumatic): ______________________________
   ____
   ____
   ____

(Over for P.2)

Sect. IV. MISSION COMMENTS

CEP Trial ID#: ______.
(Army post: ________.)

14. Is the HHV-CMT able to support your mission? Yes____ No____
If the answer is No, please explain why: ________________________________
____
____
____.

15. Do you feel you have the adequate general tools to perform most jobs? Yes____ No____
If the answer is No, please explain why: ________________________________
____
____
____.

16. Did the vehicle provide adequate storage for personal equipement? Yes____ No____
If the answer is No, please explain why: ________________________________
____
____.

17. Was there adequate space for spare parts and manuals? Yes____ No____
If the answer is No, please explain why: ________________________________
____
____
____.

18. Was the tool storage cabinets adequate for the tools provided? Yes____ No_____
If the answer is No, please explain why: ________________________________
____
____.

19. Did you like, dislike the Enclosures? (each Proto has a different style/type enclosure)
Please comment on each type:

Enclosure	Your Description	Good Features	Bad Features
on Protro#1			
On #2			
On#3			

20. Did you find the sliding roof (Prototype #1 & #3) beneficial? Yes____ No____
If the answer is No, please explain why: ________________________________
____.

21. Were interior, built lights lights necessary? Yes__ No__ ; Provided ? Y__/N__.

22. Did you have the need for lifting that would require a crane? Yes____ No____
What was the average weight of the items requiring a lift? ______________

23. Did you use the impact tools? Yes__ No_. Did you need impact tools. Which? _______.
Please check the type of impact tools most frequently used:
Hydraulic: _____ Comments: ______________________________________
____.
Electric: ______ Comments: ______________________________________
____.
Pneumatic: ____ Comments: ______________________________________
____.

24. Based on your experience, which of the above type tools would you prefer? _________.
Why? ____
____.

25. Were there too many tools for the contact missions? Yes_____ No_____
If too many tools what would you delete? ______________________
____.
What tools would you add? __________________________
____.

26. Did you need to perform re-threading operations? Yes____ No _____
What was the minimum and maximum sizes of taps/dies used?
Minimum: ___________ Maximum: _____________

27. Was the electric drill adequate for most applications? Yes_____ No _____

28. Were the drill bits adequate to perform the mission? Yes_____ No______

29. What types of welding were required on the various contact missions assigned while working with the CMT?
Wire Feed: _____ Stick Electrode: ______ Tig: ______ Oxy/Act Cut/Weld: ______

30. What was the most common size of materials to be cut? ______________________.

31. Were you required to heat large objects? Yes______ No______
What types of material were they? ______________________________.
Were the bottles capacity large enough? Yes_____ No______

32. Were the cutting/welding tips large enough for the task? Yes_____ No______

33. What types and gages of materials needed to be repaired?
Aluminum: 14-24 gage______ 8-14 gage________ 1/8"-1/4"__________
Mild Steel: 14-24 gage______ 8-14 gage________ 1/8"-1/4"__________
Stainless Steel: 14-24 gage______ 8-14 gage______ 1/8"-1/4"__________

CEP Trial ID#: _______.

(Army post: ________.)

34. Did you require the the use of compressed air? Yes_____ No_____
    What was it used for?____.

35. Does an "on demand" (no reserve tank) air compressor meet most demands for the contact teams? Yes____ No_____ Why?____.

36. Which type of auxiliary power system (APS; hydraulic, pneumatic, electric) would you prefer and why? ____.

37. What were the (10) most frequently assigned jobs for your contact team(s)?

1.__________________	6.__________________
2__________________	7.__________________
3.__________________	8.__________________
4.__________________	9.__________________
5.__________________	10.__________________.

38. If given the chance to use a black-out curtain, would you set it up perform a contact mission? Yes_____ No_____
    If No, please tell why not: ____.

39. Your other Comments or/and Concerns: ____

CEP Trial ID#: _______.

(Army post: _________.)

Question #40: Capability Assessment.

Please complete the table below, indicating your assessment of potential capabilities as follows:

Column #1. Item. - Describe potential capabilities/equipement. You may insert additional items in blank rows.

Column #2 . Need. - Insert a letter code to indicate your assessment of the importance of this capability.

E - Essential
R - Required
D - Desirable
N - Not Required
S - Should be substituted (state substitution recommendation in the remarks column.)

