Columbia ParCar Corp.

SERVICE MANUAL

MEGA AC Electric Vehicles

Van
Dropside
TiltBed
Cargo
Refuse

2013

GENERAL

This service manual has been prepared with two purposes. First, it will introduce the trained maintenance professional to the latest field tested and factory approved major repair methods. Secondly, it will acquaint the reader with the construction of the Columbia ParCar vehicles and assist him/her in performing basic maintenance and repair. We sincerely believe that this manual will make the association with Columbia ParCar vehicles a more pleasant and profitable experience.

In addition to the information given in this manual, Service Bulletins are issued to Columbia ParCar dealers, which cover interim engineering changes and supplementary information. Service Bulletins should be consulted for complete information on the models covered by this manual.

To ensure the safety of those servicing our vehicles and to protect the vehicles from possible damage resulting from improper service or maintenance, the procedures in this manual should always be followed exactly as specified. Execution of the procedures and troubleshooting tips as outlined will ensure the best possible service from the vehicle(s). To reduce the chance of personal injury and/or property damage, carefully observe the DANGER, WARNING, CAUTION & NOTICE recommendations throughout this manual. See *Section 1-Safety* for additional details.

PREPARATION FOR SERVICE

Proper preparation is very important for efficient service work. A clean work area at the start of each job will allow you to perform the repair as easily and quickly as possible, and reduce the incidence of misplaced tools and parts. Columbia ParCar vehicles that are excessively dirty should be cleaned before work begins. Cleaning will occasionally uncover trouble sources.

Tools, instruments and parts needed for the job should be gathered before work is started. Interrupting a job to locate tools or parts is a needless delay. Special tools required for a job are listed at the beginning of each section.

MODEL IDENTIFICATION

Always give the vehicle identification number (VIN) when ordering parts or making inquiries about the vehicle. Use of the full and complete vehicle identification number will ensure that the dealer or service provider is supplying you with the correct parts for the vehicle. See *Section 2-General Information* for VIN location and additional information.

USE GENUINE REPLACEMENT PARTS

⚠WARNING

When replacement parts are required, use only genuine Columbia ParCar parts or parts with equivalent characteristics including type, strength and material. Failure to do so could result in product malfunction and possible injury to the operator and/or passenger.

To ensure a satisfactory and lasting repair, follow the service manual instructions carefully and use only genuine Columbia ParCar vehicle replacement parts. This is the insurance that the parts you are using will fit right, operate properly and last longer. When you use genuine Columbia ParCar vehicle parts, you use the best.

PRODUCT REFERENCES

When reference is made in this manual to a specific brand name product, tool or instrument, an equivalent product, tool or instrument may be used in place of the one mentioned.

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CHANGE HISTORY – MEGA Service Manual		
DATE	**DESCRIPTION**	**BY**
2/4/2013	Issued	TS
4/2013	Added Section on Maintenance Indicator	TS
7/1/13	Corrected differential oil	TS
9/12/13	Added information on replacing the AC Controller	TS

OVERVIEW

Statements in this manual preceded by the words **DANGER, WARNING, CAUTION or NOTICE** and words printed in **bold face** are very important. We recommend you take special notice of these items.

It is important to note that some warnings against the use of specific service methods, which could damage the vehicle or render it unsafe, are stated in this service manual. However, please remember that these warnings are not all inclusive. Since Columbia ParCar Corporation could not possibly know, evaluate and advise servicing personnel of all possible ways in which service might be performed or of the possible hazardous consequences of each way, we have not undertaken any such broad evaluation.

Accordingly, anyone who uses a service procedure or tool which is not recommended by Columbia ParCar must first thoroughly satisfy him/herself that neither their nor the operator's safety will be jeopardized by the service methods selected.

ICONS IN PROCEDURES

Watch out for icons and symbols in procedures. Watch for international symbol icons in the margins. They are there to help you avoid situations that might expose you to an unnecessary hazard or potential injury.

⚠ DANGER

Danger indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠WARNING

Warning indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠CAUTION

Caution indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

***NOTICE*: Notices are messages not related to personal injury. They will provide key information to prevent property damage and to assure procedures are more easily understood or implemented.**

SAFETY INFORMATION

It is Columbia ParCar's specific recommendation that the following safety information must be observed at all times. Not all are repeated throughout this manual, but the recommendations included must be observed whenever these subjects (indoor vehicle operation hazards) are encountered.

⚠WARNING

Any modifications or changes to the vehicle that affect the stability or increases vehicle speed beyond factory specifications could result in severe personal injury or death.

⚠ DANGER

EYE PROTECTION REQUIRED. All batteries used in electric vehicles can explode! Always wear full face shield when working on or near batteries. Hydrogen fumes are a natural byproduct of charging and discharging and are extremely explosive.

NO SMOKING

Do not smoke around electric vehicle batteries. Keep sparks and flames away from batteries. Battery charging should only be done in a well-ventilated area. Refer to *Section 8-Electrical* for details.

⚠ DANGER

CORROSIVE MATERIALS, WEAR REQUIRED PROTECTION. Batteries contain acid which can cause severe burns. Causes severe burns. Avoid contact with skin, eyes, or clothing. Wear full face shield and rubber gloves when working on or near batteries.

ANTIDOTES:

External: Flush with water. Call a physician immediately**.**

Internal: Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil.

Eyes: Flush with water for fifteen minutes. Call a physician immediately.

⚠WARNING

When working around batteries, use approved insulated tools, remove jewelry such as rings, watches, chains, etc. and place an insulating material such as wood, plastic, rubber, etc. over batteries covering all connections.

If any problems are found during scheduled maintenance or inspections, do not operate vehicle until repairs are completed. Failure to make necessary repairs could result in fire, property damage, severe personal injury or death.

⚠ DANGER

Only trained maintenance professionals should repair or service this vehicle. Persons performing even simple repairs or service should have working knowledge and experience in general electrical and mechanical repair. Follow all procedures exactly and observe all warnings stated in this manual. Use caution and common sense.

⚠ DANGER

Proper service and repair is important for safe, reliable operation of all Columbia vehicles. The service procedures recommended and described in this service manual are effective methods for performing service operations. Some of these service operations require the use of tools specially designed for this purpose. These special tools should be used when and as recommended.
Use insulated tools when working near batteries or electrical connections. Use extreme caution to avoid shorting of components or wiring.

Moving parts hazard! When operating any vehicle in a stationary position, avoid chains, belts, and wheels which could snag clothing or cause severe injury to body parts. A running vehicle must be worked on with the greatest care. Use caution and common sense.

⚠ DANGER

Do not wear loose clothing or jewelry such as rings, watches, chains, etc. when servicing the vehicle. Failure to do so could result in personal injury or death.

⚠WARNING

Working on Columbia ParCar vehicles without following proper procedures and using proper lifting equipment may result in vehicle damage or personal injury. See *Section 3 -Lifting Instructions* detailed instructions.
Always wear safety glasses or approved eye protection while servicing vehicle. Wear a full face shield when working with batteries.
Failure to maintain vehicle properly could result in decreased vehicle performance, reliability or cause severe personal injury.
Exceeding rated vehicle load capacities could result in possible severe injury or property damage.

⚠CAUTION

Check the vehicle for proper location and condition of all vehicle safety and operation decals. Refer to Parts Manual or web site for part numbers and locations.

***NOTICE*: The modification of vehicles for use in other than its intended purpose is not recommended. Any unauthorized modification may void your vehicle warranty.**

HOT! DO NOT attempt to service hot electric motor or resistors. Failure to observe this warning could result in severe burns.

⚠CAUTION

MEGA electric vehicles are designed to transport one (1) operator and one passenger. Never exceed the rated load capacity or vehicle stability, reliability and control will be reduced. See vehicle identification plate for capacities and gross vehicle weights.

SAFETY PREPARATIONS

⚠ DANGER

Always turn Power key to OFF, Directional selector to NEUTRAL, remove Power key and block tires. Turn the master disconnect switch counterclockwise to the OFF position before servicing or repairing your vehicle. See *Section 8-Batteries*, for specific details.

DECALS

Safety, Warning and Informational decals should be ordered and replaced as soon as they are discovered to be illegible or missing. Refer to Parts Manual or web site for part numbers and ordering info.

VEHICLE IDENTIFICATION NUMBER (VIN)

⚠CAUTION

Do not remove any nameplate, warnings, or instructions affixed to the Columbia vehicle. Promptly replace any that become damaged or removed.

Each vehicle is assigned a unique Vehicle Identification Number (VIN). The VIN describes facts and features of the vehicle and contains 17 digits (NEV) or 13 digits (LSV). Refer to the charts on the right.

The VIN can be found in four locations: in the glove box (figure 2-1), on the front dash panel (Figure 2-2), on the kick panel below the driver's seat (Figure 2-3) and under the steering wheel cover (Figure 2-4).

Record the VIN here and provide this number to the dealer when repairs or adjustments are required.

VIN _____

Figure 2-1

Figure 2-2

Figure 2-3

Figure 2-4

VIN MATRIX
NEIGHBORHOOD ELECTRIC VEHICLE (NEV)

Digit 1 thru 3: 5FC = CPC	Manufacturer Identification
Digit 4: Line	L = Low Speed Vehicle
Digit 5: Series	E = Eagle M = MEGA S = Summit U = Utility N = Earlier NEV Series
Digit 6: Body Type	2 = 2 Person 3 = Long Bed 4 = 4 Person 5 = Short Bed
Digit 7: Engine Type	48V AC Induction Drive
Digit 8: Restraint	A = Type 1 Seat Belt Assembly B = Type 2 Seat Belt Assembly (3 Point)
Digit 9: Check Digit	Calculated per 49CFR 565.4
Digit 10: Model Year	A = 2010 B = 2011 C = 2012 D = 2013 etc.
Digit 11: Plant Location	1 = Reedsburg
Digit 12-17: Sequential Numbers	00019 - 000999

VIN MATRIX
LOW SPEED ELECTRIC VEHICLE (LSV

Digit 1 thru 3: Model Group	MGA = MEGA Utility
Digit 4: Power System	G = AC Drive Induction
Digit 5: System Voltage/Batteries	4 = 48V (8-6V) G = 48V GEL (8-6V) M = 48V AGM (8-6V)
Digit 6: Standard or Special Product	- = Standard Product * = Special Product
Digit 7: Controller Amperage	4 = 400 Amp 5 = 500 Amp
Digit 8: Axle Brake System	N = Front Wheel Drive F & R Hydraulic
Digit 9: Model Year	L = 2012 M = 2013 N = 2014 etc.
Digit 10-13: Build Sequence	0000 - 9999

SPECIFICATIONS

Dimension (in.)	Van	DropSide	TiltBed	Cargo	Refuse
Overall Length	131.1				
Overall Width*	58.7	60.2		58.7	60.2
Overall Height	72.1	70.9			72.1
Wheel Base	91.5				
Front Ground Clearance	6.1				
Rear Ground Clearance	7.9				
Front Track	51.1				
Rear Track	50.1				
Weight (lbs.)					
Empty Weight	1485	1474	1557	1364	1638
Rated Capacity	979	990	907	1100	831
GVWR**	2464				
Max Axle Load-Front	1144				
Max Axle Load-Rear	1518				

All Models	
Passenger Capacity	2
Maximum Rated Speed	up to 25 MPH
Range-Standard Battery Group	Up to 40 miles***
Turning Radius	19 feet
Traction Power System	48 Volt
Motor	5 KW AC
Speed Control	Solid state, regenerative braking
Charger	110-240 VAC, 50/60 Hz
Drive	Front wheel, direct
Steering	Rack & Pinion
Hydraulic Brakes-Front/Rear	Disc/Drum
Independent Suspension-Front	McPherson strut/Coil
Independent Suspension-Rear	Coil/Shock
Tires	145/70R13
Chassis	Aluminum construction

** Excluding mirrors*
*** Gross Vehicle Weight Rating*
**** Range will vary depending upon load, temperature, terrain and driving style.*

SAFETY COMMITTEE - LSV MODELS

If the vehicles are to be operated by renters or company employees, we recommend that a safety committee be appointed. The primary concern of this committee should be the safe operation of the vehicles.

Subjects which must be considered include, but are not limited to the following:

Define where the vehicles should and should not be driven and utilized.

- Ensure all proper warnings as to driving hazards are properly displayed and visible.
- Safety signage concerning hills, turns, blind crossings or intersections is highly recommended.
- Enforcement of safe driving and operating rules.
- Provide driver training for first time operators, and review safe operating recommendations regularly.
- Maintain vehicles in a safe operating condition. Maintain a schedule for daily, weekly, and monthly vehicle inspections.
- Determine who, when and how pre-operation inspections should be conducted.
- Enforcement of safe driving and operating rules.
- Define who should and who should not drive the vehicles.
- Decide what to do should an unsafe condition or operating problem be discovered.
- Enforce that vehicle should not be operated by persons under the age of 16.These basic rules of operation, combined with courtesy and common sense, will help make driving your Columbia ParCar Vehicles a safe and pleasant experience.

KEYSWITCH (Figure 2-5)

ANTI-THEFT STEERING LOCK POSITION (A): To release the steering, lightly turn the wheel while turning the key.

ACCESSORIES POSITION (B)

RUNNING POSITION (C): Do not leave the keyswitch in this position when the ignition is turned off or battery may discharge.

STARTER POSITION (D): Not used on electric vehicles.

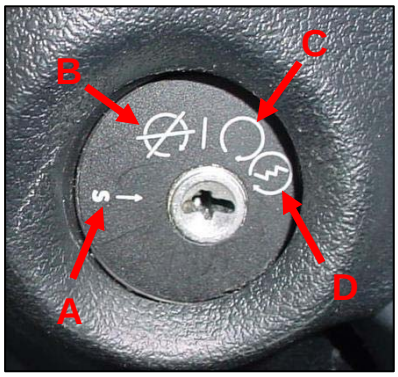


Figure 2-5

***NOTICE*: Controls should operate smoothly and easily without sticking or requiring undue effort.**

⚠WARNING

Be sure directional knob is in desired direction of travel before depressing accelerator

DIRECTIONAL KNOB (Figure 2-6)

1. With the keyswitch in the RUNNING position, move the directional knob to the desired direction of travel.
2. Move the lever to FL or FH to travel forward. The same speed occurs at either setting.

***NOTICE*: If the directional knob was in either forward or reverse when keyswitch was put in the Running position, move it to neutral (N), then back to the desired direction of travel.**

Figure 2-6

Figure 2-7

HANDBRAKE (Figure 2-7)

1. To apply the handbrake, pull the handle up without pressing the button on the end of then handbrake.
2. To disengage the handbrake, gently pull up on the handle, press the button on the end of the handbrake and fully lower the handle.

MULTI-FUNCTIONAL DISPLAY INDICATOR (MDI)

See Figure 2-8. Located to the left of the steering wheel, this meter will display the battery state of charge, an hour meter and the controller status. With fully charged batteries, the uppermost green LED is lit. A lit lower red LED indicates discharged batteries. The hour meter is an alpha-numeric liquid crystal display in the center of the MDI showing the hours worked.

Figure 2-8

If there is a controller error the hours worked will be replaced with a flashing error code. It is important to note the error code. It will aid in corrective actions. See Service Manual for AC Systems.

PRE-DRIVING CHECKLIST

⚠CAUTION

Should any item malfunction or need adjustment. Do not operate vehicle until the problem has been corrected.

- Check position of rear view mirror.
- Check and adjust seat.
- Check battery capacity. Make sure vehicle is adequately charged to provide power during duration of operation.
- Check tires for proper inflation.
- Check lights, horn and reverse buzzer for proper operation.
- Check that brake pedal has firm pedal pressure with minimal travel.
- Check parking brake for proper engagement and release.
- Check that all warning and operation labels are in place.
- Check for smooth accelerator pedal operation.
- Make sure AC charger cord is disconnected.
- Put on and adjust seat belt.
- Check that payload limits and the total authorized weight (includes weight of driver and passenger) has not been exceeded.

STARTING AND STOPPING

- Release the handbrake.
- Put the key in the RUNNING position and wait for the contact “click” and the sound of the ventilator motor fan running.
- Select the direction of travel with the directional knob.
- Press down on the accelerator.

⚠CAUTION

To avoid using both pedals at the same time drive using only one foot. Engaging both the brake and accelerator at the same time will prematurely damage the vehicle systems and will lead to a reduction in range.

- To stop, press the brake and come to a complete stop.. Engage the handbrake.

⚠WARNING

When going downhill, the regeneration of the current through the braking system will cause the vehicle to slow down. This does not take the place of using the brake to slow the vehicle.

- Place the keyswitch in the **S** (Anti-Theft Steering Lock) position.

⚠WARNING

Only trained maintenance professionals should service or repair this vehicle. Persons performing even simple repairs or service should have a working knowledge and experience in general electrical and mechanical repair. Follow all procedures and observe all warnings stated in this manual.

Use caution and common sense.

PRE-OPERATION INSPECTIONS

Each vehicle has been inspected and adjusted to factory specifications before delivery. Upon receipt, perform a pre- delivery inspection of the vehicle. Also, before using the vehicle, there are checks that must be performed to ensure that it is in safe working order.

Service Item	Service Method/Check	Reference
Vehicle Body .	Visually, check for damaged or loose hardware.	See Section 7
Steering and Linkages	Test drive, check for free movement and proper operation.	See Section 6.
Accelerator/Brake Operation	Test drive, check free travel and braking action.	Refer to Owner’s Manual index for specifications.
Warning Labels	Visually inspect all labels for readability or missing.	Verify labels are in place and readable.
Tires	Visually check for wear or damage.	See Section 6. Verify proper tire inflation.
Reverse Warning Buzzer or In- Motion Beeper	Test drive, check for proper operation.	Verify an audible sound heard.
Charger Plug and Receptacle	Check for damage and snug fi t.	
Head, Tail or Flasher, Lights	Check for proper operation	Verify lights and flashers work.
Batteries	Check Multifunctional Display Indicator (MDI) for battery condition.	Refer to Owner’s Manual index for specifications.
Horn	Check for proper operation.	

⚠ DANGER

Always turn Power key to OFF, Directional selector to NEUTRAL, remove Power key and block tires. Turn the main disconnect switch counterclockwise to the OFF position before servicing or repairing your vehicle

PERIODIC MAINTENANCE

A comprehensive maintenance program is important for the safe, reliable operation of all Columbia ParCar vehicles. The recommended procedures described in this service manual are effective methods for performing periodic maintenance and repair.

The maintenance procedures outlined in this manual are recommended when servicing the vehicle. Refer to maintenance checklist for frequency of service. Perform only those maintenance instructions described in this manual. If major repairs are needed, contact the local Columbia Dealer for assistance. Columbia Dealers have the technical experience, training and original Columbia Vehicle parts for the vehicle. Always use original Columbia Vehicle parts when servicing the vehicle.

***NOTICE*: Some procedures require the use of special tools. These special tools must be used when and where specified.**

***NOTICE*: When performing Monthly, Quarterly, Semi-Annual or Annual maintenance, ensure that Daily and Weekly inspections are included.**

***NOTICE*: The environment that the vehicle operates in can vary. Severe service operations will require the periodic maintenance recommendations to be adjusted to shorter time intervals. The following calendar is one example of how scheduling routine maintenance can be managed.**

PERIODIC SERVICE CALENDAR		
January Monthly	**February** Monthly	**March** Quarterly
April Monthly	**May** Monthly	**June** Semi-annual
July Monthly	**August** Monthly	**September** Quarterly
October Monthly	**November** Monthly	**December** Annual

***NOTICE*: Daily maintenance is performed daily before operation of vehicle by owner or operator. Weekly maintenance is performed on a weekly basis to include all daily maintenance and is performed by the owner, operator or trained maintenance personnel.**

MAINTENANCE SCHEDULE - BODY/FRAME/CHASSIS

Component	Procedure	Daily	Weekly	Monthly	Quarterly* (25 hours)	Semi-Annual* (50 hours)	Annual* (100 hours)
Body, Seat & Frame	Visually inspect for damage or tears	X					
Hardware Tighten as needed	Tighten as needed		X				
Vehicle and undercarriage	Wash as needed		X				
Clean Body and Seat	Wash as needed		X				
Warning and operating labels	Ensure labels in place and readable	X					
Windshield	Check for visibility	X					

* Performed by trained maintenance personnel.

MAINTENANCE SCHEDULE – OPERATING CONTROLS							
Component	**Procedure**	**Daily**	**Weekly**	**Monthly**	**Quarterly* (25 hours)**	**Semi-Annual* (50 hours)**	**Annual* (100 hours)**
Steering & Linkages	Check for free movement	X					
Accelerator Linkage	Check for free movement and return	X					
Brakes	Check brake operation	X					
	Check parking brake latching release	X					
	Check brake cables for damage			X			
	Clean and adjust brakes						X
	Check rear brake drum/axle nut torque (65 ft lbs)						X
Directional Knob	Check for smooth Forward & Reverse operation	X					
Light Switch	Check for operation	X					
Turn Signal & Emergency Flashers	Check for operation	X					
* Performed by trained maintenance personnel.							

