OPERATION, PREVENTIVE MAINTENANCE, TROUBLESHOOTING AND SERVICE GUIDE

MODEL VT636-2 LONGWALL SHIELD MOVER

VERSATRAC®

NOTICE

THIS GUIDE CONTAINS IMPORTANT OPERATION AND SAFETY INFORMATION AND SHOULD BE KEPT AVAILABLE TO THOSE PERSONNEL INSTALLING AND OPERATING THIS EQUIPMENT.

P/N A6474X228
Revision 3, December 2007

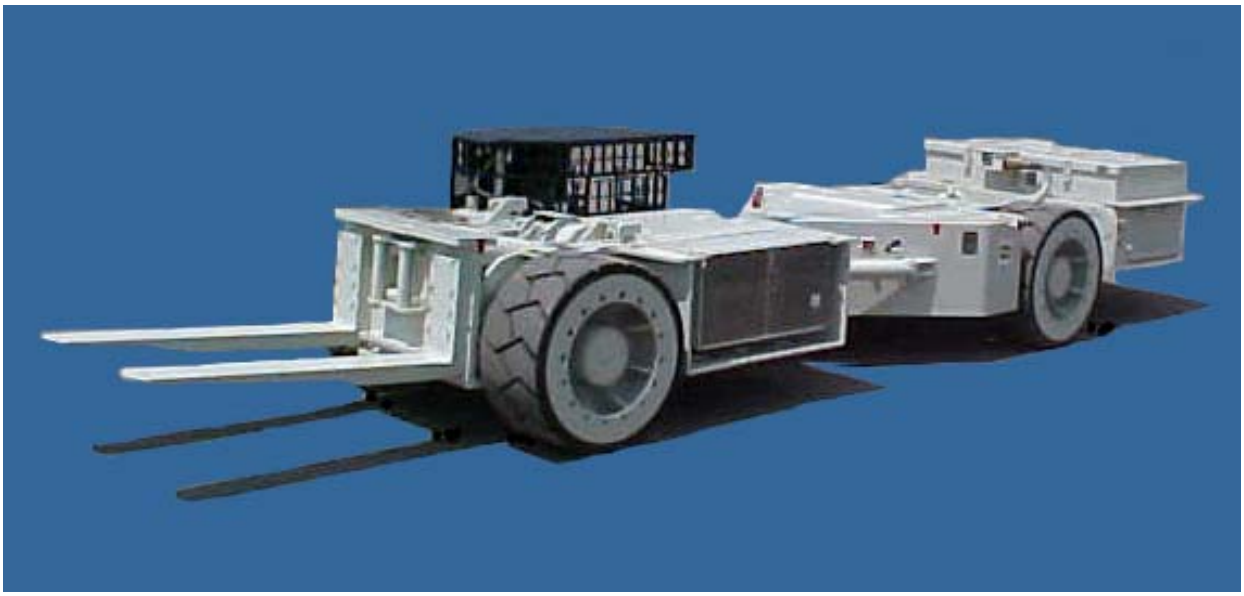
Bucyrus America, Inc.
4041 Wurno Road
Pulaski, VA 24301

Telephone: 540-980-4530
Fax: 540-994-3763

Internet: www.bucyrus.com

INTRODUCTION

FIGURE 1 – MODEL VT636-2 VERSATRAC®



The Bucyrus America Model VT636-2 VERSATRAC® can be one of the most useful and safe machines found underground today, IF IT IS OPERATED CORRECTLY BY A PROPERLY TRAINED OPERATOR.

Before operating the Model VT636-2 VERSATRAC®, study the illustration (Figure 2, page 9) to become familiar with the controls and read the description of each control. If a word is in quotation marks and capital letters, such as "OFF" or "ON," that word is found as a label on the VERSATRAC®.

DIF-LOK ACTUATOR (OPERATOR SELECT)

The operator controlled “DIF-LOK” actuator is a hand operated hydraulic push-button located to the right of the operator’s seat (Figure 2, page 9). When actuated, pushed in with the hand, the differential locks are engaged in both the front and rear axles. Releasing the push-button deactivates the differential lock.

WARNING

THE DIF-LOK (OPERATOR SELECT) SHOULD NOT BE ENGAGED DURING SPIN-OUT OR WHILE IN A TURN OR DAMAGE TO THE AXLE CAN OCCUR.

AUTOMATIC EMERGENCY/PARK BRAKE RELEASE HAND PUMP

The automatic emergency/park brake release hand pump is located to the operator's right (Figure 2, page 9). The release pump allows the automatic emergency/park brakes to be released for towing purposes when the machine is deenergized and normal brake release is not possible (see Towing Procedure, page 27).

To **release** the automatic emergency/park brake with the machine de-energized:

A. Turn the selector valve handle to "PUMP TO RELEASE".
B. Remove the pump handle retaining pin.
C. Pump the hand pump until the “EMERGENCY BRAKE" gauge reads the minimum l500 PSI.

To **reset** the emergency/park brake:

A. Turn the selector valve handle on the "EMERGENCY BRAKE RELEASE HAND PUMP" to the "NORMAL RE-APPLY" position.
B. Push the hand pump handle down and reinstall the retainer pin.

NOTICE

IF MACHINE IS EQUIPPED WITH OPTIONAL WET DISC AUTOMATIC PARK BRAKE, EMERGENCY BRAKE PRESSURE GAUGE INCREASES TO APPROXIMATELY 500 PSI.

WARNING

IF MACHINE IS EQUIPED WITH OPTIONAL WET DISC AUTOMATIC PARK BRAKE, THE "EMERGENCY BRAKE" PRESSURE GAUGE SHOULD NOT BE ALLOWED TO EXCEED 800 PSI OR DAMAGE TO WET DISC BRAKE CAN OCCUR. SHUTDOWN THE MODEL VT636-2 IMMEDIATELY (SEE SHUTDOWN PROCEDURE, PAGE 29) AND CALL A MAINTENANCE PERSON.

WARNING GONG

The warning gong (Figure 2, page 9), is located to the operator's right. It is sounded by striking the knob in the center of the gong. This warning gong should be used in accordance with the safety standards at the mine where the VERSATRAC® will be used.

THIS COMPLETES CONTROLS AND INDICATORS

FOR LONG DISTANCE TOWING, DISCONNECT AND REMOVE FRONT AND REAR DRIVE LINES.

AT NO TIME DURING TOWING SHOULD ANYONE RIDE IN OR ON THE VEHICLE BEING TOWED OR STAND IN BETWEEN THE TOWING VEHICLE AND THE DISABLED VEHICLE.