Column #3. Your Priority. - Numerically prioritize the items (below) by placing "a #1" for most imortant, a #2 for the second most important, and so on.

Column #4. Remarks. - Include any remarks of explanation, such as reasons for our assessment of priority, recommended substitutions/changes, impact on mission, related auxilary equipment requirements, etc.......

- ASSESSMENT OF CAPABILITIES -

ITEM	NEED (2)	PRI (3)	REMARKS (4)
Oxy/Gas System			
Arc/Stick Welder			
MIG and/or TIG Welder			
Exothermic and/or Plasma-Arc system			
Porta-power			
Compressed Air			
Electrical power Supply			
Other Recommendations			

CEP Trial ID#: ______.
(Army post: ______.)

Question # 41. - COMPARISON OF PROTOTYPES & COMPONENTS

Complete the table below by checking your preferred prototype. Briefly explain your reason (s) for choice in the Remarks column.

COMPARISONS

ITEM	Proto. PREFERENCE			REMARKS
	#1(h)	#2(e)	#3(p)	
ENCLOSURE (OVER-ALL)				
ENCL. CONFIGURATION				
ENCL. DURABILITY				
AUXILLARY POWER SYSTEM (APS)				
APS - MOUNTING				
POWER TOOLS				
TOOL STORAGE				
WELDER				
AIR COMPRESSOR				
PERSONAL (Duffle bag) STORAGE				
ADDITIONAL REMARKS				

PTQ Form
for HHV-CMT CEP, #92-722
ATSL-CD-T / Feb92.

CEP Trial ID# ____.
Army Post:________.

PERSONAL DATA FORM (PDF).
(1 page, on white paper).

NOTE: This information is required solely for data base information for this CEP only. All information is for official use and will not violate privacy act requirements.

Name:________________________________; Social Sec.# ______-_____-_____.
(last) (first) (m)

Rank:__________. Years active service:_____.

Your Unit:___________________. Your MOS: _________.
Name of MOS Mil. School:_______________________. Course Length:_______.
How long have you held this MOS? ______
Are you currently working in your primary MOS? Yes____ No____.

Educational Background.
High School Grad? Yes____ No____.
Vocational Technical School? Yes___ . No___. Speciality? ____________.
Number of years attended:______.
College: # of years ___. Degree: Yes ___/ No___. Major field:___________.

Non-Mil.work experience, if same as MOS speciality: Years___Months____.

What Equipment (check) & Type(s)(indicate) do you work on / maintain?
Tracked __ ___________________. Wheeled__ __________________________.
Const. Engineer__ ______________. Combat Engineer__ ___________________.
Ground Support__ _________________. Other: ____________________________.

What is your major command / unit?
Infantry (Light) Div. ____. Armored Cavalry Div. ____.
Infantry (Mechanized) Div. ____. Non Divisional ____.
Airborne Asslt Div. ____. Aviation ____ .
Armor (Heavy) Div. ____. Other: ____________________.

What type of unit are you assigned to?
Organizational Ordnance _____. (Light / Heavy)
Organizational Engineer _____.
DS/GS Ordnance ____.
DS/GS Engineer ____.
Other:_____________.

Within this Unit, are you assigned to a Contact Team (CT)? YES ___ NO ___.
When (if) in field for 10 days, how many days assigned to the CTs? _____.

****

PDF Form
HHV-CMT CEP, #92-722
ATSL-CD-TE / May 92.

ATSL Form 844, 5 May 92

Appendix F -- Underhood Welder Information Paper.
This UHW concept is related to HHV-CMT / SECM document development but was not considered part of #722 CEP core. The "underhood power" "APU" concept may be applicable to HHV-CMT. The military applicability of the existing industrial UHW idea was originally proposed in FY90. CEP was approved but received only partial TRADOC funding.

A Countryman Defence Systems "Power Horse 200" Welder/Generator Kit was procured via APG PO# DAAD06-91-P-7124. A 190 amp alternator was installed on a government furnished M998 and welding demonstrated by Countryman (Mr. Michael Watts) in fall 92 at APG. This high frequency DC welder, in kit form, includes: generator; control module; control panel housing; inter-connecting electrical cables (leads); generator air box; and, flexible electrical cables & connectors. Kit uses a 190 amp 2 kw DC generator. Countryman literature describes this "under-the-bonnet" unit as a "MOBILARC" Welder. When driven at 10,000 rpms, alternator produces 190 amps at 22 volts DC. This current is "chopped" at high frequency and provides a 100% welding duty cycle.

