TM 11-6140-208-15

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

ORGANIZATIONAL, DS, GS, AND DEPOT MAINTENANCE MANUAL

BATTERY, STORAGE BB451/U

(NSN 6140-00-889-1027)

This copy is a reprint which includes current pages from Changes 1 through 4. The title was changed to read as shown above by Change 4.

HEADQUARTERS, DEPARTMENT OF THE ARMY

APRIL 1967

WARNING

DANGEROUS CHEMICALS ARE USED IN SILVER-ZINC BATTERIES

The electrolyte used in silver-zinc batteries contains potassium hydroxide (KOH), which is a caustic chemical agent. Serious and deep burns of body tissue will result if the electrolyte comes in contact with the eyes or any part of the body. Use rubber gloves, rubber apron, and protective goggles when handling the electrolyte. If accidental contact with the electrolyte is made, use ONLY clean water and immediately (seconds count) flush contaminated areas. Continue flushing with large quantities of clean water. Seek medical attention without delay. Tell medical personnel you have been contaminated with potassium hydroxide (KOH).

WARNING

DO NOT MIX SULPHURIC ACID AND KOH

The electrolyte used in silver-zinc batteries reacts violently to the sulphuric acid used in the more common lead-acid types of batteries. DO NOT add sulphuric acid electrolyte to the battery; the mixing of the acid and KOH electrolytes will cause a violent reaction which could result in the splattering of the mixture into the eyes and onto the skin. Every effort must be made to keep silver-zinc batteries as far away as possible from lead-acid batteries. Do not use the same tools and materials such as screwdrivers, wrenches, syringes, hydrometers, and gloves for both types of batteries, Any trace of acid or acid fumes will permanently damage silver-zinc batteries on contact.

WARNING

If excessive gassing occurs, due to high temperature conditions, it may be necessary to reduce the cut off voltage to as low as 31.5 volts.

WARNING

The amount of gas given off during (and after) the eighth charging hour creates a very explosive atmosphere if in a confined area. Follow the instructions contained in paragraph 1-7. following the WARNING notice.

TECHNICAL MANUAL
No. 11-6140-208-15

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON, DC *19 April 1967*

BATTERY, STORAGE BB-451/U

CHAPTER 1. GENERAL INSTRUCTIONS

Section A SPECIAL INSTRUCTIONS

Section I GENERAL DESCRIPTION AND SPECIFICATION DATA

Section II PREPARATION FOR USE

***This manual supersedes TM 11-6140-208-15, February 1996**

CHAPTER 2. OPERATING INSTRUCTIONS (Cont'd)

CHAPTER 3. MAINTENANCE INSTRUCTIONS (Cont'd)

SECTION II
TOOLS AND EQUIPMENT

SECTION III TROULESHOOTING

CHAPTER 3. MAINTENANCE INSTRUCTIONS (Cont'd)

SECTION IV MAINTENANCE

FIGURES 1-1, 1-2, 1-3.

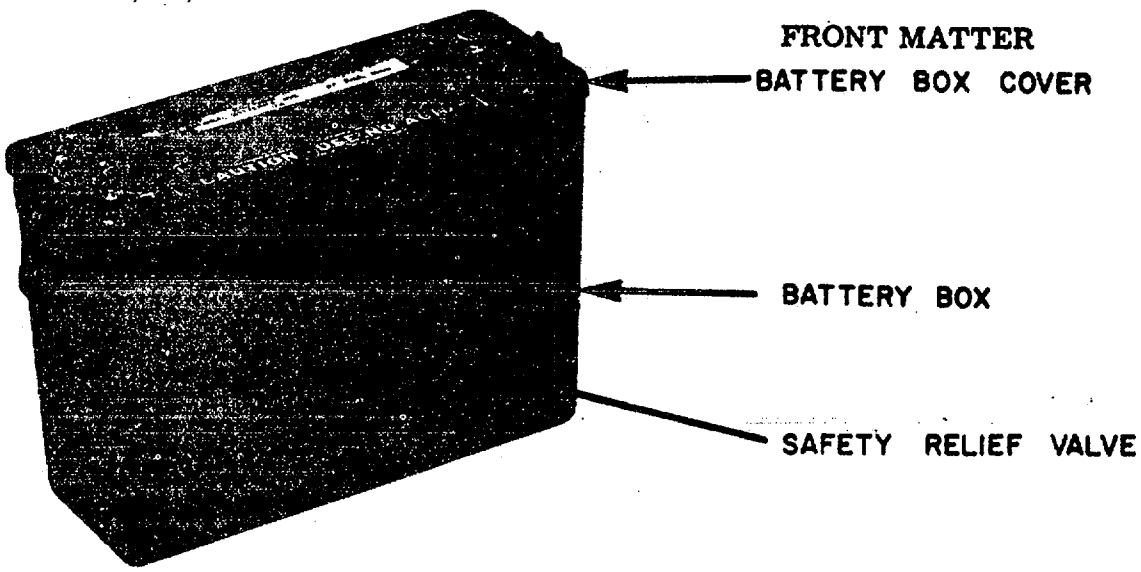


FIGURE 1-1. BATTERY BB-451/U

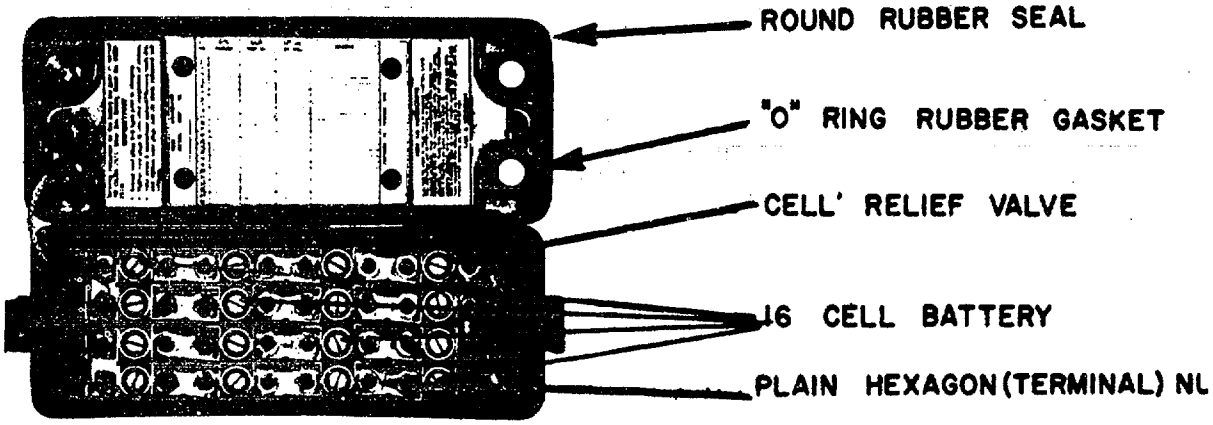


FIGURE 1-2. BATTERY, COVER REMOVED

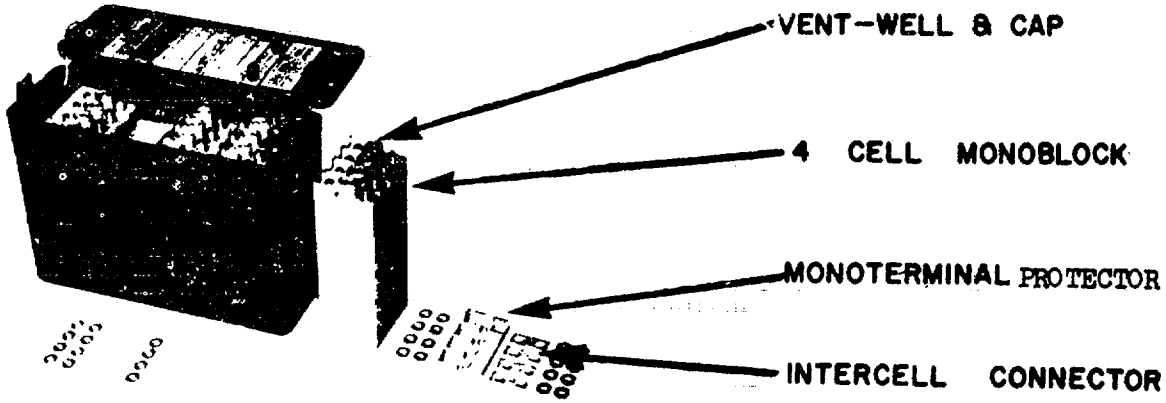


FIGURE 1-3. FOUR CELL MONOBLOCK REMOVED FROM BATTERY

Section A

A-1. Indexes of Publications

a. DA Pam 310-4, Refer to the latest issue of JA Pain 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7., Refer to the latest issue of DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment,

A-2. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment, Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST 4030.29/AFR 71-13/MCO P4030.29A, and DLAR 4145.8.

c. Discrepancy in Shipment Report (DISREP)'F 361). Fill out and forward Discrepancy in shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610,33B/AFR 75-18/MCO P4610.19C and DLAR 4500.15,

A-3. Reporting of Errors and EIR's

a. The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged, Reports should be submitted on DA Form 2028, (Recommended Changes to Publications and Blank Forms) and forwarded direct to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-MA-Q, Fort Monmouth, New Jersey 07703. A reply will be furnished direct to you.

b. Equipment Improvement Recommendations (EIR's) will be prepared using DA Form 2407, Maintenance Request. Instructions for preparing EIR's are provided in TM 38-750, the Army Maintenance Management System, EIR's should be mailed direct to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-MA-Q, Fort Monmouth, New Jersey 07703. A reply will be furnished direct to you.

A-4. Items Comprising an Operable Battery, Storage BB-451/U

NSN	*Qty*	*Nomenclature, p/n, mfr code*	*Fig. No.*
6140-00-889-1027	1	Battery Storage BB-4511U: 5122-000-1000, 88220, (This item is nonexpendable) consisting of:	1-3
6140-00-981-5864	1	Kit, Battery Filler: 5122-000-1069, 88220	

CHAPTER 1

GENERAL INSTRUCTIONS

SECTION I

GENERAL DESCRIPTION AND SPECIFICATION DATA

1-1 INTRODUCTION

a. SCOPE. This manual covers the operation, maintenance and repair of the BB-451/U Silver-Zinc Storage Battery, FSN 6140-889-1027.

b. PURPOSE. The purpose of the BB-451/U Silver-Zinc Storage Battery is to provide a light-weight power source for use with man-pack communications and electronic equipment. The silver-zinc battery is superior to the lead-acid, nickel cadmium, and silver-cadmium batteries in watt-hour capacity per-pound of battery weight. The silver-zinc battery is also superior to the lead-acid battery in voltage regulation during discharge. The construction, maintenance and personnel precautions pertaining to the silver-zinc battery vary greatly from the more familiar lead-acid battery. This manual provides adequate operational and maintenance data on *the* BB-451/U Silver-Zinc Storage Battery to ensure proper use, thus minimizing the probability of injury to the user or damage to the battery.

1-2 PHYSICAL AND FUNCTIONAL DESCRIPTION (see Figures 1-1 to 1-3 and Table 1-1)

a. PHYSICAL DESCRIPTION. The BB-451/U Storage Battery is a rechargeable, SILVER-ZINC, ALKALINE ELECTROLYTE battery, rated at 25 ampere-hours (AH). The battery contains 16 series-connected cells with a nominal cell voltage of 1.5 volts, producing a total nominal battery voltage of 24 volts, Each group of four cells is combined within separate plastic cases called monoblocks. A battery, *therefore,* contains four monoblocks. Each cell within a monoblock case consists of eight silver (positive electrodes) and eight zinc (negative electrodes) plates. Each plate is enclosed within several layers of cellulose material. The monoblock casings are made of molded plastic, and the four cells within the monoblock are equipped with threaded-screw nylon vent caps. Each monoblock is replaceable as an assembly. All metal parts of the battery are passivated and nickel or silver plated to resist reaction with the electrolyte. The overall physical size of the BB-451/U is 7-11/16 inches-high, 11-9/16 inches long and 4-9/64 inches wide. The battery weighs 16 pounds when filled with electrolyte.

TABLE 1-1. BATTERY CONSTRUCTION AND BASIC CHARACTERISTICS

Overall Dimensions (Inches)	7-11/16 H
	11-9/16 L
	4-9/64 W
Weight Filled (Pounds)	16
Cathode	Zinc
Anode	Silver Oxide
Electrolyte	40% Potassium Hydroxide
Nominal Cell Voltage	1.5
Nominal Battery Voltage	24
Nominal Ampere-Hour Capacity	25
Open Circuit Voltage	29. 76
Watt-Hour/Pound	59
Watt-Hour/Cubic Inches	4. 4
Voltage Regulation	Good
Discharge Rate (Maximum, Amperes)	25
Cycle Life (Cycles)	10- 30

b. FUNCTIONAL DESCRIPTION.

The battery when charged, has positive electrodes of silver oxide and negative electrodes of metallic zinc. During discharge the positive plates are reduced to silver while the negative plates are oxidized to zinc-oxide. Charging the battery reverses this process (returns it to the charged state). The electrolyte acts as a medium for the exchange of oxygen, and is also the current carrier within the cell. In an alkaline cell, unlike a lead-acid cell, the electrolyte does not take part in the chemical transformations. Therefore, its specific gravity does not change with state of charge of the cell. This then, makes a hydrometer useless with the BB-451/U Silver-Zinc Storage Battery.

(1) Intended Use. The BB-451/U is designed to provide a lightweight power source to meet the high-current demands for man-pack radios such as the AN/PRC-41 and the AN/PRC-47.

(2) Limitations. The following limitations apply to this battery.

(a) Heavy Discharge Sensitivity. Even though the BB-451/U is rated at 25 AH at 24 volts dc for radio receiving and transmitting applications, it is recommended that it not be discharged more than 20 AH percycle, since a deeper discharge will materially shorten the battery life.

(b) Low Temperature Sensitivity. The performance of the battery is seriously affected by low temperatures. At temperatures below approximately -350C (-31°F) the battery effectively ceases to operate.

TABLE 1-2. BATTERY PERFORMANCE AT VARIOUS TEMPERATURES

Temp (°F)	Cycle Life*	Wet Life (Months)**
-13	20	12
0	20	12
32	25	12
40	30	18
75	30	18
90	25	18
100	20	12
120	10	2
140	10	1

* Cycle Life: The number of charge/discharge cycles the battery experiences.
** Wet

(c) High Temperature Sensitivity. The performance of the battery is seriously affected by very high temperatures. At temperatures above 1000F (37. 80C), the cycle life and wet life are greatly reduced (see Table 1-2.).