MAINTENANCE SCHEDULE - ELECTRICAL							
Component	**Procedure**	**Daily**	**Weekly**	**Monthly**	**Quarterly* (25 hours)**	**Semi-Annual* (50 hours)**	**Annual* (100 hours)**
Batteries	Check charge (fill cells prior to charging)	X					
	Check electrolyte level		X				
	Clean terminals and wash battery case		X				
	Test batteries					X	
Single point watering system	Add water		X				
	Check tubing, couplers, Secure and leak free			X			
	Clean filter screen					X	
Electrical wires	Check for tightness or damage		X				
Reverse warning buzzer	Check for operation (use keyswitch)	X					
AC Motor	Check connections. Secure and not corroded			X			
* Performed by trained maintenance personnel.							

MAINTENANCE SCHEDULE - FLUIDS							
Component	**Procedure**	**Daily**	**Weekly**	**Monthly**	**Quarterly* (25 hours)**	**Semi-Annual* (50 hours)**	**Annual* (100 hours)**
Differential lubricant	Check level					X	X
* Performed by trained maintenance personnel.							

MAINTENANCE SCHEDULE – WHEELS AND TIRES							
Component	**Procedure**	**Daily**	**Weekly**	**Monthly**	**Quarterly* (25 hours)**	**Semi-Annual* (50 hours)**	**Annual* (100 hours)**
Tires	Check for wear and damage	X					X
	Check tire pressure	X					
	Check for dented or damaged rims			X			
Front wheel alignment	Check & adjust as necessary (section 6)					X	
Lug nuts	Check for tightness	X					
Steering linkage	Check for excessive movement, tightness of hardware			X			
Front wheel hub grease fitting	Apply one shot of grease to each hub fitting						X
* Performed by trained maintenance personnel.							

BATTERIES

Batteries may be recharged if vehicle has been driven 15 minutes or more since the previous charge. Before charging, be sure master power key switch is Off and key is removed from the switch. Refer to *Chapter 8* for all procedures relating to the batteries.

DIFFERENTIAL

1. Check the differential oil only if signs of leakage are detected.
2. Change oil initially between 25-50 hours.
3. Capacity 34 ounces (1 L). SAE 30 weight.

To check/change differential oil, see Figure 3-1:

1. Raise the vehicle.
2. Remove Level/Fill screw (1). The correct level of oil is level with this hole.
3. Fill if necessary through the Level/Fill screw hole (1). Do not overfill.
4. Drain through the drain screw (2).

CHASSIS CLEANING

Proper cleaning materials and techniques are vital to the care of the vehicle.

Wash underside of vehicle to remove all dirt and debris. Wash chassis and body with a mild detergent only. Do not use abrasives on the paint.

⚠CAUTION

Do not direct high pressure water at the controller or the top of the batteries. Dry the controller and top surfaces of the batteries immediately after washing.

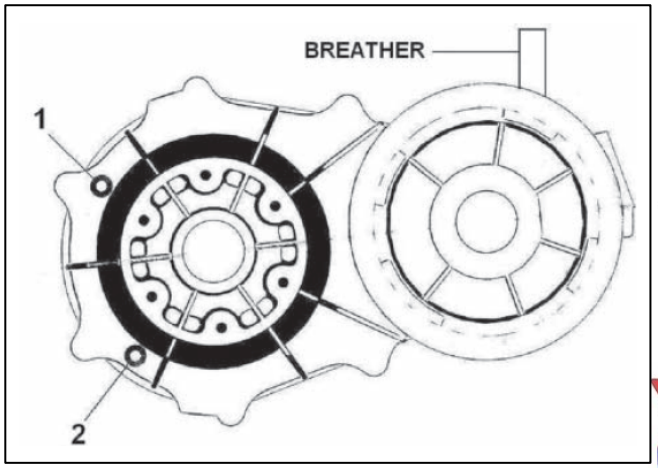


Figure 3-1

SEAT CLEANING

Proper cleaning will extend the life of the vehicle seat. Use mild soap or detergent and a soft sponge to clean whenever necessary.

For stubborn or imbedded dirt, a soft bristle brush may be used.

***NOTICE*: Do not use harsh chemicals or abrasives to clean seat material. Cracking, splitting, or "melting" of seat materials may occur. If seat material becomes torn or split, it should be replaced.**

LIFTING INSTRUCTIONS

⚠WARNING

Use extreme caution lifting or working around lifted vehicle. Vehicle should be lifted only when parked on a flat, hard and level surface.
Do not work under the vehicle unless it is firmly supported on jack stands.
When lifting the vehicle for service, use a sturdy lifting device such as a floor jack or hydraulic lift. Always wedge wheels and set parking brake of the vehicle to keep it from rolling. When using a floor jack, lift only on the frame. Place jack stands or support blocks under vehicle frame to support vehicle weight for added safety. Watch for cables, linkages or wire harness.

⚠CAUTION

If any vehicle is raised while loaded, check that the load is secured before lifting vehicle. Failure to do so could cause damage to load, vehicle, or personal injury.
Before lifting, always chock tires. Use care to prevent tipping or rolling over.
Be careful not to damage the brake cables during lifting operation.

TOOLS REQUIRED

- hydraulic trolley jack
- chocks or wooden blocks
- jack stands or support blocks

FLOOR JACK PROCEDURE

Check that the floor jack is rated at a capacity greater than the vehicle weight. Lift the vehicle sufficiently from the floor to allow the placement of jack stands or wooden blocks and hold the weight of the vehicle during service.

LIFTING REAR OF VEHICLE

1. To lift the rear, place wheel chocks in front of front wheels to prevent vehicle from rolling. Place floor jack under the rear cross frame. Do not use the cargo bed for lifting. Raise vehicle sufficiently to place jack stands underneath frame. See Figure 3-2 arrows.

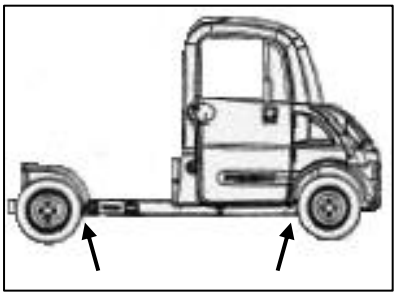


Figure -3-2

2. Place jack stands under frame at right and left sides to allow access under the vehicle.
3. When work is completed, place floor jack under rear frame cross brace, lift the vehicle and remove the jack stands, then lower vehicle to the floor.

LIFTING FRONT OF VEHICLE

1. To lift the front, set parking brake and place wheel chocks behind rear wheels. Place floor jack under the frame. Do not use the bumper for lifting. Raise vehicle sufficiently to place jack stands underneath frame.
2. Place jack stands under frame at right and left sides to allow access under the vehicle.
3. When work is completed, place floor jack under frame, lift the vehicle and remove the jack stands, then lower vehicle to the floor.

JACK STANDS

Jack stands need to be of sufficient rated load capacity to hold the vehicle safely. See *Section 2 - Vehicle Specification Chart* for empty vehicle weight.

VEHICLE STORAGE

⚠WARNING

Turn the main disconnect switch counterclockwise to the OFF position.

Electric vehicles stored over 6 to 8 weeks must be protected to maintain battery life. Several guidelines should be observed when storing the electric vehicle.

1. Clean battery terminals as described in Section 8.
2. Store vehicle in a cool dry place to prevent battery discharge.
3. Maintain tire pressure at 35 psi during storage.
4. Continue quarterly lubrication during storage period. Refer to *Periodic Maintenance* chart in the beginning of this section.
5. Clean vehicle body, seat, battery compartment and vehicle underside.
6. Do not engage parking brake. Block wheels to prevent movement.
7. Quarterly check water levels as described in *Section 8.*

The Delta-Q charger has the capability to test and recharge batteries during storage. Leave the batteries connected and the Delta-Q charger plugged into a reliable source.

RETURNING VEHICLE TO SERVICE

1. Turn the main disconnect switch clockwise to the ON position.
2. Check tire pressure and readjust to 35 psi if necessary.
3. Perform initial maintenance per *Periodic Maintenance* in the beginning of this section.
4. If equipped, with the Single Point Watering System, connect the system to its water supply for 3-5 seconds, then disconnect regardless of whether or not the batteries are completely full. Return the vehicle to its regular service. Place the vehicle back into its regular watering schedule (waiting at least 1 week until next watering.

MAINTENANCE INDICATOR

1. The MEGA Maintenance Indicator is represented by a small orange wrench and to its left, a mileage notation. See below.

2. The indicator displays when the next maintenance service should be performed. One year or 3107 miles (5000 km) are the two parameters used for this calculation.
3. After switching the ignition to position 2 for 5 seconds this indicator will show the mileage that is remaining before the next service is due. The wrench will also be lit. After 5 seconds the wrench will go out and the trip meter mileage will now be displayed.
4. If the service distance has been reached or passed the wrench will light as well as the exceeded distance and a minus (-) sign. This will flash for 5 seconds. After 5 seconds the trip meter mileage is again displayed but the wrench will remain lit.

NOTICE: **To change from English to metric units, hold down the left reset button and turn the keyswitch on. The alternate measurement units will now be displayed.**

5. After performing the required services, the Maintenance Indicator must be reset. Turn the keyswitch to the second position, after 5 seconds the wrench and a mileage are shown. At this point hold down both buttons on the dash. After 5 seconds the trip mileage will be displayed. After another 5 – 10 seconds, the word RESET will display. At this point turn the keyswitch off/on and the wrench and mileage display will indicate 3107 mi. (5000km). Depending upon the software version, it may be necessary to hold the reset buttons down prior to turning on the keyswitch.

TRANSPORTING THE VEHICLE

***NOTICE*: Never tow a vehicle behind an auto or truck unless on an approved trailer.**

When trailering the vehicle over long distances or on the highway observe the following:

1. Use trailers specifically designed to carry the Columbia ParCar vehicle that meets all federal, state and local requirements.
2. Secure vehicle to the trailer following trailer manufacturer's instruction.
3. The key should be removed from the vehicle, the parking brake firmly locked, and the wheels blocked.
4. On vehicles equipped with high or wide additions or accessories, be certain they are secured properly to prevent loss or damage while trailering.

⚠CAUTION

Increased transporting speed adds undo stress to windshield or cab and will increases chance of loss, damage, accident or injury.
Use care when transporting on windy days. Example: A 60 MPH speed into a 40 MPH head wind is equal to traveling at 100 MPH. Industrial vehicles are not rated to withstand this level of stress and parts could blow off, causing accident or injury.

METRIC CONVERSION AND TORQUE FACTORS

Individual component torques and metric equivalents are listed where the maintenance is to be performed throughout this manual. When a specific fastener torque is not specified, use the following Torque Table as a general guide in determining proper torque. When a metric equivalent is not listed, use the Conversion Factors Chart to convert to metric values.

CONVERSION FACTORS

Into metric			Out of metric		
To convert from	**To**	**Multiply by**	**To convert from**	**To**	**Multiply by**
Work force measurement					
inch pound	nm	0.1130	newton meter	in. lb.	8.8496
foot pound	nm	0.3558	newton meter	in. lb.	0.7376
Length measurement					
inch	mm	25.4	centimeter	in.	0.394
foot	m	0.3048	meter	ft.	3.2808
miles	kilometer	1.6	kilometer	miles	0.62
Liquid volume measurement					
fluid ounces	milliliters	30	milliliters	fluid ounces	0.03
pints	liters	0.47	liters	pints	2.1
quarts	liters	0.95	liters	quarts	1.06
gallons	liters	3.8	liters	gallons	0.26
Temperature					
fahrenheit	^{0}C	^{0}C = ^{0}F - 32/1.8	celsius	^{0}F	^{0}F = 1.8^{0}C + 32

Torque Table Torque to the value in this table unless specified otherwise.													
Fine or coarse thread fastener	**Grade Designation**	**Tensile Strength Minimum**	**Material**	**Screw, Stud or bolt shank size or diameter Torque figures are in ft. lbs.**									
				1/4	**5/16**	**3/8**	**7/16**	**1/2**	**9/16**	**5/8**	**3/4**	**7/8**	**1**
cap screw	S.A.E. 2 A.S.T.M. A-307 steel	64,000 psi	low carbon steel	6	11	19	30	45	66	90	150	202	300
cap screw	S.A.E. 3 steel	100,000 psi	medium carbon steel	9	17	30	47	69	103	145	234	372	551
cap screw	S.A.E. 5 A.S.T.M. A-499 steel	105,000 psi	medium carbon steel or low alloy heat treated	9	18	31	50	75	110	150	250	378	583
cap screw	A.S.T.M A-354BB steel												
cap screw	A.S.T.M A-325							100		200	355	525	790
cap screw	A.S.T.M A-354BC steel	125,000 psi	low alloy or medium carbon steel quenched tempered	11	20	34	54	81	119	167	269	427	644
cap screw	S.A.E. 6 steel	133,000 psi	medium carbon steel quenched tempered	12.5	24	43	69	106	150	209	350	550	825
cap screw	S.A.E. 7 steel		medium carbon alloy quenched tempered roll threaded										
cap screw	S.A.E. 8 steel	150,000 psi	medium carbon alloy quenched tempered	13	28	46	75	115	165	225	370	591	893

⚠ DANGER

Always turn Power key to OFF, Directional selector to NEUTRAL, remove Power key and block tires. Turn the main disconnect switch counterclockwise to the OFF position before servicing or repairing your vehicle.

PRE-TROUBLESHOOTING STEPS

Before troubleshooting a vehicle for any problem or symptoms, certain steps must be followed.

Inspect/Test	Corrective Action
1. Ensure the vehicle is safe for service.	Visually inspect for any obvious signs of hazards such as sharp edges in the body or other parts, open wire insulation or wire connections, or discolored parts of the vehicle indicating heat or chemical presence.
2. Record the Vehicle Identification Number (VIN)	This number is necessary to obtain technical help or support, submit warranty, and is essential in order to understand completely the vehicle that is being serviced. The VIN, with the help of the correct VIN matrix, will denote specific information about each vehicle, such as operating power system and voltage, brake package options, speed operation settings, and other vehicle configuration options.

BATTERY TESTING

The first step in servicing any electric vehicle that is not operating properly is to completely test the batteries. The batteries are the source of power for the vehicle drive and auxiliary systems, therefore are the most integral part of the electric vehicle troubleshooting. Battery testing should be done as follows and in the order as follows

Inspect/Test Condition		Corrective Action
1. Perform a visual examination of batteries and connections	Examine for signs of corrosion and clean/or replace any affected terminals or cables.	The batteries can be cleaned by hose washing with a standard garden hose or with a soft bristle brush (ensure battery caps are present and tight before washing batteries).
	Examine the battery hold-down. If the material from the hold-down has been dissolved by the sulfuric acid in the batteries, the hold-down can act as a drain on the battery pack.	Replace the hold-down if it appears damaged.
2. Test each battery with a VOM (volt-ohm meter).	With VOM set to a scale able to read DC volts at up to 100 volts (or greater), check each battery individually, and test the entire pack together.	Place the VOM probes on the battery positive post and battery negative post of each battery. Record the reading from each battery. Each should contain at least 6.0 volts and no battery should be more than .5 volts lower than the highest reading. If any battery tests low on charge, charge the battery individually with an auxiliary charger or the entire pack with the Delta Q charger (allow charging until the remote LED indicates a full charge). If one or more batteries still test low, the battery should be tested individually and replaced as necessary. *NOTE: It is recommended that all batteries in a system be changed together to ensure the batteries are the same brand, vintage, and service life.*
3. Test each battery cell with a battery hydro-meter.	Any battery or battery cell that tests low should be fully charged and then rechecked.	If the cell continues to test low with a hydrometer, the battery should be replaced. See note above.
4. A battery may test good with a voltage or hydro-meter test when no load is being drawn from it. Test using a battery load tester.	A battery must be able to produce 45 minutes of capacity when tested at 55 amp draw after a complete recharge cycle.	A battery that is not able to produce this capacity should be replaced. See note above.

TROUBLESHOOTING SPECIFIC COMPLAINTS

Troubleshooting is a matter of investigation and deduction based on the symptoms and the possible causes. Recording every possible solution to every possible cause would be impossible, but this troubleshooting section is designed to assist in solving issues which may arise in the service life of an electric vehicle. Problems that could be encountered with the vehicle(s) are:

- Vehicle operates slowly
- Vehicle drives in forward or reverse only
- Vehicle drives but operation is jerky or inconsistent
- Vehicle power cuts out

***NOTICE*: Always follow troubleshooting guide in exact sequence as listed. Performing tests out of sequence will cause inaccurate results and lost time in diagnosing electrical system problems.**

Before attempting to service a vehicle, complete the pre-service inspection and fully test the batteries as described on the previous page.

VEHICLE WILL NOT OPERATE OR POOR PERFORMANCE

See Figure 4-1. Set the vehicle power switch to "ON". The Multifunctional Digital Indicator (MDI) will indicate an alarm. The alarm is displayed by a code; the first two digits inform about electronic module which is in alarm (16 = MDI; 02 = Traction controller; 05 = Pump controller; ...). The last two digits give the alarm code.

See the AC Power System Manual for decoding of the displayed alarms and use of the troubleshooting handset.

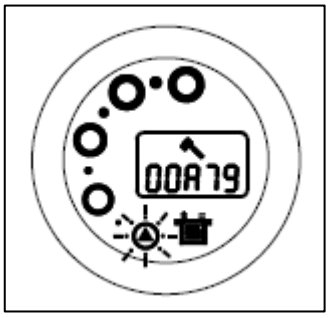


Figure 4-1

COMPONENT TROUBLESHOOTING

In addition to the problems/cause/solutions listed in this section, individual sections also contain some testing and problem solution for individual components. Check the appropriate section first, and if the information is not found, check the following when a component is causing a problem:

MULTIFUNCTIONAL DIGITAL INDICATOR (MDI)

1. Fuse failed.
   Check fuse and replace if failed.
2. Open wiring or failed connection.
   Check wiring and connections
3. Inoperable MDI gauge.
   Replace gauge.
4. Weak or failed batteries.
   Test batteries and charge as necessary.

BRAKE LIGHTS

1. Fuse failed.
   Check fuse and replace if failed.
2. Open wiring or failed connection.
   Check wiring and connections
3. Bulb failed.
   Replace bulb.
4. Misadjusted or inoperable brake light switch.
   Check switch adjustment, replace switch if necessary.

REVERSE BEEPER

1. Fuse or relay failed.
   Replace fuse or relay.
2. Open wiring or failed connection.
   Check wiring and connections
3. Inoperable reverse beeper.
   Replace beeper.
4. Weak or failed batteries.
   Test batteries and charge as necessary.
5. Controller set wrong.
   Check controller setting using hand held. Reset if necessary.
6. Inoperable directional switch.
   Test switch and replace if necessary.

HEADLIGHTS

1. Fuse failed.
   Check fuse and replace if failed.
2. Open wiring or failed connection.
   Check wiring and connections
3. Bulb burnt out.
   Replace bulb.
4. Failed power key switch.
   Test and replace contactor as necessary.
5. Inoperable switch.
   Replace switch.

POWER OUTLET

1. Fuse failed.
   Check fuse and replace if failed.
2. Open wiring or failed connection.
   Check wiring and connections
3. Inoperable power outlet.
   Replace power outlet.

TAIL LIGHT

1. Fuse failed.
   Check fuse and replace if failed.
2. Open wiring or if failed connection.
   Check wiring and connections
3. Bulb burnt out.
   Replace bulb.
4. Failed power key switch.
   Test and replace as necessary.

BACKUP LIGHT

1. Fuse or relay failed.
   Replace fuse or relay.
2. Open wiring or if failed connection.
   Check wiring and connections
3. Light burnt out.
   Replace light.
4. Failed power key switch.
   Test and replace as necessary.

BRAKES

Slow or incomplete release of brakes.

1. Shoes and linings.
   Shoes improperly adjusted. Shoes are self-adjusting; check parts for wear. Shoes distorted or incorrect. Replace with new parts
2. Mechanical parts.
   Damaged or weak return springs-replace. Cables and linkage sticking, dirty or corroded. Lubricate with a commercial solvent like WD40, PB Blaster, etc. Make sure not to contaminate brake pads with solvent.
3. Wheel bearings.
   Damaged or contaminated-replace. Grabbing or pulling-replace.
4. Air in hydraulic lines (hydraulic brakes).
   Bleed hydraulic lines.

Severe reaction to pedal pressure and uneven stopping.

1. Shoes and linings.
   Shoes improperly adjusted. Shoes are self-adjusting; check parts for wear. Shoes distorted or incorrect. Replace with new parts
2. Mechanical parts.
   Damaged or weak return springs-replace. Cables and linkage sticking, dirty or corroded. Lubricate with a commercial solvent like WD40, PB Blaster, etc.
3. Drums.
   Drums are thin (expanding when hot); oversize (beyond .030") of original specification – replace. Scored, out-of-round – replace

Squealing, clicking or scraping noises upon application of brakes.

1. Shoes and linings.
   Shoes twisted, distorted, incorrect or broken – replace. Linings worn out, glazed, loose or contaminated – replace.
2. Mechanical parts.
   Damaged or weak return springs-replace. Backing plate loose or failed – replace.
3. Drums.
   Drums are thin (expanding when hot); oversize (beyond .030") of original specification – replace. Scored, out-of-round – replace

⚠ DANGER

Always turn Power key to OFF, Directional selector to NEUTRAL, remove Power key and block tires. Turn the main disconnect switch counterclockwise to the OFF position before servicing or repairing your vehicle

ACCELERATOR PEDAL

Accelerator pedal maintenance consists of periodic inspection. No lubrication or adjustment is necessary. The accelerator pedal is a fully intergraded device and you utilize the controller to adjust and control vehicle direction and speed.

All adjustments are made using the handset. See AC Power System manual.