A Lestex/Resco "under-the-hood" welding system was also considered. Lestex Mfg., Inc. (Ft. Worth, TX) and Resco II Mfg.Inc. (also Ft. Worth) provided a Model SST-130 alternator/welder via APR PO# DAAD06-91-7218. System includes: a Miller #S-32P8 wire feed MIG gun & accessories, 20' welding lead set, control box, harnesses, and mounting hardware. Kit did not include mounting brackets, fan belts or individual welders' goggles and gloves. A government furnished M998 200amp
24v. alternator was modified, mounted and demonstrated by Lestex (Mr. Ray Savell) in fall 92 at APG. This high frequency (3
to 7 K) pulsating DC welder operates on a 100% duty cycle. Control box weight is approximately 6 lbs. Unit also provides 1700 watts at 115v DC.

(3) Link-Arc Model HR-190 "under-hood" Welder was also considered. Thru US Army AMC "FAST" program, AMCCOM evaluated at Ft. Lewis, WA a Link-Arc (Ft. Worth, TX) Model HR-190 "under-hood" welding system. Preliminary telephonic reports indicate a component failure (TBD). System included: welder/generator kit, HR control box, harnesses, and mounting hardware. Kit did not include mounting brackets, fan belts or individual welders' goggles & gloves. A government furnished M998 alternator was modified. Model HR-190 vehicle-mounted DC Arc Welder originally included a 14v. 60 amp alternator & control box and provided high frequency arc welding at a 100% duty cycle. Net weight was advertised as 23 lbs.. Unit also provides 2300 watts at 115v DC.

Appendix G -- Power Tool Selection Process and Results

Documents follow

DEPARTMENT OF THE ARMY
U.S. ARMY ORDNANCE CENTER AND SCHOOL
ABERDEEN PROVING GROUND, MARYLAND 21005-5201

REPLY TO ATTENTION OF

ATSL-CD-MS (70-1i)

3 MAR 1993

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Power Tool Selection - Performance Assessment

1. This is to announce the selection of the pneumatic based power tool system as the baseline system for maintenance equipment in the Ordnance Corps.

2. The power tool performance assessment involved the evaluation of a substantial number of criteria. The evaluation results were then validated by a senior officer review panel. The results showed the pneumatic based system as the best overall performing system.

3. This selection is not the final determining factor for procurement. The materiel developer for any particular system will consider cost and availability; however, this selection is the user's preference for power tools.

4. POCs are MAJ Mark Salesky and CPT Matt Warren, DSN 298-4042/2309.

FOR THE COMMANDER:

PATRICK W. BUTTON
COL, OD
Director, Combat Developments

2 Encls
1. Validation Memorandums
2. Data Summaries

DISTRIBUTION:
DEPUTY CHIEF OF STAFF FOR LOGISTICS, ATTN: DALO-SMT (MAJ KOEDDING), PENTAGON, WASHINGTON, DC 20310
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COMMANDER, U.S. ARMY COMBINED ARMS SUPPORT COMMAND AND FORT LEE, ATTN: ATCD-MSF (CW2 SANBORN), FORT LEE, VA 23801-6000
COMMANDER, U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND, ATTN: SMCAR-EST-W (MR. JOE KLEISS), ROCK ISLAND, IL 62199-7300
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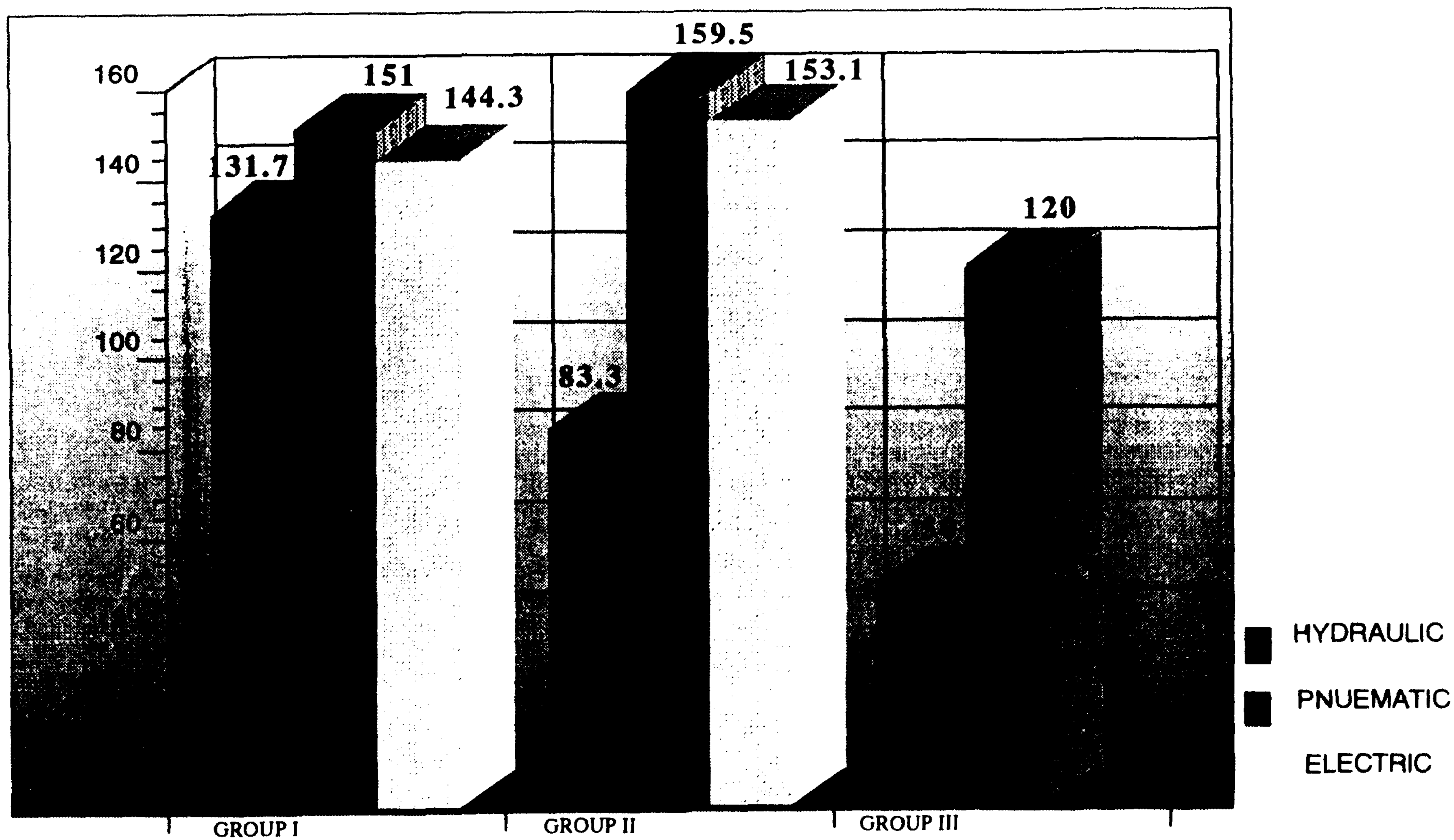
COMMANDANT, U.S. ARMY AVIATION LOGISTICS SCHOOL, ATTN: ATSQ-LCD (MR. KEN FENNELL), FORT EUSTIS, VA 23604-5416

POWER TOOL SELECTION
FINAL RESULTS



NOTE: DATA FROM GROUP III HAS BEEN AMPLIFIED - 10X

POWER TOOL SELECTION

FINAL RESULTS

TABLE 1: GROUP I - SUBJECT MATTER EXPERTS

CRITERIA

SYSTEM	PERF	ILS	S.INTERF	UTIL	VUL	INTEROP	TOTAL	RANKING
H	40.3	29	24.7	12.3	15.4	10	131.7	3
P	39	33.3	32	16.3	15.4	15	151	1
E	37	25.3	33.3	16.7	12.8	19.2	144.3	2

BEST SYSTEM - PNUEMATIC

TABLE 2: GROUP II - CEP NCO's

CRITERIA

SYSTEM	PERF	ILS	S.INTERF	UTIL	VUL	INTEROP	TOTAL	RANKING
H	19.7	9.7	21	10	15.4	7.5	83.3	3
P	44.7	30.7	32.7	17	19.4	15	159.5	1
E	39	32	31.3	16.7	16.6	17.5	153.1	2

