



A6474X285
March 2012

Operation and Maintenance Manual

SH650 (China) Shield Hauler

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Characters and symbols used

The following characters and symbols are used for safety instructions and important information in the operating manual.

Try to memorize the symbols and their meanings.

DANGER!

Points in the text marked with this symbol draw your attention to immediately impending danger. Possible consequences are: very serious injury or even death.

WARNING!

These points contain information on dangerous situations. Possible consequences are: very serious injury or even death.

CAUTION!

This symbol draws attention to dangerous situations. Possible consequences are: light to moderately serious injuries and machine damage.

NOTICE!

Points in the text marked with this symbol draw attention to harmful situations. Possible consequences are: damage to the machine or damage in the immediate vicinity.



IMPORTANT!

Points in the text marked with this symbol contain useful tips and information intended to facilitate work for you. They do not warn about harmful or dangerous situations.

- Items in lists are marked with bullets.
 - Points in sub-lists are marked with a long dash at the start of the line.
- ☞ Points in text marked in this way describe individual operations. Follow these instructions step by step. They will help you carry out your work faster and more importantly, safer.

Installation and start-up

inclined face	On inclined faces secure all component parts by chains, e.g. to the support.
environmental acceptability	<p>When working with oils, greases and other chemical substances, observe the safety regulations applicable to the product.</p> <p>Dispose of cleaning rags, etc. which have been soiled with oil, grease or other chemical substances in an environmentally safe manner.</p>
controls	When starting up machine, do not operate any controls located inside the operator's compartment from outside the compartment.
starting procedures	Follow the starting procedure instructions in chapter 5 of this manual.
hazard zone	Do not operate any levers, pedals or controls if anyone is in the hazard zone. (See Hazard zone in Chapter 5 of this manual)

Operation

training	Operate the machine only if you have a profound knowledge of the control elements and their functions. It is necessary that you have been task trained on the respective machine.
before start-up	Before start-up, ensure that there are no persons or obstructions in your line of travel or in the articulation area when steering the unit.
protective devices	Check that all protective devices are installed on the machine and function properly.
operator's compartment	<p>Clean the operator's compartment at regular intervals. Ensure that the operating symbols are legible in order to avoid any operator errors and resulting accidents.</p> <p>Never climb onto, or climb out of the machine while it is in motion.</p> <p>Do not operate the machine with any part of your body outside of the operator's compartment in order to prevent body parts from being crushed between the machine and outside objects .</p>
traveling	Use extreme caution when traveling in close quarters or in congested or blind-travel areas. The warning gong should be sounded to alert personnel of your movement.
passengers	Never carry passengers to prevent the passengers from being thrown off or crushed between the machine and outside objects.
safety rules	Always follow all safety rules of each particular mine when operating the machine.
problems and malfunctions	If problems or malfunctions are encountered while operating the unit, it must be properly shutdown and the problem corrected immediately.

Before transport

temperatures below freezing

Before transporting the equipment at temperatures below freezing, all hydraulic components operated with emulsion (HF AE or HF AS) must be completely drained and then filled with a corrosion inhibitor/frost-proofing fluid (e.g. CV 50).

Transport of equipment at temperatures between -6° F (-21° C) and 40° F (-40° C) is only permissible when certain measures were taken to meet these conditions at the design and manufacture stages. Nevertheless, the individual parts and devices of this equipment must not be subjected to sudden impact loads at such low temperatures and may only be loaded statically or quasi-statically.

During transport of this equipment with floor-mounted vehicles at such low temperatures, measures must also be taken to ensure that the parts and devices are not subjected to sudden impact loads. At very low temperatures and on poor roads, the transport vehicle speed must therefore be limited to a maximum of 15 mph (25 kph) for truck transport.

electronic components

Electrical and electronic components must be removed for overseas transport or prolonged storage outdoors unless these components or the complete equipment is protected against harmful environmental influences by a suitable packaging.

The electrical cables remain in the equipment. They must be carefully protected against transport damage and soiling of the connections.

5

Operation

“GLBC/OPT.” control

The "GLBC/OPT." control lever located to the operator's left (Fig. 14) controls the battery changing system, which is made up of two hydraulic cylinders (battery lifting cylinders), one on each side of the battery. When the "BATTERY CHANGER" control lever is lifted by the operator, the battery-lifting cylinders will raise the battery. Lowering the handle will lower the battery. The battery can be lowered to the ground for battery change without tables or pedestals or raised to increase ground clearance. The control lever can also be used to control other options that can be added to the machine. The "OPTION/GLBC LIFT" diversion valve located to the operator's right must be rotated to the correct position before operating the "GLBC/OPT." control lever.

CAUTION!

For more information on how to change the battery, see Battery change procedure in this chapter. If the machine is in a low roof area, the battery may be damaged if raised too high or damaged if lowered to the ground.

WARNING!

Never attempt to disconnect a hydraulic hose from the battery lifting cylinders with the battery in the "UP" position. If maintenance is required in the "UP" position always securely block the lift mechanism. Never allow any part of the body to be under the battery in the raised position. The battery could fall and result in injury or death.

“PTO/CAB” control lever

The "PTO/CAB" control lever located to the operator's left (Fig. 16) controls the hydraulic "PTO" and "CAB". The "PTO/CAB" diversion valve located to the operator's right must be rotated to the correct position before operating the "GLBC/OPT." control lever. When the "PTO" control lever is lifted by the operator, the "B" port is pressurized. Lowering the handle pressurize the "A" port. When the "CAB" control lever is lifted by the operator, the hydraulic cab will raise. Lowering the handle lowers the hydraulic cab.

CAUTION!

Do not operate the "PTO" system continuously for more than 30 minutes at a time.

Never block or tie the "PTO" function to active position.

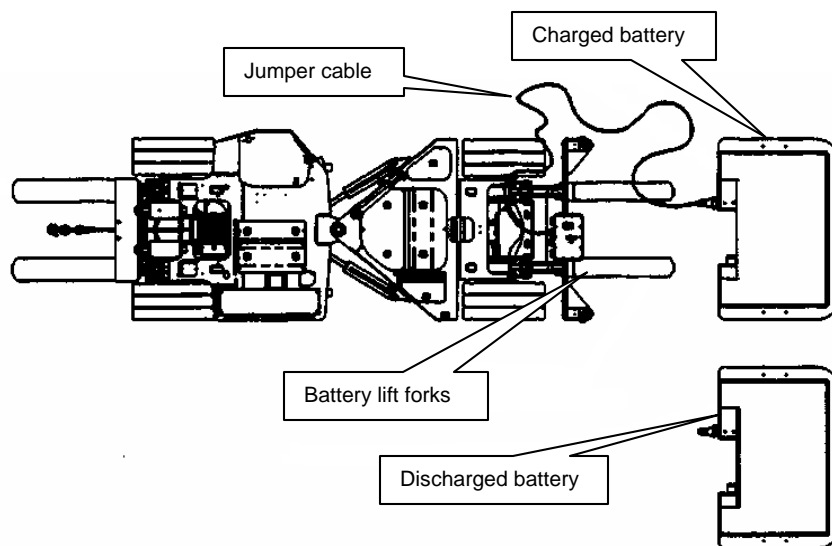
WARNING!