(d) Sensitivity to Over-Filling. Both the silver and zinc plates of the battery are soluble in the electrolyte, therefore, the instructions on filling should be carefully followed (see paragraph 1-4 "Servicing").

(e) Sensitivity to Over-Charging. The battery will not accept excessive current during overcharge, but rather, this current will cause the generation of hydrogen and oxygen, and will be of no aid to charging the battery.

WARNING

THE BB-451/U IS A SILVER-ZINC BATTERY UTILIZING AN ALKA-LINE ELECTROLYTEOF 40% POTASSIUMHYDROXIDE (KOH). DO NOT INSERT SULFURICACID (H2S04) USED INLEAD-ACID BAT-TERIES, AS ACID WILL REACT VIOLENTLY WITH THE ALKALINEELECTROLYTE CAUSING PERMANENTD AMAGE TO THE BAT-TERY AND POSSIBLE INJURY TO THE USER

1-3 BATTERY DIFFERENCES

a. BOX DIFFERENCES. Boxes used on the first group of batteries procured were fabricated of a random-oriented fiberglass. This type box is susceptible to breakage from high impact. There is no way to prevent this because the box material will not withstand a high impact (such as a 3-foot drop onto concrete) without cracking slightly. Battery boxes currently being procured are made of an oriented, glass filament-epoxy approaching structural steel in yield strength. This box can withstand strong impacts; however, older type boxes should be used until they are completely unserviceable. The two types of boxes are readily distinguishable from one another by visual observation of the fiber orientation.

b. MONOBLOCK DIFFERENCES.

(1) Vent-Caps. Original production batteries have vent-cape with an integral tube and 1/4-28 fine threads which extend about 0. 6-inch into the cell. Batteries manufactured in 1963 had the thread size changed to 1/4-20 coarse threads and retained the integral tube. Batteries manufactured after 1964 have 1/4-20 coarse threads but the integral tube was removed from the vent-cap and placed, instead, in the cell vent-well. Vent-caps with integral tubes can be modified by sawing off the tube and filing the saw cut smooth to permit use on batteries with the tube built in the vent-well, however, be sure the thread sizes agree.

(2) Terminal Posts. On later model monoblocks the terminal posts are potted to the underside of the cell top. This was not true on earlier models and, consequently, was a source of trouble since if the cell terminal nuts loosen, the unpotted terminal posts can slide down and short the cells.

c. TERMINAL PROTECTOR DIFFERENCES. Batteries manufactured through mid-1966 have terminal protectors that span two interconnected monoblock terminals simultaneously. Due to the design of the battery, the old two span protectors required removal of 32 terminal nuts in order to permit removal of the first monoblock from the battery. To reduce this requirement to 16 nuts, an improved Monoterminal protector has been designed, .The new Monoterminal protector is shown in Figure 1-3. This protector replaces both the old two span terminal protector and the old single terminal protector used under the terminal nuts securing the external connector leads.

d. CHARGING LOG DIFFERENCES. Batteries manufactured after mid-1966 are equipped with a removable charging log secured to the battery box cover by means of the four rubber bumpers located on the inside of the cover. This log provides considerably more area for recording data since it utilizes both sides of the log.

e. COVER BUMPER STUDS. Batteries manufactured after late 1963 have 1/4-inch long studs securing the four rubber bumpers inside the cover. Earlier models have 5/16-inch studs. To prevent possible shorting of the cells, by the longer studs, all batteries in the field must have these studs shortened to 1/4-inch.

Section II PREPARATION FOR USE

1-4. Unpacking and Preparation for Servicing

a. Unpacking. Each BB-4511U battery kit is packed in a set of two fiberboard cartons. The larger carton is marked FSN 6140-889-1027, Battery BB-451/U and contains one battery in an Unactivated condition (dry, charged and filled with an inert gas). Remove the battery and inspect for damage to either the battery box or the battery box cover, which is secured to the box by a nylon cord. The appearance of these items should conform to Figure 1-2. Inspect the battery box to determine whether it is an early model fabricated of random oriented fiberglass or a current-production glass filament epoxy box. The random oriented fiberglass boxes should be handled with care due to relatively low impact-breakage characteristics. This type of box can be readily distinguished by visual inspection of the fiber orientation. The second carton is marked FSN 5122-000-1069. Kit, Electrolyte Filling. Remove the contents of this carton and inspect for inclusion of all items listed below. Prior to release of the battery for field usage, the battery must be serviced by filling (activating) with electrolyte, charging and inspecting in accordance with the procedure given by the following paragraphs.

b. Preparation for Servicing. All items required to activate the battery are contained in the Electrolyte Filling Kit described below. In order to charge the battery after activation, the following additional items are required (see paragraph 1-5, for activating instructions).

Electrolyte Filling Kit Contents

Quantity	*Item*	*FSN*
16	Bottles with Electrolyte Fluid	5122-000-1071
16	Cotton Balls	5122-000-1084
4	Filler Spouts	5122-0041040
4	Sealing Washers	5122-000-1041
2	Relief Valves	5122-00-1059-6
2	Gloves, Polyethylene	5122-000-1090
	Tweezers	5122-000-1085
	Container of Waterproof Adhesive MIL-A-101	

(1) Voltmeter: Multimeter TS-352( )/U.
(2) Charger: Charger, Battery PP-6241/U.
(3) Monoblock Puller: (locally fabricated, see figure 3-1).
(4) Tool Kit, Battery Service TK-90/G.

WARNING

Never use the same tools for silver-zinc batteries and lead-acid batteries.

1-5. Activating the Battery

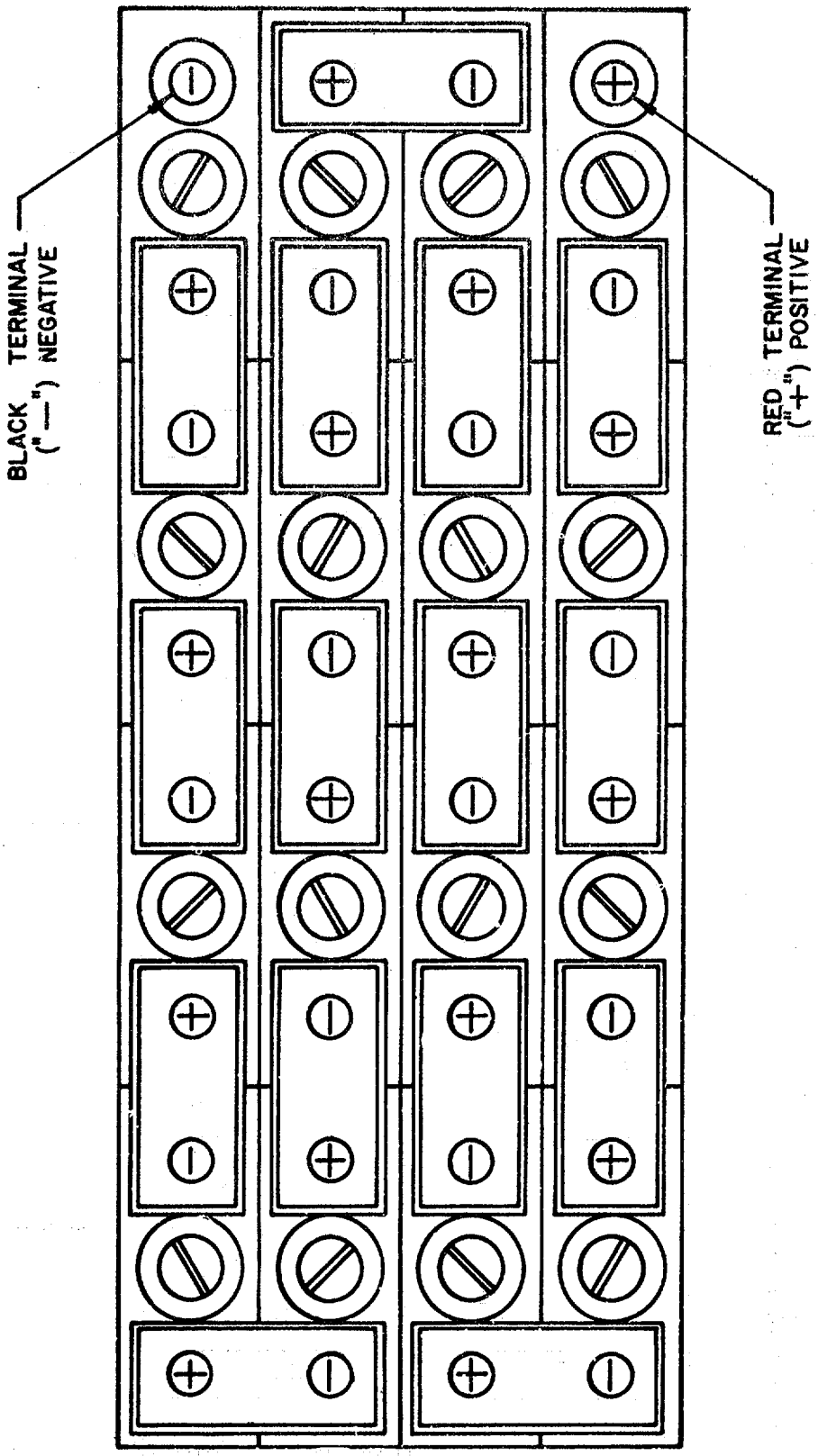
a. Preparation. To prepare a dry-charged battery for service, all cells, must be filled (activated) with electrolyte furnished in the filling kit (Potassium Hydroxide, KOH).

b. Electrolyte. The electrolyte for this battery is packaged in small plastic squeeze bottles, sixteen of which are furnished, with each bottle contains precisely the amount of electrolyte required to fill and activate one cell, (61 +1/2 cubic centimeters of KOH).

CAUTION

Prior to activating battery, ascertain correct interconnection of all cells, otherwise cell reversal may occur, discharging all cells and ruining the reversed cell.

c. Ascertaining Correct Cell Interconnection (fig. 1-4).
(1) The POSITIVE (+) terminals of the cells are RED.
(2) The NEGATIVE (-) terminals of the cells are BLACK..
(3) The MAIN battery case terminal with a white "+" must be connected to a RED (+) terminal on a cell.
(4) The BLACK (-) terminal of this same cell must then be connected to a red terminal on an adjacent cell, and so on.
(5) The BLACK (-) terminal of the last-connected cell must then be connected to the MAIN battery case terminal marked, with a WHITE "-".
(6) The battery should now be correctly assembled.



NOTE: NUTS REMOVED FOR CLARITY

ASCERTAINING CORRECT CELL INTERCONNECTION

Figure 1-4

(7) Run a quick visual observation to ensure that NO LIKE (Plus (+) to Plus (+)/Red-to-Red, or Minus (-) to Minus (-)/Black-to-Black) terminals have been connected to each other, and that the series sequence has been-correctly established.

d. *Battery Activation*. To activate the battery, proceed as follows.
(1) Pry out the two red plastic terminal dust plugs.
(2) Unscrew the two thumbscrews on top of the cover.
(3) Remove the battery case cover.
(4) Tighten all top terminal nuts to 30-inch pounds torque (see paragraph 3-3 b.).

CAUTION

BE CERTAIN THAT CELL TOPS ARE CLEAN AND FREE OF DIRT, AND DO NOT ALLOW ANY DIRT TO ENTER THE CELLS DURING THE FILLING OPERATION.

(5) Unscrew and remove vent-caps from each filling well of all sixteen cells. (See Figure 1-5 A). Be certain that the vent-caps are kept clean while they are out of the battery.
(6) Unscrew the black plastic cap from the bottle of electrolyte; replace it with the spouted filling cap provided in the filling kit.

WARNING

DURING INITIAL FILLING, ELECTROLYTE MAYV IOLENTLY SPRAY FROM CELLS. FOR THIS REASON, USE POLYETHYLENE GLOVES, GOGGLES AND RAIN GEAR WHILE FILLING BATTERY

(7) Tilt the battery 450 to one side and quickly invert the bottle of electrolyte into the threaded vent-well of the cell to be filled (see Figure 1-5 B). Return the battery to the upright position.

WARNING

ELECTROLYTE WILL SPLASH IN FACE IF BOTTLE IS NOT FIRMLY SEATED INVENT-WELL OR IF BOTTLE IS SQUEEZED TOO RAPIDLY. SEE 2-7.

(8) Rotate the plastic bottle to snug the filling spout into the vent-well (see Figure 1-5 *C).* Very gently squeeze the bottle and hold it a few seconds before releasing. Repeat slowly until all electrolyte has entered the cell.

(9) Remove the empty bottle and immediately insert a wad of cotton into the vent-well, this will serve as an indication that the cell has been filled (see Figure 1-5 D).