BEST SYSTEM - PNUEMATIC

TABLE 3: GROUP III - USERs

TRIALS

SYSTEM	4(H,P)	6(H,P)	7(H,P,E)	8(H,P,E)	TOTAL	RANKING
H	0	3	1	1	5	2
P	3	2	3	4	12	1
E	N/A	N/A	0	0	0	3

BEST SYSTEM - PNUEMATIC

SYSTEMS
H - HYDRAULIC
P - PNUEMATIC
E - ELECTRIC

CRITERIA
PERF - PERFORMANCE
ILS - INTEGRATED LOGISTICS SUPPORT
S. INTERF - SOLDIER INTERFACE
UTIL - UTILITY
VUL - VULNERABILITY
INTEROP - INTEROPERABILITY

TRIALS
4 - FT CAMPBELL
6 - FT. BRAGG
7 - FT BENNING
8 - FT IRWIN

ATSL-CD-MS 16 Nov 92

MEMORANDUM FOR SENIOR REVIEW PANEL, Power Tool Selection

SUBJECT: Data Summaries

1. The accompanying tables and graphs show the numerical rankings of the three candidate systems by each of the three groups of participants. Tiers 1 and 2 were conducted on 16 Sep at the Ordnance School IAW the PTS Plan.

2. Subject Matter Expert and CEP NCO Groups.

a. The representatives comprising Group #1, Subject Matter Experts, were SGM Varsel, USAOC&S, Mr. Charles Genhart, AMCCOM, and SFC Moeller, USAES. The representatives comprising Group #2, CEP NCOs, were SFC Kammler, SSG LuGrain, and SFC Winger, all from USAOC&S. CPT Matt Warren, who has not been otherwise involved in any of the Contact Maintenance Truck planning, conducted the PTS process.

b. Both groups evaluated all three systems for each of 37 different criteria and gave a relative ranking of the three system. Those rankings were recorded numerically (1 thru 5), and the numbers summed to give a total numerical value. Tables 1 and 2 show these numerical values for each of the six major criteria.

c. One reason we chose this particular methodology is that is allows for and then mitigates predispositions of each group. We expected that the SME group would respond from a managerial or systems supportability bias, and that the CEP NCOs would respond with more concern for the actual performance of the systems. Indeed, the ranking from each group tend to show this bias, with the range of numerical values much smaller for the SME group than the NCO group (range = 20 points and 66 points, respectively). Nevertheless, both groups produced the same absolute ranking of the three systems: in order of preference, pneumatic, electric, and hydraulic.

3. Because of the nature of the field trials, it was not feasible to use the same detailed evaluation criteria for the soldiers who actually operated the systems in the field. Their bias was towards performance only, with little or no concern for the systems' long-term supportability. Consequently, their input was in the form of solely subjective perference. Throughout the CEP, while many soldiers were able to see and/or operate one of the power tool systems, only a limited number were able to operate under field conditions two or more of the systems. Four different locations/units operated at least two of the systems during field exercises: at Forts Cambell, Benning, and Bragg, and at the National Training Center. In all, data was collected from 17 soldiers who indicated their preference: in order, pneumatic, hydraulic, electric. Their responses are shown at Table 3.

