TECHNICAL MANUAL

OPERATOR'S, UNIT AND DIRECT SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST) FOR CHEMTRIX FIELD pH METER MODEL 4012

This technical manual is an authentication of the manufacturer's commercial literature and does not conform with the format and the content requirements normally associated with Army technical manuals. This technical manual does, however, contain all essential information required to operate and maintain the equipment.

Approved for public release; distribution is unlimited.

HEADQUARTERS, DEPARTMENT OF THE ARMY
28 SEPTEMBER 1990

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SUPPLEMENTARY INTRODUCTORY MATERIAL

1-1. Maintenance Forms and Records.

Department of the Army forms and procedures used for equipment maintenance will be those described by DA Pam 738-750, The Army Maintenance Management System.

1-2. Reporting Errors and Recommending Improvements.

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letters, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual, directly to: Commander, U.S. Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished to you.

1-3. Destruction of Army Material to Prevent Enemy Use.

Refer to TM 750-244-3 for instructions covering the destruction of Army Material to prevent enemy use.

1-4. Administrative Storage of Equipment.

a. Placement of equipment in administrative storage should be for short periods of time when a shortage of maintenance effort exists. Items should be in mission readiness within 24 hours or within the time factors as determined by the directing authority. During the storage period appropriate maintenance records will be kept.

b. Before placing equipment in administrative storage, current preventive maintenance checks and services should be completed. Shortcomings and deficiencies should be corrected, and all modification work orders (MWO's) should be applied.

c. Storage site selection. Inside storage is preferred for items selected for administrative storage. If inside storage is not available, trucks, vans, conex containers and other containers may be used.

Field pH METER
Instruction Manual

Table of Contents

WARRANTY. All instruments are fully guaranteed against defective materials and workmanship for one year. Any attempted repair voids the warranty on this instrument.

1.0 INTRODUCTION

The field portable pH meter is housed in a rugged plastic carrying case and allows pH and oxidation reduction measurements to be taken directly at the sampling site. The pH meter has analog readout and features temperature compensation and an expanded mode. Also included is a zero millivolt input for diagnosis of meter function.

2.0 SPECIFICATIONS

Readout:	6 inch analog
Operating Modes:	pH, Expanded pH mV, Expanded mV
pH Measurements:	
Range(s):	0-14 pH (Normal) Any 1.4 pH F.S. (Exp.)0
Sensitivity:	0.05 pH (Normal) 0.5 pH (Exp.)

Accuracy:	0.05 pH (Normal) 0.01 pH (Exp.)
Temp. Compensation:	Manual, 0-100°C
Millivolt/Redox Measurements Ranges:	±700 mV (Normal) ±70 mV (Exp.)
Accuracy:	1 mV
Input Impedance:	> 10 Ohms
Connectors:	BNC Redox
Power:	DC/AC (rechargeable)
Size:	12 1/4"W X 41/2"H X 8"D
Weight:	4.5 lbs. (2.04 Kg)

3.0 PRELIMINARY SET-UP

3.1 Remove and inspect carton for the following items:

a. Field portable pH meter
b. Support Rod
c. Detachable electrode support
d. pH 4.00, pH 7.00, and pH 10.00 buffer solutions and rack
e. Batteries and battery charger
f. Operation Manual

3.2 The instrument should be used in a location with adequate ventilation and freedom from vibration. The instrument should be located on a relatively flat, dry surface and close proximity to high voltage wires or transformers should be avoided.