HYDRAULIC BRAKE SYSTEM

The hydraulic brake system utilizes a combination of mechanical and hydraulic components and is equipped with front disc and rear drum brakes.

A mechanical brake pedal/linkage assembly is utilized to actuate a master cylinder. The master cylinder creates hydraulic pressure which operates the brakes.

Hydraulic brake systems require a separate mechanical parking brake. A hand operated parking brake, mechanical linkage and cables are utilized to mechanically lock the rear brakes for parking.

⚠CAUTION

Do not handle hydraulic system parts with greasy hands or permit parts to come in contact with oil or grease. Grease or oil will damage the rubber parts.

PERIODIC BRAKE INSPECTION

Intervals between brake service and inspection may vary depending on driving habits, type of driving, road and climate conditions, and vehicle load.

⚠CAUTION

Periodic brake inspection is required to prevent potential accident or injury and vehicle damage.

Periodic inspection should always include the following:

1. With vehicle stationary, depress the brake pedal. Pedal should not travel in excess of 2-1/2” as measured from floor board. If pedal travels in excess of 2-1/2” before resistance is felt, or if pedal feels spongy and soft, repair or maintenance is required.
2. Inspect brake master cylinder and adjoining brake lines for signs of fluid leakage. Remove master cylinder cover (Figure 5-1). Fluid must be clear and fluid level should be within 1/4” of cylinder top (with vehicle on level ground).

Figure 5-1

3. Check parking brake operation. Parking brake hand lever should travel no more than 3-1/2” upward when engaged. Check that ratchet mechanism automatically holds parking brake handle in up position. Make sure release button on handle frees the parking brake lever and that lever returns to full down (released) position.
4. Operate vehicle on level ground, applying brakes to ensure that both rear brakes apply equally. Check that excessive force is not required to apply brakes. Excessive force required to apply brakes could indicate malfunctioning brake system or excessive wear to brake shoes.

ANNUAL BRAKE INSPECTION

⚠WARNING

To perform this service, raise vehicle using floor jack and safely support it with jack stands positioned under main frame tubes. See *Section 3 - Lifting Instructions*.

1. Perform steps 1 & 2 under *Rear Drum Brake Disassembly*.
2. Inspect drum for excessive or uneven wear. Refer to *Brake Drum Service*. Look for cracks radiating from stud holes.
3. Inspect brake shoes for thickness, uneven wear or physical damage. If brake shoe lining at any point is measured to be less than 1/16” (1.6 mm), brake shoes must be replaced. See *Rear Drum Brake Disassembly.*
4. Inspect for oil or grease contamination. Replace brake shoes that are contaminated. See *Rear Drum Brake Disassembly*.
5. Inspect wheel cylinder area for fluid leakage. Inspect axle and axle tube area for leakage from axle bearing.

6. Wash mud, brake shoe debris, and dirt from brake assemblies and drum. Apply white lithium grease to contact points between brake shoe and brake back plate. Remove excess grease to prevent brake shoe contamination.

⚠CAUTION

Do not use compressed air to blow dust from brake assembly. Brake dust contains potentially harmful contaminants.

7. Perform steps 5-8 under *Rear Drum Brake Reassembly*.

REAR DRUM BRAKE DISASSEMBLY

⚠CAUTION

Do not depress brake pedal while shoes and drum are removed from the vehicle. Pistons will be forced from the wheel cylinders causing fluid leakage and damage.

***NOTICE*: It is not recommended to remove the hydraulic brake assembly from the axle for repair or service.**

- Before removal of existing parts, note location of colored springs and other parts for correct reassembly.
- Always use a brake spring tool to remove and install springs.
- Always lay out brake shoes and other parts in order removed. Reinstall in same order.
- Always replace brake shoes that have been contaminated with oils or lubricants.
- Always replace any springs that appear stretched or deformed.
- Never use petroleum based cleaners or lubricants on hydraulic brake parts as they will contaminate the brake fluid.

***NOTICE*: Do not mix parts from left and right brake assemblies as they may differ.**

1. Engage the parking brake. Remove four nuts and remove rear wheel/tire assembly.
2. Release parking brake. Remove Torx screw (Figure 5-2) and brake drum.
3. Remove axle nut and wheel hub (Figure 5-3).

Refer to Figure 5-4 for steps 3 - 6.

4. Use a brake spring tool and remove the shoe return springs (short and long). Unhook each spring from the brake shoes and set it aside.
5. Remove the spring clips and remove the brake shoes.
6. Clean the brake assembly to remove brake debris, dust, dirt and mud.
7. See *Brake Drum Service* and rebore/replace drum as necessary.
8. See *Wheel Cylinder* and replace as necessary.

⚠CAUTION

Do not use solvents or other chemical cleaners unless formulated for cleaning brake parts.

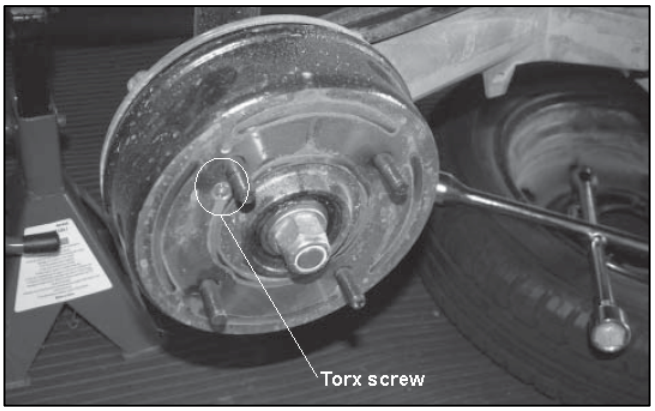


Figure 5-2

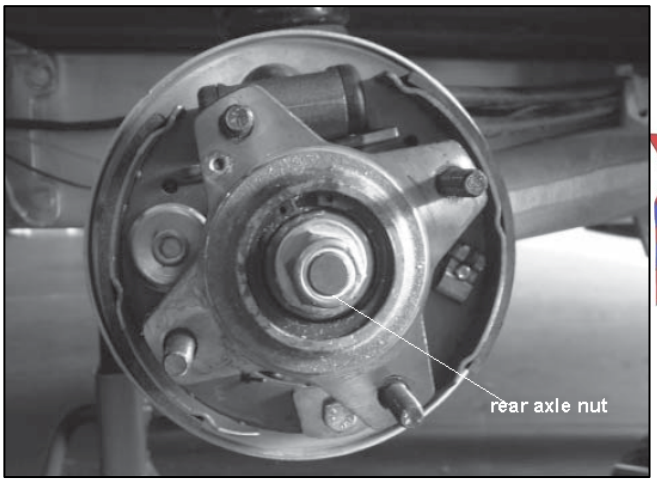


Figure 5-3

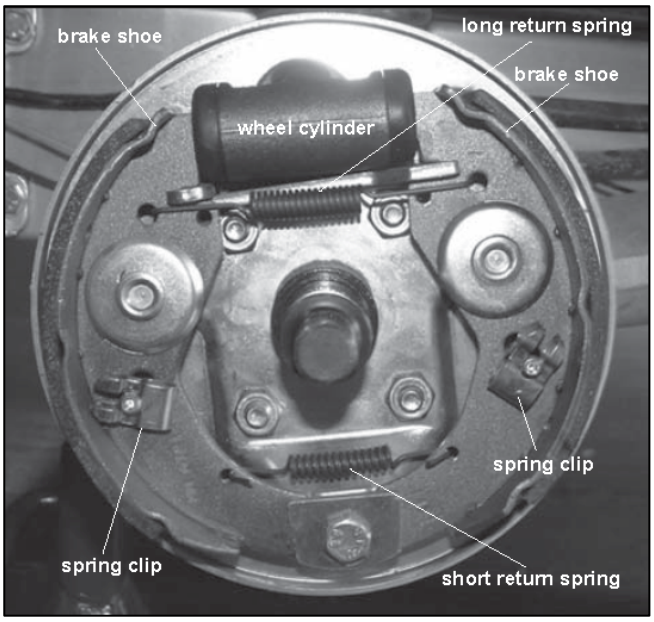


Figure 5-4

BRAKE DRUM SERVICE

1. Rebore or replace drum:
   if rubbing surface is rough or ragged, or if depth of scoring exceeds .010".

   if inside diameter of drum at open end exceeds inside diameter at closed end by more than .010".

   if surface variance exceeds .005" on the side.

   if hard spots cause noticeable effects such as pedal pulsations or brake roughness. If spots are severe, replace drum.

   if heat checking is plainly visible or can be felt with a fingernail.

   if checks are severe, replace drum.

   if out-of-round condition exceeds .006" total indicator reading or if pedal pulsations or brake roughness is noticeable.
2. To measure a drum diameter, place gauge in drum so contact points are at greatest diameter. Be careful to hold both contact points at same depth (distance from outside edge of drum).
3. Rebore limit is .060" over original drum diameter.
4. Difference in diameter of drums on opposite ends of the same axle must not exceed .010", or when turning drums turn them in pairs to same oversize (within .010") to ensure equal braking effort on all wheels.

⚠CAUTION

Never rebore a drum to maximum wear or discard diameter.

5. When re-boring a drum, remove only enough metal to obtain a smooth braking surface. If drum does not clean up when turned to maximum rebore diameter, replace it. Removal of more metal will affect ability of drum to dissipate heat and may cause drum distortion.

WHEEL CYLINDER SERVICE

The wheel cylinder is a one piece cast assembly. Removal of the wheel cylinder is recommended only when replacement is required. To remove, see *Section 7 - Rear Axle and Rear Wheel Assemblies*.

REAR DRUM BRAKE REASSEMBLY

1. Place brake shoes into position on retaining pins. Install spring clips. Make sure shoes are positioned properly on cylinder. Check that brake shoes are correctly positioned into the slots provided in each master cylinder piston.
2. Install long return spring (top) and short return spring (bottom).
3. Install the brake drum fully onto brake assembly and install four new nuts.
4. Reinstall rear wheel/tire assembly and four lug nuts. Engage brake and tighten lug nuts in a crisscross pattern to a maximum 65 ft. lbs. (Figure 5-5). Repeat for other rear wheel/tire assembly. Recheck lug nut torque with vehicle on the ground.

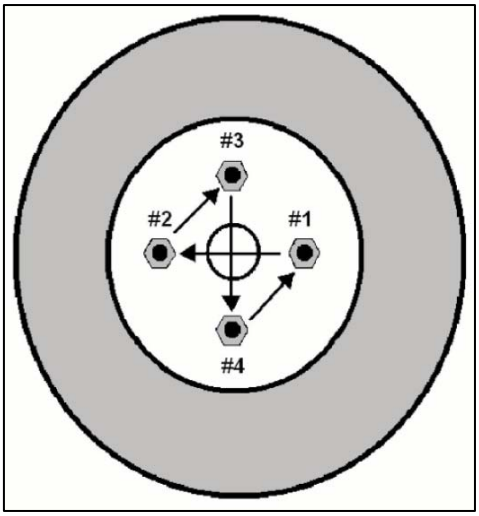


Figure 5-5

BRAKE FLUID MAINTENANCE

1. Maintain fluid level within 1/4" of master cylinder filler opening (Figure 5-1).

2. Changing brake fluid:
   As a result of use, brake fluid loses some of its original qualities and may become contaminated. When performing major brake work to the hydraulic system, remove old fluid and replace it with clean brake fluid.

   Brake fluid must be changed following extended usage or contamination. Anytime fluid looks milky or dark, there are contaminants in the fluid.

   If any of the hydraulic system parts are corroded, or the fluid is discolored, flush the hydraulic system to remove old fluid, then fill with clean brake fluid.

3. Soft or swollen rubber parts, or milky or discolored fluid indicate the brake fluid is contaminated.
   Drain old fluid from the system.

   Replace cups and seals.

   Flush hydraulic system with clean brake fluid.

   Refill system with clean brake fluid.

4. Handling and storing brake fluid:
   Keep brake fluid clean. Do not allow any foreign material in the fluid.

   Prevent any petroleum product (gasoline, kerosene, oil, grease, etc.) from contaminating the brake fluid.

   Use only clean containers for dispensing brake fluid. Do not use containers contaminated with dirt, grease, etc.

   Always cover or cap brake fluid containers when not actually dispensing the fluid. If containers are left open or uncovered, the fluid absorbs moisture from the air.

   Never reuse old brake fluid drained from the system. Used brake fluid is contaminated to some extent.

   Store brake fluid containers in a clean, dry place.

BLEEDING THE HYDRAULIC BRAKE SYSTEM

⚠WARNING

Brake fluid can cause irritation of eyes and skin, and may be harmful if swallowed. If fluid is swallowed, induce vomiting by administering two tablespoons of salt in a glass of warm water. Call a doctor. In case of contact with skin or eyes, flush with plenty of water. Get medical attention for eyes. KEEP BRAKE FLUID OUT OF THE REACH OF CHILDREN

If any line or cylinder has been opened when servicing the brake system, or when satisfactory brake adjustment is unobtainable, or pedal is spongy, bleed air from the hydraulic system as follows:

1. Install a length of appropriate size plastic tubing over the wheel cylinder bleeder valve located on the back side of the hub assembly (Figure 5-6).

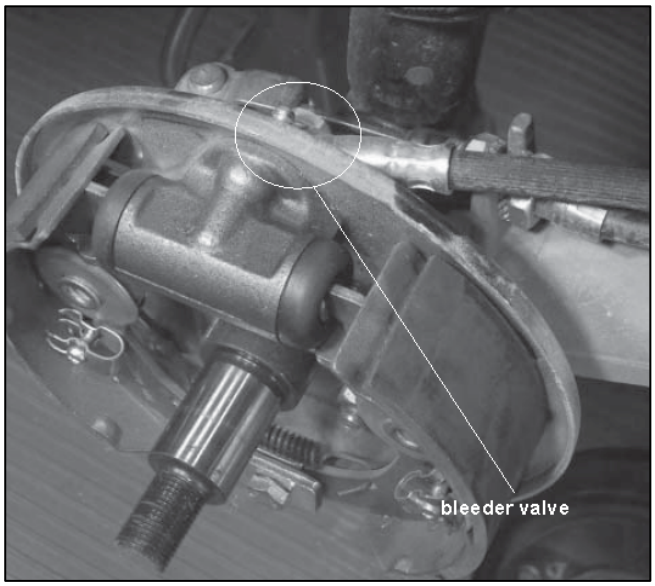


Figure 5-6

***NOTICE*: Bleed both right side wheels first, then both left side wheels.**

2. Place the other end of tubing in any clear glass jar containing about 1/2" of brake fluid.

3. Open bleeder valve by rotating it counterclockwise about 1/2 turn. With master cylinder full of fluid at all times, slowly depress the brake pedal repeatedly until fluid flows from bleeder valve free of air bubbles.

4. Add fluid to master cylinder to bring 1/4" from cover. Close bleeder valve. Repeat procedure on left wheel.

5. Do not reuse fluid unless it is clear and free of sediment. If it is impossible to bleed all air from system, master cylinder is faulty and a master cylinder repair kit should be installed.

FRONT DISC BRAKE

Disc brakes are not adjustable and rarely cause problems. If problems are encountered, refer to the following service and inspections procedures for possible causes and solutions.

REPLACING BRAKE PADS

⚠CAUTION

Do not depress brake pedal while brake pads are removed from the vehicle. Pistons will be forced from the wheel cylinders causing fluid leakage and damage.

1. With vehicle on the ground, depress the brake pedal to engage the brakes. Loosen wheel assembly mounting nuts.

2. Raise and secure vehicle as described in *Section 3-Lifting Instructions.*
3. Remove four nuts and front wheel/tire assembly.
4. Disengage the brakes and remove brake caliper mounting hardware (Figure 5-7).

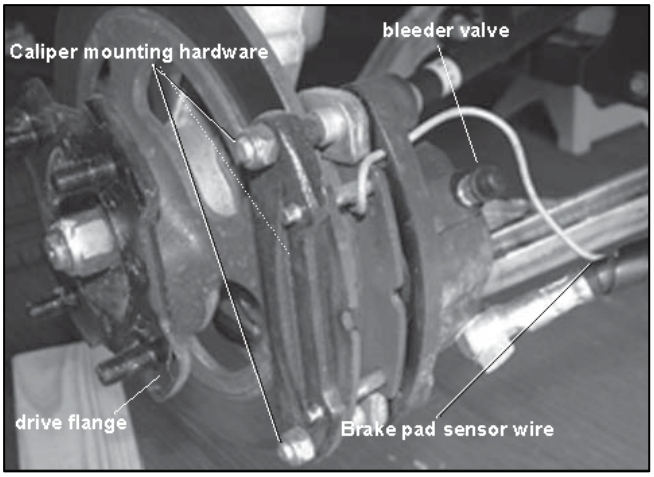


Figure 5-7

5. Remove old pads and replace with new pads.

***NOTICE*: The inner brake pad has a sensor wire attached. Unwrap the protective wire covering on the brake line enough to expose the wire connector. Disconnect brake pad wire from main harness. Plug in wire from new pad and rewrap protective covering.**

6. Reinstall brake pad mounting hardware and tighten.
7. Repeat steps 4 - 8 for other front wheel.
8. Reinstall rear wheel/tire assembly and four lug nuts. Engage brake and tighten lug nuts in a crisscross pattern to a maximum 65 ft. lbs. (Figure 5-5). Recheck lug nut torque with vehicle on the ground.

BRAKE CALIPER SERVICE

The pistons must be removed from the bores. Using the vehicle's hydraulic pressure to force them out is the easiest method.

1. Remove brake pads as described above.
2. Rotate the caliper off the rotor. With caliper still bolted to the vehicle and hydraulic lines connected, press brake pedal until both pistons slide out of the bores. Push one side out, then remove piston from the other side. To prevent brake fluid from squirting out, cover the calipers with a cloth.
3. Remove the seals and boots. Rubber dust boots and seals should be replaced whenever the caliper is disassembled.
4. Clean pistons in alcohol, then wipe dry with a clean lint-free cloth.
5. Blow out all drilled passages with compressed air.
6. Inspect cylinder bores in both sides of the caliper housing for scoring and pitting. Bores that show light corrosion can be cleaned with fine grit crocus cloth. Caliper bores with deep scratches or scoring should be honed with a 1/4" electric drill. The same attachment is used for honing wheel cylinders on drum brakes. The caliper cylinder must not be honed out larger than the manufacturer's specifications-not more than .002" oversize.
7. Black stains on the bore caused by piston seals are not harmful and need not be removed.
8. After honing, take care in cleaning the caliper parts. Flush them with alcohol, wipe dry with a clean lint-free cloth, then flush and dry them again. Clean mating surfaces with No. 400 wet or dry sandpaper, ***never*** use a file.
9. Lubricate internal areas, pistons and piston O-rings with new brake fluid. Install parts into caliper.
10. Install brake pads and secure with mounting bolts.
11. Rotate caliper with rotor centered in brake pads and install caliper upper mounting hardware (Figure 5-6).
12. Reinstall rear wheel/tire assembly and four lug nuts. Engage brake and tighten lug nuts in a crisscross pattern to a maximum 65 ft. lbs. (Figure 5-5).
13. Perform all steps in *Bleeding the Hydraulic System*.
14. Recheck lug nut torque with vehicle on the ground.

BRAKE ROTOR SERVICE

Disc must be flat with no warping or hot spots. Runout in a disc brake rotor is like out-of-roundness in a drum brake. It causes a loss of brake pedal height because of extra lining clearances.

Runout wears the caliper pistons and seats rapidly due to the high speed pulsations created whenever the brakes are applied.

Runout tolerances are critical, usually only about .002".

***NOTICE*: As much as .015" of metal can be removed from each side of the rotor without exceeding specifications. If removing the maximum specified amount will not clean up a rotor's problems, install new rotors.**

1. With vehicle on the ground, depress the brake pedal to engage the brakes. Loosen wheel assembly mounting nuts and axle nut. Loosen on both wheels if both rotors are to be serviced.
2. Raise and secure vehicle as described in *Section 3-Lifting Instructions.*
3. Remove four nuts and front wheel/tire assembly. Remove axle nut and washer.

4. Remove brake caliper mounting hardware and brake caliper (Figure 5-6).

⚠CAUTION

Do not depress brake pedal while brake caliper is removed from the vehicle. Pistons will be forced from the wheel cylinders causing fluid leakage and damage.

5. Remove front hub assembly as described in *Section 6-Wheel, Suspension & Steering.*
6. Remove retaining ring from back of hub assembly. Using an arbor press, remove rotor/drive flange assembly from front hub assembly.
7. Remove drive flange from rotor.
8. Perform rotor service or replace rotor.
9. Install drive flange to rotor.
10. Press rotor/drive flange assembly into hub assembly. Reinstall a new retaining ring.
11. Install front hub assembly as described in *Section 6-Wheel, Suspension & Steering.*
12. Reinstall brake caliper with mounting hardware (Figure 5-6).
13. Reinstall front wheel/tire assembly and four lug nuts. Engage brake and tighten lug nuts in a crisscross pattern to a maximum 65 ft. lbs. (88.1 Nm) (Figure 5-5).
14. Tighten axle nut.
15. Lower vehicle to the ground as described in *Section 3-Lifting Instructions.*
16. Recheck lug nut torque and axle nut torque with vehicle on the ground.
17. Reinstall wheel cover (if equipped).