The machine is equipped with a solid state speed controller. This means that the farther the speed switch foot pedal is depressed, the faster the machine will tram.

- ☞ 15. To change direction of travel, press "J2" and hold, then press either "J9" or "J10" and hold until the dashboard display indicates direction of travel. Then release "J9" or "J10" depending on direction selected and then release "J2".
- ☞ 16. Each time the direction of travel is changed, the foot pedal will require recycling through the off position.
- ☞ 17. To disable tramping, press "J9" or "J10".
- ☞ 18. To leave pump motor running, set park brake, and disable tramping, press "J8".
- ☞ 19. To disable tramping, turn off the pump motor and set the park brake, press "J3" or "J7".
- ☞ 20. "J12" traction assist is unavailable on the model SH650 machine.
- ☞ 21. Press "J4" then release "J4" for ⇐ direction lights.
- ☞ 22. Press "J6" then release "J6" for ⇒ direction lights.
- ☞ 23. For auto position headlights, whereas the headlights follow the direction of the selected tram direction, press "J2" and hold, press "J4" release "J4", then release "J2". Lights will stay in auto position until "J3", "J4" or "J6" is pressed.
- ☞ 24. To turn off all lights, press "J4" and "J6" simultaneously and then release both "J4" and "J6" simultaneously.
- ☞ 25. If equipped for all position headlights, whereas all headlights, front and rear are on, press "J2" and hold, press "J6", release "J6", then release "J2". Lights will stay in all position until "J3", "J4" or "J6" is pressed.

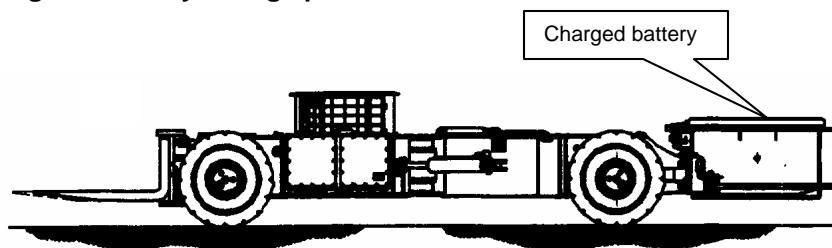
- ☞ Start the machine (see Starting procedure in this chapter). Gently pull away from the discharged battery while the second person holds the jumper cable away from possible damage.
- ☞ Line the machine up with the fully charged battery. Move the machine back until the battery lift forks are fully inserted into the pockets provided on the battery (Fig. 28).

Fig. 28: Battery change procedure



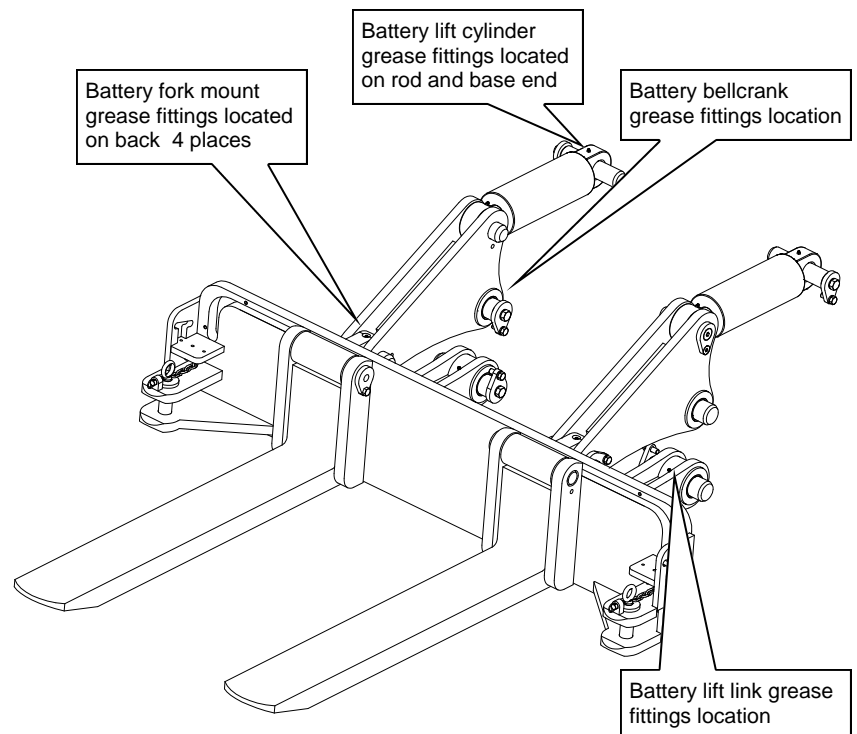
- ☞ Shutdown the machine (see Shutdown procedure in this chapter). Re-insert the retainer pins on both sides of the battery along with their corresponding detent pins (Fig. 25).
- ☞ Disconnect the jumper cable and connect the charged battery directly to the machine's cable. Remember to be careful with the plugs. After the plug (s) is in the receptacles, the lock ring should be rotated clockwise (CW) until hand tight. The padlock must be in the locking lug and locked for this connection to be permissible.
- ☞ Start the machine (see Starting procedure in this chapter).
- ☞ Raise the battery by pulling the "BATTERY" change control lever upward. Continue to hold the battery change control lever in this position until the battery is no longer resting on the surface (Fig. 29).

Fig. 29: Battery change procedure



- battery lift cylinders** Lubricate the battery lift cylinders (4 places) with Spec. 100-3 through the grease fittings located on the rod and base end of each cylinder (Fig. 35). Pump grease into the fittings until new grease can be observed coming out of the pins.
- battery fork mount** Lubricate the battery fork mount (4 places) with Spec. 100-3 through the grease fittings located on the four (4) pivot lugs (Fig. 35). Pump grease into the fittings until new grease can be observed coming out of the pins.
- battery lift bellcrank (s)** Lubricate the battery lift bellcrank (s) (2 places) with Spec. 100-3 through the grease fittings located on the back of each bellcrank (Fig. 35). Pump grease into the fittings until new grease can be observed coming out of the pins.
- battery lift link** Lubricate the battery lift link (2 places) with Spec. 100-3 through the grease fittings located on each side of the lift link (Fig. 35). Pump grease into the fittings until new grease can be observed coming out of the pins.