5. Begin towing the vehicle.

6. Once the destination is reached, stop both vehicles and set the parking brake on the disabled vehicle before removing the towing devices. The disabled vehicle should be choked in both directions at all four wheels for additional stability. The brake is "set' by turning the valve handle on the hand-pump to “NORMAL RE-APPLY”.

FAILURE TO SET THE PARKING BRAKE ON THE DISABLED VEHICLE BEFORE REMOVING THE TOWING DEVICE COULD ALLOW THE DISABLED VEHICLE TO ROLL AWAY UNCONTROLLED.

MAINTENANCE CAPACITIES AND SPECIFICATIONS

Drive System

Drive Motors:
Totally-enclosed, explosion-proof 128-volt, dual field, series wound, DC electric motor, coupled to a speed-reducing gear box.
Rating: 30 horsepower continuous
50 horsepower 1-hour rating

Motor Controller:
Solid state, stepless, speed control.
Rating: 1200 amps per motor
Current Limit is factory set and should be adjusted any time a drive motor, solid state panel, or logic card is changed.

Drive Axles:
Rigidly mounted planetary axles equipped with hydraulically power-applied, shaft speed, wet-disc brakes and optional operator selected differential lock.
Weight: 2085 lbs dry
2157 lbs wet

Drivelines:
72N Series

Hydraulic System

Pump Motor:
128-volt, totally-enclosed, fan-cooled, explosion-proof motor.
Rating: 10 horsepower continuous
15.8 horsepower 1 - hour rating

Hydraulic Pump:
Single section gear pump 1 1/2" gear width
Rating: 20 GPM
Maximum System Pressure: 2500 PSI

Filtration:
Suction to Pump: 100-mesh strainer inside hydraulic oil tank.
Pressure Filter (Between pump and relief valve) 25 micron cartridge-type.
Return Line Filter (Located in top of oil tank) 25 micron cartridge-type.
Strainer screens inside brake solenoid valve and accumulator charging valve.

Hydraulic System Pressures:

Main Hydraulic System Relief	2250 PSI (Max)
Steering Relief (dual, each direction)	1600 PSI (Max)

ONCE PER MONTH

1. Check the oil level in the two (2) axles (Figures 34, 35, 36 and 37) (for oil specifications, see page 40).

THE AXLE HOUSING, PLANETARY WHEEL ENDS, AND BRAKE ASSEMBLIES DO NOT HAVE A COMMON OIL/COOLANT LEVEL. THE BEST MEANS TO FILL WITH OIL IS ACCOMPLISHED BY FILLING THROUGH EACH WHEEL END, (FIGURES 35 AND 37), EACH BRAKE ASSEMBLY (FIGURE 38), AND THE HOUSING OR DRIVE UNIT (FIGURES 34 AND 37).

MAKE SURE THE LEVEL AND FILL HOLES IN THE PLANETARY WHEEL END COVERS ARE IN THE PROPER POSITION. REFER TO THE INFORMATION CAST INTO THE COVERS AND ROTATE THE WHEEL END AS REQUIRED.

WHEN FILLING THE AXLE HOUSING, PLANETARY WHEEL ENDS OR BRAKES ALLOW ENOUGH TIME FOR THE LUBRICANT TO FLOW THROUGH THE VARIOUS CAVITIES AND AROUND COMPONENT PARTS IN EACH ASSEMBLY.

FIGURE 34 – AXLE HOUSING (REAR AXLE)

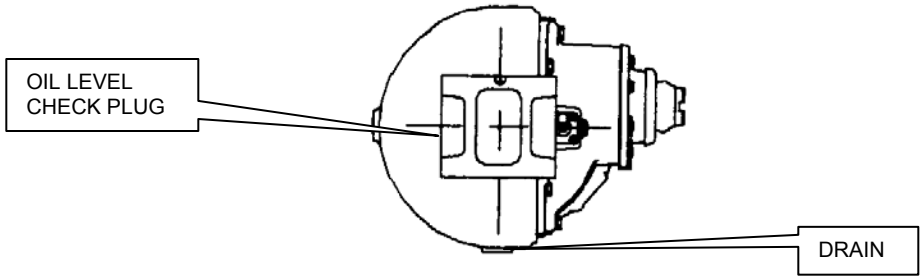


FIGURE 35 – WHEEL END (REAR AXLE)

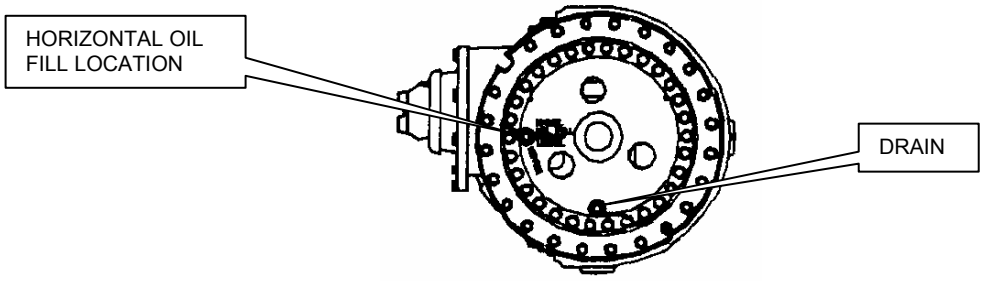
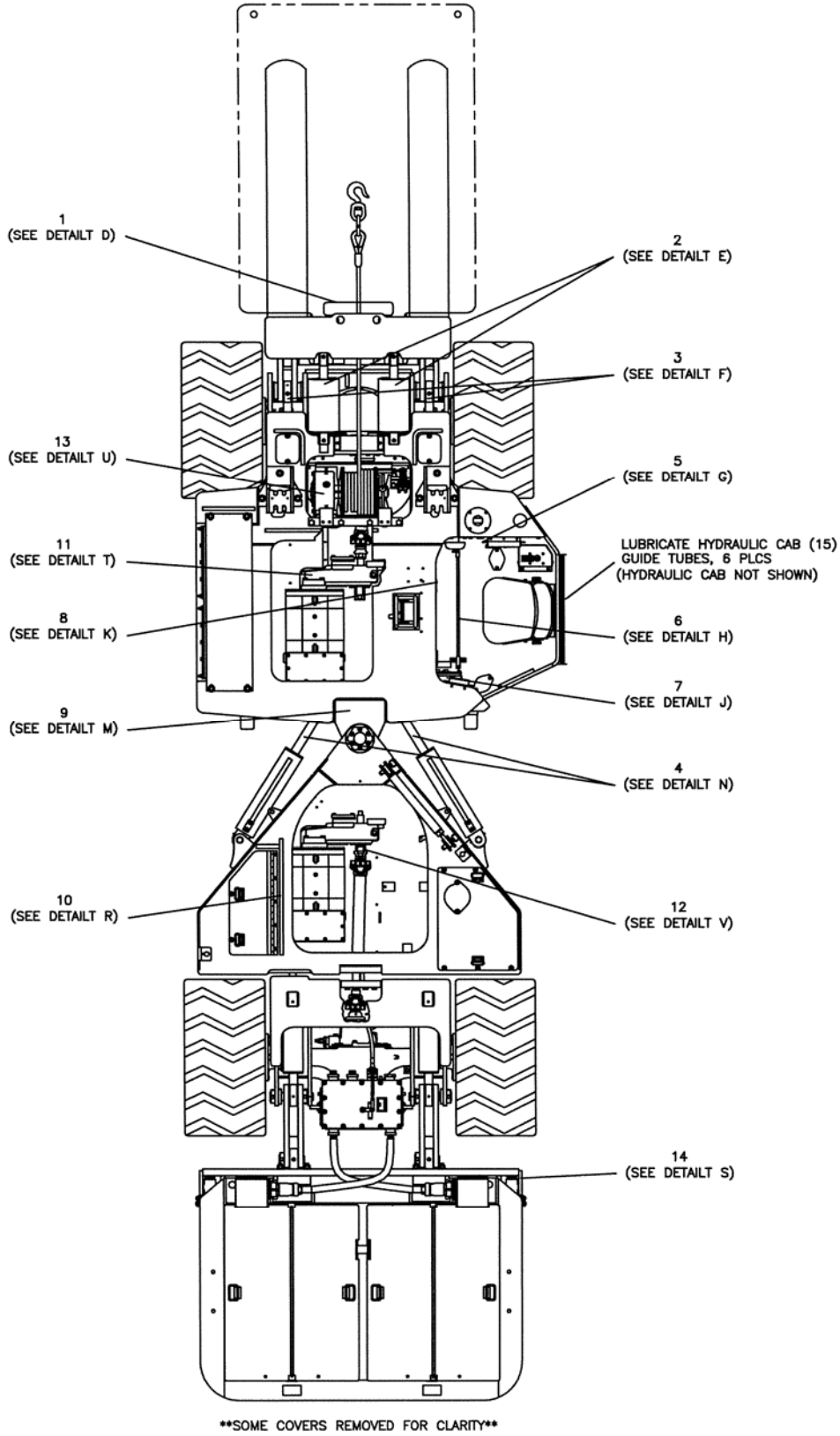