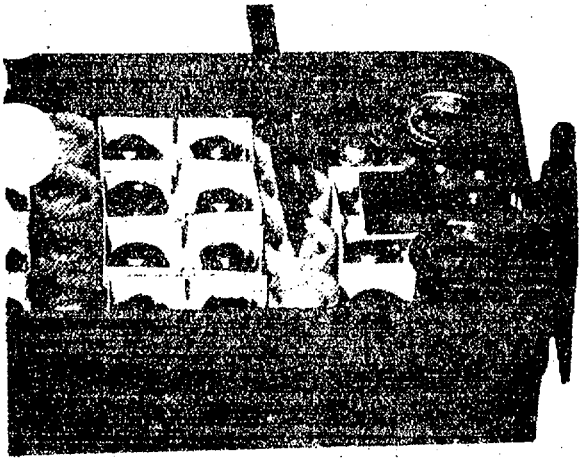


Figure 1-5A

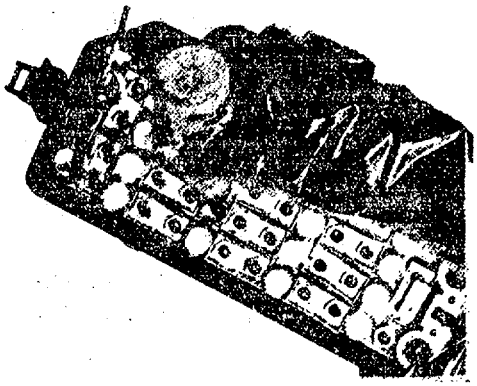


Figure 1-5B

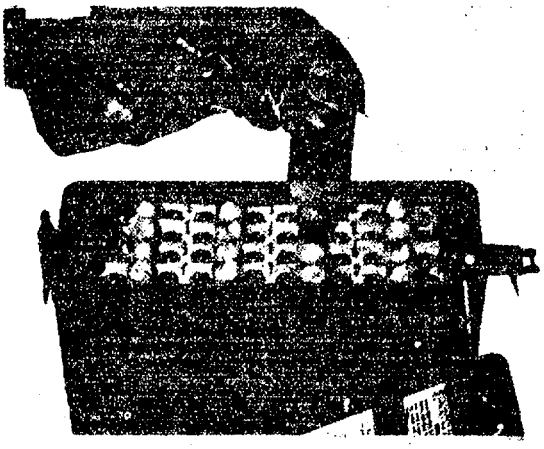


Figure 1-5C

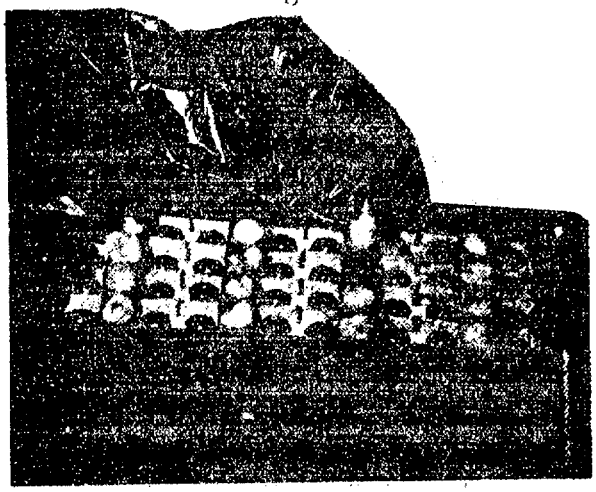


Figure 1-5D

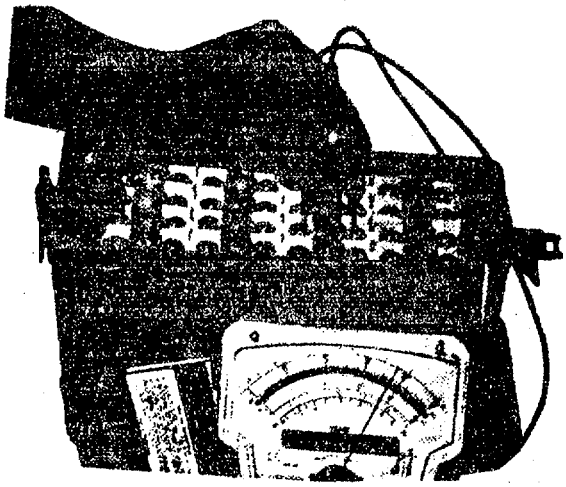


Figure 1-5E

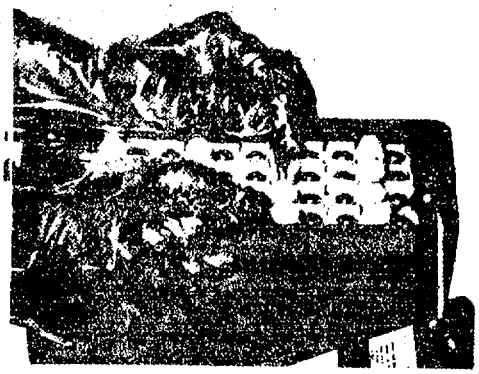


Figure 1-5F

Figure 1-5. Battery Activation

NOTE

WHEN FILLING CELLS, ANY SPILLED ELECTROLYTE MUST BE IMMEDIATELY WIPED AWAY. THE ELECTROLYTE CAN CAUSE A SHORT BETWEEN TERMINALS AND WILL ALSO ATTACK ALL RUBBER AND METAL PARTS OF THE BATTERY CASE. COMPLETE AND IMMEDIATE REMOVAL OF ALL SPILLED ELECTROLYTE IS A NECESSITY FOR PROPER BATTERY MAINTENANCE.

NOTE

REPEAT STEPS 5 THROUGH 9 TO FILL THE REMAINING CELLS. THE FILLING SEQUENCE SHOULD START AT ONE END OF THE BATTERY AND PROGRESS BACK AND FORTH ACROSS THE WIDTH (RATHER THAN LENGTH) OF THE BATTERY.

WARNING

AS SOON AS THE ELECTROLYTE (KOH) IS ADDED TO THE CELLS, THEY MUST BE HANDLED AS FULLY CHARGED CELLS, THEREFORE, EXERCISE EXTREME CARE TO AVOID SHORTING THE CELLS WITH ANY METALLIC OBJECT OR OTHER CONDUCTIVE MATERIAL.

(10) Measure individual cell voltages (see Figure 1-5 E) with a voltmeter.

A voltage should be indicated. A cell that, does not show a voltage was probably missed during filling and should be filled with the proper amount of electrolyte.

(11) Wipe up any spilled electrolyte with a damp, clean, cloth; then dry the battery thoroughly.

(12) Allow the battery to stand on open-circuit for a minimum of 23 hours with the cotton wadding inserted into the vent wells (vent-caps removed) before proceeding to step (13).

(13) Use the pair of tweezers (see Figure 1-5 F) provided in the electrolyte filling kit to swab each vent well. Remove the cotton wad after swabbing and replace the vent-caps. Tighten all vent-caps with a screwdriver until they bottom firmly in the vent wells.

1-6 INITIAL CHECKOUT AND ADJUSTMENTS

a. GENERAL.. Once the battery has been activated (filled with KOH electrolyte), the following procedure must be employed.

(1) Measure the battery voltage at the main terminals using a voltmeter as previously stated. Set the meter to a range greater than 32. 0 volts. If the battery voltage is above 29.2 volts, it is ready for an operational discharge (use).

TABLE 1-3. ACTIVATED STORAGE SELF-DISCHARGE LOSSES			
Storage Temperature (°F)	Length of Activated Storage (Months)	Wet Life (Months)	Capacity Loss After 1 Month Activated Storage
-13	1	12	3%
32	1	12	3%
68	1	18	3%
100	1	12	10%
122	1	2	50%

(2) If the battery voltage is below 29.2 volts, proceed as follows:

(a) Check all interconnections to ensure that no cell has been connected in a reverse position (see paragraph 1-5 C).

CAUTION

IF A REVERSED CELL IS FOUND, THE MONOBLOCK CONTAINING THIS CELL MUST BE REPLACED, SEE PARAGRAPH 3-7.

(b) If the cells are found to be correctly assembled and installed, it is probable that the battery has previously been exposed to high storage temperatures. If so, a charge will be required before the battery is ready for use.

(c) If the battery has been stored in the activated state, a self-discharge loss is normal (see Table 1-3). If this is the case, a charge will be required prior to using.

1-7 CHARGING THE BATTERY

a. GENERAL. The specific conductivity of the electrolyte used in the BB-451/U decreases at low temperatures resulting in high internal resistance. Battery charge acceptance (charging) is poor at 320F (0°C) and becomes worse as the temperature decreases. The battery will also gas more severely when charged at low temperatures. For the preceding reasons, battery charging should be performed at room temperatures. If this is not possible, the batteries should be warmed by whatever means available prior to charging (excluding open flame). The following instructions are critical and must be carefully followed before any attempt at charging is made.

b. REQUIRED EQUIPMENT.

(1) Voltmeter. Use Multimeter TS-352B/U for all voltage readings detailed in this manual.

(2) Battery-Charger. A battery-charger with the capability of producing 32.0 volts at 1. 0 to 2. 5 amperes. The optimum charger should be self-regulating with an automatic cutoff that operates when the battery on-charge voltage reaches 32. 0 volts maximum. Under no circumstances should the voltage exceed 32. 0 volts. To illustrate the problems caused by overcharging, if the charge cutoff voltage should exceed 32.0 volts by only 0. 8 volts, the battery will require an additional 8-10 hours of charging time and will only provide about 2.5 AH of additional capacity, while simultaneously reducing the cycle life of the battery. In addition, if the battery is charged at an excessive rate (over 2.5 amperes) most of the energy will be lost in generation of hydrogen gas. Also, since the negative plates in the discharge state are soft powder (zinc oxide) the plates will physically break up and wash away.

CAUTION

BATTERY WILL BE DAMAGED IF CHARGED AT TOO HIGH A CURRENT RATE OR TOO HIGH A VOLTAGE.

WARNING

THE AMOUNT OF GAS GIVEN OFF DURING (AND AFTER) THE EIGHTH CHARGING HOUR CREATES A VERY EXPLOSIVE ATMOSPHERE IF IN A CONFINED AREA; THE INSTRUCTIONS CONTAINED BELOW MUST, THEREFORE, BE OBSERVED.

i. Charge battery only in a well-ventilated area.

ii. Charge in an area away from open flames or spark-producing devices.

iii. Do not smoke in charging area.

iv. Observe battery during initial moments of charging, and periodically during charging for excessive gassing.

v. Insure that battery charger cuts off automatically or is manually cut off when battery voltage reaches 32.0 volts.

vi. Insure that charging current is set to no more than 2.25 amperes.

*(*a) The Battery Charger PP-6241/U is a new multichannel battery charger capable of simultaneously charging up to three batteries.

*(*b) In addition, the PP-4567/U (a multichannel charger) and the PP-3240A/U may be used to charge the BB-451/U.

NOTE

The following comments apply to Charger, Battery PP-3240A/U

i. The voltmeter on the PP-3240A/U is not stable enough to set at 32.0 volts; consequently it may be necessary to set the charger to 32.8 volts maximum to ensure fully charged batteries. However, if an accurate voltmeter is available, 32.0 volts is the optimum cut off voltage.

ii. The PP-3240A/U becomes increasingly unreliable as it ages and should be adjusted regularly.

WARNING

If excessive gassing occurs, due to high temperature conditions, it may be necessary to reduce the cutoff voltage to as low as 31.5 volts.

(*3) Charging Logs.* In order to provide sufficient data to maintain the battery two logs are required as follows:

(a) Battery Box Log. Log located inside battery box cover.

(b) Battery Shop Log. Log maintained and retained in battery shop.

Complete procedures for maintaining these logs are given in paragraph 3-2a. The importance of faithfully following these procedures cannot be over stressed since most maintenance requirements are based upon these logs.

c. Battery Charging. One of three types of charges is given to the battery. These are: rational charges, booster charges, and ,emergency charges. To determine whether an operational or booster charge is required, measure the battery open-circuit voltage. If the voltage is below 28 volts, an operational charge is required; if the voltage is between 28 and 29.2 volts, a booster.charge is required. Emergency charges should be resorted to only under extreme conditions such as when time or equipment will not permit normal charging. Emergency charging will damage the battery.
The following paragraphs describe the three types of charges.

(*1) Operational Charge.* An operational charge is given whenever the battery open-circuit voltage is below 28 volts.

(a) Measure the open-circuit voltage of each cell. Individual cell voltages should not vary over a range of more than 0.20 volts. If they do, equalization of voltages across the cells must be performed as indicated in paragraph *3-8(a).*

(1) before charging the battery, after performing cell equalization, record this fact in the shop battery log.

(b) Measure and record in the shop battery log the cycle number, date, starting time and total battery open-circuit voltage.

(c) Adjust charger to cutoff at 32.0 volts output at initial current rate of 1.75 to 2.25 amperes.

(d) Loosen and remove battery case cover.

(e) Loosen each cell vent-cap two or three complete turns before charging; this will prevent the electrolyte from spraying out of the cells during charge.

(f) Connect battery to charger and record the starting current in the battery charging log. Charge battery until the battery charger indicates a full charge (about 10 hours, *NEVER* more than 20 hours).

(g) Measure battery on-charge voltage at end of 10 hours or when charger indicates full charge. Voltage should read between 31.5 and 32.0 volts, if it does not, continue charge until voltage comes up as required, but *NEVER* exceed 20 hours on a normal battery, regardless of the capacity removed on the previous discharge.

h) Record the terminal voltage and current at the end of charge, the stopping time and the total elapsed charging time in the battery shop log.

(i) Fifteen minutes after completion of charge, tighten the vent-caps until they are all firmly bottomed.

(j) Whenever feasible, battery condition

should be checked between 3 and 24 hours after completion of charge. Procedure is given in paragraph 3-8b.

(2) Booster-Charge. A booster charge is given whenever the open-circuit battery voltage is above 28 volts, but below 29. 2 volts. Record all data in the battery log and shop log as discussed in paragraph 1-7 b. (3).

(a) Adjust the battery charger so that the output cutoff voltage is 32. 0 volts and the initial current rate is between 1.75 and 2. 25 amperes.

(b) Loosen and remove battery case cover.

(c) Loosen each cell vent-cap two or three complete turns before starting charge, this will prevent the electrolyte from spraying out of the cells during charging.

(d) Connect battery to charger and charge the battery until the charger indicates a full charge or the on-charge battery voltage measures 32. 0 volts (about 1 to 5 hours).

(e) Tighten the vent-caps 15 minutes after completion of charge, and insure that they are firmly bottomed.

(3) Emergency Charge. Where emergency charging of a battery is required, any source of dc current of 30. 0 to 32. 0 volts is suitable. If at all possible, the initial current should be limited to 25 amperes by use of a suitable dropping resistor or other current limiting device. - A 24-volt vehicle generating system will meet the requirements of an emergency charge. When using this procedure, do not charge for over 4 hours. Emergency charging at 32. 0 volts will provide the following capacities:

One hour replaces 50 per cent of full capacity.

Three hours replaces 60 per cent of full capacity.

CAUTION

THE BATTERY WILL BE DAMAGED AND CYCLE LIFE WILL BE GREATLY DIMINISHED BY EMERGENCY CHARGING. WHEN USING THIS PROCEDURE, DO NOT CHARGE FOR OVER 4 HOURS.

1-8 TRANSPORTING ACTIVATED BATTERIES IN THE FIELD

a. SINGLE BATTERY. Each battery is supplied with a strong nylon strap to facilitate transporting the battery. No special precautions apply with the exception that the battery should not be allowed to stand in the open sunshine on warm days since heat accelerates loss of charge retention and increases the rate of outgassing of hydrogen. Because the battery can outgas hydrogen which is explosive under certain conditions, it should not be sealed or placed in airtight containers.

TABLE 1-4		
UNACTIVATED STORAGE SELF-DISCHARGE LOSSES		
Continuous Storage Temp (°F)	Length of Storage	Capacity Loss
below 90	1 year	1%
91 - 122	1 year	20%
123 - 167	1 month	25%

WARNING

DO NOT SEAL ACTIVATED BATTERIES IN AIRTIGHT CONTAINERS SUCH AS TRANSIT CASES, AS HYDROGEN OUTGASSING MAY CREATE AN EXPLOSIVE ENVIRONMENT.

b. MULTIPLE BATTERIES. The general precautions cited previously for transportation of a single battery also apply to transporting more than one battery. However, to facilitate field transportation and stacking of batteries, a simple convenient carrying case has been designed. This case will contain two or three batteries and is constructed of two interchangeable fiberglass trays which clamp or sandwich the batteries. The trays are secured by means of two adjustable buckles and straps. The design of the trays permits easy stacking of loaded transit cases up to three high without danger of tipping, provided the bottom tray is placed on a firm flat surface. ETA for the case is early 1967. Proper name: Three-Battery Transit Case for BB-451/U Batteries.

