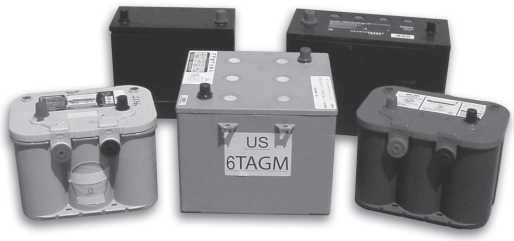
*TB 9-6140-252-13

TECHNICAL BULLETIN
FOR

RECHARGING PROCEDURES FOR AUTOMOTIVE VALVE REGULATED LEAD-ACID BATTERIES

NSN 6140-01-441-4272 NSN 6140-01-485-1472
NSN 6140-15-180-0587 NSN 6140-01-374-2243
NSN 6140-01-582-5710 NSN 6140-01-557-6221
NSN 6140-01-529-7226 NSN 6140-01-523-6288
NSN 6140-01-520-7112 NSN 6140-01-556-4352
NSN 6140-01-502-4973 NSN 6140-01-502-4405
NSN 6140-01-534-6466 NSN 6140-01-545-0940
NSN 6140-01-457-5296 NSN 6140-01-457-5469
NSN 6140-01-475-9355 NSN 6140-01-545-6924
NSN 6625-01-539-5418 NSN 6130-01-510-9594



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HEADQUARTERS, DEPARTMENT OF THE ARMY
22 September 2011

WARNING SUMMARY

This warning summary contains general safety precautions and instructions that must be understood and applied during the operation and maintenance for the Automotive Lead-Acid Storage Batteries to ensure personnel against injury, long-term health hazards, or death. Failure to observe these precautions could result in serious death or injury to personnel. Also included are explanations of safety and hazardous materials icons used within the Technical Bulletin (TB).

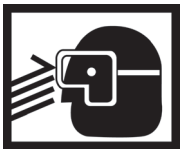
FIRST AID

For first aid information, refer to FM 4-25.11, First Aid.

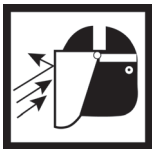
EXPLANATION OF SAFETY WARNING ICONS

CHEMICAL - drops of liquid on hand shows that the material will cause burns or irritation to human skin or tissue.

EXPLOSION - rapidly expanding symbol shows that the material may explode if subjected to high temperatures, sources of ignition, or high pressure.



EYE PROTECTION - person with goggles shows that the material will injure the eyes.



FLYING PARTICLES - arrows bouncing off face shield show that particles flying through the air will harm face.

HEAVY OBJECT - human figure stooping over heavy object shows physical injury potential from improper lifting technique.

HOT AREA - hand over object radiating heat shows that part is hot and can burn.

WARNING SUMMARY - Continued

EXPLANATION OF SAFETY WARNING ICONS - Continued

VAPOR - human figure in a cloud shows that material vapors present a danger to life or health.

SAFETY WARNINGS DESCRIPTION

WARNING

This battery contains sulfuric acid electrolyte so proper care and considerations should be taken to protect equipment and personal clothing when handling batteries with damaged or broken cases. Use approved, acid resistant protective clothing and wash and neutralize battery box after removal of damaged battery pieces. Failure to do so may result in personnel injury or death.

WARNING SUMMARY - Continued

SAFETY WARNINGS DESCRIPTION - Continued

WARNING

- Perform all charging functions in a ventilated area. The potential for hydrogen gas build up and explosion exists with any lead-acid battery. Do not smoke or have open flames in the charging area. Failure to comply may result in personnel injury or death.
- Immediately stop charging any battery that develops signs of melting or swelling or if the surface temperature of the case is too hot to comfortably touch with a bare hand. Do not handle or attempt to move battery until it has cooled for a couple hours to avoid the risk of an explosion. Failure to comply may result in personnel injury or death.
- Many of these batteries weigh over 80 pounds and a two-man lift is required. Battery should be carried by the handles supplied and should not be lifted by a battery strap attached to the posts. Failure to carry a battery in this manner may lead to personnel injury or damage to the battery.
- All charging functions should be performed in a ventilated area. The volume of hydrogen gas emitted from the VRLA battery is far less than can be expected from the 6TMF flooded lead acid battery. The technology used in the VRLA battery greatly reduces the risk of explosion, however, the potential for hydrogen gas exploding exists with any lead-acid battery.
- Monitor the battery for excessive heat during charging. During the charging procedure, some heat is generated as a natural result of charging. However, if a battery becomes too hot to comfortably touch with the bare hand or the case or lid begins to melt or shows signs of swelling, it should be removed from the charger immediately. Allow battery to cool before attempting to move. If this condition exists repeatedly with a specific charger, the charger may not be compatible for use with VRLA battery technology and its use should be discontinued.

WARNING SUMMARY - Continued

SAFETY WARNINGS DESCRIPTION - Continued

WARNING

- Many of these batteries weigh over 80 pounds and a two-man lift is required. Battery should be carried by the handles supplied and should not be lifted by a battery strap attached to the posts. Failure to carry a battery in this manner may lead to personnel injury or damage to the battery.
- These batteries contain sulfuric acid electrolyte so proper care and considerations should be taken to protect equipment and personal clothing when handling batteries with damaged or broken cases. Use approved, acid resistant protective clothing and wash and neutralize battery box after removal of damaged battery pieces. Failure to do so may result in personnel injury or death.
- Immediately stop charging any battery that develops signs of melting or swelling or if the surface temperature of the case is too hot to comfortably touch with a bare hand. Do not handle or attempt to move battery until it has cooled for a couple hours to avoid the risk of an explosion. Failure to comply may result in personnel injury or death.