FIGURE 44 – LUBRICATION CHART (SHEET 1)



TROUBLE, SYMPTOM OR CONDITION	PROBABLE CAUSE	TEST, CHECK AND/OR REMEDY
ACCUMULATOR CHARGING TIME TOO LONG	1. No oil or low oil level in tank. 2. Relief valve setting too low. 3. Pump worn or defective and not delivering full flow or pressure. 4. Defective charging valve.	1. Check oil level. 2. Check valve setting. 3. Check pump. 4. Remove charging valve.
ACCUMULATOR FAILS TO START CHARGING	1. No oil or low oil level in tank. 2. Worn or defective pump. 3. Defective relief valve. 4. Defective charging valve.	1. Check oil level. 2. Check pump pressure and flow. 3. Check relief valve setting. 4. Replace charging valve.
VERY RAPID CYCLING OF CHARGING VALVE	1. Accumulator gas charge too low. 2. Accumulator gas charge too high. 3. No gas charge in accumulator. 4. Defective charging valve.	1. Check gas charge. 2. Check gas charge. 3. Check gas charge. 4. Replace charging valve.

CONTACTOR TIP REPLACEMENT

BEFORE REMOVING THE CONTROLLER COVER, REMOVE POWER FROM THE SYSTEM BY UNPLUGGING THE BATTERY. WHEN THE COVER IS REMOVED, WAIT ONE MINUTE FOR THE CAPACITORS TO FULLY DISCHARGE BEFORE WORKING INSIDE THE CONTROLLER.

1. Insure electrical power is off and capacitors are discharged (See page 65).

2. Change the stationary contactor tips (Figure 48 below):

   A. Remove the bolt that holds the old tip in place and remove the old tip.
   B. Position the new tip in place and replace the bolt. Check the placement of the tip to insure that it is correctly positioned and the bolt is tight.
   C. Repeat for all stationary tips.

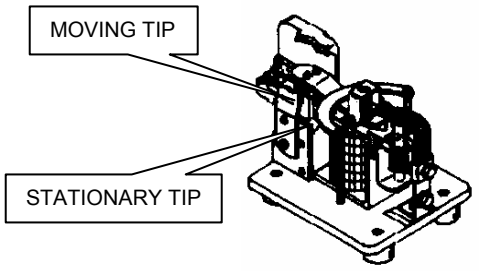
THE BOLTS USED TO FASTEN THE STATIONARY CONTACTOR TIPS IN PLACE ARE SPECIALLY SIZED TO PREVENT THE CONTACTOR TIP FROM GROUNDING TO THE CONTACTOR COIL. IF REPLACEMENT BECOMES NECESSARY, IT IS IMPORTANT TO USE BOLTS AND WASHERS IDENTICAL TO THE ORIGINAL ONES. ALL CONNECTIONS MUST BE TIGHT BEFORE THE UNIT IS PUT BACK INTO SERVICE.

3. Check for grounding between the stationary tips and either terminal of the contactor coil by using a volt/ohm meter set on R x 1. Correct any shorts if found.

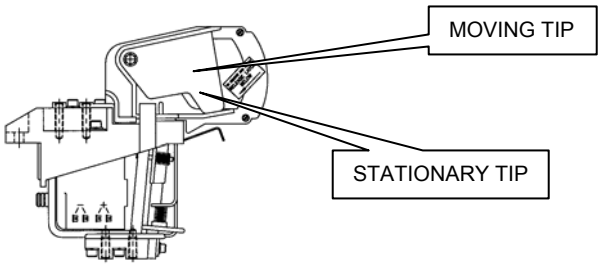
4. Change the moving contactor tips (Figure 48 below).

   A. Remove the two (2) nuts that secure the tip and remove the old tip.
   B. Position the new tip and secure with new nuts. Check the placement of the tip to insure that it is correctly positioned and the nuts are tight.
   C. Repeat for all moving tips.