Fig. 35: Battery lift lubrication points

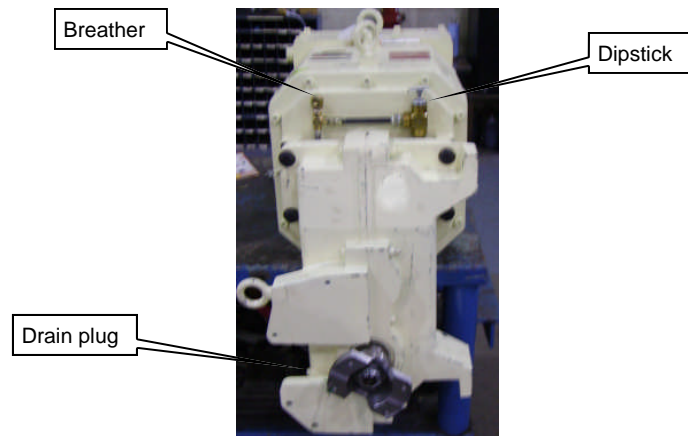


speed reducer (gear case) oil

Check the oil in both speed reducers (Fig. 50).

- ☞ Park the machine on solid level ground, clean dirt and debris from around the dipstick.
- ☞ Remove the dipstick from gear case and wipe clean. Insert dipstick back into gear case and remove. The oil should be level with the full line indicated on dipstick.
- ☞ Should it be necessary to add oil, clean dirt and debris from around the fill fitting and remove fitting.
- ☞ Should it be necessary to add oil. Add oil (Spec. 100-6) through the dipstick hole slowly, just until it reaches the full level on dipstick. Allow sufficient time for the oil to travel throughout the speed reducer when filling.
- ☞ Reinstall dipstick.

Fig. 50: Speed reducer (gear case) oil



Main relief – accumulator pump section

This relief valve (Fig. 58) is rigid (close coupled) to the outlet port of the secondary pump section (furthest from the pump motor interface) and is to be set at a maximum of 2,650 psi. Adjustments to this relief require that the unloading valve setting be maximized (see Unloading valve adjustment in this chapter), or that the relief is isolated from the rest of that circuit.

Two people are required to set the main relief: one person adjusts the relief while the second person remains in the operator's compartment at all times. The second person will watch the pressure gauge and must be ready to shutdown the machine, if necessary.

CAUTION!

Two people are required to adjust the valve: one person performs the adjustment while the other remains in the operator's compartment, ready to shutdown the machine, if necessary. Failure to have someone in the operator's compartment may result in damage to the machine or injury to personnel.

Once the valve circuit has been isolated:

- ☞ Remove the protective hex cap from the adjustment stem of the cartridge and loosen the jam nut (turn ccw) that holds the adjustment stem in place.
- ☞ Turn the adjustment stem out (ccw) significantly to minimize the initial start-up pressure the pump will generate and connect a test gauge to one of the gauge ports provided on the valve body.
- ☞ Start the machine and note the pressure on the test gauge.
- ☞ Turn the adjustment stem in (cw) until the desired setting is reached.
- ☞ Hold the adjustment stem in position with a hex key and tighten the jam nut (cw) that holds the adjustment stem in place. Replace the protective hex cap.
- ☞ Shut the machine off.
- ☞ Remove the test gauge and re-secure it's connection point.
- ☞ If the unloading valve setting was maximized, it must now be reset (see Unloading valve adjustment in this section) to establish an initial upper limit that will be lower than 2,650 psi before proceeding. Otherwise, reconnect the circuit to it's original configuration before returning the machine to normal service.

Troubleshooting procedures

The following section lists possible problems encountered when servicing the machine and can aid in locating and correcting these problems.

This section covers basic hydraulic components, with each listed in a trouble-cause-remedy format.

For electrical instructions, troubleshooting, and maintenance procedures, refer to the "BUC2000 Dual Motor Controller Solid-State Troubleshooting Guide".

WARNING!

Some procedures must be carried out with the cover of the electrical controller removed and some procedures require the controller to be energized during the tests. It is extremely important that you take all necessary precautions to prevent accidental electrical shock while working within the controller. An MSHA-certified electrician must supervise and inspect all work performed.

For maintenance procedures and tests that DO NOT require the controller to be energized, these precautions include:

- ☞ 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 discharge before working inside the controller. To insure that the capacitors are discharged, connect an insulated 100-ohm, 10-watt resistor between the center buss bar and the outer buss bar of the capacitor bank and hold for 30 seconds.
- ☞ Use insulated gloves and tools where possible.
- ☞ All connections must be tight and care must be taken to prevent bolts, nuts, washers and other small metal fasteners from being dropped or lost inside the controller. These lost fasteners could cause electrical shorts inside the controller.

For procedures that DO require that the controller be energized while the cover is off:

- ☞ At no time should you reach inside the controller while it is energized. If it becomes necessary to make adjustments or to replace parts inside the controller, the machine circuit breaker must be turned to the "OFF" position and the capacitor bank discharged (see above). Once the circuit breaker is in the "OFF" position and the capacitor bank discharged, adjustments or parts replacements can be made.
- ☞ Use insulated gloves and tools where possible.

6

Technical data

Table 17: Set screws (Socket standard steel)

Nominal diameter	Recommended torque setting
#6	9 in-lbs
#8	16 in-lbs
#10	30 in-lbs
1/4"	6 ft-lbs
5/16"	12 ft-lbs
3/8"	18 ft-lbs
7/16"	29 ft-lbs
1/2"	43 ft-lbs
5/8"	100 ft-lbs
3/4"	146 ft-lbs
7/8"	199 ft-lbs
1"	262 ft-lbs

Table 27: Light gear oil, SAE 40 motor oil (Spec. 100-10)

	Supplier	Brand name
1	Amoco Oil Company	Amoco 300 SAE 40
2	Gulf oil	Super Duty 40
3	Mobil Oil Corporation	Delvac 1340
4	Chevron U.S.A.	Chevron RPM Heavy Duty Motor Oil 15W-40
5	Sun Oil Company	Sunoco Super C 40
6	Unocal 76	Guardol Motor Oil SAE 40
7	Shell Oil company	Rotella Oil 40 (Automotive) Turbo Oil 150 (Industrial) Rimula CT40 (Foreign) Rotela SX40 (Foreign)
8	Century	Flexe SAE 40
9	Texaco Lubricants Company	Ursa Super plus SAE 40
10	Exxon	XD-3 Extra SAE 40 or XD-3 SAE 40
11	Pennzoil	Long Life SAE 40 Motor Oil
12	Lubricating Engineers	8440 Monolex GFS Engine Oil
13	Conoco Inc.	Fleet Heavy Duty Motor Oil SAE 40
14	Hydrotex	Hyfilm SAE 40
15	Phillips	Super HD II Motor Oil SAE 15W-40