WARNING

Perform all charging functions in a ventilated area. The potential for hydrogen gas buildup and explosion exists with any lead-acid battery. Do not smoke or have open flames in the charging area. Failure to comply may result in personnel injury or death.

LIST OF EFFECTIVE PAGES/WORK PACKAGES

Date of issue for the original bulletin is:

Original 22 September 2011

TOTAL NUMBER OF PAGES FOR FRONT AND REAR MATTER IS 26 AND THE TOTAL NUMBER OF WORK PACKAGES IS 12, CONSISTING OF THE FOLLOWING:

Page/WP No.	Change No.	Page/WP No.	Change No.
Front Cover	0	WP 0005 (2 pages)	0
Warning Summary (4 pages)	0	WP 0006 (2 pages)	0
Title Block Page (2 pages)	0	WP 0007 (2 pages)	0
Table of Contents (2 pages)	0	WP 0008 (2 pages)	0
Chapter 1 Title Page	0	WP 0009 (2 pages)	0
WP 0001 (4 pages)	0	WP 0010 (2 pages)	0
WP 0002 (2 pages)	0	WP 0011 (2 pages)	0
WP 0003 (2 pages)	0	WP 0012 (2 pages)	0
Chapter 2 Title Page	0	Index (2 pages)	0
WP 0004 (6 pages)	0	Back Cover	0

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 22 September 2011

TECHNICAL BULLETIN
FOR
RECHARGING PROCEDURES
FOR
AUTOMOTIVE VALVE REGULATED LEAD-ACID BATTERIES

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NSN 6625-01-539-5418 NSN 6130-01-510-9594

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this publication. If you find any errors, or if you would like to recommend any improvements to the procedures in this publication, please let us know. The preferred method is to submit your DA Form 2028 (Recommended Changes to Publications and Blank Forms) through the Internet on the TACOM Unique Logistics Support Applications (TULSA) Web site. The Internet address is https://tulsa.tacom.army.mil. Access to all applications requires CAC authentication, and you must complete the Access Request form the first time you use it. The DA Form 2028 is located under the TULSA Applications on the left-hand navigation bar. Fill out the form and click on SUBMIT. Using this form on the TULSA Web site will enable us to respond more quickly to your comments and to better manage the DA Form 2028 program. You may also mail, e-mail, or fax your comments or DA Form 2028 directly to the U.S. Army TACOM Life Cycle Management Command. The postal mail address is U.S. Army TACOM Life Cycle Management Command, ATTN: AMSTA-LCL-MPP/TECH PUBS, MS 727, 6501 E. 11 Mile Road, Warren, MI 48397-5000. The e-mail address is tacomlcmc.daform2028@us.army.mil. The fax number is DSN 786-1856 or Commercial (586) 282-1856. A reply will be furnished to you.

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TABLE OF CONTENTS

CHAPTER 1

GENERAL INFORMATION, EQUIPMENT DESCRIPTION, AND THEORY OF OPERATION

GENERAL INFORMATION

SCOPE

This Technical Bulletin (TB) is provided as an aid to correctly recharge Valve Regulated Lead-Acid (VRLA) Absorbed Glass Mat (AGM) batteries and reduce the incidences of premature disposal.

MAINTENANCE FORMS, RECORDS, AND REPORTS

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 750-8, The Army Maintenance Management System (TAMMS) Users Manual.

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. The preferred method is to submit your DA Form 2028 (Recommended Changes to Publications and Blank Forms) through the Internet on the TACOM Unique Logistics Support Applications (TULSA) Web site. The Internet address is https://tulsa.tacom.army.mil. Access to all applications requires CAC authentication, and you must complete the Access Request form the first time you use it. The DA Form 2028 is located under the TULSA Applications on the left-hand navigation bar. Fill out the form and click on SUBMIT. Using this form on the TULSA Web site will enable us to respond more quickly to your comments and to better manage the DA Form 2028 program. You may also mail, e-mail, or fax your comments or DA Form 2028 directly to the U.S. Army TACOM Life Cycle Management Command. The postal mail address is U.S. Army TACOM Life Cycle Management Command, ATTN: AMSTA-LCL-MPP/ TECH PUBS, MS 727, 6501 E. 11 Mile Road, Warren, MI 48397-5000. The e-mail address is tacomlcmc.daform2028@us.army.mil. The fax number is DSN 786-1856 or Commercial (586) 282-1856. A reply will be furnished to you.

DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE

Refer to TM 750-244-6, Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use.

DEFINITION OF COMMON TERMS

Buss Bar - A means of attaching one charger to two or more batteries to be charged at the same time.

Passivation - When batteries are left in a discharged state, a layer of lead oxide begins to coat the plates hampering the cells' ability to accept or release energy. Passivation may result in a battery taking 24 hours or more to begin to draw current during charging, and may result in false "bad battery" readings by battery analyzers and chargers.

Pulsing - Some chargers apply "pulses" of current to the battery, purported to remove the sulfating layers accumulated on the battery cell plates.

Vent - There are six vents per 12 volt battery. They are located in the lid in a 3X2 pattern, circular in shape, one inch or 2.5 cm in diameter.