HYDRAULIC BRAKE LINKAGE ADJUSTMENT

Gently depress brake pedal and check for free movement before master cylinder piston is depressed. If there is no free travel in the pedal before the master cylinder plunger begins to move, or if the free travel of the pedal exceeds 3/8", adjustment of the brake rod will be required.

1. Remove cotter pin and clevis pin from brake rod at the brake pedal.
2. Rotate brake rod clevis accordingly to decrease or increase free play as required.
3. Reconnect brake rod clevis with clevis pin and new cotter pin.
4. Recheck brake pedal for correct free movement.

PARKING BRAKE PEDAL ADJUSTMENT

***NOTICE*: Correct parking brake operation should be confirmed before adjustments are made to cables and mechanical linkage. Check that corrosion has not caused excessive resistance in the operation of the brake cables. If corrosion is present, replace cables before performing adjustments.**

Lift up the parking brake handle to monitor the amount of travel. The handle should click or ratchet two or more times before resistance is felt and the parking brake is set. If the brake handle rises in excess of 3-1/2" from its original down position, brake cable and linkage adjustment is required as follows:

1. Parking brake rod linkage is connected to the brake equalizer, located under the seat.
2. Loosen jamnut securing the brake clevis to the rod. Turn adjusting nut to shorten or lengthen rod as required, then retighten jamnut.
3. Recheck parking brake operation to confirm adjustment.

⚠ DANGER

Always turn Power key to OFF, Directional selector to NEUTRAL, remove Power key and block tires. Turn the main disconnect switch counterclockwise to the OFF position before servicing or repairing your vehicle

GENERAL

The steering system is operated by rotating the steering wheel. The steering wheel rotates the steering shaft connected to the rack and pinion steering assembly. The rack and pinion assembly pushes and pulls on tie rod ends to control front wheel steering.

The front suspension consists of two shock absorbers and springs.

***NOTICE*: Always inspect the condition of vehicle steering components before making adjustments. Worn, broken or damaged parts must be replaced before proper adjustment can be performed.**

REMOVING WHEELS

1. Before raising vehicle, with wheels on the ground, remove wheel cover (if equipped) and break loose the lug nuts.

⚠WARNING

To perform this service, raise vehicle using floor jack and safely support it with jack stands positioned under main frame. *See Section 3 - Lifting Instructions*.

2. Remove lug nuts and wheel assembly from the hub.

INSTALLING WHEELS

1. Place wheel assembly on the hub studs.
2. Tighten four lug nuts by hand and wrench until snug using a crisscross pattern (Figure 5-5).
3. Lower the vehicle as instructed in *Section 3-Lifting Instructions*. 4. Torque the lug nuts to 65 ft. lbs. using the same crisscross pattern.
5. Reinstall wheel cover (if equipped).

TIRE REMOVAL

In the event of a flat tire, remove wheel assembly from vehicle. Inflate tire to 3 - 35 psi . Immerse wheel assembly in water to determine point of leak. Mark leak location. If tire can be repaired, use the following procedure to remove and install tire.

***NOTICE*: Tire must be removed from valve stem side of wheel.**

1. Remove wheel assembly from vehicle.
2. Remove valve cap and valve core to deflate tire.
3. If tire machine is unavailable, lay wheel assembly on ground (valve stem side up) and break the tire bead from the wheel (Figure 6-1).
4. Pry the tire off the wheel flange and push into the wheel well (Figure 6-2).
5. Apply tire mounting lubricant to tire bead. With valve stem side up, carefully start upper bead over wheel flange with a flat tire tool. When top bead is free from wheel, pry lower bead over wheel flange (Figure 6-3).

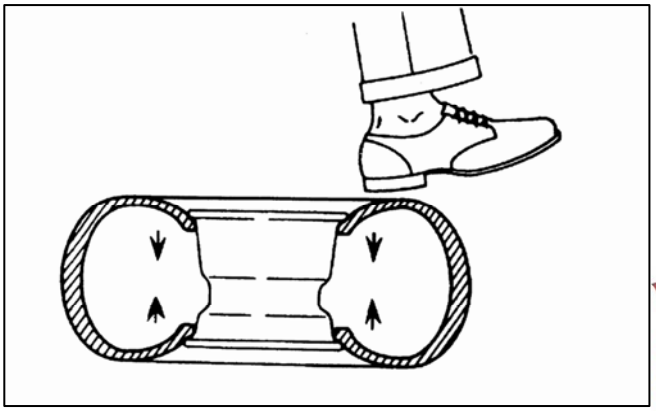


Figure 6-1

INSTALLING TIRE

⚠WARNING

Keep hands, fingers, etc. from exposed areas between tire bead and wheel while mounting or inflating tire.

***NOTICE*: Tire must be installed to wheel from valve stem side.**

IMPORTANT! Cleaning tire and wheel is very important, as tubeless tires require a perfect seat to seal.

1. Clean tire beads to remove dirt and foreign matter. Use a wire brush to clean wheel where the bead seats.
2. Check valve stem. Replace worn or leaking stems.
3. Apply liberal amount of tire mounting solution to both tire and wheel.
4. Install tire on wheel from valve stem side. If tire machine is unavailable, use rubber mallet and tire iron to install tire on wheel.
5. Remove valve stem core and position tire so the bead is seated on bead area.
6. Place tire upright against a wall and push against tire on opposite side (Figure 6-4). This three-point contact will bring bead out to contact wheel and bead snaps into place as air is applied.

⚠WARNING

Use care when inflating a tire with a high pressure air supply. Due to low pressure requirements of a small tire, over inflation may be reached in a matter of seconds. Over inflation could cause the tire to explode resulting in possible personal injury. Do not exceed maximum tire pressure as stated on tire sidewall.

7. Apply high pressure air through valve stem. Approximately 40 psi should be used to seat tire bead.
8. Quickly remove air pressure and install valve stem core.
9. Inflate tire to correct tire pressure and immerse wheel/ tire assembly in water to check for leaks.
10. Place wheel assembly on the hub studs.
11. Tighten four lug nuts by hand and wrench until snug using a crisscross pattern (Figure 5-5).
12. Lower the vehicle to the ground and torque the lug nuts to 65 ft. lbs. (89 Nm) using the same crisscrossing pattern.

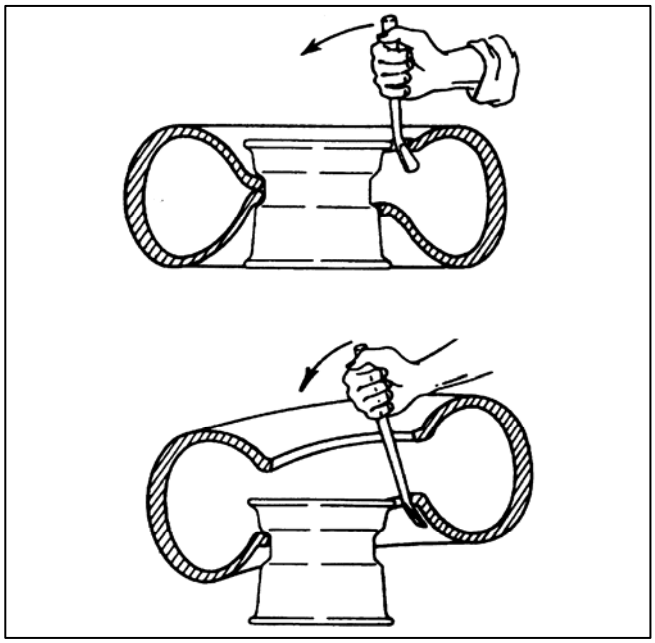


Figure 6-2

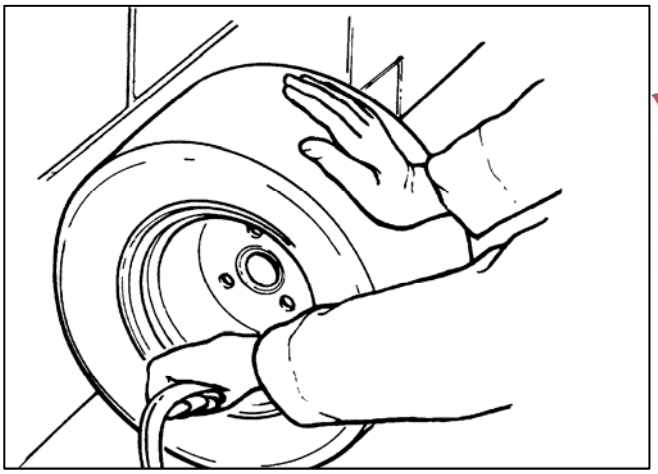


Figure 6-3

REMOVING REAR WHEEL HUB & BEARING

1. Remove rear wheel as described previously.
2. Remove the axle nut and washer then remove wheel hub (Figure 6-4).

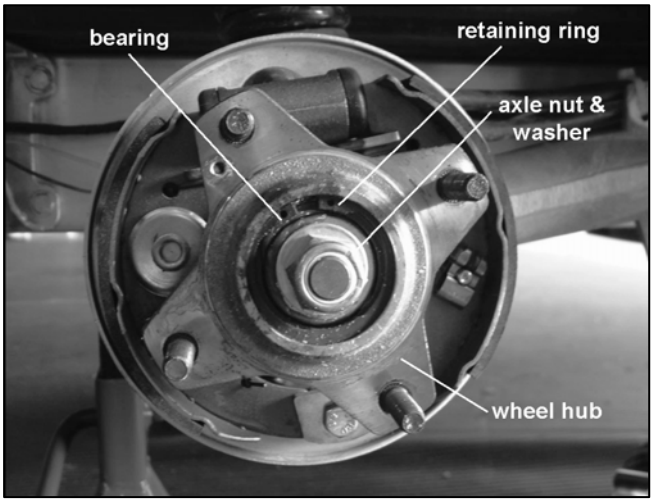


Figure 6-4

***NOTICE*: Press on the outside of the bearing rim and not on the inside parts, or the bearing will be destroyed.**

REAR HUB SEALED BEARINGS

Rear wheel hubs have sealed bearings. They cannot be repacked and must be replaced if damaged. Bearings should be replaced whenever wheel hub is removed. Never reuse a sealed bearing once it has been removed from the wheel hub. Replace with a new bearing.

1. Remove retaining ring from hub.
2. Set hub on blocks, in a press, with grease seal on the bottom.
3. Match up a socket to the outside diameter of the bearing.
4. Carefully press out the bearing.
5. Clean the hub. Inspect the hub for galling, rust, or metal residue. Replace hub if it is damaged.
6. Support hub in a press. Carefully press in new bearings.
7. Apply a quality wheel bearing grease to inside of wheel hub and around bearings.
8. Install new retaining ring to hub.

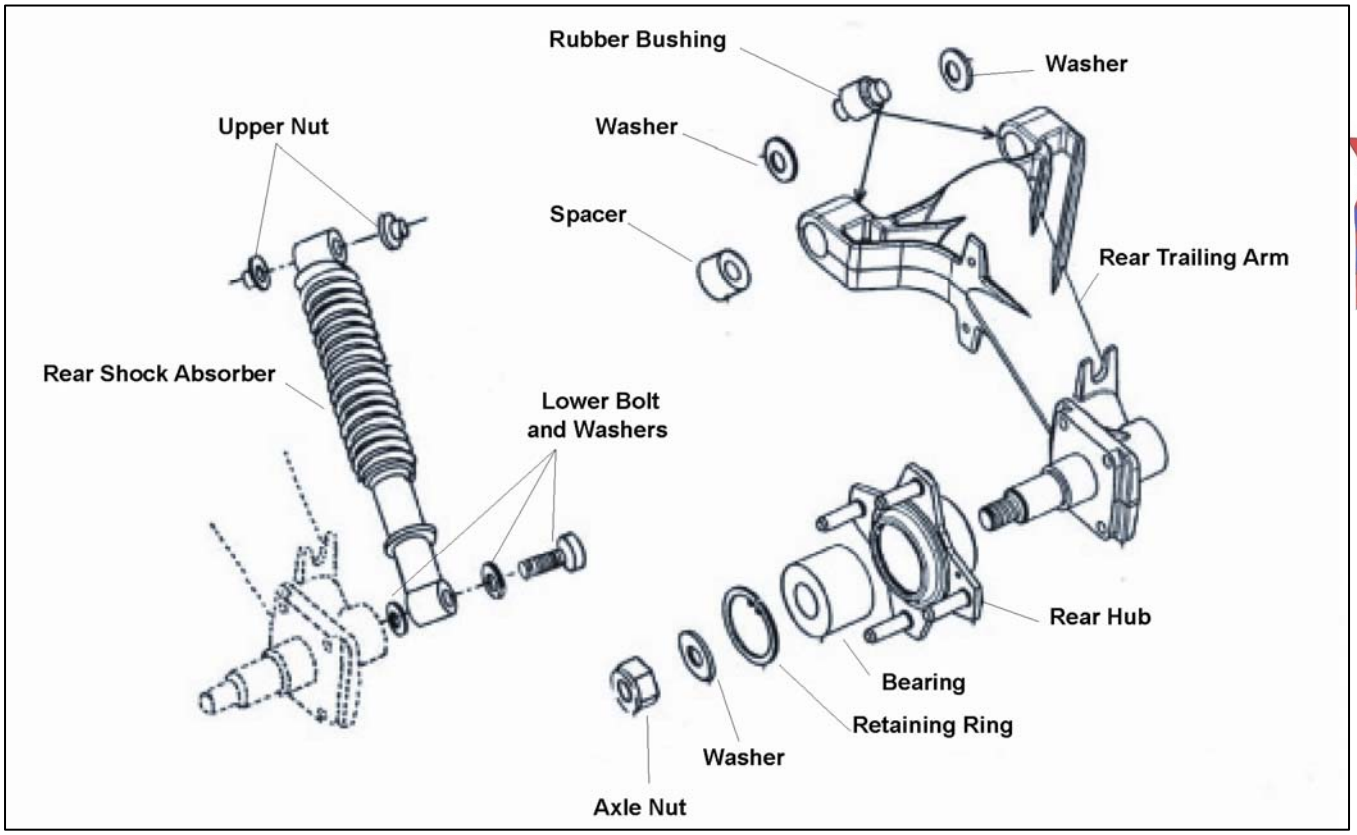


Figure 6-5

INSTALLING REAR WHEEL HUB

1. Clean spindle. Apply a thin coating of grease and install hub onto the spindle.
2. Install flat washer and new axle nut. Torque axle nut to 45 ft. lbs.

REAR SHOCK ABSORBERS

1. Remove rear wheel as described previously.
2. Remove upper and lower shock mounting hardware.
3. Replace shock absorber with a new unit and reinstall with hardware removed in step 2.
4. Reinstall wheel as described previously on page 6-1.

REMOVING REAR TRAILING ARM

1. Remove rear wheel as described previously on page 6-1.
2. Remove the axle nut and washer then remove wheel hub (Figure 6-4).
3. Disconnect the rear shock absorber from the trailing arm (Figure 6-5).
4. Remove the cotter pin, washer and clevis pin securing hand brake cable to back of rear brake assembly and disconnect hand brake cable from brake assembly.
5. Remove four brake assembly mounting bolts (Figure 6-6) from back side of brake assembly and remove brake assembly from rear hub.
6. Cut the cable strap securing the brake line to the trailing arm (Figure 6-7).
7. Remove the mounting hardware securing the trailing arm to the frame and remove the trailing arm (Figure 6-7).
8. Replace the two rubber bushings (Figure 6-5).

INSTALLING REAR TRAILING ARM

1. Install the trailing arm to the frame using the mounting hardware (Figure 6-8).
2. Install the brake assembly to the rear hub using four mounting bolts (Figure 6-6).
3. Reattach the hand brake cable to the brake assembly using clevis pin, washer and new cotter pin.
4. Secure brake line to the trailing arm with new cable strap (Figure 6-7).
5. Re-attach lower shock to trailing arm with bolt and washers (Figure 6-5).
6. Reinstall washer and axle nut. Torque nut to 65 ft. lbs.
7. Reinstall wheel as described on page 6-1

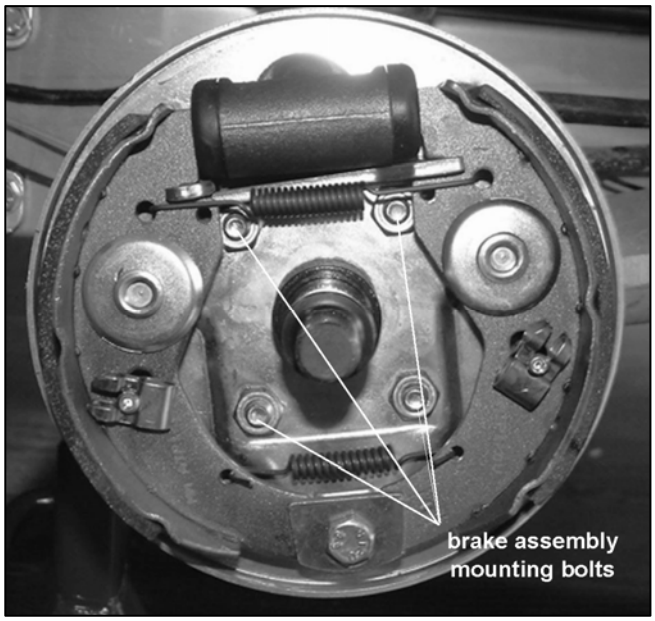


Figure 6-6

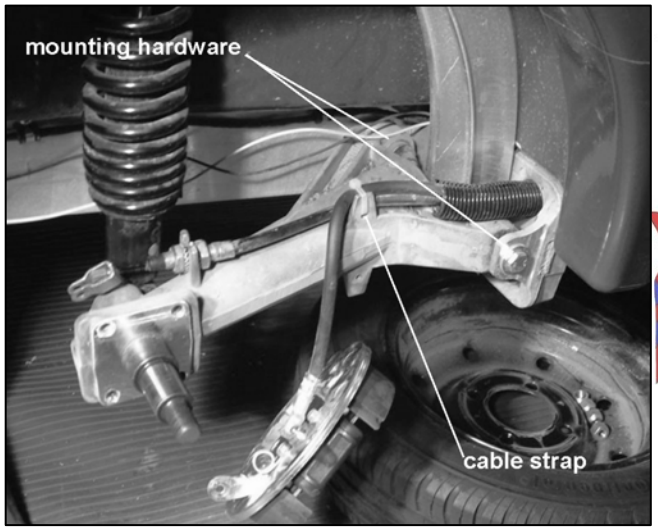


Figure 6-7

REPLACING FRONT SHOCK ABSORBER

1. Remove wheel as described on page 6-1.
2. Remove front hub assembly as described on page 6-6.
3. Remove screw securing inner liner to head lamp cover (Figure 6-8) and move inner liner out of the way to expose shock absorber upper mounting hardware.
4. Remove top nut and washer securing shock absorber to upper frame (Figure 6-8).
5. Install new shock assembly, securing to upper frame with washer and nut.
6. Reattach inner liner to head lamp cover.
7. Install front hub assembly as described on page 6-6.
8. Reinstall wheel as described on page 6-1.