1-9 PREPARATION FOR STORAGE AND SHIPMENT

a. UNACTIVATED STORAGE AND SHIPMENT (see Table 1-4).

(1) When received from the manufacturer, the BB-451/U is Unactivated (dry, charged, and filled with an inert gas) and sealed within a shipping container.

(2) As long as the battery is Unactivated, there is no danger of hydrogen gas being generated.

(3) Storage in a cool or cold area is recommended because the charge retention of the dry battery is optimum under these conditions. If stored in a warm area for a month or more, the battery will require booster charging after activation. Charge retention characteristics in the Unactivated state are listed in Table 1-4 (see page 1-16)

(4) There are no special storage requirements for the battery provided the shipping container has not been opened. After the container has been opened, the battery must be kept away from lead-acid batteries.

b. ACTIVATED STORAGE AND SHIPMENT.

WARNING

DO NOT STORE ACTIVATED BB-451/U BATTERIES AND RADIO SETS WITHIN THE SAME TRANSIT CASE. HYDROGEN GAS DIFFUSING INTO THE RADIO CASE CAN CAUSE EXPLOSION UPON USE.

(1) Hydrogen Outgassing. To three minor explosions which were reported when the battery was first Activated batteries do generate hydrogen, and explosive concentrations can be reached under certain conditions, however, excessive apprehension of this hazard is unwarranted. As long as any type of ventilation is provided, the explosive hazard is virtually eliminated. The following paragraphs indicate proper storage conditions for various structures and shipment in aircraft. These procedures will provide more than an adequate safety environment if properly followed. Shipment by railroad, truck or ship can also be safely accomplished if ventilation air is provided as discussed below.

(2) Explosive Hazard. For the types of enclosures and aircraft listed below, no explosion hazard exists under normal storage conditions. The following general comments apply to the discussion of these enclosures:

(a) Quantity Storage. At temperatures above 100 F (37. 5 C) and in airtight enclosures, certain ventilation requirements must be met if large quantities of batteries are to be stored.

(b) Temperature Consideration. In general, the quantity of batteries that can be considered as a "safe storage load" can be doubled for every 20 F drop in temperature below 140 F (60 C)(see Appendix I).

(c) Storage Conditions. All temperatures referred to are those within the storage area, and not the outside ambient temperature.

(d) Storage Temperature. Appendix II shows that the quantity of ventilation air required at higher temperatures is, much higher than that required at lower temperatures, therefore, whenever possible, the batteries should be stored at lower temperatures to reduce the ventilation requirements. Storing at lower temperatures is also desirable from the standpoint of battery charge retention.

(3) Buildings and Tents.

(a) Prefabricated Buildings.

1. With all window ventilators and the vestibule door open, 300 batteries maximum may be safely stored.

2. With all doors opened along with windows, there is no limit to the number of batteries which may be stored, provided stacking is in an open arrangement with 18-inches minimum spacing from walls or partitions, and 3 feet minimum spacing between any two aisle-stacks.

3. During the winter, if a vented fuel-burning heater that draws air from the interior of the building for combustion is used, no special ventilation precautions need be observed as the heater will consume all hydrogen evolved. However, be sure the heater is vented and proper ventilation is provided when heater is not used. Also, be sure all hydrogen gas which may have inadvertently accumulated is completely vented by opening all doors and windows for at least 10 minutes prior to igniting heater.

(b) Tents.

1. General Purpose Tent: '7680 batteries maximum.

2. 10-Man Arctic Tent: 1800 batteries maximum.

3. Two-Man Mountain Tent: 150 batteries maximum.

4. Aircraft.

(a) HUS-1 Helicopter, Cargo Compartment.

1. On ground, 156 batteries for 3-3/4 hrs at 1400F (600C).

2. On ground, 156 batteries indefinitely with cargo compartment ramp and all ventilators opened.

3. In Flight: 156 batteries indefinitely - (HUS-1 has positive ventilation system for cargo compartment).

(b) C-130 Aircraft, Cargo Compartment.

1. On ground: 2188 batteries, for 2 hours, 1400F (600C).

2. On ground: 2188 batteries, indefinitely, 1400F (600C) with cargo compartment ramp open.

3. In Flight: 2188 batteries, indefinitely (C- 130 has positive ventilation system in flight).

5 Typical Building (Volume approximately 3200 cubic feet).

(a) Completely sealed: 8 batteries, 1400F (600C), two weeks.

(b) Completely sealed: 41 batteries, 10O°F (38°C), two weeks.

(c) Completely sealed: 160 batteries, 700F (210C), two weeks.

6 Other: See Appendices I through III for calculation data where necessary,

c. SUMMARY OF GENERAL STORAGE AND SAFETY REQUREMENTS.

(1) DO NOT confine batteries within an airtight enclosure such as a transit case or storeroom, without ventilation.

(2) DO NOT store a large number of activated batteries within one area.

(3) DO NOT smoke in or near a battery storage area.

(4) DO NOT store batteries in the vicinity of lead-acid batteries. The slightest trace of sulfuric-acid fumes should not be permitted to permeate an area where silver-zinc batteries are contained.

(5) DO provide adequate ventilation.

(6) DO locate storage and charging areas away from open flames and spark-producing devices.

(7) DO store the batteries in cool temperatures wherever possible (gas generation below 320F (OOC) is negligible).

SECTION III

DEMOLITION TO PREVENT ENEMY USE

1-10 GENERAL When capture or abandonment of BB-451/U Batteries to the enemy is imminent, the responsible unit commander must make the decision to either destroy the equipment or to render it inoperative. Based on this decision, orders are issued that indicate the desired extent of destruction.

1-11 DEMOLITION TO RENDER BB-451/U BATTERIES INOPERATIVE If only a few batteries are available, they may be rapidly rendered temporarily inoperative by dead-shorting or removing vent-caps and inverting the batteries, otherwise, demolition as specified in paragraph 1-11 must be accomplished.

1-12 DEMOLITION BY EXPLOSIVES OR WEAPONS FIRE

a. SMALL QUANTITIES. For 10 or less batteries, rifle fire is recommended to destroy each battery. Fire a shell through each battery from end-to-end so that all monoblocks and plates are ruined, but keep a reasonable distance in case of electrolyte spattering.

WARNING

IT IS NOT RECOMMENDED THAT SMALL QUANTITIES OF BB-451/U BATTERIES BE DESTROYED BY MECHANICAL MEANS AS THE SPLATTERING OF ELECTROLYTE IS HAZARDOUS.

b. LARGE QUANTITIES. For a storehouse of batteries or any considerable quantity over 10, use fragmentation and incendiary handgrenades to first puncture, then burn all batteries.

WARNING

CARE MUST BE TAKEN NOT TO ALLOW BATTERY ELECTROLYTE TO BE SPLATTERED ON OR NEAR PERSONNEL.

CHAPTER 2

OPERATING NSTRUCTIONS

SECTION I

THEORY OF OPERATION

2-1 ELECTRICAL THEORY

a. CHARGE-DISCHARGE CYCLE. The battery when charged has positive electrodes of silver oxide and negative electrodes of metallic zinc.

During discharge the positive plates are reduced to silver while the negative plates are oxidized to zinc oxide. Charging the battery reverses this process (returns it to the charged state). A combination of a charge and a discharge is called a "cycle". Very little hydrogen is evolved during cycling provided the electrodes are chemically pure, and the charging voltages at which the plates begin to gas freely are not exceeded.

b. PURPOSE OF ELECTROLYTE. The electrolyte acts as a medium for the exchange of oxygen; it also is the current carrier within the cell. In an alkaline cell, unlike a lead-acid cell, the electrolyte does not take part in the chemical transformations. Therefore, its specific gravity does not change with the state of charge of the cell which makes a hydrometer useless with the BB-451/U.

SECTION II

SERVICE REQUIREMENTS OF USER

2-2 SERVICE UPON RECEIPT OF BATTERIES

a. INSPECTION. Upon receipt of the batteries, the following checks should be made.

(1) Inspect battery box for damage during shipment.

(2) If battery box is damaged, employ the following procedure:

(a) Disassemble the battery very carefully and inspect all monoblocks. If monoblocks are undamaged, reassemble in a replacement battery box and put into operation.

(b) Monoblocks are damaged, battery is unserviceable.

b. SERVICING. After verifying that the batteries have not been damaged in shipment, follow the procedures indicated in Chapter I, Section II, "PREPARATION FOR USE", to prepare the battery for use.

2-3 PREVENTIVE MAINTENANCE

a. PURPOSE OF PREVENTIVE MAINTENANCE. Proper preventive maintenance will materially lengthen the life of any battery. Due to the high cost of the BB-451/U, proper preventive maintenance is absolutely essential.

b. INTERVALS. The intervals between preventive maintenance actions are based on the number of cycles sustained by the battery. Therefore, it is important to enter each charging of the battery in the charging log located inside the battery case cover and, the shop log maintained in the battery shop. See paragraph 1-7 b. (3) for a description of these logs. The following preventive maintenance shall be performed at the intervals indicated below.

(1) <u>During and After Each Charge</u>.

(a) Spilled Electrolyte. Remove all spilled or spattered electrolyte and all carbonate deposits. Use cotton balls or similar disposable material for wipe up. Dry the tops of cells and connectors thoroughly.

(b) Battery Condition. Determine battery condition by measuring cell voltages as indicated below.

1. On-Charge. The battery voltage (with the charger connected and operating) should be within the range of 31. 5 to 32.0 volts at end of charging period. Ascertain that the battery charger is operating properly and that all electrical connections are clean and tight. If the voltage is not within the specified range, continue charging until voltage comes up as required but NEVER exceed 20 hours on a normal battery.

2. Open-Circuit. Three to twenty-four hours after a charged battery is removed from the charger, measure and note the open-circuit voltage. The open-circuit "stand" time is necessary to allow battery voltages to stabilize. The open-circuit voltage of each cell should be between 1.82 and 1.91 volts (with a battery-voltage of 29. 2 to 30. 5 volts) at room temperature. If voltages are not as required, check the trouble- shooting section of this manual (paragraph 3-6).

(c) Battery Contacts. Clean the silver battery contacts that mate with the radio by using a crocus cloth to ensure good electrical contact.

(2) After each fifth charging.

(a) Remove and thoroughly flush each vent-cap with tap water.

(b) Insure that the vent-holes and threads of each vent-cap are free of deposits.

(c) Dry the vent-caps thoroughly before reinstalling.

(d) Insure that each vent-cap "O" ring is in place.

(e) Tighten all vent-caps with a screwdriver until they are firmly bottomed.

(3) Prior to every tenth charging.

(a) Check electrolyte level within each cell by removing each monoblock (see paragraph 3-7 a.) Level CANNOT be determined by looking through hole in vent-well. Cells must be discharged prior to checking electrolyte level.

(b) Each cell should have about TWO-INCHES of free electrolyte in the bottom.

(c) If level is below two inches, and is low only due to gassing, bring the level up to TWO-INCHES by adding distilled water. If distilled water is not available bring level up to two inches by adding electrolyte (40% KOH, Potassium Hydroxide).

(d) If level is below two inches and is low due to spillage or spewing of electrolyte, bring the level up to TWO-INCHES by adding electrolyte (40% KOH, Potassium Hydroxide).

(e) Clean, and check the operation of the Battery Safety Relief Valve. This operation should be performed whenever monoblocks are removed for a check of the electrolyte level. Procedures for cleaning the valve are given in paragraph 3-7 b.

SECTION III

USE UNDER SPECIFIC CONDITIONS

2-4 USE UNDER NORMAL CONDITIONS

No special precautions need be taken other than those listed under "PREVENTIVE MAINTENANCE" (paragraph 2-3) and "TRANSPORTING ACTIVATED BATTERIES IN THE FIELD" (paragraph 1-8).

2-5 USE UNDER EMERGENCY CONDITIONS

In the case of the BB-451/U, "emergency" conditions are defined as those conditions requiring that an emergency charge be given to the battery. Instructions for emergency charging are listed in paragraph 1-7 c. (3).

2-6 USE UNDER ADVERSE CLIMATOLOGICAL CONDITIONS

a. GENERAL. The BB-451/U is basically fungus proof, watertight, airtight, and stable under all but the most extreme Climatological conditions; however, special considerations apply under conditions of extreme cold or heat. These considerations are cited in the following paragraphs.

b. EXTREME COLD

(1) Capacity and Voltage. The battery is seriously affected by low temperatures. At -30° C (-22° F) the ampere-hour capacity of the battery is reduced to approximately one-half its capacity at 210 C (700 F) and the end of discharge voltage is reduced to approximately 20.0 volts. At temperatures below approximately -350 C (-310 F) the battery effectively ceases to operate.

(2) Charging. The conductivity of the electrolyte used in the battery decreases at low temperatures which results in high internal resistance. For this reason, battery charge acceptance is poor at 0o C (320 F) and becomes worse as the temperature decreases. If charging must be accomplished at temperatures below.4. 50 C (400 F) the charger cutoff voltage should be increased from the normal 32. 0 volts to 33. 6 volts. However, repeated charging at these temperatures will result in progressively reduced performance on subsequent discharges.

(3) Minimum Exposure Temperature. The battery should not be exposed to temperatures below .46° C (-50° F) after it is filled with electrolyte. The normal electrolyte solution (40% KOH, Potassium Hydroxide) freezes at this temperature.

c. Extreme Heat.

(*1) Capacity and Voltage.* The ampere-hour capacity and voltage of the battery are not as seriously affected at high temperatures as at low temperatures, however, the cycle life is drastically reduced. For example, at a temperature of 71°C (160°F) the life of the battery is reduced to approximately one third of the life to be expected under normal (4.5°C/40F to 32.2C/ 900F) temperature conditions.

(*2) Charging.* Charging the battery at temperatures above 32°C (900F) causes excessive gassing which results in a reduction of operational life beyond practical limits. If, under emergency conditions, charging must be accomplished at temperatures above 32°C (900F) the charger cutoff voltage should be limited to 31.5 volts.

(*3) Maximum Exposure Temperature.* The battery will be damaged if exposed to temperatures in excess of 60°C (140°F) after it is filled with electrolyte.

CAUTION

DO NOT expose battery to temperatures below -46°C (-50°F) or above 600C (140°F) after they are filled with electrolyte.