LIST OF ABBREVIATIONS/ACRONYMS

The following table lists abbreviations and acronyms that appear in this Technical Bulletin (TB).

Abbreviations/Acronyms	Name
AGM	Absorbed Glass Mat; a lead-acid battery format where the electrolyte is held in fiberglass mats suspended between the battery plates
AMC	Army Materiel Command
amp	Amperage
BCI	Battery Council International
CCA	Cold Cranking Amperage; an indication of Amperage available to perform start function
cm	centimeter
DRMO	Defense Reutilization and Marketing Office
EIR	Equipment Improvement Recommendation
FM	Field Manual
NATO	North Atlantic Treaty Organization
NSN	National Stock Number
OCV	Open Circuit Voltage; the electrical value measured between the positive and negative posts on the battery without a load
SATS	Standard Automotive Tool Set
SOC	State Of Charge
TACOM	Tank Automotive Command
TAMMS	The Army Maintenance Management System

LIST OF ABBREVIATIONS/ACRONYMS - Continued

Abbreviations/Acronyms	Name
TARDEC	Tank Automotive Research, Development and Engineering Center
TB	Technical Bulletin
TM	Technical Manual
TULSA	TACOM Unique Logistics Support Applications
VDC	Volts Direct Current
VRLA	Valve Regulated Lead-Acid maintenance free battery
WP	Work Package

END OF WORK PACKAGE

EQUIPMENT DESCRIPTION AND DATA

CHARACTERISTICS

The Valve Regulated Lead-Acid (VRLA) battery's approximate State Of Charge (SOC) can be determined by measuring its Open Circuit Voltage (OCV). For a "rested" battery (a battery that hasn't been charged or discharged for at least eight hours) OCV and SOC are related as follows:

> 12.9 volts OCV: 95% - 100% SOC
12.7 volts OCV: about 80% SOC
12.5 volts OCV: about 60% SOC
12.3 volts OCV: about 50% SOC
12.1 volts OCV: about 35% SOC
11.9 volts OCV: about 20% SOC
11.7 volts OCV: about 10% SOC
11.5 volts OCV: about 5% SOC
< 11.4 volts OCV: 0% SOC

If the battery hasn't "rested" sufficiently after charging, the voltage reading will be a bit higher than normal. If the battery hasn't "rested" sufficiently after discharging, the voltage reading may be a bit lower than normal.

DESCRIPTION

Several battery manufacturers make VRLA-AGM. They now come in all Battery Council International (BCI) groups; they weigh 10-25% more than the equivalent flooded cell battery.

END OF WORK PACKAGE

THEORY OF OPERATION

GENERAL

Valve Regulated Lead-Acid (VRLA) and Absorbed Glass Mat (AGM) batteries have proven to be rechargeable multiple times from voltages as low as 0.24 VDC. Therefore, the battery must be charged and tested before disposal is approved. It is a sealed system with Absorbed Glass Mat (AGM) technology that contains an absorbed amount of electrolyte in the cell chamber; therefore NO liquid will be introduced into the cell chamber at any time after manufacturing. Other than removal of dust, dirt or corrosion buildup on the exterior of the battery no maintenance beyond recharging is required.

WARNING

This battery contains sulfuric acid electrolyte so proper care and considerations should be taken to protect equipment and personal clothing when handling batteries with damaged or broken cases. Use approved, acid resistant protective clothing and wash and neutralize battery box after removal of damaged battery pieces. Failure to do so may result in personnel injury or death.

Recharge and Disposal Directive

When the user's organization does not have the capability to recharge the VRLA battery it should be directed to the supporting sustainment unit to have the battery recharged and returned to service. Field level maintenance is not authorized to turn in this battery for disposal (unless physically damaged) but, due to the cost and rechargability of this battery, it should be disposed of only after testing and attempting to recharge it without success. If field level maintenance is unable to test or recover the battery, turn into sustainment level for testing and recharging. Only sustainment level may dispose of VRLA batteries deemed un-rechargeable.

END OF WORK PACKAGE

CHAPTER 2

BATTERY CHARGING INSTRUCTIONS

BATTERY CHARGING AND TEST EQUIPMENT

INITIAL SETUP:

Not Applicable

GENERAL

Any charger that has a constant voltage output (rated at 12 VDC or 12/24 VDC) that can apply a charge to one or more batteries at a time using either alligator clamps or NATO slave connector may be used.

To verify the voltage rating of a charger, attach charger to a fully charged battery (6TMF or VRLA), apply power, wait a couple minutes until the amp meter registers 1 amp or less, then measure the voltage on the leads at the battery terminals. Do not exceed 15 VDC if charging one 12 volt battery or 30 VDC if charging a 24 volt battery system.

Constant current chargers are not recommended for charging Valve Regulated Lead-Acid (VRLA) Absorbed Glass Mat (AGM) batteries, especially to ensure a complete charge of new batteries.

BATTERY CHARGERS

Table 1. Pulse Tech Pro-HD (Roll Around) NSN 6130-01-500-3401.

Minimum Battery Voltage (OCV) Start:	Approximately 4.0 VDC Black color; Cream 1.5 VDC
Diagnostic Time:	Instantaneously
12/24 Capability:	12 and 24 volt auto select
Charge Time:	24 hours or more
Number of Charge Cycles to Recharge a Battery:	Multiple cycles may be needed
End of Charge Charger Status:	Light comes on and charging stops

This charger will instantly go to 'Charge Complete' status (all lights off except complete) for highly passivated batteries. It will not pulse a battery until it begins to take a charge. This charger comes with a NATO slave connector, interchangeable with the alligator clamp leads.