FIGURE 48 – CONTACTOR TIP INSPECTION AND REPLACEMENT

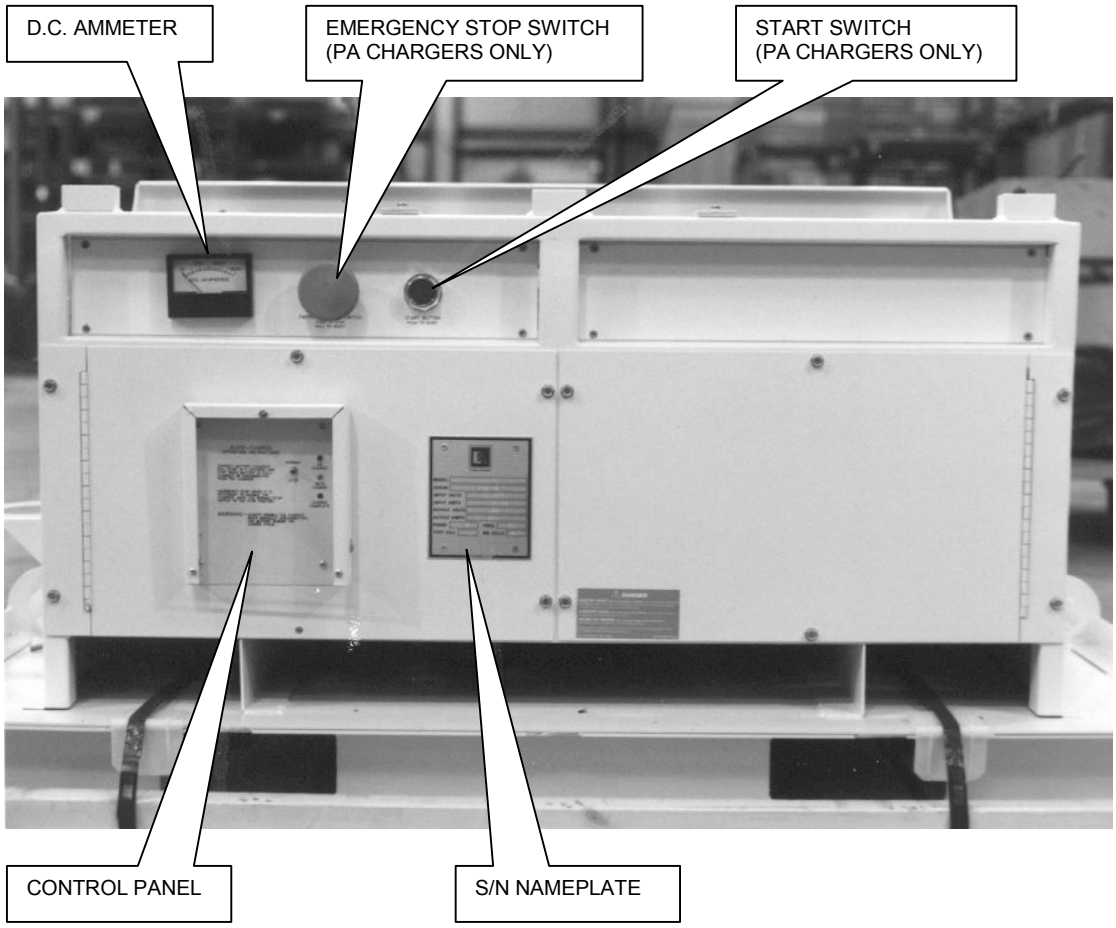


PUMP CONTACTOR



MAIN CONTACTOR

FIGURE 2 – CHARGER CONTROLS



491868X8 LA-12 Battery Charger 480/575 Volt, 60 HZ (Pa Kit)

REFERENCE	QUANTITY	PART NUMBER	DESCRIPTION
1	2	491868X560	HEATSINK MTG. BRKT. (TOP LEFT)
2	2	491868X541	HEATSINK MTG. BRKT. (TOP RIGHT)
3	2	491868X559	HEATSINK MTG. BRKT. (BOTTOM)
4			
5	1	491868X539	WIRE HARNESS, TIMER BOARD
6	1	491868X540	CONTROL TRANSFORMER (CT)
7	1	491868X506	AUTOMATIC TIMER BOARD
*8			
*9	1	491868X508	POS. DC OUTPUT TERM. (BLK)
10			
11	12	491868X510	CAPACITOR BRACKET, 5.75” HIGH
12	1	491868X511	SECONDARY FUSE BLOCK
*13	1	491868X512	TERMINATION BASE COMPONENT
*14	4	491868X513	THREADED INSULATOR
15	3	491868X561	POWER TRANSFORMER ASSY. LA12 (PT)
*16	4	491868X515	SURGE PROTECTOR ASSY. (SP)
17	1	491868X563	HEATSINK PLATE, 25 X 8 X 1/8
18	3	491868X564	EXTRUDED ALUM HEATSINK
19	1	491868X518	FUSE BLOCK, THREE POLE (AC)
20	1	491868X519	FUSE (C), 3 AMP - 600V (CTF)
21	3	491868X565	FUSE (B), 80 AMP - 600V (AC)
22	3	491868X521	FUSE (AT), 200 AMP - 130V (DCF)
23	6	491868X566	CAPACITOR BRKT., 1.91 X 2.91
*24	1	491868X523	ACF BLACK MOUNT BRKT. 26F - AG
25	6	491868X524	CAPACITOR, 660V - 30MFD (C3)
26	6	491868X567	CAPACITOR, 660V - 6MFD (C2)
*27	1	491868X526	AMMETER SHUNT, 300 AMP - 100MV (S)
28	1	491868X527	DC AMMETER, 0 - 300 AMP (A)
29	6	491868X528	SILICONE DIODE, 150 AMP - 1KV (SD)
*30	1	491868X529	CONTACTOR, 3P - 115VAC (AK)
31	1	491868X530	COPPER BUSS, (DC FUSE BLOCK)
*32	1	491868X531	CONTACTOR COIL
33	1	491868X532	CHARGER BASE
34	1	491868X533	CHARGER DOOR LEFT
35	1	491868X534	CHARGER DOOR RIGHT
*36	1	491868X535	PLEXIGLASS
37	1	491868X536	DISPLAY GUARD
38	1	491868X537	GUARD BRACKET
39	1	491868X538	TOP COVER
40			
41			
42	1	491868X543	CT. MOUNTING BRACKET
*43	4	491868X544	WEATHERPROOF SWITCH CAP
44	1	491868X545	EMERGENCY STOP SWITCH (ESS)
45	1	491868X546	START SWITCH (SB)
*46	1	491868X547	MTG. BRKT. GRND INTEGRITY CIRCUIT
*47	2	491868X548	CASE SWITCH MTG. BRKT.
*48	4	491868X549	P.B. SWITCH SPDT MOMENT (CDS DDS)
*49	1	491868X550	HEX STANDOFF/ALUM PLATE
*50	1	491868X551	RESISTOR, 2000 OHM VAR, 10W (RD1)
*51	1	491868X552	RESISTOR, 5 OHM VAR 100W (RD3)
*52	1	491868X553	BARRIER TERMINAL STRIP
*53	1	491868X554	BARRIER TERMINAL STRIP 2PT
*54	1	491868X555	FWB RECTIFIER 400V, 10 AMP (FWB)
*55	1	491868X556	RELAY, 12VDC (GCR1)
*56	1	491868X557	RELAY, 110VDC (CR1)
*57	1	491868X558	SILICON DIODE 1A 800V (SD5)

* INDICATES PARTS NOT SHOWN.