Table 28: Synthetic EP gear lubricants (Spec. 100-11)

	Supplier	Brand name
1	Century Lubricants Company	Synthetic EP Gear Lubricants

Table 29: Multi-purpose tractor hydraulic fluid (Spec. 100-12)

	Supplier	Brand name
1	Exxon / Mobil	Mobilfluid 424
2	Century / Fuchs	Multitran
3	Shell	Donax TD
4	Chevron	Tractor Hydraulic Fluid
5	BP Lubricants	Tractran UTH
6	Quaker State	Quaker State FCI HD
7	Conoco	Powertran Fluid

1

About this manual

Operating conditions

Intended use

The battery charger has been designed and manufactured purely for recharging of mine storage batteries.

Intended uses include:

- the recharging of mine power storage batteries that are specified on the charger nameplate

Unauthorized use

Applications not expressly listed as intended uses are unauthorized uses and are not allowed to be performed with the charger.

- the recharging of other types of batteries not specified on the charger nameplate

Caterpillar accepts no liability for any damage resulting from any such unauthorized use.

3

Storage and transport

Installation

The SCR-18C battery charger is designed to operate on a specific type of battery with a specified number of cells. The nameplate on the charger indicates the type and number of cells required. When connecting the DC output cables to the battery, be certain the positive terminal of the charger is connected to the positive battery terminal, and the negative terminal is connected to the negative of the battery. A grounding connection is also provided for complete protection. Once properly installed, the unit should automatically complete its charge cycle every time it is connected to a discharged battery. Install the unit so that the flow of air through the ventilators is vertical and not obstructed.

A terminal block is provided within the unit for the AC input connections. Before connecting the AC input cable, check the line power with that specified on the nameplate of the unit. Units with multiple AC input units have taps inside, which must be set for the proper AC setting (see Table 2). The AC input current specified on the nameplate is for rated output.

Table 2: Voltage control taps

	660V	695V
CT	H2 (B)	H1 (B)
PT	2 (A)	3 (A)

Voltage control taps are located in boxes 2 and 3. Taps in **BOTH** boxes must be set.

Input AC breakers must be sized for the overload or current limiting point of the charger, which is 105% of the rated nameplate value.

Location

- locate the charging station away from rain, snow, wet conditions or areas of high traffic if possible
- Never place this unit directly above the standard flooded battery. Gases from the battery will corrode and damage equipment. A sealed maintenance free or valve regulated lead acid (VRLA) may be placed below this equipment

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The automatic start/stop feature senses the connection of a battery and determines if it is in the proper range, 1.4 to 2.5 volts per cell, and then slowly ramps the output current up to start the charge. If the discharged battery is not the correct number of cells or if the correct battery is over discharged the unit will not start and the digital display will indicate number "0003". The charger will automatically turn off at the end of the charge cycle.

A push to stop button is provided to de-energize the charger. Be sure to push this button before disconnecting the battery during the charge cycle.

In the normal mode, the charger will charge the battery for 3 hours after the 80% point is reached (unless the rate program terminates the charge first) or the battery is disconnected. In the equalize mode, a 6 hour timer is initiated after the 80% point is reached.

A momentary equalize switch is provided so that equalizing may be selected to give a 6 hour charge after the 80% point is reached. Equalizing should be done once per week. This switch, when activated, will start the equalize charge mode for that cycle only. After completion of the cycle, the charger will automatically be reset to the "normal" mode.

When the 80% point is reached, the 80% charge lamp will flash at a one second rate. At this point, the timer in the SCR is set for 3 or 6 hours depending on whether or not the equalize mode is active. The charger will continue the trickle rate until the SCR control turns unit completely off. When a charging cycle is completed correctly, the 80%/Complete light will be on solid until the battery is unplugged and the amp hours returned, elapsed charging time and elapsed time from charge complete will be displayed. Unplugging a charged (charge complete light "On") battery will place the unit back in the autostart mode.

Disconnecting the output connector while a battery is being charged is not recommended. If the battery is disconnected during a charge cycle, the control will turn off the charger, the complete light will not light, all timers will reset, and the unit will go into the autostart mode. The push to stop button must be pushed before disconnecting the battery during a charge cycle.

If the battery never reaches the 80% charge point (due to battery failure), the unit will turn off in 12 hours from the override timer. The complete light will not light. The "ON CHARGE" light will turn off, the "FAILURE" lamp will light and the display will indicate "0004." If this occurs, the unit will not autostart. The on/off switch will have to be turned off to reset the lights and turned back on to initiate the autostart mode

If the AC input voltage goes off, the unit will stop and the failure lamp will light. When the AC is restored, the unit will turn on again and resume the charge where is left off.

Table 5: S2A-358S Pot adjustments

P1	Constant voltage setting
P3	Low start rate*
P4	Mid start rate
P5	High start rate
P8	Low finish rate
P9	Mid finish rate
P10	High finish rate
P11	I-I curve voltage trip
P13	High voltage clamp

- * Verify the jumper selection on the AC input terminal block. If Low start rating is 101A and 250A/100mv shunt is used, adjust P3 until 101A and 250A/100mv shunt = 40.4mV across the shunt bar.