Figure 1. Pulse Tech Pro-HD.

BATTERY CHARGERS - Continued

Table 2. Associated Model PP-1660-F/U (Roll Around) NSN 6130-01-518-7866.

Minimum Battery Voltage (OCV) Start:	Approximately 2.4 VDC
Diagnostic Time:	45-50 minutes
12/24 Capability:	12 and 24 VDC manual select
Charge Time:	24 hours or more
Number of Charge Cycles to Recharge a Battery:	Multiple cycles may be needed
End of Charge Charger Status:	Display gives a status reading, then beeps every minute till power is terminated

Charger has a 45-50 minute diagnostic cycle and will give a defective battery reading. Allow the battery to rest up to five minutes and restart. It was found that many batteries required five or more of these diagnostic cycles before they begin to take a charge. Once battery started to accept a charge it often would recharge in less than two hours. This charger comes with a NATO slave connector, interchangeable with the alligator clamp leads.

Figure 2. Model PP-1660-F/U.

BATTERY CHARGERS - Continued

Table 3. Pulse Tech HD Pallet Charger (Roll Around) NSN 6130-01-532-7711.

Minimum Battery Voltage (OCV) Start:	Approximately 1.5 VDC Cream color; Black 4.0 VDC
Diagnostic Time:	Instantaneously
12/24 Capability:	12 volt only
Charge Time:	24 hours or more
Number of Charge Cycles to Recharge a Battery:	Multiple cycles may be needed
End of Charge Charger Status:	Light comes on and charging stops
Battery Capacity:	This charger comes with 12 individual (six foot) plug in leads with alligator clamps

This charger will pulse charge until battery begins to take a charge.

Figure 3. Pulse Tech HD Pallet Charger.

BATTERY CHARGERS - Continued

Table 4. Pulse Tech Model 745-600 (Desk Top) NSN 6130-01-474-4703.

Minimum Battery Voltage (OCV) Start:	Approximately 0.2 VDC
Diagnostic Time:	None
12/24 Capability:	12 volt only
Charge Time:	18-30 hours
Number of Charge Cycles to Recharge a Battery:	Multiple cycles may be needed
End of Charge Charger Status:	Light comes on and charger stops

This charger is a 12 volt charger, designed to charge one battery at a time.
The type of battery switch (AGM-Flooded) is located on the rear of the charger.

Figure 4. Pulse Tech Model 745-600.

TEST EQUIPMENT

- Multimeter or Voltmeter: any type that reads in 1/10th VDC increments.
- Battery analyzer (e.g. Midtronics or Pulsetech) or load tester (any brand available).

OTHER EQUIPMENT NEEDED

- Battery post cleaner (NSN 5120-00-926-5175) or wire brush (NSN 7920-00-291-5815), any brand.
- Pliers, slip joint preferred, any size.
- Permanent marker, any color.
- Chalk or pencil.

END OF TASK

END OF WORK PACKAGE

PRE-CHARGING PROCEDURES

INITIAL SETUP:

References
WP 0006

GENERAL

This work package covers pre-charging inspection and testing of batteries.

INSPECTION

Before starting to test or recharge any battery, a visual inspection must be performed. Any batteries with physical damage described below should be disposed of immediately. With a permanent marker label battery as "DAMAGED". Things to look for consist of the following:

NOTE

Do not attempt to replace missing vents.

1. Check top, sides, and bottom for cracks, dents, leaking or swelling in the battery case and lid.
2. Check that battery lid and case is sealed.
3. Make sure terminals are not melted, bent, or otherwise damaged.
4. Check that all vent caps are in place (flush) and do not appear to be elevated. Elevated vent caps are a sign of a defective vent or that the battery has gassed excessively. Gently tap or screw vent back in place, then with a permanent marker, mark the vent with an "R". If it elevates again during charging or operational use, dispose of battery.
5. If a battery is turned in for recharge and a vent cap with an "R" marked on it is elevated again, disposal is authorized without further testing. Label battery as "DAMAGED".

END OF TASK

TESTING

After performing the visual inspection, test the battery for potential internal electrical damage.

1. Using a battery post cleaner or wire brush, clean any corrosion buildup from the terminals.
2. Using voltage meter, test Open Circuit Voltage (OCV) of the battery. Set meter to lowest VDC reading that is greater than 15 VDC. Place the positive lead (red) on the battery post marked with a (+) sign and the negative lead (black) on the other battery post with the (-) sign. Note the voltmeter reading and, with chalk or pencil, record test OCV on top of battery. This OCV becomes a reference point for future tests and should be removed at the conclusion of charging and testing.
3. Determine if internal damage exists. Many testers will not give a reading if OCV is less than seven (< 7) VDC. If no reading is given, proceed with charging procedures (WP 0006). If no reading is given, charge the battery for 24 hours and retest with Multimeter and Analyzer. If no change is detected after 24 hours of charging, the battery is considered bad. Mark battery as "CHARGED, TESTED BAD."
4. If at any time an "Unstable Battery" reading is received, use pliers and apply gentle force to make sure terminals are snug with a clockwise turn effort. If any movement is experienced greater than an 1/8th of a turn in either post, the battery is defective. Label battery as "DAMAGED" and dispose. **DO NOT** force posts to turn by applying strong force.
5. If a battery analyzer is not available proceed with charging the battery per instructions in (WP 0006).