WIRING DIAGRAM 491736X1

NOTE: SEE FORM NO. E-004 FOR ASSEMBLY DRAWING.

FIGURE 3B – BATTERY CHARGER ASSEMBLY (FORM NO. E-004)

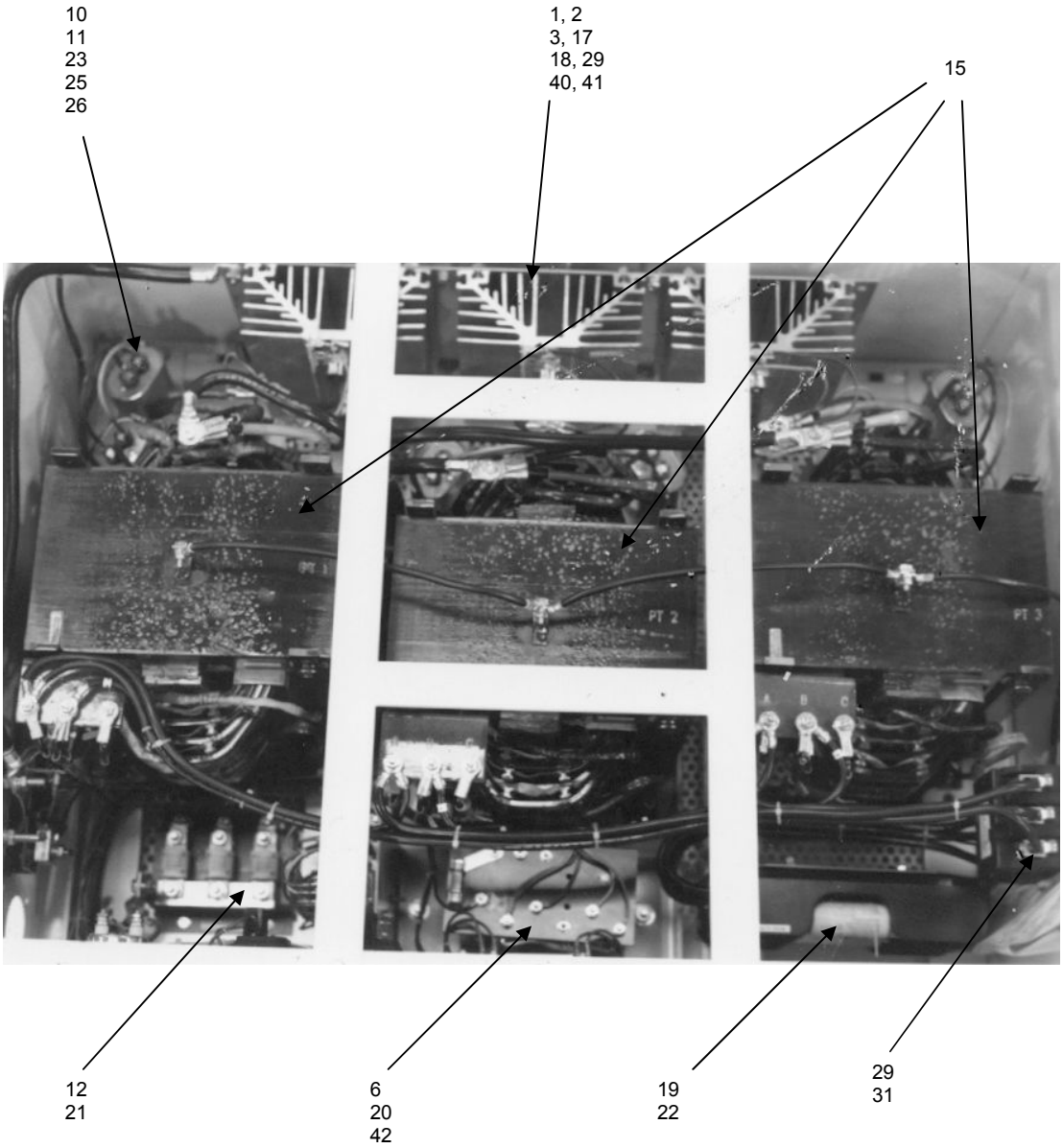


FIGURE 8A – 5-POLE BRASS RECEPTACLE ASSEMBLY (A14161 Sheet 1 of 2)