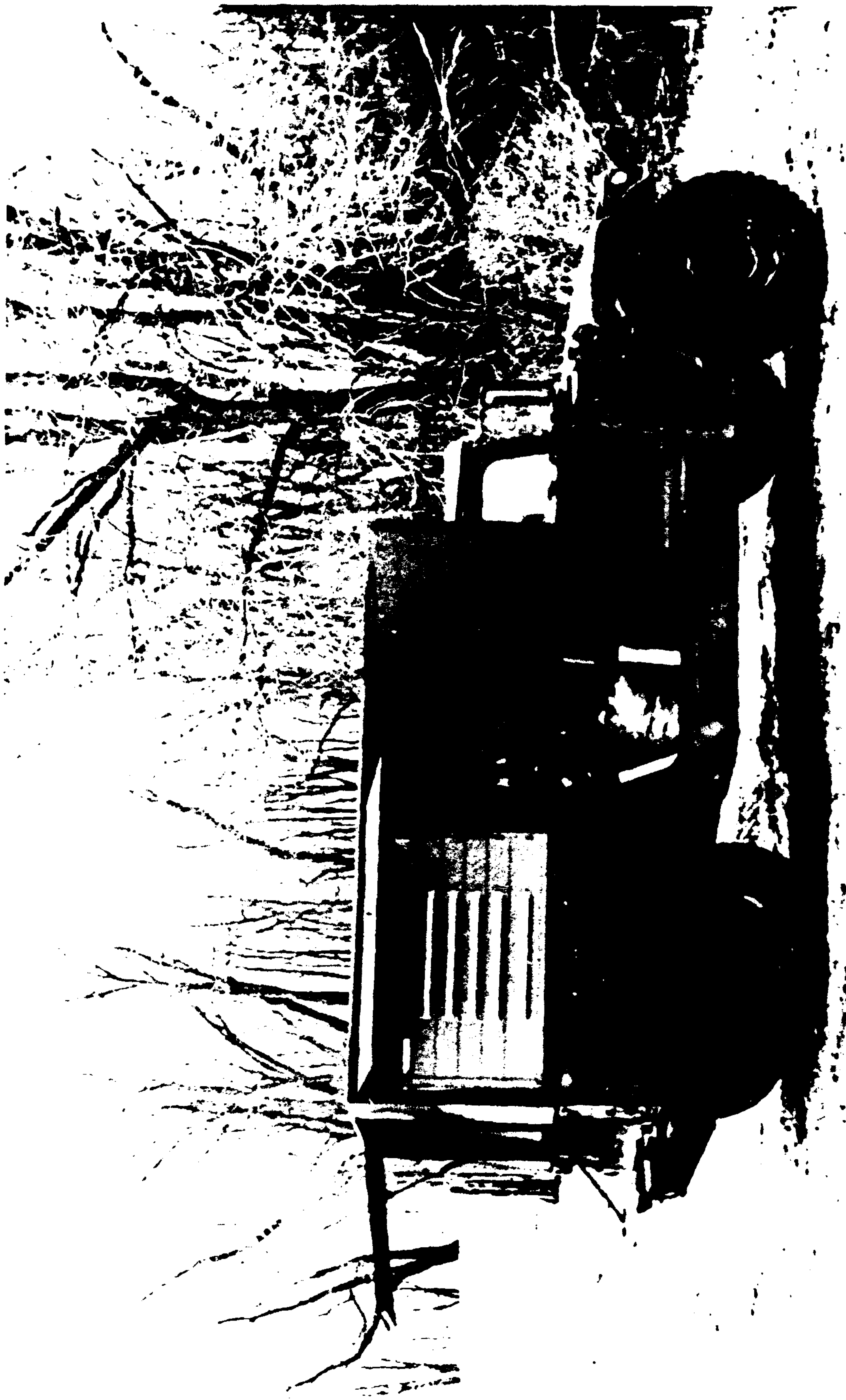
Appendix H -- Generic Hand Tool List

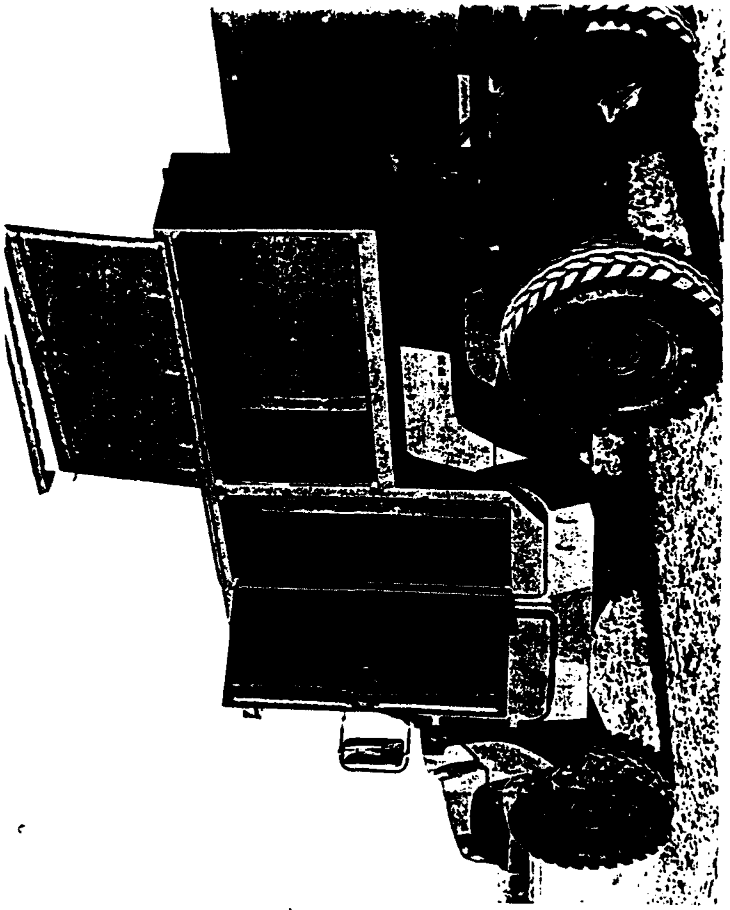
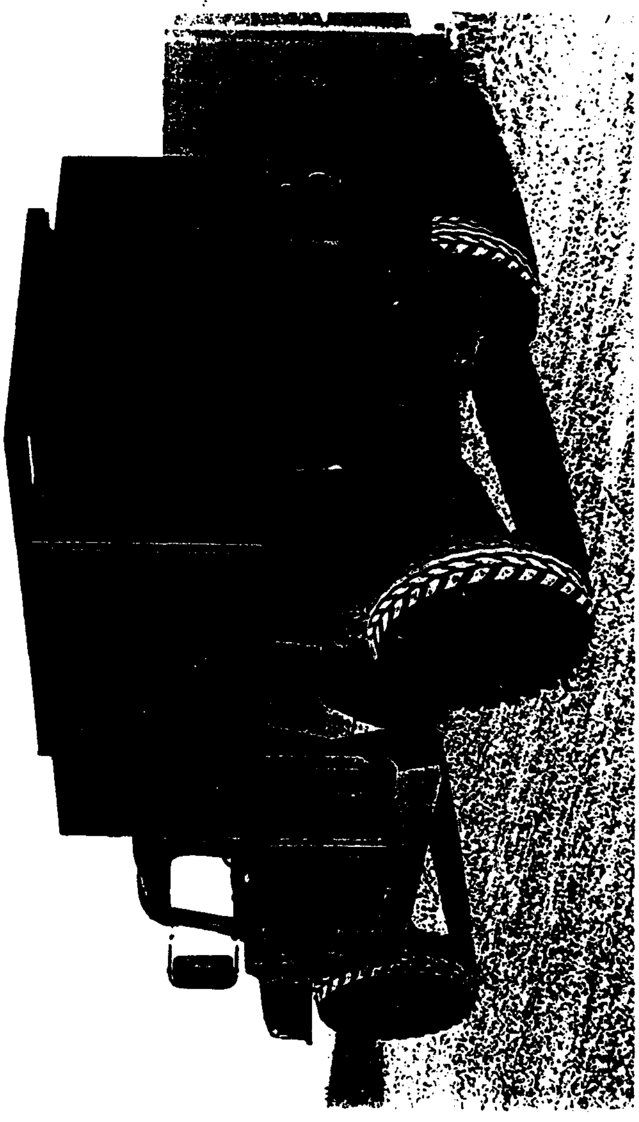