END OF TASK

END OF WORK PACKAGE

CHARGING PROCEDURES INTRODUCTION

INITIAL SETUP:

References
WP 0007
WP 0008

References (cont.)
WP 0009
WP 0012

Equipment Condition
Pre-charging procedures completed (WP 0005)

GENERAL

This work package covers general instructions for all charging procedures. For detailed information about different charging configurations, see (WP 0007, 0008, and 0009).

WARNING

- Perform all charging functions in a ventilated area. The potential for hydrogen gas build up and explosion exists with any lead-acid battery. Do not smoke or have open flames in the charging area. Failure to comply may result in personnel injury or death.
- Immediately stop charging any battery that develops signs of melting or swelling or if the surface temperature of the case is too hot to comfortably touch with a bare hand. Do not handle or attempt to move battery until it has cooled for a couple hours to avoid the risk of an explosion. Failure to comply may result in personnel injury or death.
- Many of these batteries weigh over 80 pounds and a two-man lift is required. Battery should be carried by the handles supplied and should not be lifted by a battery strap attached to the posts. Failure to carry a battery in this manner may lead to personnel injury or damage to the battery.
- All charging functions should be performed in a ventilated area. The volume of hydrogen gas emitted from the VRLA battery is far less than can be expected from the 6TMF flooded lead acid battery. The technology used in the VRLA battery greatly reduces the risk of explosion, however, the potential for hydrogen gas exploding exists with any lead-acid battery.
- Monitor the battery for excessive heat during charging. During the charging procedure, some heat is generated as a natural result of charging. However, if a battery becomes too hot to comfortably touch with the bare hand or the case or lid begins to melt or shows signs of swelling, it should be removed from the charger immediately. Allow battery to cool before attempting to move. If this condition exists repeatedly with a specific charger, the charger may not be compatible for use with VRLA battery technology and its use should be discontinued.

GENERAL - Continued

CAUTION

If you are unsure of the output voltage of your charger test it first, see (WP 0005). If charger is an older version and has no adjustments it most likely is not compatible with Absorbed Glass Mat (AGM) Batteries. Closely monitor its usage to ensure it does not damage the batteries being charged.

SERVICE

NOTE

- When charging multiple batteries in one set they must be identical types. Do not charge a flooded battery and a VRLA battery on same charger at the same time.
- Do not mix flooded and VRLA batteries in the vehicle. VRLA batteries should be from same manufacturer.
- Be sure to charge batteries in well ventilated areas only.
- During charge cycle, the batteries should be examined daily.
- Voltage levels stated in this Technical Bulletin should not be used to set the vehicle voltage regulator, refer to the appropriate vehicular Technical Manual for this value.
- VRLA-AGM batteries are lead-acid batteries and must be disposed of following local procedures for the recycling of hazardous waste materiel. Do not dispose of by putting out with the trash (WP 0012).

1. After performing the pre-charge inspection and testing, the Valve Regulated Lead-Acid (VRLA) battery can be charged either in or out of the vehicle by attaching charger leads directly on the battery (12 VDC) red lead to positive post (+), black lead to negative post (-) or through the vehicle's NATO slave connection, (24 VDC). Batteries can be charged individually or as a group using the following procedures. If using the NATO slave receptacle use a charger with 24 volt capacity and a NATO slave connector plug.
2. If charging on the vehicle make sure all current draws (i.e. lights, electronic equipment etc.) are turned **OFF**. Do not attempt to jump start the vehicle with the charger unless it is specifically designed to do so; i.e. includes power assist mode.

END OF TASK

END OF WORK PACKAGE

BUSS BAR MULTIPLE BATTERY CHARGING

INITIAL SETUP:

References
WP 0003
WP 0011

Equipment Condition
Pre-charging procedures completed. (WP 0005)

GENERAL

This task is intended for use by military battery shops or units with chargers that will handle more than one battery at a time.

CAUTION

When hooking up batteries, large amounts of current are available even in discharged batteries. Make sure all leads are clear; avoid making contact with any material but the intended battery post. Attach all the positive (+) terminals first then the negative (-) terminals. Disconnect in the reverse order, negatives (-) first. Do not mix battery types (such as flooded 6TMF and AGM) on the buss during charging. Failure to comply may result in equipment damage.

NOTE

- Group batteries for charging by Open Circuit Voltage (OCV). Group ranges are 0 to 5.9 VDC; 6.0 to 9.9 VDC; 10.0 and above. Ideal voltage spread of the group is no more than 3.0 VDC and can cross groups (i.e. OCV= 4.4 to 7.4 VDC).
- Batteries connected to a standard constant applied voltage buss bar charger set should have voltage adjusted to between 14.7 volts and 15.2 volts. Clamp wiring and contacts must be tight and clean with minimal corrosion to assure good connections.
- These settings should result in approximately 14.7 volts to 15.2 volts applied potential when measured at the battery's terminals at the end of the charge period.
- Do not use values listed for the vehicle's voltage regulator setting. Consult the appropriate Technical Manual (TM).