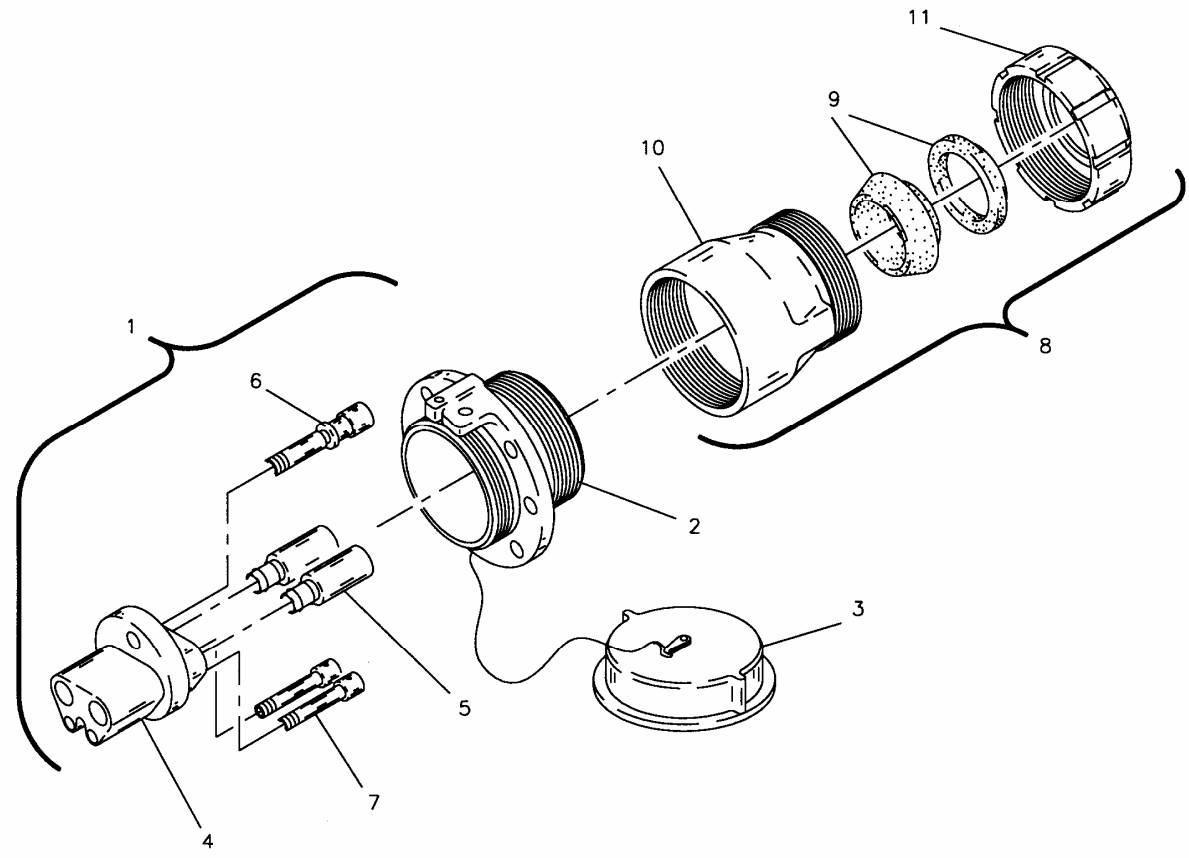


FIGURE 17 – ALUMINUM PLUG ADAPTORS (A15056)

LONG AIRDOX PART NUMBER	GROMMET SIZE				WITH OR WITHOUT HOSETUBE
ALUMIUM	HOLE 1	HOLE 2	HOLE 3	HOLE 4	
A15056X1	1.440	-	-	-	WITH
A15056X2	1.275	-	-	-	WITH
A15056X3	.73 X 1.35	-	-	-	WITH
A15056X4	1.520	-	-	-	WITH
A15056X6	.73 X 1.35	-	-	-	WITHOUT
A15056X7	1.520	-	-	-	WITHOUT
A15056X8	ORDER GROMMET SEPARATELY				WITH
A15056X9	ORDER GROMMET SEPARATELY				WITHOUT

NOTES:
THESE PLUG ADAPTORS ARE USED WITH A15054(BRWASS W/ALUM.), A14914 (BRASS) AND A15054X1 (BRASS W/ALUM. LOCK RING & PULL HANDLE) BATTERY PLUGS

REFER TO GROMMET CHART A15058 TO ORDER GROMMET.

MAJOR HAZARDS

AREA WHERE HAZARD CAN OCCUR	HAZARD WHAT CAN HAPPEN IF PRECAUTIONS AND SAFEGUARDS ARE NOT OBEYED	SAFEGUARDS HOW TO AVOID THE HAZARD
MOTORS AND CONTROLLER	Electrical shock could cause irreparable injury or death.	All electrical systems should be maintained by certified electricians. The battery should be disconnected before servicing the motors or controller. When the controller cover is removed, wait for one minute for the capacitors to discharge.
BATTERY	The battery produces lethal amounts of power whether connected to the machine or charger, or not.	The battery should be maintained by qualified personnel. (Refer to Bucyrus America, Inc. "INSTALLATION, USE, MAINTENANCE, AND REPAIR OF MINE POWER STORAGE BATTERIES," PART NUMBER A6474X26, for complete instructions).
	Battery covers could fall crushing hands or arms.	Be sure cover supports are in place when working on battery.
	Battery hold-down clamps could crush fingers or hands.	Keep fingers and hands away from hold-down clamps.
	Batteries produce explosive gases that could be ignited causing burns or explosions.	Batteries should be well vented before servicing particularly if welding or burning on the battery. Batteries should be maintained by qualified personnel.
	Batteries contain strong acid that could cause severe burns if spilled or splashed on body parts or in the eyes.	Protective clothing, gloves, and eyewear must be worn when working on batteries. Batteries should be maintained by qualified personnel.

Configuration Jumper Table

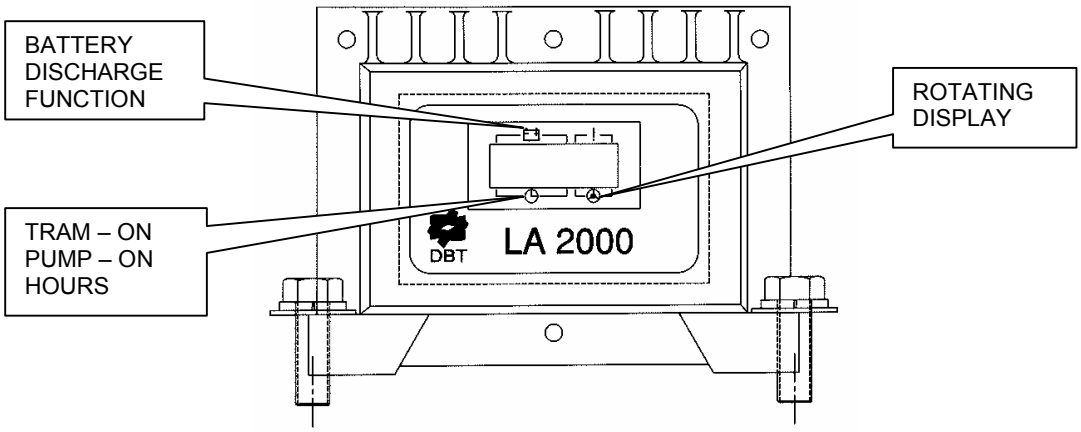
MAX. CURRENT CONFIG. LOGIC PIN 12	VEHICLE TYPE
OPEN	SINGLE MOTOR – 1200 AMP
GROUND (CLOSED)	SINGLE MOTOR – 1100 AMP
OPEN	DUAL MOTORS 1100 AMP PER MOTOR – ADJUSTABLE TO 1200 AMP
GROUND (CLOSED)	DUAL MOTORS 800 AMP PER MOTOR

OPTIONAL DASHBOARD DISPLAY FEATURES (See Figure 9)

- A battery discharge indicator
- An hour meter displaying tram-on hours
- An hour meter displaying pump-on hours
- A rotating display showing:

1. Battery voltage
2. Pump motor current
3. Diagnostic fault status, when applicable. Rotating display will lock on one of the following fault messages: (See Fault Message Chart, page 19)