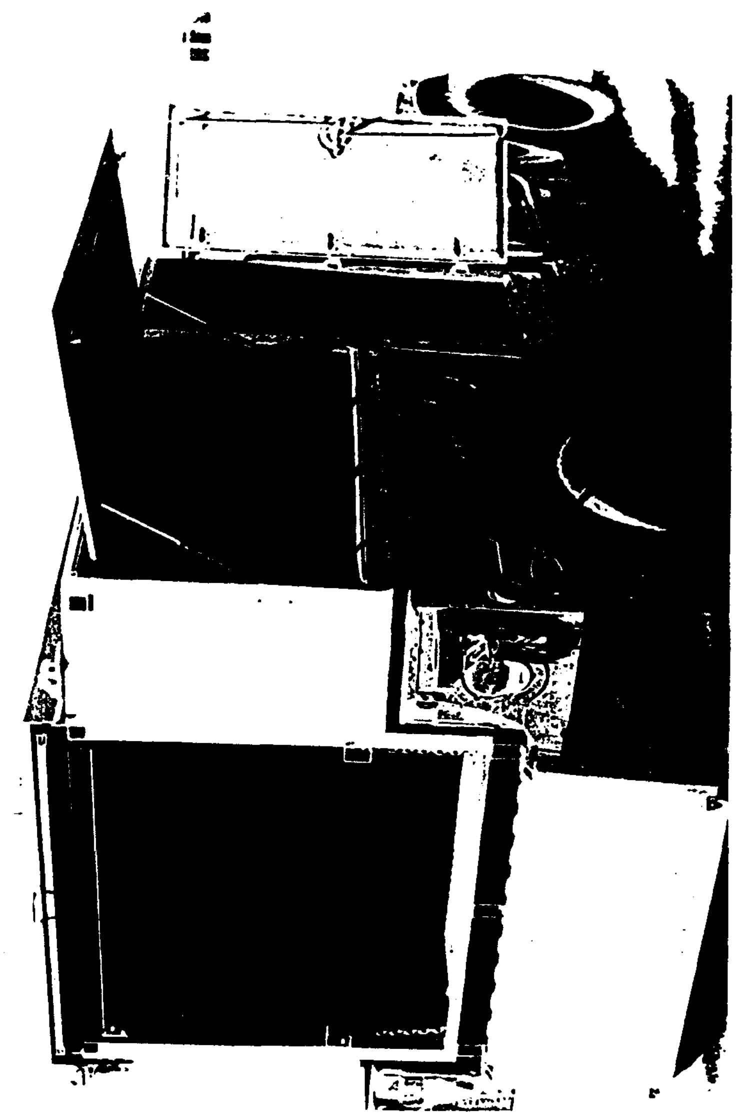
Final tool list will not be made with completion of CEP. Supply Catalog SC -B26 will authorize the tools for the production CMT.