SERVICE

1. Allow for at least a 10 amp charging current available per battery on the buss. Higher buss charge current will help accelerate the battery charge time. For example, if you are using a charger that has a max output of 100 amps source do not attempt to connect more than 10 batteries to it.
2. Charge batteries for 24-48 hours (see Step 5 below). Weekend charging of 64 hours (Friday 1600 to Monday 0800) can be performed, but best to have someone check the system at least once per day to assure proper operation (no excessive heat, gassing, leaking, proper voltage applied) and to determine whether charge has been completed. Severely depleted batteries can take two to three days or longer to recharge. See Theory of Operation (WP 0003) for charger operational lab observations.
3. Immediately remove any battery from buss that shows signs of excessive heat, gassing, leaking, or swelling during charge stage. Battery should then be disposed of. Battery should be marked with a permanent marker with date and statement "CHARGED, TESTED BAD"; then processed for disposal.
4. After removing a bad battery from the charger and before charging another battery, measure the Open Circuit Voltage (OCV) of the batteries in the setup and select one with similar OCV + 1 VDC.
5. Batteries are finished when charge current (amp meter on charger) drops to < 1 amp per battery and holds there for three hours. For example, if 12 batteries are on buss, then overall current should be < 12 amps.
6. Test batteries individually; see (WP 0011).

END OF TASK

END OF WORK PACKAGE

SINGLE BATTERY CHARGING PROCEDURES

INITIAL SETUP:

References
WP 0004
WP 0010

Equipment Condition
Pre-charging procedures completed. (WP 0005)

GENERAL

This task is intended for use by military battery shops or units with chargers that will handle only one battery at a time.

SERVICE

1. Connect charger to the battery posts. Clamp wiring and contacts must be tight and clean with minimal corrosion to assure good connections.
2. If possible, use a constant voltage charger of newer technology, which may have multiple charge settings and steps (such as Absorbed Glass Mat (AGM) setting, if charger has this switch setting select this switch position). If voltage is adjustable the voltage should be set between 14.4 volts and 15.0 volts and there should be at least 10 amps of current available for charging.
3. Before applying power to charger, select the charger setting to AGM. If the charger has adjustable voltage settings, adjust the voltage to 14.4 volts to 15.0 VDC.

NOTE

Do not use values listed in Step 4 for the vehicle's voltage regulator setting. Consult the appropriate Technical Manual (TM).

4. If battery charger has no adjustments or switches (and is not a SMART Charger and output voltage is > 15.0 VDC) the battery should be closely monitored (every 15 minutes) during the first two hours of charge process. If it shows signs of excessive heat when touching the exterior, gassing, leaking or swelling during charge stage, charging should be stopped immediately. If charger is an older model and user is unsure as to the output voltage of the charger, see (WP 0004) for testing procedure.

CAUTION

If using a "Constant Current Charger," use formula of: 120 divided by output Amperage = allowable hours of charge Time (120/amps=Time). Do not charge a battery longer than formula value (example: 20 hours if charger has a 6 amp constant amperage output). This type charger is NOT recommended for use on Valve Regulated Lead-Acid (VRLA) batteries, especially for supplemental charging to ensure a complete charge. Use of this charger may result in equipment damage.

5. Charge batteries for 12 hours or longer (see Step 7 below). Weekend charging of 64 hours (Friday 1600 to Monday 0800) can be performed, but be sure to check the system at least once per day to assure proper operation (no excessive gassing or leaking, proper voltage applied) and to determine whether charge has been completed. Severely depleted batteries (OCV < 10 VDC) can take up to four days to recharge. If Open Circuit Voltage (OCV) is not significantly improved (> 10 VDC) after four days it may never take a full charge.

SERVICE - Continued

6. Immediately remove any battery from charger that shows signs of excessive heating, gassing, leaking, or swelling during charge stage. Battery should be disposed of. Battery should be marked with a permanent marker with date and statement "CHARGED, TESTED BAD"; then processed for disposal.
7. Battery is finished when charge current (amp meter on charger) drops to < 1 amp and holds there for three hours. Automatic chargers will stop charging and give a screen reading of "Charge Complete". Some automatic chargers may not fully recharge with one charge cycle; may or may not indicate a good battery. Additional charge cycles may be required to ensure full recharge of the battery. If the OCV is unchanged in two consecutive cycles the battery has reached its capacity. Proceed with testing.
8. Test battery; see (WP 0010).

END OF TASK

END OF WORK PACKAGE

NATO SLAVE RECEPTACLE CHARGING PROCEDURES

INITIAL SETUP:

References
WP 0010

Equipment Condition
Pre-charging procedures completed (WP 0005)

GENERAL

This task is intended for use by standard military battery shops or units without access to chargers but with access to the NATO slave receptacle cable and a vehicle capable of slave charging.

SERVICE

1. Connect charger to the NATO slave receptacle. Ensure cable clamps and contacts are tight and clean with minimal corrosion to assure good connections. Ensure all current drawing devices are OFF i.e. lights, electronic equipment etc.
2. If possible, use a constant voltage charger of newer technology, which may have multiple charge settings and steps such as an Absorbed Glass Mat (AGM) setting. If charger has this switch setting select this switch position. If voltage is adjustable the voltage should be set between 28.8 volts and 30.0 volts or 24 volt switch setting selected and there should be at least 5 amp current per battery available for charging. Such settings may give the operator the option of setting the charge voltage and current, to expedite charge time, and will assure decreasing amperage output as the battery charges in Step 5.

NOTE

Do not use the values listed in Step 3 for the vehicle's voltage regulator setting. Consult appropriate Technical Manual (TM).