Section IV. FIRST AID

2-7 First Aid Procedures

Electrolyte used in the cells is alkaline. It will cause skin irritation and destroy fabric if spilled. The following first aid instructions apply.

a. Antidote for External Contamination. The electrolyte used in silver-zinc batteries contains potassium hydroxide (KOH), which is a caustic chemical agent. Serious and deep burns of body tissue will result if the electrolyte comes in contact with the eyes or any part of the body. If accidental contact with the electrolyte is made, use ONLY clean water and immediately (seconds count) flush contaminated areas. Continue flushing with large quantities of clean water. Seek medical attention without delay. Tell medical personnel that you have been contaminated with potassium hydroxide (KOH).

b. Antidote for Ingestion. Give large quantities of water and weak -acid solutions such as vinegar, lemon juice, or orange juice. Then follow with a demulcent such as egg whites, olive oil, starch water, mineral oil, butter or milk. Seek medical attention without delay. Medical personnel should be informed that the patient has ingested potassium hydroxide (KOH).

CHAPTER 3

MAINTENANCE INSTRUCTIONS

SECTION I

INTRODUCTION

3-1 MAINTENANCE DEFINITIONS

a. SERVICE. To clean, preserve, and to replenish distilled water or electrolyte.

b. INSPECT. To verify service- ability and to detect imminent failure.

c. TEST. To verify serviceability and to detect imminent mechanical of electrical failure by use of special equipment such as meters and so on.

d. REPLACE. To substitute serviceable for unserviceable parts.

e. IROAN. Inspect and Repair Only as Necessary (IROAN) is that maintenance technique that determines the minimum repairs necessary to restore equipment, to prescribed maintenance serviceability standards by utilizing all available diagnostic equipment and test procedures, and by minimizing disassembly and parts replacement.

f. REPAIR. To restore that which is unserviceable to a serviceable condition by adjusting or replacing damaged or unserviceable parts, components or assemblies.

g. OVERHAUL. To restore an item to a completely serviceable condition by inspecting, disassembling, and as necessary, replacing parts and performing necessary repair operations followed by reassembly and final inspection.

3-2 FORMS, RECORDS AND REPORTS

a. BATTERY LOGS.

(1) A battery log must be maintained and kept by the battery shop on each battery serviced by the shop. Although a log is provided inside the cover of the battery box, it provides insufficient space to record all required battery maintenance data. For this reason, a separate battery log is a necessity. Since these batteries are not assigned serial numbers by the manufacturer, a new style log, ETA late 1966, has been designed for insertion in the battery box cover which has space provided for recording an identification number. In the meantime, such a number can be recorded on the existing log. The new log in the cover also provides for recording the following data:

(a) Cycle Number

(b) Date Charged

(c) Equipment Used On

(d) Estimated Operating Hours

(e) Remarks

The assignment of the battery identification number and the entry of the charging date are responsibilities of battery shop maintenance personnel. All other entries should be made by the using organization prior to return of the battery to the shop for charging. The "equipment used on" and "estimated operating hours" columns will provide shop personnel with a degree of measure of depth of discharge and battery performance. For example, if used on the AN/PRC 47, assuming a ratio of receive time to transmit time of 9 to 1, . fully charged battery in good condition should provide a total operating time of 8 to 10 hours under normal operating temperature conditions (4.5 ^{0} C/ 40 ^{0} F to 32.2 ^{0} C/90 ^{0} F).The "remarks" column should be used by the radio operator to record data such as: leaking, gassing, heats up, etc.

(2) The shop log is keyed to the battery through the battery identification number. This number, assigned by the battery shop, should consist of the using Unit Designation (abbreviated or RUC Code) followed by a dash and a separate number for each battery in the unit, such as, 1, 2, 3 and so on.

NOTE

BE SURE ASSIGNED BATTERYNUMBER IS RECORDED INBOTH BATTERY COVER LOGAND SHOP LOG.

In this manner, the battery shop can identify each battery individually. In order to provide useful data, the battery log maintained by the shop must contain the following minimal information:

(a) A separate page for each battery, with the battery identified by the number recorded in the battery cover.

(b) Cycle number.

(c) Date of charge.

(d) Open circuit battery voltage prior to charge.

(e) The starting current at the beginning of each charge cycle.

f) The terminal voltage at the end of each charge.

(g) The terminal current at the end of each charge.

(h) The time required to charge the battery (i. e., start time, stop time and total elapsed time).

(i) Date and cycle number of cell voltage equalization.

(j) Repairs and preventive maintenance.

(k) Remarks.

With the possible exception of items (d), (e), (f), (g) and (h), the reason for requiring the above information in the shop battery log is obvious. The purpose of logging the open circuit voltage prior to charging (d) and the starting current (e) is to provide an indication of the depth of battery discharge. As a rule of thumb, a voltage of 26 to 28 volts represents a

mild discharge, 22 to 25 volts a normal discharge, and below 22 volts a deep discharge. A starting current of 2..25 to 2..50 amperes also indicates a normal to deep discharge while a current of less than 2.25 amperes indicates a mild depth of discharge. In addition, a high starting current which fails to decline with charging time may indicate presence of a shorted cell. A voltmeter check of each cell should be made to pinpoint the defective cell. Logging the terminal voltage and current (f) and (g)provides the shop with an indication of the condition of the battery before going to the field. In general, an end-of-charge voltage of 32.0 volts and no more than 0.5 ampere charging current indicates an adequately charged battery. Recording the elapsed charging time (h) provides an indication of battery charge acceptance capability. In no case should a battery be charged for over 20 hours. Battery logs need not be limited to this information, It is to be stressed that this is the minimal amount of in- formation which will enable maintenance personnel to predict battery charging, repair, replacement, and parts requirements and provide battery shop personnel with the needed data to permit complete familiarization with battery characteristics.

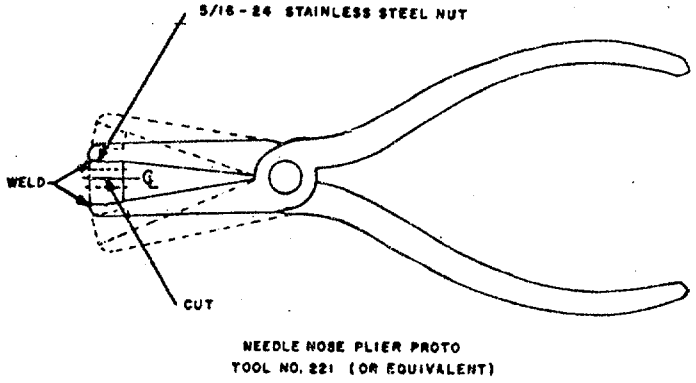
SECTION II

TOOLS AND EQUIPMENT

3-3 TOOLS USED TO MAINTAIN THE BB-451/U

a. MONOBLOCK PULLER. A locally fabricated monoblock puller is required for battery disassembly. See Figure 3-1 for instructions.

b. TOOLS. Use Tool Kit, Battery Service TK-90 / G



NOTE:
NUT MUST BE ELECTRICALLY WELDED IN POS1TION
A3 SHOWN AND THEN CUT ON CENTER LINE (C)

LOCALLY FABRICATED MONOBLOCK PULLER TOOL
FIGURE 3-1

SECTION III

TROUBLESHOOTING

3-4 GENERAL. This section is provided to enable the user to rapidly determine the most probable cause of a malfunction, and apply corrective action as quickly as possible.

3-5 TROUBLESHOOTING PROCEDURE. The corrective actions indicated in paragraph 3-6, Troubleshooting, must be applied with equipment of the same accuracy as described in Chapter I, paragraph 1-7 b. "Required Equipment". A convenient listing of all troubleshooting symptoms is provided below:

a. Cells leak or spew electrolyte when battery is being charged.

b. Cells leak when battery is inverted.

c. Metal parts corrode and rubber parts deteriorate.

d. Removal of nuts and intercell connectors is difficult.

e. Excessive voltage drop under load.

f. Carrying-strap retaining pins bend or break.

g. Battery box lid thumbscrew becomes uncaptivated.

h. Low ampere-hour output from new batteries.

i. Battery cover blows off.

j. Old style terminal connectors (FSN 5940-689-999) defective.

k. Electrolyte leakage around cell safety relief valves.

l. Electrolyte leakage around terminal posts.

m. Battery box cracks under impact.

n. New battery will not accept charge after activation.

o. Firm contact cannot be made between battery and radio set.

p. Lumpy electrolyte.

3-6 TROUBLESHOOTING

a. TROUBLE: CELL(S) LEAK OR SPEW ELECTROLYTE WHILE BATTERY IS BEING CHARGED.

Probable Cause	Corrective Action
(1) Vent-caps not loosened prior to charging.	(1) Loosen vent-caps two or three turns.
(2) Battery charger improperly adjusted or malfunctioning; charging current rate too high; charging voltage too high	(2) Verify that charging current and voltage are within the limits specified in paragraph 1-7 c. Be certain that the main battery terminals and charger contacts are clean and making good contact.
(3) Excessive amount of electrolyte is offending cells.	(3) Remove excessive electrolyte by removing monoblock (see paragraph 3-7 a.) and pouring out excess electrolyte.
(4) Shorted cells within the battery which will lower the battery on- charge voltage and cause the battery charger to overcharge the remaining cells.	(4) Replace the monoblock; being sure to record this fact on the shop battery log record.

b. TROUBLE: CELL(S) LEAK WHEN BATTERY IS INVERTED

Probable Cause	Corrective Action
(1) Vent-cap(s) not tightened securely.	(1) Use a screwdriver and tighten the vent-cap(s) until *bottomed* firmly.
(2) "O"-ring(s) missing or defective.	(2) Replace "O"-ring(s).
(3) Carbonate deposits in threads.	(3) Clean vent-caps. Check to see if caps are sheared. Replace if necessary. Washing vent-caps as required in preventive maintenance (paragraph 2-3 b. (2) will prevent this from occurring.

c. TROUBLE: METAL PARTS CORRODE AND RUBBER PARTS DETERIORATE.

Probable Cause	Corrective Action
(1) Affected parts are being attacked by electrolyte. This can be caused by a loose vent cap, defective "O ring or loose terminal nut.	(1) Remove affected parts and wash in warm water; dry thoroughly. If corrosion is excessive on metal parts, replace them. All affected rubber parts should be replaced. When reassembling battery ascertain that all components are torqued as required.(See paragraph 3-7 a.)

NOTE

WHEN BATTERIES ARE CHARGED IN ACCORDANCE WITH THE INSTRUCTIONS INDICATED, AND THE ELECTROLYTE IS MAINTAINED AT THE PROPER LEVEL, AND ALL CONNECTIONS ARE KEPT CLEAN AND TIGHT, THIE BATTERY PARTS WILL ALL LAST THE CYCLE LIFE OF THE BATTERY.

d. TROUBLE: REMOVAL OF NUTS AND INTERCELL CONNECTORS IS DIFFICULT.

Probable Cause	Corrective Action
(1) Nuts torqued down too tightly when battery was assembled.	(1) Disassemble with EXTREME CAUTION to avoid cell damage. When the battery is re-assembled, follow instructions in paragraph 3-7 a.
(2) Carbonate deposits on threads.	(2) Remove affected parts and wash in warm water. Dry thoroughly upon reassembling.

e. TROUBLE: EXCESSIVE VOLTAGE DROP UNDER LOAD.	
Probable Cause	Corrective Action
(1) Cell interconnections corroded causing voltage drop between cells.	(1) Remove and wash interconnecting hardware in warm Water; dry and reassemble. (See paragraph 3-7 a. for disassembly instructions).

f. TROUBLE: CARRYING-STRAP RETAINING PINS BEND OR BREAK	
Probable Cause	Corrective Action
(1) Defective design. New batteries use nuts and bolts to alleviate problem.	(1) Replace pins with appropriate size nuts and bolts. Any bolt of 1-1/8-inch length or more, and 3/32-inch or less diameter, will suffice. Preferably the nuts and bolts should be plated.

g. TROUBLE: BATTERY BOX LID THUMBSCREW BECOMES UNCAPTIVATED.	
Probable Cause	Corrective Action
(1) Retaining ring damaged or lost.	(1) Replace damaged or lost part with locally fabricated part.

h. TROUBLE: LOW AMPERE-HOUR OUTPUT FROM NEW BATTERIES.	
Probable Cause	Corrective Action
(1. Storage temperatures prior to activation may have been such that some capacity was lost.	(1) Give the battery a booster charge prior to using as described in paragraph 1-7 c. (2).
(2) Previous charge cycle inadequate.	(2) Give battery a booster charge.

i. TROUBLE: BATTERY COVER BLOWS OFF.

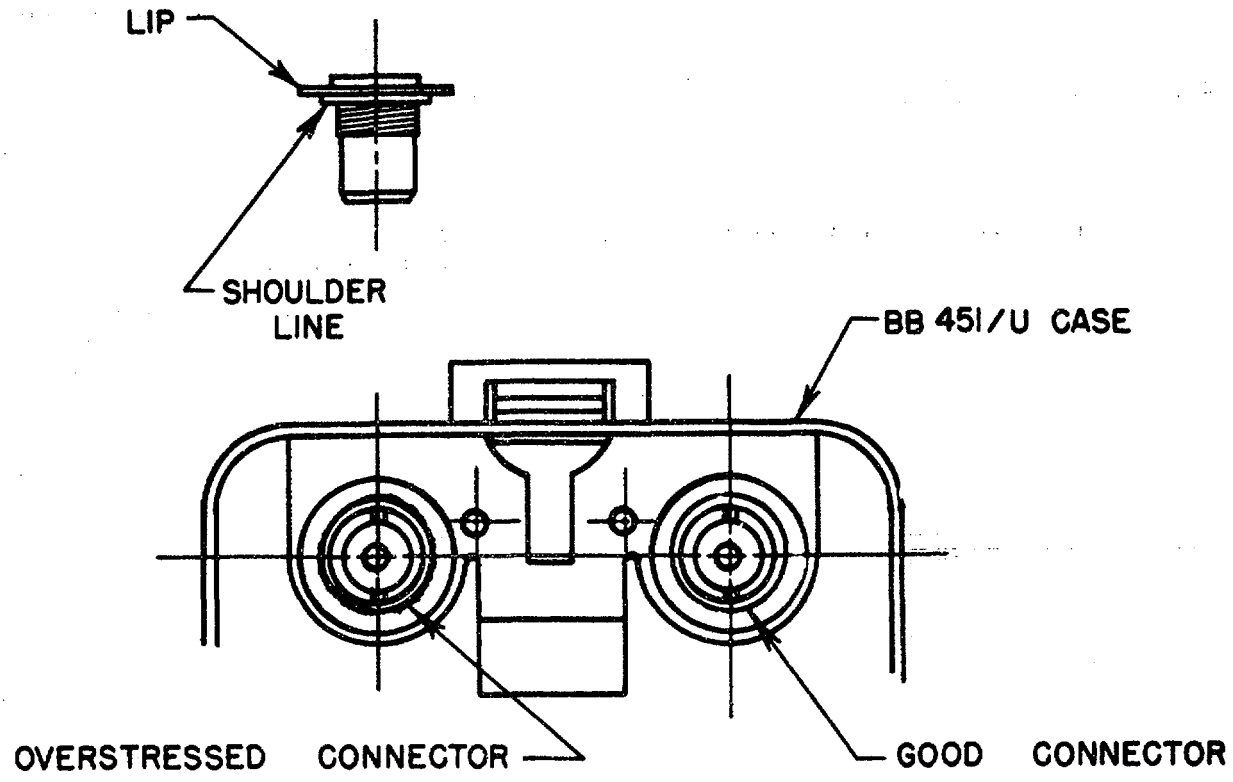
Probable Cause	Corrective Action
(1) Battery being charged with cover in place and vent-caps not loosened.	(1) Charge battery in accordance with the instructions in paragraph 1-7 c.
(2) Battery safety release valve corroded and will not release.	(2) Clean and check operation of safety release valve in accordance with paragraph 3-7 b.