Table 12: Electrically zinc plated (Coarse thread)

Property class	Torque	Recommended torque setting			Nominal diameter			
		Ma	M33	M4	M5	M6	M7	M8
5.6	Nm	0.56	1.28	2.50	4.3	7.1	10.5	21
	Ft-lbs	0.41	0.94	1.84	3.1	5.2	7.7	15
8.8	Nm	1.28	2.90	5.75	9.9	16.5	24	48
	Ft-lbs	0.94	2.14	4.24	7.3	12.1	17.7	35
10.9	Nm	1.80	4.10	8.10	14	23	34	67
	Ft-lbs	1.33	3.02	5.97	10.3	16.9	25	49
12.9	Nm	2.15	4.95	9.70	16.5	27	40	81
	Ft-lbs	1.59	3.65	7.15	12.1	19.9	29	59

Table 12: Electrically zinc plated (Coarse thread, continued)

Property class	Torque	Recommended torque setting			Nominal diameter			
		Ma	M12	M14	M16	M18	M20	M22
5.6	Nm	36	58	88	121	171	230	
	Ft-lbs	26	42	54	89	126	169	
	Nm	83	132	200	275	390	530	
8.8	Ft-lbs	61	97	147	202	287	390	
	Nm	117	185	285	390	550	745	
10.9	Ft-lbs	86.2	136	210	287	405	549	
	Nm	140	220	340	470	660	890	
12.9	Ft-lbs	103	162	250	346	486	656	

Table 12: Electrically zinc plated (Coarse thread, continued)

Property class	Torque	Recommended torque setting			Nominal diameter			
		Ma	M24	M27	M30			
5.6	Nm	295	435	590	800	1030	1340	
	Ft-lbs	217	320	435	590	759	988	
	Nm	675	995	1350	1830	2360	3050	
8.8	Ft-lbs	497	733	995	1349	1740	2249	
	Nm	960	1400	1900	2680	3310	4290	
10.9	Ft-lbs	708	1032	1401	1902	2441	3163	
	Nm	1140	1680	2280	3090	3980	5150	
12.9	Ft-lbs	840	1239	1661	2278	2935	3798	

1

About this manual

Safety instructions

- cordon off working area** Cordon off your working area widely for the machine.
- moving parts** Never allow parts of your body to come between parts which could move, such as e.g.:
- false bottoms
 - pivot points
 - battery lifts
- steering lockout** Connect the steering lockout device before performing maintenance or repairs on the machine.

Storage and transport

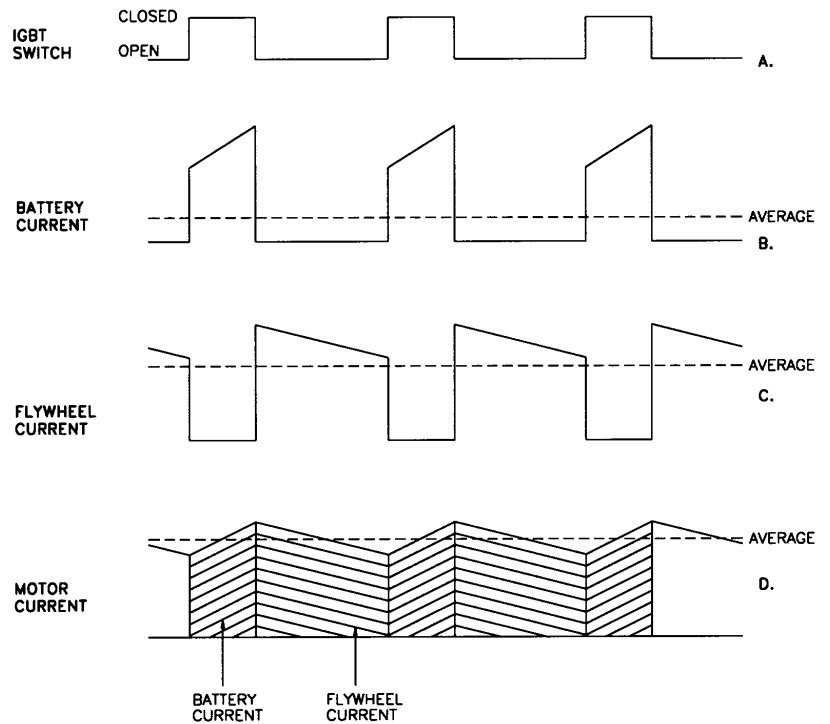
Maintain the prescribed storage periods and observe the instructions for storage.

Do not store materials or parts in the travel way or in your working area.

Inform the persons involved about the intended transport route and the anticipated duration of the transport.

- transport safety device** Ensure that the transport safety devices are correctly fitted.
- Fix all moving parts with transport locks.
- Never stand under unsupported parts or suspended loads.
- means of attachment** Connect the lifting equipment only to the points of attachment provided for that purpose. Observe the different load limits of the attachment points. Also observe the instructions on the transport sheet.
- Only use means of attachment which are in good condition and have been designed for the loads to be handled.
- For round components use transport straps, only. Never use chains or steel cables for this purpose.
- Do not damage the treated or polished surfaces of shafts, sealing surfaces, etc.
- mobile handling equipment** When using mobile handling systems for transport make sure that the center of gravity is as low as possible.

Fig. 6: Flywheel current (low speed)

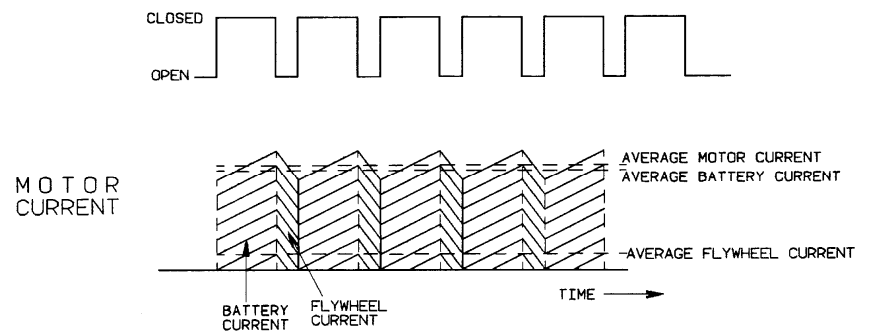


To summarize, the motor current is made up of a combination of battery current and "flywheel" current so that under all conditions the average motor current is always greater than the average battery current.

At low speeds the motor current can be several times greater than the battery current.

At high speeds, when the IGBT switch is open only for short periods before closing, the motor current is made up almost entirely of battery current.