3. Before applying power to charger, select the charger setting for AGM. If the charger has adjustable voltage output capabilities, adjust the voltage to 28.8 volts to 30.0 VDC.
4. If battery charger has no adjustments or switches (and is not a SMART Charger and output voltage is > 30.0 VDC) the battery should be closely monitored every 15 minutes, during the first two hours of charge process. If it shows signs of excessive heat when touching the exterior, gassing, leaking or swelling during charge stage, charging should be stopped immediately. If charger is an older model and user is unsure as to the output voltage of the charger, see (WP 0005) for testing procedure.
5. Charge batteries for 12 hours or longer (see Step 8). Weekend charging of 64 hours (Friday 1600 to Monday 0800) can be performed, but it is best to have someone check the system at least once per day to assure proper operation (no excessive gassing, leaking, proper voltage applied) and to determine whether charge has been completed. Severely depleted batteries (OCV < 10 VDC) can take up to four days to recharge. If Open Circuit Voltage (OCV) is not significantly improved (> 10 VDC) after four days it may never make a full recharge.
6. Immediately remove any battery from charger that shows signs of excessive heating, gassing, leaking, or swelling during charge stage. Battery should be disposed of. Battery should be marked with a permanent marker with date and statement "CHARGED, TESTED BAD"; then processed for disposal.

SERVICE - Continued

7. If a battery is removed from a vehicle and the others are still charging, measure the OCV of the other batteries and replace with a battery of similar OCV (+ 1 VDC is acceptable) or charge the remaining batteries and install a new battery when they have completed the charging cycle (WP 0010).
8. Batteries are finished when charge current (amp meter on charger) drops to < 1/2 amp per battery and holds there for three hours. For example, if four batteries are in the battery box, then overall current should be < 2 amps. Automatic chargers will stop charging and give a screen reading of "Charge Complete". Some automatic chargers may not fully recharge with one charge cycle; may or may not indicate a good battery. Additional charge cycles may be required to ensure full recharge of the battery. If the OCV is unchanged in two consecutive cycles the battery has reached its capacity. Proceed with testing.
9. Test batteries individually; see (WP 0010).

END OF TASK

END OF WORK PACKAGE

POST-CHARGING PROCEDURES

INITIAL SETUP:

References
WP 0006
WP 0007

References (cont.)
WP 0008
WP 0009

RESTING BATTERIES

Remove batteries from charger and allow them to settle (rest; cool preferably overnight). See rest times below for type of testing to be performed. Batteries that are still heated from charging process may give erroneous readings.

TESTING

After resting, if battery Open Circuit Voltage (OCV) and load voltage are above 12.65 VDC and 10.80 VDC respectively, the battery is good for reissue to fleet as is without need for recharging. If the battery OCV and load voltage are below 12.65 VDC and/or 10.80 volt respectively, it needs additional charging. If at the end of two charge cycles the OCV is identical + 0.1 VDC to the previous cycle, the battery has probably reached its potential. Proceed and use this value for all tests. This value may increase as the battery rests (cools to ambient temperature).

1. **Open Circuit Voltage Test Only:** After a rest period of 18 hours minimum, using a voltmeter measure the batteries OCV which should be >12.85 VDC (new battery) or >12.65 VDC (used battery). Voltmeter should read in 1/10th volts or smaller units.
2. **Load Test:** After a rest period of two hours minimum, measure the battery OCV & load test at a discharge rate: 550 amps for batteries with a CCA >1000; for CCA <1000 use 350 amps. Apply designed load for 15 seconds (with ambient temperature between 68°F/20°C to 87°F/30°C if possible.) Load testing provides actual engine start simulation load to the battery simulating actual use in the field. This testing Steps 3 through 5 below allows for fast, easy, and economical determination of a battery's State Of Charge and State of Health. Use Load Tester 6625-01-539-5418 or similar to perform load tests. Use battery analyzer (490PT) 6130-01-510-9594 or equivalent.
3. **Measure OCV:** Using a voltmeter measure the batteries OCV which should be >12.85 VDC (new battery), or 12.65 VDC (used battery). Voltmeter should read in 1/10th volts or smaller units.
4. **Load Test:** Follow manufacturer's instructions for your Load Tester, for Steps b and c below.
   a. Attach Load Tester to battery.
   b. Select load value 550 amps if >1000 CCA or 350 amps if <1000 CCA.
   c. Apply load for 15 seconds. While under load monitor the OCV; battery OCV should be > 10.00 VDC at 15 seconds of load. If voltage drops below 10.0 VDC additional charging is required and retest or disposal recommended for older used batteries or failed again during retest.
   d. After a two minute rest measure the OCV which should have returned to value measured in Step 1.
   e. If time available recharge the battery for approximately one hour to restore energy lost during testing.

TESTING - Continued

5. If a Load Tester is not available an alternate method of testing the battery is approved: Using a battery analyzer meter such as 490PT (available in SATS) measure the battery voltage and CCA rating. Note this meter reading is not a true CCA value; however it is considered a reliable reflection of the batteries capacity. For a used battery if the CCA value indicated on the meter is less than the batteries CCA rate additional charging is required or disposal is recommended.
6. Disposal: Battery determined by the above tests to be disposed of should be marked as "BAD-TESTED" and date of test.