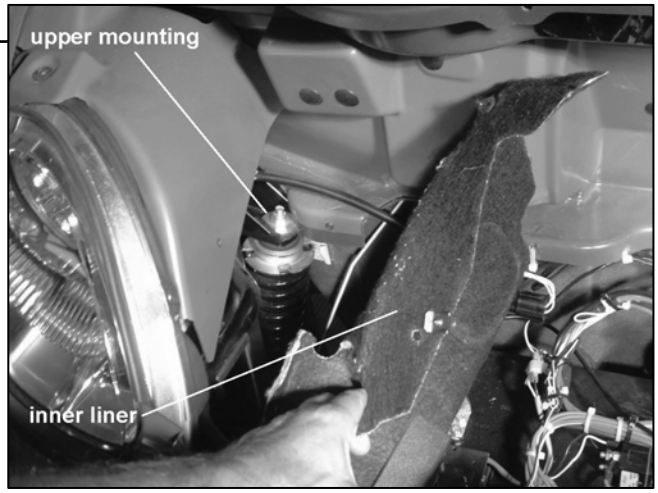


Figure 6-8

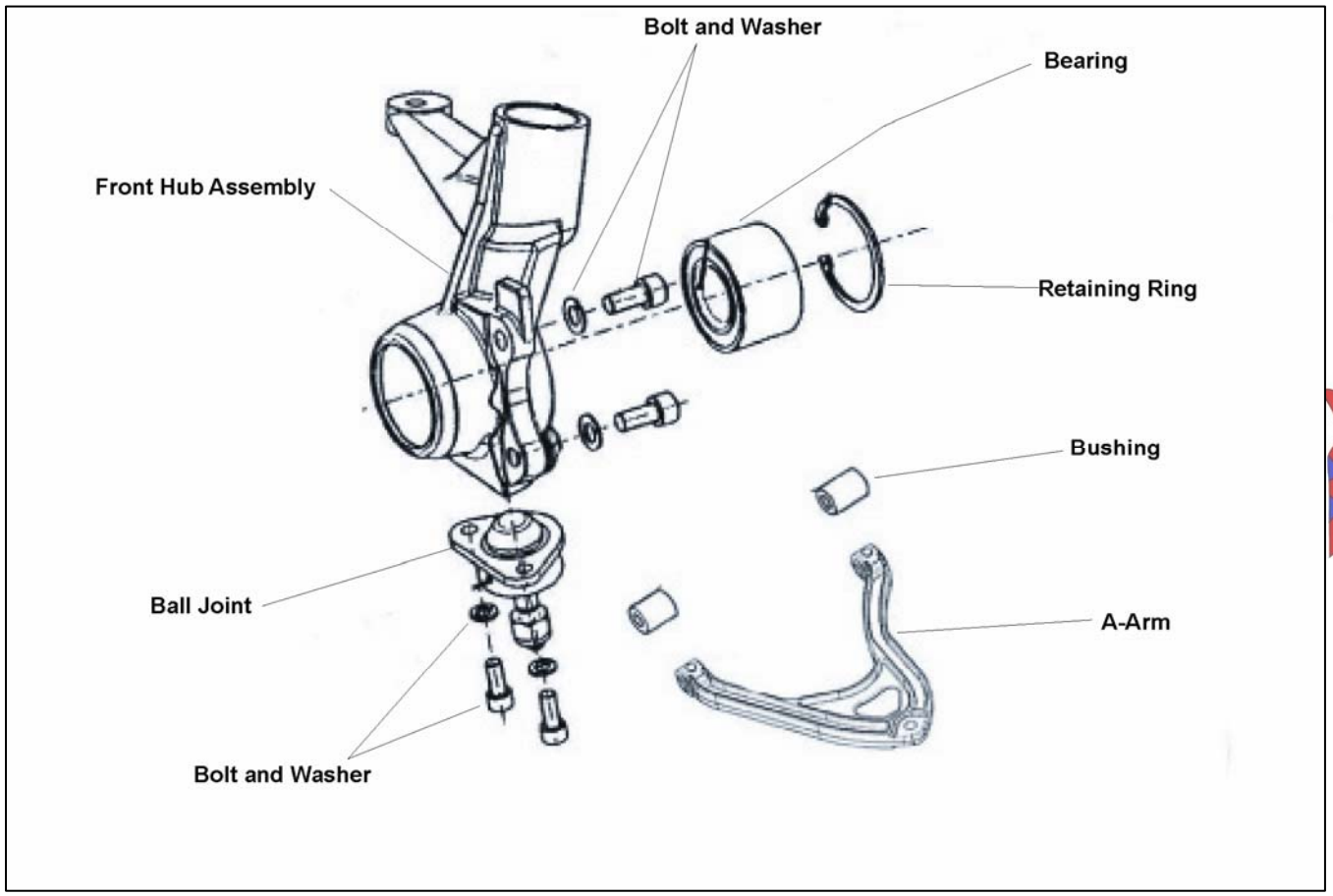


Figure 6-9

REPLACING BALL JOINT

1. Remove wheel as described on page 6-1.
2. Remove a-arm mounting nut and washer (Figure 6-10).
3. Remove ball joint mounting bolts and washers, then remove ball joint.
4. Install new ball joint with bolts and washers.
5. Attach a-arm to ball joint with mounting nut and washers. Washers are positioned above and below a-arm.
6. Tighten nut securely.

REMOVING FRONT HUB ASSEMBLY

1. Remove wheel as described on page 6-1.
2. Remove front disc brake assembly as described in *Section 5 - Accelerator and Brake System*.
3. Remove axle nut and washer (Figure 6-11).
4. Disconnect ball joint from hub assembly (Figure 6-10).
5. Disconnect tie rod end from a-arm (Figure 6-11).
6. Disconnect shock absorber from a-arm.
7. Remove hub assembly from drive shaft.

FRONT HUB SEALED BEARING

The hub assembly has two bearings; one sealed bearing and one ball bearing. The sealed bearing cannot be repacked and must be replaced if damaged. Bearings should be replaced whenever wheel hub is removed. Never reuse a sealed bearing once it has been removed from the wheel hub. Replace with a new bearing.

1. Remove retaining ring from hub.
2. Remove retaining ring from back of hub assembly. Using an arbor press, remove rotor/drive flange assembly from front hub assembly.
3. Set hub on blocks, in a press. Match up a socket to the outside diameter of the bearing.
4. Carefully press out the bearing.
5. Clean the hub. Inspect the hub for galling, rust, or metal residue. Replace hub if it is damaged.
6. Support hub in a press. Carefully press in new bearings.

> ***NOTICE*: Press on the outside of the bearing rim and not on the inside parts, or the bearing will be destroyed.**

7. Apply a quality wheel bearing grease to inside of wheel hub and around bearings.
8. Using an arbor press, install rotor/drive flange assembly to front hub assembly. Install new retaining ring to hub.

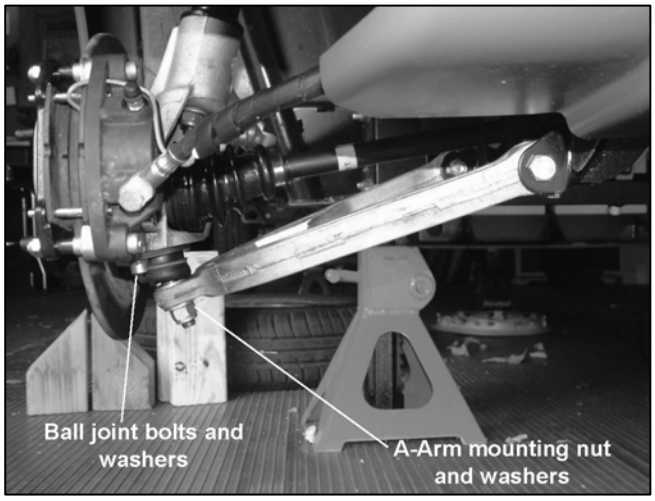


Figure 6-10

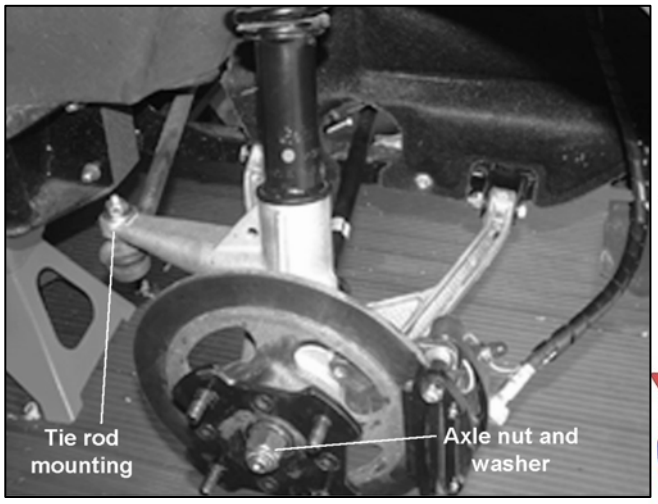


Figure 6-11

INSTALLING FRONT HUB ASSEMBLY

1. Connect shock absorber to hub assembly.
2. Place hub assembly onto drive shaft.
3. Connect tie rod to hub assembly (Figure 6-11).
4. Connect ball joint to hub assembly (Figure 6-10).
5. Install washer and axle nut. Torque axle nut to 65 ft. lbs.
6. Re-install disc brake assembly to hub assembly as described in *Section 5 - Accelerator and Brake System.*
7. Re-install wheel assembly as described on page 6-1.

REPLACING TIE ROD END

1. Remove front wheel as described on page 6-1.
2. Disconnect tie rod end from a-arm (Figure 6-11).
3. Install new tie rod end to tie rod.
4. Reconnect tie rod end to a-arm (Figure 6-11).
5. Re-install wheel assembly as described on page 6-1.
6. Lower vehicle to the ground.

TOE IN ADJUSTMENT

1. With wheels pointed directly forward, loosen jamnuts on tie rod ends (Figure 6-12).
2. Using a rod or stick approximately 46”-46½” long, check distance between front edge of both tires. Then check the distance between back edge of both tires.
3. The distance between tires at front edge should be 1/4”-1/8” less than the distance between the back edge of the tires.
4. If distance between tires (toe in - toe out) is incorrect, rotate tie rods to adjust as necessary.
5. When correct distance is achieved, tighten tie rod jamnuts against tie rods.
6. Recheck measurements.

STEERING WHEEL & COLUMN REPLACEMENT

1. Remove dashboard as described in *Section 7 - Body and Chassis.*
2. Disconnect inner steering shaft from the steering rack (Figure 6-14) and from the steering column (Figure 6-13).
3. Remove steering column mounting hardware (3 places, Figure 6-13).
4. Install new steering column using hardware removed in steps 3.
5. Connect inner steering shaft to steering column (Figure 6-13) and to steering rack (Figure 6-14).
6. Install dashboard as described in *Section 7 - Body and Chassis.*

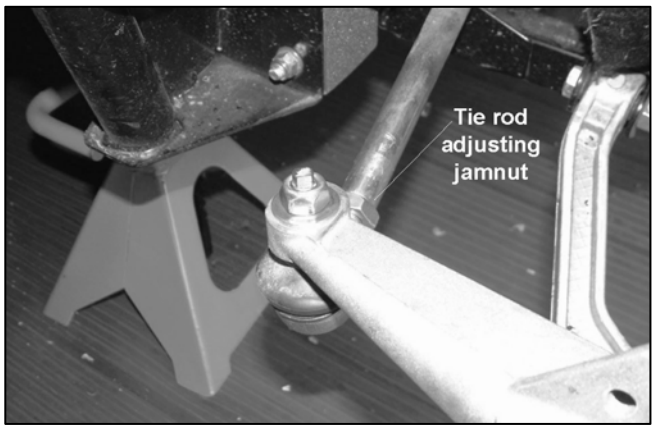


Figure 6-12

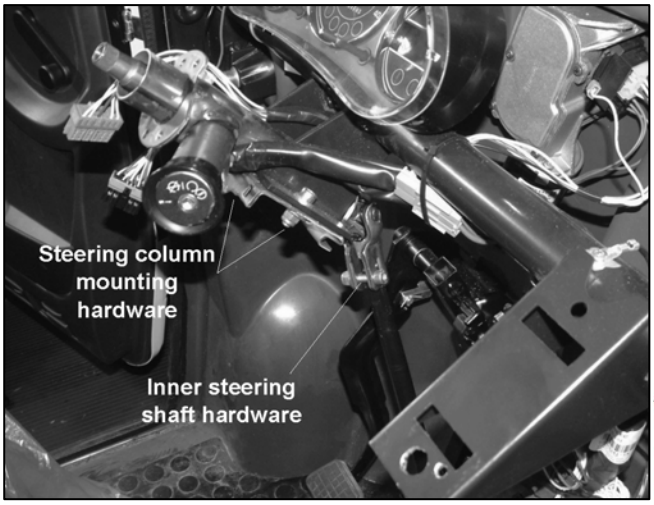


Figure 6-12

REMOVING STEERING RACK

1. Remove front wheels as described on page 6-1.
2. Remove the protective cover from underneath the front of the frame.
3. Support motor/axle frame at the rear.
4. Disconnect tie rod ends from a-arm (Figure 6-11).
5. Disconnect steering rack from steering shaft (Figure 6-14).
6. Disconnect steering rack from dampener (Figure 6-14).
7. Remove steering rack-to-frame mounting hardware (Figure 6-14).

INSTALLING STEERING RACK

1. Install steering rack to frame (Figure 6-14).
2. Connect steering rack to dampener (Figure 6-14).
3. Connect steering rack to inner steering shaft (Figure 6-14).
4. Adjust both ends of the steering rack assembly (Figure 6-15) so they are parallel to the floor.
5. As shown in Figure 6-16 top, measure the distance “B” on each side. For each side, the distance is 14-9/16” (± 1/16”). Figure 6-16 bottom, left and right show an enlarged view of each measurement location.
6. Unlock the steering and use the steering wheel to adjust if needed. Once correct, re-lock the steering.
7. On each side, verify that there is 5 ball joint threads exposed. Adjust if needed. Connect the ball joints to the hub assembly arms and torque to 27 ft. lbs. (37 Nm).
8. Connect tie rod ends to a-arm (Figure 6-11).
9. Install the protective cover to the underside of the frame.
10. Re-install front wheels and lower vehicle to the ground.
11. Perform toe-in adjustment as described on previous page.

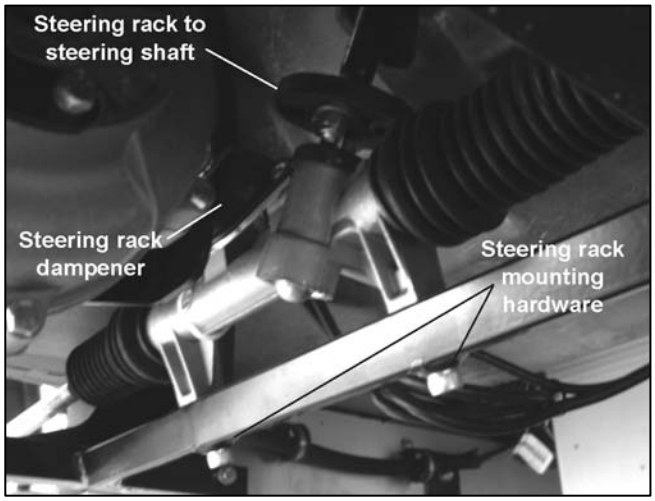


Figure 6-13

Figure 6-14

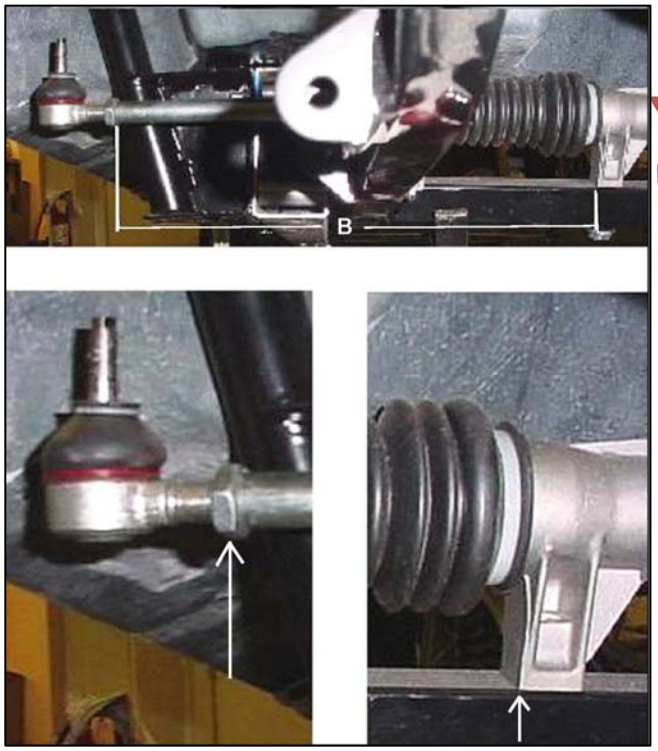


Figure 6-15

⚠ DANGER

Always turn Power key to OFF, Directional selector to NEUTRAL, remove Power key and block tires. Turn the main disconnect switch counterclockwise to the OFF position before servicing or repairing your vehicle

REPLACING FRONT TURN SIGNAL BULB

1. Lift up the front hood. The release latch is located under the dash, behind the accelerator pedal.
2. Remove two screws, washers and rubber washers securing inner liner (Figure 7-1) to access the turn signal housing (Figure 7-2).
3. Twist turn signal housing 1/4 turn counterclockwise and remove it from the headlight housing.
4. Install new bulb into turn housing and place housing into headlamp housing. Twist 1/4 turn clockwise to secure.
5. Install inner liner with two screws, washers and rubber washers (Figure 7-1).

REPLACING FRONT HEADLIGHT BULB

1. Lift up the front hood. The release latch is located under the dash, behind the accelerator pedal.
2. Remove two screws, washers and rubber washers securing inner liner (Figure 7-1) to uncover the headlight bulb access cover (Figure 7-2).
3. To access the front headlight bulb, twist the rear access cover slightly in a counterclockwise direction and remove the cover. (Figure 7-3).
4. Bulb is held in position with wire clamp (Figure 7-4).
5. Squeeze clamp and pull out to release. Replace the bulb with a new one, and secure in place with wire clamp.
6. Install access cover by turning slightly clockwise (Figure 7-3).
7. Install inner liner with two screws, washers and rubber washers (Figure 7-1).

REPLACING FRONT HEADLIGHT ASSEMBLY

1. Lift up the front hood. The release latch is located under the dash, behind the accelerator pedal.
2. Remove two screws, washers and rubber washers securing inner liner (Figure 7-1).
3. Remove the turn signal housing from the headlamp housing (Figure 7-2).

4. Disconnect the headlamp wiring connector from the main wiring harness.

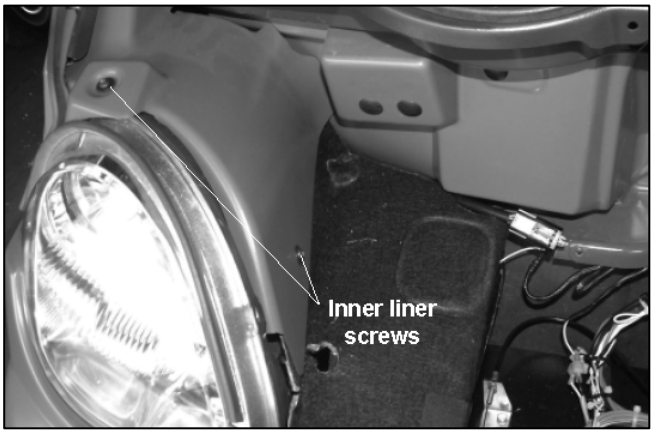


Figure 7-1

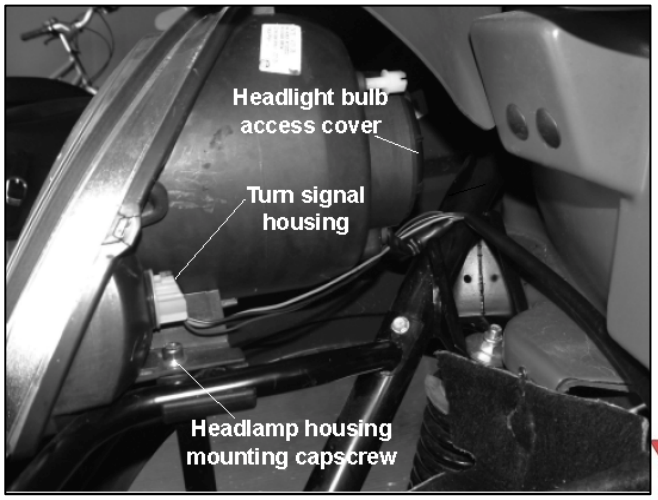


Figure 7-2

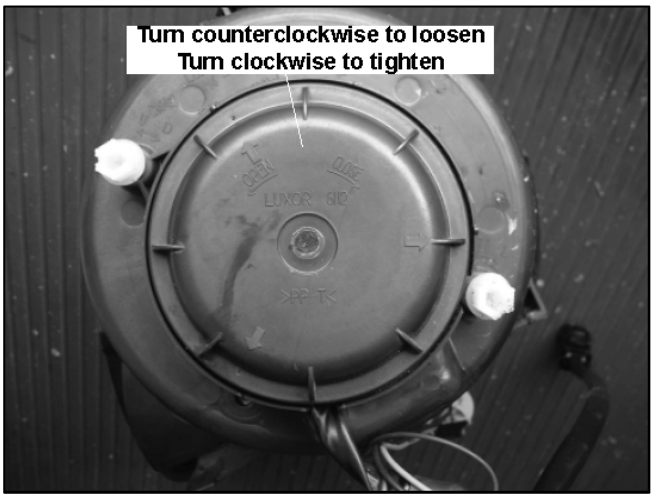


Figure 7-3

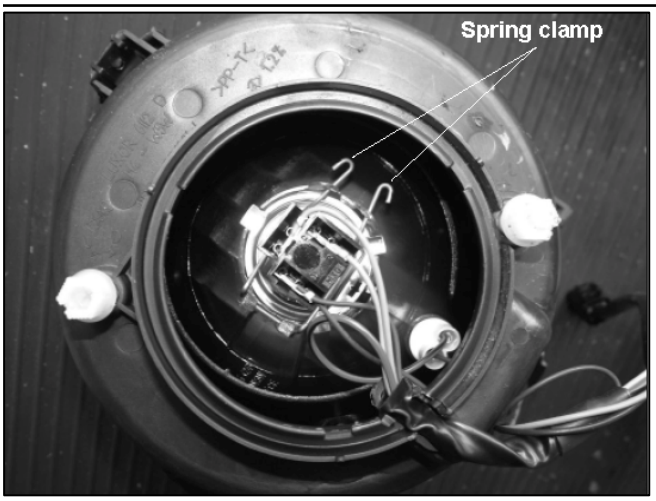


Figure 7-4

5. Remove the Phillips head screw and washer, and the locknut and washer securing headlamp housing to frame (Figure 7-5). The capscrew (Figure 7-3) securing locknut and washer is also threaded into the frame and will required unscrewing it. 6. Remove headlight assembly.
7. Place new headlight assembly into frame and secure using capscrew (Figure 7-3) along with locknut and washer, and Phillips screw and washer (Figure 7-5).
8. Connect headlight wiring connector to main harness.
9. Install turn signal housing into headlamp housing.
10. Install inner liner (Figure 7-1).

REPLACING TAILLIGHT & REAR TURN SIGNAL BULBS

1. Remove two screws securing taillight lens cover, and remove cover.
2. Remove old bulb and replace with new bulb (Figure 7-6). Install lens cover with two screws.