3.3 Make certain that the front knob is turned to OFF.

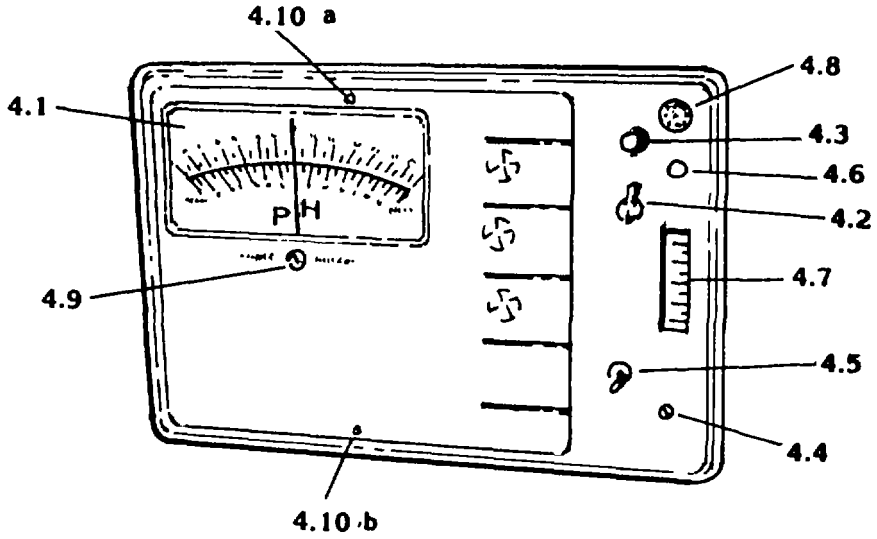
3.4 Plug the rechargeable unit into the appropriate outlet (the field pH meter is available in both 110 VAC and 220 VAC models). To assure a full battery charge, the unit should be allowed to charge at least overnight.

3.5 Attach the pH or ORP probe into the BNC connector. pH or ORP probes with U.S. standard connections will require an adapter.

3.6 To decrease breakage, the electrode should then be placed in the electrode holder and attached to the support rod. The electrode holder can then be raised or lowered for sample measurement.

3.7 The instrument can now be calibrated and used. See section 5.0 for pH calibration procedures. Turn the front switch to ON for use.

4.0 FRONT PANEL



4.1 Analog face-6" mirror-backed analog display for pH and millivolt readings.

4.2 OFF/MV/pH

OFF: Power to instrument is off.

mV: Millivolt-meter will display millivolt input from oxidation-reduction (ORP) or pH electrode.

pH: Meter will display pH input from pH electrode.

4.3 SET Calibration knob used for first point in two point calibration usually pH 7.00 buffer. It can also be used for millivolt offset.

4.4 SLOPE Calibration screw used for second point in two point calibration, usually pH 4.00 or pH 10.00 buffer.

4.5 NORM-EXP Toggle switch that allows meter display in normal (NORM) mode 0-14 pH units, ±700 mV or expanded (EXP) mode-only 1.4 pH units, ±70 mV.

4.6 ZERO Used for standard input of zero millivolts. When the button is depressed, the meter should read zero millivolts. The reading can be adjusted using the SET knob. Establishing zero millivolts is especially important when the instrument is used in the expanded mode.

4.7 TEMP Temperature compensation knob when this knob is set to the sample temperature, the pH readings are temperature compensated. Note: All temperature settings are in degrees centigrade.

4.8 BNC Connector The connector for the BNC fitting of an ORP or pH electrode.

4.9 Mechanical Zero Screw used to adjust meter needle to 0 starting position when meter is3 OFF.

4.10 a & b: Panel Screws Removable screws that allow access to the rechargeable batteries.

5.0 STANDARD pH CALIBRATION

5.1 Three buffer capsules are available, pH 4.00, pH 7.00, and pH 10.00. Use the buffers for calibration that are closest to the pH range that you will be using. If your use will span the entire pH range, the instrument should be calibrated with two buffers and checked with a third.

5.2 Make pH buffers by dissolving one capsule per 100 ml of deionized or distilled water. After complete dissolution, the buffers should be properly stored in clearly labeled, tightly capped containers. Commercially prepared buffers can also be used.

5.3 Check meter needle position Before the calibration procedure is performed, the meter needle position should be checked when the meter is turned OFF. If the meter needle does not read zero, then the mechanical zero screw should be used to adjust the needle to read zero.

5.4 Place pH electrode in pH 7.00 buffer. Sufficient buffer should be used to immerse the pH tip. Freshly poured buffers should be used for each calibration so avoid using excessive amounts. The temperature control knob should be adjusted to 25 °C or room temperature.