J. TROUBLE: OLD STYLE TERMINAL CONNECTORS (FSN 5940-689-999) DEFECTIVE.

Probable Cause	Corrective Action
(1) Connectors with plastic lips overstressed due to excessive nut torque, or radio set being forcefully placed on battery in backward position.	(1) Refer to Figure 3-2. Inspect battery cover to pinpoint over- stressed connectors. If shoulder line as seen through lip appears sharp and distinct without signs of plastic stress connector is good. If shoulder line as seen through lip appears milky and blurred in appearance, or, in extreme cases, actual fracture lines show, the connector is bad. Replace overstressed connectors with new connectors.

NOTE

THE MANUFACTURER HAS PROVIDED NEW CONNECTORS (FSN 5935-790-0179) WITH METAL SHELLS AND LIPS PREVENTING THIS SHEARING PROBLEM IN LATER MODELS



OVERSTRESSED CONNECTORS

FIGURE 3-2

k. TROUBLE: ELECTROLYTE LEAKAGE AROUND CELL SAFETY RELIEF VALVES.	
Probable Cause	Corrective Action
(1) Cells overfilled with distilled water.	(1). Remove monoblocks, correct levels by pouring out excess and refilling as necessary with electrolyte.
(2) Rubber "O"-ring not used for vent-cap.	(2) Ensure that the black rubber "O"-ring for the vent-cap is used.

l. TROUBLE: ELECTROLYTE LEAKAGE AROUND TERMINAL POSTS.	
Probable Cause	Corrective Action
(1) Loose terminal post nut. Corrective Action	(1) Tighten terminal post nut. Do not twist, turn or push down on terminal posts at any time as this will cause the "O"-ring underneath the cell cover to loosen resulting in further leakage.

NOTE

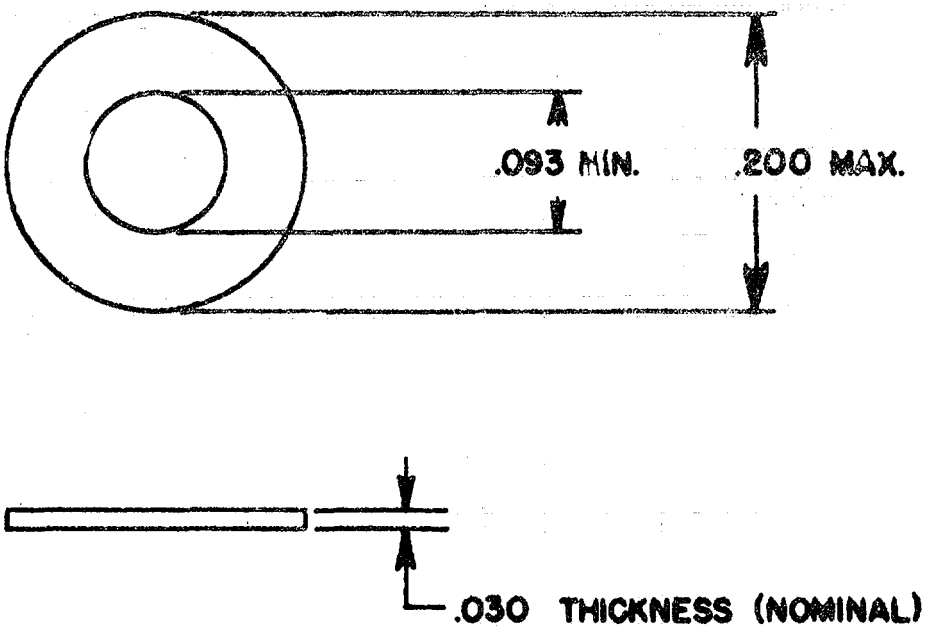
NEW TERMINAL POSTS ARE BEINCG POTTED TO PREVENT THIS LEAKAGE.

m. TROUBLE: BATTERY BOX CRACKS UNDER IMPACT.	
Probable Cause	Corrective Action
(1) Early production cases were made of random-oriented fiberglass. This case will probably crack on impact during a paradrop.	(1) There is no method of fixing Later production cases are made of oriented glass-filament epoxy and approach structural steel in yield strength.

n. TROUBLE: NEW BATTERIES WILL NOT ACCEPT A CHARGE AFTER ACTIVATION.	
Probable Cause	Corrective Action
(1) Due to manufacturing process of dry-charged plates	(1) Perform following steps. (a) Ensure that the battery has "soaked" for 24 hours. (b) Discharge battery at 5 amperes for 4 or 5 hours (c) Charge battery at 1 ampere rate for 20 hours, then let stand for 4 hours. (d) Check terminal voltage for normal, and repeat discharge- charge cycle again if necessary.

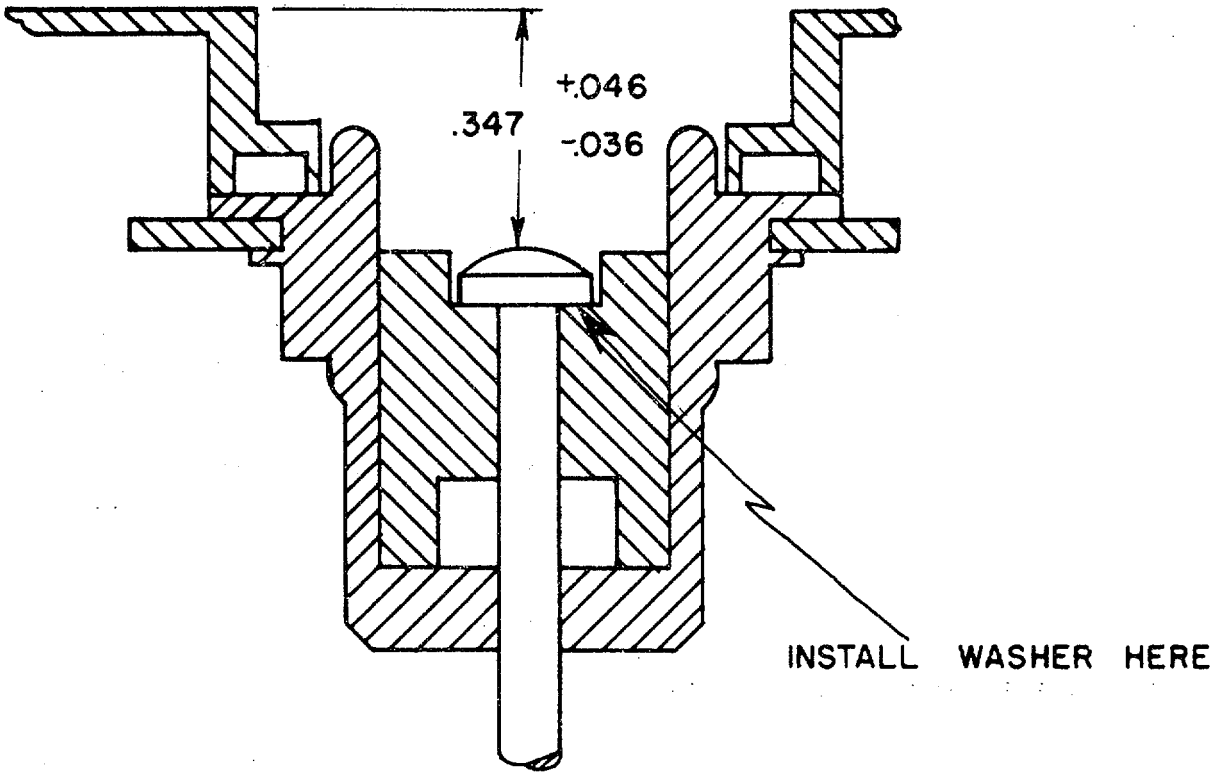
o. TROUBLE: FIRM CONTACT CANNOT BE MADE BETWEEN BATTERY AND RADIO SET, OR CHARGER.	
Probable Cause	Corrective Action
(1) Terminal post in battery seated too low.	(1) Fabricate non-metallic washer as shown in Figure 3-3 A&B (p. 3-13, 3-14).

p. TROUBLE: LUMPY ELECTROLYTE.	
Probable Cause	Corrective Action
(1) Due to low temperature additive used in the past as a test.	(1) Shake well prior to using; if lumps persist, the electrolyte may be used anyway.



LOCALLY FABRICATED WASHER

FIGURE 3-3A



NOTE

REPLACEMENT OF THE EXISTING POLYETHELYENE TERMINAL ASSEMBLY FSN 5940-689-999MAY BE ACCOMPLISHED ON AN "AS FAILED" BASIS BY THE NEW TERMINAL ASSEMBLY FSN-5935-790-0179, WHICH IS MUCH STRONGER AND WILL PHYSICALLY PREVENT THE BACKWARD INSTALLATION OF THE BATTERY.

TERMINAL CROSS SECTION

FIGURE 3-3B

SECTION IV

MAINTENANCE

3-7 MAINTENANCE INSTRUCTIONS.

Maintenance of the BB-451/U is primarily a first and second echelon function. For this reason, most maintenance instructions required for the battery have been cited in Chapters 1 and 2 under paragraphs: 1-4, UNPACKING AND PREPARATION FOR SERVICING, 1-5, ACTIVATING THE BATTERY, 1-6, INITIAL CHECKOUT AND ADJUSTMENTS and 2-3, PREVENTIVE MAINTENANCE. The information contained in these paragraphs of Chapters 1 and 2 plus the information provided in this Section constitute all the maintenance requirements for the battery.

a. MONOBLOCK REMOVAL.

Removing the first monoblock from the BB-451/U requires removal of 32 terminal nuts for batteries having Two Terminal Span Terminal Protectors. To reduce this quantity of terminal nuts to 16, a new style Mono terminal Protector has been designed. The new Monoterminal Protector will replace the old style Two Terminal Span Protectors, FSN 6140-952-3544 and Single Terminal Protector, FSN 6140-952-3543 used in batteries manufactured through mid-1966. Batteries returned to the shop for routine maintenance or repair operations shall be outfitted with the new protectors whenever it becomes necessary to remove or replace monoblocks. Incorporation of the new protector to replace the existing Single Terminal Protector, however, should not take place until the present stock of Single Terminal Protectors has been depleted. ETA for the new style Monoterminal Terminal Protector: late 1966 or early 1967. The purpose of the old two span and new style protectors is two-fold. First, the protectors prevent tools, terminal nuts or other metallic objects which may be accidentally dropped inside the battery from shorting adjacent intercell connectors. Secondly, the protectors prevent spilled or spattered electrolyte from forming a continuous conducting path between terminals which are at different electrical potentials. Removal procedures and tools are cited below:

(1) Tools. To remove the monoblocks use the tools designated in paragraph 3-3.

(2) Removal of Monoblocks with Two Span Terminal Protectors.

NOTE

FIGURE 1-3 ILLUSTRATES MONOBLOCKS WITH NEW STYLE MONOTERMINAL PROTECTORS.

(a) Remove top terminal nuts.

(b) Remove intercell connectors.

(c) Remove lower terminal nuts.

(d) Remove Two Span Terminal Protectors.

(e) Remove monoblock (use monoblock puller).

(f) To replace monoblock, reverse the above procedure and tighten lower and top-terminal nuts to 30-inch-pounds torque.

CAUTION
OVER-TORQUING NUTSWILL DAMAGE CELLS.

(3) Removal of Monoblock with Monoterminal Protectors (see Figure 1-3).

(a) Remove top terminal nuts.

(b) Remove intercell connectors.

(c) Rem6ve monoblock (use monoblock puller).

(d) To replace monoblock, reverse the above procedure and tighten top terminal nuts to 30-inch- pounds torque.

CAUTION
OVER-TORQUING NUTS WILL DAMAGE CELLS.

b. BATTERY BOX SAFETY RELIEF VALVE. Whenever monoblocks are removed from the battery, the battery box safety relief valve should also be removed, inspected, tested and cleaned in accordance with the following procedure:

(1) Remove the stainless- steel nut on the inside of the box.

(2) Push the valve out of the battery box.

(3) Thoroughly wash in warm water.

(4) Inspect to insure that all carbonate deposits are removed.

(5). Dry valve.

(6) Test the valve: It should release at 3 psi $\pm$1 psi and reseat at 50% actual release pressure. If instruments are not available to check the valve use the following procedure.

(a) Place flanged end of valve against mouth and blow.

(b) Valve should release at about the same pressure required- to inflate a new toy balloon.

(c) As pressure against valve is decreased, valve should reseat.

(d) If valve will not release by blowing into it, replace valve.

(7) Reinstall valve in battery box and tighten nut.

3-8 DETERMINATION OF BATTERY CONDITION BY MEANS OF CELL VOLTAGE READINGS

a. DISCHARGED CELL VOLTAGES. Voltage across individual cells will vary during operational usage. Prior to charging, these volt ages should be measured as discussed

in paragraph 1-7 c. to determine if the individual cell variation exceeds 0.2 volt. If so, to prevent some cells from charging faster than others, with subsequent damage to fully charged cells by the charging current, equalization of voltages across the cells must be strictly adhered to as discussed below.