REPLACING BACKUP LIGHT

1. Open tailgate to access backup light wiring connector located on backside of backup light.
2. Unplug wiring connector. Push backup light through body to remove.
3. Lightly coat the new light rubber gasket with soap. Carefully install light through the body so gasket seals on both sides of body.
4. Plug the wiring connector to the light.

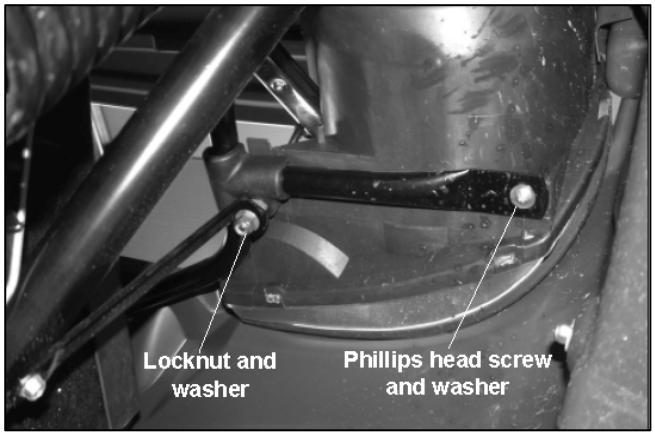


Figure 7-5

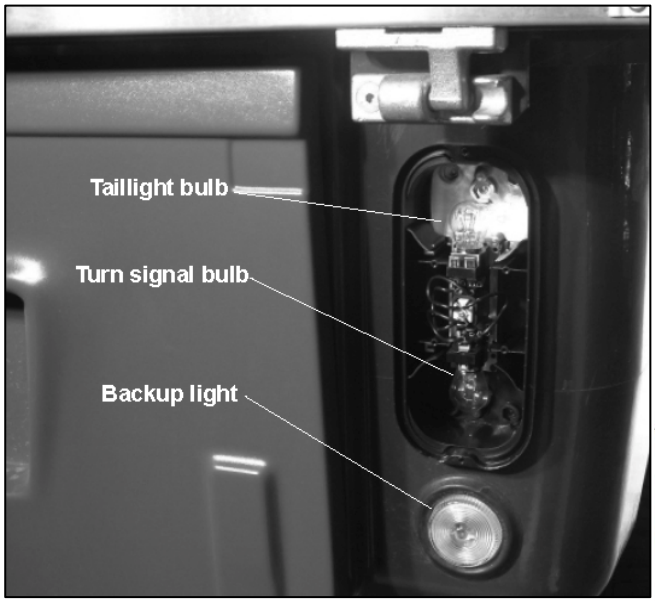


Figure 7-5

REMOVING THE DASHBOARD

> ***NOTICE*: The dashboard must be removed to service any dash mounted instruments or switches such as the Multi-Functional Display Indicator (MDI) and direction knob.**

1. Remove steering wheel hub cover by carefully prying it out from steering wheel.
2. Remove shaft bolt and steering wheel (Figure 7-7).
3. The steering wheel housing (Figure 7-8) is secured with two screws from the bottom. Remove screws and housing halves.
4. Remove three capscrews and washers securing turn signal/ wiper assembly to the steering shaft (Figure 7-9). Unplug wiring connectors from back of assembly and remove from steering column.
5. Remove two screws (one each side) from under side of dashboard (Figure 7-10).
6. Pull direction knob straight out to remove it. Remove thin nut, spacer and directional backplate (Figure 7-11). There is a star washer located between the directional backplate and flasher switch.
7. Pull out on the sides of the dashboard (Figure 7-10) to release it from the cab.
8. Disconnect wires from the MDI (Multi-Functional Display Indicator). Unplug the connector from the emergency flasher switch.
9. For vehicles equipped with heaters, cut the ties holding the flex heater tubes and disconnect from the dash heating vents.
10. Remove dashboard.

INSTALLING THE DASHBOARD

1. Place dashboard into position in the vehicle. Connect the wires to the MDI (Multi-Functional Display Indicator).
2. Push on the sides of the dashboard to seat it in place.
3. Plug connector into emergency flasher switch.
4. Install direction switch with star washer through bracket and hole in dashboard and secure with backplate, spacer and thin nut (Figure 7-11). Backplate has a locating pin that must engage the mounting bracket to prevent switch assembly from rotating. Install direction knob onto switch.
5. Secure each side of dashboard with screws (Figure 7-10).
6. Install turn signal/wiper assembly onto steering shaft and secure with three washers and capscrews (Figure 7-9).
7. Install steering wheel housing onto steering shaft and secure with two screws (Figure 7-8).

Figure 7-7

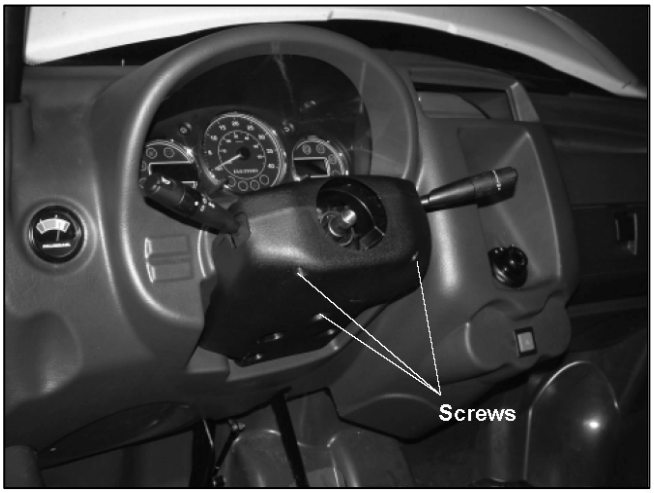


Figure 7-8

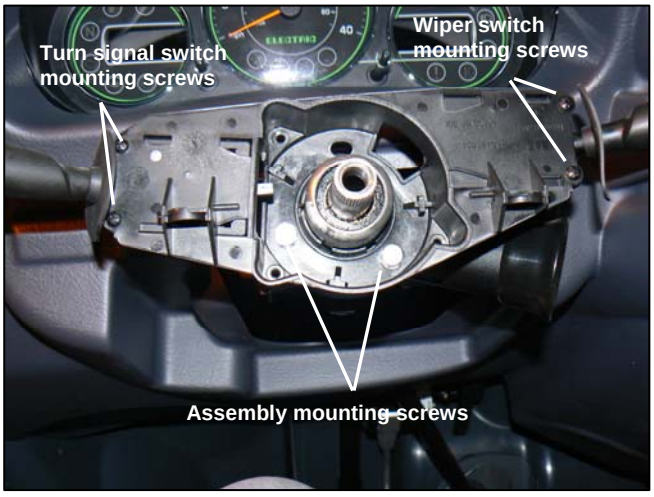


Figure 7-9

8. With front wheels pointed straight ahead, place steering wheel partially onto shaft, then turn the steering wheel 90° to the left so signal cancelling tab on steering wheel clears the turn signal tab. Push steering wheel onto shaft and secure with bolt (Figure 7-7).
9. Install steering wheel cover.

***NOTICE*: Dashboard and control may be configured differently then what is shown.**

REPLACING THE INSTRUMENT CLUSTER

1. Remove the dashboard as described above.
2. Remove the two screws from the top of the instrument cluster (Figure 7-12).
3. Unplug the wiring harnesses from the back of the instrument cluster. Plug harnesses into new instrument cluster.
4. Secure new instrument cluster using the two mounting screws (Figure 7-12).
5. Re-install dashboard as described on the previous page.

REPLACING TURN SIGNAL/WIPER SWITCHES

It is not necessary to remove the dashboard to replace either the turn signal switch or wiper switch.

1. Remove steering wheel cover, nut and steering wheel (Figure 7-7).
2. The steering wheel housing (Figure 7-8) is secured with two screws from the bottom. Remove screws and housing halves.
3. Remove two screws holding either switch in place to remove it from the assembly.
4. Unplug the connector from the switch. Plug connector into new switch and install using original two screws.
5. Install steering wheel housing using two screws (Figure 7-8).
6. Make sure wheels are pointed straight ahead and install steering wheel onto shaft and secure with nut (Figure 7-7).
7. Install steering wheel cover.

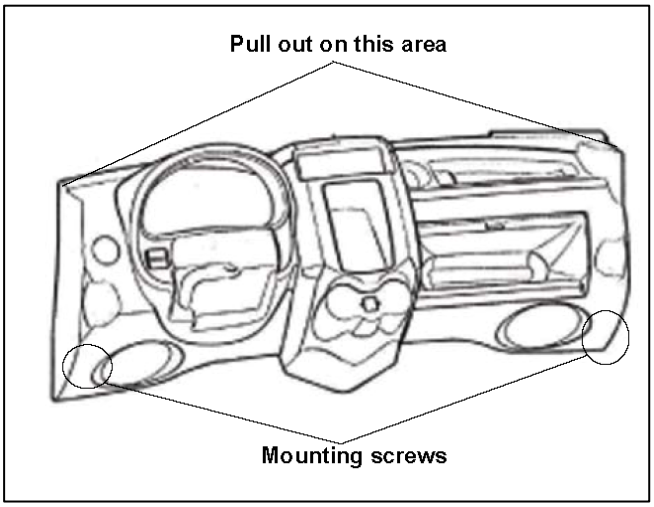


Figure 7-10

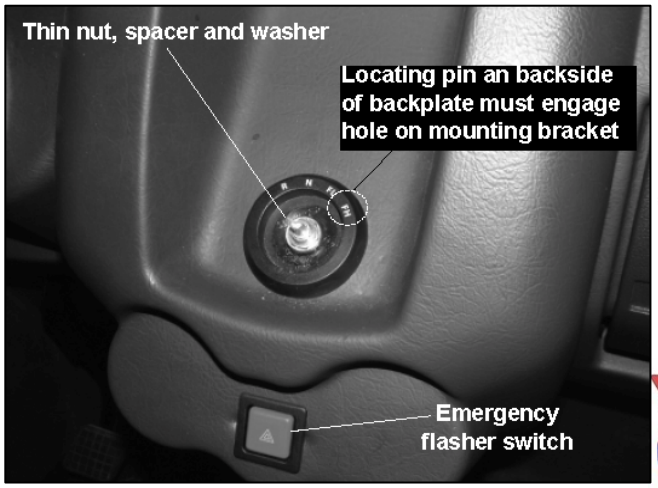


Figure 7-11

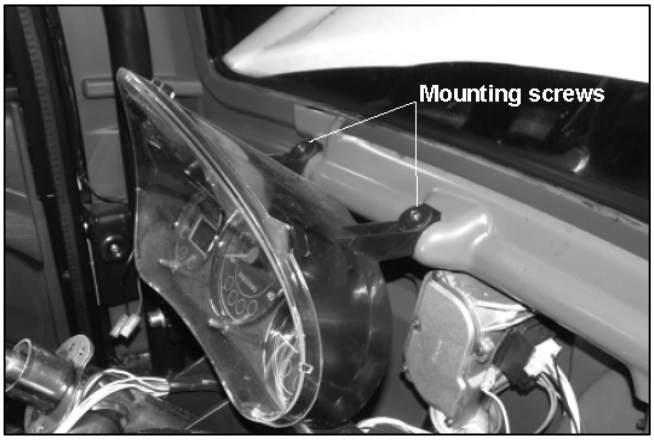


Figure 7-12

REPLACING WIPER MOTOR

1. Remove dashboard as described on page 7-4.
2. Unplug wire connectors from wiper motor assembly (Figure 7-13).
3. Open the hood with the latch located under the dashboard, behind the accelerator pedal.
4. Pull back on wiper cover (Figure 7-14). Remove locknut and wiper blade from motor shaft.
5. Remove mounting bolt (Figure 7-14).
6. Remove thin nut (Figure 7-14) and remove wiper motor assembly from inside of cab.
7. Place new wiper motor into mounting hole and secure with thin nut and mounting bolt.
8. Install wiper blade assembly onto shaft and secure with locknut. Push cover down into place over locknut.
9. Install wire connectors to new motor.
10. Install dashboard as described on page 7-4.

REPLACING HORN

1. The horn is mounted underneath the left front fender.
2. To replace the horn, unplug the wires from the horn and remove it from the mounting bracket.
3. Install new horn and reconnect the wires.

FUSES

There are two fuse boxes. They are shown in Figure 7-15 and 7-16.

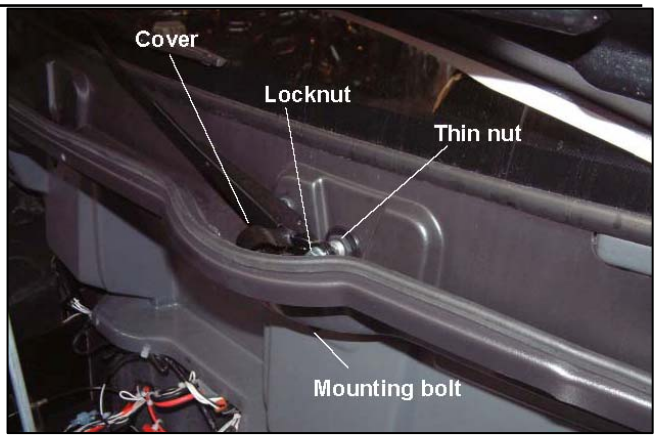


Figure 7-13

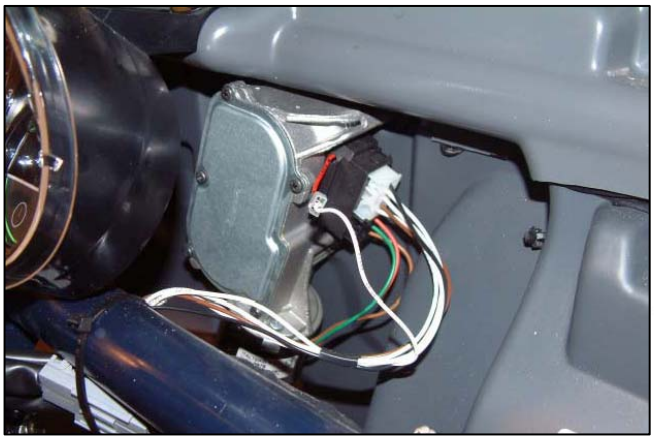
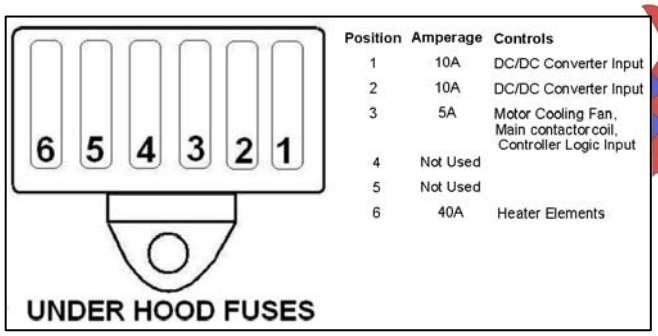
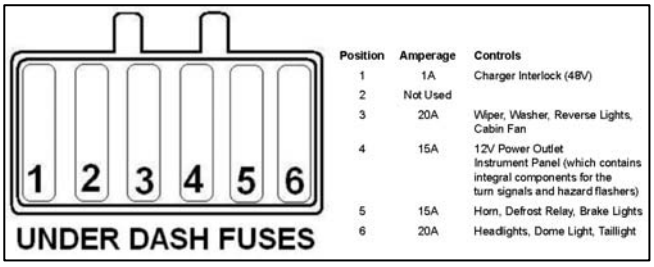


Figure 7-14



Position	Amperage	Controls
1	10A	DC/DC Converter Input
2	10A	DC/DC Converter Input
3	5A	Motor Cooling Fan, Main contactor coil, Controller Logic Input
4	Not Used	
5	Not Used	
6	40A	Heater Elements

Figure 7-15



Position	Amperage	Controls
1	1A	Charger Interlock (48V)
2	Not Used	
3	20A	Wiper, Washer, Reverse Lights, Cabin Fan
4	15A	12V Power Outlet Instrument Panel (which contains integral components for the turn signals and hazard flashers)
5	15A	Horn, Defrost Relay, Brake Lights
6	20A	Headlights, Dome Light, Taillight

Figure 7-16

IMPORTANT INFORMATION

The type of battery used in a Columbia vehicle has a service requirement which is quite different from that of an automotive battery.

The electric vehicle battery supplies all of the power to drive the vehicle. During operation the power stored in the batteries is expended. While the amperage drain rate can vary greatly depending on the type of service, the duration of use and the number of "starts" and "stops" made during a day, the batteries nevertheless progress through each duty cycle from "fully charged" to an almost depleted state. This type of service is known as "deep cycle" service and electric vehicle batteries are specifically designed to handle this type of service.

Proper performance of your Columbia Vehicle can only be obtained from specified deep cycle, electric vehicle batteries.

PLEASE REVIEW IMPORTANT DANGER STATEMENTS WHEN WORKING AROUND BATTERIES AND CHARGING SYSTEMS!

⚠ DANGER

Before servicing or repairing the vehicle, always turn power keyswitch to OFF and remove, turn directional selector to NEUTRAL, block tires, and turn the main disconnect switch counter clockwise to the off position.

All batteries used in electric vehicles can explode! Batteries produce explosive hydrogen gas at all times, especially, during charging or discharging. Ventilate area when charging batteries.

Do not attempt to charge a battery if it is frozen, or if the case is bulged excessively. Frozen batteries can explode!

Properly dispose of the battery.

Do not smoke around batteries. Keep sparks and flames away from batteries and the charging area.

When working around or servicing batteries use care to prevent an accidental arc which could cause an explosion. Use only approved insulated tools, remove jewelry such as

rings, watches, chains etc. and place an insulating material (wood, plastic, rubber etc.) over all battery connections.

If any problems are found during scheduled maintenance or inspections, do not operate vehicle until repairs are made. Failure to make necessary repairs could result in fire, property damage, severe personal injury, or death.

Battery acid is poisonous and can cause severe burns. Avoid contact with skin, eyes, or clothing.

ANTIDOTES

EXTERNAL: Flush with water. Call a physician immediately.

INTERNAL: Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call a physician immediately.

EYES: Flush with water for fifteen minutes. Call physician immediately.

***NOTICE*: Automotive batteries should never be used for "deep cycle" application, as their useful life will be very short.**
Install surge arrestors on incoming AC power lines. Surge arrestors will help protect electrical/electronic components in the charger and vehicle from all but direct or "close proximity" lightning strikes.
Damaged or corroded battery terminals should be replaced or cleaned as necessary. Failure to do so may cause overheating during operation.

BATTERY CLEANING

Battery terminal connections should be individually cleaned and maintained annually. More frequent cleaning may be required under heavy use, or as batteries age.

***NOTICE*: Make note of any accessory wire connections before disconnecting batteries. Refer to wiring diagrams for proper connection.**

1. Remove battery cables and wire connections from all battery terminals.
2. Brush battery cable and wire connections clean using soft brass wire brush.
3 Replace battery cable terminals that are damaged or corroded.
4. Keep the batteries clean, fully charged, properly secured and terminal connections tight. Do not over tighten connections. Acid soaked dirt on the battery tops causes current leakage, reduced battery efficiency and promotes rapid self-discharge during storage.
5. Hose wash battery tops periodically with clean, low-pressure water to keep them free of acid spillage, dirt and other debris. If vented batteries are used, make sure vent caps are secure before washing. Do not hose wash electronic controllers, switches, solenoids, and other electrical control devices. Direct water away from these components, covering them if necessary.
6. Wash battery tops with a baking soda mixture (1/2 cup per quart of water) and a stiff non-metallic bristle brush if a low-pressure hose does not remove the direct. Rinse with clean water. Take care to ensure that the baking soda mixture does not enter the vent opening in the battery caps
7. Make sure that the battery tops are clean and dry before putting the batteries into storage.

BATTERY SERVICE (WATER)

***NOTICE*: The following information does not apply to sealed batteries.**

The operating environment of the electric vehicle could vary widely. Severe service operations will require that periodic maintenance recommendations be adjusted to shorter time intervals.

Use only distilled water in your batteries. Vehicle batteries may use up to 16 quarts of water during their useful life and non-distilled water may contain harmful minerals which will have a cumulative adverse effect on battery performance and life.

Watering intervals are dependent on the local climate, charging methods, application, and age of batteries. After the initial watering of new batteries, it is recommended that batteries be checked once a month until you get a feel for your water consumption rate.

Typically for a heavy use application, recommend watering is maximum of once per week, and for light use applications once per month

ADDING WATER (See Figure 8-1)

- Check the electrolyte level on brand new batteries before putting them into service, and at least weekly on batteries in service. Water use increases as batteries age.
- Never allow the electrolyte level to fall below the top of the plates (A). If the plates are exposed, add only enough distilled water to cover the plates before charging.
- Do not overfill batteries. Do not fill the water level up into the well of the filler tube of the cell. Electrolyte expands and can overflow during charging (B). Water added to replace the spillage dilutes the electrolyte and reduces its specific gravity. Cells with lower specific gravity have lower charging capacity.
- Make sure the electrolyte covers the plates before charging (C). Fill cells to the markers only after batteries are charged.