5.5 Make sure the front panel switch is set on pH and the expanded model is set to NORM.

5.6 Use the SET knob to adjust the analog needle to read a pH of 7.00.

5.7 Rinse the electrode with distilled water and carefully blot dry, using lint-free paper.

CAUTION

Do not wipe the electrode. Wiping can cause static electrical charges which can result in faulty readings.

5.8 Immerse the electrode in a second standard buffer, either pH 4.00 or pH 10.00. Allow time for equilibration.

5.9 Use the SLOPE screw to adjust the readout to read exactly 4.00 or 10.00 depending on the second buffer used.

5.10 Rinse the electrode and blot dry. The meter is now ready for use in the pH mode.

NOTE

The calibration of a pH meter is not permanent. It should be done on a regular basis and any time the pH reading response becomes slow or erratic.

6.0 EXPANDED MODE CALIBRATION

For sensitive pH or millivolt measurements, the instrument should be used in the expanded (EXP) mode. For pH measurements in the expanded mode, go to 6.2. For millivolt measurements in the expanded mode, go to 6.1.

6.1 Expanded Millivolt Calibration. It is important to understand that in the expanded mode, the full scale will span a range of 140 millivolts. Before deciding to use the expanded mode, the user must first establish that the total millivolt range required will not exceed this value.

a. Turn selection switch to mV (millivolt).

b. Place probe in a solution of known potential.

c. Use SET knob to adjust meter needle to read zero millivolts.

d. Switch toggle switch from NORM to EXP (Expanded).

e. Use SET knob to reset meter needle to the appropriate position for the millivolt range required.

f. The meter is now calibrated in the expanded millivolt mode and will reflect a change of 140 millivolts full scale.

g. Before switching the meter back to the NORM (normal) mode, make certain to reset the meter needle to zero millivolts. This prevents pegging the needle.

Example

For example, an oxidation-reduction potential (ORP) titration is to be performed, the starting solution has an initial ORP of +200 mV and a final end point of +320 mV. The probe is placed in the starting solution for the expanded mode calibration. Once in the expanded mode, the meter needle is set to -600 millivolts. Therefore, in the expanded mode, the scale would read as follows:

-700 mV is now equal to 190 mV
-600 mV is now equal to 200 mV
-400 mV is now equal to 220 mV
0 mV is now equal to 260 mV
+400 mV is now equal to 300 mV
+600 mV is now equal to 320 mV
+700 mV is now equal to 330 mV

6.2 Expanded pH Calibration. It is important to understand that in the expanded mode, the full scale will span a range of 1.4 pH units. Before deciding to use the expanded mode, the user must first establish that the total pH range required will not exceed this value.

a. Turn selection switch to pH.

b. Calibrate the meter in the standard pH mode. (Section 6.0).

c. Place probe in a standard buffer or a solution of known pH d. Use the SET knob to adjust the. Meter needle to read pH 7.00.

e. Switch toggle switch from NORM to EXP (expanded).

f. Use SET knob to reset meter needle to the appropriate position for pH range required.

g. The meter is now calibrated in the expanded pH mode and will reflect a change of 1.4 pH units full scale.

h. Before switching the meter back to the NORM (normal) mode, make certain to reset the meter needle to 7.0. This prevents pegging the needle

Example

For example, a solution has a starting pH of 3.25 and needs to be adjusted to an exact pH of 4.30 +.01. A pH 4.00 buffer solution is a good reference point. The probe is placed in pH 4.00 buffer. Once in the expanded mode, the meter needle is set at pH 10.00. Therefore in the expanded mode, the pH scale would read as follows:
pH 0.0 is now equal to 3.00
pH 1.0 is now equal to 3.10
pH 3.0 is now equal to 3.30
pH 7.0 is now equal to 3.70
pH 10.0 is now equal to 4.00
pH 13.0 is now equal to 4.30
pH 14.0 is now equal to 4.40

7.0 ELECTRODE CARE

Many electrode problems can be eliminated with reasonable care. Proper storage and use decreases down-time and provides maximum benefits

Storage

7.1 Gel and refillable electrodes should be stored in an acidic solution with a low salt content. Commercial soaking solutions are available or you can make your own by mixing a 1M KCI solution adjusted to pH 4.0.