APRON WELDERS
HACKSAW W/BLADES
BRUSH WIRE
CABLE ELECT EXT
BATT BOOST CABLES
NATO CABLE KIT
CAPS VISE
CHISEL SET
CLAMP C SET
LEANER BATT TERM
CLEANER SET WELD
TANKER BARS
ENDER TUBING
CUTTER/FLARING KIT
GAS BOTTLES OXY/ACTE
DRILL ELECT 1/2
DRILL SET
FILE SET
FILE THREAD SET
FINGERS MECH
SPARK LIGHTER/FLINTS
FUNNELS VARIOUS
GAGES GAP SETTING
GLOVES WELDERS
GOGGLES CLR/SHADED
HAMMER SET
HELMET WELDERS
HOIST CHAIN
HOSE WELDING
KEY WRENCH SETS
PUTTY KNIFE
LAMP 24V/110V
LENSES WELDING
LIGHT EXTENSION
MEASURE LIQUID VARIOUS
MULTIMETER
PLIERS SIDE CUT DIAG
PLIERS SLIP JOINT
PLIERS SNAP RING SETS
PULLER KITS
PUNCH SET
REMOVER STUD
SCREWDRIVER SET
EXTRACTOR SET
SHEARS STD/COMPD
TERMINAL KIT
TESTER BATTERY
TAP/DIE SET
MASTER TOOL BOX
TOOL RETRIV MAG
TORCH SET
VALVES OXY/ACET
VISE BENC
WRENCH ADJ VARI
WRENCH PIPE VARI
WRENCH SET DBL BX STD/MET
WRENCH SET COMB STD/MET
WRENCH IMPACT 110V/24
WRENCH SET FLAIR NUT
WRENCH SET OPEND STD/MET
SOCKET SET 1/4 DR STD/MET
SOCKET SET 3/8 DR STD/ME
SOCKET SET 1/2 DR STD/MET
SOCKET SET 3/4 DR
SOCKET SET DEEP(1/4-3/8-1/2
DR)-STANDARD & METRIC
WRENCH TORQUE IN LB/FT LB

Appendix I -- Photographs

Photographs follow



Appendix J -- Proponent Evaluation Report Distribution.

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US Army Training and Doctrine Command
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Washington D.C. 20310

Program Executive Office
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Division of the Stanley Works
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