END OF TASK

END OF WORK PACKAGE

PLACING BATTERIES INTO SERVICE

INITIAL SETUP:

References
WP 0007

References (cont.)
WP 0008
WP 0009

PLACING NEW BATTERIES INTO SERVICE

1. When replacing a battery or set of batteries with a fresh new battery(s); before they are installed or the vehicle is operated, the batteries should be charged (topped off) until the Open Circuit Voltage (OCV) reaches >12.65 VDC and the amperage meter on charger reads < 1 amp for one hour. For best results, allow batteries to charge overnight. Follow procedures in (WP 0007, 0008, 0009) as applicable.
2. If replacing one battery in a string of batteries, it is best to replace with a used battery that has been recharged, or to replace all batteries in the string with new ones and redistribute the used serviceable batteries. Battery should be tested and charged (topped off) to ensure the OCV is > 12.85 VDC upon installation.

END OF TASK

PLACING USED BATTERIES INTO SERVICE

1. When replacing a battery or set of batteries with a used battery(s); before they are installed or the vehicle is operated, the batteries should be charged (topped off) until the OCV reaches > 12.65 VDC and the amperage meter on charger reads < 1 amp for one hour. For best results, allow batteries to charge overnight. Follow procedures in (WP 0007, 0008, 0009) as applicable.
2. If replacing one battery in a string of batteries, it is best to replace with a used battery of similar age that has been recharged, or to replace all batteries in the string with new ones and redistribute the used serviceable batteries. Used battery should be tested and charged (topped off) to ensure the OCV is > 12.65 VDC upon installation.
3. Good used batteries will recharge to voltages > 12.85 VDC but after an eight hour rest period should stabilize > 12.65 VDC. They should also have a CCA rating > than 90% of CCA rating shown on battery, when tested with a battery analyzer i.e. PT490.

END OF TASK

END OF WORK PACKAGE

BATTERY DISPOSAL

INITIAL SETUP:

References
WP 0005
WP 0010

BATTERY DISPOSAL PROCEDURES

1. The Valve Regulated Lead-Acid (VRLA) and Absorbed Glass Mat (AGM) battery shall be inspected and tested before permission to dispose is granted. Disposal authority is given to the field level for physically damaged batteries; all other disposal authority is at sustainment level.
2. Use a permanent ink marker to mark the battery when indicated during the inspection (WP 0005) or testing phase (WP 0010).
3. The VRLA-AGM battery is a lead-acid battery. Follow local procedures for the handling of hazardous waste materials. Do not dispose of by placing with trash. Most states or countries require disposal through a local Defense Reutilization and Marketing Service site (DRMO).

END OF TASK

END OF WORK PACKAGE

INDEX

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 310-1; the proponent agency is the Army Adjutant General Center.	Use Part II (reverse) for Repairs Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	DATE Date form is filled out
TO: (Forward to proponent of publication or form) (Include ZIP Code) U.S. Army TACOM Life Cycle Management Command ATTN: AMSTA-LCL-MPP/TECH PUBS MS 727 M6501 E. 11 Mile Road, Warren, MI 48397-5000	**FROM:** (Activity and location) (Include ZIP Code)	

PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE
TB 9-6140-252-13	22 SEPTEMBER 2011	HAWKER BATTERY

ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.*	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)
	xxxx-x	X	X	X	X	XXXXXXXXXX
	xxxx-x	X	X	X	X	XXXXXXXXXXXXX

*Reference to line number within the paragraph or subparagraph.

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

DA FORM **2028**
1 FEB 74

REPLACES DA FORM 2028, 1 DEC 68, WHICH WILL BE USED.

TO: *(Forward to proponent of publication or form) (Include ZIP Code)*	FROM: *(Activity and location) (Include ZIP Code)*	DATE
U.S. Army TACOM Life Cycle Management Command ATTN: AMSTA-LCL-MPP/TECH PUBS MS 727 M6501 E. 11 Mile Road, Warren, MI 48397-5000		

PART II- REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

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PAGE NO.	COLM NO.	LINE NO.	FEDERAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPROTED	RECOMMENDED ACTION

PART III - REMARKS ***(Any general remarks or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)***

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By Order of the Secretary of the Army:

RAYMOND T. ODIERNO
General, United States Army
Chief of Staff

Official:

Administrative Assistant to the
Secretary of the Army
000000

DISTRIBUTION: To be distributed in accordance with the initial distribution number (IDN) 000000, requirements for TB-9-6140-252-13.

THE METRIC SYSTEM AND EQUIVALENTS

Linear Measure

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

Weights

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Pounds
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

Liquid Measure

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

Square Measure

1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inches
1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet
1 Sq Kilometer = 1,000,000 Sq Meters = 0.0386 Sq Miles

Cubic Measure

1 Cu Centimeter = 1,000 Cu Millimeters = 0.06 Cu Inches
1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

Temperature

9/5 C° +32 = F°
5/9 (°F - 32) = °C
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius

APPROXIMATE CONVERSION FACTORS

To Change	To	Multiply By
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Sq Inches	Sq Centimeters	6.451
Sq Feet	Sq Meters	0.093
Sq Yards	Sq Meters	0.836
Sq Miles	Sq Kilometers	2.590
Acres	Sq Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Sq Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

To Change	To	Multiply By
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Sq Centimeters	Sq Inches	0.155
Sq Meters	Sq Feet	10.764
Sq Meters	Sq Yards	1.196
Sq Kilometers	Sq Miles	0.386
Sq Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Sq Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621

PIN: XXXXXX-XXX