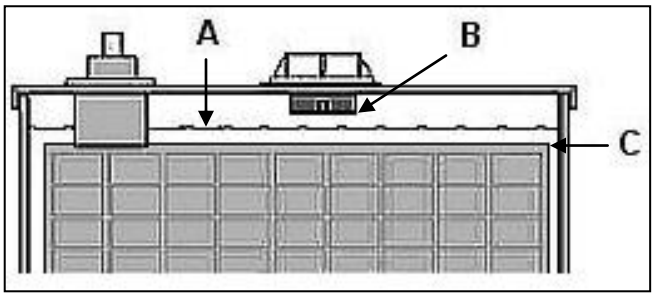


Figure 8-1

US Batteries features SpeedCap™ battery cell caps. See Figure 8-2. To open SpeedCap™ locate the two tabs on either side of the center cell of the battery. Move these tabs in the directions shown in Figure 8-2.

Figure 8-2

SINGLE POINT WATERING SYSTEM

This vehicle may have a Single Point Watering System (Figure 8-3) used for adding water to the battery pack. It consists of a fill tube, one end having a filter screen, the other having a female coupler and a rubber squeeze bulb.

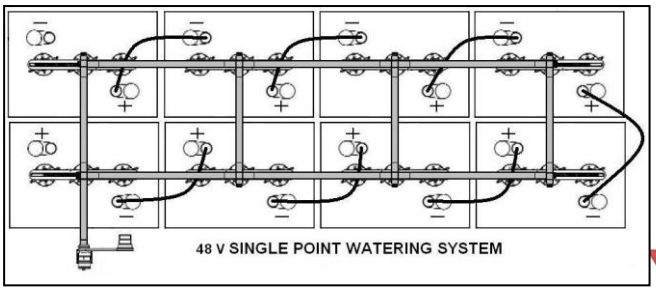


Figure 8-3

***NOTICE*: To avoid overfilling of the Single Point Watering System do not operate this system on brand new batteries. New batteries should be in service 1 to 2 weeks with heavy use or 3 to 4 weeks with light use. System is to be used only after fully charging the batteries and batteries are warm.**

When using this system, check the battery pack water level weekly by:

- Inserting the fill tube filter end in a distilled water supply.
- Attaching the female coupler to the battery pack male coupler.
- Squeeze the rubber ball until firm which indicates that filling is complete. Immediately disconnect the couplers by depressing the push button on the female coupler. If the water supply is left connected after the filling process is finished it could lead to an overfill.

CONDITIONS WHICH AFFECT CHARGING

Always schedule enough charging time to allow the batteries to become fully charged. Charging time is affected by age and battery condition, state of discharge, electrolyte temperature, AC line voltage, and other variables. Correct charging methods extend battery life and vehicle range between charges.

New batteries need up to four hours more charging than “mature” batteries. Charging time will vary based on conditions noted above but will probably be 6 to 10 hours.

Battery efficiency is affected by temperature. If the temperature of the outside air and/or batteries is below 60º F, battery capacity is reduced. Batteries will require more frequent and longer charge periods in early spring, fall and winter.

As batteries age, they finish charge at progressively higher charge rates and tend to use more distilled water. At this point in battery age, charger will automatically begin reducing charge time. Batteries found defective must be replaced. All batteries in a vehicle should be matched according to age, capacity and brand.

BATTERY CHARGING

⚠ DANGER

Observe all safety information in this section, safety information listed at the beginning of this section, and safety information in Section 1 of this manual.

Columbia electric vehicles are equipped with a solid state, onboard, fully automatic, Delta-Q Battery Charger as standard equipment. See Figure 8-4.

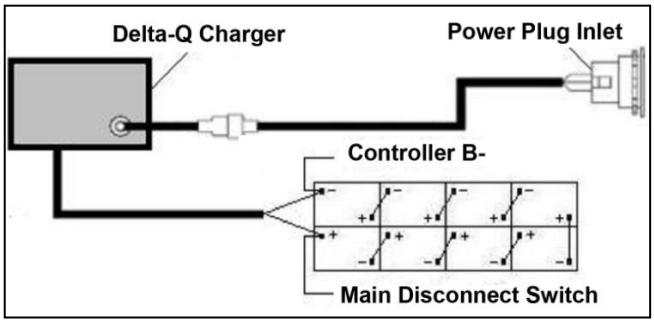


Figure 8-4

It is important to be aware of the differences and improvements over prior chargers, which are explained in the Delta-Q Charger Operating Instructions in this manual.

Correct charging methods extend battery life and vehicle range between charges. Before the first new vehicle use, completely charge new batteries. Charging time is affected by age of battery, condition of battery, state of discharge, temperature of electrolyte, AC line voltage level, and other variables.

Charging time usually takes 12 hours. New batteries need up to four hours more charging time than “mature” batteries.

Always schedule enough charging time so that the charger completes a full charge cycle. Opportunity charging is an acceptable practice for use during a shift to extend the range, but always allow for a full charge cycle at end of shift.

New batteries have less capacity than batteries which have been through numerous charging cycles. Therefore it is advisable to limit the use of new batteries until 15-20 charging cycles have been completed.

Recharge batteries immediately after use. Leaving batteries in a state of discharge will reduce their capacity and useful life.

Battery chargers are voltage specific; 24, 36 or 48 volts. However, chargers can be programmed at the factory for different types of batteries, as well as different brands and capacities of batteries. Refer to Battery Brand Algorithms for Charger Programming, See Table 1.

The lead-acid storage battery supplies electrical power through the chemical action. This action is reversible, which means the battery must be connected to a charger and have an electrical current passed through it in the direction opposite to the direction of discharge in order to restore the battery’s active chemicals.

CHARGER SAFETY INFORMATION

⚠ DANGER

Do not attempt to charge a battery if it is frozen or if the case is bulged excessively. Frozen batteries can explode. Dispose of battery.

Charge batteries in well ventilated area.

Ventilation fans should be located at the highest point in charging area. These fans should be able to exchange the air 5x per hour. Consult a local HVAC engineer.

Remove rings and watches prior to service. Only trained technicians should repair or service the charger. Contact Columbia for assistance.

Replace worn, cut or damaged power cords or wires.

Do not connect the power cord near fuels, grain dust, solvents, thinners, or other flammables.

Install surge arrestors on incoming AC power lines. This protects from all but direct or close proximity lightening strikes.

Do not cover charger cabinet cooling fins. This protects the charger from overheating.

Make sure all battery and charger connections are clean and tight. This prevents overheating and arcing at the terminal. Replace as necessary.

Disconnect negative (-) cable first to avoid crossing terminals that would create a spark.

The Delta-Q Charger will not over charge batteries if left plugged in.

***NOTICE*: When using ordinary automotive chargers, there is the possibility of overcharging and damaging the cells.**

ALGORITHM ID	ALGORITHM DESCRIPTION	AMP HOUR	TYPE	DESIGNED FOR	COMPATIBLE WITH
1	Trojan Flooded	225	Flooded	Trojan T105	150 - 260Ah 6V, 8V, 12V flooded golf
5	Trojan Group 31 Flooded	130	Flooded	Trojan 30XHS, 31XHS	85 - 150Ah 12V flooded "marine" Exide Orbital AGMs, Optima AGMs
11	200 - 255Ah Flooded Constant Power dv/dt	230	Flooded	US Battery US145 & 225	200 - 255Ah flooded golf
42	80 - 150Ah AGM	100	AGM	EV31A	other 80 - 150Ah AGM
43	200 - 400Ah AGM	300	AGM	EVL16A, EVGC6A, EV185A	200 Ah – 400 Ah AGM
72	250 - 335Ah Flooded Constant Power dv/dt	305	Flooded	US Battery US-305HC	250 - 320Ah Flooded
125	Fullriver 160-220Ah AGM	180	AGM	Fullriver DC180-6, DC224-6	Fullriver 160 - 220Ah AGM
126	Fullriver 85-145Ah AGM	110	AGM	Fullriver DC115-12	Fullriver 85 - 145Ah AGM

Table 1

DELTA-Q CHARGER OPERATION

These vehicles are equipped with a remote panel (Fig. 8-5 A) with a single LED which indicates the Delta Q status. For each Delta Q the remote panel will be located near the charger receptacle. See SINGLE LED DISPLAY.

1. Connect power cord at charger receptacle to properly grounded wall outlet.

***NOTICE*: Connect the charger AC cord to a source capable of supplying 15 amperes minimum per charge (20 amperes recommended). The charger is equipped with an equipment-grounding AC electric cord, and a grounding type plug.**

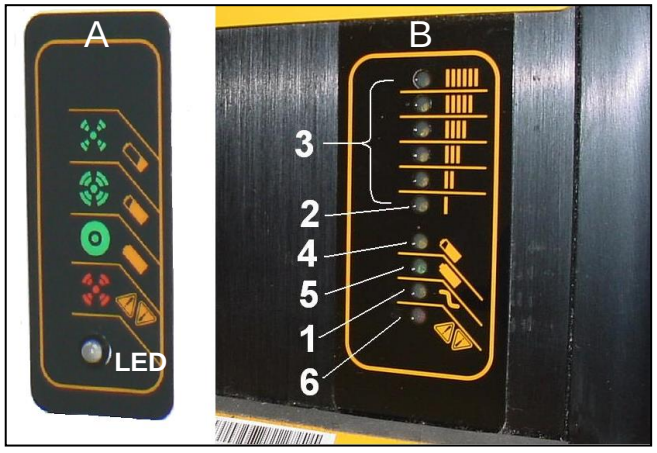


Figure 8-5

2. Connect the cord to an appropriately installed receptacle grounded in accordance with the National Electric Code ANSI/NFPA 70, and all local codes and ordinances.
3. The Yellow AC power LED (No. 1, Fig. 8-5B) should remain illuminated while the Charger is plugged into an AC source. If Yellow LED is not lit, before replacing Charger, recheck the AC connection and the AC source fuse or breaker. If this fails to correct the problem, contact your Columbia Dealer for assistance.
4. Charger will automatically turn on and conduct a short self-test and battery pack test. All LED's will flash in sequence and then a trickle current will be applied to batteries until a minimum voltage is reached. In Figure 8-5B No. 3 indicates the Bar Graph and No. 2 indicates the lowest LED. Three (3) amperes is displayed as the lowest LED on the Bar Graph
5. If the batteries meet the minimum voltage requirements of the Charger, signifying they are serviceable (chargeable), the Charger enters the bulk charging (higher amperage-constant current) stage. The Bar Graph LED's indicate the electrical current being delivered to the batteries as the Charger moves through its automatic charge profile. The length of charge time at each level will vary due to battery size and battery charge depletion.

***NOTICE*: If the batteries are excessively discharged, the Delta-Q will not be able to charge the complete set of batteries. The Delta-Q will have the RED FAULT LED (No. 6, Fig. 8-5B) flashing red (see RED LIGHT CHARGER ERROR CODES). It will then be necessary to follow the instructions in EXCESSIVELY DISCHARGED BATTERIES.**

6. When the Yellow LED (No. 4, Fig 8-5B) is lit, the Charger has completed the bulk stage and the batteries are at approximately 80% state of charge. The 80% LED remains on as the last 20% of charge is returned to the batteries in the second phase (constant voltage phase).

***NOTICE:* You can terminate charging at this point if necessary. The vehicle can be used, but completing the charge cycle is highly recommended.**

7. Charge completion is when the 100% Green LED is lit, (No. 5, Fig. 8-5B). Repeated "Short Charging" leaving the charge short of 100% will shorten operating cycle distance and reduced battery life.
8. A low current "finish-charge" phase returns and maintains batteries to maximum capacity. The 100% Green LED will blink until "finish charge" phase is complete.
9. A 100% Green LED continuously lit indicates the batteries are completely charged. The Charger may now be unplugged from the AC source. If the batteries will not be used for a length of time, check monthly for the charge level. It is also acceptable to leave the Charger plugged in. The Delta-Q has the capability to test and recharge if necessary.
10. A fault occurring while charging causes the RED FAULT LED to flash with a code relaying the error. Some errors may require repair by a qualified technician and others may be simply transient and will automatically recover when the fault condition is eliminated and the Delta-Q cycled by disconnecting the AC source for a minimum of 11 seconds.

NOTICE: A Yellow (Amber) blinking LED in the upper Bar Graph (No. 3, Fig. 8-5B) usually indicates the thermostatic control has limited the Charger output due to ambient temperature conditions. It is still charging, but at a reduced rate.

SINGLE LED DISPLAY (Figure 8-5A)

SOLID GREEN – Charging complete, in maintenance mode

FLASHING GREEN – Short < 80% charge

Long > 80% charge

GREEN when battery not connected – Algorithm number

FLASHING YELLOW – Reduced power mode: low AC voltage or high internal charger temperature.

FLASHING RED – Charger error. Reset charger power and see RED LIGHT CHARGER ERROR CODES.

***NOTICE:* Do not disassemble the charger. There are no serviceable parts.**

RED LIGHT CHARGER ERROR CODES

1 Flash

Battery Voltage High: Auto-recover. May be temporary condition, or wrong charger installed, i.e. 36 volt charger on 48 volt battery pack.

2 Flash

Battery Voltage Low: Auto-recover. Confirm each individual batteries minimum voltage with a volt meter. Two or more 6 volt batteries register less than 5.85 volts, or accumulative total pack voltage has been discharged to less than 20% remaining. Vehicle operation will cease until batteries are recharged. See Special Procedure for Excessively Discharged Batteries in this section.

3 Flash

Charge Timeout: The charging did not complete in allowed time, 12-14 hours. This may indicate a battery problem, or that the charger output was reduced due to high ambient temperatures. Disconnect AC supply, confirm sufficient ventilation, allow cool down time, and restart charger.

4 Flash

Check Battery: The batteries could not be trickle charged up to a minimum level to start charger. This may be the result of badly discharged batteries, or one (or more) damaged cells. See Special Procedure in this section.

5 Flash

Over-Temperature: The charger shut down due to high internal temperature. May require reset (AC unplugged) and a cool down to restart charging cycle. This fault may indicate inadequate cooling airflow or high ambient air temperatures. Check for debris or blockage at cooling fi ns. Move the vehicle to a cooler better ventilated area, or adjust time of day when charging.

6 Flash

Delta-Q Charger Fault: An internal fault was detected and charger may need to be checked/replaced by a qualified dealer technician. It may also be the result of badly discharged batteries, or one (or more) damaged cells. A RED 6 FAULT flash must be validated first by testing individual batteries with a voltmeter, and see Special Procedures, before deciding charger has failed.

A Steady Red Fault LED

Confirms an internal electrical fault of the Delta-Q and also requires charger replacement and return.

DETERMINING THE CHARGING ALGORITHM:

1. Ensure the charger is disconnected from AC power source.
2. Disconnect the charger positive cable from the battery pack using a ½" wrench (leave the negative connection intact).
3. To determine the charging algorithm, apply AC power to the charger. The current algorithm # is indicated by the 80% LED light (Figure 8-5 #4). A single digit algorithm # is indicated by the number of blinks separated by a pause. A two digit algorithm # is indicated by the number of blinks for the first digit followed by a short pause, then the number of blinks for the second digit followed by a longer pause.

CHANGING AN ALGORITHM:

1. To change the algorithm, during the 11 second display period, touch the positive connector to the battery pack's positive terminal for 3 seconds and then remove.
2. The algorithm # will advance after 3 seconds. Repeat until the desired algorithm # is displayed. A 30 second timeout is extended for every increment.
3. Incrementing beyond the last algorithm moves back to the first algorithm.
4. After the desired algorithm # is displayed touch the charger connector to the battery positive until the output relay is heard to click (~ 10 seconds). The algorithm is now in permanent memory.
5. Remove AC power from the charger and reconnect the charger positive connector to the battery pack. It is highly recommended to check a newly changed algorithm by repeating the above steps.

QUIQ PROGRAMMING KIT (P/N 70002-12)

See Figure 8-6. This kit can be used to:

- Add a charge algorithm to the charger.
- Select a different default algorithm
- Delete an algorithm from the charger
- View past charging history

NOTICE: The QuiQ software must be installed.

⚠WARNING

Charger outputs greater than VDC pose an energy and/or shock hazard under normal use. Do not energize charger with as until wire assembly clips are securely connected to charger output, and all leads are secured against movement.

The kit contains a USB Interface Module, an installation CD, a USB cable, a wire assembly and instructions.

⚠CAUTION

Ensure that the battery leads from the USB Interface Module are protected from sources of electrostatic discharge that may damage the unit.

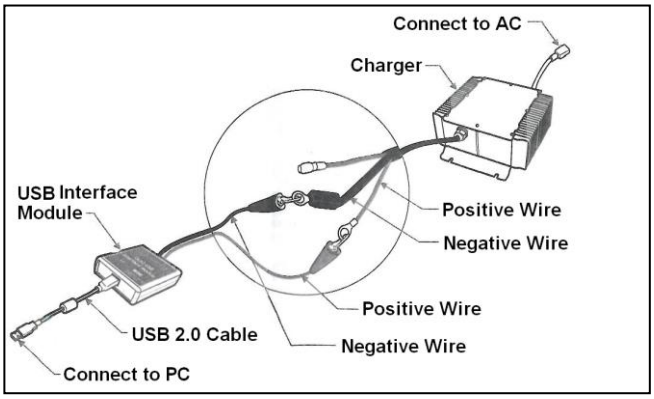


Figure 8-6

To connect to your computer:

- Disconnect AC power from charger.
- Disconnect charger from batteries.
- Connect the wire assembly red clip to the charger red wire (positive).
- Connect the wire assembly black clip to the charger black wire (negative).
- Connect the wire assembly to the Interface Module.
- Connect USB cable upstream to a PC open USB port.
- Connect the USB cable downstream to the module.
- Connect the charger to AC power.

CHARGING PROCEDURE

1. Check electrolyte level in all cells. Add distilled water as necessary to cover tops of plates. Do not over fill, as electrolyte expands during charging.
2. Be sure charger is turned OFF. Insert electrical plug into vehicle's charger receptacle.
3. Charger will start automatically. Check that amp meter rises fully when charger starts. If charger needle only rises to half scale or does not rise at all, check AC outlet for proper power supply or check charger owner's manual for testing and repair information.

BATTERY SPECIFIC GRAVITY TEST

***NOTICE:* Specific Gravity Test information does not apply to sealed batteries.**

It is possible to determine a battery's ability to perform by measuring the specific gravity of each cell with a hydrometer.

The hydrometer readings indicate two things:

- State of Charge - The amount of electrical power stored in the battery.
- Condition - The ability of battery to store and deliver power.

***NOTICE :*Batteries should be fully charged before performing specific gravity tests to determine battery condition. Hydrometer tests of batteries not fully charged are misleading and inconclusive.**

BATTERY HYDROMETER TEST

1. Squeeze rubber bulb and insert nozzle in cell, release bulb, slowly drawing electrolyte up into barrel.
2. Adjust electrolyte level in barrel so float rides free of bottom but is not striking top of barrel.
3. Hold hydrometer vertically, making sure float moves freely and is not contacting sides of barrel. Read scale at the level of electrolyte in the barrel. Record the reading.
4. Return electrolyte to cell from which it was removed.
5. Repeat these steps on all battery cells.

Hydrometer readings are affected by the temperature of the electrolyte being tested. Measure the temperature of the electrolyte, and correct the readings as follows:

Above 80ºF: Add .004 to the specific gravity readings for each 10º above 80ºF (26ºC).

Below 80ºF: Subtract .004 from the specific gravity readings for each 10º below 80ºF (26ºC).

Results Interpretation

State of charge. Check specific gravity of each cell. See Table 2 & 3.

Specific Gravity vs. State of Charge	
SG Reading at 80° F.	**State of Charge**
1.250 – 1.270	100%
1.220 – 1.240	75%
1.190 – 1.210	50%
1.160 – 1.180	25%

Table 2

If the difference between the highest and lowest cell is 0.050 (50 points) or more, the battery is nearing the end of its useful life and should be replaced.
If the highest cell reads less than 1.2, the test for condition is questionable. Recharge the battery and perform the test again.

Specific Gravity vs. Action Required				
	SG Reading			**Action**
Battery	**Cell 1**	**Cell 2**	**Cell 3**	
1	1.100	1.100	1.100	Charge & recheck
2	1.260	1.180	1.250	Cell 2 bad – replace battery
3	1.250	1.260	1.250	Good
4	1.190	1.170	1.120	Charge & recheck Suspect cell 3

Table 3

DISCHARGE (LOAD) TEST

The discharge, or load test, is the recommended method of determining battery condition because it simulates electric vehicle operation under controlled conditions. A 75 amp draw is applied to the battery bank with a Load Tester. The time it takes the battery bank to drop to 31.5 volts, along with individual battery voltages, is used to determine battery condition.

***NOTICE:* Use of automotive type of load tester is not recommended and will offer inaccurate results.**

Use an appropriate volt tester that gives voltage and minutes of discharge.

Test Preparation

The following preparations must be verified before discharged load testing. Should any of the following recommendations not be performed, results of testing will be inaccurate and misleading.

- Batteries must receive a full charge before conducting Discharge (Load) Test.
- Discharge (Load) Test must be performed within 18 hours of charging.
- Vehicle must not be used, even for short runs, prior to Discharge (Load) Test.
- Electrolyte level must be correct in all cells.

Test Procedure

⚠WARNING

Discharge Load Test must be performed in well ventilated area.

1. Connect tester leads to battery bank.
2. Check and record electrolyte temperature of center cell of each battery.
3. Turn tester on.
4. After 20-30 minutes, with tester on, check and record individual battery voltages to the nearest 0.1 (1/10) volt.

All six individual battery voltage readings must be made as rapidly as possible to be accurate.