7.2 Electrode storage in a field unit is more difficult due to the horizontal storage. To assure proper hydration of the pH bulb, the electrode should always be stored wet in the solution described above. The easiest way to accomplish this is to store the electrode using the plastic cap or soaking bottle that accompanies the new electrode when shipped.

Use

7.3 Electrodes should always be used in a vertical position.

7.4 Electrodes should be rinsed between samples with distilled or deionized water. NEVER wipe an electrode to remove excess water, just blot the end of the electrode with a lint free paper. Wiping an electrode can cause spurious readings due to static charges.

7.5 The level of filling solution in refillable electrodes should be kept at least 2/3 full. The filling hole should be open during use.

7.6 pH electrodes are fragile. A proper electrode holder should be used to provide support and aid in raising and lowering the probe into solutions.

8.0 THEORY OF pH MEASUREMENT

8.1 Color Methods. Over the years, researchers have discovered dyes and chemicals that will change color at prescribed pH values. Litmus paper is a good example of a commonly used indicator. In an alkaline solution, the paper turns blue and in acid solution, the paper will turn pink. But there are two major drawbacks with the use of indicators. First is the difficulty of detection in highly colored or turbid solutions and second is chemical interferences with the indicator, invalidating the test. With the invention of the pH probe and meter, scientists were able to eliminate these drawbacks as well as increase the precision of pH measurements.

8.2 Instrument Methods. There are three components of pH measurement. The measuring electrode, the reference electrode, and the pH meter. Instrumental pH measurement can be performed relatively fast and with a high degree of precision.

a. Measuring Electrode The key to the pH measuring system is the glass bulb at the end of the measuring electrode. This glass bulb is manufactured from a special glass which is very sensitive and highly selective to hydrogen ions. The pH measurement is then a function of a voltage charge across the bulb which is directly related to the hydrogen ion concentration.

b. Reference Electrode A second electrode, the reference electrode, is then required to complete the electrical circuit between the measuring electrode, through the meter, into the sample being measured. The reference electrode completes this circuit by very, very slow seepage of KCI (K++ CI -), into the sample through a porous junction. Clogging of this junction can cause erratic and incorrect pH readings.

c. Combination Electrode Combination electrodes are electrodes which contain both a measuring and a reference electrode in one probe.

d. pH Meter The input signals from the electrodes are displayed on the pH meter. A direct reading of the voltage input is displayed when the meter is set on the millivolt scale. For the more common pH usage, the meter converts the voltage input from the electrodes to a unit of pH which is displayed when the meter is set on the pH scale.

9.0 TROUBLESHOOTING

9.1 Symptom Meter exhibits no response.

Action

a. Check battery power. Plug the attached recharger into the appropriate power outlet (110 VAC or 220 VAC depending on model ordered) for at least 24 hours to insure full battery charge. Recheck function. If there is still no response, then replace batteries.

b. Change batteries

1. Turn meter OFF.

2. Unplug battery charger.

3. Remove the panel screws.

4. Carefully remove front panel and turn over.

5. The batteries are located underneath the right side of the front panel.

6. Replace the four AA rechargeable batteries one at a time to insure proper alignment.

7. Plug the recharger into the appropriate outlet and recharge for 24 hours.

8. Recheck function. If there is still no response, continue.

c. Check millivolt function of the pH meter.

1. Turn selection knob to mV (millivolt). Place electrode in fresh pH 7.0 buffer. Meter should read ±15 mV.

2. Place electrode in fresh pH 4.0 buffer. Meter should read + 177 mV.

3. Place electrode in fresh pH 10.0 buffer. Meter should read 177 mV.

Conclusion

— If pH meter responds correctly in mV mode, this pinpoints the fault to the pH board. The pH meter needs to be serviced.