FIGURE 9 – OPTIONAL DASHBOARD DISPLAY

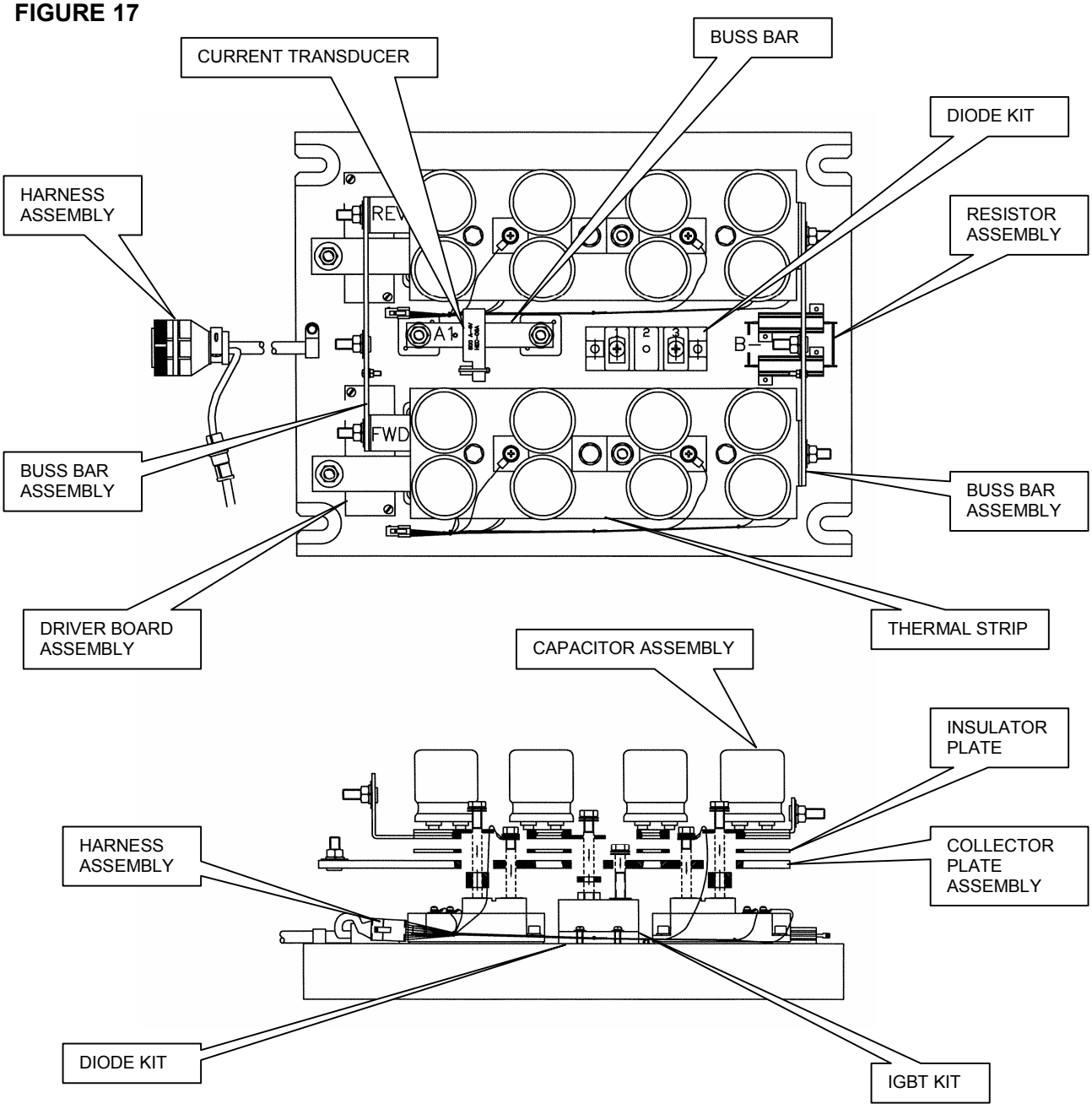


Error Code Legend (Status Display)

ERROR CODE	DESCRIPTION
0	No Fault
1	Caps failed to change after power-up Check for shorted cap
2	Single Motor Block “0” Point “A” short Shorted IGBT or short between motor and ground
3	Dual Motor Block “0” Point “A” short Shorted Right IGBT or short between motor and ground
4	Dual Motor Block “0” Point “A” short Shorted Left IGBT or short between motor and ground
5	Vehicle configuration ID invalid
6	Diagnostic Point “A” trip failed to disable UVR Coil Replace logic assembly
7	Diagnostic Right FWD Point “A” trip failed to disable Replace logic assembly
8	Single Motor Point “A” trip failed to disable FWD IGBT Replace logic assembly
9	Diagnostic Right REV Point “A” trip failed to disable Replace logic assembly
10	Single Motor Diagnostic REV Point “A” trip failed to disable Replace logic assembly
11	Diagnostic Left FWD Point “A” trip failed to disable Replace logic assembly
12	Diagnostic Left REV Point “A” trip failed to disable Replace logic assembly
13	Diagnostic test to enable UVR Coil driver failed Fault in logic assembly or faulty UVR Coil
14	Diagnostic Right FWD Point “A” trip failed Replace logic assembly
15	Single motor diagnostic FWD Point “A” trip failed Replace logic assembly
16	Diagnostic Right REV Point “A” trip failed Replace logic assembly
17	Single motor diagnostic FWD Point “A” trip failed Replace logic assembly
18	Diagnostic Left FWD Point “A” trip failed Replace logic assembly
19	Diagnostic Left REV Point “A” trip failed Replace logic assembly
20	Breaker welded fault
21	Internal error (Software Only) Replace logic assembly