Fig. 7: Flywheel current (high speed)



Operation

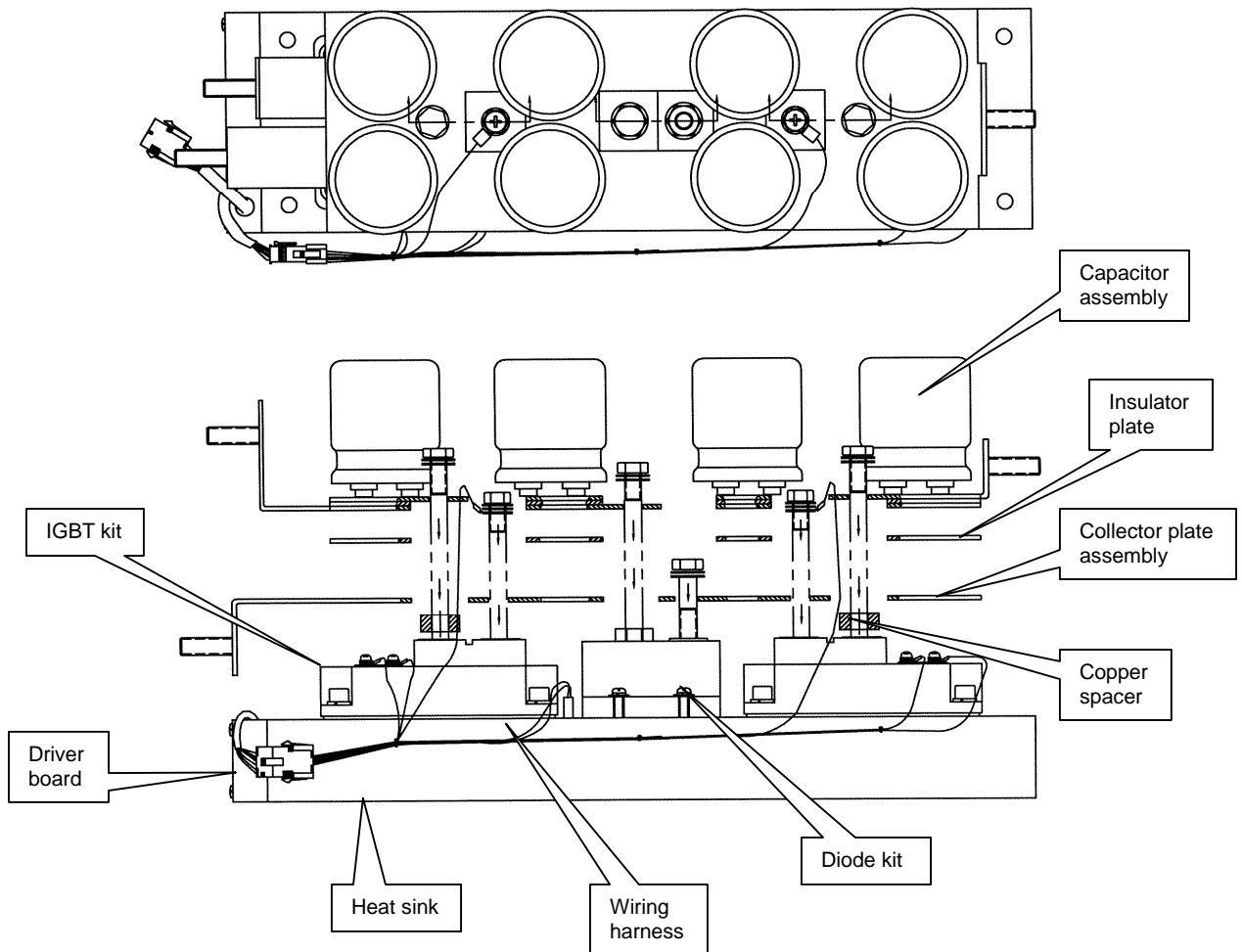
Table 2: Fault message chart (cont.)

Dashboard display	Calibrator display	Description	Possible causes/checks
"I. D. FAULT"	"VEHICLE ID FLT."	Vehicle Configuration ID invalid	
"L FWD OFF"	"TRACT L. FWD OFF"	Diagnostic LEFT FWD point "A" trip failed to disable PWM1.	Faulty logic board or driver board.
"L FWD ON"	"TRACT L. FWD ON"	Diagnostic LEFT FWD point "A" trip failed to be disabled.	Faulty logic board, shorted motor to ground or shorted IGBT.
"LPTA SHORT"	"P. UP L. PTA SHORT"	Dual motor Block 0 point "A" short (Note: Block 0 is right, point A (PTA) is any point between battery positive and battery negative.)	Motor short to ground or LEFT IGBT shorted Other electrical component shorted or grounded not allowing voltage to come up to or above 64VDC on IGBT panel. Some examples (list is not all inclusive) are: <ul style="list-style-type: none"> - Shorted solenoid - Confirm diodes and transistors are not shorted. - Pump drive shorted or grounded. - Pump motor grounded. - DC-DC converter for IS relays shorted. - DC-DC converter for PLC shorted. - Grounded tram motor. - Any grounded control wiring.
"L REV OFF"	"TRACT L. REV OFF"	Diagnostic LEFT REV point "A" trip failed to disable PWM1.	Faulty logic board or driver board.
"L REV ON"	"TRACT L. REV ON"	Diagnostic LEFT REV point "A" trip failed to be disabled.	Faulty logic board, shorted motor to ground or shorted IGBT.
"PTA SHORT"	"P. UP PTA SHORT"	Single motor Block 0 point "A" short (Note: Point A (PTA) is any point between battery positive and battery negative.)	Motor short to ground or IGBT shorted Other electrical component shorted or grounded not allowing voltage to come up to or above 64VDC on IGBT panel. Some examples (list is not all inclusive) are: <ul style="list-style-type: none"> - Shorted solenoid - Confirm diodes and transistors are not shorted. - Pump drive shorted or grounded. - Pump motor grounded. - DC-DC converter for IS relays shorted. - DC-DC converter for PLC shorted. - Grounded tram motor. - Any grounded control wiring.
"REV OFF"	"TRACT REV OFF"	Single motor Diagnostic REV point "A" trip failed to disable PWM0.	Faulty logic board or driver board.
"REV ON"	"TRACT REV ON"	Single motor Diagnostic REV point "A" trip failed to be disabled.	Faulty logic board, shorted motor to ground or shorted IGBT.
"R FWD OFF"	"TRACT R. FWD OFF"	Diagnostic RIGHT FWD point "A" trip failed to disable PWM0.	Faulty logic board or driver board.
"R FWD ON"	"TRACT R. FWD ON"	Diagnostic RIGHT FWD point "A" trip failed to be disabled.	Faulty logic board, shorted motor to ground or shorted IGBT.
"RPTA SHORT"	"P. UP R. PTA SHORT"	Dual motor Block 0 point "A" short (Note: Block 0 is right, point A (PTA) is any point between battery positive and battery negative.)	Motor short to ground or RIGHT IGBT shorted Other electrical component shorted or grounded not allowing voltage to come up to or above 64VDC on IGBT panel. Some examples (list is not all inclusive) are: <ul style="list-style-type: none"> - Shorted solenoid - Confirm diodes and transistors are not shorted. - Pump drive shorted or grounded. - Pump motor grounded. - DC-DC converter for IS relays shorted. - DC-DC converter for PLC shorted. - Grounded tram motor. - Any grounded control wiring.
"R REV OFF"	"TRACT R. REV OFF"	Diagnostic RIGHT REV point "A" trip failed to disable PWM0.	Faulty logic board or driver board.
"R REV ON"	"TRACT R. REV ON"	Diagnostic RIGHT REV point "A" trip failed to be disabled.	Faulty logic board, shorted motor to ground or shorted IGBT.