(1) Cell Equalization. Connect 16 identical 10 watt resistors of some value between I and 2 ohms (e.g. 16 each 1. 5 ohm, 10 watt resistors) across each cell. After connecting the resistors, immediately measure the individual cell voltages and repeat these measurements at 10 minute intervals thereafter. As each cell discharges to 1. 0 volt remove its load resistor. Continue this operation until all cells are equalized at 1.0 volt. Following equalization, the battery must be given an operational charge as discussed in paragraph 1-7 c. (1). After charging the battery, allow it to stand on open- circuit for 24 hours and again measure the open-circuit voltages. If individual cell variations still exceed 0. 2 volt, cells are unserviceable and the monoblock must be replaced.

b. FULLIY CHARGED CELL VOLTAGES. On-charge levels of individual cells measured at end of charge should be 31.5 to 32. 0 volts; and after the battery is removed from the charger and allowed to stand on open-circuit for 3 to, 24 hours, voltage levels of individual cells should measure between 1.82 and 1.91 volts (battery voltage of 29. 2 to 30.5 volts). When all cell voltages are not within the above stated ranges, one of the following conditions exist:

(1) Battery insufficiently charged.

(2) Cells out of balance.

(3) Battery may contain bad cell(s).

Follow-up procedures for the preceding three conditions are as follows:

Condition (1): If voltage level is less than 1.82 volts and the widest spread between any two cell voltage readings is not greater than 0. 05 volts, the battery is in-sufficiently charged; continue charging of the battery but never charge battery more than 20 hours. If cell voltages vary by more than 0. 05 volts, follow the procedures given for conditions (2) and (3).

Conditions (2) and (3):

Step 1. Enter in the battery shop log that the cell voltages are not in balance and that the battery will require cell equalization before the next charge.

Step 2. After operational discharge, equalize cell voltages (see paragraph 3-8 a. (1)).

Step 3. Give the battery an operational charge (see paragraph 1-7 c. (1).

Step 4. Measure the open-circuit voltages again after a 3-hour stand on open-circuit. If voltages still are not between 1. 82 and 1,91 volts, or if any two cells vary by more than 0.05 volts, cells are unserviceable and monoblock must be replaced.

NOTE

SINCE CELL CHARACTER- ISTICS CHANGE WITH CYCLE LIFE, IT IS NECESSARY THAT REPLACEMENT MONOBLOCKS ARE ALL APPROXIMATELY WITHIN + 3 CYCLES OF EACH OTHER AND ALSO ACTIVATED WITHIN A 30-DAY PERIOD OF EACH OTHER. A BATTERY COMPRISED OF MONOBLOCKS THAT ARE NOT WITHIN ± 3 CYCLES OF EACH OTHER WILL BE OUT OF BALANCE AND DELIVER FEWER TOTAL CYCLES.

3-9 REJUVINATION OF LOW AMPERE HOUR CAPACITY MONOBLOCKS

a. GENERAL. Batteries containing low capacity monoblocks which are otherwise serviceable (not shorted, leaking, etc.) but provide operating capacities of less than 6 ampere -hours after being fully charged can under certain conditions have much of their lost capacity restored. The procedure to be followed is cited below.

CAUTION

REJUVINATION OF MONO- BLOCKS SHOULD NOT BE ATTEMPTED EXCEPT ON MONOBLOCKS THAT ARE OTHERWISE UNSERVICE- ABLE DUE TO LOW CAPACITY.

b. PROCEDURE

CAUTION

ADDITION OF DISTILLED WATER TO THE LEVEL INDICATED BELOW SHOULD BE ATTEMPTED ONLY AS A LAST RESORT.

(1) Remove all cell vent- caps and add distilled water until the electrolyte is visible.

(2) Give battery an operational charge (see paragraph 1-7 c. (1).

c. MAINTENANCE. Batteries modified by adding distilled water to the level indicated in b. Above should have this level maintained by adding distilled water, if the level is reduced by gassing, or by adding electrolyte (40% Potassium Hydroxide, KOH) if the level is reduced due to splattering during charging.

d. LIMITATIONS. Batteries modified as stated herein will exhibit extremely poor low temperature and high temperature characteristics. At low temperatures battery discharge capacity is seriously reduced and danger of freezing is increased. At high temperatures the self-discharge rate of the cells is increased significantly. Therefore, these procedures should be limited to batteries that will be used under normal temperature conditions 4.50°C (40 °F) to 32.2 °C (90 °F).

CAUTION

DO NOT PERMIT BATTERIES MODIFIED PER PARAGRAPH 3-9 TO BE EXPOSED TO TEMPERATURES BELOW 0° C (32° F) SINCE DILUTION OF ELECTROLYTE WILL GREATLY REDUCE ABILITY OF BATTERY TO WITHSTAND FREEZING.

3-10 MONOBLOCK DISPOSITION

Unserviceable monoblocks should be disposed of in accordance with Section III, paragraph 12, of AR 755-21, dated 3 September 1966. These monoblocks contain approximately $17.50 in recoverable silver.

3-11 BATTERY REQUISITIONING PROCEDURES

a. NORMAL PROCEDURE. Complete batteries are not normally furnished as replacement items; instead, using units shall rebuild batteries by replacing components as required. If a battery needs complete replacement as a result of normal training use, the individual component parts must be requisitioned, not the complete battery.

b. COMBAT PROCEDURE.
Batteries lost through combat action should be requisitioned as complete replacements, i.e., Storage Battery BB-451/U, FSN 6140-889-1027.

3-12 MAINTENANCE AND CHARAC- TERISTIC NOTES. The following notes provide a useful summary of battery characteristics, and should be carefully read so that the user may fully understand how the battery must be handled to ensure optimum performance and maximum battery life.

a. CAPACITY AND LIFE. When the battery is discharged at various temperatures for a maximum of 20 AH per-cycle, the battery will deliver the minimum capacity and cycle-life values as given in Appendix IV.

b. ADVANTAGES. The silver-zinc battery (BB-451/U) has the following main advantages when compared with other rechargeable batteries:

(1) Compact (more power output per-unit weight).

(2) Allows higher rates of discharge.

(3) Flat voltage-discharge curve.

(4) Shock and vibration resistant.

(5) Spill resistant.

(6) Less danger of gas accumulation under normal operating conditions.

c. COST. The BB-451/U costs approximately $200. 00, therefore, proper use and maintenance are obvious necessities.

d. ELECTROLYTE. Both the silver and zinc plates of the battery are soluble in the electrolyte; therefore, the cells must not be overfilled with electrolyte.

e. EXCESS CHARGINC. When prescribed current-charging rates are exceeded, the battery plates will

not accept the excess current as charge, instead, the excess current causes generation of hydrogen and oxygen.

f. LIFE VERSUS TEMPERATURE. The operating life of the battery is substantially shortened when operated at temperatures below -25°C (-13 F) and above 38 C (100 F) (see Appendix IV).

g. HEAVY DISCHARGES. Heavy discharges in the vicinity of 75% capacity, materially shorten the cycle life of the battery.

h. EARLY VENT-CAPS. Vent- caps of earlier monoblock cells have an integral tube that extends about 0.6 inch into the cell, later models have this tube as an integral part of the cell top.

i. EARLY MONOBLOCK. On earlier monoblock models, the under- side of the terminal posts were not potted in epoxy as in the later models. This was a source of trouble, and, if any of these type are found, caution should be taken not to force the terminal post down-into the cell as this can cause shorting of the plates.

j. GASSING. The generation of hydrogen-gas in the battery decreases as the ambient temperature decreases, and increases with ambient temperature increase.

k. TEMPERATURE EXTREMES. The battery must not be subjected to temperatures below -46 °C (-50° F) or above 60 °C (160 °F) once it is filled with electrolyte.

l. RUBBER BUMPERS. The four threaded studs mounted in the cover of the battery are insulated by rubber protectors, thereby preventing shorting two of the monoblocks. The studs in the batteries built since late 1963 have been shortened from 5/16-inch to 1/4-inch. However, these rubber protectors should be inspected whenever they are removed to turn the charging log over, and replaced when they show signs of wear.

SECTION V

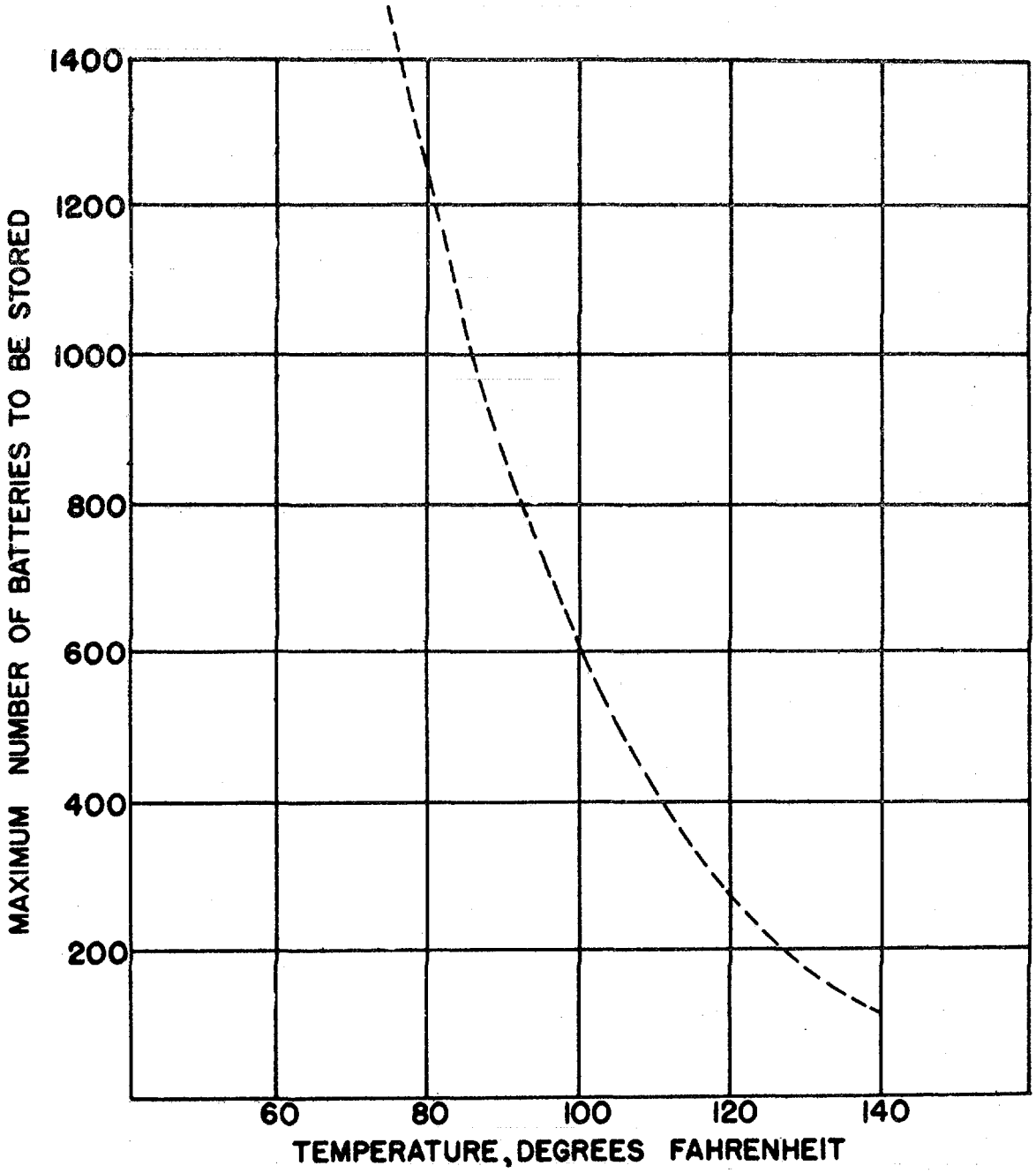
PREPARATION FOR LONG TERM STORAGE

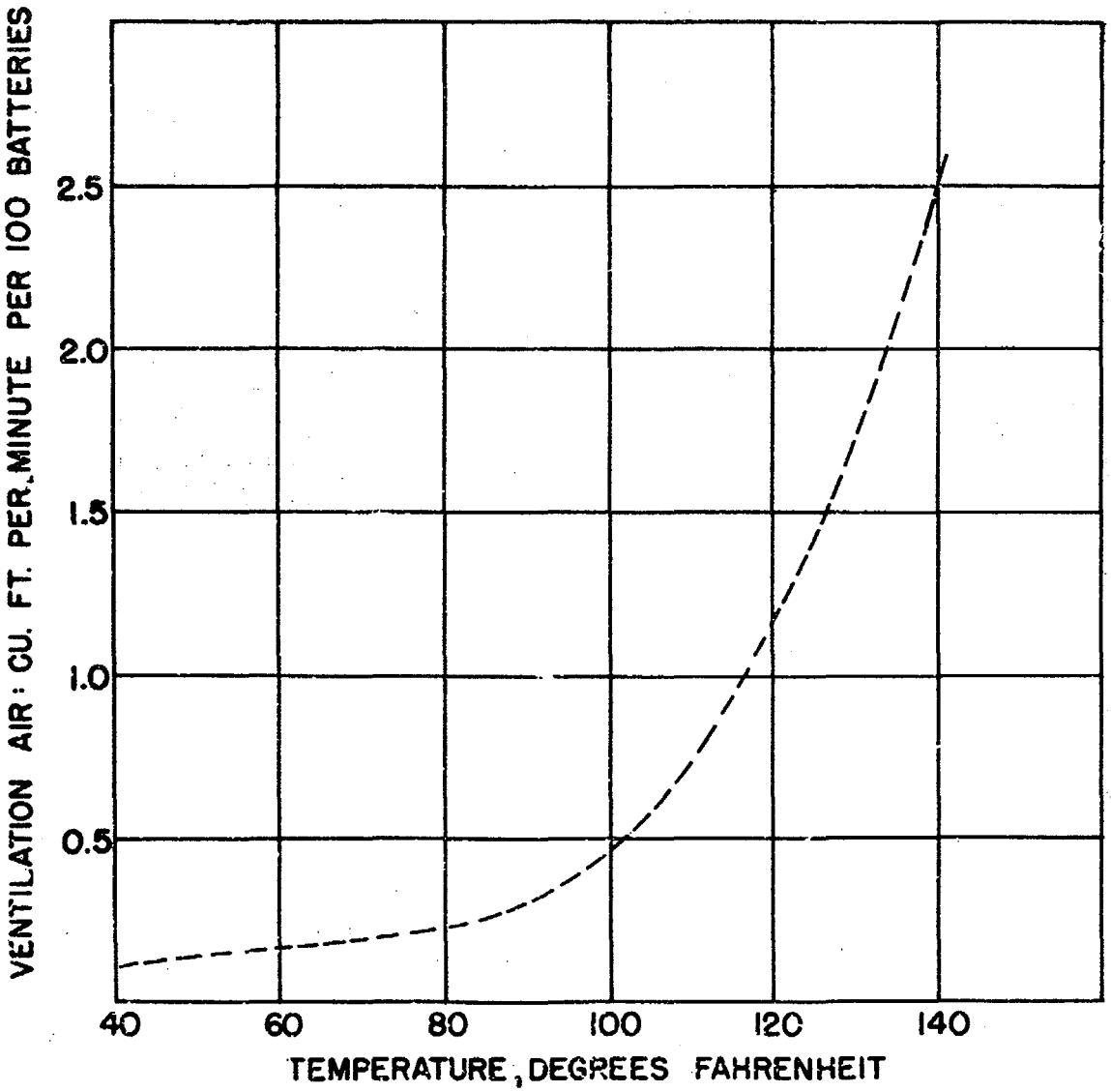
3-13 UNACTIVATED LONG TERM STORAGE. Unactivated batteries can be stored at temperatures between -60°C (-75°F) and 66 °C (150° F) for periods up to five years. Best storage life is obtained at temperatures below 90 °F. Table 4-1 lists self-discharge data for batteries that have been stored in their original, unopened packages(see Table 1-4).