IGBT Single Motor Panel

FIGURE 17



CHAPTER 1 - INTRODUCTION

Section I. General

1-1. Scope

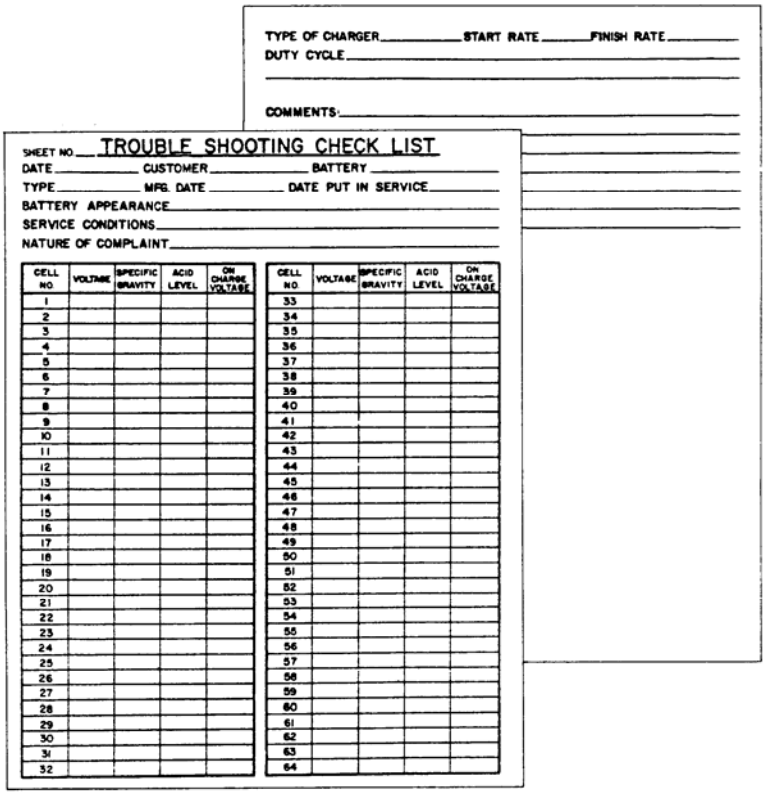
This guide contains information concerning the theory, construction, installation, use, maintenance, repair, and hazards of lead-acid storage batteries used to power mine tractors, scoops, locomotives, and coal haulers.

1-2. Forms, Records and Reports

The following form will be used by personnel responsible for the receipt, storage, operation, charging, and maintenance of lead-acid storage batteries.

a. Monthly Storage Battery Record - The Monthly Storage Battery Record is to be used to record the services performed on motive power batteries. This record should be prepared and maintained by the using operator and should accompany the battery at all times. (See Figure 1 for a typical "Monthly Storage Battery Report" form.)

FIGURE 1 – MONTHLY STORAGE BATTERY RECORD



TYPE OF CHARGER _____ START RATE _____ FINISH RATE _____
DUTY CYCLE _____

COMMENTS: _____

SHEET NO. __ TROUBLE SHOOTING CHECK LIST
DATE _____ CUSTOMER _____ BATTERY _____
TYPE _____ MFG. DATE _____ DATE PUT IN SERVICE _____
BATTERY APPEARANCE _____
SERVICE CONDITIONS _____
NATURE OF COMPLAINT _____

CELL NO.	VOLTAGE	SPECIFIC GRAVITY	ACID LEVEL	ON CHARGE VOLTAGE
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				

CELL NO.	VOLTAGE	SPECIFIC GRAVITY	ACID LEVEL	ON CHARGE VOLTAGE
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				

2. Remove vent caps and check the electrolyte level in each cell. Take and record the specific gravity reading, electrolyte temperature, and individual open circuit voltage of each cell. Note any irregularities.

3. Check to make sure that all cells are properly connected and that terminal connections are tight. If there are irregularities in the electrolyte levels or specific gravity readings, or if the battery has been in storage for more than 30 days, it should be given a freshening charge (see Paragraph 2-10d).

4. Recheck electrolyte levels after charging and after gassing has stopped. Again take and record specific gravity readings and electrolyte temperatures. If irregularities in electrolyte specific gravity readings still exist, they should be adjusted as described in Paragraph 3-12.

2-5. General

Economical and dependable performance from a storage battery depends, to a great extent, upon proper charging. Faulty charging causes a decrease in battery service life and dissatisfaction with its performance. The selection of suitable charging equipment and methods is as important as the application of the correct battery. A mine battery installation is completely satisfactory only when the unit, battery, and charger operate as a smoothly functioning team. **This text on chargers is for general information and guidance only.** If specific data is required on a particular type of charger, contact the nearest sales representative.

When preparing a battery to be charged, make certain that all points of contact between the charger and the battery are clean to assure good conductivity. Also make certain that the positive terminal of the battery is connected to the positive terminal of the charger and, correspondingly, negative of battery to negative of charger.

PERMANENT DAMAGE TO THE BATTERY OR CHARGER MAY RESULT IF THE BATTERY IS CONNECTED INCORRECTLY.

2-6. Charging Principles

Charging, as applied to a storage battery, is the conversion of electrical energy into chemical energy within the cell or battery. This restores the active materials and is accomplished by maintaining a unidirectional current to the battery in the opposite direction to that during discharge. When a cell or battery is said to be charged it is understood to mean fully charged. The type of battery, service condition, time available for charging, and the variation in battery voltages will strongly influence which charging method is best for a particular situation. Normally lead-acid batteries are recharged in 8 hours following a full discharge. However, they can be recharged within other time periods when desirable. A deeply discharged battery will absorb high current rates when the voltage is low. As the charge progresses, the voltage steadily increases until it reaches gassing voltage, approximately 2.37 volts per cell at 77 degrees F. At this point, battery chargers normally reduce charging rates automatically and taper to finishing rates which are used to complete the charge. The battery is fully charged when nearly all of the active material has been converted and when the specific gravity of the electrolyte and cell voltage have reached their maximum or constant values (corrected for temperature), as indicated by similar readings over a two or three hour period.

Batteries used in mine power applications are cycled - they are either being charged or discharged. In most circumstances, batteries are charged after each shift of use, so they are cycled many times during their lifetime. Incorrect charging for only a few cycles will do little harm, but if repeated day after day, the battery's service life will be seriously shortened.

TABLE 5		
STORAGE BATTERY TROUBLESHOOTING CHART		
SYMPTOMS	**PROBABLE CAUSE**	**POSSIBLE REMEDY**
BATTERY OVERHEATS DURING CHARGE	1. Malfunctioning charging equipment.	1. Replace or repair defective charger parts (timer, voltage sensitive relay, control board, etc.)
	2. Charging equipment out of adjustment.	2. Adjust start or finish charging rates.
	3. Defective or weak cell(s).	3. Replace or repair problem cell(s).
	4. Battery worn out and beyond economical repair.	4. Replace battery.
	5. High resistance connection within battery.	5. Check for hot wires, cells, intercell connectors, charging plugs, etc. Repair or replace defective component(s).
	6. Low electrolyte level.	6. Add water; Just cover separator protector when discharged.
	7.Battery charged in the vehicle with battery compartment closed or the tray cover closed.	7. Open the compartment during charge or charge the battery out of the unit with the tray cover opened.
	8. Battery over 100 degrees F. when placed on charge.	8. Allow battery to cool below 90 degrees F. before charging.
BATTERY OVERHEATS DURING DISCHARGE	1. See causes 3 through 8 above.	1. See remedies 3 through 8 above.
	2. Worn out bearings, brakes dragging, or other vehicle problem causing high current draw.	2. Repair or replace defective unit problems.
	3. Over discharge of battery.	3. a. Require drivers to return battery for recharge when vehicle begins to slow down. b. Put more batteries into service.