Fig. 18: IGBT heat sink assembly

X1 CONNECTOR

PIN #	COLOR	LENGTH	DESTINATION
1	WHITE	8.0"	THERMISTOR
2	WHITE	8.0"	THERMISTOR
3	ORANGE	6.0"	IGBT LEFT "C"
4	ORANGE	14.5"	IGBT RIGHT "C"
5	GREEN	4.0"	IGBT LEFT "G"
6	GREEN	13.5"	IGBT RIGHT "G"
7	GREY	4.75"	IGBT LEFT "E"
8	GREY	12.5"	IGBT RIGHT "E"



Troubleshooting

This section provides troubleshooting information. This guide assumes you have a working knowledge of IGBT controller servicing and that you have the following equipment.

- volt/ohm meter or digital meter with diode check function
- appropriate leads for meter
- insulated basic hand tools

WARNING!

Follow all Mine, State, and Federal lockout/tagout regulations.

WARNING!

When working inside the controller, use insulated gloves and tools where possible.

WARNING!

All connections must be tight and care must be taken to prevent bolts, nuts, washers and other small metal fasteners from being dropped or lost inside the controller.

WARNING!

Before starting any power-related performance tests, the machine must be securely blocked clear of the ground with all four (4) wheels free to turn.

NOTICE!

Refer to the parts manual for your particular machine wiring diagrams and schematics.

NOTICE!

The logic unit contains no user-serviceable parts. Opening this sealed device will void the warranty.

WARNING!

Never power up logic without the 32 pin connector connected to the logic. Powering up the logic without the 32 pin connector will result in damage.

4 **Tightening torques**

Table of contents



1. About this manual

About this manual	1.3
Before starting to work	1.3
Who is this operating manual intended for?.....	1.3
What is the purpose of this operating manual?.....	1.4
Characters and symbols	1.5



2. Your safety

Your safety	2.3
Personnel	2.4
Operation.....	2.4
Installation and repair	2.4
Operating conditions	2.5
Intended use.....	2.5
Unauthorized use	2.5
Safety instructions	2.7
General rules	2.7
Storage and transport.....	2.7
Pre-start inspection	2.8
Operation.....	2.8
Maintenance and repair.....	2.9
Battery hazards	2.10
Safety procedures	2.11
Federal standards	2.11
While handling batteries	2.11
While charging batteries	2.12
While handling acids.....	2.13
While servicing or repairing batteries	2.14
Overview of the safety instructions	2.15
Chapter 3: Storage and transport.....	2.15
Chapter 4: Installation	2.15
Chapter 5: Operation.....	2.15



3. Storage and transport

Storage and transport	3.3
Storage	3.3
Storage methods	3.3
Charged and wet batteries.....	3.3'
Charged and dry batteries	3.3
Transport	3.4
Load units	3.4
Shipment	3.4
Unpacking upon receipt	3.5

2

Your safety

Overview of safety instructions

Safety procedures

federal standards

Congress passed the Occupational Safety and Health Act (OSHA) in 1970. This act established the minimal acceptable standards for safe and healthful working conditions. The safety procedures suggested in this manual have been compiled from standards developed over the years by professional and technical organizations and by battery manufacturers and users. Experience has shown them to be the most effective safety standards. In all cases, they exceed the minimum standards of OSHA for personal safety and include procedures for safeguarding equipment as well.

The safety procedures have been grouped by functional area of most logical application or need.

while handling batteries

- Lift batteries with mechanical equipment, such as an overhead hoist, crane or lift truck. A properly insulated lifting beam, of adequate capacity, should always be used with overhead lifting equipment. Do not use chains attached to a hoist at a single central point forming a triangle. This procedure is unsafe and could damage the steel tray.
- Always wear safety shoes and safety glasses.
- Tools, chains, and other metallic objects should be kept away from the top of uncovered batteries to prevent possible short circuits.
- Battery operated equipment should be properly positioned with switch off, brake set, and battery unplugged when changing batteries or charging them while in the equipment.
- Personnel who work around batteries should not wear jewelry made from a conductive material. Metal items can short circuit a battery and could cause severe burns.
- Only trained and authorized personnel should be permitted to change or charge batteries.
- Reinstalled batteries should be properly positioned and secured in the unit. Before installing a new or different battery, check both the unit nameplate and battery service weight to make sure that the proper weight battery is being used. A battery of the wrong weight could change the center of gravity and cause equipment to upset.

Storage and transport

This chapter contains important information on the correct storage and transport of the mine power storage battery.

Observance of the instructions and tips will increase the service life and availability of the battery. You will also be able to carry out the transport work quicker and more safely. Careful attention to the points in this chapter will help you to simplify your day-to-day work.

Storage

Storage methods

charged and wet batteries

Lead acid batteries may be stored in a charged and wet (filled with electrolyte) condition when necessary for periods of up to several months. During such periods they should be stored in a clean, cool, dry, and well ventilated location away from radiators, hot air ducts, or other sources of heat, and protected from exposure to direct sunlight.

Before being stored, the battery should be fully charged and the electrolyte brought to the proper level. Any leads should be disconnected or insulated to prevent accidental discharge. The top of the battery should be protected from dust, foreign matter, and moisture. **Do not attempt to dismantle the battery.**

If the average storage temperature is 80° F or higher, the specific gravity of the electrolyte should be checked at least monthly. If the temperature is below 80° F, check the specific gravity at least every two months. Whenever the specific gravity, corrected to 80° F, falls to 1.240 or below, the battery should be given a freshening charge as described in Chapter 5 of this manual. A freshening charge is also recommended just before returning a battery to service.

charged and dry batteries

New batteries are often supplied charged and dry (without electrolyte). Batteries in this condition can remain in storage, unattended, for a period of at least two years. They should be stored in a cool, dry place with vent caps tightly closed. Average temperatures should not exceed 80° F.

Batteries should not be stored near radiators, hot air ducts, or other sources of heat, and should be protected from exposure to direct sunlight. The top of the battery should be protected from dust, foreign matter, and moisture.

When removed from storage, charged and dry batteries should be activated as described in Chapter 5 of this manual.

Operation

This chapter contains important information on the operation and maintenance of the battery. Read this chapter carefully and thoroughly. In particular, observe the safety instructions in chapter 2, "Your safety".