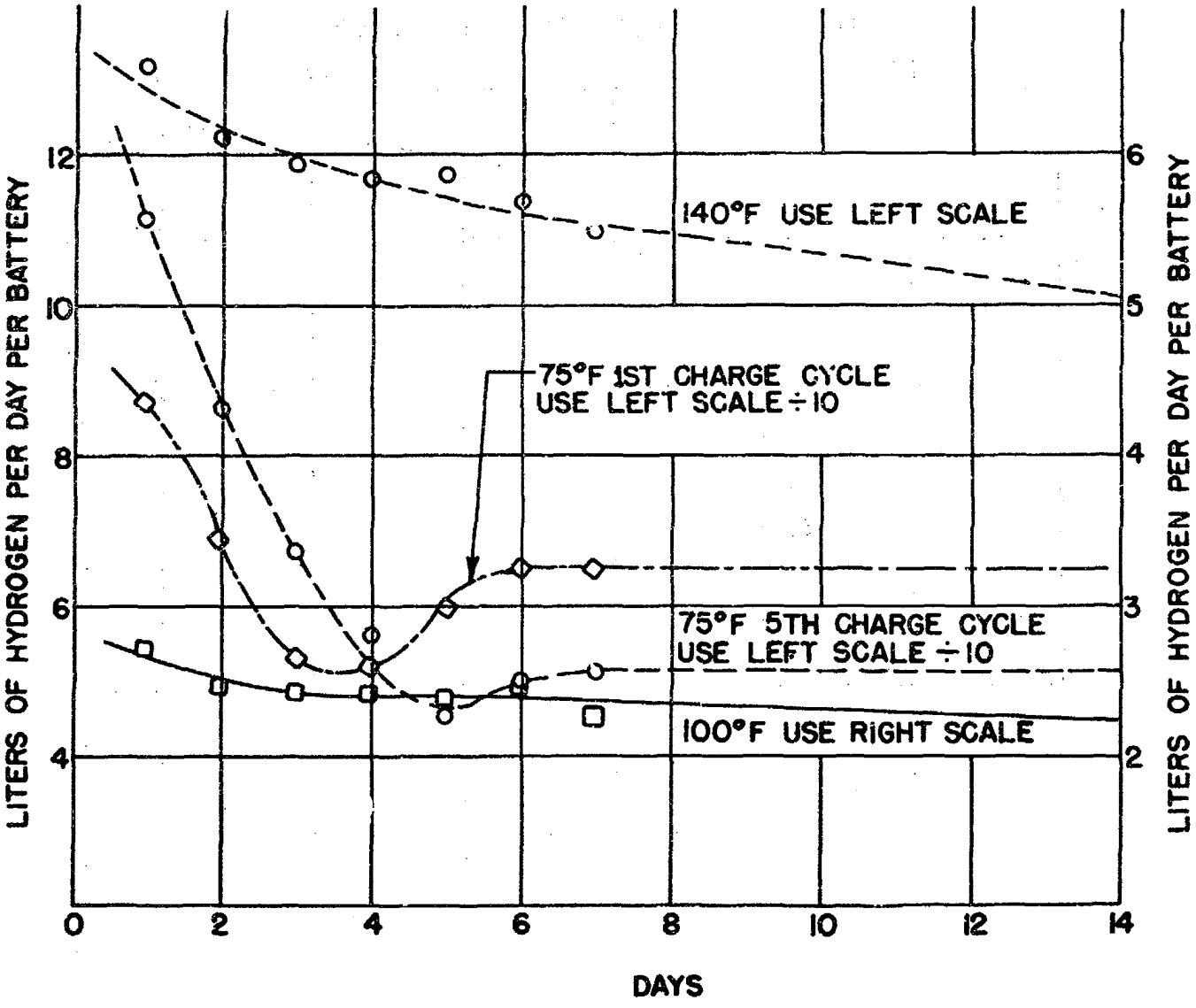
3-14 ACTIVATED LONG TERM STORAGE.

a. LOSSES. As can be seen by referring to Table 1-3, Activated BB-451/U Batteries cannot be stored for long periods of time. Under ideal temperature conditions, approximately 10° C (50° F), the battery loses 3% of its capacity per month of storage and the total wet life is approximately 18 months.

b. VENTILATION. Ventilation requirements as stated in paragraph 1-9 must be met when storing activated batteries. This provides adequate and safe ventilation to disperse the hydrogen outgassed by the batteries.


1400
1200
1000
800
600
400
200
MAXIMUM NUMBER OF BATTERIES TO BE STORED
60
80
100
120
140
TEMPERATURE, DEGREES FAHRENHEIT


VENTILATION AIR: CU. FT. PER MINUTE PER 100 BATTERIES
2.5
2.0
1.5
1.0
0.5
40
60
80
100
120
140
TEMPERATURE, DEGREES FAHRENHEIT


LITERS OF HYDROGEN PER DAY PER BATTERY
LITERS OF HYDROGEN PER DAY PER BATTERY
12
10
8
6
4
6
5
4
3
2
0
2
4
6
8
10
12
14
DAYS
140°F USE LEFT SCALE
75°F 1ST CHARGE CYCLE
USE LEFT SCALE ÷ 10
75°F 5TH CHARGE CYCLE
USE LEFT SCALE ÷ 10
100°F USE RIGHT SCALE

APPENDIX IV

MINIMUM BATTERY PERFORMANCE AT VARIOUS TEMPERATURES

Temperature (°F) / (°C)	Cycles	Wet Life (Months)
-13 /-25.0	20	6
0 / 18.0	20	6
32 / 0	25	12
40 / 4, 5	30	18
75 / 24.0	30	18
90/ 32.2	25	18
100 / 37.5	20	12
120/ 48.8	10	2
140 / 60.0	10	1

NOTE: ABOVE CYCLES BASED ON 20 AH DISCHARGES. BATTERY WILL CONTINUE TO DELIVER USEFUL CYCLE LIFE IF USED AT LOWER AH RATES.

APPENDIX V

REFERENCES

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	U.S. Army Equipment Index of Modification Work Orders.
TM 11-6130-239-15	Organizational, DS, GS, and Depot Maintenance Manual Including Repair Parts and Special Tool Lists: Chargers, Battery PP-3240/U and PP-324OA/U.
TM 11-6625-366-15	Organizational, DS, GS, and Depot Maintenance Manuals Multimeter TS-352B/U.
TM 38-750	Army Equipment Record Procedures.

APPENDIX VII
MAINTENANCE ALLOCATION

Section I. INTRODUCTION

A7-1. General
This appendix provides a summary of the maintenance operations for Battery, Storage BB-451/U. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

A7-2. Maintenance Function
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.

b. Test. To verify serviceability and to detect cipient failure by measuring the mechanical 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 (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the 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 known accuracy, to detect and adjust any discrepancy, the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or 'ing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. Replace. The act of substituting a service- able like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to 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) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. 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. Re build 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 equipments/ components.

A7-3. Column Entries

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b Column 2, Component I Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which

maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d Column 4, Maintenance Category. Column 4 specifies, by the listing of a "worktime" figure in the appropriate subcolumn(s), the lowest level 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 "worktime" figures will be shown for each category. The number of task-hours specified by the "worktime" 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, troubleshooting 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. Subcolumns of column 4 are as follows:

C - Operator/Crew
0 - Organizational
F - Direct Support
H - General Support
D- Depot

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

f. Column 6, Remarks. Column 6 contains an alphabetic code which leads to the remark i- section IV, Remarks, which is pertinent to item opposite the particular code.

A7-4. Tool and Test Equipment Requirements (sec III)

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d National l /NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed the Federal Supply Code for manufacture, (5-digit) in parentheses.

A7-5. Remarks (sec IV)

a Reference Code. This code refers to the appropriate item in section II, column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing in section II.

SECTION III MAINTENANCE ALLOCATION CHART
FOR
BATTERY STORAGE BE-451/U

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT	(6) REMARKS
			C	O	F	H	D		
00	BATTERY, STORAGE BB-451/U	SERVICE		4.O				1,2,3	
		INSPECT		0.2				3	
		TEST		1.0				1,2	
		REPAIR		0.2				3	
		REPAIR			1.0			3	
		REPAIR					1.5	2,3	
	BATTERY BOX	SERVICE			0.1			3	A
		INSPECT			0.1				
	REPLACE				0.5			3	
	CONNECTOR ELECTRICAL BATTER	SERVICE		0.1				3	A
		INSPECT		0.1					B
		REPLACE			1.0			3	
	COVER, BATTERY BOX	SERVICE		0.1				3	A
		REPLACE			0.5	3			
	COVER, DUST	SERVICE	0.1						A
		INSPECT	0.1						B
		REPLACE	0.1						
	BATTERY, STORAGE, FOUR CELL MONOBLOOK	INSPECT			0.1				A,B
		TEST			0.2			2	
		REPLACE			1.0			3	
		OVERHAUL			1.0			3	

SECTION'II: TOOL AND TEST EQUIPMENT REQUIREMENTS FOR BATTORY, STORAGE BB-451/U

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/ NATO STOCK NUMBER	TOOL NUMBER
1	O F H D	CHARGER, BATTERY PP-6241/U	6130-00-106-6445	
2	O,F,H,D	MULTIMETER TS-352( )/U	6625-00-242-5023	
3	**O,F,H,D**	**TOOL KIT,** BATTERY SERVICE TK-90/G	5180-0**00**542-5812	

SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A	MAINTAINED AS PART OF FUNCTIONAL GROUP 00
B	VISUAL INSPECTION ONLY.

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL AND TEST REQUIREMENTS				
TOOLS AND EQUIPMENT	MAINTENANCE CATEGORY	NOMENCLATURE	FEDERAL STOCK NUMBER	TOOL NUMBER
1	0	CHARGER, BATTERY PP-3240A/U	6130-987-9503	
2	F,H,D	CHARGER, BATTERY PP-4567/U	6130-903-1163	
3	O,F,H,D	MULTIMETER TS-352( )/U	6625-242-5023	
4	O,F,H,D	TOOL KIT, BATTERY SERVICE TK-90/G	5180-542-5812	
		ADDITIONAL EQUIPMENT AND SUPPLIES		
5	O,F,H,D	APRON, BATTERY WORKER	8415-234-9253	
6	O,F,H,D	BORIC ACID, CRYSTALS, COMMERCIAL PURE (SOLUTION 3% BY WEIGHT REQUIRED)	6750-174-5454	
7	F,H,D	ADHESIVE, DUTCH BRAND Nr 281, 2 Pt Btl	8040-926-9059	
8	O,F,H,D	CLOTH, LINT FREE	8305-170-5062	
9	F,H,D	CORROSION PRVENTIVE COMPOWND	8030-903-0931	
10	F,H,D	DISTILLED OR DEIONIZED WATER	6810-356-4936	
11	F,H,D	KIT, BATTERY FILLER NOTE: To be used as replacement electrolyte only. Batteries and monoblocks come with Battery Filler Kit.	6140-981-5864	
12	O,F,H,D	GOGGLES, INDUSTRIAL TYPE	4240-521-0586	

APPENDIX VIII
EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

A8-1. Scope

This appendix lists expendable supplies and materials you will need to operate and maintain the Battery, Storage BB-451/V. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

A8-2. Explanation of Columns

a Column 1- Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., "Use cleaning compound, item 5, App. D").

b. Column 2 - Level. This column identifies the lowest level of maintenance that requires the listed item.

C - Operator/Crew
O - Organizational Maintenance
F - Direct Support Maintenance
H - General Support Maintenance

c. Column 3 -National Stock Number This is the National stock number assigned to the item; use it to request or requisition the item.

D Column 4 - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the part number followed by the Federal Supply Code for Manufacturer (FSCM) in parentheses, if applicable.

E Column 5 - Unit of Measure (UIM) Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

(Next printed page is A8-3.)

SECTION II EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NO	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(6) UNITS OF MEAS
1	O,F,H,D	8415-00-715-0450	APRON, IMPERMEABLE, BATTERY WORKERS MIL-A-41801 (813 49)	EA
2	F,H,D	8040-00-926-9059	ADHESIVE, DUTCH BRAND NO. *281* 2 PT BTL	BTL
3	O,F,H, D	8305-00-267-3015	CLOTH, CHEESECLOTH, LINTLESS, CCCC440 (81348)	YD
4	F,H,D	8030-00-903-0931	CORROSION PREVENTIVE COMPOUND NOX RUST NO. 366 (02847)	PT
5	O,F,H, D	4240-00-203-0317	GOGGLES, IIDUSTRIAL, CHEMICAL TYPE GGG-G-521 TYPE **II,** (81348)	PR
6	F,H,D	6140-00-981-5864	KIT, BATTERY FILLER	EA
			NOTE: TO BE J**US**ED AS REPLACEMENT ELECTROLYT. ONLY IN CASE OF **SPILLAGE. BATTERIES** AND MONOBLOCKS ARE ISSUED WITH BATTERY **FILLER KIT.**	

By Order of the Secretary of the Army:

HAROLD K. JOHNSON,
General, United States Army
Chief of Staff.

Official:
KENNETH G. WICKHAM
Major General, United States Army,
The Adjutant General.

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USACDCWA (1)
USAMC (5)
USCONARC (5)
ARADCCM (5)
ARADCOM Rgn (2)
OS Maj Comd (4)
LICOKD (2)
USAMICOM (4)
CSASTRATCCI (4)
USAESC (70)
MDW (1)
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Corps (2)
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USAAMS (2)
USAARMS (2)
USAES (2)
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UASTC (2)
WRAMC 1)
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Ft Hancock (4)
Ft Gordon (10)
Ft Huachuca (10)
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WSMR
Ft Knox (12)
Gen Dep (2)
Sig Sec Gen Dep (5)
sig Dep (12)
A Dep (2) except
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SAAD (30)
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11-57
11158
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}1-587
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11-597
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G None.
USAR None.
For explanation of abbreviations used, see AR 320-50.

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