— If the pH meter does not respond, you may have a faulty pH meter or faulty electrode. Proceed to next step.

d. Check pH circuitry of the pH meter.

1. Turn selection knob to pH.

2. Push zero button.

3. This should result in a stable needle reading which can be deflected more than 3 pH units using the SET knob.

Conclusion

— If the pH meter responds correctly when shorted, the meter is in good working order and the problem is probably a faulty electrode. Go to the next step.

— If the pH meter does not respond correctly when shorted, the meter is faulty and requires repair.

e. Check for faulty electrode.

1. If a faulty electrode is suspected, replace with a new or other working electrode and recheck pH function.

2. If another electrode is unavailable, a new electrode should be ordered.

9.2 Symptom Unable to standardize meter

Action

a. Check temperature knob to verify correct setting.

b. Open a new bottle or make a fresh batch of standard buffer and recheck standardization.

c. Check electrode for physical defects.

1. Visually check electrode for cracks or other abnormalities. A cracked or damaged electrode should be replaced.

2. Visually check electrode for low filling solution or excess KCI crystals. Filling solution should be at least 2/3 full, bulb and filling hole should be free of excess KCI crystals.

Conclusion

— If no defects are seen, go to next step.

d. Clean the electrode to eliminate a clogged reference junction.

1. Immerse the tip of the electrode into concentrated NH40H for 10 15 minutes.

CAUTION

NH40H is very caustic and should be used in a hood.

2. Rinse the electrode.

3. Soak in pH 4.0 buffer for 10-15 minutes.

4. Recheck calibration.

Conclusion

— If cleaning does not result in improved performance, the meter could be at fault. Go to Section 9.1-c.

9.3 Symptom pH readings are unstable, slow, erratic, or drift.

a. Check the sample.

1. A changing sample temperature Allow sufficient time for a sample temperature to stabilize.

NOTE

Vigorous stirring on an uninsulated stirring motor can lead to small but significant sample temperature changes.

2. A non-uniform sample pH "zones" which result in erratic or drifting readings can be eliminated by gentle stirring using an insulated stirring motor.

3. A very low or very high ionic strength sample These readings can take a long time to stabilize.

4. A sample that is incompatible with the pH electrode When measuring pH of special solutions such as HF, strong oxidizing solutions, or solutions that contain elements that can poison an electrode be certain that you are using the correct electrode. If you have questions, your electrode supplier can usually help.

b. Check electrode for physical defects. (See Section 9.2-c).

c. Clean the electrode. (See Section 9.2-d).

d. Check the pH meter. (See Section 9.1-c).

10.0 PARTS LIST

The following parts can be ordered individually to aid in maintenance and repair. For price, please call your supplier.

AC/DC (110/220)

	100K BALL BEARING POT	634-0104-10
	2K COMP POT	634-0202-00
	pH METER MOVEMENT	650-1040-00
	TOGGLESWITCH	742-7121-10
	PUSH BUTTON SWITCH	740-8121-10
	BATTERY HOLDER	567-2182-00
	BNC CONNECTION	738-3110-00
	ELECTRODE CLIP	559-1006-00
•	CIRCUIT BOARD	600-0400-30
	pH ELECTRODE	H-105
	RECHARGEABLE BATTERIES	706-0500-00
	PORTABLE BOX	526-2585-00
	BOTTLE RACK	538-0046-03
	PROBE HOLDER ASSEMBLY	610-0106-00
	ROD	532-0011-00
••	11OV CHARGER	702-8113-10
••	220V CHARGER	702-0504-20
	TYPE 400 MANUAL	175-4012-00
	TYPE 5995-30 MANUAL	175-5995-30

• No circuit board components are available separately

•• Make certain to order the correct charger for your meter.

APPENDIX A
REFERENCES

A-1. **Scope.** This appendix contains all forms, pamphlets and technical manuals referenced in both the Air mobile and Semitrailer mounted Laboratories.

A-2. Forms.