Definitions

The definitions referenced throughout this manual generally agree with accepted industry standards. For a more complete listing of "Definitions for Lead-Acid Industrial Storage Batteries", see NEMA Standards publication No. 1B 1-1971.

Copies of NEMA standards may be obtained at nominal cost by writing to: National Electrical Manufacturers Association, Department of Engineering and Safety Regulations, 2101 L Street, N.W. Washington, D.C. 20037.

Description and construction

Battery

Mine power lead-acid batteries for electric vehicles typically consist of a steel tray into which the cells are assembled, a battery terminal connector, and various other components necessary to secure and protect the cells and provide the necessary electrical interconnections.

battery identification and data

The essential information necessary for proper care of an industrial motive power battery appears on the battery, either stamped into one of the intercell connectors or on a name plate affixed to the tray. This information usually includes the manufacturer's name and model, number of plates per cell, battery capacity, battery voltage, serial number, suggested charging rate, and fully charged specific gravity of electrolyte.

If vital information is missing or is no longer legible, the information can be obtained by contacting your nearest representative.

Some manufacturers list, as a part of the model or type designation, the rated ampere-hour capacity of a single positive plate, such as "SS75". As an alternate means of determining rated battery capacity, this number should be multiplied by the total number of positive plates in one cell. To find the number of positive plates in a cell, subtract one from the total number of plates and divide by two. To find the capacity of a battery designated "SS75-19," therefore: $19 - 1 = 18$; $18 \text{ divided by } 2 = 9$; $9 \times 75 = 675 \text{ Ah battery capacity}$.

Sulfation

Sulfation occurs when conditions within the cell cause sufficient accumulation of abnormal lead sulfate at both the positive and negative plates, permanently affecting the normal chemical reactions. Habitual over discharging below final voltage, prolonged operation in an undercharged condition, and extended stand periods while in a discharged state are major causes of sulfation. A servicing schedule should be followed to provide frequent monitoring and adequate charging. See the maintenance section in this chapter for methods of restoring a sulfated battery.

Operating cycle

An operating cycle of a storage battery consists of the discharge, subsequent charge cycle to restore its initial condition, and an eight hour cooling, or rest, period following the charge.

Service life

The service life of a storage battery is the period during which it provides useful power while being discharged. It is usually expressed as the time period, or number of cycles, which elapses before the ampere-hour capacity falls below 80% of its rated value. To obtain maximum service life, it is recommended that a battery be restricted to one full cycle per 24 hour day or fewer than 300 cycles per year. Other factors which most often adversely influence service life are:

- Abnormally high or low electrolyte temperatures.
- Frequent over discharging.
- Failure to add water regularly.
- Frequent overcharging.
- Poor, or high, resistance, connections or contacts.
- Overfilling with water, which causes electrolyte loss.

Temperature

The normal operating characteristics of a storage battery are affected by unusually low or high cell temperatures.

low temperature

Available battery power is reduced by low temperature because electrolyte viscosity and resistance is increased and diffusion throughout the pores of the active material is retarded. For example, a fully charged battery (1.280 to 1.295 specific gravity at 77° F.), when its electrolyte temperature is about 32° F, will deliver only 75% of the capacity which would be available at normal room temperature (see Table 1). This drops to 40% at 0° F. The electrolyte could freeze if a discharged battery were exposed to very cold temperatures for several hours. (See Table 2 for freezing points of various electrolyte concentrations.)

Fig. 3: 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	CELL NO.	VOLTAGE	SPECIFIC GRAVITY	ACID LEVEL	ON CHARGE VOLTAGE
1					33				
2					34				
3					35				
4					36				
5					37				
6					38				
7					39				
8					40				
9					41				
10					42				
11					43				
12					44				
13					45				
14					46				
15					47				
16					48				
17					49				
18					50				
19					51				
20					52				
21					53				
22					54				
23					55				
24					56				
25					57				
26					58				
27					59				
28					60				
29					61				
30					62				
31					63				
32					64				

Repairing batteries

Storage batteries which have been damaged or which contain defective cells may, if the rebuilding cost and time are justified, be restored to a serviceable condition.

It is important to check a battery thoroughly if it has been involved in an accident or if it is believed to be defective. A neglected battery will continue to deteriorate even when not in use. **Usually, rebuilding is justified if the majority of the cells are in good condition.**

This section explains how to remove cells from a battery and how to repair them if they are to be salvaged. Some special tools and parts will be required, depending upon the work to be done. Reference will be made to the use of such special devices but they will not be further identified in this manual. Each manufacturer identifies all tools, accessories, and replacement parts by an appropriate part number. Use this number when making reference to them.

Purging gas

- ☞ Before starting any repairs, remove all vent caps from cells to be repaired as well as from all surrounding cells.
- ☞ The space above the electrolyte must be cleared of hydrogen gas before proceeding with repairs. Introduce a low volume air stream (volume and force equal to that produced by fanning each cell with a stiff piece of cardboard or other suitable nonconducting material) into each cell for at least 30 seconds. Be very careful when using air so that the electrolyte is not splashed out of the cell.

CAUTION!

Do not blow breath into cells. Wear protective face shield or goggles, rubber gloves, and apron.

- ☞ After cells have been purged, cover all vent openings with several layers of water-dampened cloth before starting repairs.

Removing intercell connectors

Special intercell connector drills, available in different sizes, are designed to cut the bond between the cell post and the connector while permitting the post to remain for later rebuilding.

- ☞ Make certain vent plugs are in place.
- ☞ Cut the bond between the cell post and the connector. Be careful to cut only as deep as necessary, usually 1/4" to 3/8". During drilling, try to center on the cover bushing and make sure any lead curl produced does not short across other connectors.
- ☞ Lift the intercell connectors off with a pair of pliers.

Tightening torques

Table 11: FSR hex bolts (SAE 5 and 325 steel)

Nominal diameter	Recommended torque setting
1/4"	9 ft-lbs
5/16"	18 ft-lbs
3/8"	31 ft-lbs
7/16"	50 ft-lbs
1/2"	75 ft-lbs
9/16"	110 ft-lbs
5/8"	150 ft-lbs
3/4"	250 ft-lbs
7/8"	378 ft-lbs
1"	583 ft-lbs
1 1/8"	782 ft-lbs
1 1/4"	1,097 ft-lbs
1 3/8"	1,461 ft-lbs
1 1/2"	1,748 ft-lbs
1 3/4"	3,114 ft-lbs
2"	4,504 ft-lbs
2 1/4"	6,497 ft-lbs
2 1/2"	7,144 ft-lbs
2 3/4"	12,092 ft-lbs
3"	15,744 ft-lbs

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