5. Allow tester to shut off automatically, and record time elapsed from start of discharge.

   Tester shutoff should occur at a battery voltage of 42v +/- 0.2v (48 volt system) or 21v +/- 0.2v (24 volt system). Check tester shutoff voltage periodically. This setting must be accurate for a valid test.

Results Interpretation

1. Compare individual battery voltages recorded in step 4 of *Discharge (Load) Test Procedure* and discard any battery that is 0.2 (2/10) volt lower than the highest battery in bank. If defective battery is found, recharge the entire bank for 12 hours. Then, replace the defective battery with a good fully charged battery of the same brand and date code, if possible. Equalize the bank by placing it on charge for an additional three hours, then retest.
2. If all battery voltages are within 0.2 volts of each other, compare discharge time from step 4 of *Discharge (Load) Test Procedure* with minimum times in Temperature and Time Table.

   Even if individual battery voltages are satisfactory, but the discharge time fails to meet minimums in Temperature and Time table, the entire battery bank should be replaced.

DISCHARGE LOAD TEST: Temperature & Time	
Electrolyte Temperature (Step 2)	Minimum Discharge Time (Step 5)
40-49° F (4-9° C)	40 Minutes
50-59° F (10-15° C)	45 Minutes
60-64° F (16-17° C)	50 Minutes
65-69° F (18-20° C)	54 Minutes
70-74° F (21-23° C)	57 Minutes
75-79° F (24-25° C)	60 Minutes
80-84° F (26-29° C)	62 Minutes
85-89° F (30-32° C)	64 Minutes
90-99° F (33-37° C)	66 Minutes
100-109° F (38-43° C)	68 Minutes
110-119° F (44-48° C)	70 Minutes
120-129° F (49-54° C)	72 Minutes
130-150° F (55-66° C	74 Minutes

Table 4

STORING BATTERIES

- Batteries can remain in vehicle.
- Batteries should be fully charged.
- Clean battery tops and connections.
- Fully charged batteries should be stored in as cold of an environment as possible. Batteries "self discharge" when not in use. The colder the temperature, the slower batteries self discharge.

⚠CAUTION

Batteries in low state of charge (low specific gravity readings) will freeze at higher temperatures than those fully charged.

Check specific gravity periodically, and recharge batteries as necessary. Batteries stored in temperatures above 80ºF (26ºC), will discharge faster and require recharge every few weeks. Batteries stored at or below 0ºF (-12ºC) may not require recharge for periods up to 4 months. When recharging, bring batteries to 1.250-1.270 specific gravity to prevent freezing. See Table 5.

State of Charge	Specific Gravity	F° Freezing point C°		Risk of Sulfation
100%	1.260	-70	-57	Low
75%	1.230	-39	-38	Low
50%	1.200	-16	-26	Low
25%	1.170	-2	-19	Moderate
Discharged	1.110	+17	-8	High

Table 5

As ice forms in a freezing battery, the electrolyte expands and can crack the case, ruining the battery. If a battery is allowed to stand or is operated in a discharged condition for a long period of time, lead sulfate may develop on the plates, which is dense, hard and crystalline, and which cannot be electrochemically converted to normal active material again.

Lead sulfate formed on the plates during discharge is relatively insoluble as long as the specific gravity of electrolyte is kept above 1.125 specific gravity, but if allowed to drop below this value, the lead sulfate becomes increasingly soluble and may migrate into the pores of the separators and deposit as a white crystalline mass.

Subsequent charging may convert these deposits into stringy metallic lead which may short the positive and negative plates through the areas affected. These small shorts may cause a condition of low cell voltage when battery is allowed to stand idle in less than 25% charged condition. See Table 5.

EXCESSIVELY DISCHARGED BATTERIES

NOTICE: **The Delta-Q Automatic Battery Charger will not charge a dead battery. Each battery will need to be brought up to an acceptable state of charge, and establish that it does not have an internal fault or bad cell. If a battery has remained too long in a discharged state, it may be internally damaged and not capable of accepting a charge. It must be replaced.**

If the Delta-Q Battery Charger does not reach the full charging mode, identified by a steady LED in the upper region of the Bar Graph display (18/15/12...), or the RED Fault Light is lit, it may indicate that the minimum voltage is not present to allow the charger to control the charging of the complete set of batteries.

If the electrolyte specific gravity is low (less than 1.140 SG), or the individual battery voltage is less than 10.50 volts for 6 cells, it will need to be recharged with an ordinary automotive style trickle charger at a rate of 3 to 6 amps for several hours each.

Follow specific charger instructions. It is not necessary to disconnect the battery cables, as the alligator style clips can be connected to each positive and negative battery post.

⚠WARNING

Always disconnect the AC power first when moving the positive/negative alligator clips to prevent a spark from igniting the gas emitted from the batteries.

Be sure to charge all of the batteries in the set. Each battery may require 2-3 hours of charging to bring it back to serviceable condition. Measure the Specific Gravity (SG) of each cell after this charging procedure is completed, to verify that the battery is OK for use. Replace any batteries that can not be re-charged (no change or improvement in SG).

After all batteries have been individually charged, and with the temporary automotive charger removed, try operating the Delta-Q Charger again to verify operation. Allow the Delta-Q Charger to complete a full charge cycle for proper equalization of batteries.

If the 6 Flash Fault persists; an internal fault may be present and the charger will need to be replaced by a qualified dealer technician. A STEADY RED FAULT LED confirms an internal electrical fault of the Delta-Q, and also requires charger replacement and return.

REPLACING BATTERIES

Remove batteries by removing the entire pack and battery tray together. Do this by:

1. Jack the entire vehicle up and support it with jackstands as described in *Section 3-Lifting Instructions*.
2. Disconnect the main power cables and charger wires from the battery pack.
3. Place a pallet jack underneath the battery tray.
4. Remove the six bolts (Figure 8-7) holding the tray to the chassis, and lower the battery pack out of the vehicle.
5. Once out of the vehicle, remove the battery hold down bar, the watering system (if equipped) and the positive & negative leads.
6. Reverse to reinstall batteries.

Figure 8-7

REMOVING THE CHARGER

***NOTICE:* The black and white wires are terminated in a thermistor. Take extra care when handling the thermistor.**

1. The charger can be accessed from under the driver's seat. Tilt seat forward to access the panel. Remove panel (Figure 8-8).

Figure 8-8

2. Disconnect 3 wires (Red, Green and Black & White together) in charger output lead from battery B-, battery B+ and wire 14 (Figure 8-9). Unplug power inlet cable from charger pigtail.

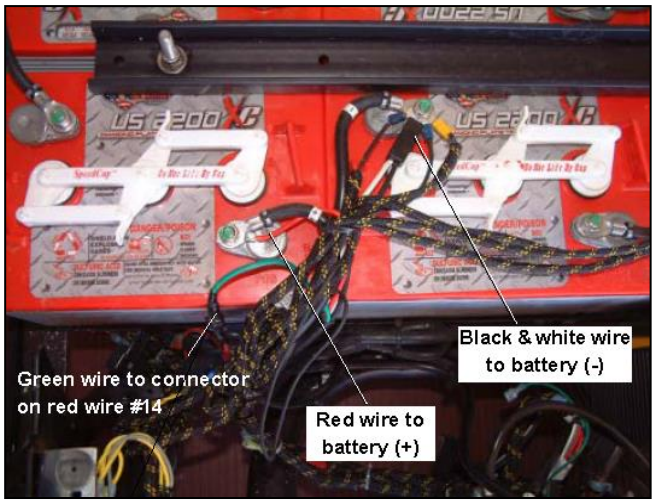


Figure 8-9

3. Remove nuts, washers, bolts and charger (Figure 8-10).

INSTALLING THE CHARGER

1. Position new charger to mounting bracket (Figure 8-10).
2. Secure new charger with four nuts, washers and bolts. Tighten charger attaching hardware.
3. Install charger output electrical leads as follows; black and white to battery B-, red wire to battery B+, green wire to red wire from interlock harness. See Figure 8-9. Plug in cord from power inlet to charger pigtail. Tape the two plugs together so they cannot accidentally separate.
4. Bundle the excess charger output cable and secure it neatly with wire ties.
5. Reconnect battery negative cable. Install Power key.
6. Reinstall access panel (Figure 8-8).
7. Power key ON. Check MDI display.

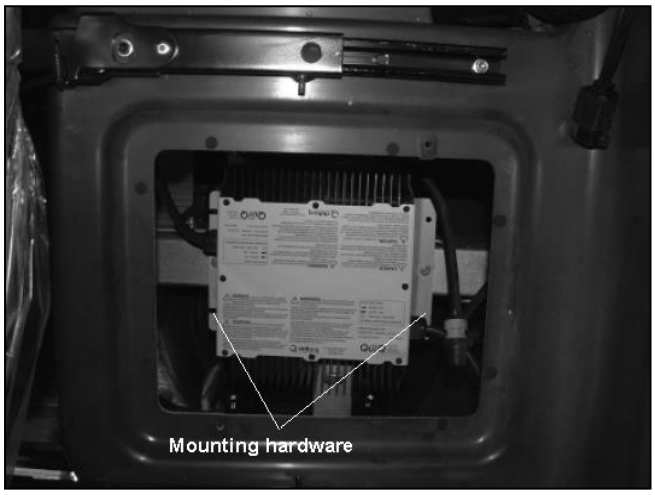


Figure 8-10

REMOVING THE MAIN DISCONNECT SWITCH

To access the Main Disconnect Switch, remove the thumb screws securing cover, and remove cover.

1. Remove the Disconnect Switch positive cable at the battery pack. Cover cable end to prevent accidental contact.
2. Remove the other Disconnect Switch cable (Figure 8-11 A) from the fuse block.
3. Remove the four 4 mm socket head cap screws (Figure 8-11 B) attaching the Disconnect Switch.
4. Note the location for each cable connection.
5. Remove cables from the Disconnect Switch.

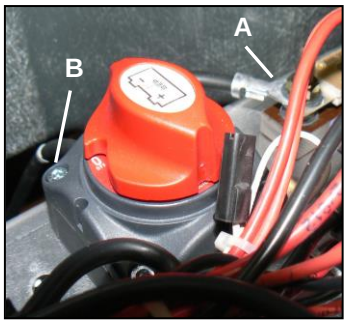


Figure 8-11

Figure 8-12

INSTALLING THE MAIN DISCONNECT SWITCH

1. A Disconnect Switch has a bottom plate, three removable side panels, four 17 mm nuts and two lock washers.
2. Remove the side panels and set aside.
3. See Figure 8-12. With the switch in the ON (green) position, the top of the switch shows the cable connections. The + side receives the battery pack cable and the – side connects to the fuse block.
4. Place a nut on each post and torque to 70 in. lbs.
5. Next put on the appropriate cables, a lock washer and the second nut. Torque the second nut to 70 in. lbs. Run the wires together as shown in Figure 8-11.

⚠WARNING

Before connecting the wires be sure to turn the switch to the OFF (red) position.

6. Replace the three side panels, the bottom plate and install.
7. Connect the wires to the battery pack and fuse block.

REMOVING THE CONTROLLER

The controller is located under the hood. To access the controller, remove the thumb screws securing cover, and remove cover. Refer to *Section 4 - Troubleshooting* for controller.

1. Turn the main disconnect switch counterclockwise to the OFF position.
2. Label/mark controller cables with controller terminal identification, if not already labeled.
3. Remove the 13 mm bolts, lock washers, flat washers and all the cables and wires connected to the controller.
4. Remove 32 pin controller connector and the 8 pin MDI connector.
5. The controller is secured to a mounting plate with 4 four 6 mm nuts, washers and bolts. This plate is secured to the vehicle with 4 additional 6 mm bolts (Figure 8-13 A). Remove these bolts first which will allow the controller and mounting plate to be removed. Remove the 4 mounting plate 6 mm bolts, washers and nuts to release the controller.

***NOTICE*: Do not attempt to disassemble the controller. There are no repairable parts inside.**

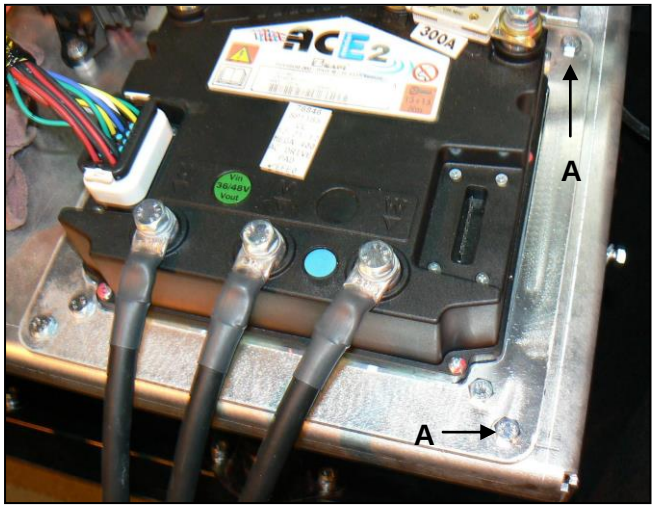


Figure 8-13

INSTALLING THE CONTROLLER

1. Position new controller to the mounting bracket and secure with 6 mm bolts, washers and nuts. Install assembly in vehicle with four 6 mm bolts.
2. Install cables to controller terminals according to Figure 8-14 and to cable identification labels. Make sure there is a flat washer under the terminal ends of the cables. This will spread the load and help prevent the terminal ends from folding over.

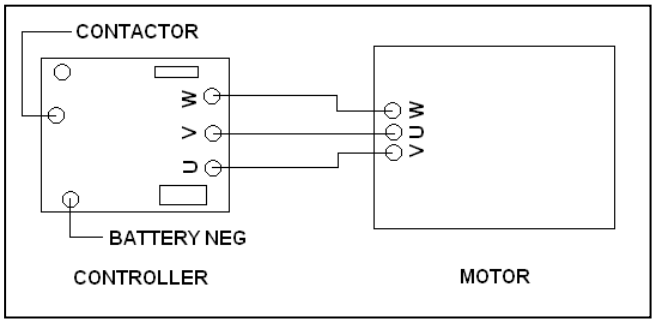


Figure 8-14

3. Use dielectric grease in both multi-pin harness connections.
4. Torque controller cable attaching bolts to 100 in. lbs.
5. Reconnect battery negative cable. Turn the main disconnect switch clockwise to the ON position.
6. In most cases the hours on the MDI gage and the new controller hours will be different. With the vehicle key ON, if there is a difference in the hours, an alarm (AL98) is generated for ***one minute***. During this one minute, a technician can make one of the following choices:
   a. Do nothing to have the controller's hour meter overwrite the MDI hour meter.
   b. To maintain the MDI hour meter reading, turn the vehicle key OFF and disconnect the MDI meter. Plug in the Handset, and set "load HM from MDI" to ON. Save the setting and exit the menu. Reconnect the MDI meter and turn the vehicle key ON. The controller has a primary and secondary hour meter. The secondary meter will be overwritten with the MDI reading. The primary hour meter of the controller will remain unchanged and must be read from the handset.

Once this alarm code stops displaying it is not possible to start over. The MDI will display the time on the controller and cannot be reset.

7. When replacing the controller the accelerator will need to be synchronized with the new controller. This is done with the ZAPI handset or software loaded on a computer. The procedure is outlined in the AC Power System Manual under “How to Use the PROGRAM VACC Function of the Handset”.

   If there is a “TILLER” error or notification, it is because the vehicle has a seat switch and an individual must be sitting in the seat.

8. Perform an operational check of the vehicle’s driving abilities.

MAIN CONTACTOR/SOLENOID

This solenoid is an electro-magnetic switch that energizes when current is applied to the small control circuit terminals. When energized, the solenoid core moves up from magnetism created by the coil and internal contacts, creating a connection between two large terminals, allowing current to pass through the solenoid.

When control circuit voltage is removed from the small terminals, the magnetic field collapses and a spring returns the core to its rest position. A single contact solenoid in the normal position has an open circuit between the large terminals, preventing current from passing through it.

Solenoids are mounted in vertical position. Gravitational pull aids internal spring in returning to normal position.

REMOVING THE MAIN CONTACTOR

1. The contactor/solenoid is located under the hood. To access the controller, remove the thumb screws securing cover, and remove cover.
2. Turn the main disconnect switch counterclockwise to the OFF position.
3. Label contactor cables with terminal identification.. Remove two nuts, washers and cables from stud terminals (Figure 8-15).
4. Remove control circuit wires from spade terminals.
5. Remove two nuts, washers, bolts and contactor.

INSTALLING THE MAIN CONTACTOR

1. Position new contactor to mounting bracket.
2. Secure contactor to mounting plate with two bolts, nuts and washers.
3. Install heavy cables to stud terminals. Install control circuit wires to spade terminal. Double check wiring diagram to ensure connections are correct.
4. Turn the main disconnect switch clockwise to the ON position.
5. Operational Check: Contactor should emit an audible click when the power key switch is set to ON position.

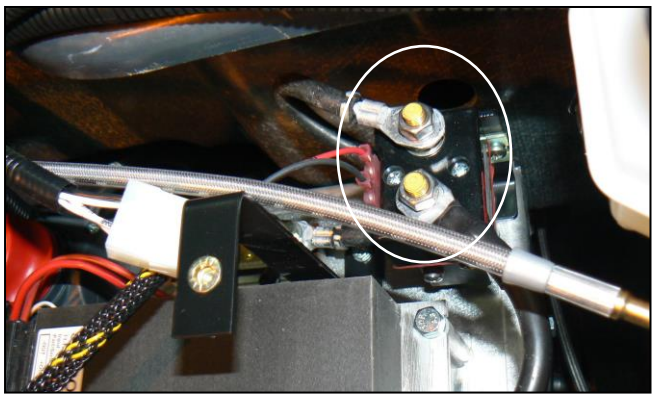


Figure 8-15

⚠ DANGER

Always turn Power key to OFF, Directional selector to NEUTRAL, remove Power key and block tires. Turn the master disconnect switch counterclockwise to the OFF position before servicing or repairing your vehicle

MOTOR MAINTENANCE

A good planned maintenance program will save many hours of future down time and prevent catastrophic failure of major components. Maintenance schedules consist of periodic routine inspections of motors, battery and wiring circuitry.

The following recommendations are suggested for periodic maintenance inspection:

Normal service – 8 hours per day operation

- Routine inspection every 1,000 hours

Severe service – as stated in the below ***NOTICE***.

- Routine inspection every 500 hours

***NOTICE*: Severe service would include; Dusty or sandy locations such as cement plant, lumber or flour mills, coal dust or stone-crushing areas. High temperature areas such as steel mills, foundries, etc. Sudden temperature changes such as continuous in-door-outdoor movement, as in refrigeration plants.**

EXTERNAL MOTOR INSPECTION

1. Check for clean, tight, terminal studs and mounting bolts.
2. Internal and external spline drives, between motor and final drive axle, must be periodically lubricated with a thin layer of quality, anti-seize compound.
3. Check for any signs of oil leaks from final drive axle, which might cause oil to enter traction motor.

REMOVING THE MOTOR

***NOTICE*: Studs and jam nuts on the electric motor can be damaged when attaching or removing electrical leads. Hold a thin open end wrench on the electrical stud connector jam nut while loosening or tightening attaching nuts.**

1. Remove front, right hand wheel assembly, the lower panel and the inspection plate.
2. Mark traction motor cables (if not already marked), with motor terminal identification. Figure 9-1 shows the motor /controller connections.
3. Use 13 mm wrenches to remove cables hex nuts and washers.
4. Remove hardware securing motor to frame.
5. Carefully support motor to prevent it from falling, and loosen and remove six bolts, lock washers and flat washers securing motor to axle/differential housing. Pull motor away from rear axle housing and lift it clear of the vehicle.

⚠ CAUTION

Traction motor weighs 85 lbs. and awkward to move. Get help stabilizing and lifting motor to prevent possible personal injury.

INSTALLING THE MOTOR

1. Coat open end of the spline and rear axle input shaft with Anti-Seize compound. Place motor into vehicle and onto input shaft.
2. Rotate motor to align mounting bolt holes to axle/differential housing. Install the 6 bolts lock and flat washer securing motor to axle/differential housing, while carefully supporting motor to prevent it from falling. Torque bolts to 100 in. lbs.
3. Secure motor to frame with hardware.
4. Inspect electrical system cables for terminal identification. Position cables to traction motor, double checking wiring to ensure connections are correct.
5. Install inspection plate, lower panel and front, right hand wheel assembly.
6. Attach motor cables with flat washers and hex nuts. Torque motor cable attaching nuts to 100 in. lbs. while holding the bottom nut, with a thin open-end wrench.
7. Place vehicle on the ground or onto dynomometer to test motor operation.

⚠ CAUTION

Do not run motor at full voltage without a load.

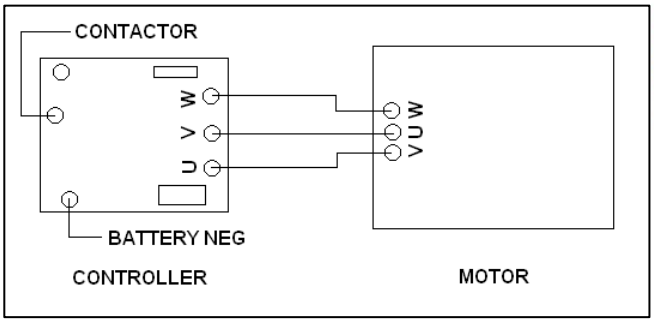


Figure 9-1