Recommended Changes to Publications	DA Form 2028 DA Form 2028-2
Quality Deficiency Report	SF 368
Equipment Inspection and Maintenance Work Sheet	DA Form 2404
Hand Receipts	DA Form 2062

A-3. Field Manuals.

Petroleum Testing Facilities:	
Laboratories and Kits	FM 10-72
Inspecting and Testing Petroleum Products	FM 10-70
ASTM Test Method Supplement to	FM 10-92C1/C2

A-4. Technical Manuals.

Atlas-Copco Compressor	TM 10-4310-392-13&P
Alcor Jet Fuel Thermal Oxidation Tester Operating and Maintenance Manual	TM 10-6635-210-13&P
Bacharach Gas Alarm and Calibration Data	TM 10-6665-297-13&P
Brother Portable Typewriter	TM 10-7430-218-13&P
Chemtrix Field Ph Meter	TM 10-6630-237-13&P
Elkay Manufacturing 30 GPH Cooler	TM 10-4130-240-13&P
Emcee Micro-Separometer	TM 10-6640-222-13&P
Foxboro Pressure Recording Gauge	TM 10-6685-365-13&P
Gammon Aqua Glo Water Detector	TM 10-6640-221-13&P
Gammon Mini Monitor Fuel Sampling Kit	TM 10-6630-230-13&P
Jelrus Burn-Out Furnace	TM 10-6640-231-13&P
Koehler Cleveland Open Tester	TM 10-6630-236-13&P
Koehler Cloud and Pour Point Chamber	TM 10-6630-238-13&P
Koehler Copper Strip Corrosion Bomb Bath	TM 10-6640-220-13&P
Koehler Distillation Apparatus	TM 10-6630-233-13&P
Koehler Dropping Point Apparatus	TM 10-6635-211-13&P
Koehler Electric Pensky-Martins Tester	TM 10-6630-231-13&P
Koehler Foaming Characteristics Determination Apparatus	TM 10-6640-228-13&P
Koehler Kinematic Viscosity Bath	TM 10-6630-239-13&P
Koehler Tag Closed Cup Flash Tester	TM 10-6630-235-13&P
Lab-Line Explosion Proof Refrigerator	TM 10-6640-219-13&P
Lily Freezer	TM 10-6640-234-13&P
Millipore OM 39 Filter Holder	TM 10-6640-225-13&P
Millipore Vacuum Pump	TM 10-6640-217-13&P
Ohaus Harvard Trip Balance	TM 106670-278-13&P
Precision Gas-Oil Distillation Test Equipment	TM 10-6630-219-13&P
Precision General Purpose Water Bath	TM 10-6640-229-13&P

Precision High Temperature Bronze Block Gum Bath	TM 10-6630-234-13&P
Precision General Purpose Ovens	TM 10-6640-218-13&P
Precision Heater Instruction Manual and Parts List	TM 10-6640-223-13&P
Precision Oxidation Stability Bath	TM 10-6640-232-13&P
Precision Pensky-Martens Flash Testers	TM 10-6630-231-13&P
Precision Reid Vapor Pressure Bath	TM 10-6640-226-13&P
Precision Slo-Speed Stirrer	TM 106640-224-13&P
Precision Universal Centrifuge	TM 10-6640-230-13&P
Precision Universal Penetrometer	TM 10-6640-228-13&P
Sargent-Welch Vacuum Pump	TM 10-4310-391-13&P
Sartorious Analytical Balance	TM 10-6670-277-13&P
Scotsman Cuber	TM 106640-227-13&P
Soltec VOM-Multimeter	TM 10-6625-3127-13&P
Teel Self-Priming Centrifugal Pump	TM 106640-217-13&P
Teel Submersible Pump	TM 10-4320-320-13&P
Texas Instrument TI-503011 Calculator	TM 10-7420-210-13&P

A-5. Pamphlets.

The Army Maintenance Management System (TAMMS)	DA Pam 738-750

A-6. Miscellaneous Publications.

The Army Integrated Publishing and Printing Program	AR 25-30
Laboratory, Airmobile, Aviation Fuel	MIL-L-52733A(ME)
Apparatus, Instruments, Chemicals, Furniture, and Supplies for Industrial, Clinical, College and Government Laboratories	Fisher Scientific Laboratories Catalog
Petroleum-Petrochemical Testing Equipment	Precision Scientific Catalog

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. General.

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance categories.

b. The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance categories.

c. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from Section II.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2. Maintenance Functions. Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

b. Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.

C. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

D. Adjust. To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. Align: To adjust specified variable elements of an item to bring about optimum or desired performance.

f.Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of knob accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Remove/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

H. Replace. To remove an unserviceable item and install a serviceable counterpart in its place. "Replace" is authorized by the MAC and is shown as the third position code of the SMR code.

i. *Repair.* The application of maintenance services, ' including fault location/troubleshooting2 removal/installation, and disassembly/assembly procedures3 and maintenance actions, 4 to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j *Overhaul* That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications (i.e, DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

k. *Rebuild.* Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipment/components.

B-3. Explanation Of Columns In The MAC, Section II.

a. *Column I. Group Number.* Column 1 lists functional group code numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly. End item group number shall be "00."

b *Column 2. Component/Assembly.* Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. *Column 3. Maintenance Function.* Column 3 lists the functions to be performed on the item listed in column 2. (For a detailed explanation of these functions, see paragraph B-2.) *d. Column 4. Maintenance Category.* Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate work time figures will be shown for each category. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/ assembly time), troubleshooting/fault location time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance categories are as follows:

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1 Service, inspect, test, service, adjust, align, calibrate, and/or replace.

2 Fault locate/trouble shoot the process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or unit under test (UUT).

3 Disassemble/assemble encompasses the step-by-step taking apart (or breakdown) of a spare/functional group coded item to the level of its least componency identified as maintenance significant (i.e., assigned an SMR code) for the category of maintenance under consideration.

4 Actions welding, grinding, riveting, straightening, facing, remachining, and/or resurfacing.

C .....Operator/Crew
O .....Unit Maintenance
F ..... Direct Support Maintenance
H ..... General Support Maintenance
D ..... Depot Maintenance

e. Column 5. Tools and Equipment. Column 5 specifies, by code, those common tool sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.

f. Column 6. Remarks. This column shall, when applicable, contain a letter code, in alphabetic order, which shall be keyed to the remarks contained in section IV.

B-4. Explanation Of Columns In Tool And Test Equipment Requirements, Section III.

a. Column I. Reference Code. The tool and test equipment reference code correlates with a code used in the MAC, section II, column 5.

b. Column 2, Maintenance Category. The lowest category of maintenance authorized to use the tool or test equipment.

c. Column 3. Nomenclature. Name or identification of the tool or test equipment.

d. Column 4. National Stock Number. The National stock number of the tool or test equipment.

e. Column 5. Tool Number. The manufacturer's part number.

B-5. Explanation Of Columns In Remarks, Section IV.

a. Column I. Reference Code. The code recorded in column 6, Section II.

b. Column 2. Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, section II.

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT	(6) REMARKS
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
01	pH METER	INSPECT	0.1						
		REPLACE		0.1					
		REPAIR			1.0			1.2	A

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR MAINTENANCE ALLOCATION CHART

(1) TOOL OR TEST EQUIPMENT REF CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NSN	(5) TOOL NUMBER
1	O, F	TOOL KIT, GENERAL AUTOMOTIVE	5180-00-177-7033	(50980) SC 5180-90-CL-N26
2	F	KIT, SOLDERING GUN, 115V, 60 CYCLE COMPLETE WITH SOLDER AND CASE	3439-00-618-6623	

Section IV. REMARKS

REFERENCE CODE	REMARKS
A	Repair at this level may require returning meter to commercial repair activity.

APPENDIX C

COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LISTS

NOT APPLICABLE

APPENDIX D

ADDITIONAL AUTHORIZATION LIST

NOT APPLICABLE

APPENDIX E

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

NOT APPLICABLE

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

THOMAS F. SIKORA
Brigadier General, United States Army
The Adjutant General

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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